ANNUAL REPORT 1989

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JOINT RESEARCH CENTRE

COMMISSION OF THE EUROPEAN COMMUNITIES

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Message from Vice-President Pandolfi

The year 1989 has been a particularly important one for the Joint Research Centre in that the new structure comprising eight research institutes dedicated to particular disciplines has begun to function well.

Following this extensive reorganisation, considerable efforts have been made to establish the new institutes both as scientific centres of excellence and by the implementation of multiple links with the outside world to assure their place on the Community scientific scene. In this respect, one should note the steady increase in visiting scientists and research fellows, and the growing number of agreements established with other institutes and organisations in the Community. An important contribution is the stress placed upon carrying out work under contract for industry and government departments.

At the same time, I am pleased to see other Commission services making increasing use of JRC expertise and facilities in support of Commission policies ranging from agriculture to transport and from energy to aid for developing countries. Special mention should be made of exploratory research and its role in ensuring scientific vitality among researchers and developing new skills. It is an important factor in keeping our Institutes up-to-date and provides a spin-off into future activities by pre-assessing research of potential future promise.

I am happy to see the Centre as a whole giving satisfaction to our Member States in performing its tasks within specific programmes of the Multiannual Framework Programme for Community Activities in the Field of Research and Technological Development.

Finally, I must thank the Board of Governors and its Chairman, Sir John Kendrew, for their sterling work on our behalf. Their statements and advice given during the year have helped us in both the management of the JRC and the provision of a well-balanced service to the European Community.

F.M. Pandolfi

Filippo Maria Pandolfi
Vice-President of the Commission of the European Communities

Foreword

During 1989 the thoroughgoing reform of the Joint Research Centre, which had been authorized in 1988, was largely implemented. The new structure is having a positive impact on all areas of the Centre's work and the Board of Governors looks forward to further stages in the process of reorganization.

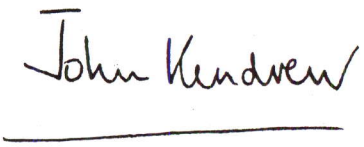
The Board recognises the progress achieved in the execution of the Specific Research Programmes, and in particular the effort made by the Centre to associate national laboratories and universities with its activities. The participation of the JRC in an increasing number of EUREKA projects has also made a good start and the Board hopes that the number of these initiatives will continue to grow in the future.

The Board also welcomes the increasing volume of the activities which the JRC carries out in scientific and technical support of the various Directorates-General of the Commission; this evolution should steadily enhance the JRC's scientific role in the formulation and implementation of the European Community's policies, notably in connection with those for energy, agriculture and the environment, and also in the setting up of technical regulations.

The noticeable increase in research and development performed by the JRC at the request of external clients is an indication of its ability to satisfy many current scientific and technical needs. The Board hopes that arrangements to expedite the carrying-out of this work will bear fruit. At the same time, the Board is impressed by the successful efforts of the staff and of the JRC management in fostering this activity and hopes that their success will be sustained during the coming years.

The Board hopes to see the initial contacts with representatives of the European Parliament prosper and in future extend to other Community institutions.

During the year, the Board enjoyed excellent contacts with On. F.M. Pandolfi, the Vice-President of the Commission responsible for the JRC; his guidance and interest have been much appreciated.



Sir John Kendrew
Chairman of the Board of Governors

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1989: IMPLEMENTING THE NEW STRUCTURE

The year 1989 was characterised by a further implementation of the profound and penetrating reform of the Joint Research Centre (JRC) decided during the previous year.

However, any modern research organisation must be constantly on the move, and have its ears and eyes open for the trends ahead and be prepared for pacesetting decisions for the future. This applies notably to an organisation like the JRC which serves the entire European Community. Thus 1989 also saw the first new signs along the path of the medium term future with the Commission's proposal for a new Framework Programme for Community activities in research and technological development 1990-1994, and the discussion of this plan in the Community Institutions during the Autumn of the year leading to a common orientation of the Council in December.

Nevertheless, at the working level within the JRC, throughout the scientific institutes in which the scientific/technical forces were concentrated in the 1988 reorganisation and in the support and planning units, the chief concern was to strive further towards the objectives set for the JRC in the 1988-1991 period which were decided in 1988. For any particular year, and thus for the year of this report, the goals under the multiannual plan are expressed through an annual working plan decided with the Board of Governors and progress was monitored throughout the year by the Board.

It is recalled that 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, which will be reduced to 70% of the total JRC activities over the 4 years;
- **exploratory research** - a new feature to ensure future scientific vitality, which will represents 4% of the JRC activities (or 5% of the JRC specific research programmes);
- **scientific and technical support for the Commission** - a task carried out at limited level in the past, which will be significantly increased to represent 12% of the JRC activities over the four years; and
- **work for external third parties** - again a new task which should represent 14% of the global JRC activities over the four years.

The main achievements in 1989 which contribute towards the objectives of the specific research programmes are of course multifaced and are described in the following chapters of this report. The scientific quality of the work which helps to develop further the scientific excellence of the Community's own laboratories is a strong concern in the programme execution, but it is not the only concern. Equally strong attention is continuously paid to other horizontal approaches, such as the dissemination of the results of the work and their ultimate application. Moreover through strong promotion of collaborations and associations with other Laboratories, the JRC contributes to the scientific and technological cohesion of the Community.

The current research is result oriented and 1989 has brought an increasing number of projects for transforming the outcome of JRC research into products which can be licensed to interested parties. In addition to normal scientific publishing, results have been made available specifically as scientific-technical know-how to be used in setting new norms and standards as well as codes of practice. This underlines the prenormative dimension of JRC research. In

several cases the research has lead to conclusions and results which being used, as a scientific base, for work performed upon request from other Directorate Generals of the Commission.

The successful conclusion of the earlier research programme on Radiation Environment Monitoring is but one example of scientific excellence with good applicability from 1989.

There is in the JRC stock of research programmes provisions for specific contributions to overall European efforts in particular fields. A typical example is the JRC work on Thermonuclear Fusion Technology and Safety where there has been a clear fulfilment of the demand from the European Fusion Programme for the year.

The progress on the execution of the specific research programmes has contributed to the scientific excellence not only of the Centre but also to that of other laboratories. During 1989 the JRC has entered into a further number of collaborative and associative arrangements with national laboratories, notably in the fields of Advanced Materials and Reliability of Structures. Throughout the 1989 report there are references to progress made during the year concerning association schemes set up last year or earlier. Clearly, the JRC's central role as the Commissions' own research laboratories is increasingly recognised. In this respect the JRC is beginning to act as a European federating catalyst for many research matters. There has also been a strong participation in an increasing number of EUREKA projects by many of the Institutes.

Certainly the scientific competence of a research organisation has many aspects. It is reflected in the ability and qualifications of the staff; the way in which the work is organised and the tools and equipment available for the work. The overall 1988-1991 programmes called for some novel major installations, deemed of common interest for the Community, to be constructed. The Board of Governors has taken a particular interest in the planning and installation of the new facilities and has monitored these proposals from an early stage in order to ensure that working plans are produced for the effective utilisation of the new installations. In this respect they have also reviewed the existing major installations of the Centre. A special chapter of this report provides a summary account of these aspects.

The JRC's work in support of other Commission services continues to exhibit strong customer demand. In fact the demand now exceeds the agreed financial target for 1989. There has been a welcome increase in multiannual agreements with some customer Directorate Generals of the Commission and a shift towards major projects.

The exploratory research projects are proving of great value in building up new competences and opening new avenues for future programmes. The Board of Governors has agreed to the continuation of a number of projects started in 1988 and has also accepted four new proposals. The Boron Neutron Capture Therapy work at Petten and Ispra is a particularly important example of the benefits of the exploratory research programme. This project, which is concerned with the treatment of particular tumours, involves a number of Commission services and Member State laboratories and if successful could represent a new and valuable use for the Petten High Flux Reactor.

The JRC's work for Third Parties also continues to give satisfaction in terms of scientific and technical activity, not only to those customers who have benefited

from the work carried out on their behalf but also to those of the JRC's scientific and technical staff who have been involved in this new task. The order book grows satisfactorily but its implementation displays some delay: new commercial attitudes and skills have to be acquired and this is taking time. A vigorous effort will be conducted to make further progress in this competitive field. Major and minor industrial companies are represented in the list of customers as well as a Member State government departments and institutions from outside the Community. The legal basis for this work was consolidated by the Council in May 1989.

The Institutes continue to develop their individual characteristics and capabilities to meet the challenges set by the Framework Programme and the various customers for their services. Dr. R.W. Witty, has been appointed as Director of the Systems Engineering Institute* and Mr. H. Hannaert as Director of Administration, this contributing to the consolidation of the new structure.

One of the important aspects of the new policy for the revitalised JRC was the policy decision to increase the number of visiting scientists and research fellows working in the Centre, to encourage seconded staff from Member State institutions and to promote increased staff mobility. In all these areas there has been considerable progress. The number of JRC Visiting Scientists and Fellows has increased and the new concept of seconded experts from national bodies has given raise to award a dozen such arrangements. It is our intention to steadily increase the quality of the visitors so as to maximise the value from their presence. Finally, staff mobility is increasing and this is also helping to create a more lively scientific atmosphere.

The Council approved the special measures for early retirement during 1989 and it is expected that 100 officials will leave before the end of February 1990 thus liberating posts for increased recruitment of younger scientists, allowing for a better adaptation to the present needs in scientific expertise.

The good relations between the JRC as a Commission service and the Council, the European Parliament and the Economic and Social Committee, which are so essential during a period of change, have been consolidated during the year through many high-level contacts and presentations to these bodies.

The new scientific advisory committee structure for the Institutes is still being established. One committee (Safety Technology Institute) is now operational and one expects the remainder to be set up during 1990. In the meantime the JRC continues an active and useful dialogue with the relevant Advisory Committees on Management and Coordination or committees with a similar function. However the most important committee by far for the JRC remains the Board of Governors. The Board, which has created sub-committees amongst itself on staff and finance, scientific/technical matters and programmes and exploratory research, has been unstinting with its time and has provided most valuable help and guidance throughout this testing year to the Director General and his senior staff.

Clearly 1988 was a difficult year for the JRC with the establishment of a completely new institutional structure and the adoption of a new programme. However 1989 was no less challenging as all the changes agreed in the previous year were implemented and first evaluations were obtained. According to the JRC programme decision a mid-term evaluation was required in 1989 and the evaluation panel, ably chaired by Dr. H. Beckers, was asked

to make a first assessment of the impact of the JRC reorganisation. This report, made available in December 1989, has been further analysed and commented on by the Board of Governors. Both documents note favourably the progress made by the JRC up to now and are optimistic about further improvements. These documents have been transmitted by the Commission, to the Council and the Parliament.

The Commission and the Director General gratefully acknowledges all the invaluable advice it has received during the year from the Board of Governors, from other Community Institutions, the Evaluation Panel and from many other bodies and individuals. However, as always, the effective implementation of programmes, no matter how well advised, depends on a dedicated and enthusiastic staff. It is their efforts at all levels which must be acknowledged in reporting the progress made during 1989.

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* Which has been userged early in 1990 with the Centre for Information Technologies and Electronics into the Institute for System Engineering and Informatics

JRC ANNUAL REPORT 1989

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 up new avenues and to maintain scientific excellence.

and as it enhances scientific cohesion within the Community by participating in EUREKA projects and by grouping scientific resources under schemes as Associated Laboratories in well specified scientific topics.

The JRC specific research programmes are concentrated mainly on three major topics:

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

Other studies are related to information technologies and electronics and to prospective technology assessments.

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 harmonisation of reference methodologies and materials. The CBNM executes the programme on Nuclear Measurements and Reference Materials.

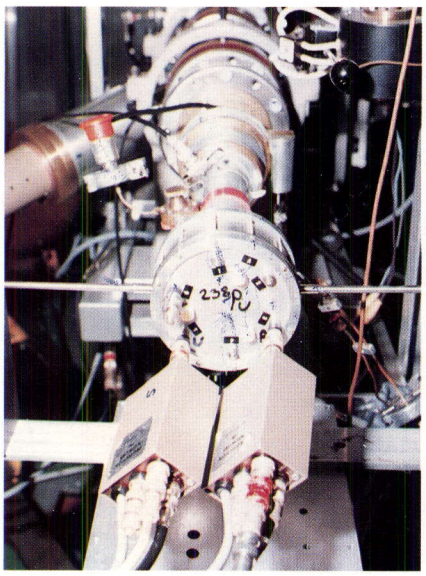


Figure 1: Close up of a measuring station for an experiment at the 7 MV Van de Graaff accelerator.

Nuclear Measurements

Nuclear measurements have been carried out on the basis of the needs collated by international organisations such as IAEA, NEA, BIPM; some are performed at the request of national institutions.

In a wide experimental effort the standard neutron spectrum of the spontaneous fission of ^{252}Cf has been studied in great detail in the ''cold'' fission region.

High resolution α-particle spectrometry has been applied to determine α-particle emission probabilities to better than 0.5% for major transitions in some plutonium isotopes.

Measurements of η for ^{235}U have been extended to the subthermal energy region and with an accuracy between 0.5 to 1% for η values in the energy range from 2 to 100 meV.

In extension of earlier studies, the subthermal fission of ^{241}Pu has been measured. First results suggest that the Westcott factor gf(T) at 20.44 °C is about 1% lower than evaluated elsewhere.

Neutron capture measurements were performed on request of the international Task Force, set up in 1983 by NEANDC (Nuclear Energy Agency's Nuclear Data Committee) to solve the discrepancy between results of capture and those of transmission measurements for the important 1.15 keV resonance in ^{56}Fe

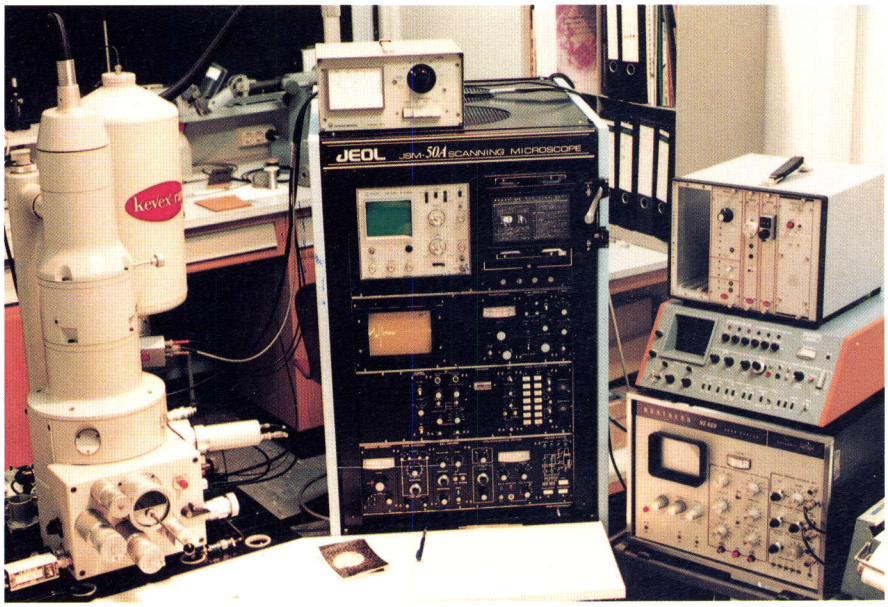


Figure 2: Laboratory configuration for Scanning Electron Microscopy.

(Participant laboratories are: ORNL (USA), AERE (GB) and JAERI (J) and the CBNM (EUR)). Results have revealed a new width of this resonance of $\Gamma n = (69.2 + 2.1)$meV in close agreement with values obtained from transmission experiments; the discrepancy between capture and transmission results are thus eliminated.

Reference Materials

High quality nuclear reference materials have been prepared, characterized and certified at CBNM; they are used to guarantee European independence in the field 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.

High purity plutonium dioxide has been characterised.

Work on establishing plutonium reference materials for gamma-ray spectrometry with ^{239}Pu-mass abundances from 60 to 98% is continuing.

Synthetic mixtures of enriched plutonium isotopes have been prepared with ^{239}Pu/^{242}Pu ratios between 0.1 and 10, similar to previous work with uranium.

Satisfactory progress has been made with the certification of spike Reference Materials of ^{233}U and ^{239}, ^{242}, ^{244}Pu.

An increasing number of reactor neutron dosimetry Reference Materials have been made available although not all of them have been officially certified.

The first phase of the Si project for the redetermination of the Avogadro Constant has been finalised in collaboration with the Physikalisch Technische Bundesanstalt, Braunschweig, Germany resulting in the new value NA = (6.022 134 + 0.000 006)10^{23} mol-1, reducing the uncertainty from two to one ppm.

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. Under the same objective the Institute also contributes to the execution of the Radioactive Waste Management Programme.

Basic Safety Research on Nuclear Fuels

A comprehensive investigation is being performed on processes and mechanisms occurring in LWR fuels up to very high burn-ups (i.e. 60 GWd/t). For this purpose, well planned laboratory experiments to provide basic fuel data are complemented with the results of specially designed irradiation experiments, and the combined results are then used to develop and validate computer codes which should predict the fuel behaviour over a wide range of operational conditions (normal, transient, and accidental).

In 1989, fuel samples which had been base-irradiated to about 4.5% burn-up and then transient tested to around 41 kW/m in the frame of an international cooperation (International Fission Gas Release Project Risø III), were subjected to electron microscopic and electron microprobe analysis. The same type of examination was applied to irradiated LWR fuel pins containing small amounts of plutonium (MOX fuel).

Evidence was obtained about the mechanisms of reactor melt down and the core temperature reached during the accident from an examination of samples extracted from the melted-down core of the TMI-2 reactor.

The thermal conductivity of molten UO_2 was remeasured (confirming previous results obtained in this laboratory). An apparatus for measuring the specific heat of acoustically levitated fuel samples up to very high temperatures (in the solid and the molten state) was further improved. The spectral emissivity of UO_2 was measured up to 4000 K and attempts are under way to provide a theoretical basis for the observations.

The TRANSURANUS fuel pin code has been further improved and applied to the interpretation of the Risø III experiments and, in combination with the FUTURE code developed at the Institute, to the modelling of fission gas release.

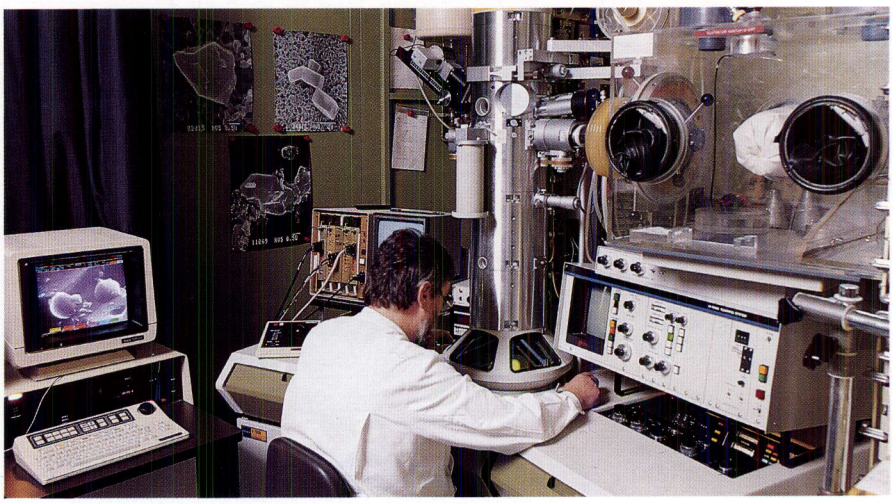


Figure 3: Hitachi H700HST electron microscope equipped for the investigation of irradiated fuel samples.

Safety Aspects of Fuel Operation and Handling

The basic studies on the development of porous nitride fuel with a high thermal stability at a specified material density of 80 to 85% TD were continued. By varying the consolidation procedure, a very promising reaction product was obtained which is being tested between 1875 and 2400 K both under isothermal conditions and in an applied radial temperature gradient.

The study of the release of simulated radioactive aerosols from a glove box fire was continued with the installation of a cascade impactor into the fire test chamber. The results of these studies will contribute to an evaluation of the risk of contamination originating from a fire in a nuclear installation.

The resuspension mechanisms of radioactive dust particles was investigated with uranium-plutonium oxide particles in a glove box. Earlier findings, that at most 2% of the inventory of radioactive particles can be expected to be transported to the ventilation ducting of a room in which a glove box fire occurs, were confirmed.

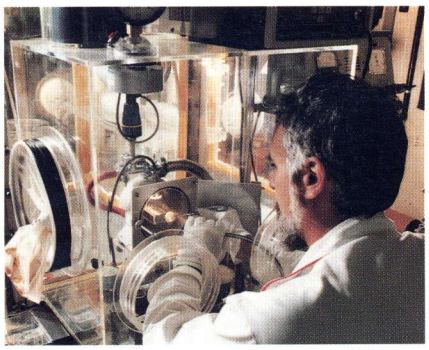


Figure 4: Radiochemistry: Preparation box for α and γ spectroscopy carried out in support of reprocessing studies.

Actinide Determination and Recycling

It was demonstrated that inductively-coupled plasma mass spectrometry is an appropriate technique for the analysis of Np concentrations in the 100 ppb range. The technique was used to measure Np concentrations in fuel samples discharged from the KNK fast test reactor prototype of the German Nuclear Research Centre (Karlsruhe), an experiment which has been set up to study the in-pile behaviour of minor-actinide containing fuel.

The fast flux experiment SUPERFACT, designed to study the in-pile behaviour of minor actinide containing fuel and carried out in the PHENIX reactor, is currently awaiting analysis in the Institute's hot cells.

The study of the coupling of light water reactors and fast reactors to the transuranium element fuel cycle has shown that the quantity of α-bearing waste and consequently its long term hazards can be reduced, by a factor of at least 200, when all transuranium elements are recycled.

Characterisation of Waste Forms and High Burn-Up Fuels (Programme on Radioactive Waste Management)

The objective of studies on the characterisation of nuclear waste forms is to assess the thermal and mechanical stability of unprocessed spent fuels and of high level vitrified waste under long-term storage conditions. Measurements of the radioactive nuclide inventory, determination of the redistribution of actinides and fission products, performance of leach tests with various leachant compositions and investigations into the effects of radiation damage on the long-term storage behaviour of the waste material are carried out.

Unirradiated fuel samples have been subjected to leach tests and the surface of these samples was analysed by Rutherford back scattering and channelling techniques. The hydrogen take up at the surface was measured by elastic recoil detection analysis. The results indicated that at 200 °C thick layers of hydrated UO_3 had formed on the surface of the samples. Similar measurements are being performed on UO_2 fuel samples with simulated burn-up.

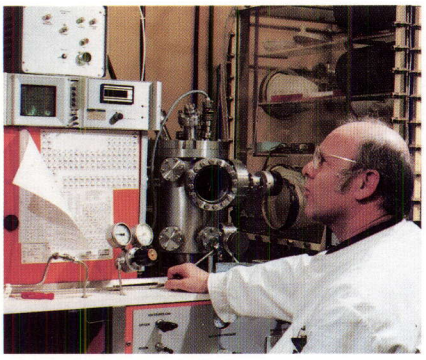


Figure 5: Installation for diffusion measurements in nuclear fuel samples.

Leach tests with **spent UO_2 and MOX fuel specimens** have been conducted by means of Soxhlet extractors over periods of 7, 30 and 100 days. The results of these experiments will help in the understanding and quantification of the various processes affecting the stability of fuel during long-term storage.

The long-term storage behaviour of **vitrified waste** has been investigate by studying the effects of alpha radiation damage in ^{244}Cm doped glasses; it has been observed that radiation damage significantly increased the fracture toughness of the glasses. This is thus a positive effect of irradiation which will render the glass more robust towards alteration with time.

Actinide Research

The central objective of actinide research at the Institute, as well as in its numerous collaborations, is the elucidation of the electronic structure of actinide metals and actinide compounds, in particular of the behaviour of the 5f electrons. The dualism between localised and itinerant characteristics which is particularly clear for the actinide series, is a key problem in these studies.

These goals are approached by both experiment and theory. An important basis for the experimental study is the preparation of polycrystalline and single crystal samples of actinides of high specific activity, and their careful characterisation.

As in previous years, the preparation of chemically pure, single phase, and well characterised compounds of actinides of high specific activity was a basis for solid state physics work at the Institute and in a wide variety of collaborations with external laboratories. The accent in 1989 was on ternary compounds of neptunium or plutonium with silicon or germanium, with a transition metal as the third component. Twenty eight of these compounds were prepared and crystallographically characterised for the first time.

Theoretical calculations have been performed which demonstrate that the properties of the last element in the actinide series (lawrencium) are not those of a simple metal, as expected, but that this material behaves like a transition metal.

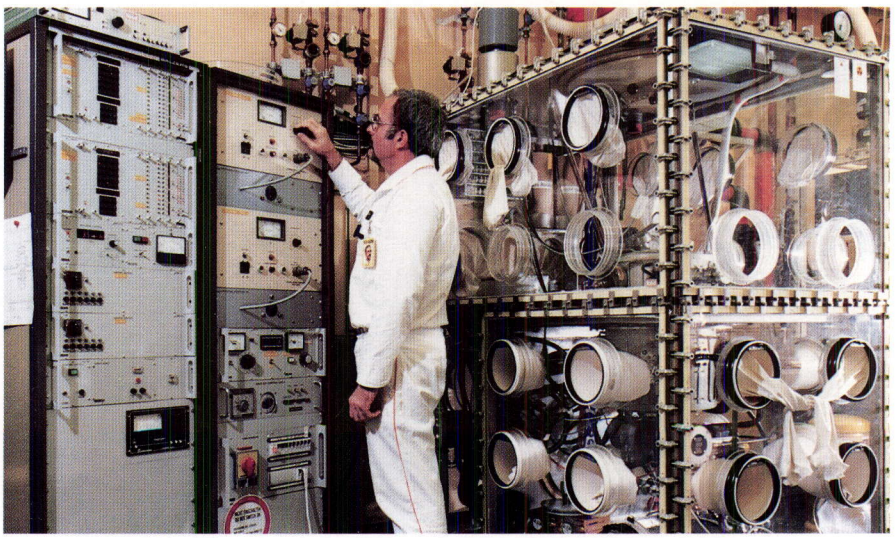


Figure 6: Instrumentation for XPS/UPS facility used in photoelectron spectroscopy in support of basic actinide research.

New high-pressure phases were found for PuSe, U(P,S) and the dioxides ThO_2 and PuO_2.

The phase relations diagram for the lanthanide metals was completed by a high-pressure study of promethium, the only rare earth metal which had not been studied under pressure.

Work continued on the complex low-temperature phase transitions in alpha uranium.

A new technique employing highly energetic x-radiation from synchrotrons (at Daresbury, UK, and Brookhaven, USA) was used for the first time to study the magnetic properties of UO_2.

The Institute for Advanced Materials

1989 has been a year of consolidation of the specific research activities of the Institute for Advanced Materials, which executes the programme on Advanced Materials along the vectors defined earlier and represented in the work of the operational units: Functional Materials; Materials Processing and Engineering; Characterisation; Performance and Reliability; Non-Destructive Evaluation and Testing. The last two of these units are also contributing to the realisation of the Nuclear Reactor Safety programme and of the Fusion Technology and Safety programme.

The Surface Modification Laboratory in Ispra is now operational: with a combination of a 200 KEV Ion Implanter, a 5KW laser, plasma spray, sputter spray, surface analysis as well as property testing equipment, it now constitutes a unique, highly integrated assembly for the dedicated study of ion/photon/electron treatments of surfaces.

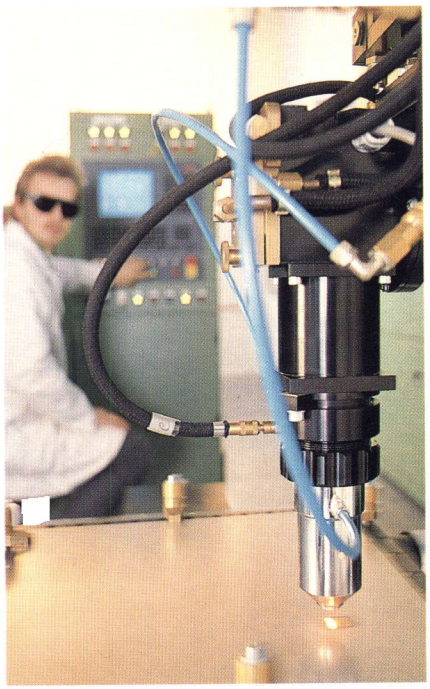


Figure 7: Surface modification by laser treatment: a close-up view of the 5 kW CO_2 laser beam line exit with welding adaptor.

Protective coatings for advanced materials components, such as those provided by plasma assisted techniques and chemical vapour deposition have a rapidly growing industrial value. In recognition of future European interests and needs, a Protective Coatings Technology laboratory is being installed in Petten in a Joint Venture with ECN (the Dutch national energy research centre) and as part of a programme to investigate the science of coating protection and also to supply a technological service to European industry.

Particular attention has been paid to creating close project coordination between the two geographically separated parts of the Institute. Already there are good signs of progress in several specific project areas which benefit through complementary expertise.

New materials having specific electrical and chemical functions are a targetted area for study in this Institute, in close collaboration with external Associated Laboratories, in this case, with the group ''Milano Ricerche''. Here, an interesting development has been the taking out of a patent for the innovation of a long life sensor in which a cermet of noble metals (Pt, Au) and nonstoichiometric oxides (CeO_{2+x}) forms the electrode of an electromechanical solid state oxygen sensor. Such an electrode has two advantages, a long duration, (many times greater than that of the conventional porous platinum electrode), due to the absence of poisoning effects in complex gaseous atmospheres. In addition, it covers in a single device continuously the whole range of oxygen pressures detectable in industry (from 10^{-20}atm to more than 1atm).

Figure 8: Mounting a sample into the SAM (Scanning Auger Microscope) preparation chamber for surface materials studies.

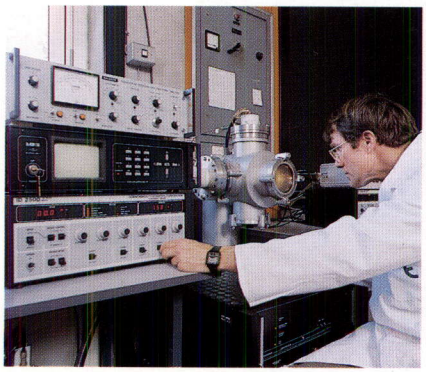
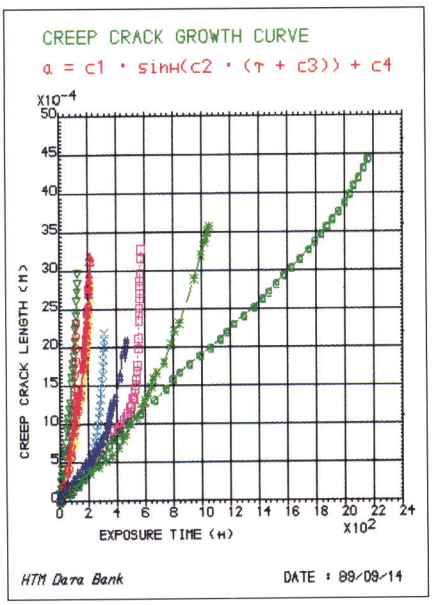


Figure 9: A dual ion beam sputter device used in surface materials studies.

The High Temperature Materials Databank has been redeveloped, following a revision of its field definition structure and vocabulary. The mature system is now ready for services for external users, and some have already participated at training sessions. The access conditions have greatly improved through user-friendly front-end software which is distributed on diskettes for the personal computers of users.

The important features of progress in the individual projects, may be summarized as follow:

- in connection with **corrosion** studies, it is now possible to study reactions in agressive environments using a hot stage (up to 1500 °C) optical microscope with environmental chamber. Kinetic and mechanistic studies have been carried out on a range of alloys, superalloys and engineering ceramics in gaseous and hot salt atmospheres of relevance to a range of industries. These laboratory studies have been validated by monitoring in-plant exposures. The mechanistic understanding of materials degradation forms the basis for failure analysis, lifetime prediction and provides recommendations for new materials developments:



POOL NO.	SYMB.	REF. NO.	TEMP. (C)	STRESS (MPa)	MATERIAL
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1	▽	6030301	550	46	ALLOY 800
1	+	6030401	550	38	ALLOY 800
1	X	6030501	550	36	ALLOY 800
1	□	6030601	550	39	ALLOY 800
1	◇	6030701	550	43	ALLOY 800
1	○	6031101	550	35	ALLOY 800
2	✳	6030801	700	17	ALLOY 800
2	⊠	6030901	700	16	ALLOY 800
2	#	6031001	700	13	ALLOY 800

POOL NO.	LINE STYLE	METHOD
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2	———	SPLINE
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2	- - - -	ANALYSIS

Figure 10: Creep crack growth curves with model of spline fits produced by the HTM-databank.

- the study of **thermomechanical fatigue** is a strong feature of the work of this Institute. The effect of diffusion coatings on the resistance to thermal and strain cycling of single-crystal superalloys for turbine applications has been investigated. A deleterious phenomenon has been observed, namely cracks in the coating facilitate crack nucleation in the bulk of the alloy. A way of representing thermomechanical fatigue data for design purposes has been implemented.
- an important mechanism for degradation of high temperature alloys is that due to **corrosion/creep interactions**. Rare-earth coatings offer an economical way of protecting these alloys from corrosion in industrial atmospheres. This project on creep-corrosion synergisms has demonstrated that this protection is compromised by the presence of mechanical stress, load cycling and thermal cycling. Observation shows that cerium applied as an alloying addition retains protection better than surface coatings.
- in connection with **component testing**, in-situ measurements of longtitudinal cracks propagating in through-wall direction under multiaxial stress in tubes of alloy 800H have been used to develop a fracture prediction procedure. This enables lifetime and rupture stress predictions to be made on the basis of conventional creep crack growth test data.
- **pre-normative materials research** is implicit in many of the Institute programmes: there is an awareness that the increasing complexity of new technologies has created a need for defining new service-relevant testing methodologies, as in mechanical property and corrosion testing of alloy ceramics. Particular developments are in the field of uniaxial tensile testing of ceramics; fatigue and thermomechanical fatigue testing of metals; hot corrosion of ceramics, and in standardised multiaxial stress testing for which a draft code of practice is being launched spearheaded by this Institute and in collaboration with other laboratories.

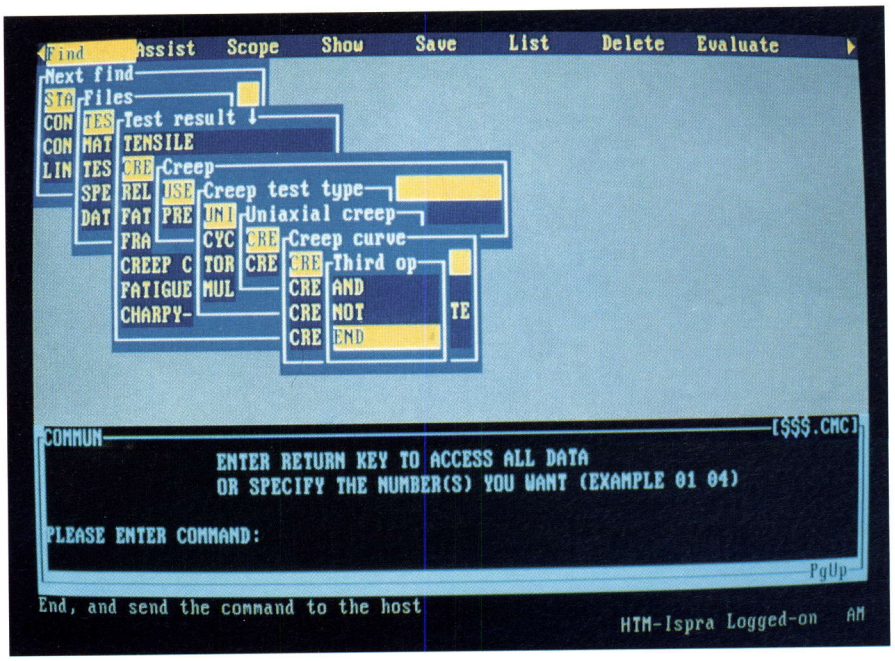


Figure 11: Window display of an HTM-databank query as generated by the PC front end.

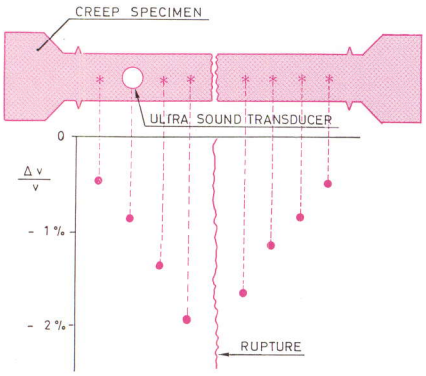


Figure 12: Reduction of ultrasonic velocity owing to creep damage in a ruptural specimen (Material AMCR0033)

- for the **development of NDE methods for the in-situ study** of materials deformation processes, the feasibility of an ultra-sonic technique is being tested. Here, extended sound velocity measurements on austenitic stainless steels loaded in the thermal creep regime have shown that it is possible to follow the formation of grain boundary cracks through the modification of the sound velocity and supported by metallographic analysis of the cracks. Theoretical evaluations of the creep damage have been used to underpin the measurements and these are guiding the further development of this potentially important technique.

The Institute is responsible for the technical secretariat of the two COST projects:

COST 501 - Advanced Materials for Power Engineering. This is a large concerted action programme into which 13 European countries plus the JRC are contributing a total of over 500 man years effort.

COST 505 - Materials for Steam Turbines. This is a programme with 9 European member countries plus the JRC of about 100 man year effort. COST 505 concludes its programme at the end of 1989. A Status seminar was held at Petten from which a number of assessment reports are currently in preparation.

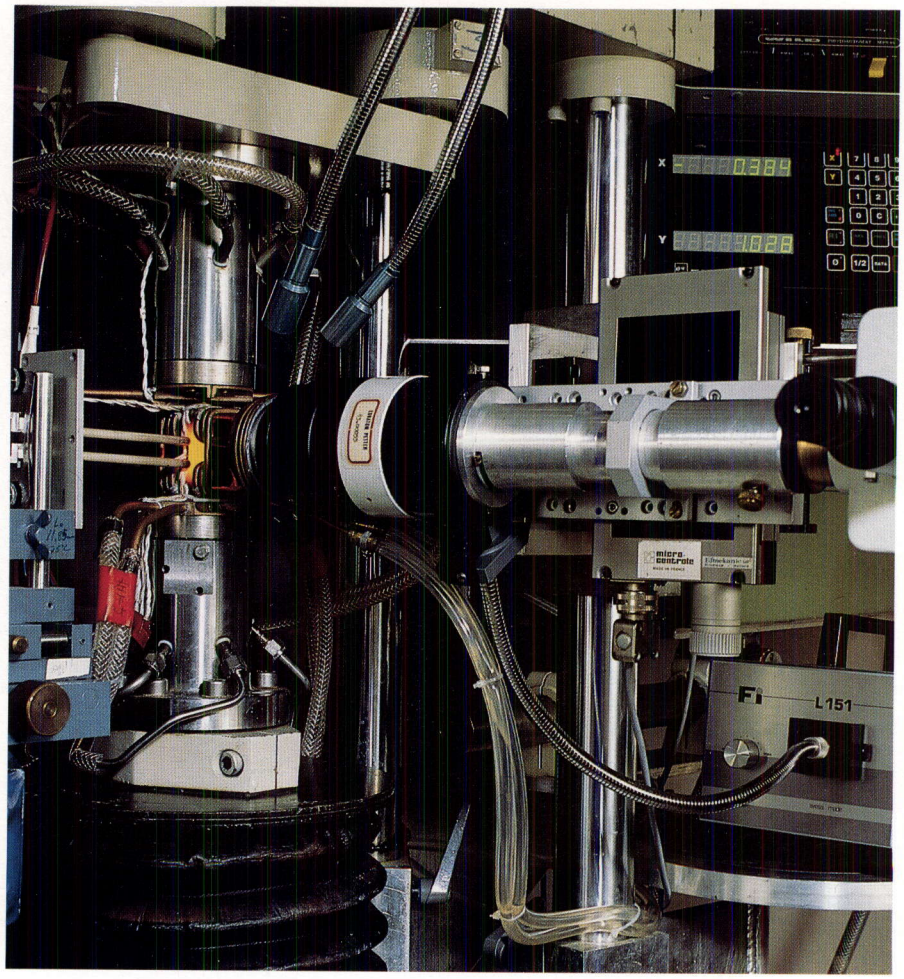


Figure 13: Experimental set-up for the thermo-mechanical fatigue testing of advanced gas turbine blade alloys.

The Institute for Systems Engineering

The Institute for Systems Engineering at Ispra executes the programmes on Reference Methods for Non-Nuclear Energies and is leading and partly executing the programmes on Safeguards and Fissile Materials Management and on Fusion Technology and Safety. It performs also researches on risk and reliability of structures, plants, and sociotechnical systems for the programmes Nuclear Reactor Safety, Industrial Hazards and Reference Methods of Reliability of Structures lead by the Institute of Safety Technology and researches on Artificial Intelligence applied to advanced diagnostics for the programme Advanced Materials lead by the Institute for Advanced Materials.

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

The main achievements concerning photovoltaic modules and passive solar systems are:

- Set-up of indoor procedures for testing amorphous silicon degradation, to be proposed as an international standard;
- analysis of measurement campaign for silicon solar radiation sensors in view of guidelines for sensor construction and calibration;

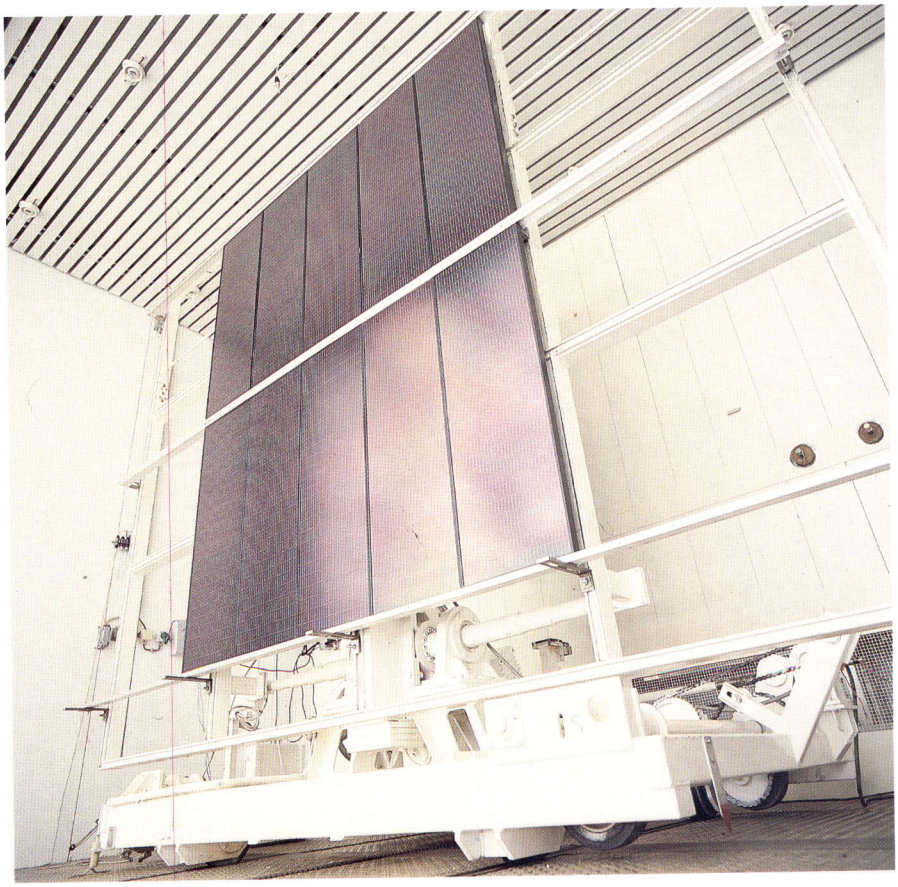


Figure 14: ESTI: Solar amorphous modules under Light Soaking Test.

- experiments on transient effects in flash calibrations and construction of a new pulsed solar simulation suitable for testing high efficiency crystalline silicon cells;
- a working group was created, the ''Thin Film Qualification Task Force'', in order to establish recommendations for measurements and qualification procedures on thin-film photovoltaic products, e.g. amorphous silicon. Main achievement is the draft of a qualification standard being presented to CENELEC for endorsement;
- improvement of test methodologies for solar passive cells through the elaboration of experimental data from the PASSYS test cell with the statistical programme SAS, the implementation of thermal simulation software such as TRNSYS, ESP, CODYBA and the qualification of human comfort;
- feasibility study of seasonal cold storage in the ground, which could be of interest for developing countries;
- issue of recommendations for Performance and Durability Tests of Solar Collectors and Water Heating Systems. Parts of this document have been retained by ad hoc ISO (International Standard Organisation) committees.

The programme on **Safeguards and Fissile Materials Management** addresses technical problems in relation to development of safeguarding the present and future nuclear fuel cycle. The programme which relies on a variety of scientific disciplines is executed in five different Institutes of JRC. The systems analysis activities and overall coordination for the programme is performed at the Institute for Systems Engineering, assuring a coherent approach in the scientific activities in the different Institutes. The activity is performed in cooperation with the major R & D organisations in the field within the Community (ESARDA association) and in the USA. Close contacts have recently been established with research organisations in Canada and Japan.

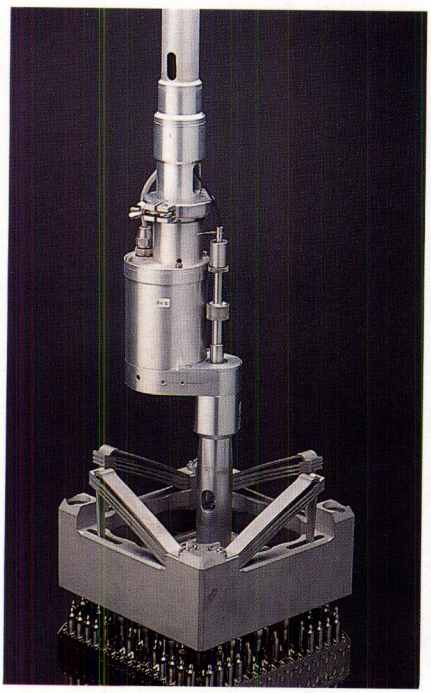


Figure 15: Ultrasonic reading - head used for the underwater verification of Pressurised Water Reactor (PWR) fuel analysis.

Important milestones in 1989 are:

- Because of the increasing role of Containment and Surveillance in safeguarding modern large and automated nuclear facilities, the need is strongly felt to characterise the performance of Containment and Surveillance devices and complete systems. A number of subjective (efficiency against diversion routes) and objective (reliability) statements have to be combined to express the overall performances. A first attempt has been made to formulate on the basic of realistic examples, the different characteristics of seals and optical surveillance systems;
- the general layout of a laboratory called LASCO (Laboratory for Surveillance and Containment) has been studied and construction started end 1989. The first experimental set up in a simulated storage area has been designed using robots and surveillance devices for inventory verifications. An integrated multisensor system is also being studied to be extensively tested in LASCO;
- a new computer programme, which performs errors evaluation in material balances, has been tested on real plant conditions of a Low Enriched Uranium fabrication plant and a Mixed Oxide Fuel factory. The programme has been documented and will be made available to European plant operators;

- JRC has participated in international working groups organised by IAEA on the application of safeguards to large throughput reprocessing facilities and to nuclear waste;
- the development of an ultrasonic sealing system for fresh LWR fuel has continued and a prototype has been prepared. Furthermore the sealing identity reading instrument, prepared in cooperation with SANDIA laboratories (USA), has been tested at Ispra and improvements are now being implemented;
- the ''fingerprinting'' of small areas of items (e.g. structure seal, key) has been studied using the surface topography technique. A laser reader has been tested with different kinds of metallic surfaces. Improvements are being studied for the control of reading accuracy.

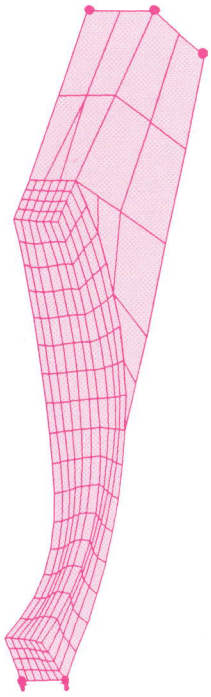


Figure 16: Deformation shape on NET first wall under electromagnetic forces.

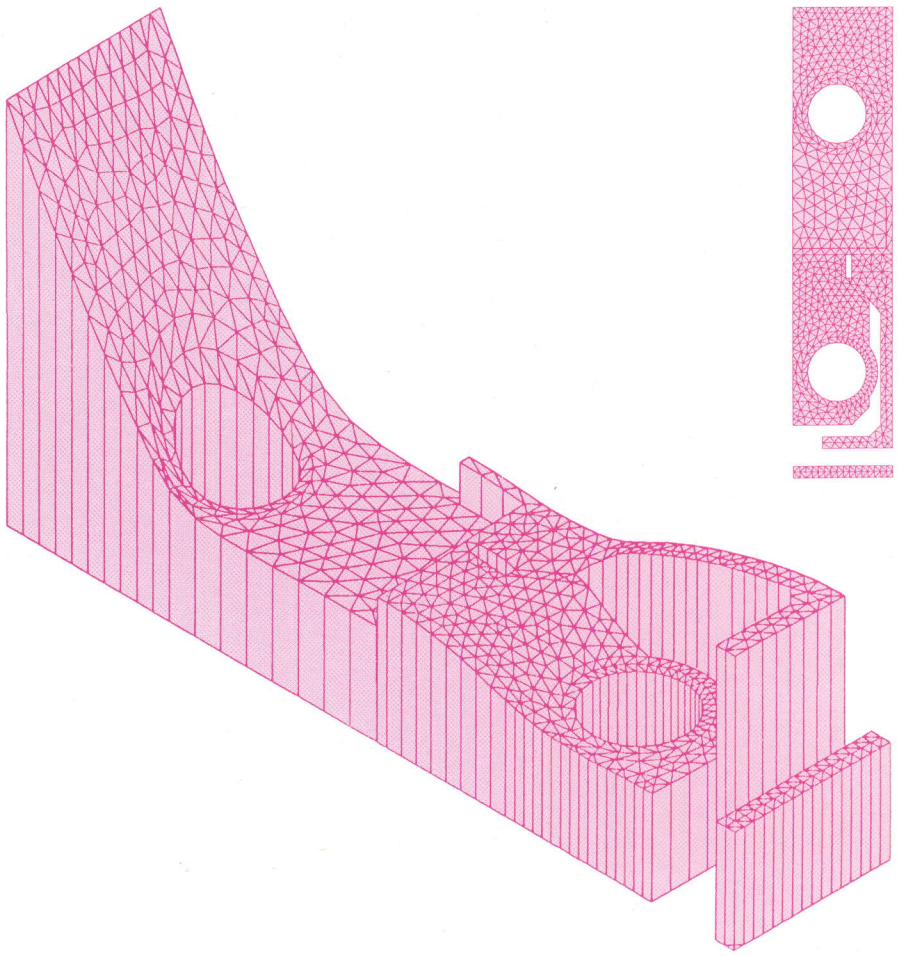
The programme on **Fusion Technology and Safety** has been oriented,in line with the European Fusion Technology Programme; in parallel the construction of the tritium handling laboratory at Ispra (ETHEL) has been pursued in the Institute for Safety Technology.

The following steps were reached in 1989:

- the design studies have been focussed on International Thermonuclear Experimental Reactor (ITER) Project whose pre-design phase started at Garching at the start of 1989. JRC contribution concerned among others the evaluation of the electromechanical effects of internal components in case of a plasma disruption by 3-D code systems developed at Ispra. Computer

Figure 17: A view of the Remote Handling Laboratory with the Manipulator Test Bench used to simulate handling procedures of internal components in support of design studies on ITER.

Figure 18: Mesh and spatial distribution of temperature on a divertor plate for fusion reactors loaded by a thermal flux.



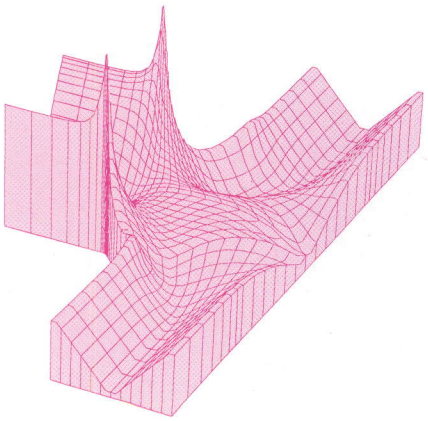


Figure 19: Spatial distribution of equivalent stresses (Von Mises) on a T-beam loaded by bending moments.

simulation and engineering animation techniques have also been set-up in order to investigate the remote handling procedures of the internal components of the machine, such as the blanket and divertor segments. In parallel the set-up of a facility to simulate the handling procedure on scale 1:3 mock-up has been started. First tests by this facility are scheduled by early 1991;

- the design parameters of a liquid breeder (Li-Pb eutectic), water cooled blanket suited for test in NET/ITER have been set-up in collaboration with CEA. The maximum operating breeder temperature is well below the allowable corrosion limit (450 °C). Experiments on Li-Pb steel compatibility have focussed on the effect of breeder impurities. Kinetics of deuterium desorption from the breeder has been investigated in a loop operating at Ispra which simulates the blanket tritium recovery system;
- safety analyses in case of a loss-of-flow accident (LOFA) in the whole Next European Torus (NET) reactor have shown that no major hazard occurs if the cooling circuits are designed to allow natural cooling (thermosyphon effect). 3-D thermomechanical analyses of the loss-of-coolant (LOCA) of the ITER divertor plates have enabled the definition of the best design solution for the protection - support structure. The loss-of-vacuum accident (LOVA)

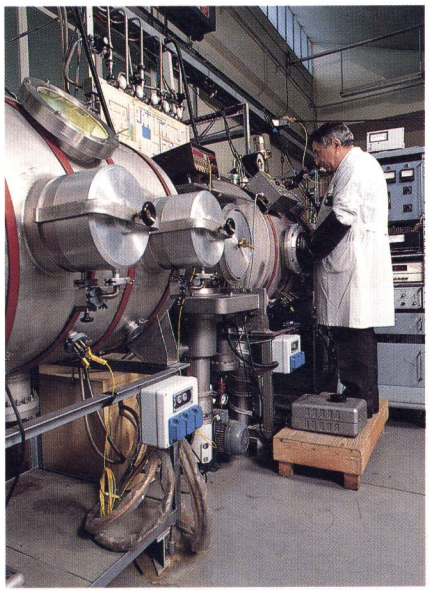
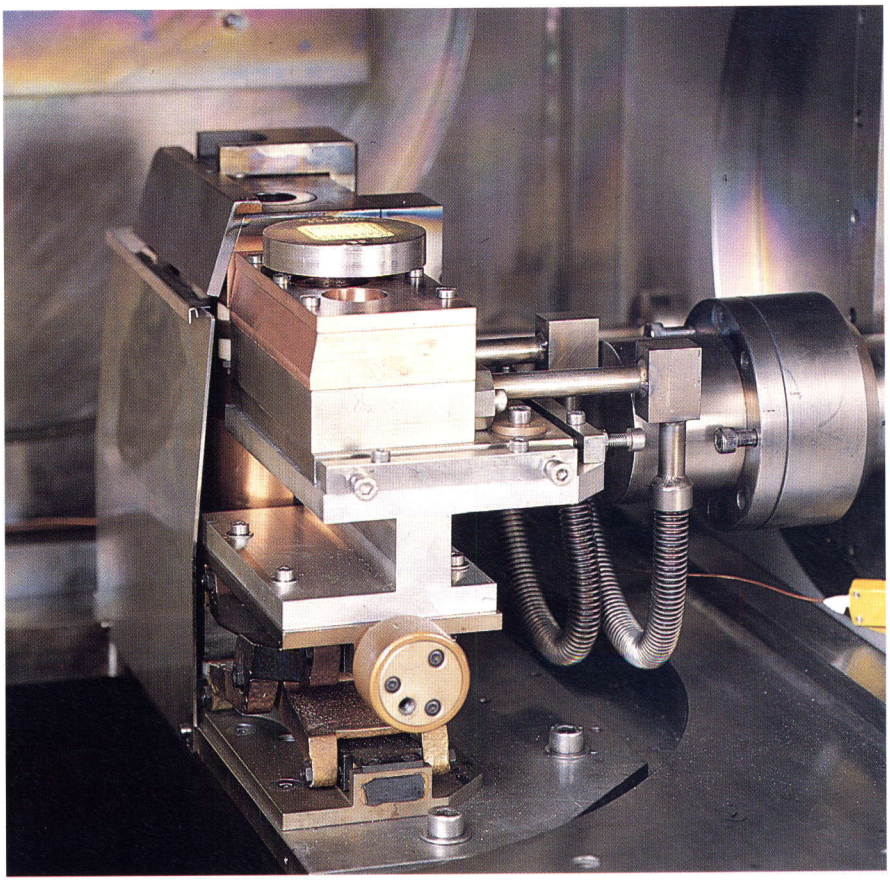


Figure 20: Stainless steel glove box (equipped with an electron beam welding device) used for liquid metal handling under high vaccuum or pure Argon.

of the NET vacuum wall, previously carried out for the bare wall case, has been extended to the case with graphite (reactive wall). It was found that the accident development is strongly dependent on the breach size; combustion gas temperatures up to 2400 K and overpressures of 20 kPa can be obtained in the worst case conditions examined (breach size of about 0.2 m^2 but no stack effects due to additional opening).

- more general safety analysis work was conducted for ITER and NET related to loss of flow and loss of coolant accidents. The work performed with a newly developed code called THERM which allows a 2-dimensional thermal and thermomechanical analysis of major reactor components including the proposed divertor plate.
- results were obtained in fusion blanket tests which simulate the interaction between liquid LiPb and water. Experiments simulating steam generator tube rupture showed that the chemical reaction is self limiting due to hydrogen and lithium oxide formation and that steam explosions are unlikely to occur. In collaboration with the Westinghouse Hanford Company the transport of potentially radioactive species in the alloy has been measured;
- the thermal fatigue facility set-up to investigate the lifetime of NET/ITER first wall has been operated to test a clean-geometry panel for benchmark evaluations and a real panel (brazed concept) supplied by industry;

Figure 21: Mechanical system for shifting a sample undergoing electron beam gun treatment for studies in disruption simulation effects.



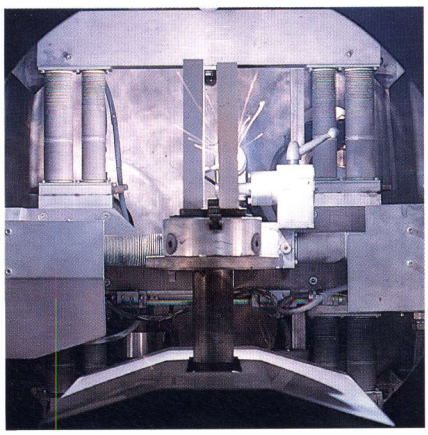


Figure 22: A robot capable of performing fine different movements used in uniform surface coating by vaccuum plasma spray of complex components.

- in-beam (Ispra cyclotron) and in-pile (HFR) experiments to investigate the mechanical behaviour of steel at low temperature (below 200 °C) have been pursued as a part of the implementation of the NET/ITER structural materials data base. Radiation creep was observed even at room temperature;
- Further studies of the behaviour of helium in high manganese stainless steels showed a rather complex interaction of helium, carbon and nitrogen; the formation of helium bubbles covered with nitrides has been observed. Coatings on stainless steel have been developed, and aimed to increase the absorption of infra-red radiation for the cooling of protective tiles;
- the off-site Benchmark calculations for accidental tritium releases in the frame of the NET/ITER environmental impact analyses has been completed;

The contributions of the Institute for Systems Engineering to the Reference Methods for Reliability of Structures, to the Nuclear Reactor Safety and to the Industrial Hazards programmes are described later.

The Institute for the Environment

The Environment Institute at Ispra executes the programme on Environmental Protection, and is leading and partly executes the programme on Radioactive Waste Management.

Environmental Protection

As in 1988, progress is reported on the Research Areas: Environmental Chemicals, Air Pollution, European Monitoring Network, Water Quality, Chemical Wastes and Food & Drug Analysis. The new research area Environmental Studies in the Mediterranean Basin is under development while the likewise new area on Genetically Engineered Substances is still in a preparatory phase.

Figure 23: Thermostated room with three chambers, two made of glass and one of stainless steel, for the measurement of organic emissions from building materials, household and hobby products.

Environmental Chemicals

New and updated data on toxicology, occupational health and safety, chemical economy, physico-chemical properties and legislation were introduced into the ECDIN (Environmental Chemicals Data Information Network) data bank.

Several working groups have been established in the frame of the concerted action "Indoor Air Quality and its Impact on Man"; they prepared a "practical guide for the investigation of causes of unspecific complaints in large buildings", a report on "strategy for sampling chemical substances in indoor air", a guideline for the "determination of the steady state formaldehyde concentration from wood based materials in test chambers" and a document on "biological effects in man related to indoor air pollution".

Four non-Community countries have now joined the project and the secretariat is handling an increasing number of information requests. Standardisation of measurement procedures and methods for the characterisation of VOC source

Figure 24: Indoor Air Quality — Mouse embryos at different development stages after 3 days of growth in the presence of 10^{-5} M of Methylglyoxal in order to detect their embryotoxicity.

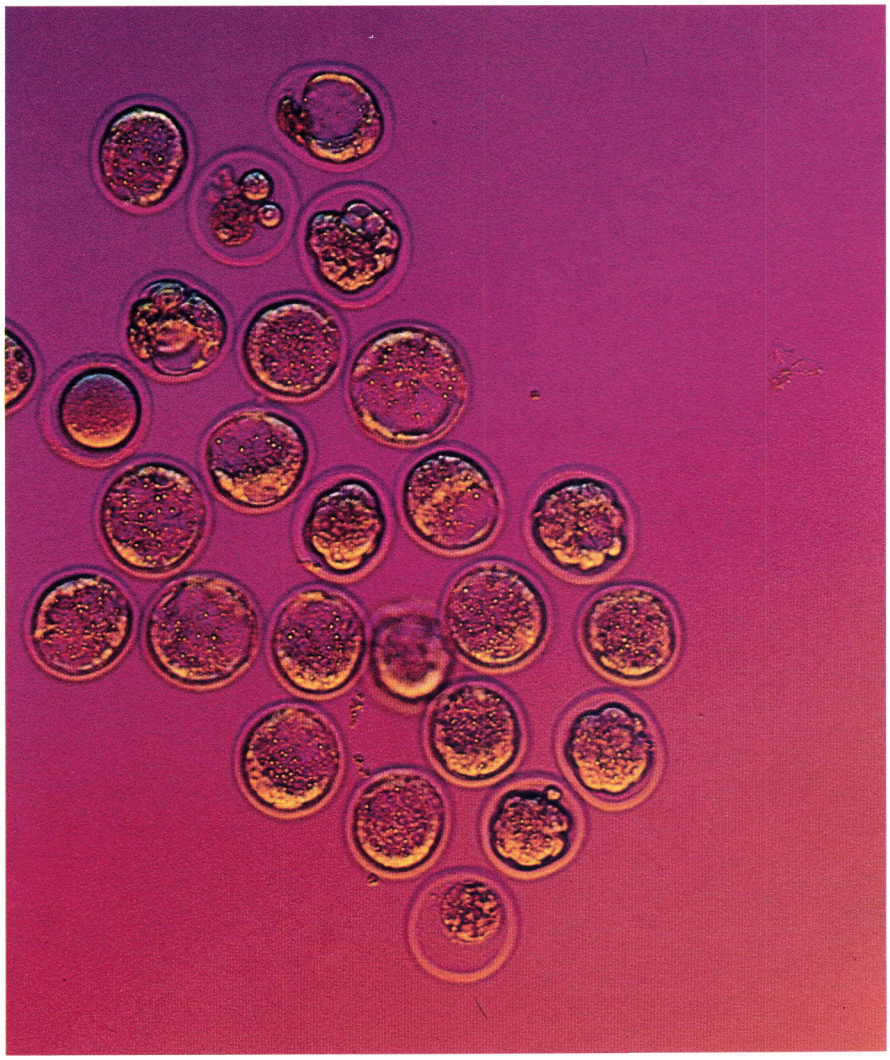


Figure 25: Laboratory configuration for the introduction of VOC samples into the gas chromatograph by way of a thermal desorption cold trap injector.

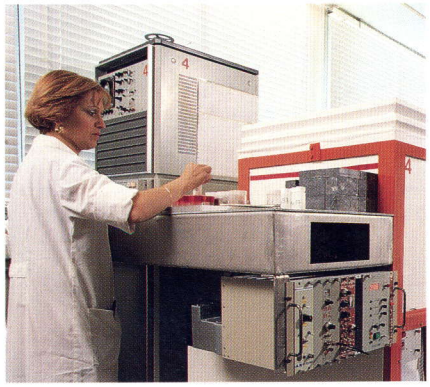


Figure 26: A view of the γ spectrometry analyser and GE Detector used for trace metal studies.

emissions is still of major concern for the comparability of results obtained at different times and locations. Therefore the Institute participated in an international comparison of VOC emitted from several building/furnishing materials. A strategy for investigating the potential influence of VOC pollution on complaints in office buildings has been devised and applied in six buildings of the European Parliament.

The study on the biological monitoring of Co, Ta and W within the activity on "Exposure and Health Effects of Trace Metals" was continued in 1989 and confirmed earlier results. Trace metal determinations in the pleural-pulmonary tissue of malignant mesothelioma affected patients showed significant variations of Zn, Cu, Co and Cr compared to tissues of healthy subjects. For the study of trace metal metabolism the activity was focussed on the development and use of in-vitro bio-assays (cell cultures) in order to reduce the use of test animals. In vivo experiments continued with the study of the distribution of thallium in rat brain following exposure to toxic doses.

Figure 27: Deposition studies: continuous stirred tank reactor for fumigation of plants with mixtures of atmospheric pollutants.

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 in 1989; it is confirmed that biogenic emissions increase the overall acidity when reacting with an O_3-SO_2-NO_2 polluted forest air.

Atmospheric reactions of NO_3 with alkenes were simulated in the laboratory and the formation of nitroxy-carbonyl, nitroxy-alcohol and dinitrate species was observed. The ratio between simple carbonyl and organic nitrate products was independent of the NO_2 concentration, which means that an extrapolation to real field conditions is realistic. Studies on the reaction of NO_3 and DMS (dimethyl sulphide) have been started as DMS accounts for 25% of the total atmospheric sulphur balance. It appears that the formation of HNO_3 by the NO_3-DMS reaction represents an efficient NO_x sink in the marine troposphere.

Two processes are under study for the development of a combined desulphurisation/denoxing process: catalytic reduction with hydrogen and cathodic electrolytic reduction. Screening tests for candidate catalysts were completed and a patent application for the cathodic reduction of NO to N_2 via an anodic ammonia conversion was filed.

Figure 28: The environmental mobile laboratory during field experiments in alpine terrain carried out as part of a campaign performed in the frame of the TRANSALP Project.

European Monitoring Network

The differential optical absorption monitor was employed for the first time, in a field campaign for continuous O_3 and NO_2 measurements. Passive diffusion tube sampling of NO_2 proved to be an interesting technique for the design of new monitoring networks, and was employed for NO_2 distribution studies in Athens, Paris, Varese and elsewhere. The Institute is employing the perfluorcarbon tracer technique for atmospheric transport and diffusion studies on a routine basis. During the MECAPIP experiment (Castellon, July 1989) for the first time the tracer was sampled by an instrumented aircraft giving thereby a new opportunity to modellers to describe flow over complex terrain, as a 3D wind- and concentration field and a known source strength are available for experimental validation. In the frame of the TRANSALP pre-experiment (Canton Ticino, October 1989) the channelling of air masses was investigated in collaboration with Swiss and Italian laboratories. The tracer was detected up to the top of the St. Gotthard and Lucomagno passes, proving that transalpine pollutant transport is possible.

Figure 29: A view from a helicopter's cockpit during a flight to take atmospheric samples and related data during trace experiments to study atmospheric dispersion in a complex lake-mountain area.

Water Quality

The present condition of Lake Varese, used as a model case, was characterised, in view of its recovery by nutrient concentration, oxygen content, algal biomass, integral phosphorous loading and chemical composition of sediments. Modelling was applied to evaluate the need of daily oxygen supply to predict lake recovery times. For Lake Orta, one of Europe's most polluted fresh water bodies, metal distribution maps for anthropogenic trace elements and nutrients were elaborated. Additionally analysed samples of seven contributing rivers, the outlet river, surface run-off and precipitations will allow to establish a total

Figure 30: Facilities for the cultivation of planktonic algae (freshwater and marine) with axemic stock cultures in screw capped flasks.

metal balance. A dispersion model will be validated by the experimental data. For the further development of phytoplankton analysis a suitable staining technique to distinguish algal species by blue nuclear and yellow granular fluorescence has been set up. The application of flow cytometry to the bacterial analysis of water has been tested. Cultured strains as well as fresh water bacterial populations were studied by epifluorescense microscopy as a reference method and compared to flow cytometry with a good agreement.

Figure 31: The Multi Analysis Floating apparatus for Limnological Data Assessment (MALFADA) on Lake Orta (Italy), where it is monitoring a cleaning operation of the lake.

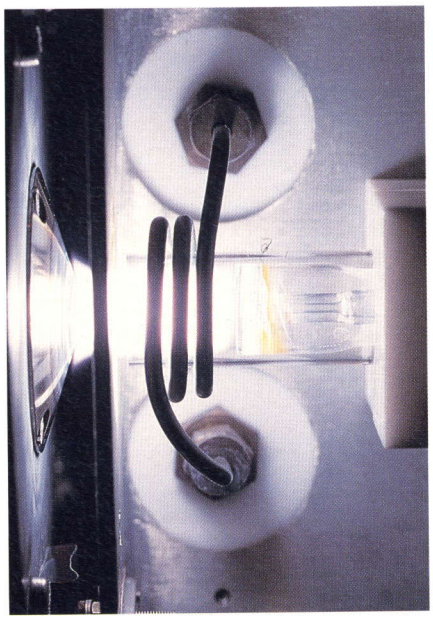


Figure 32: A detailed view of the plasma source of the ICP mass spectrometer used for inorganic ultra trace (ppt level) element determination.

Chemical Wastes

Work continued in support to a dynamic finite element model for pollutant migration experiments on inorganic and organic pollutants in porous media. A soil sampling field station was established at Ispra to provide samples of homogeneous and well defined material from seven different origins. By neutron activation analysis about 30 minor and trace elements were detected. The adsorption of trivalent and hexavalent ^{51}Cr radiotracer was studied in batch experiments and a good linear relationship between calculated and measured Cr concentrations was obtained. Other experiments were dealing with soil absorption of AS (III) and AS (V) and the determination of the distribution coefficients of Cr (VI) in sand. The distribution coefficient between soil and water is an essential parameter for the transport of hydrophobic polychlorinated biphenyls.

In the frame of the activity ''molecular dosimetry for the assessment of human exposure to genotoxic compounds'' a new method based on Constant Neutral Loss Mass Spectroscopy has been developed. Modified nucleotides formed in DNA and blood lymphocytes after in-vitro exposure to alkylated agents were isolated by HPLC and measured at 2 to 5 ng levels by mass spectroscopy.

The Chemical Emergency Management (ChEM) decision support system has been further developed with modules on accidents by release of halogenated aromatic compounds and the management of PCB contained in electrical equipment.

Figure 33: Isolating metallobiocomplexes in the laboratory for in-vitro toxicity testing of chemicals.

Environmental Studies on the Mediterranean Basin

As a starting point for the definition of joint Mediterranean projects the Institute organised a meeting with experts from Italy, France, Spain, Portugal and Greece. At this event research topics on the behaviour of atmospheric pollutants, groundwater quality, microphyte toxins in fresh and sea water, harmonisation of analytical methods and sampling techniques were agreed subject to further definition and elaboration by national experts and JRC staff.

As a substantial contribution to the Spanish MECAPIP project the JRC participated with tracer experiments and organised the participation of an instrumented aircraft for meteorological and airchemistry measurements.

Food & Drug Analysis

The instrumentation of the laboratory is now complete and highly sophisticated techniques like Nuclear Magnetic Resonance, IR- and UV spectroscopy, HPLC, GC, IC and enzymatic/immunological methods are available. First experimental activities have been focussed on the detection of wine sugaring, the build-up of a European Databank for Nuclear Magnetic Resonance fingerprints of wines; the determination of the purity of starches by different analytical methods and the detection of plant proteins in meat extracts.

The laboratory is in contact with the Commission's departments of Agriculture/Consumer Protection, Industry and Customs Union to define and complete its programme.

Figure 34: The 300 MHz Nuclear Magnetic Resonance Spectrometer used to determine the history and origin of the alcoholic content of wines and other alcoholic beverages.

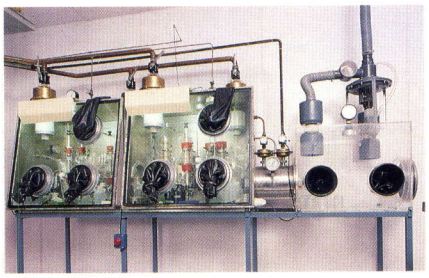


Figure 35: Migration experiments in an anoxic box as part of environmental research into radioactive waste disposal in geological formations.

Radioactive Waste Management

The programme is divided in four research areas: operation of the PETRA facility, actinide monitoring, characterisation of radioactive waste and safety of final storage in geological formations.

The two first research areas are treated by the Institute for Safety Technology and the third by the Institute for Transuranium Elements. They are described in the corresponding sections of this report.

The objective of the fourth research area, which is treated by the Environment Institute, with a small contribution of the Institute for Advanced Materials, is the assessment of the long-term safety of waste disposed in geological formations under conditions presently studied in the European Communities.

Main achievements for theoretical assessment activities were:

- the preparation of a new version of the probabilistic risk assessment code LISA, especially developed for application to hard rock formations;
- the successful participation in intercomparison activities organised by the NEA;
- organisation of a seminar on techniques of risk analysis in nuclear waste management.

Regarding experimental activites, those on the near-field, are executed by the Institute for Advanced Materials, and essentially deal with possible effects of the thermal gradient on the evolution of the source terms. Radionuclide migration in geological media in general are dealt with by the Environment Institute. They regard:

- the study of the influence of humic acids present in ground water on Pu per migration, where an association of Pu with mobile humid acid particles (less than 600 nanometers in diameter) has been found;

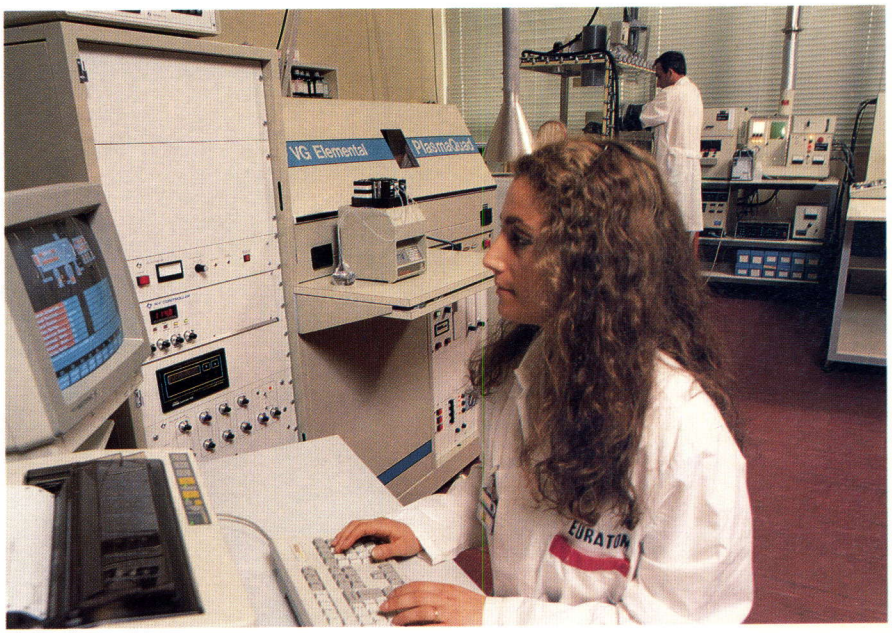


Figure 36: A view of the laboratory housing the Inductively Coupled Plasma Mass Spectrometer (ICP-MS) used in chemical waste research activities.

- the study of the specific conditions of groundwater above the Gorleben salt-dome in relation to Pu and Np migration;
- transport processes in fissured media (in collaboration with CIEMAT/Spain);
- development of analytical techniques both for laboratory studies (laser spectroscopic techniques and mass spectroscopy) and for in-field investigations (geophysical and geochemical probes).

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

The programme deals with land use mapping and land cover statistics over the Department of Ardèche (France) by automatic processing methods using mainly Landsat Thematic Mapper data (30 m resolution). A geometric registration method has been developed, which includes the use of a digital elevation model to correct for the relief displacement effect. With this method the average superposition accuracy is within one pixel over the whole image. An atmospheric correction method starting from scene-based target reflectances (and not from additional on site measurements) has been also set up in order to derive physically calibrated temporal features for the characterisation of vegetation categories.

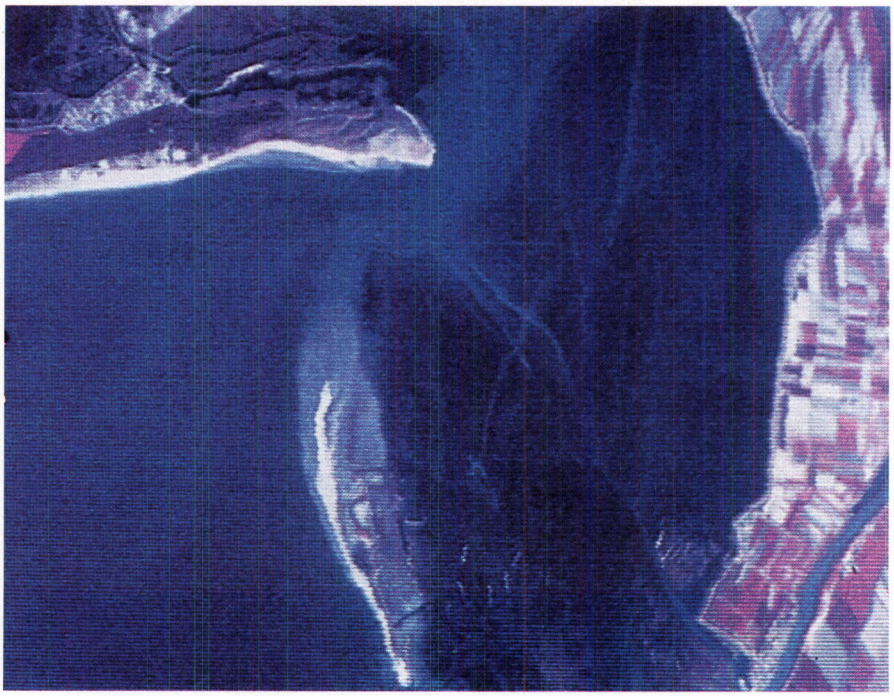


Figure 37: GER 63 band multispectral scanner quicklook of the EISAC Venice Lagoon test site. The image is only roll corrected, no radiometric conversion of DNs to radiances and no atmospheric corrections have been applied.

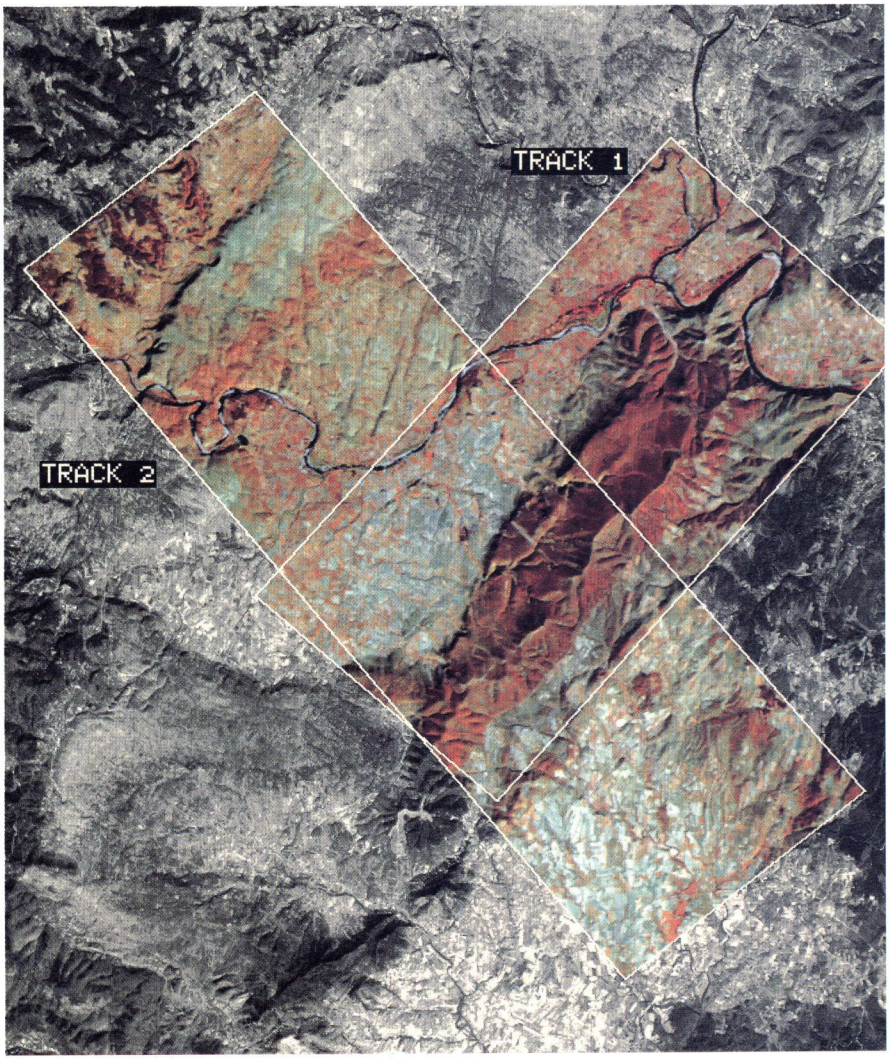


Figure 38: Flight tracks covered from the GER 63-Band Airborne Scanner during the acquisition of High Resolution Spectrometry data over the experimental test site in the southern Département Ardèche, France (29-06-1989). The data availability is represented by the overlay of Landsat Thematic Mapper data (colour) on geocoded SPOT-1 imagery (black & white).

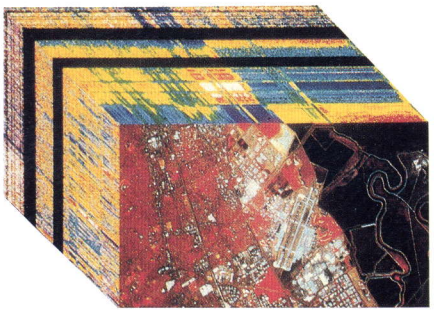


Figure 39: The image, obtained from the Airborne Visible and Infrared Imaging Spectrometer (AVIRIS), displays very well the high radiometric dimensionality of imaging spectrometer data. It is the result of stacking the colour coded relative reflectance spectra, achieved from the 224 AVIRIS bands, of each of the pixels along the top and along the left hand edge of the false colour top image. (Processed by the Centre for the Study of Earth from Space, University of Colorado, Boulder).

A first test of multitemporal classification was carried out on a reduced area (512x512 pixels) using multitemporal data compression techniques. The average mapping accuracy for 9 main vegetation classes, including agriculture, orchards, forest and natural vegetation, is of the order of 80%. This percentage will probably increase when such a technique is applied to the whole Ardèeche Department.

Work has begun on developing artificial intelligence approaches to improve the image classification. The overall goal is to build a knowledge based (or "expert") system able to store and process facts and heuristics about the area and to integrate them with the image processing environment. One important component of this "image understanding" system is close to completion, namely the evidential reasoning system, the purpose of which is to combine in a realistic way all the available evidence about a pixel (or segment).

The collaborative Programme, aiming at the use of remote sensing data in Geographical Systems is described later.

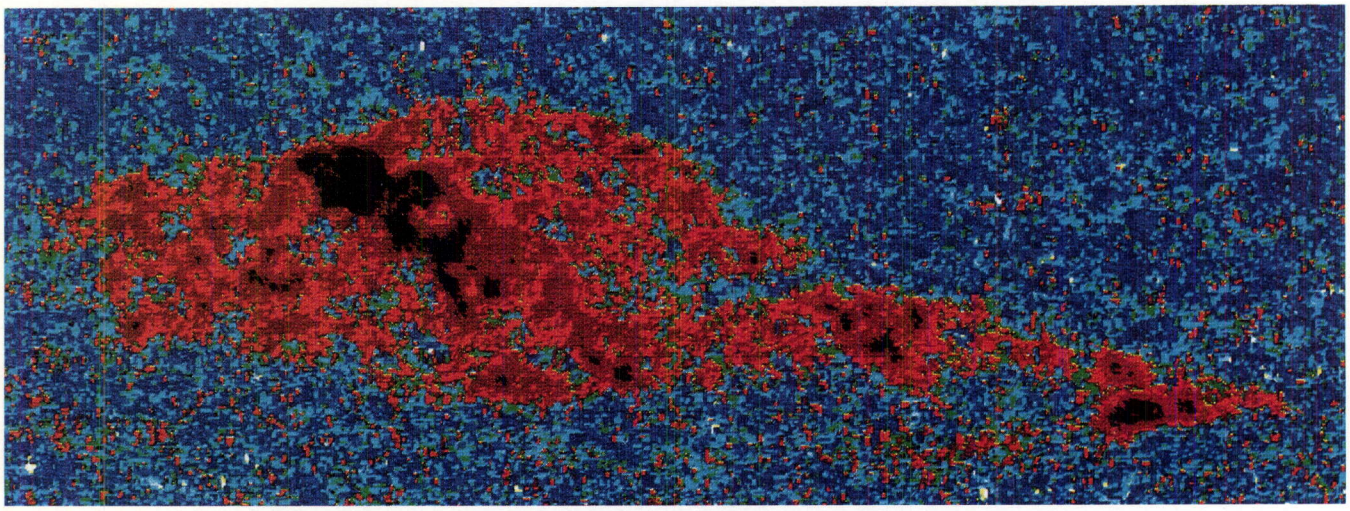


Figure 40: A SLAR (Sideways Looking Airborne Radar) image of an oil spill in the North Sea taken during the Archimedes 2A Campaign on the measurement of oil slick thickness.

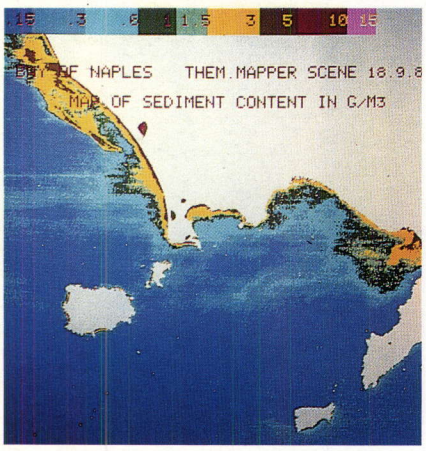


Figure 41: Thematic Mapper data describing Chlorophyll concentrations in the Gulf of Naples, Italy.

Monitoring of Marine Environment

Sea Pollution Surveillance: The ARCHIMEDES project was completed in collaboration with operators and research institutes. The 90 GHz Passive Microwave Radiometer succeeded in measuring thickness of thin oil spills, the possibility of discriminating between mineral oils and biogenic films was demonstrated. A report on the entire ARCHIMEDES exercise has been completed.

The Coastal Zone Colour Scanner - CZCS has been used to study the coastal transport of pollution by the analysis of sea colour data. Forty nine consecutive maps of chlorophyll for the North Adriatic basin have been correlated with the Po rivers' run off for the most significant months. Discharge rates correlate well with points for the area near to the estuary. Peaks of Chlorophyll follow peaks of run off with a time lag of 3-5 days.

Implementation of CZCS data processing using new ''transputer'' technology on a personal computer was adopted in view of providing rapid production for the numerical modelling group.

Updating and extension of the analysis of the Thematic Mapper performance versus in-situ experiment has continued in the Gulf of Naples, yielding an improvement in the algorithms for Chlorophyll and sediment retrieval and a new algorithm for atmospheric correction-accounting for horizontal aerosol variation.

Advanced Technology

Microwave Remote Sensing Activity

Emphasis is placed on the development of all-weather remote sensing techniques; in both operational applications and scientific investigations related to land and sea. Significant developments in 1989 are summarised below:

- Microwave Signature Laboratory: This proposed facility received a favourable recommendation of an international group of experts in October

1988 and in turn, the Board of Governors advised the JRC to implement the project. After a call for tender a contract has been placed to construct the laboratory by December 1990. In the meantime an Interim laboratory has been designed and constructed in order to test components and measurement techniques.

- In August 1989 an airborne microwave campaign was undertaken over four forestry and agricultural European Test Sites using the NASA/JPL three frequency (C-, L- and P-band) polarimetric SAR. This was the first opportunity for European scientists to evaluate this new technology.
- During 1989 the European Radar Cross Section Database (EURACS) was designed and implemented, and is currently in its validation phase. In addition the scope of EURACS has been extended from agricultural applications into the field of forestry.
- A Microwave Signal processing system under the UNIX operating system has been installed in 1989. This links the various elements of the microwave programme, and also incorporates significant developments in the field of software development for radar data analysis.
- EARSEF: In September 1989 JRC/ESA organised a meeting of European groups interested in providing an input into the definition of a possible European Airborne Remote Sensing Facility (EARSEF). Five groups attended this meeting (from the Netherlands, Spain, Denmark and FRG (2)).

Figure 42: Testing components and measuring techniques in the Microwave Signature Laboratory seen here in its temporary location.

Laserfluorosensor Activity

- a control and support activity for the construction by the CISE, Milan (I) of the airborne ''Time Resolved Lidar Fluorosensor'' and the preparation of the validation campaigns;
- equipping the support ground laboratory with the same type of instruments as those used in the airborne system with the main objective of improving the time resolution and the extension of the water column simulation capabilities.

Figure 43: The excitation laser and recieving telescope used for fluorescence light collection which forms a part of the LIDAR Fluorosensor Facility's analysis of remote targets in environmental investigations.

Figure 44: A 7 metre high tank used to simulate LIDAR measurements on a water collum.

The Institute for Safety Technology

The Institute for Safety Technology, at Ispra, is leading and partly executes the programmes on Reference Methods, Reliability and Structures, on Nuclear Reactor Safety and on Industrial Hazards; it operates the PERLA nuclear facility and is responsible for the construction of the ETHEL Laboratory on behalf of the Institute for Systems Engineering; it also operates the PETRA nuclear facility on behalf of the Environment Institute.

For the sake of unity, the contributions of the Institute for Systems Engineering to the Programmes on Reference Methods, Reliability and Structures, on Nuclear Reactor Safety and on Industrial Hazards are reported here; the contribution of the Institute for Advanced Materials (PISC project) is also reported here.

Reference Methods, Reliability and Structures

Reference Methods for the Evaluation of Structure Reliability - Reaction Wall Project

The objectives of this activity are to improve the modelling of non linear structural mechanics problems in both transient dynamic and quasi static regimes including the behaviour of materials under these conditions. The Institute has

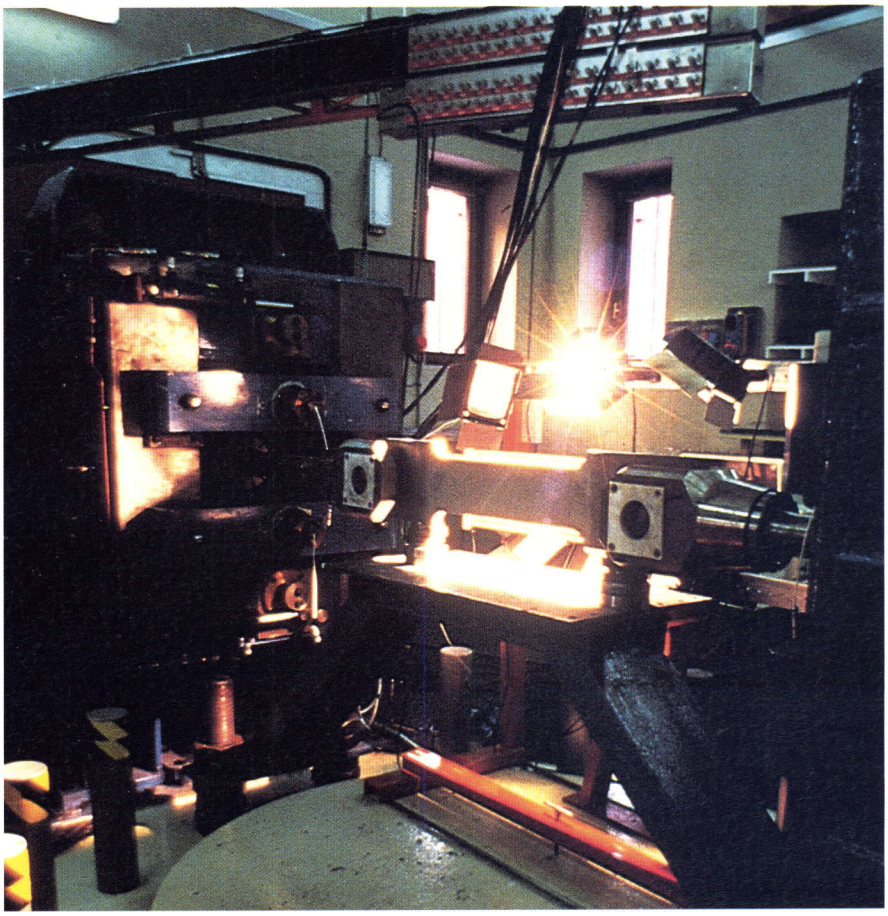


Figure 45: An experiment under way in the central room of the Large Dynamic Test Facility (LDTF).

many years of experience in this area with steel structures and cooperates with a large number of organisations in the Member States which most recently have decided to combine their efforts in an association of laboratories. When enlarging the scope of this research including e.g. structures made of concrete, experience had to be gained quickly by testing reinforced concrete elements and developing global physical models. Uniaxial cyclic bending tests were performed and biaxial bending tests in the presence of axial compressive loads are being prepared. Research also continued on steel specimens to determine dynamic material response under biaxial loading conditions showing that the von Mises criterion is really valid only for the initial yield surface.

The Institute already possesses small and large testing machines to determine material properties. To those a large reaction wall with a height of 16 m and a width of 21 m will be added, the construction starting end 1989. This facility is designed for large and full scale testing of sub-assemblies and full structural systems. It will be available to industry for testing innovative design concepts and prototypes.

In the area of computational mechanics the development of Plexis-3C, a finite element computer programme developed in collaboration with CEA for the analysis of nonlinear transient dynamic problems involving compressible fluids has been completed. Modelling of natural convection has been extended from 2D to 3D situations.

Reliability Modelling of Structures
(performed by the Institute for Systems Engineering)

In this project three main activities are carried out:

- Tests on 1:5 Scaled Pressure Vessel Models
  The experimentation on vessel model R2 (A) has been completed with the unexpected appearance of a leak in the lower dome. Some 875000 cycles have been performed before this failure.
  The prediction of damage accumulation and of the residual lifetime, performed by JRC team and by four external laboratories and the comparison with the experimental evidence allowed conclusions about the main source of uncertainties, the origin of the crack nucleation, the cladding residual stresses effect and behaviour and the relevance of non algorithmic knowledge (heuristic and domain expert experience) in prediction possibility.
  Vessel R2 is now to be inspected by X-Ray and Ultrasonic testings before its destructive examination. The destructive testing and the fractographic examination, by electronic microscope, of the lower dome through crack will be performed by CISE-Milano, in the frame of the existing collaboration contract JRC Ispra-CISE Milano-EPRI USA, aimed at exploiting experimental results on environmentally assisted fatigue in pressure vessels and at implementing, in the COVASTOL code, a new model for FCG in PWR environment.
- Pressurised Thermal Shock Experiment (PTS)
  The main parameters have been analysed from the point of view of their uncertainties.
  A knowledge engineering tool for management of the PTS experiment has been implemented.

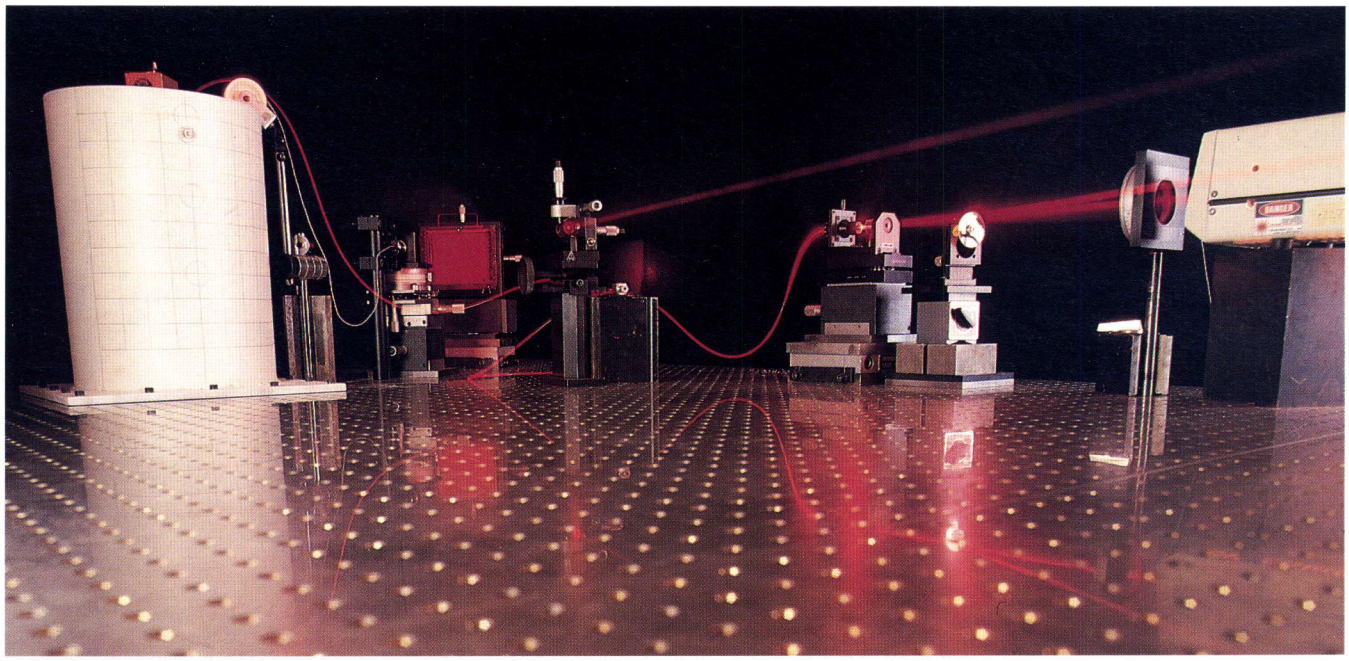


Figure 46: Laboratory set up for strain analysis using optical fibres for Laser holographic interferometry.

Following the conclusions of a preliminary research phase, a new analytical tool for the heat conduction, stress and Fracture Mechanics analysis (Study contract with MPA Stuttgart), has been developed

- Development of new diagnostic techniques
  The possibility to perform accurate strain analysis on non directly accessible regions by laser holographic interferometry via optical fibres has been proved. Single-mode fibres turned out to be the most suitable for carrying the reference light; in particular those maintaining the light wave polarisation would allow for a better quality interference. A small, versatile endoscopic probe has been developed.

Nuclear Reactor Safety

Reliability and Risk Evaluation (performed by the Institute for Systems Engineering)

In this project three main activities are carried out:

- European Reliability Data System
  Component Event Data Bank has increased its size with data coming from Spain, Italy and Sweden; furthermore an informatics transcoding system has been set up for transferring data from our classification to another; analysis of the pump failure data set has allowed finalisation of univariate analysis methods. The Abnormal Occurrences Reporting System (AORS) has been used for several investigations such as on common cause failure; the feasibility of setting up an incident data bank based on the know-how accumulated with AORS and supported from now by publicly available records, has been ascertained.

Progress is continued on the more theoretical investigation on fuzzy information processing: from one side a fuzzy database systems is being studied for dealing with the estimation of component reliability parameters, from the other side the use of fuzzy theory to represent and combine expert judgments has been investigated.

- System Response Analyser
  The structure of the operator model has been up-dated on a Blackboard Architecture skeleton which enables a more adaptive representation to various cognitive mechanisms; furthermore a first modelling of operator behaviour under stress has been studied. A fast simulation code for Chemical Volume Control System has been developed.
- Probabilistic Risk Assessment
  The Event Sequence Reliability Benchmark Exercise has been terminated. The final results of this exercise are still under study, it can be anticipated that problems will mainly arise because of system interdependency in the analyses of complex systems. This Exercise was the last of a series of four Benchmark Exercises; the previous ones have been devoted to systems reliability, common failures and human reliability.
  The Benchmark Exercises have suggested guidelines for Probability Study Analysis Studies mainly in the area of common failures and dependence among sequences. They have also given suggestions for failure developments in the dynamical Probability Study Analysis Studies models able to take in account, in a more satisfactory way, man-machine interactions.
  The pre-project phase of Software Tools for Reliability of Safety has been terminated and the project has been officially started: a prototype version of the fault tree construction module has been developed; a graphical interactive interface is almost completed.

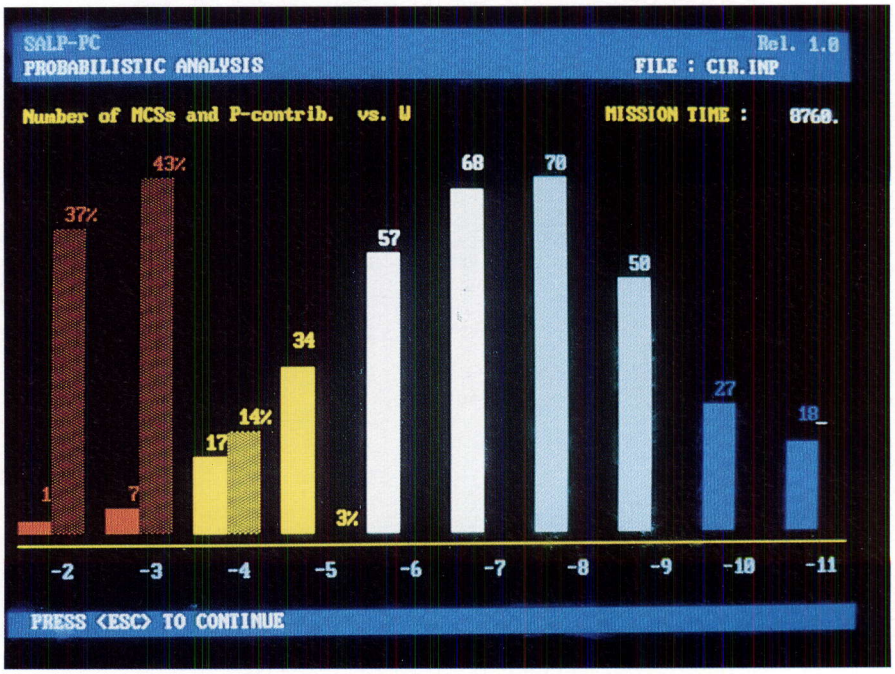


Figure 47: The SALP - PC program for fault tree analysis.

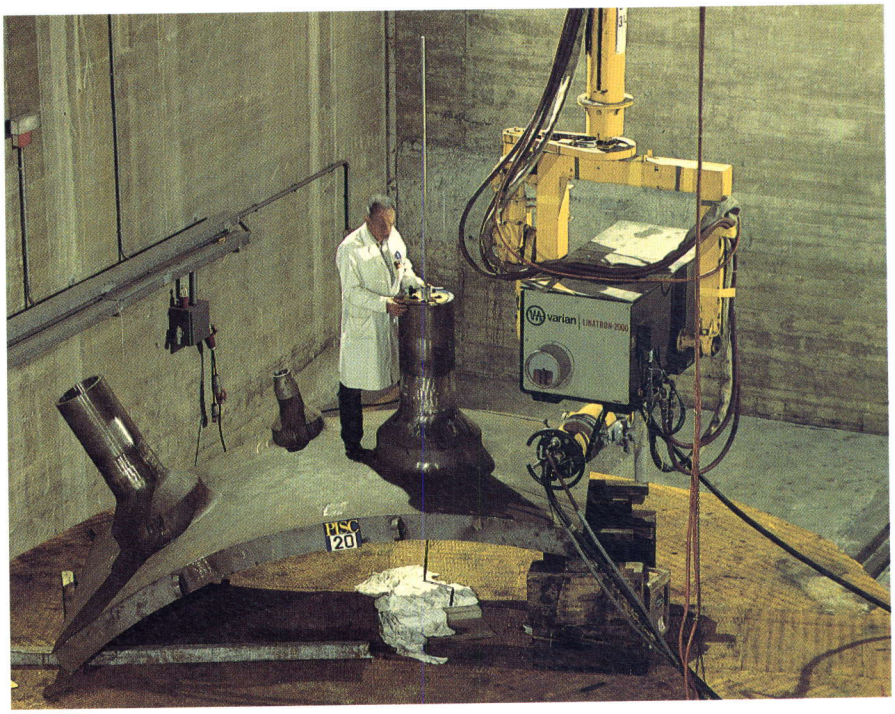


Figure 48: PISC III: Radiographic examination of an assembly using a 2HeV linear accelerator.

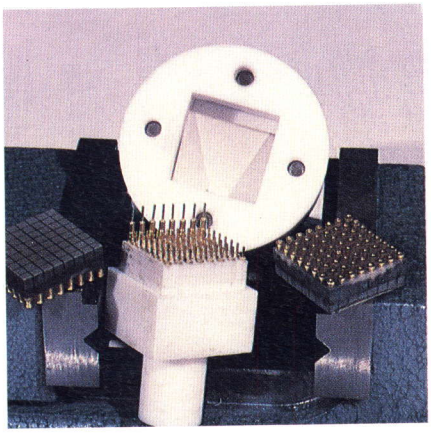


Figure 49: Examples of a transducers array with 64 elements. Each ultrasonic transducer has a nominal frequency of 5 MHz.

PISC (Project for the Integrity of Structural Components) (performed by the Institute for Advanced Materials)

This international programme jointly sponsored by the OECD (NEA) and the CEC, on the assessment of the effectiveness of inspection techniques and procedures and of their reliability when applied to structural components, is now in its third phase (PISC III) with an emphasis on the in-service inspection of the primary circuit of nuclear Light Water Reactors.

The work has been executed through a number of actions:

Action 1: inspection of actual contaminated reactor structure pieces, Action 2: full scale vessel automated inspection, Action 3: nozzles and safe-ends inspection capability, Action 4: austenitic steel round robin tests, Action 5: steam generators integrity tests, Action 6: mathematical models validation, Action 7: reliability exercises.

Furthermore, two new actions are in preparation: Action 8: PISC methodology for NDT evaluation in non - nuclear industries, and Action 9: Support to Codes and Standards bodies.

Among the main achievements this year, one notes the effective coordination of this international project concerning 14 countries and about 100 institutions; the manufacturing and certification of numerous test assemblies by the reference laboratories; the execution of Round Robin Tests on full scale PWR/BWR weld nozzles and safe-ends (the analysis of radioactive components were performed in the hot cell facilities of the Institute for Safety Technology); the validation of mathematical models on the simulation of ultrasonic equipment failures and of the ultrasonic response from particular defects. We note also that this activity undertakes the very sensitive role of "invigilator".

Figure 50: FARO-UO_2 collected upon release from the furnace after interaction with a stainless steel plate.

Abnormal Behaviour of Reactor Cooling Systems and Accident Modelling

The LOBI facility, a 1:700 volume-scaled model of a four loop 1300 MWe PWR was recommissioned following modifications and has since performed 3 tests in which a steam generator tube rupture, a 5% cold leg break and bypass behaviour in the upper plenum/upper downcomer were investigated. This experimental programme provides the necessary data for an extensive code application and assessment effort. Extensions of this programme to solve accident management problems are being studied.

Six tests were performed with the FARO facility in which up to 125 Kg of molten UO_2 at about 3000 °C were released from the furnace in various test sections in which fuel freezing and plugging phenomena and the potential of a fuel jet to perforate a steel plate were investigated for boundary and initial conditions of a sodium cooled reactor.
The study of these phenomena is highly relevant to the understanding of in-vessel and ex-vessel phenomena during a core melt down. Test results are used to verify models and codes which should predict very low probability events in a nuclear power station.
The built in flexibility of the FARO facility means that it can probably be used next to solve light water reactor severe accident problems. Planning for this project is advanced.

The development of the European Accident Code (EAC) for the analysis of the initiation phase of low probability whole core accidents in LMFFBR's continued in 1989. The second version of the code is being released; compared to the first version, it presents advanced modelling in the areas of fuel pin behaviour, molten fuel motion inside the pin and fuel motion in the coolant channels. Moreover the code now simulates correctly the hexcan geometry and has a new, detailed neutronics calculation.

Source Term

Always in the frame of unlikely but severe events, a large effort was continued in cooperation with Member States on the potential release of radioactive products into the outer containment during a fuel melt down accident.

This project has its focal point in the execution of in-pile tests in the Phebus PF facility at CEA Cadarache which are planned to commence in 1992. The Institute for Safety Technology provides a deputy project manager and a small team which is integrated in the project work on site. Shared cost activities are being carried out by laboratories in Member States to help in the choice of instrumentation, definition of the test matrix, execution of out-of-pile tests e.g. on fission product chemistry and analysis of detailed layout of the experimental rig. Existing calculation tools of the Institute are widely used in this preparatory phase but a more general and wider ranging activity for a European Source Term Suite has been launched which is intended to integrate European models and codes.

Industrial Hazards: The FIRES Project and Emergency venting of chemical reactors

The Institute broadens the spectrum of those activities which are not solely applicable to the nuclear area and in which experience gained in the past, particularly in thermodynamics and structural analysis, find challenging new applications.

Research on chemical and fluid dynamic phenomena associated with runaway reactions continued as part of the Industrial Hazards programme. The facility called FIRES (Facility for Investigating Runaway Events Safety) whose central part is a 100 litre capacity standard chemical reactor, is planned to be completed in 1990. Most of the 1989 resources were dedicated to this installation. In addition 1:1 scale model tests were performed in a glass reactor to determine the stirrer performance on the reaction mixture. The 2 litre reaction calorimeter purchased in 1989, was used to gain basic knowledge of the chemical processes prior to their investigation in FIRES.

Figure 51: An exterior view of the wall of the FIRES bunker which will house a 100 l Chemical Reactor for Runaway Reaction Studies.

Satisfactory agreement between experimental data and the results of the mathematical simulator were obtained. This indicates that interactive real time computer simulation of batch-type chemical reactors could also become a promising control and operation tool for industry.

Investigations on multiphase flow phenomena in reactor relief systems during venting were continued with measurements of the influence of viscosity and surface tension on vented mass fractions and related flow patterns.

Analytical studies performed in parallel with the experimental work make use of existing US codes but concentrate on the development of a new computer programme called VESSEL which models one-dimensionally the transient behaviour of multicomponent mixtures of chemicals during a venting process.

The nuclear reactor safety code RELAPS5/Mod 1 has been used to describe the behaviour of a petrochemical plant under off-normal conditions.

The contribution of the Institute of Systems Engineering to the Industrial Hazards programme, consists of the execution of 4 projects.

- Safety and reliability assessment
  Phases I and II of the Benchmark Exercise on Major Hazards Analysis aimed at comparing the approaches to risk analysis for chemical installations in Europe have been completed. 20 teams participated as representing authorities, research organisations and industry.
  In working phase I (completed in 1988) the overall risk figures obtained by participants teams have been compared and the reasons of the significant spread found on the risk figures has been investigated.

The content of Working Phase II has been designed in such a way that instead of performing an overall risk assessment, specific exercises, based on rather well defined boundary conditions, have been repeated on particular topics. At the final meeting held in October 1989, the results have been compared and elements for specific recommendations for consistent procedures have been drawn up.

- Risk management
  A theoretical study identifying potential paradoxical situations in risk communication was carried out. Work on a model of decision-making, risk communication and organisational culture was begun, for the eventual use in generation of decision support systems.
  A decision support system (PURPLE) was developed for study of siting problems related to waste disposal, and the use of Petri Nets for modelling of complex decision processes has also been investigated. Further improvements were made in the the PC based system for digitising thematic data for risk management maps (MAKE MAP Computer Programme).

- Human factors in high risk prevention and management
  The feasibility study on the structure of a data base for storing and analysis of human behaviour data in various phases of the accidents has been completed. The data base is structured around the new human error classification in which parameteres derived from cognitive engineering and factors concerning social and organisational psychologies are included. The possibility of applying the cognitive model of the operator to aeroplane pilot tasks has been studied. A project for modelling navigation error of an aircraft pilot has been set up.

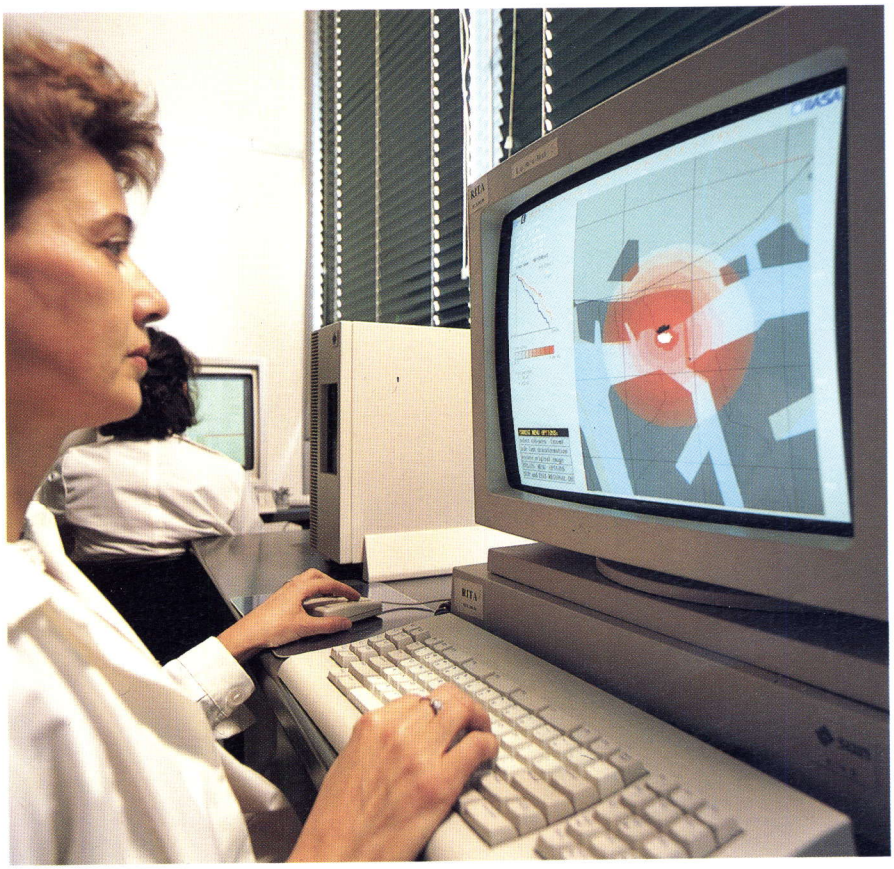


Figure 52: The Ispra Risk Management Support System (IRIMS) displaying a simulation of an accident scenario.

- Risk of transportation of dangerous products on the European scale
  Historical data for transportation accidents from open sources was studied and an empirical frequency-consequence relationship for transportation was developed.
  The first data was integrated in a Transportation Risk Management System (TRIM), including demographic, geographic (Map of Denmark), accident frequency and consequence models.

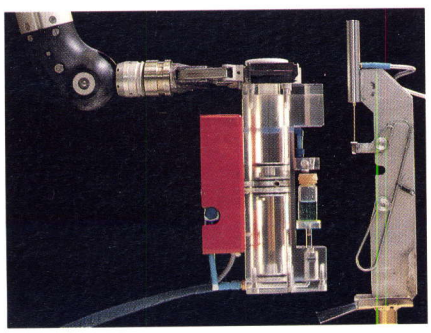


Figure 53: An automatic sampling system designed to remotely take samples by means of a master slave from the various sampling points installed in the PETRA loop housed in hot cell conditions.

Operation of PETRA - Nuclear Waste and Actinide Monitoring (contribution to the programme on Radioactive Waste Management)

The Institute's main task in the nuclear waste programme is the construction, commissioning and operation of PETRA, a facility which has the capability of performing typical high activity processing steps in fuel reprocessing, including verification, optimisation and demonstration of waste confinement and disposal concepts. The construction was completed in January 1989 and was followed by cold commissioning tests which are expected to be completed in early 1990.

The construction of a fully automated waste barrel monitor, based on triple correlation analysis, was virtually completed. This work draws from experience gathered in measuring campaigns executed on behalf of external contractors.

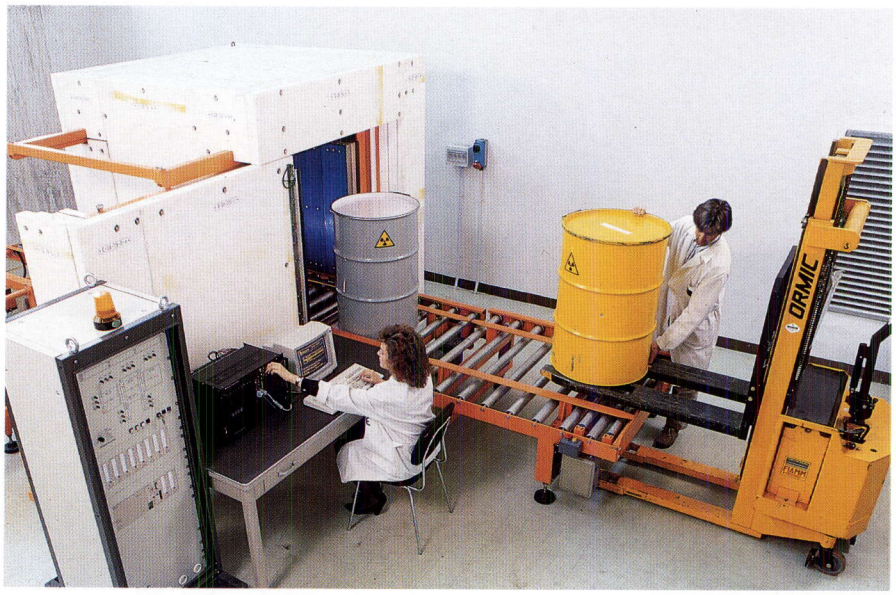


Figure 54: An overall view of the non-destructive Plutonium waste monitoring system developed at Ispra.

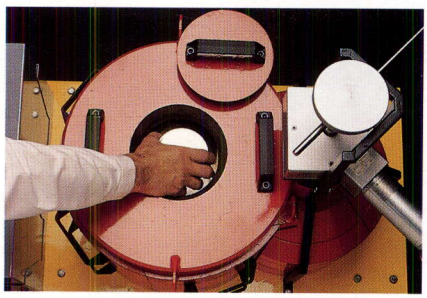


Figure 55: The PHONID 4 facility - lighter than its predecessors, this apparatus is particularly adapted for Plutonium samples. With new software and inserted in the Safeguards Headquarters system it is the new proposal from the JRC - Ispra for bulk sample measurements.

Operation of PRE-PERLA - (contribution to the programme on Safeguards and Fissile Materials Management)

The Institute is involved in the development of non destructive assay methods needed for nuclear safeguards and it runs the Performance Laboratory PRE-PERLA which constitutes a valid point of contact between instrument development and application. This laboratory is now functioning with Pu and U test samples of known isotopic composition and weight which are representative for in-field campaigns. The construction of the main PERLA Calibration Laboratoty continued and civil engineering works have been completed. The instrument development work concentrated mainly on improving the accuracy of existing measuring methods such as high resolution gamma spectroscopy, active neutron interrogation and others via the development of better data acquisition, elaboration and interpretation systems.

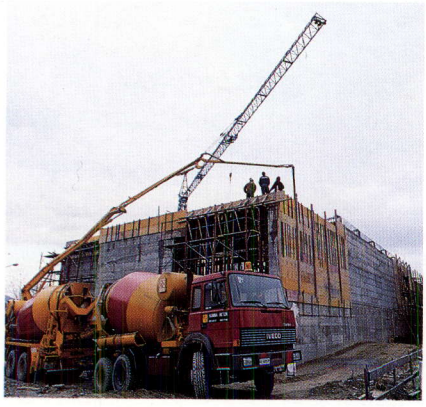


Figure 56: The ETHEL Laboratory in an advanced stage of construction.

Construction of ETHEL - (contribution to the programme on Fusion Technology and Safety)

The ETHEL project made significant progress:

- The building is completed up to the roof level;
- a 350 m^3 double skinned steel container is ready for installation;
- experimental glove box suites were successfully tested.

The construction will be completed in 1990 in accordance with the planning. While construction is in progress, tests and analysis are being carried out in such areas as:

- Assessment studies of tritiated waste;
- tritium recovery from liquid LiPb eutectic,;
- recycling of hydrogen and deuterium from first wall materials;
- hydrogen interaction with fusion relevant materials, etc.

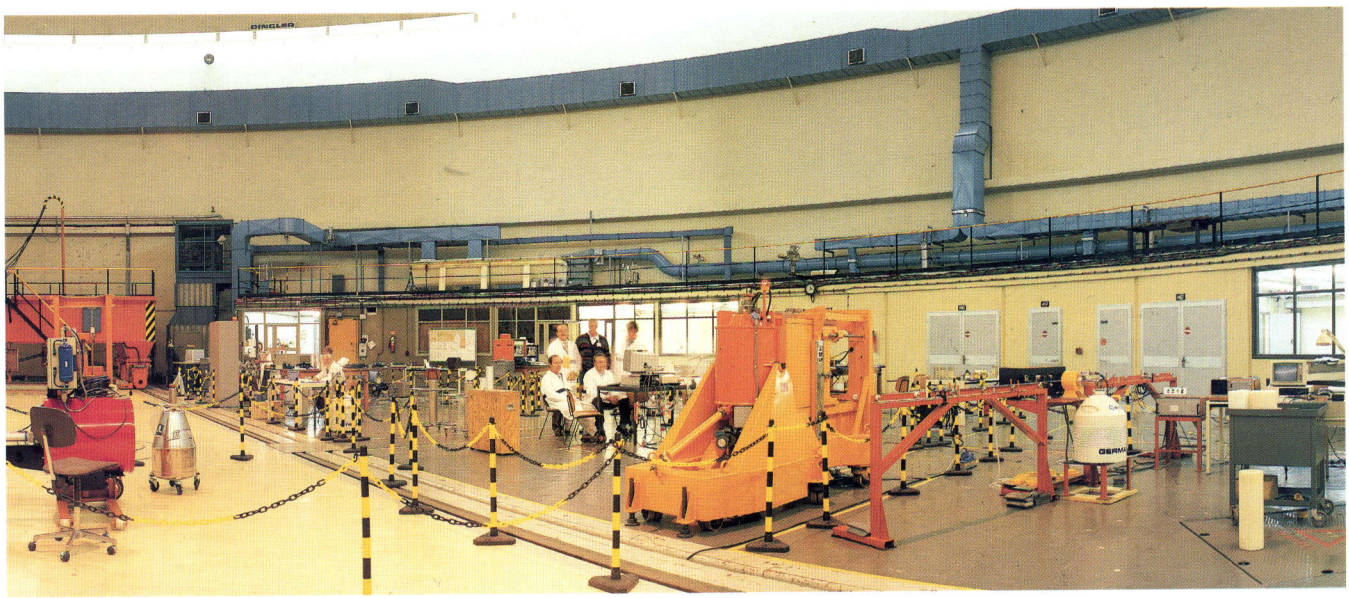


Figure 57: Pre-PERLA activities: The PERformance LAboratory (PERLA) during a training exercise for Euratom and IAEA Inspectors.

Centre for Information Technologies and Electronics

The Centre for Information Technologies and Electronics and the Institute for Prospective Technological Studies are mainly performing 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.

Centre for Information Technologies and Electronics (CITE)

The Centre consists of two divisions:

The **Informatics Division**, which consists of the Computing Centre and Software Services. The Division provides services in informatics to in-house users and to external customers.

The **Division of Advanced Applications of Information Technologies and Electronics**, which is a research unit concentrating on advanced computing, applied artificial intelligence, visionics, process control and signal processing.

Informatics Division

- Computing Centre
  The Computing Center has improved its facilities and the quality of the services offered. Since the beginning of 1989, two operating systems are working in parallel on the AMDAHL mainframe one of which is based on UNIX and is complementary to the UNIX environment now available on micro, mini and mainframe machines.

  The automatic control of the work of the mainframe is in the final phase of development.

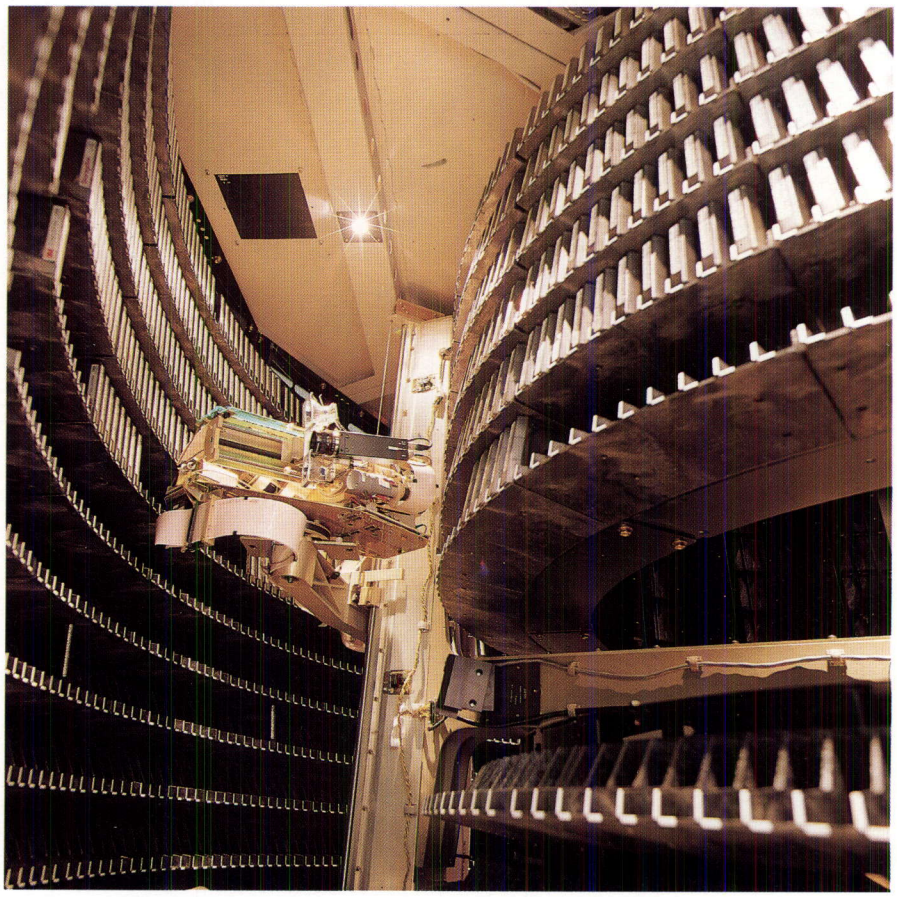


Figure 58: A 'Juke Box' optical disk archive system (WORM) possessing 300 Gigabytes of data - an integral part of the automated tape cartridge library.

The use of an external CRAY has been maintained, under service bureau agreements, at a somewhat lower level (200 Kecus/a) than in 1988, corresponding to the user demand.
Two TELMAT T-NODE scientific computers will be installed as part of a collaboration agreement and will be accessible to JRC users through a network.

In order to connect the various Ethernet LANS already spread over the Ispra site, an optical fiber backbone network with professional communication nodes is currently being installed, as a second generation of the experimental Dual network.
Office automation has developed consistently and, by now, about 180 users (on the five JRC sites) are connected and can communicate through heterogeneous systems using the X. 400 protocols.
Inter-site telecommunications have been improved by the introduction of compression tools to compensate for the scarse capacity of current international X 25 public networks.

- Software Service
  Under the new JRC structure, the software section has joined the computing centre within the Informatics Division. This should allow for better complementarity and integration of efforts and translate into an improved service for end users.

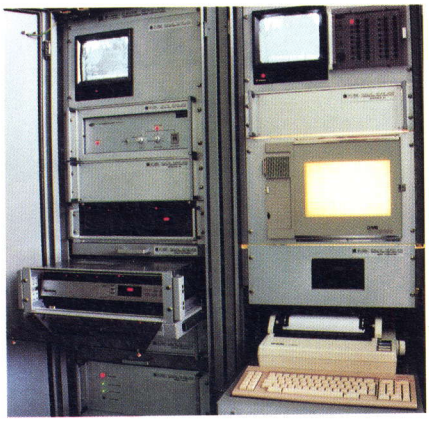


Figure 59: A detail of an integrated workstation performing Computer Aided Video Surveillance (CAVIS).

To improve the SIBECA service (on-line budgeting and real time accounting system), a help-desk is now available to the end user.

Continuing support for the JRC Data Bases has been provided, assuring the correct production and maintenance, and providing all necessary improvements.

Division for Advanced Applications of Information Technologies and Electronics

The activities of this new Division have developed rapidly. The Division participates in and has made significant contribution to several projects within the following specific programmes:

- Safeguards:
  - Design and implementation of an innovative safeguards information system;
  - the following main achievements may be reported in the field of surveillance techniques:
    a) development of methods based on image processing systems with increased level of intelligence for the automatic review or on line reduction of surveillance video data
    b) design of multisensor systems, integrating surveillance pictures with other sensor information for achieving a higher degree of assurance and reliability in safeguards measures

Figure 60: A computer room where research is carried out in support of Hypermedia and knowledge engineering studies.

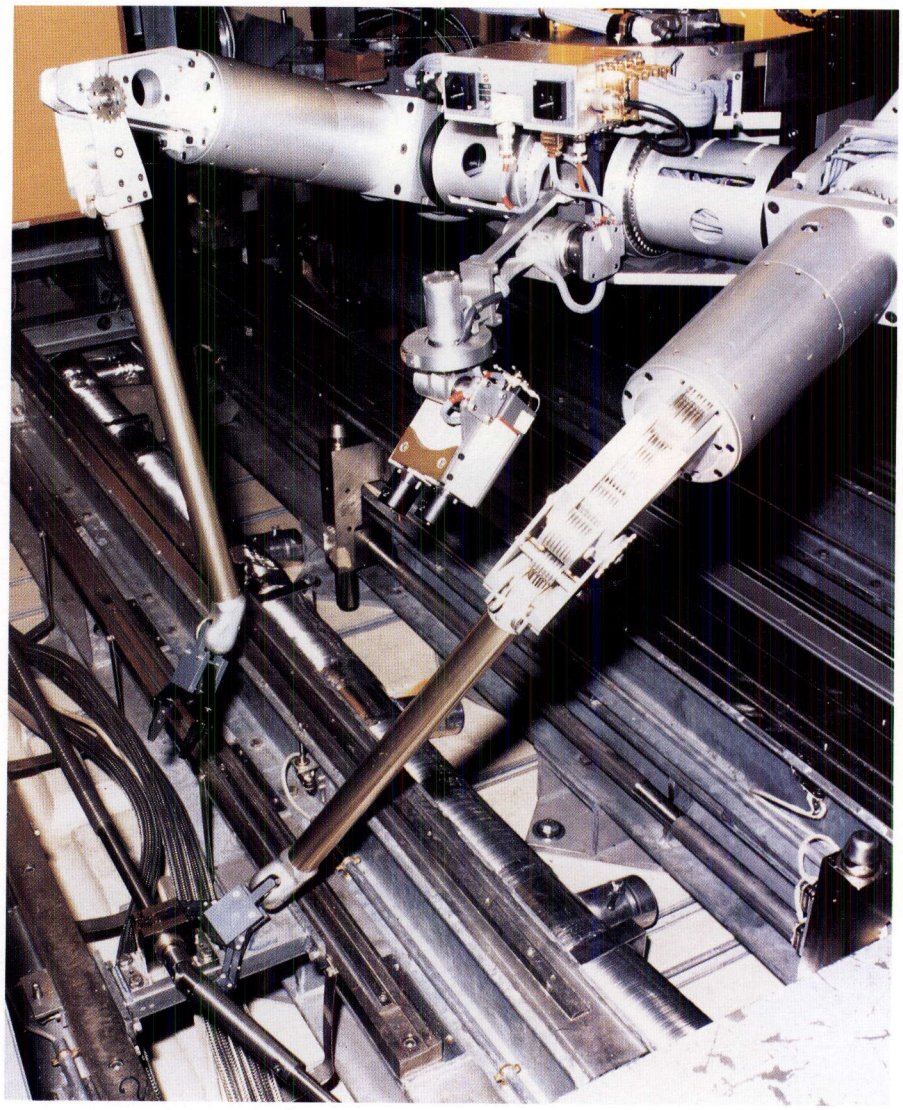


Figure 61: A tele-operated vehicle at work - part of a collaborative project between the JRC and CERN regarding the development of image data bases for inspection purposes.

c) feasibility study of computer assisted tele-operations including remote vehicle guidance and object handling in inaccessible areas of a pilot storage facility to be implemented in LASCO.

- Safety/Industrial Risk: set up of a general system for storing and manipulating data from experiments and their visualization.
- Environmental Protection: Development of a toxic waste management decision support system (CheM).
- Remote Sensing: development of data processing systems for radar data.

Institute for Prospective Technological Studies

The Institute for Prospective Technological Studies, was created only at the beginning of 1989. Consequently, this first year has been largely devoted to putting in place the tools and structures necessary for the fulfilment of its designated tasks.

To this end the Institute is engaged in building up a Science and Technology Observatory which, it is hoped, will eventually provide European decision-makers with a unique and readily accessible source of information on the state-of-the-art of key technologies, the major players involved in their development and Europe' s state of preparedness relative to our major trading partners.

The Observatory represents not only a technical but also a human challenge since it will depend, for its information inputs, on a complex structure of sources and much skilled evaluation. The intention is to rely heavily on networks of experts (including the JRC' s own scientists) to supplement such traditional sources as journals, newsletters, press reports and data bases.

The other main task entrusted to the Institute is the conduct of strategic analyses of new areas of science and technology. Based on the JRC' s existing expertise, but drawing also on the skills and knowledge of research fellows, visiting scientists and experts on secondment from other institutions, such studies are performed on the request of various clients, mainly from within the Community institutions but also including national and regional authorities and private industry.

Clients can include other JRC Institutes. Among the studies initiated during 1989 were two for the Institute of Advanced Materials and one for the Environment Institute. Preliminary work also commenced on three studies for DG XII: one, on the underlying structure and dynamics of the technological system, at the request of the Director-General; the other two, on R&D strategies for transport-related environmental problems and on research aspects of norms and standards, as part of the MONITOR programme.

Other work in support of Commission services is providing assistance to the ''Forward Studies Unit'', newly established by the Commission.

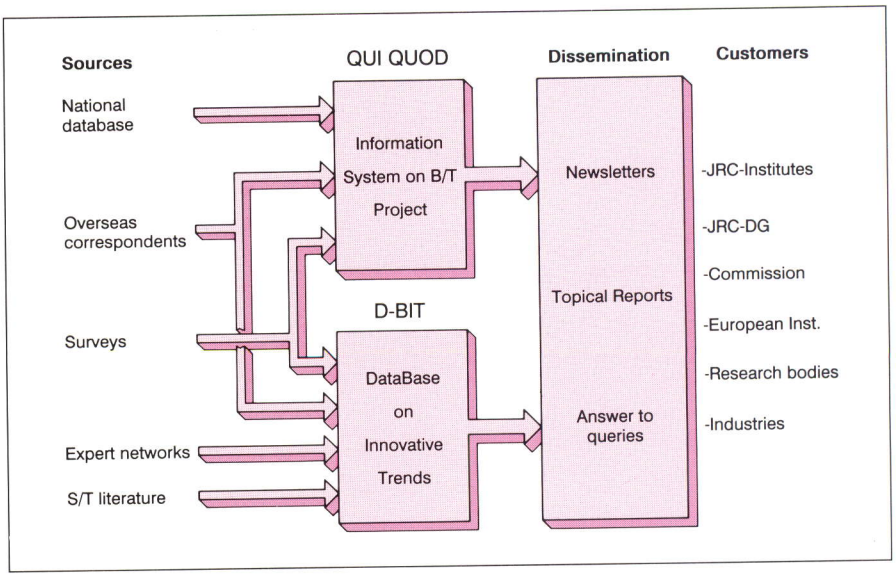


Figure 62: A chart describing the functions of the European Science and Technology Observatory (ESTO).

JRC EXPLORATORY RESEARCH

Research Projects 1988/89

The Board of Governors examined the JRC Exploratory research at its meetings on 3rd February 1989 and on 2nd May 1989.

In agreement with its advice, eight exploratory research projects already funded in 1988 were continued, six projects were transfrerred into specific research programmes and the others projects were terminated; the funding of four new proposals was also decided.

Main achievements arising from exploratory research projects which were continued in 1989 were as follows:

Study of Transition Radiation (CBNM, Geel) is concentrating on the measurements of both optical and X-ray radiations

An optical system for observation of the visible light emitted from thin foil radiators has been installed using a sensitive CCD camera set up outside the target room. The X-ray spectra emitted by various stacks of foils have been calculated. In view of reducing some non relevant Bremsstrahlung the magnetic deviations have been modified.

Development of Isotope Dilution Mass Spectrometry (CBNM, Geel)

The development of isotope dilution mass spectrometry (IDMS) for rubidium concentration measurements has been pursued. 85Rb/87Rb isotope ratio measurements in the presence of a 10^6 fold excess of caesium were applied to determine rubidium traces. For the first time IDMS of silicon on gaseous silicon compounds has been performed using SiF_4.

Acoustic Aerosol Scavenging (TUI Karlsruhe)

The feasibility of the use of high intensity acoustic waves to combat airborne spreading of accidentally released radioactive or toxic material has been investigated for the past two years. During 1989 the acoustic agglomeration of submicron combustion aerosols produced by burning rubber in a 15 m^3 chamber was studied and compared to earlier results obtained in a 4.5 m^3 chamber. The results have shown that increasing the sound pressure level

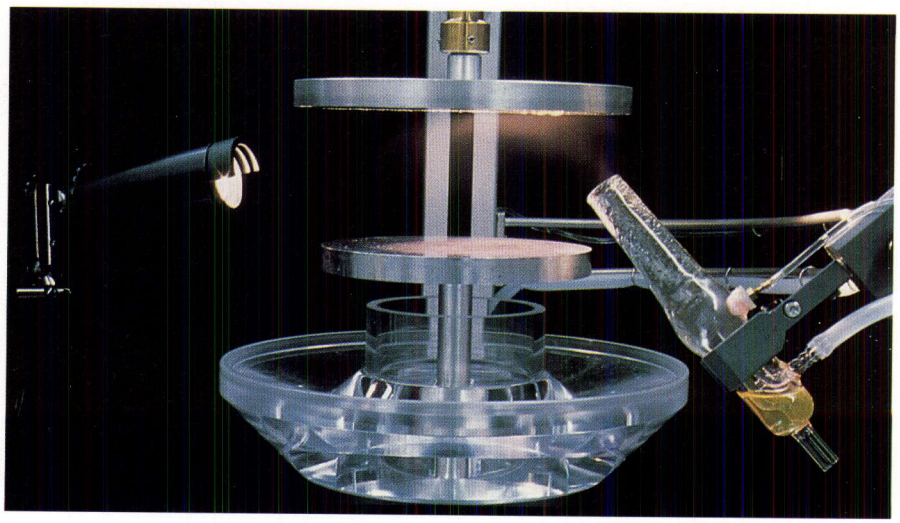


Figure 63: Coagulation of a water aerosol by an ultrasonic field.

drastically increases the agglomeration rate. However, their sedimentation velocity increases only slightly due to the fact that smoke agglomerates are open structures with modest aerodynamic diameters.

Future experiments will concentrate on acoustic agglomeration of well defined aerosols under dynamic flow conditions. A potential application is the acoustic pretreatment of fine particles in gas streams to increase particle sizes and hence the efficiency of electrostatic filter or cyclone precipitators. The necessary equipment is being installed.

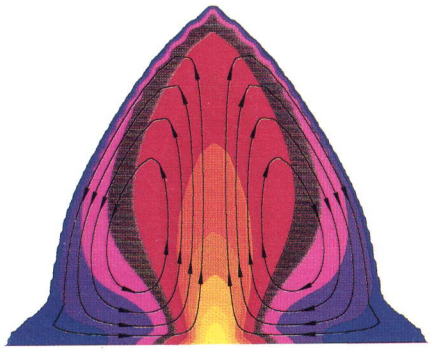


Figure 64: Marangoni Convection in a Laser Melted Pool.

Micro-hydrodynamics of Laser Melted Metallic Pools (Advanced Materials)

The two - dimensional computer model developed in the Institute can map out the current flows driven by surface tension gradients (Marangoni flow) and thermal gradients.

The model has been extended to another urgent problem encountered in practice, namely, rippling of the solidified surface. During laser surface melting, a sharp temperature gradient extends radially away from the centre of the laser beam. This results in a motion of liquid away from the centre, causing a localised depression in the surface of the molten substrate which after solidification appears as a ''ripple''.

This generic modelling which is being published in several papers, is finding potential application to various phenomena, some of which have immediate interest in materials science and technology, for example;

- problems in erosion in smelting furnaces due to chemical dissolution of the furnace walls, believed to be due to a form of Marangoni flow.
- microgravity and growth of perfect crystals.
- plasma disruptions experienced on the first wall of a thermonuclear fusion reactor.

Figure 65: View of a part of 3-D image processing laboratory.

Image Processing and Synthesis for Diagnostics (Institute for Systems Engineering and CITE, Ispra)

Analysis and synthesis of holograms

A study carried out in collaboration with the University of Milan has shown that the holographic synthesis is possible via the use of proper analytical illumination models.

As far as the analysis of interferometric fringes is concerned, it has been proved that the use of a multi resolution, multi orientation procedure using a pyramid (wavelet transform) scheme allows to obtain a smoothed and enhanced version of the original image, with non linear noise-rejection, and consequently to achieve a robust fringe detection.

Beside this, a more powerful and general approach, although more difficult, is being developed. It is based on modelling amplitude and phase variations by stochastic processes and on the assumption that the Paley-Wiener relationship applies, assuring that the process is a non-deterministic regular one and enabling the application of the theory of irreversible dynamic processes.

Analysis of the topological structure of turbulent flows

Images obtained from the visualization of the turbulent flow under particular lighting conditions (coherent light) have been analysed by image processing techniques.

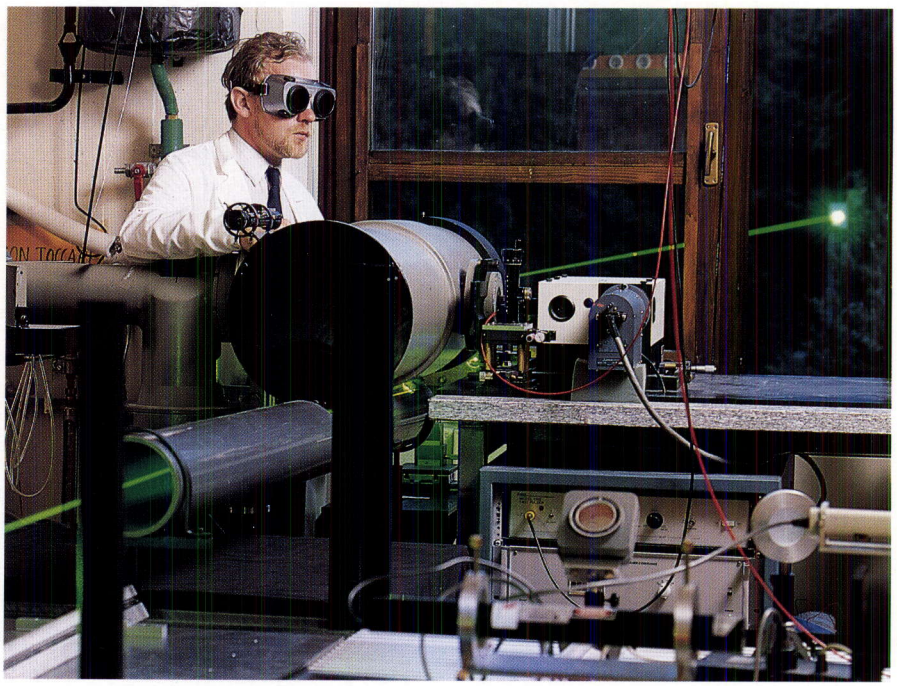


Figure 66: A simulation facility developed at the JRC Ispra for remote spectral and time characterisation of laser induced fluorescence.

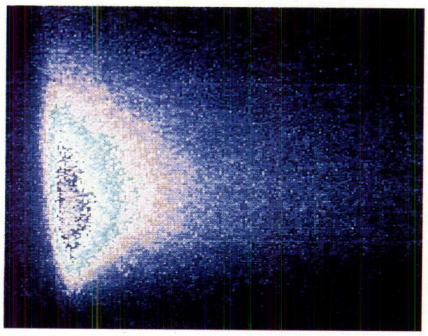


Figure 67: A spectro-temporal image showing the fluorescence signal intensity as a function of wavelength and time.

The possibility to explore fractal structure of turbulent phenomena relevant for environmental impact evaluation (growth of a plume in atmospheris flow).

Application of Laser spectroscopy (Institute for Remote Sensing Applications, Ispra)

The 1989 objectives were to perform vitality tests on vegetation using classical instrumentation for plant physiology work and to build up a system for time resolved fluorescence measurements. Initial results on green leaves show, that at room temperature, time resolved measurements of the chlorophyll fluorescence decay can be analysed using a four exponential kinetic model.

The overall decay is characterized by lifetimes of approx. 10-40 ps, 80-140 ps, 400-450 ps and 700-900 ps. By blocking the photosynthetic electron transport system with herbicides, the lifetimes of the two slowest components increase by a factor of 4. To correlate these results with physiological parameters, a biological laboratory with the possibility to monitor net-photosynthesis, transpiration, stomata conductance, the potential photosynthetic activity and the water potential of the plants has been developed.

Neuronal Networks Application (CITE)

Identification of applications in the processing of remote sensing images and in econometric time series forecasting.

A multilayer feedforward neural network with sigmoid activation functions, trained by the on-line back-propagation algorithm has been set-up. This architecture has been successfully used to forecast the behaviour of two time series from the CRONOS domain about industrial conjuncture covering the period January 1971 - August 1988.

H/D Extraction, Purification and Separation (Institute for Safety Technology, Ispra)

Gas-solid separation processes were analysed to resolve problems of purification and extraction of gases. Gas chromatographic techniques were employed to characterize Ba-, Ca-, and Ni-modernites as adsorbent materials.

The final aim of these studies is to develop a model which can predict the adsorptive properties of materials and hence may give guidance in the production of adsorbants for given separation or purification processes.

Research Project 1989

Main achievements arising from exploratory research initiated in 1989 are:

Boron Neutron Capture Therapy (Advanced Materials, Petten and Safety Technology, Ispra)

New major developments in tumour - seeking boron compounds have led to a renewed interest in use the highly localised energy release following the nuclear fission of the boron-10 to destroy the tumor. Because the High Flux Reactor at Petten provides favourable conditions, a programme has been initiated to set up a clinical facility at one of the large cross-section beam tubes. The neutron and gamma field characteristics have been assessed and measured and optimisation calculations for neutron filters are underway. The work is executed in cooperation with the JRC Institute of Safety Technology, the Netherlands Cancer Institute, and the Netherlands Energy Research Foundation, Petten. The work is supported by a European Working Group on Boron Neutron Capture Therapy organised as a Concerted Action under the Medical and Health Programme of the European Communities.

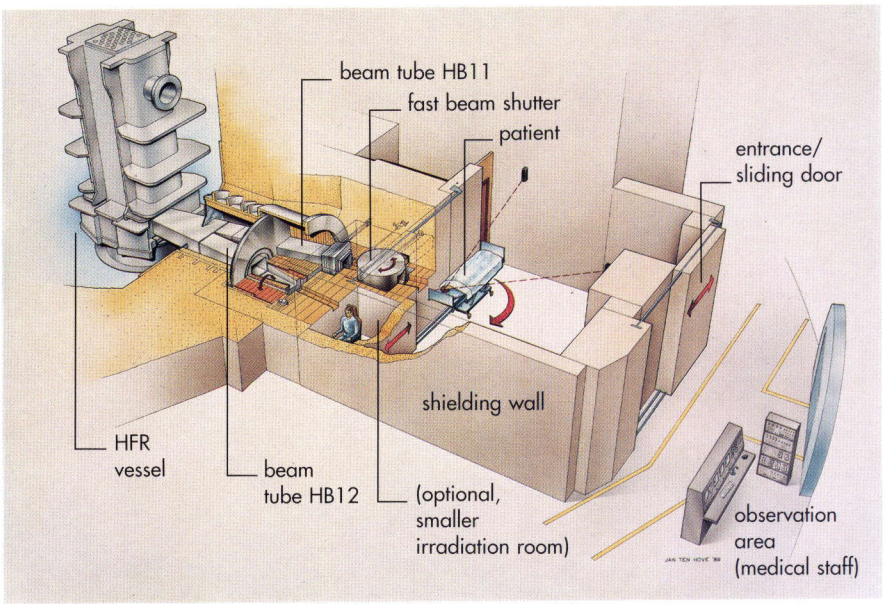


Figure 68: A cut away of the Boron Neutron Capture Therapy (BNCT) Installation at Petten. First clinical trials are due to begin in 1991/92.

Ceramics/Metals joining (Advanced Materials, Petten-Ispra)

The ability to join ceramics to metals or other ceramics is a prerequisite for their future industrial acceptance. This project is aimed at exploring new routes for the joining of ceramics through careful design of the microchemical features of the joint interface.

A technique has been developed for tailoring joint interfaces in silicon nitride by use of transition metal interlayers as well as ion implantation which facilitates diffusion bonding. Average joint strengths can now be obtained which are acceptable for certain industrial applications, but the scatter in strength, due largely to joint porosity, is being improved.

Artificial Intelligence Techniques for the Integration of software systems (Kwick) (Systems Engineeering, CITE, Ispra)

Study, design and implementation of an intelligent agents system for the integration of multi-media engines with operation system functions and other application software.

The specific tasks developed during 1989 were:

- Functional definition of the envisaged Supervisor
- Acquisition of an existing multimedia engine for the first phase of prototyping
- Definition of the software environment for software design and experimentation
- Experimental study of some Agent's properties.

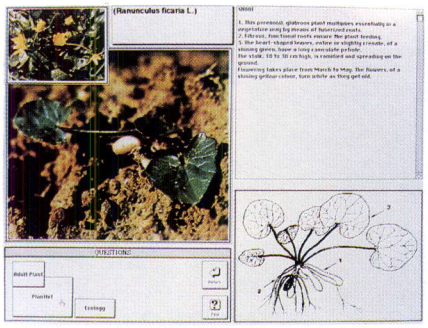


Figure 69/70: Plant Classification using an hypermedia expert system developed at Ispra (detail above).

Man-machine interaction with a cooperating agents worlds (Archon) (CITE, Ispra)

Study, design and implementation of the man machine interface of the software environment supporting cooperation between semi-autonomous intelligent agents.

The specific tasks developed during 1989 were:

- Studies of the concept related with the interaction of a human user with a Cooperating Agent's world;
- First prototyping of a testbed of agents by using some existing software environments;

The specific agents used have been developed within the specific research programme on environemtanl protection (CheM activity).

JRC S/T 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 management of projects or contracts;
- scientific and technical expertise and elaboration of elements for Council directives or recommendations.

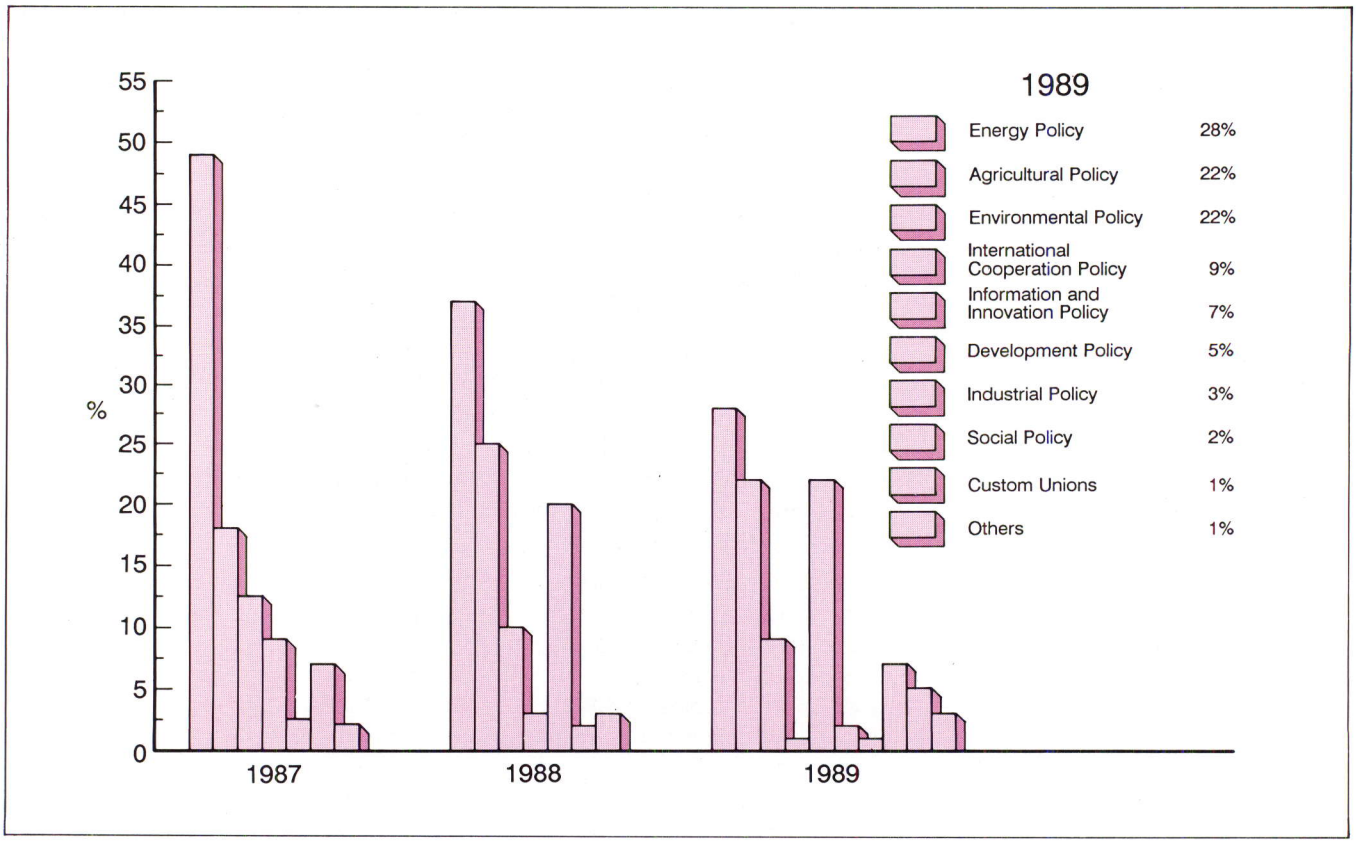
During 1989 support to Community policies accounted for 13% of the JRC budget, an increase from 10% in 1988 and from 3% in 1987; this share is expected to increase further according to the demands of the Commission services. An illustration of the distribution of this support to the various Community policies is given in the figure below.

Support to International Cooperation

IAEA Safeguards (CBNM, Centre for Information Technologies and Electronics, Institute for Environment, Safety Technology, Systems Engineering, Transuranium Elements and Administration Directorate)

Technical support is provided to the IAEA safeguards inspectors in a large variety of disciplines such as nuclear measurement techniques, sealing and surveillance techniques and accountancy methods.

Figure 71: Support distribution to the various Community policies.



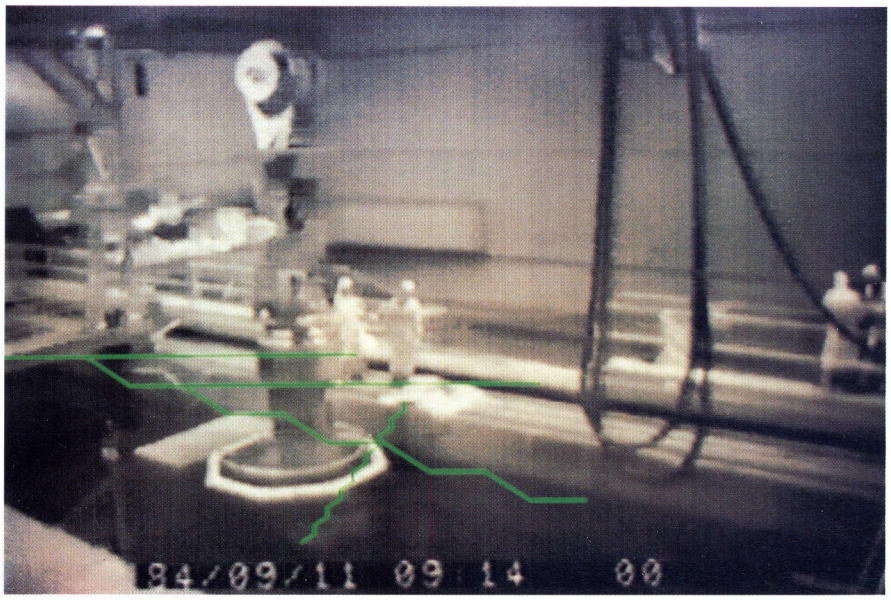


Figure 72: An example of polyline method for videotape review.

The main achievements are the following:

- an engineered prototype of the laser surveillance system has been installed at a spent fuel storage pond for field tests in air; two other systems have been produced for further investigation in underwater operation;
- in the framework of support programmes between several countries and the IAEA, JRC has presently provided an automatic system for video reviewing to IAEA headquarters, La Hague reprocessing plant and AECB (Canada) for CANDU reactors;
- a knowledge based system for the automatic transit matching of nuclear material movements has been developed and installed at IAEA headquarters; extension of this evaluation system is now being undertaken for both international and domestic (EC countries) transfer;
- simulation of reprocessing input measurements are performed (in collaboration with ENEA). The computer simulator has been adapted to a prototype of a large throughput reprocessing plant tank;
- well caracterized metallic spikes of U-Pu alloys for reprocessing input analysis have been prepared and interlaboratory measurement evaluation programmes are conducted on U and Pu materials;
- the Transuranium Institute (Karlsruhe) has contributed to the evaluation and the automation of analytical techniques in support to the Safeguards Analytical Laboratory of Seibersdorf. The tasks which are currently being carried out cover the development of software for quality control of analytical results on input samples, field-testing of a K-edge densitometer for reprocessing plant samples and the automatic conditioning of samples by robots. A joint evaluation and exchange of experience made with the robot will be done shortly. A cooperative field test of on-site sample conditioning by robots will be executed at the pilot plant at Gatchina near Leningrad. The scope of the experiment and the design of the robot are at present under discussion;

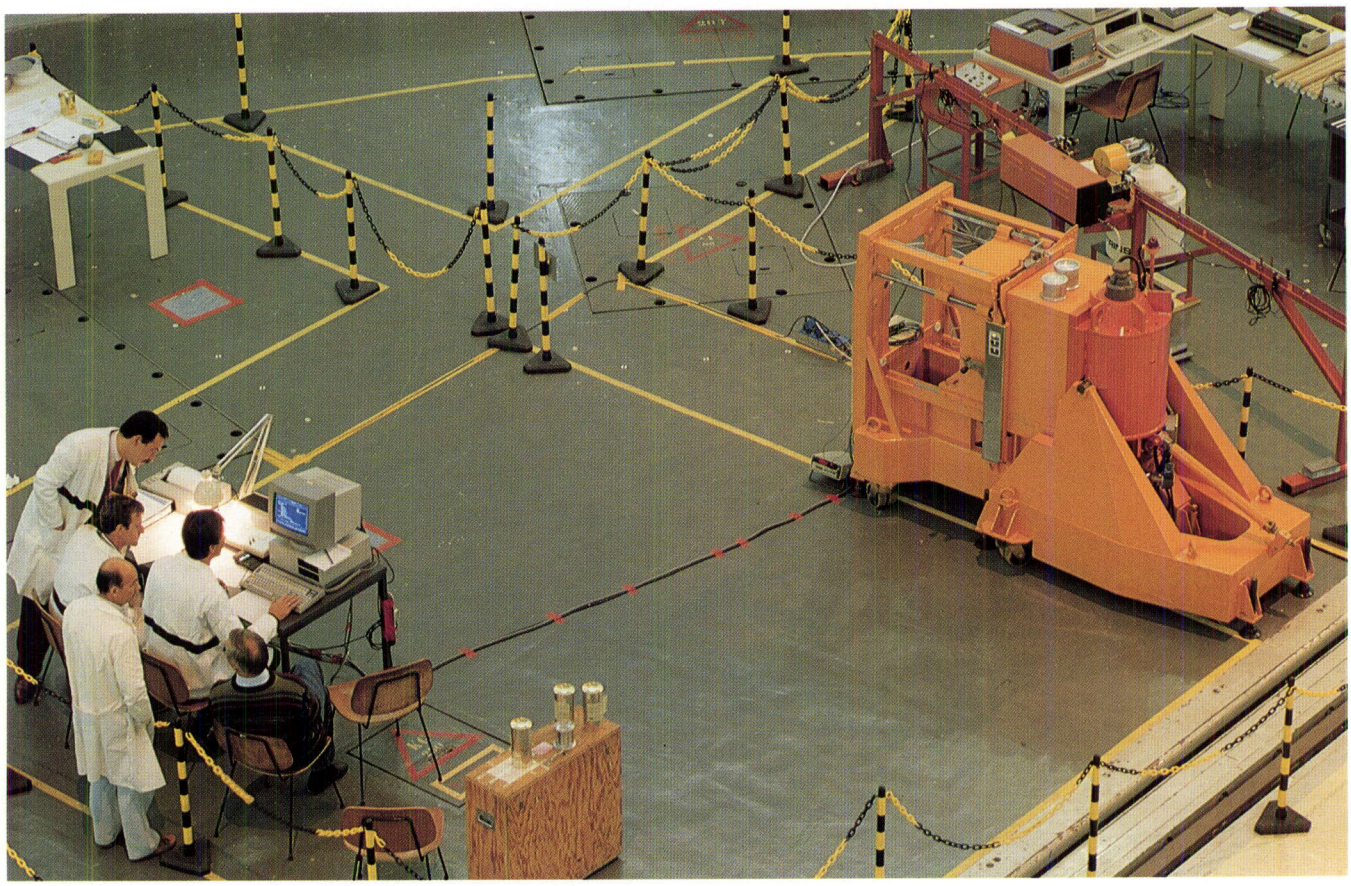


Figure 73: The PHONID 3 facility (top right) in use during training exercises in the Pre PERLA Laboratory.

- a compact active neutron interrogation system has been designed and a laboratory prototype is now ready to be tested at PERLA;
- procurement schemes for Non Destructive Analysis (NDA) PERLA standards are being developed with IAEA experts, to assure their acceptability for international safeguards;
- three campaigns have been performed at PERLA with IAEA staff in view of the calibration of NDA instruments for Plutonium isotopic measurements and U assay in Material Testing Reactor's fuel elements by gamma ray spectrometry and U analysis with an active neutron assay system;
- an intercomparison exercise of calorimeters for the measurement of large Pu samples is now being set up and will be conducted in 1990.
- the second physical inventory exercise on highly enriched uranium samples has been held at PERLA for IAEA inspectors.

Programme of Assistance and Technical Cooperation in favour of Developing countries (PACT)

According to the agreemnet with the IAEA (Vienna) ten trainees from developing countries were trained in advanced analytical techniques such as neutron activation analysis, X-ray diffraction, radiotracer techniques, X-ray fluorescence spectrometry and atomic absorption spectroscopy.

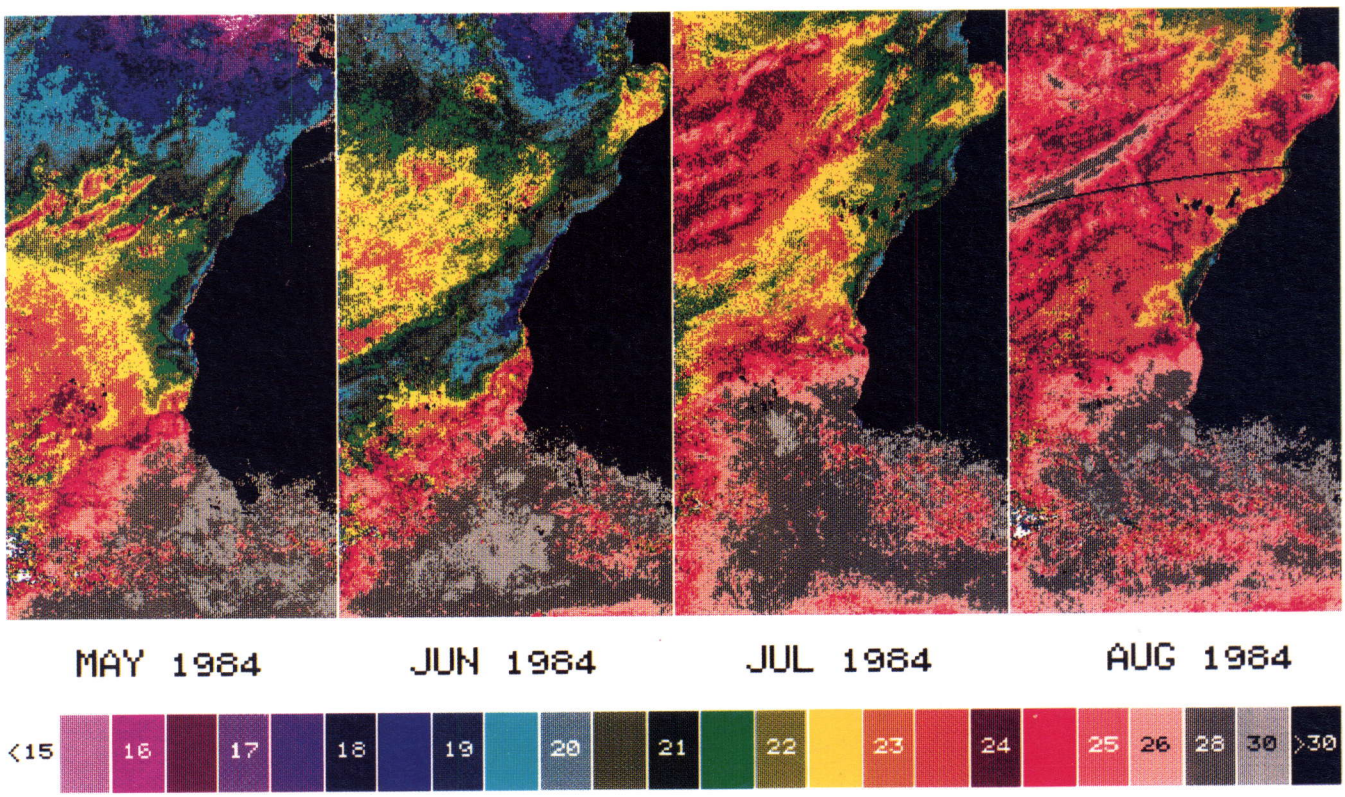
Study of the Northwest African upwelling area

The study, performed by the Institute for Remote Sensing Applications, of coastal upwelling along the North Adriatic coast of Morocco relies on remote sensing of sea colour, and surface temperature data. The objective is to demonstrate how knowledge of upwelling dynamics obtained by remote sensing and complemented with other types of data can be used to evaluate resources and thus to identify stock conservation requirements.

A descriptive study of the Northwest African upwelling area has been carried out using a series of NOAA AVHRR images. They have been processed into maps of sea surface temperature (where Sea Surface Temperature is used as an indicator of upwelling) and are interpreted with respect to upwelling variability and eastern boundary circulation. Analysis of daily wind fields are consistent with the large scale spatial and temporal variability of coastal upwelling as seen in the Sea Surface Temperature images.

Variability aspects have been further investigated in a study of simultaneously acquired CZCS and AVHRR images, which have been processed into maps of chlorophyll and Sea Surface Temperature. The spatial and temporal relationship between these parameters is highly variable in the upwelling area. Images acquired during a well developed upwelling event demonstrate a consistent degree of relationship while images acquired after relaxation of upwelling show very different distributions of chlorophyll and Sea Surface Temperature.

Figure 74: Monthly maximum value composites of sea surface temperature derived from NOAA/AVHRR satellite data for spring-summer 1984. (Area 0-40°N, 6-30°W). The images show the strong heating of the surface waters off NW Africa and the upwelling phenomenon along the coast that was persistent during June 1984. Results of processing of the NOAA/GAC archive during 1989.



JRC Support for Industrial Policy

World Shipbuilding Data Bank (Systems Engineering)

The operation of the Bank has been improved using a new method for distributing the statistics. A computer program is now available to obtain the statistical tables on floppy disks from the main frame. The work for UNCTAD and EUROSTAT was continued to obtain an internationally agreed ship classification.

Standards for ceramics (Advanced Materials)

The Institute for Advanced Materials has initiated a number of actions and organised several industrial workshops in order to promote European prenormative research for ceramics standards following which the European Standards Organisation CEN/CENELEC has identified a number of projects and work programmes to be conducted through R&D cooperative schemes

Pharmaceutical Databank

A prototype databank was developed and presented to representatives from Member States. Search programmes for the interrogation of the databank already loaded with selected sample data were also tested.

Figure 75: Fractionation of intercellular compounds from mamalian tissues in a cold room (+4°C).

Figure 76: A typical configuration of an analytical laboratory for food analysis.

JRC Support for Social Policy

Biological Monitoring and Occupational Exposure to Chemicals (Environment)

A first volume on ''Carcinogenity of Industrial Chemical Substances'' has been compiled and disseminated. The data collection on toxicology of industrial chemicals continued and the data are available through the ECDIN databank.

Renal Insufficiencies and Trace Metals (Environment)

The tracemetal contamination of patients by dialysis equipment was further investigated and a work in the global ''mass balance'' of trace metal during hemodialysis concluded. Other studies concerned the assessment of trace metal exposure of uremic patients during $CaCO_3$ treatment and biochemical mechanism of the Al toxicity.

JRC Support for the Common Agricultural Policy

Laboratory for food analysis (Environment)

For the creation of a databank on European wine based on the Nuclear Magnetic Resonance technique proposed by Prof. Martin, Nantes, an automatic measurement device for the routine interocmpairson of alcohol samples was implemented on the nuclear magnetic resonance spectrometer. A collaborative research on wine analysis from selected sites was started with the State Laboratory of Bavaria at Würzburg.

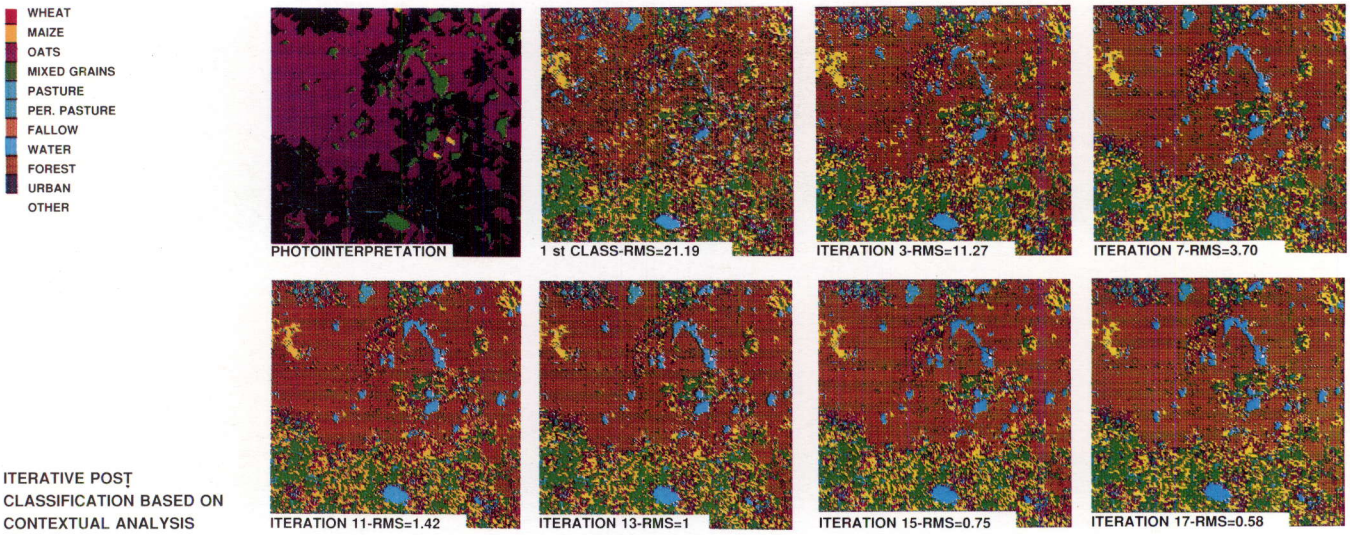


Figure 77: Textural and Contextual Features related to satellite imagery have been used for modelling pixel labelling errors in a GIS environment. The iterative post classification approach which has been carried out using this model resulted in high statistical and thematic accuracies.

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

In the frame of this activity expert group meetings and symposia on subjects like "fruit flies of economic importance", "control of cereal pests and diseases", "weed control in perennial crops" were organised.
Moreover, the proceedings of scientific meetings, lectures of training courses and final reports of study contracts were edited and a training course on "integrated control in viticulture" was organised.

Application of remote sensing to agricultural statistics (Remote Sensing)

This project consist of seven actions, the first four making up the major themes and the latter three being in support of these main actions; the first four actions progressed particularly in 1989.

Regional inventories
The inventories of the five regions have been followed up with the same contractors as last year. The ground surveys and the automatic classifications of satellite data were analysed; SPOT and LANDSAT provided almost complete coverage of 100,000 km^2 and allowed to increase significantly the accuracy of the ground survey. An effort has been made to improve the rapidity with which results are released. We are testing the possibility of estimating yield. Internal research is aimed at improving the registration and digitisation of the segments recorded by enumerators, in order to accelerate the automatic classification of satellite images.

Vegetation conditions and yield indicators
Seven contractors are studying methods to monitor vegetation with low-resolution (AVHRR) satellite data. Intermediate Reports for all the studies have been received and final reports from three of the contractors will be available by the end of the year. In parallel with these thematic studies, the Institute for Remote Sensing Applications is collaborating with the European Space Agency (ESA) to provide a user service for AVHRR data.

Models of yield prediction
Currently the work involves setting up a reliable data base containing historical agronomic climate and agro-meteorological information. Intermediate reports have been obtained on:

- agro-meteorological characteristics of the main crops
- standard estimation of evapo-transpiration at a European scale
- analysis of atmospheric pollen loadings for yield prediction of grapes and olives and determination of flowering stages.

All of this information is necessary for the creation of European scale yield prediction models.

Rapid estimates of changes in acreages and potential yield
A single consortium is executing a three-year contract to interpret high-resolution imagery of sample sites. Software specifically designed for image interpretation of crop characterisation has almost been finalised and in parallel a methodology for estimation of changes in areas is ready for initial testing.

Olive tree cultivation register
Technical assistance for the realization of olive tree registers in Spain, Greece and Portugal was provided. Reports submitted by these countries concerning preliminary measurements to be carried out for setting up suitable methods have been examined and suggestions made.

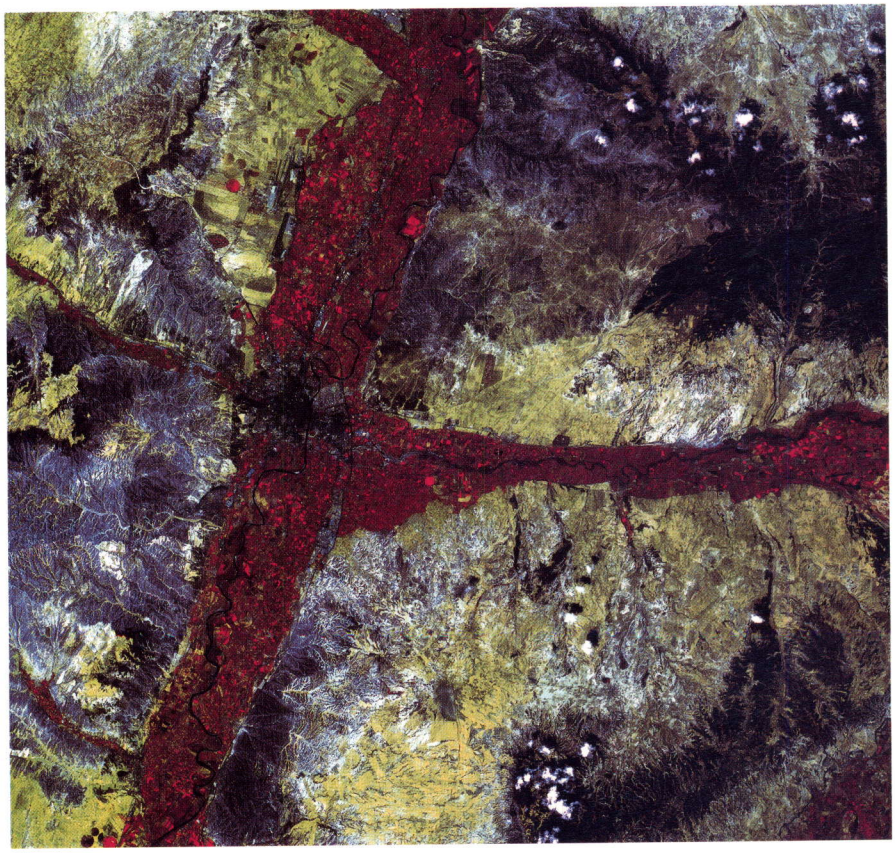
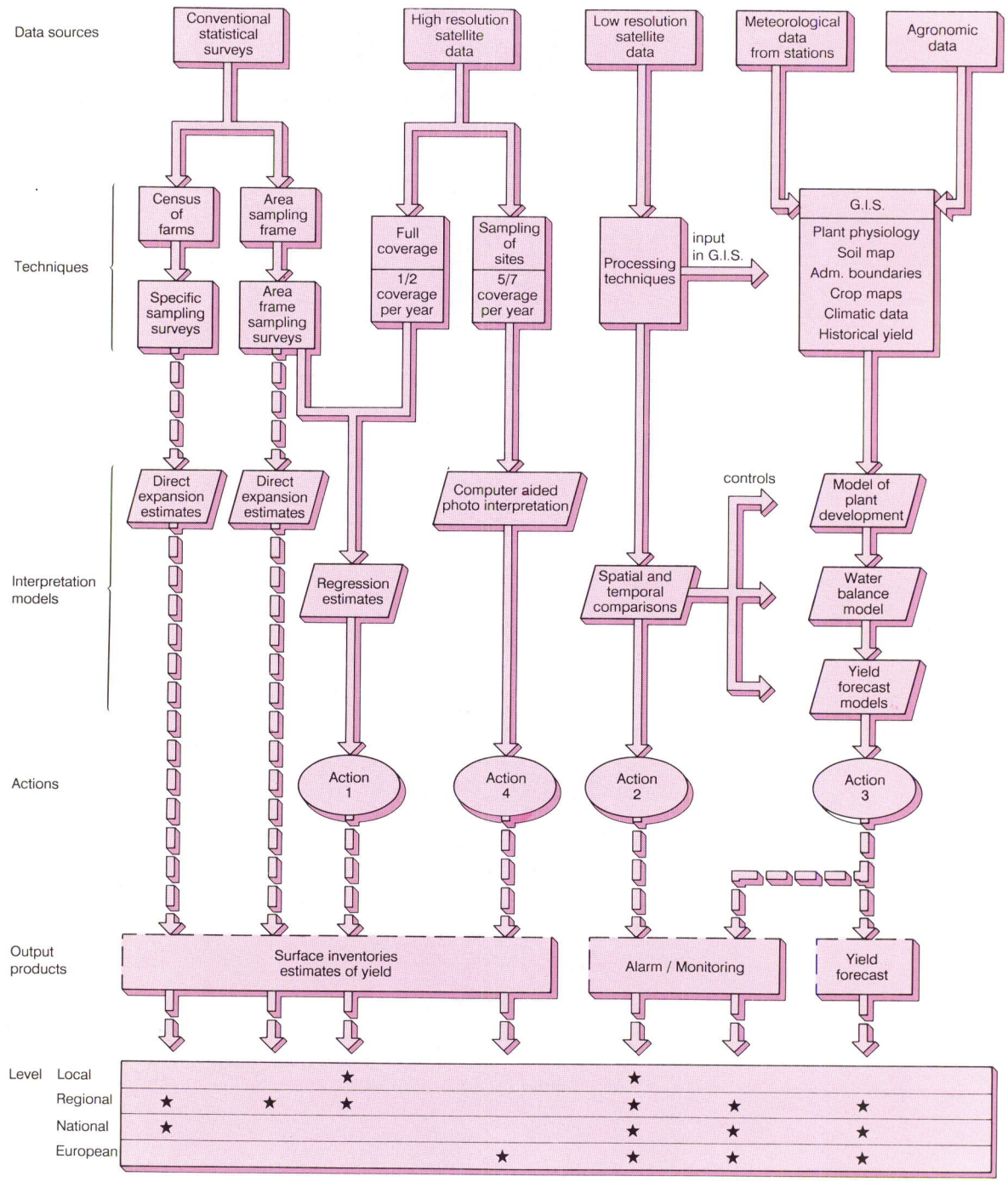


Figure 78: An example of a high resolution SPOT image suitable for carrying out inventories of crop acreages and potential yield, but too detailed for regional monitoring.


Data sources
Conventional statistical surveys
High resolution satellite data
Low resolution satellite data
Meteorological data from stations
Agronomic data
Techniques
Census of farms
Area sampling frame
Full coverage
1/2 coverage per year
Sampling of sites
5/7 coverage per year
Processing techniques
input in G.I.S.
G.I.S.
Plant physiology
Soil map
Adm. boundaries
Crop maps
Climatic data
Historical yield
Specific sampling surveys
Area frame sampling surveys
Interpretation models
Direct expansion estimates
Direct expansion estimates
Computer aided photo interpretation
controls
Model of plant development
Regression estimates
Spatial and temporal comparisons
Water balance model
Yield forecast models
Actions
Action 1
Action 4
Action 2
Action 3
Output products
Surface inventories estimates of yield
Alarm / Monitoring
Yield forecast
Level
Local
Regional
National
European

◀ **Figure 79**: The objective of the Advanced Agricultural Information System is to process results of the M.A.R.S. project with the aim to improve agricultural statistics in the Community.

Figure 80: Major fire event (large red area in the centre ≃ 10000 km^2) as seen by the AVHRR sensor in Southern Guinee - West Africa.

Figure 81: Man made fire in a tropical rain forest of the Amazon Basin.

JRC Support for Development Policy

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

The current data set consists mainly of archives of low resolution satellite data (AVHRR) obtained daily since 1982, over the whole continent of Africa and of the current production by the Maspalomas station covering most of West Africa.

Three main fields of application have been investigated; they relate to a specific aspect, role or functioning of the tropical ecosystems.

Technical developments in the use of LANDSAT data for the elaboration of a sampling frame adapted to rainfed crops have been completed. The results are being used by the national statistical services. The yield of the main crops (millet, sorghum) has been estimated using time series of vegetation index measurements by the NOAA satellite. It has been shown that, empirically, two thirds of the yield variability can be described using such satellite data. A deterministic yield model linking the primary productivity process to the vegetation index measurement has also been tested and evaluated.

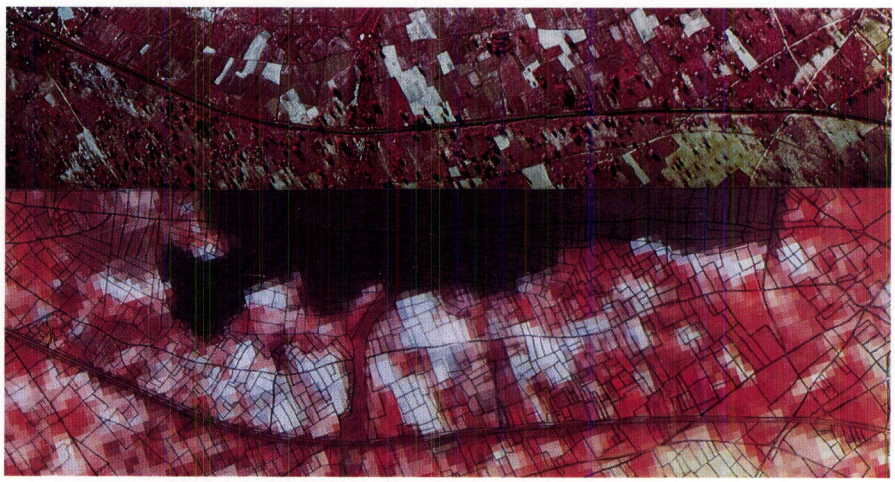


Figure 82: Comparison between SPOT colour composite (bottom) and a mosaic made with false colour infrared photographs taken from ultra-light aircraft (top) - in Mali, West Africa.

The study of the vegetation conditions in the large watersheds is based on the analysis of time series of satellite data at low resolution. These were assembled for each major basin of the region and then characterized in terms of dynamics of land cover. Two parameters were used to characterize surface parameters: the vegetation index and the surface temperature. An interpretation of fire patterns is included in the methodology. The insertion of such information in existing hydrological models is currently investigated. This work is guiding the selection of priority basins for intervention by the FED regional programme.

Tropical deforestation has first focussed on West Africa where it has been shown that the regional views provided by the NOAA satellite can be used to study the dynamics of vegetation at the interface between the tropical forest and other vegetation types. Biomass burning which is a major biosphere atmosphere linkage is being intensively studied using thermal data of the AVHRR. A preliminary investigation, using a similar methodology, has also shown the possibility of characterizing tropical deforestation at the regional level in Southeast Asia.

The investigations carried out provide new information on the use of remote sensing for characterizing dynamic phenomena over large regions. The results are increasingly interpreted in the framework of the study of global changes in terrestrial ecosystems.

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)

For the publication of the EINECS inventory the final master version was prepared, taking into account the comments of translation services, national authorities and the Chemical Abstract Service.

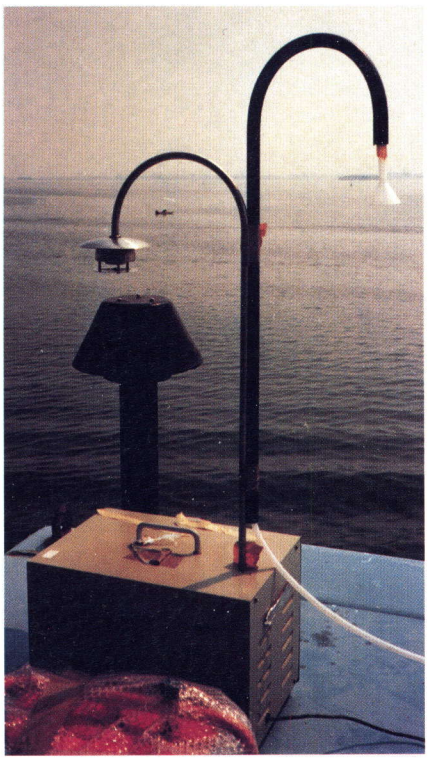


Figure 83: Intercomparison monitoring of total suspended particulates at Marghera Station (Italy), during the Second Quality Assurance Programme.

Work on risk assessment of existing chemicals was focussing on high production (1000t/y) chemicals. To check data availability and develop assessment criteria, a collaborative study with GFS, Neuherberg, and the Danish Water Quality Institute was started.

For the implementation of the EC 79/831 directive on "testing requirements and testing guidelines for chemicals" JRC accepted the technical/scientific responsibility.

Atmospheric Pollution (Environment)

The Central Laboratory for Air Pollution Measurements completed its second Quality Assurance programme with the quality control of network instruments at 27 selected Member States stations. A final report with a chapter on "Recommendations to the Member States" is in preparation. Main results are: 80% of SO_2 instruments are within ± 20% of the Central Laboratory instrument and 80% of the total supended particulate ambient measurements are within ± 15% of standard methods.
For the preparation of a possible directive on volatile organic compounds (VOC) a meeting with European experts was convened at Ispra discussing a priority list of 25 VOCs on which abatement strategies should be focussed, state-of-the-art of sampling and measuring techniques and the organisation of intercomparison campaigns.

Water Quality (Environment)

The study on the adaptation of the EC-Directive 80/778 on drinking water quality to technical and scientific progress was concluded and a final report is available. A study on the input quantification of non-point sources of trace elements to the aquatic environment has been started for elements such as Mo, B, Hg, Se and completed for the elements As, Ni, Zn, Cr and Cu.

Other studies are concerning the ecological impact of the trace metals Cu, Cd, Zn, Ni and the presentation of eco-toxicological reports for selected pesticides.

Chemical Waste (Environment)

The development and assessment of analytical methods for PCBs in sewage sludges and oil has been completed with special emphasis on the separation of the most toxic isomers.
Fast screening methods for in-field determination of PCBs in used oil have been improved.

Support for the implementation of the EC Directive on Major Accident Hazards (Systems Engineering)

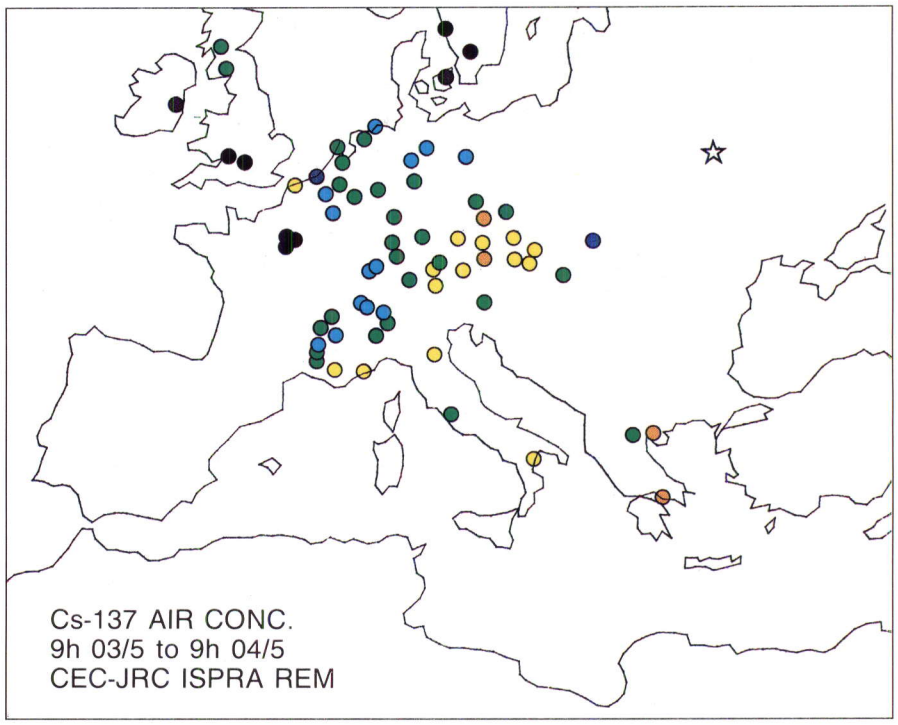
The action on major accidents analysis has been continued along the directions established in the previous years: i.e. analysis of accident topologies and causes and preventive measures.

In addition, a Community Documentation Centre on Industrial Risk (CDCIR) has been created to collect, classify and disseminate information on Safety regulations, technical rules and accidents relevant for the implementation of the Directive.

A comparison study on the national approaches to the safety reports has been completed and is now the subject of discussion among the National Compe-

Figure 84: REM activity: Sampling locations showing Cs-137 concentrations in the air during the period 1984-1985.

- 1.0E+1 < C (Bq/m^3)
- 3.2E+0 < C (Bq/m^3) < 1.0E+1
- 1.0E+0 < C (Bq/m^3) < 3.2E+0
- 3.2E−1 < C (Bq/m^3) < 1.0E+0
- 1.0E−1 < C (Bq/m^3) < 3.2E−1
- 3.2E−2 < C (Bq/m^3) < 1.0E−1
- 1.0E−2 < C (Bq/m^3) < 3.2E−2
- C (Bq/m^3) < 1.0E−2



tent Authorities. A Conference on Communicating with the Public on Major Accidents Hazards was held and the aim was to confront and homogenise national practices and to draw conclusions for further guidance of the Competent Authorities.

Support to Cooperation and Mutual Assistance in Case of Disaster

The Centre for Information Technologies and Electronics is developing a pilot information system in order to link the national civil protection services and to offer easy access to information of common interest.

Radiation Environmental Monitoring

Radiation Environmental Monitoring is a support programme for DG XI/A1 (Radiation Protection), in line with the strengthening of the Commission activities on radiation protection after the accident at Chernobyl. Three databanks have been set up collecting data on 1) radioactivity levels in the environment of the EC for the period 1984-1986, 2) radioactivity emissions to air and water from nuclear installations for the period 1977 - 1986 and 3) occupational exposure of personnel of nuclear installation for that period.

The banks are utilized for the preparation of summary reports on the matter. The bank on radioactivity levels in the environment, in particular, is open to external interrogations, and it is utilized for projects on validation of models of radionuclide distribution in the environment following nuclear accidents.

Experimental activities on harmonization of sampling methods for airborne radioactive particulates and to study the interaction of gaseous radionuclides and rain droplets have also been initiated.

Figure 85: Preparatory step for cryogenic milling in the course of processing biological material.

JRC Support to the Community Bureau of Reference

The CBNM has intensified its support to the Community Bureau of Reference (CBR) with respect to the storage, sale and distribution of Reference Materials. About 30.000 new reference samples were received; 4775 Reference Materials have been sold and 1162 samples have been dispatched for analytical intercomparisons. Non-ferrous metal Reference Materials (titanium) and biological materials (fish, fruit juice) have been prepared. The fish is to be certified for iron, zinc, cadmium, lead and mercury traces and fruit juice samples have been sent to 30 laboratories for interlaboratory comparison to determine amino acids and sugar contents.

JRC Support for Telecommunications, Information Industrial and Innovation Policy

The Institute for Advanced Materials is implementing a number of pre-normative tasks in order to encourage market penetration and integration of European materials data services. This involve cooperation with international organisations and standards bodies, in particular VAMAS, CODATA, ISO and ASTM. Major activities have addressed standardisation aspects of Materials Data Interchange, the Integration of Materials Information into the Computer-Aided Engineering Environment, and the conclusion and evaluation of the Materials Databanks Demonstrator Programme operated by DGXIII; the concluding workshop of this programme was organised in December 1989 at Petten.

Technical assistance to DG XIII-COSINE network projects was given by the Centre for Information Technologies and Electronics. Coordination of the ER-COFTAC and AERONAUTICAL users was made as regards the use of IXI, Y-NET, IES networks and services across the national academic networks. In particular the analysis of the national network characteristics in I, CH, F, UK, D, P, E was carried out.

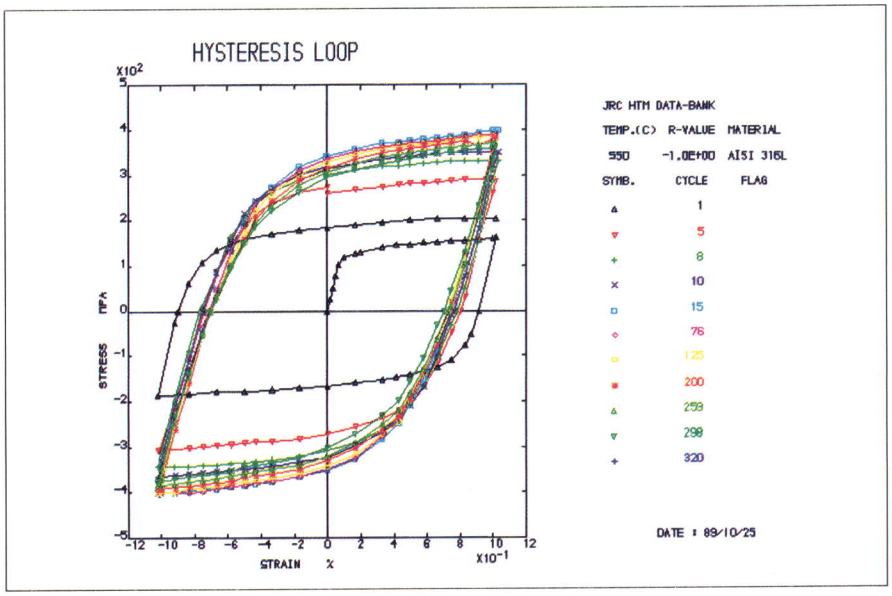


Figure 86: Fatigue hysteresis loops as stored in the HTM-Databank.

Figure 87: The 50 kW PV plant at Aghia Roumeli (Crete) is followed by ESTI using on-site power measurements and data from monitoring.

Figure 88: Solar terrace - greenhouse in the south of France, part of a project to revitalise existing terraced land which would otherwise have been abandoned.

JRC Support for Energy Policy

Rational use of energy and new energies (Systems Engineering)

The Institute for System Engineering collects and disseminates technical information and provides technical advice to the Community Energy Bus Programme: 3 data bases of the European Data System for Energies Saving (EDSES) implemented by the Institute are now in full operation and contain about 16000 audits. In 1989 the audits of the sectorial activities were loaded. 39 new proposals for demonstration projects concerning the Energy Conservation in Buildings have ben evaluated.

The development of a methodology to assess and promote demonstration projects replication has been started. In support to Building Energy Certification, a promising experimental procedure for the energy certification (or labelling) of buildings is being studied. This procedure is based on the technique of Parameter Identification. In order to test the applicability and reliability of this method to occupied buildings, a monitoring campaign has been set up on four apartment buildings.

A study began on ways of improving the Degree-days values contained in the EUROSTAT Energy Statistical Year Books.

Operational data from more than 20 Photovoltaic Demonstration Projects have been analysed: 29 new proposals have been evaluated. The SESAME data bank is continuously updated.

The "European Working Group on Photovoltaic Plan Monitoring" has continued its activity to improve monitoring techniques and is issuing a Newsletter. The assessment activity of Solar Thermal Demonstration Projects is following the same lines as for the photovoltaic demonstration projects. A "European Monitoring Working Group" has been set up and is dealing principally with the preparation of uniform monitoring guidelines for solar thermal systems.

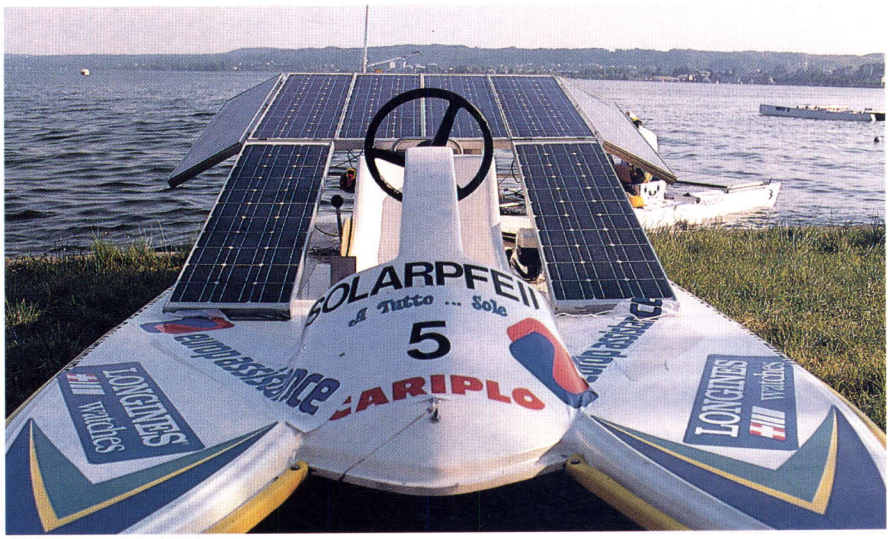


Figure 89: Even the solar boats participating at the 1989 race Angera-Locarno were measured by ESTI.

Review and judgement of new proposals of Demonstration Projects for Transport have been performed under the specific aspects of energy saving and pollution abatment.

Nuclear Safeguards

(Systems Engineering, Safety Technology, Centre for Information Technologies and Electronics, Transuranium Elements, CBNM, Administration)
The main achievements in the activities in support to the EURATOM Safeguards Directorate are as follows:

- a computer aided video surveillance system has been installed at Luxembourg headquarters for long term tests and inspectors training; full documentation has been provided and functional specifications for next generation are being defined;
- a back-up system for image archive of E metal seals with increased capacity and improved data retrieval has been implemented. Automatic recognition of seals is under development;
- a material accountancy data evaluation system, installed at headquarters has been extended for parallel treatment of different material balance areas and/or different categories of nuclear materials;
- since 1986, a number of JRC MARK-II ultrasonic sealing-bolts for spent fuel containers undergo a long term underwater test in a storage pond in Sellafield (UK). Various demonstration campaigns have indicated that the seals and the portable reading equipment work properly. In 1989, a particular effort has been devoted to simplify the reading technique by merging the ''identity'' and ''integrity'' features of a seal so that only one reading would be used;
- the know-how for the fabrication of multipurpose ultrasonic cable seals on an industrial basis has been transferred to a French company and a technical support is being given as well. The seal embodies a built-in transducer and could simplify largely the reading of ultrasonic seals;

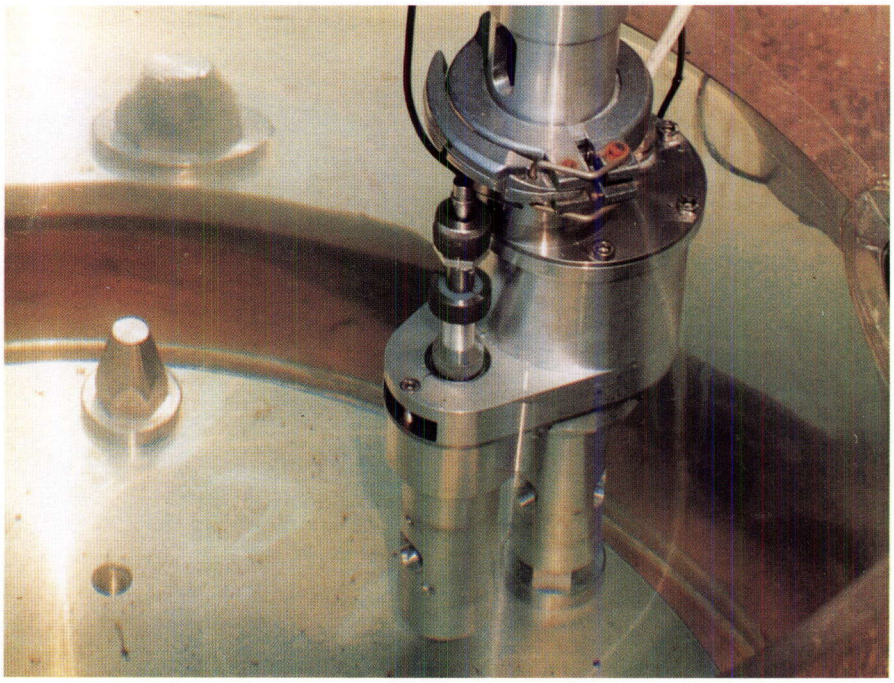


Figure 90: JRC Sealing bolts system for BNFL (MEB) containers being tested in actual scale conditions at Ispra prior to shipping to Sellafield.

- after the redesign of the active neutron interrogation system already used routinely by inspectors, three such measurement devices were ordered by the Safeguards Directorate and are now being constructed. They will be delivered during 1990;
- a new PC based neutron correlation instrument has been demonstrated to the Directorate and is now being tested in Harwell (UK). Furthermore a gamma scanning system for Material Testing Reactor's fuel, has been designed and constructed and will be made available to inspectors in 1990;
- extensive Monte Carlo calculations have been performed to assess the possibility of measuring underwater LWR spent fuel in Multi-Element-Bottles;
- in the framework of the Euratom network of analytical laboratories, a large number of destructive analysies has been performed on samples taken by inspectors in different parts of the EC fuel cycle. Also several measurement campaigns have been performed in bulk handling facilities with transportable analytical chemistry instrumentation; quality control exercises have been performed with well characterized reference materials;
- several development activities have been conducted to automatise some analytical methods (using on-line computers for controlling the analytical procedures, identification of samples and data evaluation);
- a new method is being studied for the analysis of solid residues in highly active wastesor input solutions using inductively coupled plasma/mass spectrometry employing the technique of laser ablation directly on the solid material;
- a conceptual design is being conducted for the installation of an on site analytical laboratory to be situated at a nuclear fuel reprocessing plant and capable of analyzing the input and output material;

- training courses for safeguards inspectors have been organized on NDA techniques (gamma spectrometry-neutron counting), on the physical inventory taking in highly enriched uranium plant and on radioprotection;
- support to Safeguards inspectors in Radiation Protection and Conventional Work Safety.

JRC Support to the Customs Union (Environment and Safety Technologies)

This activity deals with the verification of scientific instruments for the correct application of custom tarifs; 50 cases were examined. A similar activity is dealing with the identification of chemical and biological products.

JRC Support to the ''Forward Studies Unit''

The Institute for Prospective Technological Studies is currently engaged in feasibility studies, related to the impact of scientific and technical development on the Community, for the ''Forward Studies Unit'', a newly established unit of the Commission.

JRC WORK FOR THIRD PARTIES

Work for third parties will constitute in the future a growing source of revenues for the JRC. Target values as set out at the time of the decisions on JRC activities 1988-1991 are indicated in line 2.1 of Table 1.

To achieve such ambitious goals, the JRC launched an agressive 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.

Line 2.2 of Table 1 and Figure 2 - which gives the monthly evolution of the ordered contractual work and their revenues - indicate that the total ordered contractual work is approaching the target. On the other hand, execution of the work, which is reflected by the amounts invoiced (line 2.3) and the payments received (line 2.4), is lagging behind - delays in implementing early retirement measures and slow recruitment procedures could be identified as one of the main causes for this slow start -. Measures will be taken to ensure a more rapid execution of such work.

Table 1: Work for Third Parties (MioEcu)

Year	1988	1988-1989	1988-1990	1988-1991
1. Exploitation of HFR (annual credits)	17.2	36.6	56.7	78.0
2. Other third party work				
2.1 Target value	2.9	17.5	33.4	52.0
2.2 Order book actual	5.79	15.71 (1)	—	—
2.3 Amounts invoiced	2.67	6.67		
2.4 Payments received	1.93	4.74	—	—

(1) including 3 Mioecus for a contract to be signed early in 1990 (a letter of intent is signed for this sum)

Exploitation of the High Flux Reactor

Institute for Advanced Materials, Petten

During 1989 the reactor operated undisturbed and according to schedule. The availability was near to 100% of the scheduled operation time. The occupation of the irradiation positions was between 70 and 80%.

Major upgrading projects for the reactor installation and its ancilliary equipment were executed. The Beryllium reflector elements were replaced by new ones after more than 25 years operation. A new emergency power supply system was installed. The original pool heat exchanger, designed for reactor power of 20MW was replaced by a new one which has a higher cooling capacity in view of the present nominal power of 45MW. The data acquisition system, for reactor and experiment data processing was upgraded and equipped with quicker data logging equipment.

The exploitation programme comprised fuel and structural materials irradiations under steady state as well as transient and specified load conditions for LWR's,

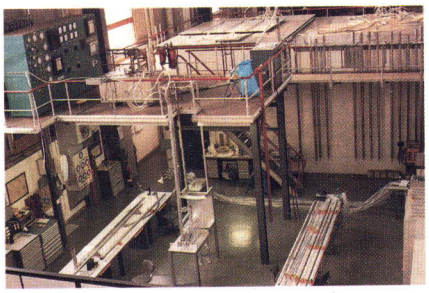


Figure 91: A view of the quality control laboratory at the High Flux Reactor (HFR), Petten where quality control and quality assurance of irradiation devices is carried out.

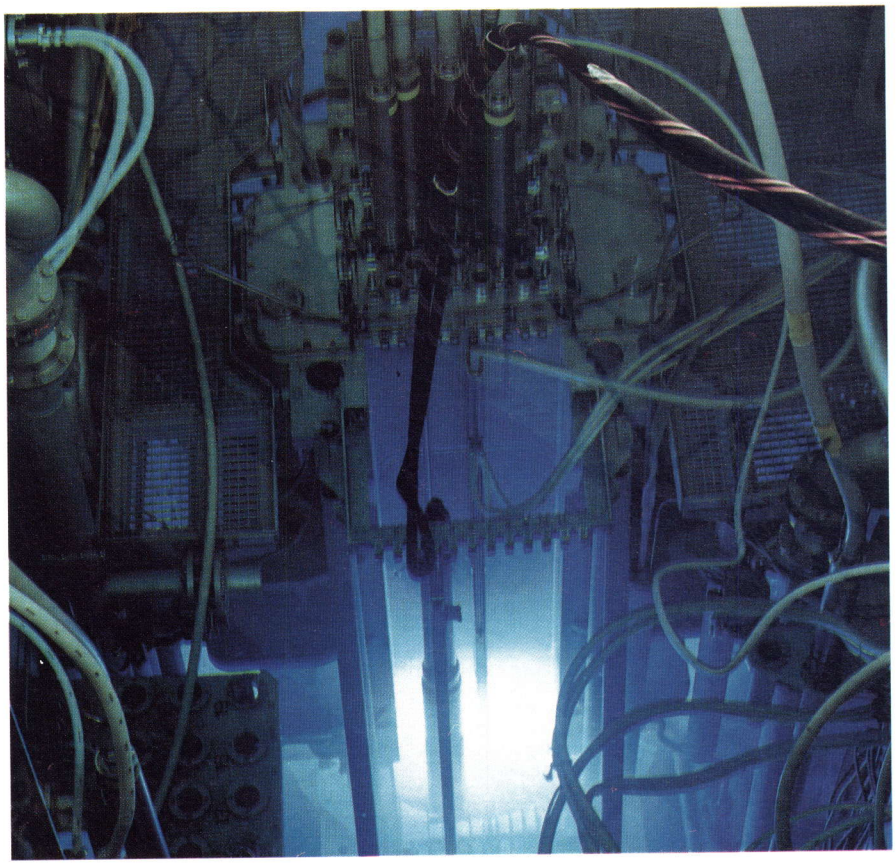


Figure 92: The reactor pool of the HFR, Petten.

HTR's and LMFBR's; radiation damage investigations for prospective first wall materials and tritium behaviour in prospective blanket breeder materials for fusion reactors; the extensive use of beam tubes for nuclear physics and materials research; production of radioactive isotopes for medical and industrial uses as well as the use of neutrons for changing properties of materials; neutron radiography and activation analysis for internal and external customers. Preparatory work for designing a clinical facility for Boron Neutron Capture Therapy was continued.

The following achievements deserve to be mentioned separately:

- completion of an irradiation facility for investigating iodine release from LWR fuel under severe accident conditions,
- graphite investigations under irradiation to validate creep model,
- studies of fission product release from HTR fuel at elevated water vapour concentration in cooling gas,
- studies on fission gas bubble growth and migration in fast breeder reactor fuel at elevated linear heat generation rates,
- contract signed with a commercial company on large scale irradiation of minerals to alter their physical properties.

The present and future HFR exploitation was reviewed in a "HFR Colloquium", held in Petten in April 1989.

Prospective Technological Studies

The Institute for Prospective Technological Studies has been contracted by the German Federal Ministry for Research and Technology (BMFT) to undertake two studies: a review of current literature on fusion and a feasibility survey on strategies for dealing with solid industrial waste.

Nuclear Measurements

In the frame of the possibilities available at the Central Bureau of Nuclear Measurements a series of contract work has been performed:

- at the Van de Graaff neutron irradiations of mice for radiobiology studies,
- the final evaluation of results from the 57Co comparison for clinical physics studies,
- radioactive waste barrels checks by non destructive gamma-ray scanning for environmental monitoring,
- preparation control by REIMEP (Regular European Interlaboratory Measurement Evaluation Programme) for a large number of laboratories from many EC and non-EC countries,
- preparation and characterization of samples and targets upon request for various application.

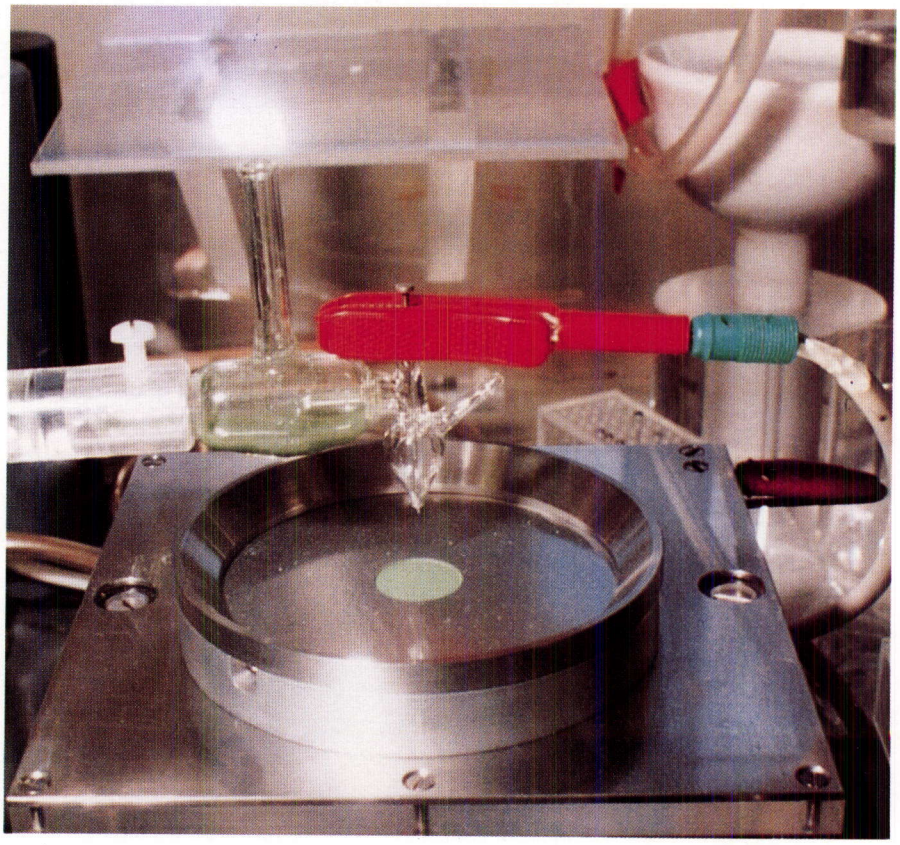


Figure 93: Equipment for the preparation of deposits by electrospraying.

Transuranium Elements

The Institute for Transuranium Elements had in 1989 about 20 contracts with third parties under execution. In several cases however efforts had to be limited to preparatory work, if the investigation on radioactive material, in particular irradiated fuel specimens from outside partners were involved, due to transportation problems beyond our control.

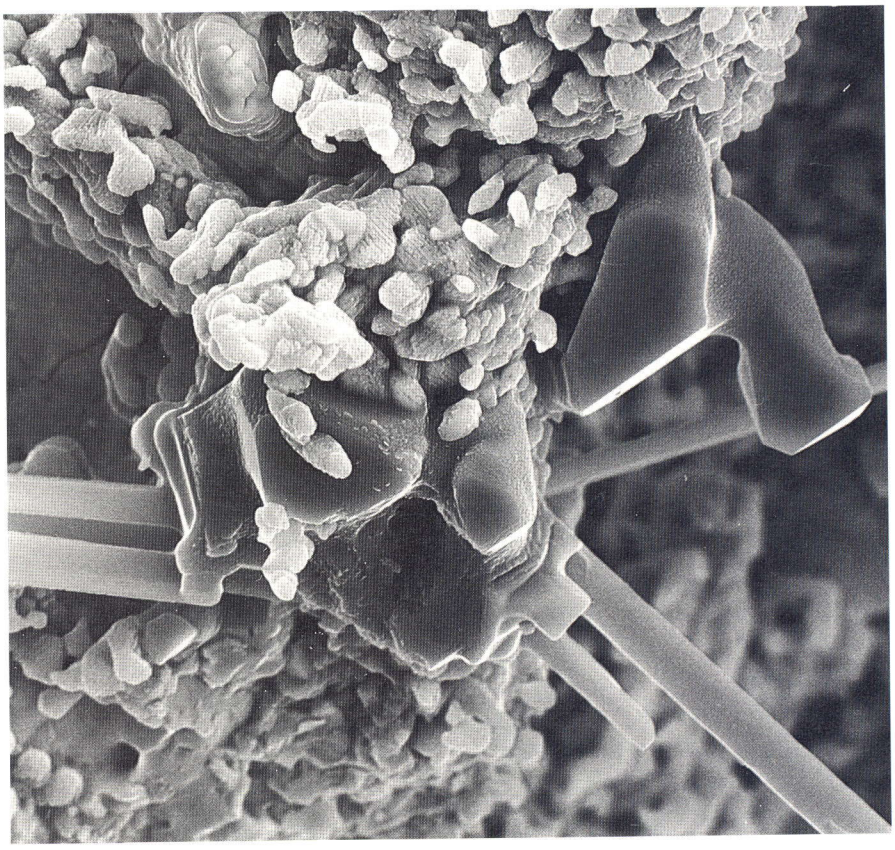


Figure 94: Crystals deposited from the vapour phase after heating a sample by radiation from a 220W CO_2 laser (measurement of thermal conductivity of molten nuclear fuel).

Activities for third parties concerned

- the execution of boron analysis on samples from nuclear power stations,
- the purification and storage of enriched UO_2,
- Plutonium determinations and the chemical analysis of MOX fuel,
- a design study for a robotized radio-analytical laboratory,
- the preparation and characterisation of alloys containing the "minor" actinides (Np, Am, and Cm),

and

- the preparation of alpha-emitters for radiotherapeutical applications.

Major contracts dealing with the analysis of reprocessing residues and with the post-irradiation examination of LWR fuel rods are under preparation.

The total volume of all contracts under study and under preparation (some of them extending over several years) is of the order of 3 MECU.

Advanced Materials

The Institute of Advanced Materials signed an increasing number of contracts during the last two years and the expected revenues for the 4 years programme are generally on target. 25 contracts totalling a volume of 1.5 Mioecus have been signed for research work in advanced materials mainly for Aeronautics, Energy, Petrochemical, Automobile and Materials industries.

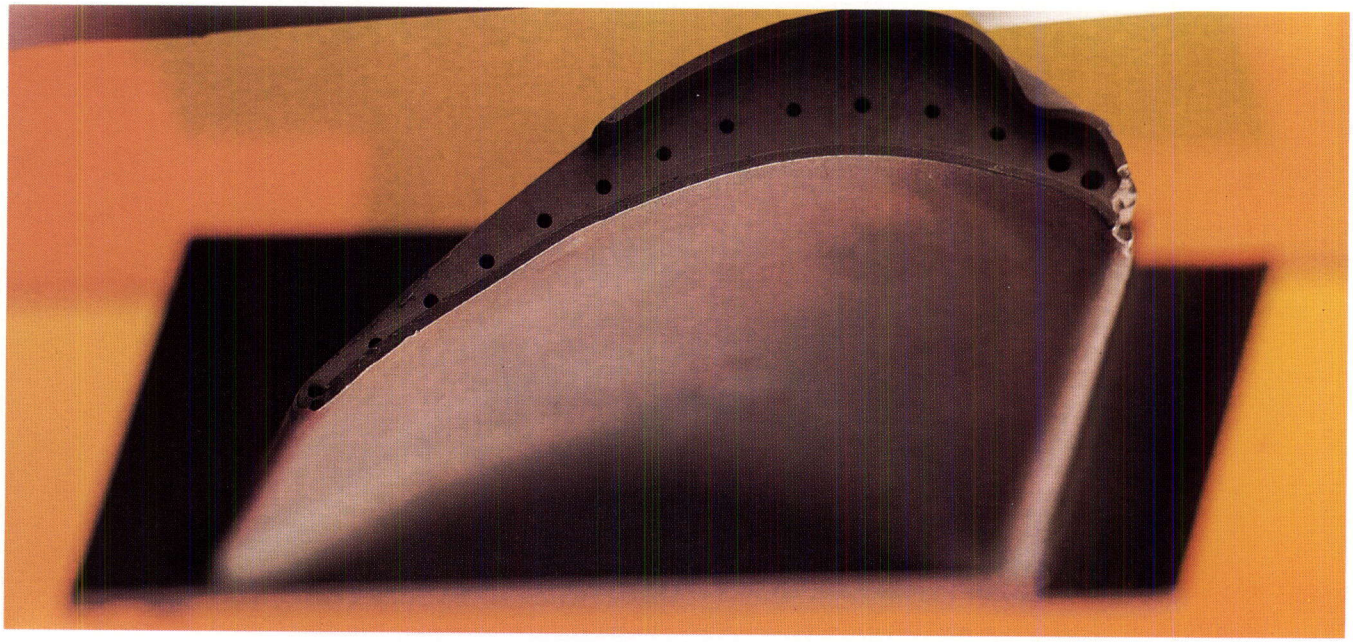


Figure 95: A power plant turbine blade made of a nickel alloy and plasma spray surface coated with corrosion and erosion resistant layers.

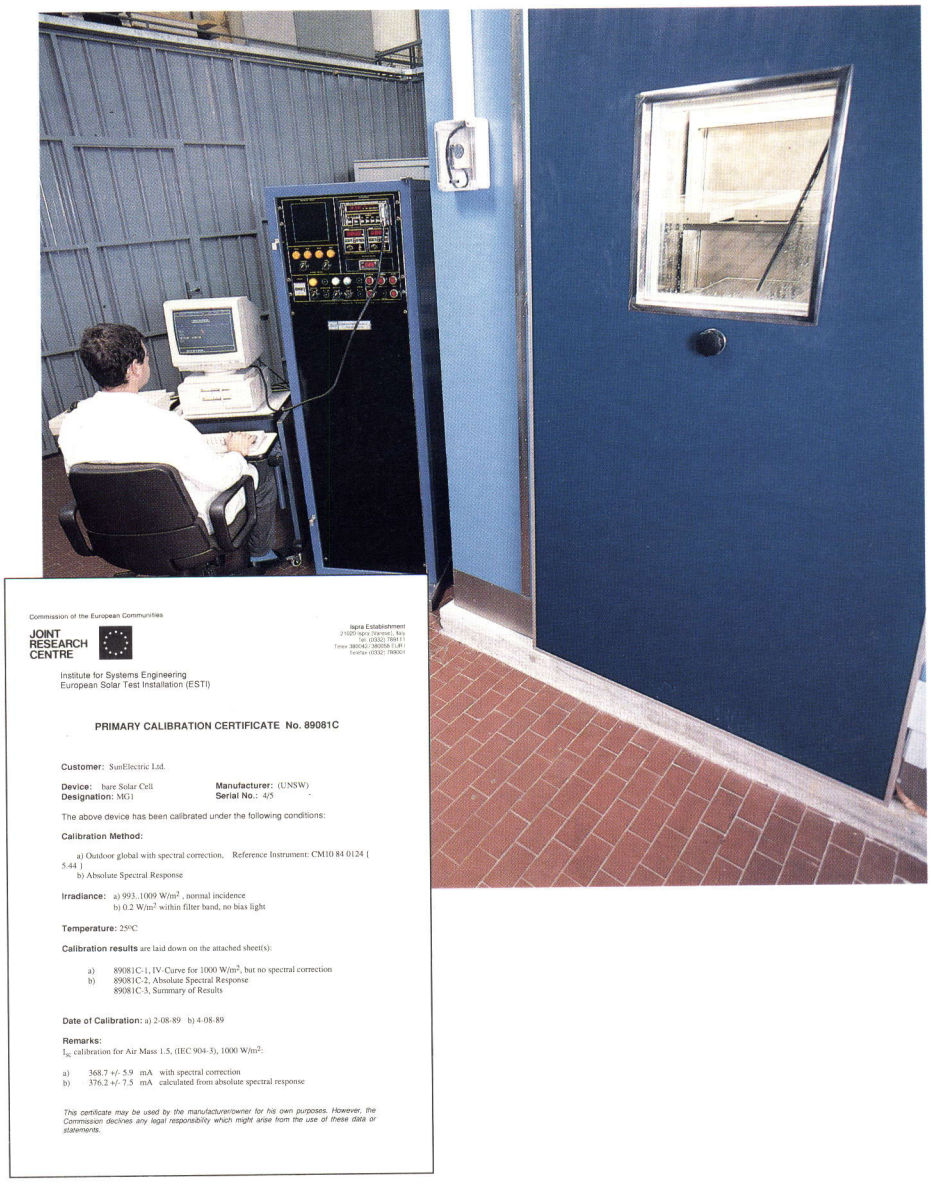
The equivalent situation exist for HFR where in addition to the Supplementary Programme budget, revenues in the order of 1.7 Mioecus have been found in sale of irradiation services, mainly for isotope production, minerals irradiation and aeronautics applications.

Figure 96: A microscopic study of the surface of the alloy ($MiCoC_2Hly$) which is resistant to heat corrosion.

System Engineering

In 1989 the Institute for Systems Engineering had 15 contracts for third parties under execution. The work performed concerned:

- Qualification of photovoltaic modules on ESTI including certification of eight new products; assessment of prototype devices; and on site power measurements of Europe's first photovoltaic power plant for hydrogen generation.
- Energy analysis of regional building stock, with application to the Regione Lombardia.
- Risk assessment of transportation of dangerous substances.
- Development of expert systems for the inspection and maintenance of industrial structures (BRITE Project P. 124).



Commission of the European Communities

JOINT RESEARCH CENTRE

Ispra Establishment

Institute for Systems Engineering
European Solar Test Installation (ESTI)

PRIMARY CALIBRATION CERTIFICATE No. 89081C

Customer: SunElectric Ltd.

Device: bare Solar Cell
Designation: MG1
Manufacturer: (UNSW)
Serial No.: 4/5

The above device has been calibrated under the following conditions:

Calibration Method:

a) Outdoor global with spectral correction, Reference Instrument: CM10 84 0124 (5.44)
b) Absolute Spectral Response

Irradiance: a) 993..1009 W/m², normal incidence
b) 0.2 W/m² within filter band, no bias light

Temperature: 25°C

Calibration results are laid down on the attached sheet(s):

a) 89081C-1, IV-Curve for 1000 W/m², but no spectral correction
b) 89081C-2, Absolute Spectral Response
89081C-3, Summary of Results

Date of Calibration: a) 2-08-89 b) 4-08-89

Remarks:
I_{sc} calibration for Air Mass 1.5, (IEC 904-3), 1000 W/m²:

a) 368.7 +/- 5.9 mA with spectral correction
b) 376.2 +/- 7.5 mA calculated from absolute spectral response

This certificate may be used by the manufacturer/owner for his own purposes. However, the Commission declines any legal responsibility which might arise from the use of these data or statements.

Figure 97: The Climatic Simulation Chamber (ESTI) and related instrumentation used for studies in the determination of a given module's ability to withstand a variety of stresses caused by repeated changes of temperature.

Figure 98: The simulated effects of the impact of hailstones on a solar module achieved with the use of a pneumatic gun designed and realised by the JRC.

Figure 99: Training exercises which form part of a course on Civil Protection organised in collaboration with the Regione Lombardia, Italy.

- Consultancy work for the ARIPAR Project aiming at assessing the risk of the Ravenna Industrial Harbour area.
- Optimisation study of the cooling of the transformer coil of the fusion experiment IGNITOR.
- Organisation of a pilot course for 40 students of civil protection for Regione Lombardia.
- Development of a decision support system for the management of industrial wastes (mainly toxic) on a regional scale.
- Development of a decision support system for the management of the Po River Master Plan.
- Research on stress fatigue affecting human behaviour when controlling complex plants (cooperative project with CNR's FATMA project).
- Participation as subcontractor to the Esprit 2 Basic Research, action 3105 MOHAWC (Models of Human Action in Work Context).
- Analysis of operational data stored in the CEDB (Component Event Data Bank) collected in two of ENEL's power plants.

The total volume of contracts signed in 1989 is about 2 MECU. Contracts for further 3 MECU are under negotiation.

Safety Technology

Work for Third Parties,conducted by the Institute for Safety Technology, can be subdivided into 3 groups:

- activities in progress since 1988
- activities which started in 1989
- activities which are being prepared

In the first group extensive use is made of existing nuclear installations and related competences. It includes a contract for increasing the capabilities of the LOBI installation, the delivery of special safeguards equipments, experiments for the incineration of low activity resins and decontamination studies of LWR components.

In the second group a contract was signed which foresees the use of a nuclear installation under construction and smaller activities were agreed in the development of finite elements codes.

Contracts which are being prepared concern both nuclear and non nuclear activities. It is envisaged to launch larger projects with participation of several contractors for one particular task in which the multidisciplinary nature of the Institute could be valorized.

Environment

Work for Third Parties conducted by the Institute for the Environment are related to

- an Atmospheric Transport Models Evaluation Study initiated jointly with the International Atomic Energy Agency and the World Meteorological Organization,

and to

- two co-operation agreements signed with the Spanish Agency for Radioactive Waste Management (ENRESA), one focussed on probabilistic risk assessment for the site-specific disposal of radioactive wastes, the second on the experimental study of the migration of radionuclides.

JRC PARTICIPATION IN EUREKA PROJECTS

JRC participation in EUREKA projects has been increasing in 1989. Today the JRC is participating in EUROTRAC and FORMENTOR; it envisages to participate in LASFLEUR, ALPSOLAR, Vibration Measurements using Laser Technology and EUROENVIRON.

Systems Engineering

The Institute for Systems Engineering is participating in FORMENTOR; the preliminary definition stage of FORMENTOR originally launched by French and Norwegian partners, has been completed. The Institute for Systems Engineering entered as a full member of the Consortium at the beginning of 1989, at the onset of the project phase. The objective of this EUREKA project is the development of an on-line expert system to provide advice to operators of complex man-made systems in potentially hazardous situations. Several work packages have been initiated especially concerning the so-called methodological stream. A first application has been identified concerning the Airbus A320.

The Institute for Systems Engineering is exploring the possibility to participate in ALPSOLAR aimed at the development of electric generators using photovoltaic solar captors specially designed to function in the meteorological conditions of the Alpine environment.

The Institute is also examining the possibility to participate in the EUREKA project Nr. 383 on vibration measurements using laser technology, a sector in which it has acquired a wealth of experience.

Environment

The Institute for the Environment is participating in EUROTRAC aimed at the study of the consequence of human activities on continental (Europe) tropospheric chemistry. As an interdisciplinary programme, it involves field measurement campaigns and laboratory studies as well as the development of advanced instrumentation and model simulations, in view of studying the transport, transformation and deposition of trace constituents -of natural and anthropogenic nature - closely connected with tropospheric ozone formation and acidic deposition.

The Institute is actively participating in the following EUROTRAC sub-projects:

- TRACT specifically addresses the study of the transport of trace pollutants from extended industrial areas over complex terrain such as the South-Western part of Germany from Main river to the northern edge of the Alps and from the Swiss plateau to the North-Western part of the Po valley in Italy. Measurement campaigns designed in 1989-1990 are scheduled to be carried out in 1990, 1991 and 1992;
- BIATEX is focussed on the quantification of pollutants fluxes between atmosphere and biosphere, on the identification and understanding of the mechanisms responsible for these processes. Two field intercomparison

measuring campaigns have been performed in the Bavarian Forest on the emission of terpenes and on the determination of their transformation products;

- JETDLAG is aimed at the development of special instrumentation based on Tunable Diode Laser Absorption Spectrometry for the measurement of atmospheric trace gas in view of meeting one of the major requirements of the EUROTRAC objectives.
  The Institute is particularly involved in the evaluation of high resolution spectral parameters, individual lines intensity and broadening coefficients.
  For the optimisation of the operational characteristics of IR spectroscopy based ambient air monitors and for the analysis of experimental data to derive spectral parameters, a PC based computer programme has been prepared. The programme, to be used in connection with compiled bases of spectral data of atmospheric molecules, generates atmospheric spectra in different physical and instrumental conditions;
- LACTOZ is intended to provide a proper description of the complex chemical processes which lead to ozone formation and depletion in the troposphere. The main objective is to gather data for input in mathematical models describing the ozone budget.
  The Institute is particularly involved in the reactions of the NO_3 radical with alkenes, terpenes and dimethylsulfides.

Furthermore, the Institute together with interested partners in Denmark and Italy is developing a project on twin mobile analytical unit for in-field analysis of toxic waste proposed under the EUREKA EUROENVIRON umbrella project..This mobile unit should provide sampling and sample treatment capabilities on one side and instrumental analysis and analytical data handling on the other.

Remote Sensing Applications

The Institute for Remote Sensing Applications is proposing to establish a cooperation with French (CNRS, LURE), Italian and German groups, within the framework of the EUREKA LASFLEUR project. The objective of this activity is to investigate the potentialities of laser spectroscopy to perform vitality tests on vegetation (see section Exploratory Research: Laser Spectroscopy).

Advanced Materials

The Institute for Advanced Materials is in negotiation with other partners on the application of ion implantation for processing strong joints in ceramic/metal components (Eureka Project Nr. 332).

JRC AND ASSOCIATED LABORATORIES

The JRC federating role, in grouping scientific resources according to schemes such as Associated Laboratories in well specified scientific topics, is increasing. A global cooperation agreement has been signed on 5 December 1989, between the Higher Council of Scientific Research (CSIC), Spain and the Joint Research Centre. Another global agreement has been signed with the Energetic and Environmental Technological Research Centre (CIEMAT), Spain on 20 December 1989.

Nuclear Measurements

The Central Bureau for Nuclear Measurements follows for its nuclear measurements a series of close research collaborations with e.g. SCK/CEN Mol (B), University of Gent (B) and ILL Grenoble (F) and for its materials activity the very intense collaboration in the silicon study with the PTB Braunschweig (FRG).

Furthermore, the Central Bureau for Nuclear Measurements has initiated since many years an interlaboratory comparison exercise (Regular European Interlaboratory Measurement Evaluation Programme (REIMEP)) on analysis of nuclear fuel. In a recent case as an example 24 laboratories (15 from EC countries, 3 from EFTA, 5 from US and 1 from Japan) have participated in such an exercise.

Transuranium Elements

The Institute for Transuranium Elements is closely collaborating with an international group of laboratories in the Risø fission gas release study project. The objective of this undertaking is to investigate, in a cooperative effort, possibilities of an extended use of LWR fuel by studying fuel structures and fission gas release mechanisms in commercial power reactor fuel rods which have been subjected to variable loads (ramps) after high burn-up.

Several tasks related to the European PHEBUS PF project (development of in-pile temperature measuring devices and fission product release studies) have been or will be assigned to the Institute.

In the field of basic actinide research, the Institute maintains its central role on the international research scene. In 1989, 32 European and 8 US laboratories have actively collaborated with the Transuranium Institute. In most cases, samples (mostly single crystals), of actinides and actinide compounds produced in our laboratories have been subjected to solid-state investigations in outside laboratories (synchrotron radiation facilities, neutron diffraction equipment, magnetic properties measuring apparatus), and the results thus obtained were analysed (and in most cases published) in a joint effort by ITU and external staff.

Advanced Materials

Particular effort was dedicated by the Institute for Advanced Materials to create a cooperative spirit among researchers and to establish associated laboratory agreements.

The PISC project, which started fifteen years ago, is one of the best JRC initiative to associate laboratories and industries on a specific research area. Dur-

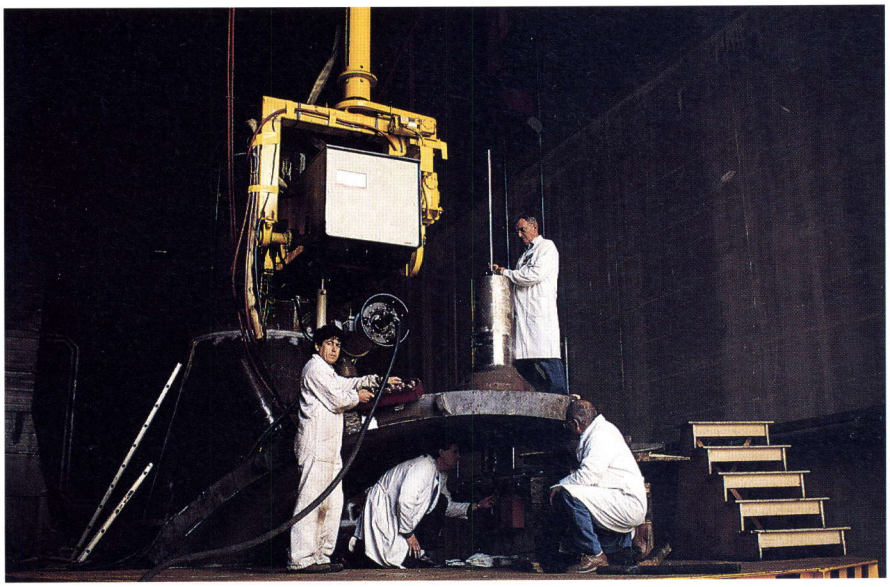


Figure 100: Non destructive Evaluation Laboratories: PISC III, this assembly (No. 20) is a piece of a real PWR vessel with nozzles.

ing the last two years, the Institute has create five new cooperative projects, which are open to new partners:

- cooperation with a consortium of Italian University Departments on basic studies on materials structure;
- consortium of materials research operators to jointly market R&D [with TNO (NL), NEL (UK), CISE (I)];
- cooperation with Milano Ricerche (I) and CSIC (E) on sensors development (in preparation);
- cooperation with CIEMAT (E) for materials and structure integrity;
- joint venture on prospective coating with ECN (NL);

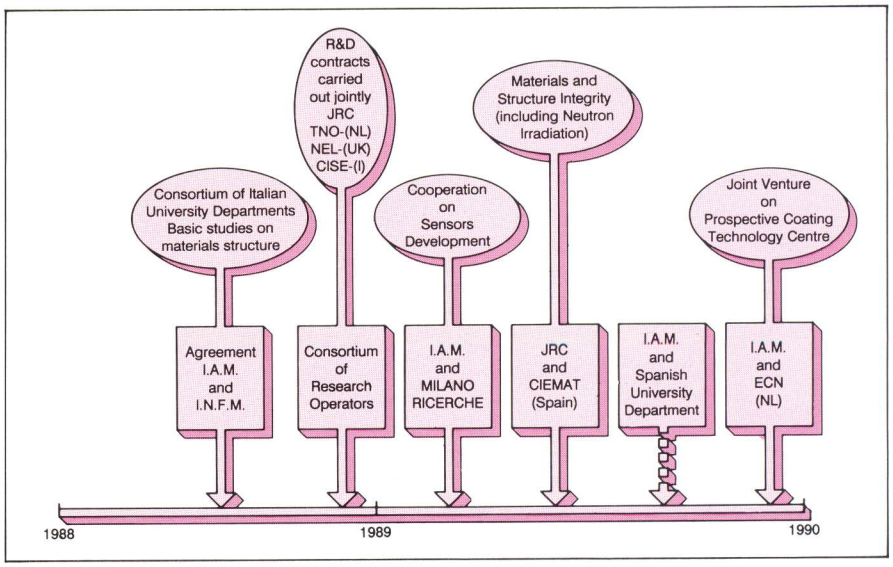


Figure 101: Cooperative initiatives and work carried out in association with other laboratories by the Institute for Advanced Materials.

Systems Engineering

The Institute for Systems Engineering has been the initiator and is actually supplying the General Secretariat for three associations.

ESARDA: The European Safeguards Research and Development Association, founded in 1969, is presently composed of eleven parties, covering all the R and D laboratories of EC countries involved in safeguards R and D.
Exchange of information on R and D activities and the execution of common projects are performed in seven working groups.
Two common actions have been promoted with a very strong involvement of JRC staff. One is the analysis of the results of the Karlsruhe general meeting on the EC nuclear fuel cycle and its impact on R and D. The second concerns the domain of the technology transfer in the field of nuclear safeguards, which will be topic of the next general meeting to be held at Como in May 1990.

Figure 102: A selection of well established documents regularly published by the various associations.

EuReDatA: The European Reliability Data Bank Association, founded in 1979, is presently composed of 46 members, representing authorities, consultants, manufacturers, research institutes, universities and utilities from the EC and EFTA countries, involved in Reliability Data Collection and Analysis.
The Association activities are organised in Project Groups.
This year they have been held on the following topics: Benchmark Exercise on Component Reliability Data Analysis, Reliability characteristics of Mechanical valves, Data Bank on Electronic components, Human Factors.
Two seminars were held, one on "Maintenance" and the other on "Reliability of Safety Systems in the Process Industry".

ESRRDA: The Association founded in 1986, is actually composed of 36 research laboratories and Universities. The aims are to encourage and harmonise research and development for safety and reliability of technological systems.

Moreover the Institute has organised two consortia of laboratories and industry:

The ''Institute Club'' is a consortium which embraces a research activity in the field of expert system technology applied to life extension of power generation plant components. The Interest Club has been set up by the Institute for Systems Engineering at Ispra and the Institute for Advanced Materials at Petten, in collaboration with some European electric Utilities (CEDB (UK), ENEL (I), LABORELEC (B)) and the University Institute MPA (University of Stuttgart (D)).

The consortium ''STARS'' is a group of research laboratories and industrial affiliates which started a joint venture for developing a homogeneous set of software tools for assisting the various phases of safety and reliability analysis. The founding participants are the Institute for Systems Engineering at Ispra, the RISØ National Laboratory of Denmark and the Technical Research Centre of Finland. The TECSA SpA company joined as a late participant. Up to now the NESTE company and ASEA Brown Boveri associated as industrial affiliates.

Remote Sensing Applications

The Institute for Remote Sensing Applications is actively integrating its activities with other initiatives

Land Use Collaborative Programme

The Collaborative Programme consists of a network of different application oriented research projects involving around 30 participating institutions and laboratories. It is aimed at the promotion of application of Remote Sensing and integration of Remote Sensing data in Geographical Information Systems in the management of land use in European marginal areas.

Following the decision agreed on during the plenary meeting in July 1988 six contracts have been given in 1989 concerning themes ranging from establishment of Land Information Systems to evaluation of natural risks and disasters

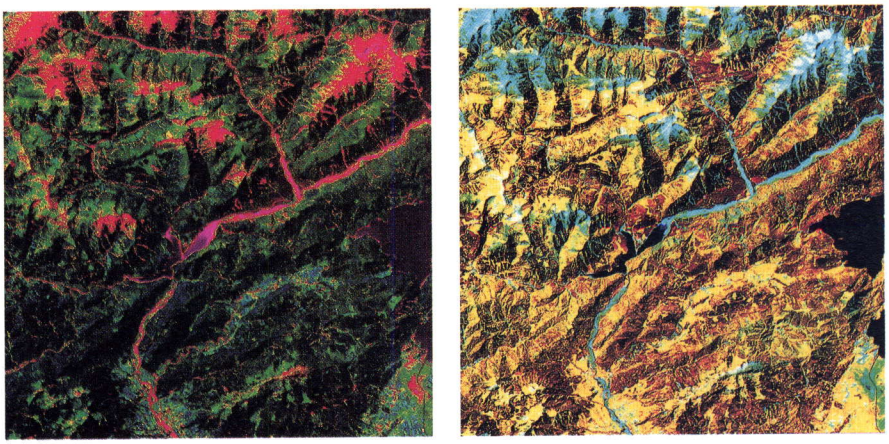


Figure 103: Multispectral satellite images of a section of the northern margin of the Alps. A colour composite of Landsat TM bands 3-5-4 enables an improved separation of general types of land-use (left); Colour composites using the I-H-S approach gives more details on water bodies and the state of the art of grasslands and pastures.

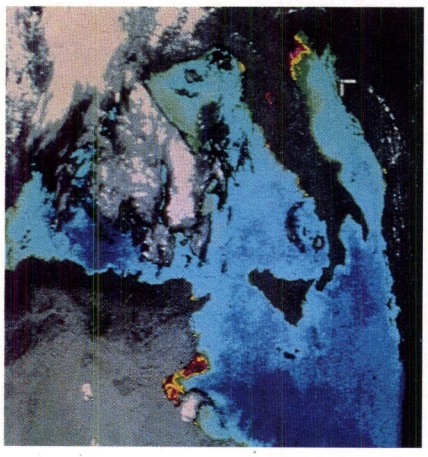


Figure 104: Chlorophyll concentration in the mediterranean Sea, information considered to be vital for understanding bio-geo-chemical and physical processes in the sea on a large scale/long term basis.

in mountainous areas. Newsletter no. 5 of the Programme was distributed (April). A brochure describing the projects has been produced and a Workshop on Integration of Remote Sensing and Personnel Computer based Geographic information Systems was held at Ispra (September).

Ocean Colour European Archive Network

A joint JRC/ESA initiative has been proposed to archive safely Large scale, long term ocean colour data such as those of CZCS (1978-86). The project would produce general scientific and operational benefits to other European programmes and is aimed

- to compile a general catalogue and an easily accessible and available archive on optical disks,
- to establish proper sets of methodologies and the related software and
- to identify and carry on a demonstration programme to exploit historical series of CZCS data.

Cooperation with the European Space Agency (ESA)

In accordance with the outcome of the meeting between President Delors and the Director-General of ESA, Prof. Lüst in February 1989, an ESA/CEC Environment and Earth Observation Working Group has been set up. The objective is to prepare joint initiatives to cover a wide range of aspects related to the field of environmental research and monitoring and the Earth observation. The working group is co-chaired by the Director General of JRC and the ESA's Director of Earth Observation. Two meetings of the working group were held in Paris (April) and at Ispra (October).

Safety Technology

The Institute for Safety Technology has set up an European Association of Structural Mechanics Laboratories; the objective of this association is to enhance the competitive position of the Community's construction industry by improving the scientific and technical basis needed to better analyse the behaviour of large structures subject to severe dynamic loading, and henceforth allowing the set up of improved construction codes and standards. A detailed collaborative research programme is under development which will make use of existing scientific resources and high performance testing facilities.

The setting-up of a European Association of laboratories, universities and industries for the analysis of chemical processes is under discussion.

Information Technologies and Electronics

The Centre for Information Technologies and Electronics is organising a Mediterranean Club for new information Technologies and Communication with Institutes from France, Greece, Italy, Portugal and Spain. The objective is to exchange information on respective activities in order to identify area appropriate for collaboration, to enhance innovation and technology transfer, to exchange scientists in order to increase internal efficiency and ultimately to pool skills to tackle, in cooperation, research projects.

JRC ANNUAL REPORT 1989

LARGE INSTALLATIONS

LARGE INSTALLATIONS

Utilisation of Large Installations

GEEL (CBNM)

ACCELERATORS

In the reporting period

- the Linac electron beam was available during 2930 h for physical experiments; 60% of this time was devoted to measurements with short pulse (1 ns). Combined neutron filters have been developed to produce beams of intense monoenergetic neutrons at the Linac.
- the 7 MV Van de Graaff machine was running during 2418 h and
- the 3.7 MV Van de Graaff machine has been used during 565 h.

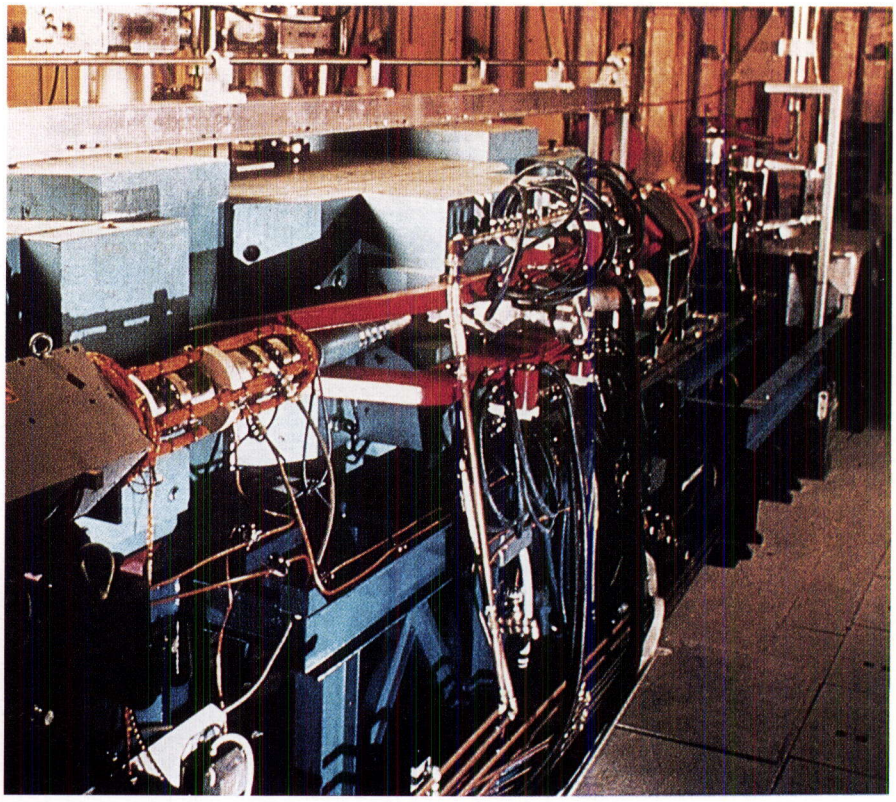


Figure 105: A view of the acceleration sections in the target room of the LINAC.

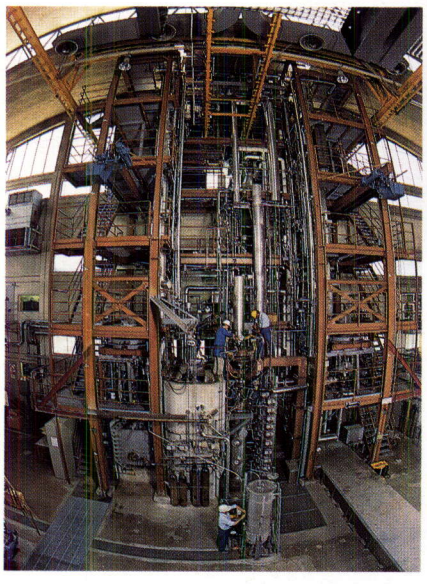


Figure 106: A general view of the LOBI installation.

ISPRA

LOBI

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

The LOBI facility was recommissioned after the execution of modifications and has performed 3 tests in 1989. A steam generator tube rupture, a 5% cold leg break and bypass behaviour in the upper plenum/upper downcomer were investigated respectively.

FARO

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

In 1989 six tests were performed in the FARO facility in which up to 125 Kg of molten UO_2 at about 3000 °C were released from the furnace in various test sections in which fuel freezing and plugging phenomena as well as the potential of a fuel jet to perforate a steel plate were investigated.

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.

The facility is available for external customers and there has been preliminary contacts with representatives of the automobile industry.

ESTI (European Solar Test Installation)

The facilities of ESTI are used to develop equipment and methods for tests on photovoltaic devices. These tests are executed to a large extent on request by industry and other laboratories. In 1989, main efforts went into assessment, calibration and qualification of both prototype and commercial photovoltaic products.

Output in 1989:

- Calibration of 37 radiation sensors by indoor and outdoor methods and issue of certificates.
- Issue of qualification certificates according to EUR Spec. 502 for 8 types of photovoltaic modules.
- Electrical Performance tests of 270 devices.
- Assessment of prototypes by special measurement procedures and stress-test sequences.

New facilities:

- Upgrading of existing large facilities for the implementation of the light soaking test for amorphous devices, developed at ESTI (LS-1/a);
- Installation of a new climatic simulation system for humidity-freeze and thermal cycle tests in line with proposed IEC Standards (International Electrotechnical Commission).

MAINFRAME COMPUTER (CITE)

The centre is equipped with a mainframe computer backed up by extensive auxiliary equipment and highly developed networks linking computers and terminals at the centre, with access to public data transmission networks. In 1989 the old 5 868-s AMDAHL mainframe has been upgraded in the new 5 890-300 E AMDAHL (two processors, 44 MIPS). An automatic cartridge "robot" and an optical disk "juke box" system have been installed, raising the storage capacity to over 1.4 Terabytes.

During the first ten months of 1989 the utilisation was 19.000 machine units against an utilisation in 1988 of 18.000 machine units.

Figure 107: Positioning the 'Puller' within the acceleration chamber in the central part of the cyclotron.

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 1989, the net effective time for experimental irradiations has been around 1.660 hours, although the Cyclotron operated during nearly 2.000 hours.

The breakdown between the major categories of experiments amounts to

Fusion Materials	77%
Environmental Trace Analysis	4%
Third Party Contracts	3%
Materials	16%

PETTEN

HIGH FLUX REACTOR

The High Flux Reactor was operated in 1989 during 234 days, and the average occupation of the irradiation positions in HFR has been 73%. The break-down into the various categories of irradiation experiments is as follows:

LWR	3%	Radionuclides production	18%
FBR	12%	Nuclear Physics	11%
HTR	12%	Solid State Physics	8%
Fusion	22%	Miscellaneous	14%

Construction of New Installations

PETRA
(Facility for Treatment of Radioactive Waste)

The construction of the PETRA facility at Ispra has been terminated in January 1989, with the successful performance of the components and systems functional tests; cold commissioning tests are expected to be finished in early 1990.

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 continued 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.

ETHEL
(European Tritium Handling Experimental Laboratory)

The ETHEL project made significant progress e.g. the building is cast up to the roof, a 350 m^3 double skinned steel container is ready for installation, experimental glove box suites were successfully tested. According to planning the construction will be terminated in 1990.

Figure 108: An interior view of the ETHEL laboratory under construction on the ESSOR Complex, Ispra.

REACTION WALL

The design study of the reaction-wall facility was started in January 1988 and was terminated in 1989; the construction started end 1989.

THE MICROWAVE SIGNATURE LABORATORY

The technical specifications of this installation have been drawn on the basis of the results of the Feasibility Study which was concluded by the end of 1988. According to these specifications a "Call for Tender" has been launched for the detailed design, the construction and the installation of the Laboratory. The selection process was concluded by August and the contract has been awarded in November 1989. The installation should be completed by the end of 1990.

THE LASER AND ION BEAM FACILITY

The Surface Modification Laboratory, which includes the Laser foundry has been completed in 1989.

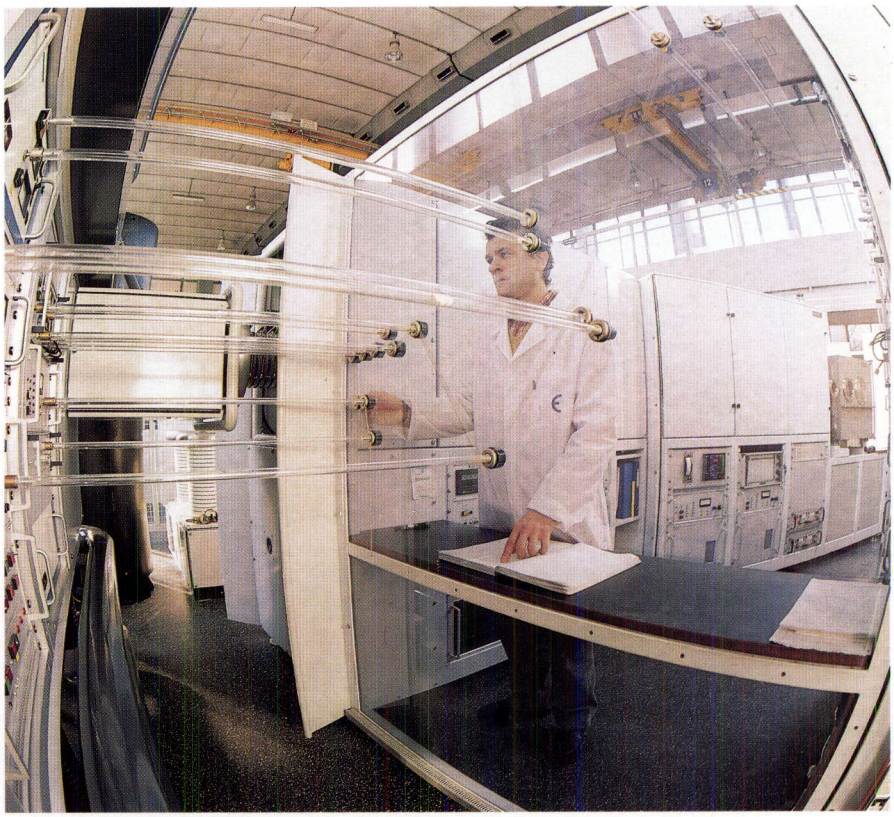


Figure 109: Remote operation panel for the High Current Ion implanter (10m Amps/200kW).

JRC ANNUAL REPORT 1989

HUMAN AND FINANCIAL RESOURCES

HUMAN RESOURCES

Staff Policy

The JRC authorized staff amounts to 2180, including both the scientific-technical and the administrative categories. The detailed organigramme is given in Annex C.

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 54% of the total staff are temporary agents and 46% are officials in the scientific-technical and administrative categories.

During 1989, 115 agents left the JRC, 87 people have been recruited as temporary agents and 9 individuals were transferred from other services of the Commission.

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).

On 21 June 1989, the Council approved Regulation (EEC) Nr. 1857/89 introducing special and temporary measures to terminate the services of officials of the European Communities. These measures apply to officials who are aged at least 50 and have completed at least 15 years of service. The number of officials to whom these measures may be applied is 100.

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 stimulated an increased flow of people from these categories into the JRC.

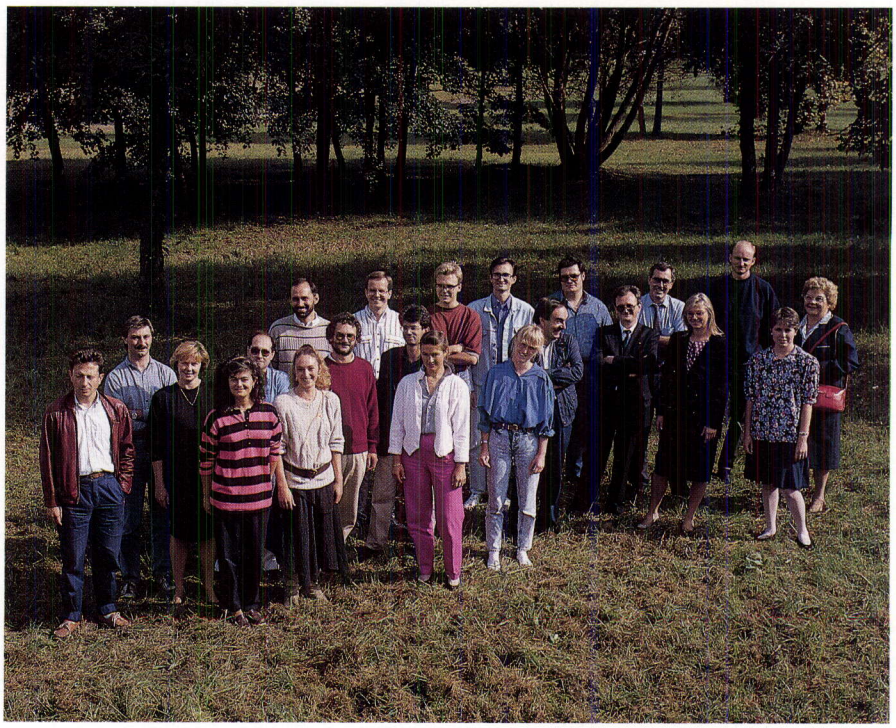


Figure 110: A group of visiting scientists/scientific fellows at the JRC - Ispra.

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.

Besides this type of fellowship, the JRC hosts visiting scientists, mostly professors on sabbatical leave and senior scientists; they are appointed for one year.

Furthermore, experts belonging to national organisations may be seconded to the JRC in order to participate to selected scientific activities.

Finally, the JRC is hosting non EC citizens having received a grant in the frame of an external agreement of the Commission.

Table 2 show where these persons were working in the various JRC Institutes.

Table 2: Visiting Scientists, Seconded Experts and Grant Holders
By Institute and by categories (EC and non EC citizen)

Institutes	Visiting scientists	Seconded expert	Post-doctoral sectorial grants	Graduate sectorial grants	Under-graduate sectorial grants	Non-EC Grant Holders	Total
Central Bureau for Nuclear Measurements	11	1		8			20
Institute for Transuranium Elements	4	4		12			20
Institute for Advanced Materials	6		4	22	1	4	37
Institute for Systems Engineering	9	2		14		3	28
Institute for the Environment	11	1		22		5	39
Institute for Remote Sensing Applications	1	4		12		2	19
Institute for Safety Technology	6	1		15		1	23
Centre for Information Technologies and Electronics	1			4		1	6
Total	49	13	4	109	1	16	192

Furthermore one visiting scientist was working at the Directorate-General

FINANCES

Expenditures committed in 1989

The commitment credits decided by the Budgetary Authority in the 1989 EC budget 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 (including up to 5% for Exploratory Research)	174.6*	Mioecus
— S/T Support to the Commission	30.8	Mioecus
Total	205.4	Mioecus

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

— HFR Reactor	21.2*	Mioecus (Supplementary programme)
— Work for Third Parties	14.6	Mioecus (Estimation)
	35.8	Mioecus

The total amount of the available credits is therefore 241.2 MioEcus (transfers from previous years: 0.9 Mioecus for Specific Research Programmes and 2.9 Mioecus for HFR).

Details about 1989 commitments are given in the following table 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 1989 (Rounded figures, Mioecu)

	Personnel	Other Expenditures	Total	1989 Budget
Specific research programmes	105.2	70.4	175.6	165.9*
Exploratory Research	2.9	2.4	5.3	8.7
Subtotal	108.1	72.8	180.9	174.6
S/T Support to the Commission	16.2	14.8	31.0	30.8
Subtotal	16.2	14.8	31.0	30.8
Work for Third Parties				
HFR Reactor	4.9	14.6	19.5	21.2*
Others	2.2	2.9	5.1	14.6**
Subtotal	7.1	17.5	24.6	35.8
Total	131.4	105.1	236.5	241.2

*) Including the transfer from previous years.
**) Estimation

A sum of 1 Mioecus has been added by the Budgetary Authority in 1989 for "Research activities in Community interest" for contractual work to be performed by the European industry.

The difference between available credits and commitments will be reimbursed to the General Budget.

Table 4 show commitments in 1988 and in 1989, the budget figures of 1990 and a projection of the expenditures expected during 1991 (Programme 1988/1991).

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

	Commitments in 1988	Commitments in 1989	Budget 1990	Projection 1991
Personnel Credits	124.8	131.4	135.5	143.0
Subtotal	124.8	131.4	135.5	143.0
Specific research programmes	66.1	70.4	67.8	66.0
Exploratory Research	2.3	2.4	3.9	3.7
Subtotal	68.4	72.8	71.7	69.7
S/T Support to the Commission	12.2	14.8	17.6	20
Subtotal	12.2	14.8	17.6	20
Work for Third Parties				
HFR Reactor	10.8	14.6	14.3*	14.8**
Others	2.5	2.9	5.8	5.4
Subtotal	13.3	17.5	20.1	20.2
Total	218.7	236.5	244.9	252.9

*) Of which 2.6 Mioecu = contribution in kind from ECN
**) Of which 2.8 Mioecu = contribution in kind from ECN

JRC ANNUAL REPORT 1989

ANNEXES

ANNEX A

PUBLICATIONS, EURO COURSES, APPLICATION OF RESULTS, AND FAIRS

Publications

In 1989 the JRC published 759 papers. The following Table gives the distribution of these publications among research programmes

Table 5: Distribution of JRC publications among research programmes in 1989

	EUR Reports	Conference papers	Public. in scientific journals	Total
Nuclear Measurements and Reference Materials	4	36	21	64
Advanced Materials	15	56	18	89
Fusion Technology and Safety	9	44	9	62
Reactor Safety	35	52	8	95
Radioactive Waste Management	5	25	18	48
Safeguards and Fissile Materials Management	3	18	3	24
Nuclear Fuels and Actinide Research	2	76	26	104
Reference Methods non-Nuclear Energies	4	6	2	12
Environmental Protection	18	60	27	105
Application of Remote Sensing Techniques	3	21	8	32
Industrial Hazards	6	21	6	33
Radiation Evaluation Monitoring	6	5	1	12
Other Publications	7	58	14	79
TOTAL	117	478	164	759

Euro Courses

During 1989, 8 Euro Courses have been organized. The courses are linked with the CEC research programme and reflect the expertise available within the JRC Institutes. The courses treated the following aspects:

Remote sensing applications:

- Vegetation Monitoring by Remote Sensing
- Imaging Spectroscopy: Fundamentals and Prospected Applications

Information Science:

- Parallel Processing with Personal Computers,
- Selected Topics of Monte Carlo Applications in Science and Technology

Health Physics and Radioprotection
- Fundamentals of Radioprotection (in Italian)
- Advanced Seminar on Selected Topics in Radiation Protection

Reliability and Risk Analysis
- Structural Reliability

Energy Conservation
- Parameter Identification Techniques for the Thermal Analysis of Buildings.

Four more courses announced on the 1989 programme had to be postponed to a later date, because of internal movements of scientific personnel and the reorganizations of the services involved in the preparation of the courses.

Six of the 8 courses were held at the JRC Ispra, two in Lisbon upon request of the local authorities. The ''Advanced Seminar on Selected Topics in Radiation Protection'' was organized with the collaboration of DG XII (Directorate D) and the Laboratorio Nacional de Ingenharia e Tecnologia Industrial, Departamento de Protecao e Seguranca Radiologica (SACAVEM) of Lisbon.

The course on ''Structural Reliability'', also held in Lisbon, was organized in collaboration with the Instituto Superior Tecnico, Universidade Tecnica de Lisboa.

The courses were attended by 300 participants from industries, public administrations and universities. They involved about 80 lecturers, two thirds being engaged from outside, the balance coming from the JRC Institutes and various CEC Directorates.
Remarkably high was the attendance of the courses in the field of Remote Sensing and Information Science.

An agreement has been reached with KLUWER Academic Publishers on the publication of the Euro Courses which will be published as volumes describing the state of the art in specific fields.

Applications of Results

The utilisation of the results stemming from research activities of the JRC are very diffused and outmost difficult to quantify as it is the case for other research organisations. Indeed, there is no way to measure precisely the effects of the flow of knowledge from the Joint Research Centre to other organisations and to the European industry; nevertheless Chapter related to the Support to Community Policies gives an idea of how JRC scientific capabilities can be fruitfully utilised for the establishment of Community policies and in particular for the establishment and the implementation of regulations, mainly in the environmental protection field; furthermore the Chapter Third Party Work highlights how Industry can also benefit from the scientific resources of the JRC.

Furthermore, a continuing but growing 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 the information through the construction of prototypes and demonstration.

13 selected projects are being supported by DG XIII (Innovation Programme) and by a JRC contribution of 10 man-year and a financial allocation of 300 Kecu. The fields of application are: Energy, Environment, Materials and Remote Sensing. This projects are:

- Electronic speed variator
- Passive downward heat transport
- Heat pipe furnace
- Object identification by surface texture
- Ispra MARK 13A process for the flue gas desulfuration
- Oxygen sensors
- Gas incapsulated in Zeolites
- Marine technology
- Antioxidant for plastics
- Automatic sampling
- Ultrasonic sealing and identification techniques
- TITUS ultrasonic seals - Reference transducers
- Amorphous metals and ceramics

The pilot plant for the demonstration of the ISPRA MARK 13A desulphurisation process at the SARAS refinery, Sarroch (Sardinia) started to operate at the beginning of 1989. JRC staff surveyed the technical acceptance of the plant and followed the first operation phases, during which a total of 2.000 operation hours in 10 months was achieved.

The project ''Amorphous metals and ceramics'' has given rise, after a careful market and industrialisation study, to a new project, worthy for valorisation, called ''Pyrometer at six wave lengths for high temperature measurements''. This equipment would be able to measure temperature at very short intervals (milliseconds) under the extreme conditions of large heating and cooling rates, required for thermophysical property studies of refractory materials under transient laser pulse heating conditions up to 5.000 K°.

During the course of the year, a new project emerged as a valuable candidate for commercialisation; it relates to the development of new acoustic techniques (already tested at the Institute of Transuranium Elements) to scavenge airborne toxic or radioactive materials, in aerosol or gas form. The European industry has shown interest to check the efficiency of the system in conjunction with electrostatic filters.

During 1989, 15 new patent proposals have been put forward and 22 patents have been granted.

Exhibitions and Fairs

In 1989 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 the table below.

Table 6: JRC Participation in fairs and exhibitions during 1989

Exhibition	Institute	Date
First European Innovation Exhibitions ''EURISKO 89'', Invention and New Products, Research, Technological and know-how Transfers Paris, France	Institutes for Advanced Materials, for Systems Engineering, for the Environment, for Remote Sensing Applications, for Safety Technology, for Transuranium Elements, Central Bureau for Nuclear Measurements	19 - 23 January
Second International Exhibition of Technologies for Environmental and Human Protection ''TAU'' Milan, Italy	Institute for the Environment and Institute for Systems Engineering	7 - 11 March
Hannover Fair, Hannover, Fed. Rep. of Germany	Institute for Transuranium Elements	5 - 12 April
''ENVITEC'' Exhibition Düsseldorf, Fed. Rep. of Germany	Institute for the Environment (ECDIN)	10 - 14 April
Grande Fiera d'Aprile Milan, Italy	Institute for the Environment	15 - 23 April
8th International Exhibition of Construction and Public Works ''SIMAC'' Lisbon, Portugal	Institute for Advanced Materials (Spontaneous Downward Heat Transport)	9 - 14 May
Valencia Seminar Valencia, Spain	Institute for Remote Sensing Applications	29 - 30 May
La Baule Exhibition La Baule, France	Institute for the Environment (MARK 13A)	21 - 23 September
KEM-TEK Conference and Fair, Copenhagen, Denmark	Institute for Transuranium Elements	7 - 10 November
''ECOEXPO, ECOLOGY-ECONOMY'' Exhibition Pescara, Italy	Institute for the Environment	13 - 18 November

Press and Public Relations

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

Table 7: Visits and meetings

	No.	No. of days	No. of persons
Visits	186	279	1356
Meetings	113	200	2700

Most significant events included visits:

- Visit of Mr Leinen, Minister for Environment, and Mr Hahn, Minister for Economy, from the Saarland (19 January) - Ispra
- Visit of Mr. F.M. Pandolfi, Vice-President of the Commission of the European Communities (30 January) - Ispra
- The opening of the Civil Protection School, in the presence of Mr V. Lattanzio, Minister for the Coordination of the Civil Protection, Italian Government (14 February) - Ispra
- Visit of Mr M. van de Kerkhove, Belgian Ambassador to Italy, and Mr L. Fobe, Belgian Consul in Milan (21 February) - Ispra
- Visit of Mrs D.R. Theato, Member of the Budget Control Committee of the European Parliament (22-24 February) - Ispra
- Visit of Mr Yu Ying, advisor to the Ambassador from the People's Republic of China to the EC (Ispra) (27 February) - Ispra
- Visit of a Spanish scientists delegation from the Communidad Valenciana (April 27) - Geel
- Visit of Mr J. Solana Madariaga, Minister for Science and Education (Spain) President of Office of the Community's Research Council, Mr A. Ruberti, Minister for Research and University of the Italian Government, and Mr M. Dido', Vice President of the European Parliament (15 May) - Ispra
- Visit of a Delegation of Japan Atomic Industrial Forum (24 May) - Ispra
- Visit Dr. S. Carpenter, NIST, Washington DC (7/8/12 June) - Karlsruhe, Geel
- Visit of Ambassadors from the Permanent Missions to the OECD (26-27 June)
- Visit of a Delegation from the Soviet State Committee for Use of Nuclear Energy (29 June) - Ispra
- Visit of Mr.H. Narita, President of CRIEPI, Japan, in company of Mr. T. Nakajima (Vice President) and T. Inoue (6 July) - Karlsruhe
- Visit of Mr K. Morris, British Consul General from Milan (19 July)
- Visit of a Working Party of the Western European Union (18-19 September) - Ispra
- Visit of a group of Belgian Senators accompanied by Mr W. Lion, Belgian General Consul in Milan (3 October) - Ispra
- Visit of Dr. H. Meincke, Generalkonsul der Bundesrepublik Deutschland, Antwerp (October 9) - Geel
- UCLAF Seminar (18-20 October)
- Visit of 50 participants in the ''European Community Contest for Young Scientists'' (October 20) - Geel
- Meeting of the General and Preparatory Cooperation Sub-Committee EC-Canada (26-27 October) - Ispra
- Visit of the Irish Minister for Industry and Commerce, Mr D.J. O'Malley (27 October)
- Visit of a team of the Korean Broadcasting System (KBS) (November 15) - Geel
- Visit Drs K. Shiba, JAERI, and T. Mishima, PNC, Japan (1 December) - Karlsruhe

and seminars and conferences:

- Seminar Dr. M. Kubota "Partitioning of Minor Actinitides at JAERI" (21 February) - Karslruhe
- In occasion of the 125th Anniversary of Milan Polytechnic a presentation activity of the Joint Research Centre and their development, Security and Technology (Polytechnic of Milan, 22 February)
- Seminar "Materials for Steam Turbines" (COST 505 Programme results) (7/8 March 1989) - Petten
- Seminar of EURACHEM on coordination of chemical analytical work within the EC (April 18/19) - Geel
- Discussion Meeting with European Federation of Ceramic Producers (GROUPISOL) (19 April 1989) - Petten
- In occasion of the 125th Anniversary of Milan Polytechnic, a presentation of the Remote Sensing Applications and Environment (Polytechnic of Milan, 18 May)
- Working group "Reference Materials for Elemental Analysis of Plutonium" (July 11) - Geel
- International Workshop "Actinides under Pressure" (24 - 25 July) - Karlsruhe
- European Colloquim: HT Corrosion of Technical Ceramics (26/28 June 1989) - Petten
- Communication with the Public about Major Accident Hazards: a European Conference (Varese, Palace Hotel, 30-31 May/1 June)
- International Union of Pure and Applied Chemistry (IUPAC) sub-committees meetings (July 31-August 5) - Geel
- Fifth European Symposium on Physico-Chemical Behaviour of Atmospheric Pollutants (Varese, Villa Ponti, 25-28 September)
- International Working Group "Hot Laboratories and Telemanipulation" (27-28 September) - Karlsruhe
- Seminar of the "Studiengruppe für Elektronische Instrumentierung" (October 2-4) - Geel
- Application of Remote Sensing to Agricultural Statistics Conference (Varese, Villa Ponti, 10-11 October)
- Europalia '89:
  - Japanese and European Approaches to Technological Innovation (9-10 October, Toulouse)
  - Perception of the Notion of Risk in Human Activities in Japan and in Europe (Varese, Villa Ponti, 12-13 October)
  - Japanse and European Approaches to Basic Science (16-17 October, Berlin)
  - Japanese and European Approaches to the Training of Scientists (19-20 October, Lisbon)
- Workshop and Partitioning and Transmutation of Minor Actinides (16-18 October) - Karlsruhe
- Seminar Dr. L. Morss, Argonne National Laboratory, USA (2-3 November) - Karlsruhe
- Seminar on the Commission Contribution to Reactor Safety Research (Varese, Villa Ponti, 20-24 November)
- Workshop - Materials Database Demonstrator Programme (6/8 December 1989) - Petten

ANNEX B

FINANCIAL STATEMENT OF ACCOUNTS

Two tables are provided in order to show in more details the commitments made in 1989.

Table 8: this table compares the commitments made by each research objective with the budget, the personnel expenses being kept apart.

Table 9: this table is similar to table 8 but the personnel cost has been added to the cost of each research objective.

Table 8: Detailed breakdown Commitments 1989, Budget 1989 (Mioecus) (Rounded Figures)

Year	1989		1989	
Reference	**Commitments**		**Budget**	
1. Personnel	131.4		132.0	
- Framework Programme		108.1		101.5
- out of Framework Programme		23.3		30.5
2. Quality of lilfe				
2.1. Radiation Protection				
- Evaluation and Monitoring of Radioactivity				
2.2. Environment	12.7		13.4	
- Environmental Protection		6.3		7
- Application of Remote Sensing Techniques		3.4		3.5
- Industrial Hazards		3.0		2.9
3. Modernisation of industrial sectors				
3.1. Science and technology of Advanced Materials	4.8		5.1	
- Advanced Materials		4.8		5.1
3.2. Technical Standards, Measurement Methods and Reference Materials	13.9		14.5	
- Nuclear Measurements and Reference Materials		8.1		8.5
- Reference Methods, reliability of structures		5.3		5.5*
- Reference Methods for Non-Nuclear Energies		0.5		0.5
4. Energy				
4.1. Fission: Nuclear Safety	31.5		32.7	
- Reactor Safety		16.4		16.5
- Radioactive Waste Management		4.3		4.3
- Safeguards and Fissile Materials Management		3.2		3.6
- Nuclear Fuels and Actinide Research		7.6		8.3
4.2. Controlled Thermonuclear Fusion				
- Fusion Technology Safety	7.5	7.5	7.4	7.4
5. Exploratory research	2.4	2.4	p.m.	p.m.
Sub-total Framework Programme (incl. Prep. Res.) (2 to 5)	72.8		73.1	
6. S/T Support to Commission	14.8		14.8	
7. HFR	14.6		15.6*	
8. Other work for third parties	2.9		5.7	
GRAND TOTAL	236.5		241.2	

*) Including transfer from previous years

Table 9: Detailed breakdown Commitments 1989, Budget 1989 (Mioecus) (Rounded Figures)

Year	1989		1989	
Reference	**Commitments**		**Budget****	
1. Quality of life				
1.1. Radiation Protection				
- Evaluation and Monitoring of Radioactivity				
1.2. Environment	35.8		36.2	
- Environmental Protection		18.6		18.9
- Application of Remote Sensing Techniques		9.1		8.7
- Industrial Hazards		8.1		8.5
2. Modernisation of industrial sectors				
2.1. Science and technology of Advanced Materials	14.8		13.9	
- Advanced Materials		14.8		13.9
2.2. Technical Standards, Measurement Methods and Reference Materials	31.9		31.9	
- Nuclear Measurements and Reference Materials		18.9		19.6
- Reference Methods, reliability of structures		11.1		10.7*
- Reference Methods for Non-Nuclear Energies		1.9		1.6
3. Energy				
3.1. Fission: Nuclear Safety	76.0		76.8	
- Reactor Safety		37.8		37.5
- Radioactive Waste Management		12.7		12.0
- Safeguards and Fissile Materials Management		10.5		10.8
- Nuclear Fuels and Actinide Research		15.0		16.5
3.2. Controlled Thermonuclear Fusion	17.1		15.8	
- Fusion Technology Safety		17.1		15.8
4. Exploratory research	5.3	5.3	p.m.	p.m.
Sub-total Framework Programme (incl. Prep. Res.) (1 to 4)	180.9		174.6	
5. S/T Support to Commission	31.0		30.8	
6. HFR	19.5		21.2*	
7. Other work for third parties	5.1		14.6	
GRAND TOTAL	236.5		241.2	

*) Including a transfer from previous years

**) Figures computed for each programme objective, by adding personnel credits to specific credits

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 de Madame Miet Smet
Secrétaire d'Etat à l'Environnement
Rue de la Loi, 56
B-1040 BRUXELLES

Professor Flemming WOLDBYE
Danish Research Administration
H.C. Andersens boulevard 40
DK-1553 COPENHAGEN V

Dr. Günter LEHR-
Ministerialdirektor
Bundesministerium für Forschung und Technologie
D-5300 BONN 2

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

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
Deputy Director of Electricity and Nuclear Energy
Ministerie van Economische Zaken
Bezuidenhoutseweg 6
Postbus 20101
NL-2500 EC DEN HAAG

Prof. José Mariano GAGO
Presidente de JNICT
(outgoing member in July 1989)
substituted by

Prof. Fernando Manuel RAMÔA RIBEIRO
Vice-Presidente JNICT
Junta Nacional de Investigaçao Cientifica e Technologica
Av. D. Carlos I, 126 - 2o
P-1200 LISBOA

Sir John FAIRCLOUGH
Chief Scientific Adviser
Cabinet Office
70 Whitehall
GB-LONDON SW 1A 2AS

Organization Chart
Joint Research Centre
April 1990

Directorate-General

Director-General

Adviser hors classe — **Brussels** — **Jean-Pierre CONTZEN**
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Central Bureau for Nuclear Measurements

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- Reference materials — Richard LESSER
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units marked (*) are specialized departments

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- Advanced information technology applications and knowledge processing	—
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• Laser fluorescence, high-resolution spectrometry	Giancarlo BERTOLINI
• Microwaves	Alois SIEBER
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• Land utilization (*)	Jacques MEGIER (acting)
• Development aid (*)	Jean-Paul MALINGREAU
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- In-pile experiments	Peter VON DER HARDT
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- Nuclear experiments	Giuseppe BARBERA
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Institute Director	**Pierre BONNAURE**
- Studies and reviews, network coordination	Carlo RINALDINI

ANNEX D

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AECB	Atomic Energy Control Board
AERE	Atomic Energy Research Establishment
ALPSOLAR	EUREKA Project to develop photovoltaic solar devices
AMDAHL	Main Frame Computer
AORS	Abnormal Occurrencies Reporting System
ASTM	American Society for Testing and Materials
ATMES	Atmospheric Transport Models Evaluation Study
AVHRR	Advanced Very High Resolution Radiometer
BIPM	Bureau International des Poids et Mesures
BWR	Boiling Water Reactor
CANDU	Heavy Water Power Reactor (Canadien)
CBNM	Central Bureau for Nuclear Measurement
CHEM	Chemical Emergency Management
CEA	Commissariat à l'Energie Atomique
CEDB	Component Event Data Bank
CENELEC	Comité Européen de Normalisation Electrotechnique
CIEMAT	Centre for Energy, Environmental and Technological Research
CISE	Centro Informazioni Studi Esperienze
CODATA	Committee on data of the International Council of Scientific Unions
COST	Scientific and Technical Cooperation
CRAY	Main Frame Computer
CRONOS	Data Bank of Macroeconomic Time Serial
CSIC	Consejo Superior de Investigaciones Cientificas
CZCS	Coastal Zone Color Scanner
EAC	European Accident Code
EAEC	European Atomic Energy Community
EARSEF	European Airborne Remote Sensing Facility
ECDIN	Environmental Chemical Data Information Network
ECN	Energie Centrum Nederland (Dutch national energy research centre)
EDSES	European Data System for Energy Saving
EINECS	European Inventory of Existing Chemical substances
ENRESA	Empresa Nacional de Residuos Radioactivos
EPRI	Electric Power Research Institute (USA)
ESA	European Space Agency
ESARDA	European Safeguards Research and Development Association
ESTI	European Solar Test Installation
ETHEL	European Tritium Handling Experimental Laboratory
EURACS	European Radar Cross Section Database
EURATOM	European Atomic Energy Community
EUREKA	European co-operation on advanced technology
EUROENVIRON	EUREKA Environmental Umbrella Project
EUROSTAT	European Statistical Office
EUROTRAC	European Experiment on Transport and Transformation of Environmentally Relevant Trace Constituents in the Troposphere (EUREKA project)
FARO	Experimental Facility for Fuel Melting
FED	Fonds Européen de Développement

FEDERCHIMICA	Association of Italien Chemical Industry
PHENIX	Fast Flux Reactor
FIRES	Facility for Investigating Runaway Events Safety
FORMENTOR	EUREKA project to develop expert system to help decision in hazardous situations (complex man made systems)
GFS	Gemeinsame Forschungsstelle (JRC)
HFR	High Flux Reactor (Petten Establishment)
IAEA	International Atomic Energy Agency
ISO	International Standard Organisation
ISPRA MARK 13 A	Flue Gas Desulphurisation Process developed at the JRC Ispra
ITER	International Thermonuclear Experimental Reactor
JAERI	Japon Atomic Energy Research Institute
LASCO	Laboratory for Surveillance and Containment
LASFLEUR	Laser Induced Chlorophyll-Fluorescence
LDTF	Large Dynamic Test Facility
LISA	Long term Isolation Safety Assessment
LMFBR	Liquid Metal Fast Breeder Reactor
LOBI	LWR off Normal Behaviour Investigation (installation)
LURE	Laboratoire pour les Utilisations de Rayonnements Electromagnétiques (University Paris XI)
LWR	Light Water Reactor
MECAPIP	Mesoscale Cycles of Air Pollution on the Iberien Peninsula
MONITOR	Community activities in the field of Research and Technology Development (SAST-FAST-SPEAR)
MOX	Mixed Oxide Fuels (Nuclear Fuel)
MPA	Material Prüf Anstalt - Stuttgart (FRG)
NASA/JPL	National Aeronautic and Space Administration/Jet Propulsion Laboratory
NDA	Non Destructive Analysis
NDE	Non destructive Examination
NEA	Nuclear Energy Agency (of the OECD)
NEANDC	Nuclear Energy Agency's Nuclear Data Committee
NET	Next European Torus
NOAA	National Oceanic and Atmospheric Administration (US)
ORNL	Oak Ridge National Laboratoy
PACT	Programme of Assistance and Technical Cooperation
PASSYS	Passive Solar Energy Systems
PCB	Polichlorinated biphenyl
PERLA	Performance and Training Laboratory (Nuclear Safeguards)
PETRA	Facility for Treatment of Radioactive Waste
PHEBUS	French in pile Programme (severe fuel demage)
PISC	Programme for Inspection of Steel Components
PTS	Pressurised Thermal Shock Experiment
PWR	Pressurised Water Reactor
RAMINO	Reliability Assessment for Maintenance of Inspective Optimization

REIMEP	Regular European Interlaboratory Measurement Evolution Programme
RELAPS5	Large System Thermohydraulic US Code, Version S5
REM	Radioactivity Environmental Monitoring
SANDIA	Sandia National Laboratories
SESAME	Databank on European Community's Energy Research and Development Projects
SIBECA	Code for financial accounting
SME	Smal and Medium Enterprise
SNEA	Société Nationale Elf-Aquitaine
STARS	Consortium of Laboratories and Industries active in Safety and Reliability Analysis
TNO	Technische Nederlandse Onderzoek Centrum
TRANSALP	Transalpine Transport of Air Pollution
TRANSURANUS	Nuclear Code
UNCTAD	UN Conference on Trade and Development
SUPERFACT	Nuclear Experiment carried out in the PHENIX reactor
VAMAS	Versailles Project on Advanced Materials and Standards
VOC	Volatile Organic Compounds

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
Fax: + 32-2-235 85 31

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
Fax: + 32-14-584 273

Institute for Transuranium Elements
Postfach 2340
D-7500 KARLSRUHE

Phone: + 49-7247-84 350
Telex: 7825483 EU
Fax: + 49-7247 4046

Institute for the Environment
I-21020 ISPRA (VA)

Phone: + 39-332-78 96 01
Telex: 380042 or 380058 EUR I
Fax: + 39-332-78 92 22

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

Phone: + 39-332-78 97 65
Telex: 380042 or 380058 EUR I
Fax: + 39-332-78 95 36

Institute for Safety Technology
I-21020 ISPRA (VA)

Phone: + 39-332-78 97 43
Telex: 380042 or 380058 EUR I
Fax: + 39-332-78 99 03

Institute for Systems Engineering and Informatics
I-21020 ISPRA (VA)

Phone: + 39-332-78 99 47
Telex: 380042 or 380058 EUR I
Fax: + 39-332-78 99 23

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

Phone: + 31-2246 - 5401
Telex: 5721 REACP
Fax: + 31-2246-33 93

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

Phone: + 39-332-78 99 41
Telex: 380042 or 380058 EUR I
Fax: + 39-332-78 90 65

Conception and Production:

JRC Ispra Publications Service
Coordination **P. De Hoe**
Graphic Design **J. Wells, M. Magermans**
Photographs **E. Gorts**

Phototypesetting **Arte Stampa**, Daverio (VA) Italy
Colour separations **Cromoflash**, Castronno (VA) Italy
Printing **CTV - Viganò**, Sangiano (VA) Italy

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