
COMMISSION OF THE EUROPEAN COMMUNITIES
JOINT RESEARCH CENTRE

Contents

Introduction

On 25.7.83, the Council of Ministers approved the proposal of the Commission of the European Community for a European scientific and technological strategy, to be pursued within a general framework programme of scientific and technological research, development and demonstration activities in the period 1984-1987. This important decision selects options of social and economic relevance, such as the promotion of the agricultural and industrial competitiveness of the Community, the improvement of the management of raw materials and of the management of energy sources, the improvement of living and working conditions in the Community, the stimulation of the EC's scientific and technological potential.

The framework programme has been partitioned, for its execution, into Research Action Programmes, designed to satisfy one or more scientific or technological objectives. A Research Action Programme is made up of a set of R and D projects within its sector. It utilises, by means of integrated management, different procedures at a Community level: shared cost contracts (indirect action), coordinated research (concerted action) and the direct action of the Community, i.e. the research performed within and by the Joint Research Centre of the European Community (JRC).

The JRC contributes, therefore, to some of the Research Action Programmes (RAP's) namely:

— INDUSTRIAL TECHNOLOGIES
— FUSION
— FISSION
— NON-NUCLEAR ENERGY SOURCES
— ENVIRONMENT

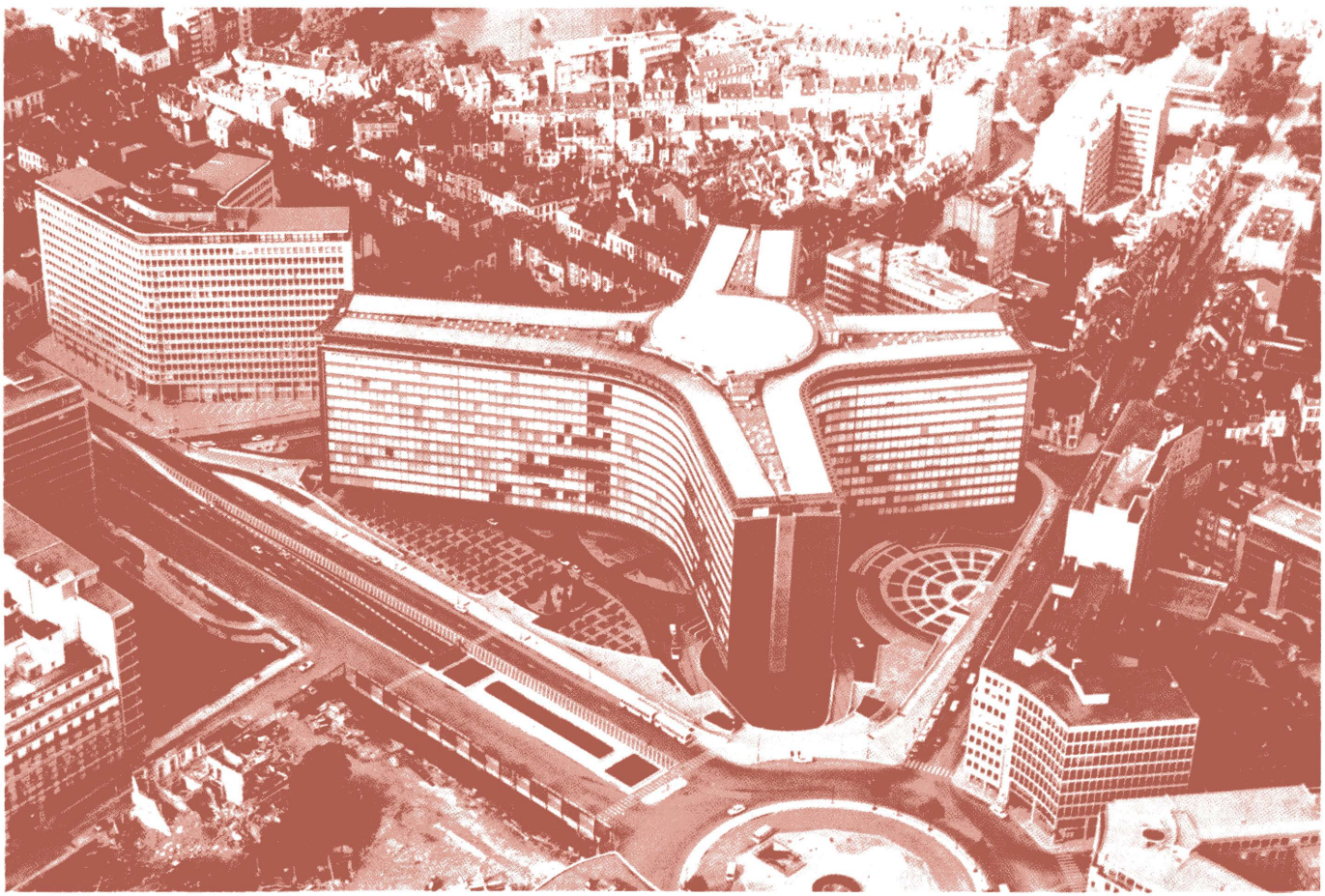
The contribution to these Research Action Programmes is in line with the main mission recognised to JRC, which is resumed in the choice of two main themes for its activity:

— safety and protection of the environment
— standardisation

Thus, nuclear and non-nuclear safety aspects are particularly emphasized in the contribution of JRC to all the above quoted Research Action Programmes. Furthermore, in the RAP Industrial Technologies, JRC, besides providing support to industry in the development of high-temperature materials, is developing an important effort in the field of standardisation. This is a very important field for the removal or reduction of barriers to trade in industrial products within the Common Market.

The role of the Joint Research Centre is intended to be central to the Community's research strategy in all those fields in which its activity is deployed. Thus, projects have been selected which are able to play a significant role in promoting international cooperation. The latter is pursued vigorously, so that JRC may act as a federator and catalyst of R and D in the Community.

BRUSSELS - Headquarters of the Commission of the European Communities



The Four Establishments

GEEL (Belgium)

- Central Bureau of Nuclear Measurements
- Linear Accelerators

PETTEN (Olanda)

- High Flux Reactor
- High Temp. Materials Lab

ISPRA (Italy)

- Large scale facilities for the simulation and study of accidents in nuclear reactors
- Cyclotron for the study of irradiated materials
- Installations for the study of Nuclear Waste Management
- European Solar Test Facility
- Installations and laboratories for studies on Environmental Protection
- Specialized laboratories in Electronics, Materials Science, Radiochemistry

KARLSRUHE (F.R. of Germany)

- Transuranium Institute
- Plutonium Fuels Lab.

The Central Bureau for Nuclear Measurements

The **Central Bureau for Nuclear Measurements** (CBNM) at Geel in Belgium is specifically described in the Euratom Treaty as "a bureau of standards specialising in nuclear measurements for isotope analysis and absolute measurements of radiation and neutron absorption".

Its two major accelerator facilities have been designed to provide nuclear measurements of basic importance to the development of nuclear power reactors. In addition the bureau has a series of well-equipped laboratories for studying the decay of isotopes and for preparing and essaying reference material used in the nuclear energy industry.

The Ispra Establishment

The **Ispra Establishment** which is situated on 395 acres (160 ha) of land on the banks of Italy's Lake Maggiore, is by far the largest of the JRC's four establishments, employing three quarters of the JRC's total staff.

Although it was initially intended as a purely nuclear research centre with the emphasis on nuclear safety, a large part of Ispra's budget is now devoted to other fields. These include, for instance, research in the environmental field, the use of satellites for agricultural purposes, and the study of non-nuclear energy sources, e.g. solar energy.

The Institute for Transuranium Elements

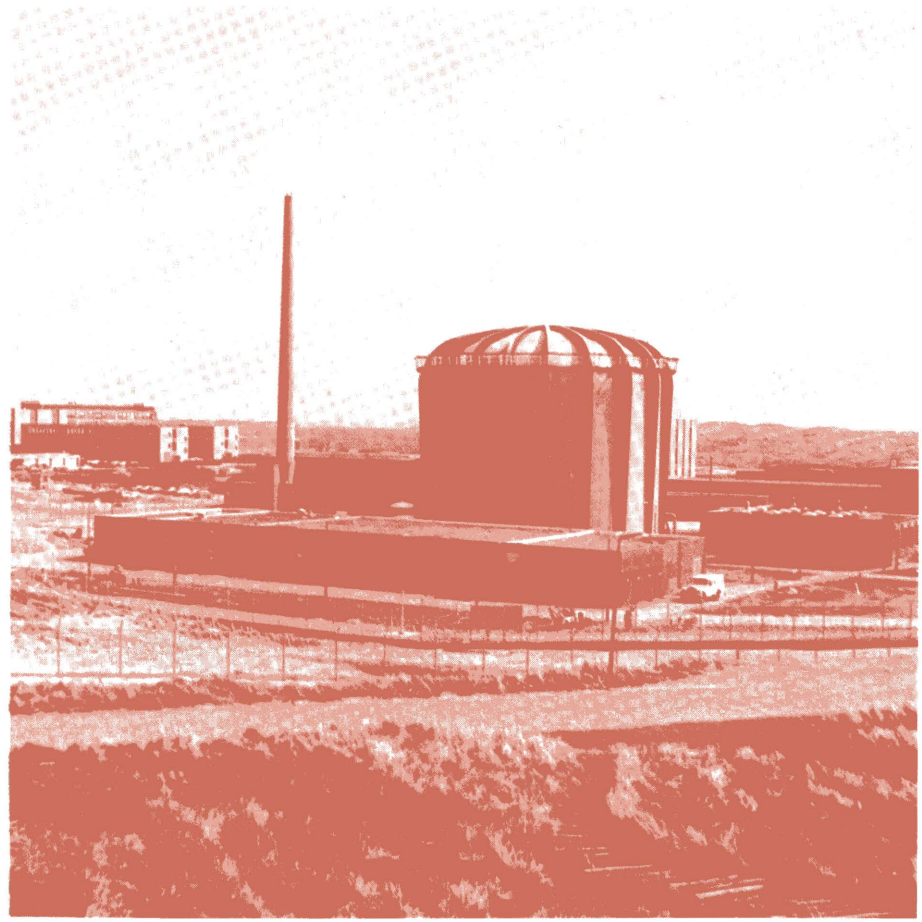
Research into plutonium and other actinides, the so-called transuranium elements (highly radioactive substances not occurring naturally, but predominantly produced in nuclear reactors) is carried out at the **Institute for Transuranium Elements** in Karlsruhe, which is located on the site of the German national nuclear research centre.

The Institute executes the JRC's Nuclear Fuels and Actinide Research programme. Because the transuranium elements are highly radioactive and radiotoxic, the institute is equipped with highly specialized facilities.

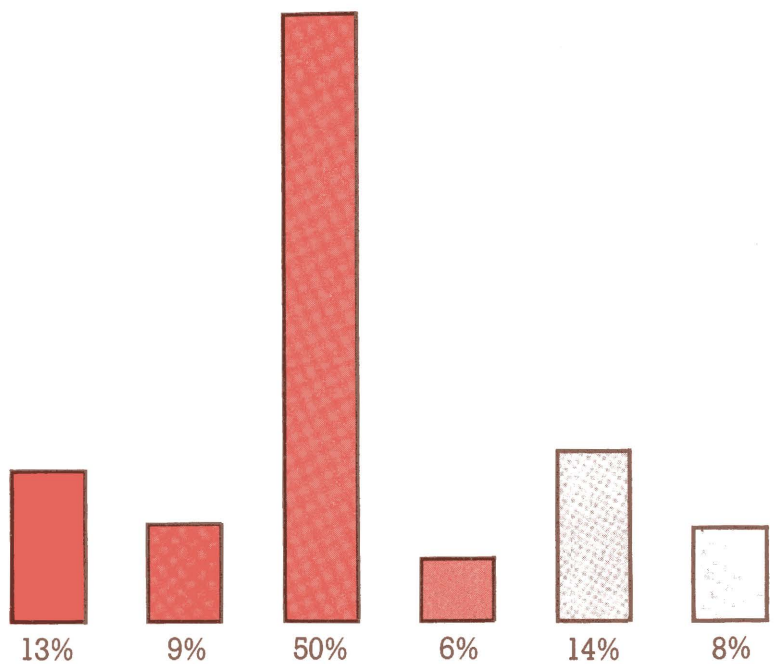
The Petten Establishment

The **Petten Establishment** is situated in Northern Netherlands and specialised in research into high-temperature materials. Its High Flux Materials Testing Reactor is one of the largest irradiation facilities in the EC and in 1979 confirmed its position as one of the busiest materials testing reactor in the world.

Apart from performing tasks for the benefit of interested Member States, surplus irradiation space is made available to outside users against payment and the centre collaborates with most nuclear research centres inside the EC.



Indicative breakdown of JRC resources on 1984-87 research programme activities



INDUSTRIAL TECHNOLOGIES 13%
1. Nuclear measurements
2. High temperature materials

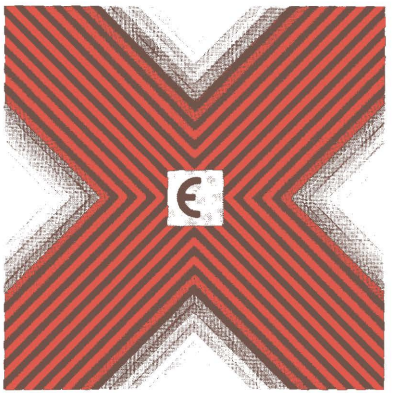
FUSION 9%
1. Fusion technology and safety

FISSION 50%
1. Reactor safety
2. Radioactive waste management
3. Safeguard and fissile materials management
4. Nuclear fuels and actinide research

NON-NUCLEAR ENERGIES 6%
1. Testing of solar energy systems
2. Energy management in habitat

PROTECTION OF THE ENVIRONMENT 14%
1. Protection of the environment
2. Application of remote sensing techniques
3. Industrial risks

EXPLOITATION OF THE HFR REACTOR 8%



Research at the JRC

The Commission draws up four-year programmes for the Joint Research Centre which it submits to the European Parliament for its opinion before they are approved by the Council of Ministers. The 1984-1987 programme will cost 700 Million ECU, value 1983.

The JRC has a total complement of 2260.

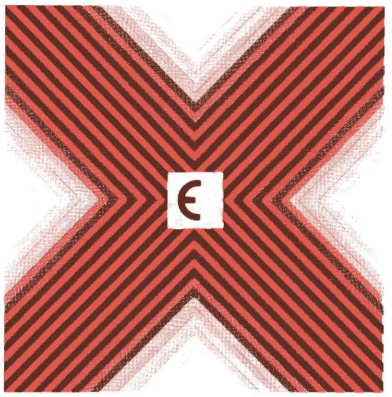
To ensure the flexibility needed by a research organization to enable it to take technical and social developments into account, the Commission has established a Board of Governors composed of a high-level government representative from each of the Member States.
The Board advises the Commission on policy and is able to authorise adjustments to the programme decided on by the Council. The Commission has also set up a Scientific Council of emminent European scientists to advise on scientific affairs and on the running of the JRC.

The research programme of JRC for 1984-1987 is coordinated under the Research Action Programmes (which are indicated hereafter by the capital letters A to E). In each JRC contribution to a Research Action Programme, particular areas of research and projects are distinguished by the RAP's capital letter and a numeral.

The JRC direct action is coordinated with the shared cost and concerted actions within the Commission's General Directorate XII for Science, Research and Development of which the JRC is a part.

The JRC has also established direct links and cooperation with a large number of research laboratories inside and outside the Community, and with international organisations such as the International Energy Agency of the OECD, the International Atomic Energy Agency and the European Space Agency. Contacts with developing countries have also been considerably stregthened in recent years through the provision of technical knowhow and expertise.
Because of their geographical dispersion and because of their specific requirements, the four establishments of the JRC enjoy a large degree of autonomy in their day to day management. The overall coordination within the JRC is assured by the Director-General of the JRC and his small staff in Brussels.

* March 1985: 1 ECU =
FB/FLUX 45.28; DM 2.24; HFL 2.53; Sterl. 0.59; DKR 8.18; FF 6.87; LIT 1374; IRL 0.73; US$ 0.77.



A. Research action programme:

Industrial technologies

A.1. Nuclear measurements and reference materials
A.2. High temperature materials

Industry is a vital element of the Community's social and economic prosperity. It is, therefore, of the utmost importance to increase its competitiveness and this has, accordingly, been chosen as one of the major objectives of the framework programme.

The RAP-INDUSTRIAL TECHNOLOGIES * pursues the following objectives for industries.

— the removal or reduction of barriers to trade in industrial products within the common market;
— stimulation of the development of new materials and new technologies in the pre-competitive phase for the benefit of various industrial sectors in the Community.

The responsibility for undertaking suitable projects falls initially to industry, the Community fulfilling the function of catalyst as regards problems on a European scale.

The comparability and quality of measurements are, for instance, of the highest importance when it comes to removing or reducing barriers to trade. Research and development in this field can undoubtedly be regarded as a Community task. For this reason the RAP-INDUSTRIAL TECHNOLOGIES includes projects directed towards the improvement of measuring methods and the preparation and certification of reference materials for use in the nuclear and other sectors. Metrology and the study of the chemical, physical and technological properties of industrial materials form part of this research action programme.

* This RAP does not include information technology and biotechnology which are the subject of separate Action Programmes.

A.1. Nuclear measurements and references materials

The programme Nuclear Measurements and Reference Materials developed at the Central Bureau for Nuclear Measurements (CBNM), JRC's Geel Establishment, has in the past contributed to the development of nuclear fission and fusion power and also to the removal and reduction of impediments to trade through the setting-up of reference materials and methods in the nuclear field.

It is intended to extend its activities to reference materials and techniques in the non-nuclear field so as to provide support to the Community Bureau of Reference (CBR).

The programme consists of two main parts, Nuclear Measurements of the one hand and Reference materials on the other. It will be noted that whereas the end products of the Nuclear Measurements part are mainly data, those of the Reference Materials project are usually sets of certified materials.

The Project Nuclear Measurements is concerned with a) the measurement of Nuclear Data using particle accelerators and b) other applications of nuclear measurements which make up the sub-project Nuclear Metrology. Concerning nuclear data, there will be a continuation of the measurement of neutron data (i.e. data on neutron induced reactions) but more emphasis than hitherto is given to data regarded as standard and also to data required for fusion technology. In Nuclear Metrology, the metrology of radionuclide decay and also neutron flux and dose are studied.

The project Reference Materials (RM's) is divided into two sub-projects, Nuclear Reference Materials and Non-Nuclear Reference Materials. In the nuclear area, actinide RM's for elemental and isotopic analysis and also special nuclear targets are provided. New features are to provide RM's for monitoring neutron fluences, especially in relation to the integrity of reactor pressure vessels and to the steel sample control programme in nuclear power stations. Work on RM's of very low level radioactivity for environmental control is another new feature. In the non-nuclear sector, some biological measurements as well as surface measurements are envisaged.

A.2. High temperature materials

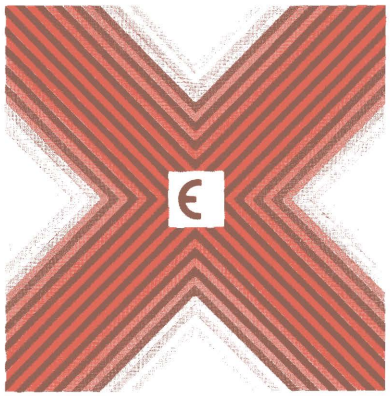
The development of advanced high-temperature technologies is linked directly to progress in materials research and development. Relevant areas in energy and industry include power generation and utilisation,

petrochemical processing, automotive, mechanical and nuclear engineering. Improved materials would allow increased efficiency, design life, reliability and safety in high temperature process plants using low grade fuel. The High Temperature Materials (HTM) programme has a recognised standing in the European high temperature field, playing a central role in providing information and facilitating R and D on engineering materials.

The programme is developed at the JRC's Petten Establishment with a contribution by the Ispra Establishment.

The new programme is tailored to the industrial needs for material for long term service in high temperature aggressive environments by promoting, coordinating and conducting studies to evaluate materials behaviour under conditions relevant to critical areas of the processes. It thus provides a scientific service, concerned with materials information, data handling and direct research programmes. The informatic and experimental actions required to achieve the stated aims are divided between five closely connected projects.

1. **Studies on Steels and Alloys** investigate selected industrial HTM for their suitability for service in aggressive environments containing sulphur, oxygen, carbon by means of experimental studies to obtain an understanding of the mechanisms causing alteration in properties and failure of samples by corrosive attack, creep or fatigue acting singly or in combination. The mechanism of protection of alloys by corrosion resistant coatings is also investigated.
2. **Studies on sub-components** verify experimental methods of applying laboratory property data to tubular sub-components operating under complex conditions of creep/corrosion, improving engineering methodologies for the analytical prediction of stress, deformation and life of components operating at high temperatures.
3. **Studies on Engineering Ceramics** involve the programme directly in a new scientific field. Development of new materials during the last decade has generated interest in the feasibility of exploiting the advantages of ceramic components in high temperature corrosive structural applications. The problems remain essentially those of fabrication and of materials reliability in service. The project contributes to both of these areas, by developing methods for obtaining and optimising the mechanical properties of selected engineering ceramics.
4. The **HTM Data Bank** assemblies selected properties of a range of important HTM. The data bank promotes coordination and standardisation of data information and will be available online or indirectly to all European Community users.
5. The **HTM Information Centre** aims to encourage information exchange to collate and distribute materials information, to identify and evaluate future R and D requirements and to promote interactive research collaboration in the HTM community. The Centre provides a service concerning all aspects of high temperature materials applications from industrial manufacturing to academic research.



B. Research action programme:

Fusion

B.1. Fusion technology and safety

The programme of research of the European Communities in the field of controlled thermonuclear fusion consists of a long-term collaboration covering all the activities undertaken in this sector in the Member States. This collaboration is designed to lead, in due course, to the industrial scale production and marketing of jointly developed prototypes.

The Community will benefit from the application of controlled thermonuclear fusion, particularly in the wider context of the security of its long term energy supplies.

Three intermediate stages are planned with a view to the attainment of this ultimate objective:

— demonstration of scientific feasibility which should be achieved during the eighties by the operation of JET (Joint European Torus) (in Culham, U.K.) and similar American and Japanese devices;
— demonstration of technical feasibility, which will require the construction of an experimental reactor in order to test different technical components for a future fusion reactor. Design of this machine has already commenced under the Community fusion programme with the establishment of the NET (Next European Torus) team;
— demonstration of industrial feasibility, which will require the construction of a demonstration reactor under actual operating conditions (DEMO).

B.1. Fusion technology and safety

In the frame of the Research Action Programme « Fusion », the Joint Research Centre plays a significant role.

The JRC has been involved since 1973 in studies of the problems related to fusion power reactors. The aim of these studies was to identify and solve some of the key issues for the construction of the experimental machine after JET (NET/INTOR). (INTOR, **IN**ternational **TO**kamak **R**eactor, sponsored by IAEA) and for the demonstration power reactor (DEMO). In the 1980-1983 programme, the JRC effort was concentrated in the following areas:

— contribution to the engineering conceptual design of the NET/INTOR reactor;
— experimental sorting and development of first wall, structural and breeding materials.

In the 1984-1987 programme the JRC contribution to the European fusion studies proceeds along the same lines, with an extension to safety and environmental aspects of fusion. The activity is sub-divided into four parts:

REACTOR STUDIES
BLANKET TECHNOLOGY
STRUCTURAL MATERIALS STUDIES
RISK ASSESSMENT

REACTOR STUDIES includes the contribution of JRC to the NET predesign, in close contact with the NET team at Garching; the continuation of the JRC partecipation to the INTOR assessment is also foreseen.

The **BLANKET TECHNOLOGY** activity is orientated towards the experimental investigation on the eutectic 17Li83Pb which appears as one of the attractive liquid breeders for NET and power fusion reactors.

The **STRUCTURAL MATERIALS STUDIES** deal mainly with investigations on stainless steels which are the main candidates for first wall and blanket structures in the future NET and DEMO reactors (AISI-316 steel, Mn-Cr commercial steels etc.). Other materials, suited for specific first wall applications, such as the plasma exhaust collectors, will also be studied.

Research is focused on the important aspect of the mechanical and chemical behaviour of these materials under high energy radiation which may cause important structural damage. This aspect is investigated through irradiation experiments performed in the High Flux Reactor (HFR) at the Petten JRC-Establishment as well as in the MC-40 cyclotron facility at the Ispra JRC-Establishment. In the MC-40 cyclotron, the materials may be submitted to bombardment with light particles up to energies of 38 MeV.

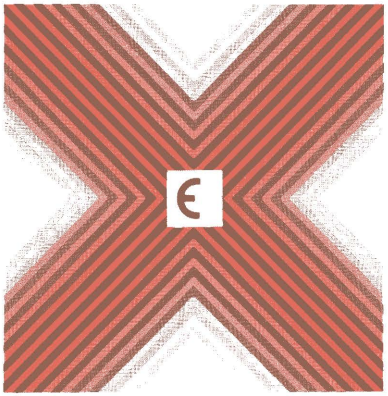
The performance of the cyclotron is as follows:

Particles Accelerated	Energy (MeV)	Extracted Beam (μA)
Proton	10-38	65
Deuterons	5-19	65
α-Particles	10-38	30

The cyclotron is equipped with several beamlines, and ancillary facilities, such as He-cooling loop.

This loop has a capacity of heat dissipation up to 300 W, a gas circulation up to 50 m3/h and a continuous purification system that keep the impurity level of oxygen and of other gases and vapours below 3 ppm.

The **RISK ASSESSMENT** focuses on safety analyses with regard to plant's damage and environmental consequences. The initiation and development of an accident in a typical fusion layout (such as first wall and blanket) are investigated.



C. Research action programme:

Fission

C.1. Reactor safety
C.2. Radioactive waste management
C.3. Safeguards and fissile materials management
C.4. Nuclear fuels and actinide research

The development of nuclear-fission energy is one of the principal means of reducing the Community's dependance on petroleum through diversification of energy sources. Continuation of a consistent nuclear programme is, in consequence, an essential aspect of the European energy policy. The Community strategy ensures that research work is consolidated and intensified, particularly in the general fields of nuclear safety, health and environmental protection and the safeguarding of fissile materials. The European Parliament has adopted a resolution approving and confirming this strategy, in respect of which the Council has also expressed a favourable opinion.

The Community R and D work is thus orientated mainly towards safety aspects, that is to say, the protection of workers and the general public.

This action covers the safety of both light-water reactors (LWR) and liquid-metal-cooled fast breeders (LMFBR) together with the safety of the fuel cycle and in particular the management of radioactive waste, the safeguarding and management of fissile materials and the fabrication and reprocessing of nuclear fuel.

The programme is executed as a direct action, carried out in the Joint Research Centre of the European Communities, as well as through shared cost actions, in which organisations of the Member States take part. In addition, collaboration with countries outside the Community are foreseen so that the Community research in this field may have access to the results of similar research.

C.1. Reactor safety

In the field of reactor safety, the Joint Research Centre plays a central role in the Research Action Programme of the Commission.

The overall objectives of the combined direct and shared cost actions in the Reactor Safety domain are:

— Accident prevention
— Accident analysis and mitigation of accident consequences.

The objective of **Accident Prevention**, is to improve the design and fabrication quality of reactor components and systems, in order to increase operation reliability and hence safety and economy of nuclear power plants. The activity of the Commission is focused on risk and reliability assessment and on the study of system and component integrity.

In the area of **Accident analysis and mitigation of accident consequences**, the Commission effort is directed to the development of models and computer codes which describe the phenómena occurring during the course of an accident. Large test rigs are run to produce experimental data for code verification.

The emphasis on the above mentioned research areas is slightly different for the two types of reactors (LWRs or LMFBRs) due to their different stages of development.

The following research lines are pursued in the Joint Research Centre:

For LWR reactors

Reliability and Risk evaluation

The scientific goal is to develop and harmonise the Probabilistic Risk Assessment (PRA) methodologies and to create a viable information system on all aspects of reactor operation.

The comparison of the PRA methodologies is obtained through the organisation of Benchmark Exercises, one of which (Reliability Benchmark Exercise) has already been carried out at the Ispra JRC Establishment. The Joint Research Centre will also pursue the implementation of a European Reliability Data System (ERDS), a centralised Bank system for collecting data on component failures and abnormal occurrences as well as operating data for LWR.

Integrity of LWR components and systems

This scientific goal is to improve and assess techniques and models for the reliability evaluation of reactor pressure vessels and piping. Work is concentrated on:

— evaluation of effectiveness of non-destructive examination techniques on non-irradiated and irradiated materials. Comparison exercises (PISC - Programme for Inspection of Steel Components) of the NDE (Non-Destructive Examination) techniques involving laboratories of 15 countries and jointly organised by OECD/NEA and CEC are presently underway.

— validation of testing techniques and life-prediction models through an experimental programme on 1/5 scale reactor pressure vessels.

Study of abnormal behaviour of LWR Cooling Systems

The scientific goal is to acquire a deep understanding of the mechanics which govern the thermohydraulic behaviour of LWR Cooling Systems. Already during the 1980-83 programme period, the Ispra JRC Establishment in cooperation with Ministry for Research and Technology of the Federal Republic of Germany (BMFT) had been operating the LOBI (Loop Blowdown Investigation) facility in which loss of coolant accidents (LOCA) and special transients in Pressurised Water Reactors (PWR) can be simulated. In the 1984-87 programme, the experimental programme will be continued and emphasis will be put on the assessment of large system codes, based on the knowledge acquired in this field.

LWR Severely Damaged Fuels

The scientific goal is to acquire the knowledge of the main phenomena underlying fuel damage, the fission product release and transport and the thermohydraulics in LWR Severe Accident conditions. Such knowledge is the indispensable basis for a physical modelling of such phenomena and for the development of adequate computer codes.

For LMFBR reactors

LMFBR Accident Modelling

The scientific goal is to acquire a deeper knowledge of the phenomena characterising the initial and late phase of postulated accidents and of the effects of the accidents on reactor components and structures. In the case of a serious accident the partial or total melting of the core in a fast reactor may be hypothesized, and a special emphasis is given to the study of the thermohydraulic and physico-chemical behaviour of the fuel and core structural materials at very high temperatures or under sudden thermodynamic transients. A basic experimental out-of-pile equipment in the Ispra JRC Establishment is the FARO multi purpose facility, designed to melt 100 kg of U02. Furthermore, for the Post Accident Heat Removal project (PAHR), in-pile experiments (on debris beds of U02 and U02 + stainless steel in sodium) are coordinated and funded by the JRC. Data acquired in this experimental activity are employed for theoretical modelling of different accident scenarios.

LMFBR Material Properties and structural behaviour

In order to predict the behaviour of reactor containment structures during normal operation as well as in accident conditions, it is important to understand the properties of materials, to define constitutive laws in various damage conditions and to improve and develop the structural analysis codes.

In this connection, it is worth mentioning the Large Dynamic Test Facility (LDTF) existing in the Ispra JRC Establishment, designed for the investigation of the mechanical behaviour of large material specimens and structures under dynamic loading.

C.2. Radioactive waste management

The future of nuclear power depends, among other factors, on the development of satisfactory methods for management and final disposal of the radioactive waste produced in the nuclear fuel cycle.
The very long half-life of a few radionuclides, both fission products and actinides, requires that safety be guaranteed for time periods which are far beyond those which have ever been considered by industrial safety, and which may extend to 100,000 years or more.
The JRC programme on waste management, which was initiated in 1973, has always been aimed at ameliorating the long term safety of waste management in various aspects, ranging from long term assessment of geologic disposal to accurate measurements of actinides in waste (actinide monitoring) to minimisation of alpha-waste arising (actinide separation). These activities have been strictly coordinated with C.E.C. contractual activities on waste management, and links between these activities are strengthened by joint coordination of important research actions such as PAGIS (Performance Assessment of Geological Isolation Systems) and MIRAGE (Migration of Radioisotopes in the Geosphere).

The overall programme objectives have been maintained for the 1984-1987 period. In particular it is intended:

— To continue, at a reinforced level of staff and budget, the activity on long term safety assessment of geological disposal in both continental and submerged geological formations.
— To maintain the on-going activities on development of non-destructive monitoring methods for actinides in waste and possibly extend them to the development of non-destructive methods for physical characterisation of high activity waste.
— To continue, at a reinforced level, the activities on actinide separation from medium level waste, taking advantage of the new hot-cell installations of the ADECO complex, and including the cost-benefit evaluations of alternatives under study.

The activities mentioned above have been structured into three projects:

Project 1 (Waste management and the fuel cycle) deals with all aspects linked to fuel cycle installations, and aims at minimising alpha-waste arising and improving their quality in relation to final disposal.

Project 2 (Safety of waste disposal in continental geological formations) includes both theoretical evaluation activities and linked experimental activities, aiming at providing a long term safety assessment of waste disposal in continental geological formations.

Project 3 (Feasibility and safety of waste disposal in deep oceanic sediments). The particular character of sub-seabed disposal made it advisable to organise the activities related to this option as a separate project, although the project goals are similar to those of project 2.

While the previous programmes were essentially executed at the Ispra Establishment, in the 1984-1987 programme the Transuranium Institute of JRC Karlsruhe will contribute to projects 1 and 2 of the programme.

C.3. Safeguards and fissile materials management

The JRC R and D programme is primarily orientated to assist the EURATOM Safeguards Directorate and the European plant operators in the implementation of their safeguards duties in the frame of EURATOM and Non-Proliferation Treaties or other agreements. To combine the technical requirements originating from the different safeguards obligations with the reality of industrial operations and fissile material management remains a major issue, which will be addressed within the frame of the programme.

The continuous increase of the use of technical resources by inspectors and operators for control purposes and the improvement of their quality, requires the development of a more systematic and detailed analysis of the safeguards practices.

The programme is structured into three projects:

1. **Methods and Instrumentation for the Assay of Fissile Materials and Containment and Surveillance**

   This project concerns the systematic evaluation of the performances of instrumentation in field conditions, the development of new methods when required and the industrialisation of those instruments which have been used satisfactorily in the past.

   A calibration and training laoratory will be established in the ESSOR complex;

2. **Safeguards Data Processing, Transmission and Evaluation**

   This project concerns the data evaluation aspects and automatic of instruments, studied mainly in the first project.

   Furthermore, studies on the applicability of statistical material accountancy evaluation methods are considered in this project.

3. **Integration of Safeguards Activities**

   This project involves the development of tools allowing to integrate the results of the two previous projects in a comprehensive scheme at facility and fuel cycle level.

As a second element of integration the JRC is developing its activities mainly in the frame of a functional integrated data evaluation system, in order to assure in particular the compatibility between the development in the different sub-projects from the data evaluation point of view.

The harmonisation of the R and D effort with Member States laboratories will be continued through ESARDA (European Safeguards R and D Association), and through bilateral collaborations. The collaboration with other countries, having a major R and D programme, such as US and Japan, will also be pursued. The Commission - IAEA (International Atomic Energy Agency) cooperative support programme will remain an important channel for supporting IAEA safeguards.

For all projects a strict cooperation with EURATOM Safeguards Directorate is assured.

C.4. Nuclear fuels and actinide research

The programme Nuclear Fuels and Actinide Research which is executed at the Transuranium Institute of the JRC Karlsruhe, is based on the experience of this Institute in the field of nuclear fuels and on its leading role in the Community in the field of actinide research.

In the programme 1984-1987 questions of safety are of primary concern. These questions include both the safe operation of plutonium containing fuels and key problems of the fuel cycle.

The previous work on fuel swelling is being replaced by the assessment of optimised advanced fuels and basic information on fuel and fission product behaviour under off-normal conditions are being provided for the evaluation of accidents in nuclear reactors.

Safety aspects of fuel fabrication and reprocessing are also being investigated.

In the field of actinide research the activity on the preparation of actinide compounds and on the determination of their physical characteristics is being continued in the framework of a large Community collaboration.

The programme consists of 4 projects:

1. **Operation Limits of Nuclear Fuels**

   One aim of this project is to elaborate the specification of an optimised advanced fuel for fast reactors, within operation limits.

   In addition the project aims at the determination of thermodynamic characteristics of nuclear materials at very high temperatures, viz. well beyond operation limits.

2. **Transient Behaviour of Oxide Fuels and Fission Product Release under Severe Fuel Damage Conditions**

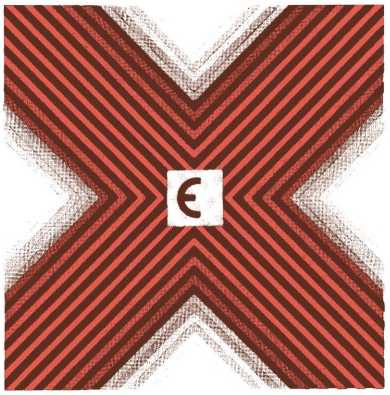
   Theoretical and experimental studies are carried out in the framework of this project which is meant to support the severe fuel damage studies included in the Reactor Safety programme.

3. **Actinide Cycle Safety**

   Experimental and theoretical studies are carried out on the formation of actinides in the reactors, on the safe handling of nuclear fuels, with special regard to aerosol formation and on some key problems of fuel reprocessing.

4. **Actinide Research**

   The project includes work on crystal chemistry (preparation and characterisation of samples) and studies of the solid state physical properties to establish and confirm a general theory of bonding in solid actinides.



D. Research action programme:

Non-nuclear energies

D.1. Testing of solar energy systems
D.2. Energy management in habitat

If the Community's dependence on imported energy sources is to continue on its downward path, substantial, judicious efforts must be made in technological R and D relating to both the energy supply (diversification and substitution) and demand (conservation and rational use). It is also aknowledged that a fruitful R and D activity in the energy sector considerably facilitates the attainment of other Community goals, such as improving industrial and agricultural competitiveness and reinforcing development aid.

In the context of European energy programmes, these objectives can be met through projects relating to:

— the efficient, economic use of renewable energy sources, including the development of suitable technologies for exploiting solar energy, biomass, windpower and geothermal energy
— the rational use of energy, evaluation techniques in energy conservation and the use of solid fuels and of new energy vectors.

D.1. Testing of solar energy systems

Solar energy systems have an important potential, from the industrial as well as the energy viewpoint. The practical realisation of that potential is dependent upon accurate measurements of performance and of degradation mechanisms of different designs.

Knowledge and techniques adequate to achieve and understand such observations need specific research and a centralisation of available experience.

The 1984-87 JRC programme Testing of Solar Energy Systems can make an important contribution in this area through the execution of specific activities and coordination of actions at Community level.

The JRC activity is coordinated closely with other Community actions (R and D Programmes, Demonstration Programmes, Aid to Development Programmes, Regional Programmes).

The primary objectives of the JRC activity are the following:

— definition and improvement of test procedures and standard methologies for the evaluation of performance of components and systems, in particular evaluation of behaviour and potential of advanced technologies;
— elaboration and application of test methods for the evaluation of durability and reliability, and the qualification of components;
— monitoring of plants, collection and exploitation of data on a common basis from projects funded or coordinated by the Commission, providing an effective feedback from Community R and D projects, diffusion of information.

The JRC activity deals with photovoltaic and thermal conversion of solar energy; thus the programme is structured into two projects.

— testing, evaluation of photovoltaic systems as support for photovoltaic conversion technologies; collection of a photovoltaic Data Base for their future development.
— definition of standard methodologies and testing procedures, collection and exploitation of data for thermal conversion.

The Joint Research Centre disposes at its Ispra Establishment of a comprehensive set of test facilities for study and measurement of performance and durability of solar convertors (ESTI: European Solar Test Installation).

D.2. Energy management in habitat

The long term potential of energy conservation in the household sector in the EC energy system is particularly important, both for new buildings or for already existing ones; substantial gain can be obtained through rather cheap measures. This household sector has the characteristic of being an objective in which several and various studies are orientated and put together to reach the goal of minimizing energy needs, with economic solutions.

For these reasons a specific approach is required for « Habitat », the household sector, calling for pluridisciplinary competences and a coordination across various technological developments.

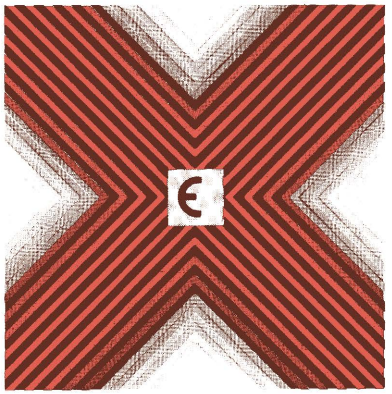
The 1984-87 JRC programme **Energy Management in Habitat** intends to give a significant contribution in this area by developing specific research activities integrated in actions within the Community.

The JRC activity takes benefit from the considerable competences and facilities available at Ispra and from the close relations with various programmes of the Commission (R and D Programmes, Demonstration Programmes, Regional Programmes) and with the activities of the International Energy Agency, in some of which the JRC plays a leading role.

Main objectives are:

— Evaluation and comparison of systems using various advanced technologies and sub-systems;
— Definition of methodologies for measurement, and intercomparison, of elements for passive technologies in buildings;
— Selection of measurement techniques, for energy auditing in buildings, collection and elaboration of data.

These objectives correspond to three strongly interconnected research areas in which the related activities are grouped into one project, in order to assure the necessary integration.



E. Research action programme:

Environment

E.1. Protection of the environment
E.2. Application of remote sensing techniques
E.3. Industrial risk

The long standing concern of the European Community for the protection of the European environment and safety of the population is demonstrated by the execution of three action programmes (from 1973 to 1986) aimed at the coordination of the national efforts in this field. Great emphasis is placed on providing scientific support for the implementation of the European Community's environmental policy. R and D in this field is therefore promoted by the Community, and in the past, the Joint Research centre has also contributed considerably to this effort;

In the Research Action Programme Environment the following topics have been assigned special importance in terms of research:

— environmental chemicals;
— atmospheric pollution;
— freshwater and marine pollution;
— pollution of the soil;
— transfrontier pollution;
— waste management.

In addition to contributing directly to these priority projects, the research activity makes it possible to implement a whole range of Community Directives relating to the classification, packaging and labelling of and emission limits for dangerous substances and the limitation of the risks arising from industrial activities.

As well as responding to needs arising under the short and medium term objectives, the research programme includes the long term studies that constitute the essential foundation for any preventive environmental policy.

E.1. Environmental Protection

This 1984-87 R & D programme is essentially a continuation of past activities in this field, which have attained a high degree of international recognition. It embraces the study of many aspects relating to indirect and diffuse risks involved in the propagation of and pathway followed by man-made chemicals.

It is divided into three areas:

— **Environmental Chemicals:** this research area contributes to establish scientific information on environmental chemicals (e.g. toxicity, biodegradability and use pattern of commercial chemical products, emission pattern of indoor spaces) needed by policy makers in drafting directives and laws for the protection of human health and the natural environment. It consists in the further development of the data bank ECDIN (Environmental Chemicals Data Information Network) intended to support EEC Directives and to be used by a broad spectrum of

environmental policy makers and research. ECDIN already now is operational, accessible via EURONET, and exploited in a two years marketing study operation. Main tasks are to make the data bank publicly available, to continue data collection and data base maintenance, to develop new applications like priority ranking and structure/effect relationships.
Activities on Indoor Air Pollution aim at creating and enlarging knowledge about air quality in non-industrial close environments to assess its relevance for human health and comfort. Studies are concentrating on field measurements of mainly organic pollutants in selected indoor spaces (private houses, school rooms, administrative buildings).
In collaboration with DG XII/G a COST concerted action on « Indoor Air Quality and Impact on Man » is going to be launched and already now the preparation of working protocols and intercomparison exercises in different European laboratories is coordinated by JRC Ispra.

— **Atmospheric Pollution:** This research area contributes to the scientific understanding of atmospheric pollution (e.g. chemical and photochemical transformation processes, mesoscale pollutants transport and environmental pathways of atmospheric pollutants) needed by policy makers to balance existing or projected pollution levels against adequate control measures. Research is mainly concentrating on the « Acid Deposition » problem and contains Air Quality studies to understand the formation of tropospheric ozone and the role of nitrogen oxides in photooxidation processes. A Central Laboratory for Air Pollution provides technical support for the implementation of the EC Directive on sulphur dioxide and suspended particulates measurements. A study on Mass Balance and Transport of Pollutants uses ground based remote sensing, micrometeorological instruments and stable tracers for the determination of air mass trajectories, atmospheric turbulence and mass flow of atmospheric pollutants. A process on power plant flue gases desulphurisation (ISPRA MARK 13 A) has been developed on bench scale (it produces hydrogen and sulphuric acid, patent pending). A pilot unit is foreseen and the process will be further extended to a combined desulphurisation/denoxing process.

— **Trace Metal Pollution:** this research area is aiming at the development of criteria documents and impact assessments for the natural environment and population by trace metals, considering wide spread and increasing pollution from industrialisation, intensive agriculture practices and coal burning for energy production. In this context, by metallobiochemistry studies, the toxicological significance of trace metals in exposed and unexposed populations will be assessed. The pathway of trace metal pollutants in a freshwater ecosystem will be determined by field measurements and modelling. Information on the ecotoxicity of Cu, Cd and Hg and their chemical structure/effect relationship will be extended. The impact of trace metals, released from solid wastes of coal/oil fired power stations, on freshwater resources will be assessed by experimental leaching studies and modelling of environmental pathways.

E.2. Application of remote sensing techniques

Earth observations by satellite borne sensors constitutes a powerful means of collecting data on agriculture, forestry, land use, marine pollution and coastal processes in a synoptic, real time, accurate and economic way. Most important efforts are being made in the USA, in URSS, in Japan and also in Europe.

Considering the large European effort on hardware development in the remote sensing field there is a real need at European level to assess the potential and the economic impact of these advanced technologies and to coordinate some applications in order to make full use of the facilities.

The JRC R and D programme is conceived to partly fulfill this need by providing the following information during this decade.

— Assessment and demonstration of the potential of advanced satellites and sensors for the conception and design of a European land information and monitoring system (inventory, monitoring, alarm, production forecasting).
— Assessment and demonstration of the potential of remote sensing technology for the detection, monitoring and forecasting of pollutant evolution in estuaries and coastal areas and of hydrocarbon slicks resulting from natural or accidental causes.
— Assessment and demonstration of the potential of advanced satellites for the management of agricultural resources under adverse climatic conditions in Sahelian countries.

The JRC programme is complementary to national programmes,

- it approaches problems at the European level (fulfilment of needs of the Commission's sectoral activities: common agricultural policy, environmental policy, aid to development policy).
- it develops projects where collaboration of many national laboratories is essential (pilot application projects in Europe or in Africa).
- it promotes and organises joint experiments and campaigns in which laboratories of the various Member States participate, in which an opportunity for the discussion and the exchange of ideas, information, techniques etc. is created.

The national and international European efforts for hardware development are done in large programmes, while those in the field of applications are small. It is important that Europe be prepared to utilise those satellites that it is developing.

The programme is composed of three projects:

1. Agriculture and land use

   This project includes research on land utilisation in Europe and crop management in Africa.

2. Sea Protection

   This project includes research on maritime oil pollution and the coastal deposition of pollutants.

3. Natural Disasters

This project deals with the evaluation of the possible contribution of remote sensing to natural disaster prevention and management (early warning, monitoring, emergency plans etc.). In a first stage the JRC will convene a number of experts currently exploring this avenue in order to identify, in close cooperation with the Environment Programme, issues of common interest. At a later stage, JRC, if appropriate, will propose some R and D actions and set up projects of Joint Remote Sensing Campaigns on subjects such as earthquakes, forest fires, deforestation, etc.

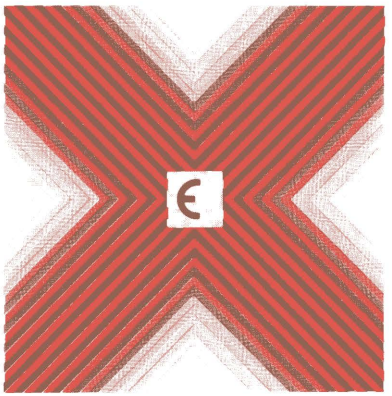
E.3. Industrial risk

This is a new area for JRC research and most activity is, therefore, at a preliminary stage. Considered are the risks associated with the operation of hazardous industries, such as processing and energy and of large technological systems, such as transportation. In this programme we specifically focus, at present, on risks associated with major accidents, as problems associated with diffused risks have been considered in the Environmental Protection programme.

After Flixborough, Seveso, Amoco Cadiz etc. there is growing public awareness of menaces to public health and to the environment which result from sudden catastrophic events. Public authorities, therefore, are seeking greater control over major hazardous industrial undertakings. An example of this public attention is the recent E.C. Council Directive « on major accident hazards of certain industrial activities ». (O.I. N° L230/1, 5.8.1982). This Directive requires the Member States to take the necessary measures to protect health and safety of the public and to protect the environment: safety reports, training and drills, incident reporting, emergency planning provisions etc..

The implementation of an adequate control of major accident risks requires a consistent R and D effort, aiming to develop methods and to obtain data for the identification, evaluation and management of low frequency high consequence events. This R and D area is very large indeed: it covers system realiability, structural reliability, man-systems interaction, decision theory and decision support systems, confined and unconfined explosions, behaviour of materials and structures under loading, atmospheric diffusion of noxious substances, emergency simulation and planning.

Many of these problems are analogous with those studied in the nuclear engineering field and the very considerable experience acquired in the assessment of nuclear plant safety can be applied to other engineering areas. A considerable nuclear safety competence already exists in the JRC and this can be harnessed to tackle other problems too, as can the strong links already forged with various nuclear safety and environmental research groups in the Community.



Exploitation of the HFR reactor

The operation and utilisation of the HFR reactor will continue in support of research programmes of the Community and of its Member States, as well as for industry. These programmes cover the fields of nuclear fission energy (especially safety aspects), thermonuclear fusion, fundamental research, together with non-nuclear applications in medicine, agriculture (radioisotopes) and in industrial neutron radiography.

During the next programme period, maintenance and updating of the reactor shall be continued as well as the further development and improvement of the irradiation devices in order to maintain this installation in its position within the group of the most important irradiation testing facilities in the European Community. The installation of the new vessel in 1983/1984 and of new equipment in the pool (supports, beam tubes, two PSF tables) will appreciably increase the experimental possibilities and the operational safety of the reactor. It may also make it possible to increase power to 60 MW.

1. **Description**

The High Flux Reactor (HFR) at Pettern is a standard material testing reactor (MTR) and utilises highly enriched uranium plate-type fuel elements and burnable poisons, a light water coolant/moderator and a beryllium moderator/reflector. Since 1962 management and operation of the reactor has formed part of the research programmes of the JRC (Joint Research Centre).

The actual operation and maintenance of the HFR installation are assigned under contract to the Netherlands Research Establishment, ECN (Energieonderzoek Centrum Nederland).

The HFR operates at 45 to 50 MW for about 285 days per year. The operation of the reactor is interrupted every year by two extended shutdown periods, a three week period for maintenance and modifications early in the year and a five-week period for vacation and maintenance during the summer season.

The operation and utilisation of the reactor shall continue in the new programme in support of research projects in the following fields:

— development of light water reactors, in particular transient fuel tests, and safety orientated experiments;
— development of high temperature reactors by irradiation testing of fissile and structural materials;
— development of fast reactors by advanced fuel testing under steady-state and transient conditions as well as irradiation testing of structural material;
— development of fusion reactors, by irradiation testing of candidate first wall and blanket materials;
— production of radioisotopes for medical, agricultural, industrial and scientific applications.

Furthermore, the horizontal beam tubes are used extensively for nuclear physics and solid state experiments. Within the new programme it is intended to profit from the improved irradiation facilities, which will be available after the vessel replacement in 1983/1984.

Further information

For further information about the JRC

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