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FUTURE DEVELOPMENTS FOR THE JOINT RESEARCH CENTRE

DISCUSSION PAPER FOR AN ORIENTATIVE DEBATE

(Communication from the Commission to the Council)

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ANNEX II

JOINT RESEARCH CENTRE - RESEARCH PROGRAMME 1984-87

1985 EXECUTION REPORT

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FOREWORD

According to the Treaty establishing the European Atomic Energy Community, the Joint Research Centre executes :

- the research programmes determined by the Council
- other tasks assigned to it by the Commission.

This 1985 execution report is dealing mainly with the first of the two missions, as requested by art. 8 of the Council decision of 22 December 1983 on the 1984-87 research programme of the JRC.

As far as the second mission is concerned, the activities in support to the Commission where dealing with almost all major Community policies :
an account is given in the annex A.

JOINT RESEARCH CENTRE 1984-1987 MULTIANNUL PROGRAMME

1985 EXECUTION SUMMARY REPORT

1. INTRODUCTION

During these first two years, the JRC in contributing to various Research Action Programmes has concentrated on developing its public service role by further concentration on the Norms and Standards and Safety aspects of all the research activities it is engaged in. At the same time, recognition of the JRC's expertise in a number of fields has led to the development of further supporting activities for other Commission sectors such as agriculture and aid to developing countries and to placing the management Shared Cost Action (work performed in Member States' Laboratories but partly financed by the Communities) in the hands of the JRC Direct Action Programme in the Reactor Safety field. Further evolution along these lines can be expected to emerge as the programme progresses, thus strengthening the Joint Research Centre's position in Community research.

As noted in last year's report, JRC research is organized as contributions to Research Action Programmes and the present report is presented in that way. Attention is drawn to sections dealing with REactor Safety where as mentioned above a reorganization has resulted in the merging of "direct" and "shared cost" actions and to the Fusion section where the Council of Ministers' decision to build a tritium handling laboratory at Ispra is recorded.

To ensure an efficient management of research in the JRC, the project control system has been completely overhauled resulting in a concentration of efforts into fewer sub-projects and the setting up of a system to continuously monitor progress of all actions. To further accelerate the orientation of the programme towards its Norms and Standards and Safety and the Environment themes, the Council of Ministers agreed to the early retirement of 120 of the JRC staff for replacement by young scientists of high academic background. This injection of new blood is expected to have a significant effect on the JRC. The scheme will begin in 1986.

During 1985 the Joint Research Centre's two new management bodies, the Board of Governors and Scientific Council became fully effective. The Board of Governors met 5 times under its Chairman Sir John KENDREW, CBE, ScD, FRS and the Scientific Council met 7 times under Dr. Léon VAN HOVE, former Director General for Research at C.E.R.N. Geneva.

2. PROGRAMME AND CONTENTS

2.1. Programme Orientations

In 1985, the second year of the 1984-1987 JRC programme, the changes begun in 1984 have been further established to reaffirm the concentration on the main themes which now include all but a minor part of the work being carried on.

2.2. Programme Structure

The programme is articulated on six main areas, five of them constituting a contribution to selected Research Action Programmes (R.A.P.s), the sixth consisting of the exploitation of the HFR reactor at the Petten Establishment.

A. R.A.P. - Industrial Technologies

- Nuclear Measurements and Reference Materials
- High Temperature Materials

B. R.A.P. - Fusion

- Fusion Technology and Safety

C. R.A.P. - Fission

- Reactor Safety
- Management of Radioactive Waste
- Safeguarding and Management of Fissile Materials
- Nuclear Fuels and Actinides Research

D. R.A.P. - Non-Nuclear Energy Sources

- Techniques for Solar Energy Tests
- Management of Energy in Dwellings

E. R.A.P. - Environment

- Environmental Protection
- Application of Remote Sensing Techniques
- Industrial Hazards

F. Activities of Scientific Departments

- Exploitation of the HFR (complementary programme)

This structure takes into account the specific character of the research objectives and permits an accurate technical and financial management of the programme.

3. FINANCES AND STAFF

3.1. Expenditures committed for the Programme Execution in 1985

The year 1985 was the second in the four-year research programme 1984-87 of the JRC adopted by the Council decision on 22 December 1983.

The expenditure commitments estimated necessary by this Council decision for the execution of the four-year programme were 700 million ECUs, at 1983 value. The indicative breakdown of this amount was 400 million ECUs for expenditures on staff and 300 million ECU for other expenditures.

The 1985 budget commitments for the execution of the programme were fixed at the level of 198.5 million ECUs. Taking into account 12.9 million ECUs carried forward from 1984, the commitments credits available in 1985 for the programme execution were 211.4 million ECUs.

The expenditures actually committed in 1985 for the execution of the programme were at the level of 201 million ECUs (109.9 million ECUs for staff and 91.1 million ECUs for operations).

The breakdown of these expenditures for different Research Action Programmes and sub-programmes is given in Table A. The staff cost includes salaries as well as those expenditures which are directly related to staff management.

The operations costs are subdivided into :

- expenditures directly connected with the execution of the programme
- expenditures indirectly charged for general services and scientific and technical support.

The expenditures for the support of Commission's policies is also reported in Table A.

In summary, the overall budget of the JRC, for both the programme and for support to the Commission, was at the level of 216,6 million ECUs and overall expenditures were at the level of 206 million ECUs.

Taking into account the adjustments made during the budget execution, the amount of 10.6 million ECUs carried forward in 1985 is subdivided into 1.3 million ECUs for staff and 9.3 million ECUs for operations. The staff underspending is due both to understaffing and to non-used provisions for the early retirement scheme.

On the operation side, the underspending is mainly concentrated on Fusion Technology and Safety Programme, where the late approval of Tritium Laboratory by the Minister's Council (July 1985) made not possible the engagement of the corresponding budget allocation (5 million ECUs).

TABLE A

EXPENDITURES COMMITTED FOR THE EXECUTION OF THE JRC PROGRAMME IN 1985 (*)
(Million of Ecus)

ITEM	PROGRAMME	COMMITMENTS 1985			EXECUTION 1985				CARRIED FORWARD 1985
		CARRIED FORWARD 1984	BUDGET	TOTAL	STAFF	OPERATION PROGRAMME	OPERATION BACK-UP + SERVICES	TOTAL	
7370	<u>Industrial technologies</u>								
	- Nuclear measurements and reference materials	0.6	18.2	18.8	10.4	2.4	5.7	18.5	0.3
	- High temperature materials	0.7	8.3	9.0	4.7	1.3	2.4	8.4	0.6
	TOTAL	1.3	26.5	27.8	15.1	3.7	8.1	26.9	0.9
7371	<u>Fusion</u>								
	- Fusion technology and safety	2.2	18.2	20.4	8.7	2.2	3.5	14.4	
	TOTAL	2.2	18.2	20.4	8.7	2.2	3.5	14.4	6.0
7372	<u>Fission</u>								
	- Reactor safety	4.0	53.8	57.8	30.7	12.9	13.0	56.6	1.2
	- Management of radioactive waste	0.7	14.1	14.8	9.5	1.8	3.5	14.8	-
	- Safeguarding and management of fissile materials	0.6	12.6	13.2	8.6	1.2	3.0	12.8	0.4
	- Nuclear fuels and actinides	0.7	18.4	19.1	9.2	2.9	7.5	19.6	-0.5
TOTAL	6.0	98.9	104.9	58.0	18.8	27.0	103.8	1.1	
7373	<u>Non-nuclear energy sources</u>								
	- Techniques for solar energy tests	0.2	6.4	6.6	3.9	1.2	1.2	6.3	0.3
	- Management of energy in dwellings	0.3	4.9	5.2	3.3	0.6	1.0	4.9	0.3
TOTAL	0.5	11.3	11.8	7.2	1.8	2.2	11.2	0.6	
7374	<u>Environment</u>								
	- Environmental protection	0.8	13.8	14.6	8.8	2.4	2.9	14.1	0.5
	- Application of remote-sensing techniques	0.7	8.0	8.7	4.6	2.3	1.5	8.4	0.3
	- Industrial hazards	0.5	5.3	5.8	3.5	1.2	1.0	5.7	0.1
TOTAL	2.0	27.1	29.1	16.9	5.9	5.4	28.2	0.9	
JOINT PROGRAMME SUB-TOTAL		12.0	182.0	194.0	105.9	32.4	46.2	184.5	9.5
7389	<u>Activities of scientific departments</u>								
	- Exploitation of the HFR reactor (complementary programme)	0.9	16.5	17.4	4.0	0.9	11.6	16.5	0.9
TOTAL PROGRAMME		12.9	198.5	211.4	109.9	33.3	57.8	201.0	10.4
7383	<u>Support for the Commission's activities</u>	0.2	5.0	5.2	3.3	0.7	1.0	5.0	0.2
GRAND TOTAL		13.1	203.5	216.6	113.8	34.0	58.8	206.0	10.6

) This is not a formal reserve-expenditure account : commitments may be cancelled and rounded figures are presented.

3.2. Staff

An indicative breakdown of this staff level by Establishment and the Brussels headquarters is given in Table B.

B. Distribution of Staff Complements
(as referred to programme execution in 1985)

General Directorate in Brussels	13
Geel Establishment	198
Ispira Establishment	1.680
Karlsruhe Establishment	208
Petten Establishment	161

TOTAL : 2.260

In terms of employment, this staff complement was planned according to a scheme where about half of the personnel was directly involved in research while the other half was allocated to general and scientific/technical support services.

4. TECHNICAL ACHIEVEMENTS

4.A. RESEARCH ACTION PROGRAMME - INDUSTRIAL TECHNOLOGIES

4.A.1. Nuclear Measurements and Reference Materials
(Implemented at GEEL)

4.A.1.1 Nuclear Measurements

4.A.1.1.1. Nuclear Data

The spontaneous fission neutron spectrum of ^{252}Cf is widely used as a standard spectrum. However, due to lack of knowledge about the nature of the fission neutrons the theoretical representation of the spectrum is uncertain. Therefore a detailed measurement of the neutron emission as a function of the fission fragment parameters (emission, angle, mass, kinetic energy) has been performed.

The (liquid methane) cold moderator has been installed at the Linac. It was successfully employed in two campaigns of simultaneous low-neutron energy. The analysis of the resonance parameters of three separated isotopes of iron has been terminated with the exception of the parameters of one important ^{56}Fe resonance, for the determination of which an international task force of OECD's Nuclear Energy Agency Nuclear Data Committee has been established. About 350 resonance parameters of three separated Cr isotopes have been presented at the Santa Fe Conference (May 1985).

An experimental set-up for the determination of double-differential neutron emission cross sections has been installed at the pulsed white neutron source of GELINA. Data have been obtained for ^7Li using a U-Hg target. Again on ^7Li a method has been developed to determine angular distributions of inelastic scattered neutrons ($Q = -478 \text{ keV}$) by analyzing Doppler-broadened γ lines.

4.A.1.1.2. Nuclear Metrology

Radionuclide Metrology

The Establishment participated in an international intercomparison organized for the measurement of the activity concentration of a ^{109}Cd solution, leading to a considerable improvement of the assay of this nuclide. Several improvements in the measurement techniques for radionuclides were achieved, e.g. a $^4\text{CsI(Tl)}$ sandwich detector for the measurement of photons between 10 and 200 keV was constructed and installed. It was used in the above mentioned ^{109}Cd measurements and yielded a 0.4 % accuracy for ^{109}Cd source-strengths.

Metrodology of Neutron Fluence and Dose

Experience was acquired also in ionometric dose determination which was applied for some neutron irradiations of biological samples for radiobiological research projects of SCK/CEN MOL. A graphite calorimeter for gamma-ray dose measurements was constructed and is operational.

4.A.1.2. Reference Materials

4.A.1.2.1. Nuclear Reference Materials

The information obtained during the first inquiry of JRC-GEEL (BCMNI) on EC needs for nuclear reference materials (1977) has been supplemented during a new inquiry in 1985. Several NRMs are in different stages of preparation and certification (e.g. uranium mineral, uranium isotope standards). The EC-NRM 171, a ²³⁵U isotope abundance certified reference material for gamma spectrometry, was prepared and certified in collaboration with NBS. In 1980 the project started at JRC GEEL and the base material was procured. The preparation of the 700 reference samples (sealed cans) was followed by an intensive testing and characterization work in the following years at JRC GEEL and NBS. After the last Working Group meeting in June 1984 and the positive advice of the Nuclear Certification Group in December, the EC-Certificate was issued by JRC GEEL in June 1985. It seems worthwhile to mention that after the evaluation of the results agreement was obtained with NBS to allocate for the joint certification figures a 3 to 1 weight to CBNM values in relation to NBS values. From the 70 EC reference material sets (5 cans each) 13 were already sold.

The Euratom Working Group on Reactor Dosimetry identified 1982 important RC needs for stocks of reference materials for neutron dosimetry. The goal is to standardize all European measurements in this field. At the end of 1985 two RMs can already be offered : Ni with very low Co content, and ²³⁸U oxide spheres with very low ²³⁵U content.

In 1985, 650 special samples and targets were prepared, characterized and delivered to requestors from national organizations, industries and universities. It should be mentioned that only samples and targets were prepared which are not commercially available.

4.A.1.2.2. Non-nuclear Reference Materials

In 1985 very accurate Au layer thickness standards were prepared at JRC GEEL by Au deposition in ultra high vacuum (UHV) and by weighting the deposit in situ using a UHV balance. A homogeneity of better than 1 % was obtained. These absolute standards will be used in a BCR project aiming at the establishment of a working standard for Au coating measurements.

For the present JRC multiannual programme, it was decided to centralize all JRC logistic support to BCR at JRC GEEL. All reference materials (RMs) stored at JRC-Ispra and JRC-PETTEN were transferred to GEEL. Connected with the storage (40.000 RMs) is the dispatching of the material : in comparison with 1984 (700 RMs), in the first semester 1985, 839 RMs were sent to customers. In parallel the preparation of the conditioning work for biological material started. All activities will be concentrated in a special building the construction of which is being finished.

4.A.2. High Temperature Materials
(Mainly implemented at PETTEN)

4.A.2.1. Steels and Alloys

The corrosion studies have demonstrated the importance of Cr- and Al-rich oxides in controlling alloy sulphidation. The concomitant screening of suitable coatings and claddings on appropriate austenitic substrates for corrosion protection has been achieved. Certain problems of ferritic-austenitic interface degradation have been identified in thermal fatigue situations. Through creep testing of selected steels in corrosive environments, the threshold boundaries of the different corrosion regimes have been mapped out with respect to temperature, corrosive gas potential and stress. Investigation of creep deformation and fracture shows that influence of sulphidation in reducing creep ductility and the improvement in life observed in carburising/oxidising atmospheres. Fatigue studies into crack initiation and life endurance testing of Alloy 800H in air and vacuum shows the influence of oxidation on life, which varies across the temperature range 500-800°C by an order of magnitude. Work on this alloy continues with investigations on micro- and macro-crack growth behaviour, for improved life prediction.

4.A.2.2. Alloy sub-components

Correlation of uniaxial with multiaxial creep behaviour of Alloy 800H has been achieved by mathematical modelling and verified experimentally. This has required the development of high temperature measurement methodologies for multiaxial strain. The work is now being extended to the effects of in-situ corrosion. The design of a thermal gradient test rig is in progress.

4.A.2.3. Engineering ceramics

Methods of characterising the starting ceramic powders and routes for fabrication of ceramic sample components have been developed. The preparatory work for optimisation of processing parameters is now in progress. Property and microstructural characterisation of ceramics is developing well with the establishment of test and analysis methodologies. Preliminary corrosion and mechanical property studies on silicon nitride materials simulating candidate service applications have been started.

4.A.2.4. High temperature materials data banks

Data has been extensively evaluated and additional data arising from the COST collaborations has been input. Extension of the data bank towards a wider range of properties has taken place. Significant progress has been achieved on the development of the user interface. The project has contributed at scientific and management levels to the DG XIII "Communities Programme for the Development of Specialised Information Market in Europe".

4.A.2.5. High Temperature Information Centre

The Petten Establishment has :

- organised scientific meetings, including an international conference on alloy potential, and several workshops on service-related materials problems, (viz. engineering ceramics, HT corrosion and strain metrology).
- published studies of current and innovative material and technological developments, (composite, processing technology, coatings, etc.)
- contributed expertise and advice to external cooperative research actions within the Commission (BRITE, Raw Materials, etc.) and in the Community at large (COST, VAMAS).
- compiled inventories of on-going HTM activities throughout the Member States.

4.B. RESEARCH ACTION PROGRAMME FUSION

4.B.1. Fusion Technology and Safety
(mainly implemented at ISPRA)

4.B.1.1. Reactor Studies

The activities are carried out in the frame of the NET (Next European Torus) predesign studies and as a contribution to the INTOR (International TOKamak Reactor) workshop.

Various mechanical configurations of the basic machine have been investigated. Maintenance schemes for both NET-Single Null and Double Null reference design have been worked-out, all based on the top loading of the renewable components (first wall, divertor plates, blanket segments) inside the vacuum vessel.

Neutron-induced radioactivity and potential hazard in the NET-components has been assessed. Scoping studies on low activation materials have been also performed.

Progress has been achieved in first wall, divertor, $^{17}\text{Li}^{83}\text{Pb}/\text{H}_2\text{O}$ breeding blanket thermomechanical design.

The installation of laboratories for tests on remote handling components and on computer simulation of the remote handling operations has started.

4.B.1.2. Breeding Blanket Technology

Solubility, diffusivity and permeability of protium and deuterium in 316L SS have been measured at different temperatures and pressures, taking also into account the effect of the presence of $^{17}\text{Li}^{83}\text{Pb}$. A review of available computer codes to evaluate tritium permeation has been accomplished.

The data base on physics and thermodynamic properties of $^{17}\text{Li}^{83}\text{Pb}$ has been completed; in particular, solubility and diffusivity of D₂ in the pressure range 0.1-100 bar have been carried-out and compared to other recent experimental results.

In the field of breeder structural material compatibility, it has been shown that no important liquid metal embrittlement effects must be expected in the NET operating conditions. The effect of impurities such as nitrogen and oxygen in 17Li83Pb on steel corrosion has been also investigated.

4.B.1.3. Structural Materials Studies.

The characterization of the commercial Mn-Cr austenitic steel supplied by Creusot-Loire, now completed, has shown that this steel looks attractive from mechanical strength point of view, as compared to 316-L, up to 500°C. At higher temperatures the mechanical properties of such steel are strongly influenced by deformation induced transformation of austenite to martensite phase. This suggests the need of a reduction of the Mn-content.

Characterization and tests under thermal cyclic loads of W-5Re/Cu bonds for divertor/limiter collectors have been carried-out up to 1000 cycles. The samples analysis and comparison with the calculation models are in progress.

In the area of thermo-mechanical behaviour of the first wall under cyclic heat load, thermal fatigue experiments on tubes have been completed and first tests on the NET-first wall panel, with thermal fluxes up to 0.5 MW/m², are in progress.

Creep and fatigue tests in the ISPRA cyclotron on the NET-reference 316-L type of steel are now in operation and the first results look promising.

The radiation tests on steels at the fission reactor HFR in PETTEN have started again early in 1985, after one-year shut-down of the reactor due to the core vessel replacement. The irradiations include specimens for tensile tests (FRUST-experiment) and for creep measurements (TRIESTE and CRISP-experiments).

The conceptual design of a spallation neutron source intended to simulate the fusion neutron damage in first wall materials has been completed and the results submitted to the European Fusion Technology Committee for further actions.

4.B.1.4. Risk Assessment

Progress has been made in the experimental investigation of accident initiators, particularly in simulating thermomechanical effects of plasma disruption by an electron gun and on small-scale tests for 17Li83Pb-water interaction analysis. A large scale facility for this purpose is under construction.

A functional analysis of the 17Li83Pb breeding blanket has been performed in order to point out the systems functions, the most relevant plant conditions and accident initiators.

The resistance of a 17Li83Pb/H₂O breeding blanket module to the rupture of a coolant pipe has been assessed with respect to plastic collapse and preliminarily, to fissure propagation.

A computer code is under development to evaluate the environmental effects of tritium releases to atmosphere, taking into account tritium oxidation phenomena.

A preliminary proposal of design standards for fusion reactor components has been set-up.

The 1985 issue of the fusion environmental report has been completed.

4.B.1.5. Tritium Laboratory Studies

In July 1985 the Council of Ministers of the European Communities has approved the construction of the laboratory at ISPRA.

Several meetings have been held with experts of national Institutions (Europe, USA, Canada) to define the technical specifications of the laboratory. In November 1985 the call for tender for the laboratory design and construction has been launched.

4.C. RESEARCH ACTION PROGRAMME FISSION

4.C.1 Reactor Safety
(Implemented at ISPRA)

Part of the Programme is executed as a the Shared Cost Actions scheme (SCAs), where the Community is cofinancing projects executed in national laboratories. The scheme has been defined in detail during 1985, a series of calls for proposals appeared in the Official Journal and, after discussion with the relevant CGC, several contracts have been launched.

4.C.1.1. Reliability and Risk Evaluation

Concerning the European Reliability Data System (ERDS), the major part of the activity was dedicated to the loading of data both in the Component Event Data Bank (CEDB) and in the Abnormal Occurrences Reporting System (AORS) and also in the Operating Unit Status Report (OUSR) that is already in normal operation. In 1985 the AORS reached a total number of 22.000 past events. The trial period of CEDB operation, in collaboration with the data suppliers, was continued. 1985 has been the start of more systematic data analysis by multivariate multicorrespondence methods in AORS and the achievement of common cause query analysis in the CEDB.

In the frame of Probabilistic Risk Assessment Methodology, the first phase of the benchmark exercise on common cause failures was completed. A new improved version of the code CAFTS (Computer Aided Fault Tree Synthesis) was also implemented, making use of more advanced graphic interfaces. The Systems Response Analyser (SRA) project saw the completion of a first application, dealing with the analysis of a PWR Auxiliary Feedwater System. Major achievements in this field regard the setting up of a version of the ALMOD code to be included in a future SRA application, the development of two operator behaviour models, one of which is already part of the AFWS

application, and of an interactive version of this last application. Two important events in the field of Man-Machine Systems, should be mentioned. JRC Ispra hosted the second IFAC Conference on Man-Machine Systems (Varese, September 1985) and contributed to a NATO Advanced Study Institute on Intelligent Decision Aids in Process Environments (San Miniato, September 1985).

4.C.1.2. PISC (Project for Inspection of Steel Components)

The objective is the assessment of procedures and techniques for non-destructive inspections of nuclear reactor structures (particularly the vessel and pipings). The results of the PISC II Round Robin Test, completed in 1984, were analysed in detail and presented at the SMIRT Conference (Brussels, August 1985). The results of the parametric studies, designed to investigate specific aspects of the Non-Destructive Techniques and to better understand the PISC results, will be presented in 1986 (Symposium at Varese, September 1986). In 1985 the definition of the seven PISC III action was completed and agreed among the participating countries. The inspection of real defects in contaminated pieces, coming from real reactor structures, will start at the end of 1986 in the hot laboratories, which were equipped at Ispra : more than 50 samples from BWRs have already been offered to this aim.

4.C.1.3. LWR Primary Circuit Life Prediction

The project is focussed on the development of a methodology for the prediction of the residual life of primary circuit components using the data on material properties, on periodic inspections and acoustic emission. A contribution to the code (COVASTOL, RELIEF) validation is given through the experimental programme on 1/5 scale vessels submitted to mechanical fatigue (with acoustic emission continuous monitoring and periodic inspections).

Concerning the development of the analytical tools for the prediction of the residual life of primary reactor structures, in 1985 the development and application of the RELIEF code (based on the damage accumulation methodology) was continued and the COVASTOL code (based on probabilistic fracture mechanics) was improved. The ELISA code, for laser interferometry application, was validated. The experimental programme on the 1/5 scale vessels is under way : in 1985 the fatigue loading of the first vessel was continued and the data of inspections analysed.

4.C.1.4. Abnormal Behaviour of LWR Cooling Systems

LOBI is a loop for the investigation of thermohydraulic behaviour of reactor cooling systems, during loss of coolant accidents or in general transient (such as station blackout and loss of feedwater). As LOBI is a scaled model it is important to show that it correctly represents the reactor behaviour. Loss of coolant accidents can be produced by small or large breaks in the pipings of the cooling circuit. (The study on large breaks has been completed in 1984).

Of the 7 tests originally planned, only 5 tests were performed, due to technical problems (pumps, gaskets, instrumentation) and with necessary modifications to the test facility. Two of the 5 tests were the very first Special Transients tests performed in LOBI and hence, in Europe : a station Blackout (loss of normal on-site and off-site power) and a loss-of-feedwater test. These two tests have shown that, contrary to the previous expectations, not only the important phenomena could be experimentally well observed, but the whole test facility has shown very typical behaviour close to that of a real plant. The three small break (SB) LOCA tests simulated 0.4% (2 tests) and a 10% break on the pressurizer relief line, in the cold leg and the hot leg, respectively. The pressurizer relief line break (stuck open valve) simulated the scenario of the TMI-2 accident. The International Standard Problem organized by the OECD-Paris, based on a small break LOBI test, saw the participation of 26 teams from 12 countries: the analysis and comparison of the test calculations were presented by the JRC at a Workshop in December 1985. The improved version of the RELAP5/LOD1 which is now called RELAP5-EUR has been used for LOBI test preparation and has been requested by several institutions in Europe. The JRC is also actively participating in the assessment of the two large system thermohydraulic codes CATHARE (F) and DRUFAN (FRG) which were installed in the JRC AMDAHL computer during 1985. Separate effect studies with these codes on channel depressurization were performed.

4.C.1.5. Source Term

This area deals with the definition of radioactive release in the case of severe accidents in LWRs. After the TMI-2 accident, considerable progress has been made in this field, however some basic problems still remain open. The JRC is presently involved in the assessment of codes, particularly on the aspects related to fission gas and aerosol behaviour in reactor containment. As expected, a report on the state-of-the-art on this research field, with particular reference to the Community, was completed early in 1985. On the analytical side, in addition to the CORRAL II code, the US MARCH-2 and CONTAIN codes were implemented at the JRC and applied to the analysis of different accident scenarios. The JRC has decided to participate in the international programme LACE (organized by EPRI) : the collaboration contract was signed in 1985 and the first test LA1 took place in October.

4.C.1.6. LMFBR Accident Modelling

This area deals with the analysis of severe accidents involving partial or total melting of the Reactor core. The FARO facility has been designed to simulate the melting of large fuel mass (FARO furnace) and to study different phenomena, like impact of fuel jets on the reactor steel structures, interaction with sodium, plugging and freezing in the channels. To this aim the molten fuel can be released in the test sections BLOKKER and TERMOS.

A new improved version in FORTRAN 77 of the European Accident Code EAC- which is a modular system for the description of the initiating phase of the whole core accidents - was released. A first simplified version of the fuel pin mechanics module PINM was completed; in addition the EAC results on the last International Comparative Exercise (unprotected loss of flow in irradiated core) were considerably improved after careful analysis and code improvement. Concerning the FARO project, a series of 8 tests were performed in 1985 : the melting of large UO₂ mass (up to 50-60 Kg) was reached several times; the problem is now the identification of a coherent procedure for a controlled release of UO₂ in the test sections BLOKKER and TERMOS which are ready for the execution of different types of tests. The code for the analysis of the impact of UO₂ jets in steel plates has been completed and the results compared with the available experimental data.

4.C.1.7. PAHR (Post Accident Heat Removal) In-Pile

This area deals also with severe accidents in LMFBR. In particular the problem is to investigate the coolability of a bed formed by UO₂ and stainless steel particles in sodium which is assumed to be deposited on horizontal structure when part or all the core is melted. To simulate the real reactor situation, in-pile tests are performed with a different type of bed composition, height and maximum temperatures. The SANDIA in-pile test programme was completed with the execution of the last test D-13 with stratified UO₂ + SS bed in sodium.

The scoping test Go, with a non-fissile particle bed, was irradiated in the MELUSINE reactor at CEA Grenoble. This test showed the capability of the experimental device to meet the experimental requirements : only a few modifications are required for G1.

For both types of in-pile tests (Mol and Grenoble) the technical problems which have caused a delay in the execution of the in-pile tests seem to be solved. The final assembly of the in-pile test sections M1 and G1 is in progress and the irradiations are foreseen respectively in April and June 1986. The PAHR 2D code has been improved also by the help of some national experts during two workshops on the modelling of debris beds. The first out-of-pile test to investigate the chemico-physical reactions occurring in a UO₂-SS particle bed and the crucible behaviour under axial thermal gradient and in sodium atmosphere at a maximum temperature of 2000°C was successfully executed.

4.C.1.8. LMFBR Material Properties and Structural Behaviour

The work on constitutive laws of austenitic steels in different damage conditions (different strain rates, temperature, irradiation) were continued (particularly on AISI 316 H and AISI 316 L which are representative for LMFBRs). In this area the mechanical behaviour of austenitic steel is investigated. Different material damage are considered, corresponding to operating conditions (temperature, irradiation, presence of sodium) and accident conditions (that is when dynamic loads have to be considered).

The programme for the definition of cracks propagation parameters for irradiated base and welded AISI 316 H steel entered in the final phase : irradiations at various fluences in the HFR reactor are being completed in 1986. In the Large Dynamic Test Facility 10 tests on AISI 316-L specimens at different strains were performed : strain variations (to the order of 20-30%) were observed as a function of the strain-rate. The influence of the LDTF specimen size and shape on the stress strain curves are also being investigated. The modification of specific components of the machine and the upgrading up to 5 MN of the maximum load suffered a few months delay and will be completed early in 1986. The direct strain measurement on the specimen by laser interferometry technique was implemented.

4.C.2. Radioactive Waste Management
(Mainly implemented at ISPRA)

4.C.2.1. Waste Management and the Fuel cycle

The setting-up of PETRA, a hot-cell facility for studying waste treatment and conditioning methods at fully active scale, is proceeding according to schedule. A preliminary safety report has been introduced to the Italian Safety Authority. A computerized process control for the facility is being set up. A pneumatic channel to transfer active samples from PETRA to the radio-analytical laboratories was installed. PETRA is expected to start active operation in spring 1987. An engineered version of the Pu-monitoring equipment based on passive neutron assay by time correlation analysis has been constructed.

4.C.2.2. Safety of waste disposal in continental geological formations

The PAGIS action (Performance Assessment of Geological Isolation Systems) has entered into its second phase (calculation of doses and probability of exposure). PAGIS is jointly coordinated by JRC and shared-cost action programme with participation of the most important national laboratories. A similar project structure, with participation of JRC to the coordination, is being set-up for the MIRAGE project (Migration of Radionuclides in the Geosphere). The computer code LISA for probabilistic risk assessment is fully operational and has been transferred to several European laboratories involved in the PAGIS action. An intercomparison with the Canadian code SYVAC is under way. Laboratory studies on degradation of conditioned waste in geological disposal conditions and on radionuclide migration are proceeding according to schedule, with main emphasis on the behaviour of Np, Tc, Am and Pu as risk-determining radionuclides.

4.C.2.3. Feasibility and safety of geological disposal in deep oceanic sediments

In the framework of the NEA seabed working group, JRC participated to the international cruise ESOPE for site characterisation of the two study zones in the Atlantic, (Great Meteor East and Nares Abyssal Plain), with contribution to on-board geochemical characterization, and data transmission from penetrators. In particular the feasibility of data transmission via the Meteosat satellite has been assessed by on-board JRC staff. Laboratory equipment to study diffusion and adsorption phenomena of radionuclides in sediments at high pressure (up to 1000 bars) have been constructed.

4.C.3. Safeguards and Fissile Material Management
(implemented at ISPRA)

4.C.3.1. Methods and instrumentation for the Assay of Fissile Materials and Containment and Surveillance

In the field of destructive assay, after a successful developemnt of a quadrupole mass spectrometer for Uranium exafluoride samples, a second type of instrument has been tested on Uranium oxide sample in a fuel fabrication plant.

The main effort in this research area has been dedicated to the final design of the PERLA laboratory, for which the licensing procedure has now started. In the meantime the PREPERLA laboratory has been constructed and will be ready for use in March 1986.

The type of nuclear materials needed for PERLA has been defined and detailed specification for Plutonium samples has been prepared and sent to potential suppliers.

As to the area of containment and surveillance, the main results are related to the development of ultrasonic sealing system for BWR fuel assemblies. This project is now finalized and the study for the extension of the same principle to PWR fuel assemblies is linked to the assessment now in course by EURATOM and IAEA inspectorates, of the technical results obtained and their potential use in a safeguards approach of LWR reactors.

4.C.3.2. Safeguards Data Processing Transmission and Evaluation

The local area network, linking the various computing facilities dedicated to the safeguards programme, has been installed in 1984 and is now used by four different laboratories for software development and for the demonstration of an integrated safeguards data evaluation system. Furthermore, encouraging results were obtained in the development of an on-line computer based automatic image processing system. This has lead to specific requests from Safeguards Directorate of EURATOM and IAEA for their image examination procedures.

4.C.3.3. Integration of Safeguards Activities

For the examination of the material accountancy data from plant operators, the IAEA data base (ISIS) has been interfaced in 1984 with a statistical accountancy package developed at ISPRA. A complete demonstration has taken place in Vienna in December 1985. IAEA has requested an important extension of this activity for the future. First laboratory results were obtained in the field of image understanding with artificial intelligence and remote operation using robots for verification of nuclear materials storage areas.

4.C.4. Nuclear Fuels and Actinide Research (implemented at Karlsruhe)

4.C.4.1. Operation limits of nuclear fuels

After a decision on the type of fuel to be studied was taken in 1985, Subproject Optimisation of Dense Fuels launched an in-depth study on the performance capabilities of mixed uranium-plutonium nitride in future fast breeder reactors and compared it with mixed carbide fuel.

As a first step, adequate fabrication procedures were developed. The method which gave satisfactory results uses mechanically blended starting materials, which are carbothermally reduced under flowing nitrogen and sintered in a nitrogen-containing atmosphere.

The evaluation of a short-term irradiation experiment with carbide fuel has confirmed the previously established mechanisms of restructuring in dense fuels of pin life; a result which is also of significance for the nitride work.

For the study of Properties of Reactor Materials at High Temperatures, experiments and theoretical background investigations are performed in order to determine the specific heat and the density of liquid UO₂. A first series of experiments involving pulsed-multibeam laser-heating, multiwavelength pyrometry, microfocus X-ray shadow technique and TV monitoring for beam adjustment and profile detection has been concluded. Laser parameters and sample dimensions necessary to heat microspheres beyond their melting points were specified, and the background pressures were defined which keep the evaporation rate at an acceptable level.

High temperature thermal conductivity studies of nuclear fuels lead to a deeper understanding of the thermal transport mechanism in oxides above 2000 K.

4.C.4.2. Transient Behaviour of Oxide Fuels and Fission Product Release under Severe Fuel Damage Conditions

In Subproject Modelling and Transient Experiments, code predictions were verified by comparing pre-calculated structural phenomena and temperature distributions with experimental results obtained with pins after high burn-up. The agreement was good, giving renewed grounds for confidence in the calculating method.

Electron probe microanalysis of fission products retained in grains at different locations in a transient tested fuel were performed, and interpreted on sound theoretical grounds. In particular it could be shown, that diffusion coefficients derived from these observations were consistent with those obtained by classical techniques.

These studies are being supported by experiments with non-irradiated samples into which artificial "fission products" are implanted by ion bombardment. Transmission electron microscopy of these specimens made it possible to define structural features where, for example, iodine bubbles are preferentially formed. These results help to explain release mechanisms and to assess fuel rod performance limits under transient conditions.

4.C.4.3. Actinide Cycle Safety

Studies on the Formation of Actinides in a reactor and preparations for an irradiation experiment (Super-fact), using "minor actinides" (Np,Am) as nuclear fuel, were continued with the development of a minor actinide fuel which satisfies all safety requirements in view of sodium compatibility and, at the same time, has a thermal conductivity sufficiently high to avoid central melting under the envisaged irradiation conditions.

The radiation doses to be expected during handling of "minor actinide" containing fuel rods were calculated and compared to the doses measured with selected samples. On the basis of these results, technically and economically feasible protective measures can be designed for the safe handling of these rods.

For the recycling of minor actinide fuel, a new separation scheme was proposed and tested.

The Superfact irradiation in the Phenix reactor is scheduled for spring 1986. It will render valuable information about economic and safety aspects of actinide recycling.

Studies on the Safe Handling of Nuclear Fuels concentrated on improvements of fabrication procedures, on studies of Plutonium aerosol dispersion and retention and on further investigations of the biological effects of inhaled plutonium particles.

Calculations of the flow field in a ventilated glove box were extended to the three-dimensional case, thus making it possible to predict glove box aerosol distributions and improving flow patterns so as to minimize particle retention on equipment and glove box walls, which constitutes a potential health hazard to operators.

The first stage of an investigation of mixed oxide particle retention on various technically relevant substrates was concluded with the observation that "particle sticking" is highest on aluminium and lowest on chromium-plated steel.

From large-scale experiments with cerium oxide powder simulating plutonium oxide it was concluded that the amount of contaminant becoming airborne in a glove box fire is only about 10 % of the total quantity and thus considerably lower than generally assumed for fire safety considerations.

In complementary small-scale laboratory fire tests the mechanism of particle resuspension from burning plexiglass could be elucidated.

Microscopic techniques were used to study the biological effects of the interaction of alpha-emitting substances with living tissue. Micro-analysis revealed that uranium-plutonium oxide particles taken up by lung cells (macrophages) of rats were surrounded by a halo of iron-containing substance, several micrometers in diameter, after 111 days of exposure. The investigation continues.

Subproject Reprocessing of Nuclear Fuels was mainly concerned with problems of nitride reprocessing as a complement to advanced fuel optimisation studies.

It is well established, that contrary to carbides, uranium-plutonium nitrides can readily be dissolved in nitric acid, which is one of the principal arguments for the choice of nitride as the most promising potential fast breeder fuel to replace the oxides.

There are, however, other problems to be solved before any technological application can be considered. These concern the formation of (radiotoxic) ^{14}C as a transmutation product of "natural" nitrogen and the appearance of ammonium ions in the dissolver solution which might complicate the reprocessing procedure.

During the reporting period, measurements were performed, which showed that the NH_4 -concentration in the dissolver solution was proportional to the amount of nitrogen in the starting material.

In addition, degradation experiments with TBP-loaded resins were continued for up to 16 months, equivalent to a dose of 10 exp.7 rad, without any sign of deterioration of the resin. These tests were accompanied by electron microscopical investigations.

4.C.4.4. Actinide Research

In Actinide Chemistry, actinide metals and compounds of high purity are prepared by suitable crystallisation techniques. In addition, basic physico-chemical properties such as crystal structure and phase diagrams are being studied.

In 1985, new techniques of specimen preparation like splat cooling and melt spinning were successfully employed. Single crystals containing plutonium, tellurium and antimon were prepared, oriented and encapsulated for neutron scattering experiments.

The crystal structures of several organo-metallic compounds, the basic ingredients of fundamental research into homogeneous catalysis, were determined.

As part of a continuing investigation into actinide hydrides, the phase diagram of the neptunium-hydrogen system was determined.

Studies in Actinide Physics aim at an understanding of the properties of actinide-containing solids in terms of the electronic structure of their constituents and the contribution of 5f electrons to the chemical bond.

Experimental techniques employed to probe the electronic structure are measurements of X-ray diffraction and optical absorption under extremely high pressures, Mössbauer spectroscopy, photoelectron spectroscopy and the observation of neutron diffraction. All these methods have been used during the reporting period, partly in collaboration with properly equipped external laboratories.

Particular attention was paid to an investigation of NpAs single crystals, which had been prepared with high purity at this laboratory (under Subproject Actinide Chemistry). Three phase transitions were detected in inelastic neutron scattering experiments, and a magnetic sine-wave structure was found below the Néel temperature of 173K of the material. As a result of Mössbauer studies of the system Pu-Sb-Y, an unusual indirect exchange mechanism between 5f electrons in Pu has been proposed. This experiment was the first in a series of various physical measurements in this system, stimulated by an earlier observation of novel magnetic excitations.

In high pressure experiments, the lattice parameter of americium metal was investigated in the pressure range from 50 to 80 GPa, and the equations of state of ThN (up to 47 GPa) and of uranium metal (up to 42 GPa) were established. Phase transformations as a consequence of applied pressure have been observed in CfBr₃ and in Bk-Cf-alloys.

All these experiments are accompanied by appropriate theoretical studies. During the reporting period energy bands for various actinide compounds (e.g. UO₂ and UO₂) are calculated and the onset of magnetism in uranium-iron has been studied.

4.D. RESEARCH ACTION PROGRAMME - NON-NUCLEAR ENERGIES

4.D.1. Testing of Solar Energy Systems
(implemented at ISPRA)

4.D.1.1. Photovoltaic Systems

Continuous improvements in the testing devices, and installation of new advanced instrumentation for the set of test facilities (ESTI European Solar Test Installation) : this ensemble is unique in Europe and is similar to the installations of JPL in USA and JMI in Japan. JRC has been designated as Operating Agent for a collaborative project on

photovoltaic solar energy under the Industrialized Countries Summit Working Group on Technology, Growth and Employment. The collaboration is a round robin measurements for calibration of reference solar cells, using different methodologies. Monocrystalline, polycrystalline, amorphous silicon cells, delivered from Japan, Italy, France, Germany, USA, were circulated and tested in the period July 1984- May 1985 in laboratories in UK, France, Italy, Germany, Canada, USA, Japan. Pre and post campaign measurements were performed by the JRC and after an experts meeting at ISPRA in September 1985 a final report with conclusions and recommendations was published by the JRC. A second exercise on photovoltaic modules was discussed and is planned to start in summer 86. JRC participates with active compilation of standard procedures for measurements of performance of photovoltaic modules, in the Technical Committees of the IEC (International Electrotechnical Commission) preparing official specifications worldwide accepted.

The implementation of an action on monitoring of operational photovoltaic plants, and subsequent data collection and analysis, with a first meeting, held at ISPRA on 11-13 November 1985, of an European Group on Photovoltaic Plant Monitoring issues with a second meeting planned at Sophia Antipolis (France) on March 1986 with the participation of about 25 experts.

The contribution to Demonstration Projects (DG XVII) for photovoltaic installations with qualification tests of modules, definition of guidelines for PV System Monitoring, analysis of progress reports of each project, was performed.

4.D.1.2. Thermal Conversion

The JRC has initiated a new phase of activity of the European Collector and System Testing Group, comprising some 20 laboratories. The Group has been active in recent years in the cost shared action of DG XII, Brussels. The first meeting was held at ISPRA on 6-7 November 1984, followed by meetings in Athens (June 1985) and Lyon (December 1985). There was an increasing participation of greek organizations, and spanish and portuguese representatives were present in the last meeting. Main subjects of the coordinated research programme are the development of test procedures for air collectors and unglazed collectors, and for domestic hot water systems, together with studies on durability and reliability.

Publication of specific recommendations is planned in the next 2 years. The correlation test fields for durability testing of thermal collectors, CTF-1 (clean air reference test field at ISPRA) and CTF-2 (industrial atmosphere close to a power station in Lombardia) were operated continuously.

ISPRA collaborated in the work of a special commission of the UEAtc (European Union of Agreement grouping the official standards organizations of several European countries) involved in the preparation of directives for solar thermal collectors to be used in buildings. A document was terminated in 1985 and is in the procedure for formal approval. Official publication is planned in 1986.

4.D.2. Energy Management in Habitat
(implemented at ISPRA)

In the European Community the energy consumption for buildings represent from 35 to 40% of the total energy consumption; it is mainly based on fossil fuels contributing significantly to the general atmospheric pollution process, particularly in some populated areas. A reduction in the use of fuels can be useful not only from the point of view of energy, but also for the protection of the environment. A specific effort was devoted to the implementation of this activity where the research is enlarged beyond specific solar energy applications to comprehensive aspects of energy management. The aim of the JRC activity is to contribute to methodologies for the evaluation of some specific systems for an optimized utilization of thermal energy in buildings.

4.D.2.1. Evaluation of Hybrid Systems

The results of the experiments with a large underground seasonal storage on the site of Ispra were presented to the INTERSOL 85, the international biennial congress of the International Solar Energy Society and the related paper had the first prize of the posters, selected by an international jury. One of the objectives of the experiments is the optimization of the global system performances by analyzing interactions between the solar collectors, the storage and the heat pump subsystems. The assessment of these combined system is the object of an international cooperation and exchange of information between the EC and IEA programmes. A joint Workshop on the specific subject was held in Vienna in May 1985, cosponsored by the IEA Solar Heating and Cooling Programme, the IEA Advanced Heat Pump Programme, and the JRC. 45 papers were presented covering almost all aspects of this technology. The more interesting solutions for small and large systems, in various conditions, were put in evidence. Priority research areas were pointed out, such as heat transfer from and to the ground, microinformatics and materials.

An investigation is in progress for the evaluation of the potential of a patent originating from the JRC concerning a device capable of transferring the heat downward without the use of electrical or mechanical energy for circulating the heat carrier fluid. A project for a plant with 10m² of solar collectors, supported by General Directorate XIII (Luxembourg) is progressing.

4.4.2.2. Passive Solar Technologies

Operation of three test cells for measurements on "passive" technologies in order to verify and compare methods for measurements. Comparison between measured and model predicted infiltration rates. Design of a "reference" test cell for passive technologies in connection with the cost-shared action project PASSYS, which is starting the construction of similar test cells in various member countries, to compare methodologies.

4.D.2.3. Energy Auditing

The participation in the task XI "Energy Auditing" of the IEA's "Energy Conservation in Buildings and Community Systems" programme, in which the JRC acts as Lead Participant, continued. A major effort in the frame of this task was devoted throughout 1985 to complete the various technical documents needed for inclusion in the "Source Book on Energy Auditing". For the rational use of energy in buildings various assessment techniques were tested in a specific application to Lombardy Region of Italy, whose authorities provided useful data for energy conservation in schools.

4.E. RESEARCH ACTION PROGRAMME - ENVIRONMENT

4.E.1. Environmental Protection
(implemented at ISPRA)

4.E.1.1. Environmental Chemicals

The semi-operational marketing study for ECDIN (Environmental Chemicals Data Information Network) has been successfully concluded after a two years test period resulting in an increasing use of ECDIN by paying users. Promising negotiations to transfer the publicly available part of the data bank to the responsibility of other Commission Services (DG XI) have initiated. A restricted and provisional EINECS (European Inventory of Existing Chemical Substances) inventory, covering more than 95 % of the final content, is now available for Member States authorities to handle the 6th Amendment of the 67/548/EEC directive.

A proposal for a COST concerted action on "Indoor Air Quality and Impact of Man" led by JRC has been submitted to the Council within the framework of the new multiannual programme 1985-1990 of DG XII/G. When adopted, it will be an essential part of the direct JRC activities on Indoor Air Pollution. Preparatory work for the validation of exposure models and the design of an indoor test facility has started. A major achievement is the drafting of a working protocol for indoor pollution emission measurements.

4.E.1.2. Atmospheric Pollution (Acid Deposition)

In the Air Quality study, the role of nitrogen oxides as promoters for the photochemical ozone formation has been evaluated. The rate constant of the reaction $CO + NO_3$ under tropospheric conditions has been determined.

The Central Laboratory for Air Pollution, which has been set up for the implementation of the EC 80/779 Council Directive on limits and guidelines for SO_2 and suspended particulate, has performed an intercomparison exercise for the SO_2 and particulate analysis within Member States. An EMEP (Evaluation Monitoring European Pollution) monitoring station for atmospheric pollutants is now routinely run on the JRC ISPRA site.

Air mass trajectories have been determined in many field experiments (Baden-Württemberg, Tuscany and Switzerland) by SF6 tracer techniques which now is operating routinely in the 50 km range. The analysis of the new perfluorocarbon tracers is now available and first field tests have been started at the Ispra site. The participation at and sponsoring of the TULLA project (mass balance of atmospheric pollutants in Baden-Württemberg) permitted to accomplish a project of real European dimensions. JRC has been directly involved with its mobile teams on tracers and correlation spectroscopy and sponsored, in collaboration with DG XII/G, airborne measurements. The field campaign was successfully concluded in March 1985.

The planification of a regional scale experiment with enriched S34 tracer has been stopped as some budgetary and organisational questions have to be resolved.

The ISPRA MARK 13 A process for flue gas desulphurisation entered a new phase with the decision to construct and operate a pilot unit for the desulphurisation of the through-out of 20.000 m³/h flue gases of an Italian refinery. Laboratory work for a combined desulphurisation/denoxing process has been delayed as technical difficulties for the choice of a suitable catalyst were encountered.

4.E.1.3. Trace Metal Pollution

Work on "Exposure & Health Effects of Trace Metals" progressed according to planning. The ultraclean laboratory technique for sampling, handling, storage and biochemical fractionating of human tissues is in an advanced development stage. Reports on the metabolism of As, Tl and V for laboratory animals are available. Trace Metal concentrations (As, Sb and Se) in fly ash leachates have been determined and the dynamic environmental model for the transfer of chromium from a fly ash depository to man via soil/groundwater/foodchain considers now also the chemical speciation of this element. The Athens lead experiment (impact of automotive lead on man) although progressing, has been partially delayed for organisational constraints. The issue of the final report of the Isotopic Lead Experiment (ILE) is postponed to 1986.

For the "Water Quality" activity the determination of the trophic level of the Lago Maggiore/Monvullina test site is almost completed and a sufficient data base on the trace metal concentrations in the rivers, the bay and sediment is available. The basic physical/mathematical model for the trace metal balance is designed and the physico/chemical parameters to be measured on the test site are defined.

The ecotoxicity studies in fresh water under seminatural conditions (enclosure technique) yielded results on the synergistic and antagonistic effects of the trace metals Cd, Zn and Cu on fresh water communities.

- 4.E.2. Application of Remote Sensing Techniques.
(implemented at ISPRA)
- 4.E.2.1. Agriculture Land Use

The final report of the SAR-580 campaign which was a joint JRC-European Space Agency (ESA) venture has been published in July 1985. The results have permitted to improve the understanding of radar signal interaction with earth objects : influence of wavelength-frequency, influence of polarization, influence of depression and aspects angles, target effects (roughness, moisture, vegetation nature and morphology, row direction, complex interactions, etc...). Calibration and preprocessing have been studied in detail. This campaign, the most important ever done in Europe has shown the importance of application of the radar to multitemporal problems (vegetation phenology, moisture evolution).

In the field of land use in less-favoured areas a large scale experiment has been set up in the test area "Ardèche" (France). A tentative soil occupation map of the whole district is being built using space imagery from the Landsat-5 Thematic Mapper. Geometric corrections are successfully applied to the space images so that they can be superimposed on topographic maps. Classification is in progress, and is being compared with ground surveys done by the Service Central des Enquêtes et Etudes Statistiques of the French Ministry of Agriculture. On the site of Freiburg (F.R.G.), radar imagery is being analyzed. Multisensor combinations (radar + visible) have obtained good results concerning the discrimination of crop categories. In parallel with internal studies, a collaborative programme has been organized, defining test-sites in each member state and corresponding experiment, so that it will be possible in the future to compare the results obtained by each experimenter in different geographic conditions.

As far as the area of agricultural resources in Sahelian Countries is concerned, the main striking progress has been the installation of an agro-hydrometeorological data collecting platform relayed by satellite at Kankan (Guinea) in view of forecasting rices yields and providing an alarm in drought conditions. This data collection platform transmits 7 variables to Ispra and to Konakry (Guinea) through METEOSAT. The study of the rice fields at Segou (Mali) has been continued together with an experimental campaign on dry crops (sorghum, millet) at Bamako (Mali).

In parallel the study of the Niger basin has been continued in order to develop a model to forecast the flood. These studies are coordinated with the programme "La lutte contre la Faim dans le Monde" contracted to several European laboratories by the Directorate-General Aid to Development.

- 4.E.2.2. Sea Protection

At the beginning of 1985, after a call for tenders, the prototype of an advanced fluorosensor for detection of marine oil pollution has been ordered to an industrial laboratory. The principle of fingerprinting an oil by the analysis in the spectral and time domains of the laser-induced fluorescence was

demonstrated in the previous laboratory experiments and the feasibility of an airborne fluorosensor was assessed. The prototype will be available at the end of 1986 for airborne tests. Diagnostic studies in order to simulate "weathering" effects of oils have been continued. Experiments concerning the measurement of oil thicknesses are in progress : they are based on the fluorescence intensity ratio at two wavelengths. The final report on oil pollution at sea experiment (Archimedes Project) has been issued on October 1985. It describes the experiments performed in the "Hoek van Holland" campaign in 1984 and the results concerning detection and quantification of simulated oil slicks. The conclusions of Archimedes-1 has led to another campaign Archimedes-2 near Helgoland (North Sea) on October 1985. New sensors (an X-band Synthetic Aperture Radar) were also compared and biogenic films were also dumped. Many European laboratories have participated to these exercises. As far as the transport of pollutions is concerned, the main progress has been the completion of a passive hydrodynamic 3-dimensions model of the Northern Adriatic in collaboration with a Belgian University. This model is being tested using the imagery processed for the "Coastal Zone Colour Scanner"(CZCS) of the satellite Nimbus-7. The potentiality of the Landsat Thematic Mapper as a CZCS substitute has been analyzed. A first report on the campaign Adria-84 has been issued.

A development of this activity has been the study of the upwelling along the Atlantic Coast of Morocco in collaboration with University of Copenhagen. This upwelling determines the primary productivity and its understanding would be useful for the management of fisheries.

In the field of natural disasters, a study, made under contract, has identified, the potentiality of remote sensing techniques and possible research areas. Due to limitations (available sensors and satellites), a decision to postpone possible continuation of this research has been taken.

4.E.3 Industrial Risk (implemented at ISPRA)

4.E.3.1. Accident Prevention

The transfer of codes and methodologies from the nuclear to the industrial field has been successful by the work on CAFTS (Computer Aided Fault Tree Synthesis), SALP-MP (Fault Tree Analysis) and DYLAM (Dynamic Logical Analytical Methodology). The idea of a common exercise on safety analysis of a "benchmark" plant pursued within ESRA (European Safety and Reliability Association) and other European institutions confirmed the interest in starting an activity in this direction. A first workshop has been organised in which significant case studies already studied elsewhere have been analysed and objectives and content of the exercise discussed. JRC has been requested to develop a benchmark proposal for 1986. For the implementation of the Major Accident Reporting System (post-Seveso directive) MARS ,criteria for incident reporting have been finalized and the MARS-collection forms

accepted by the Member States Competent Authorities. The layout of the data bank has been designed and the development of the relevant software will be started in 1986.

The Structural Safety and Reliability activity has been focussed on tests on aged components. It is envisaged to insert this activity in Joint European Programmes such as the "Joint Programme" led by British Petroleum and concerning full scale tests to failure of three big pressure vessels (cat reformers) after twentyfive years of operation in a refinery. JRC is involved in the evaluation of the results and in laboratory test on specimens taken from the vessels.

A book on Regulating Industrial Risk, was published by Butterworths (London & Boston) in October 1985. The structure and design of a software system to support the management of hazardous substances has been defined. The integrated software system has been completed as a demonstration prototype to implement several working examples of the methods and approaches that have been proposed.

4.E.3.2. Accident Management and Control

For the dispersion and pathway of chemicals project an agreement between JRC and ENI (Ente Nazionale Idrocarburi, Italy) regarding the project FIREXP has been signed. This project aims to study the dispersion of flammable materials, the effectiveness of forced dilution techniques, the modelling of industrial fires and the transient overheating of vessels and structures. Preliminary experiments will start by the end of 1985 beginning 1986.

In the field of Chemical Waste, steps to develop a decision support system for the management of super-toxic compounds based on actual data from the Seveso accident have been started. The first module of the system concerned with "Identification of the Threat" is under development. Collaboration with DG XI in the frame of the EC Directive on Toxic and Hazardous Waste, in particular on its classification, has been continued.

Preliminary results from a study contract reveal a lack in basic knowledge about numerous potential chemical Runaway Reactions. This includes comparability of data obtained by different measuring methods, the chemistry and thermodynamic behaviour of the primary and secondary reactions under a large variety of conditions like pressure, temperature, catalytic effects, impurities, etc. A round table discussion on the chemical aspects of Runaway Reactions (with experts from the Member Countries) has contributed to define topics and dimension of a possible activity of the JRC in the field. At the beginning of 1986, another round table discussion will be centered on venting and relief systems as a certain interest of pressure relief system manufacturers. Users in the EC for comparison and validation of different test methods for bursting discs and pressure relief systems in general has been found. Complementary research in the field on multiphase-

multicomponent fluid flow has been recommended for providing basic understanding of prototypical phenomena and furnishing quantitative data for the development of models.

4.F. SCIENTIFIC SERVICE ACTIVITIES

4.F.1. Exploitation of the High Flux Reactor Facility (HFR)
(implemented at PETTEN)

Following the successful reactor vessel replacement in 1984 the reactor was restarted in February 1985 with a test cycle. The experimental equipment was re-installed and the irradiation work carried out as planned in the following areas :

- a) safety of light water reactors, in particular transient fuel tests and experiments simulating accident scenarios;
- b) development of high temperature reactors by irradiation testing of fissile and structural materials;
- c) safety of fast reactors by advanced fuel testing under steady-state and transient conditions as well as irradiation testing of structural materials;
- d) technology and safety of fusion reactors, by irradiation testing of candidate first-wall and blanket materials.

5. BIBLIOGRAPHIC REFERENCES (*)

In 1985, the JRC published 597 papers. The table gives the repartition of these papers amongst:

- research programmes
- type of publication (A = EUR reports, B = papers presented to conferences, C = publications in scientific journals, D = communications to Member States)

	A	B	C	D	TOTAL
NUCLEAR MEAS. AND REF. MATERIALS	8	45	16	4	73
HIGH TEMPERATURE MAT.	3	19	6	2	30
FUSION TECHNOLOGY AND SAFETY	5	32	6	2	45
REACTOR SAFETY	11	62	21	6	100
RADIOACTIVE WASTE MANAG.	1	22	9	2	34
SAFEGUARDS AND FISS. MAT. MAN.	4	17		2	23
NUCLEAR FUELS AND ACT. RESEARCH	6	52	24	2	84
TESTING OF SOLAR ENERGY SYSTEMS	6	6	1	2	13
ENERGY MANAGEMENT IN HABITAT	1	7	5		13
ENVIRONMENTAL PROTECTION	5	46	32	2	85
APPLICATION OF REMOTE SENS. TECH.	1	20	5	2	28
INDUSTRIAL HAZARDS	2	8	5	2	17
EXPLCITATION OF THE HFR REACTOR	4	4	2	2	12
MISCELLANEOUS	8	19	10		38
TOTAL	66	359	142	30	597

(*) The figures given in the table are approximate. The exact figures will appear in issue No. 6 of the Publication Bulletin- ISSN 0254.3133. This bulletin may be obtained upon request to: JRC Publication Service - BLDG 36 - I-21020 Ispra - I.

ANNEX A. SPECIFIC SUPPORT FOR THE COMMISSION'S SECTORAL ACTIVITIES

INTRODUCTION

Two kinds of objectives are pursued at the JRC in direct support of the various General Directorates of the Commission : studies where system analysis techniques are mainly employed and technical assistance where laboratory measurements, technical expertises and management of projects are provided. The multidisciplinary competences available and the specific competence in treating data enables the JRC to execute this kind of activity in various fields. The JRC therefore acts for the Commission as a source of technical advice. In view of facilitating the utilization of JRC research results by industry, some specific work was performed, aiming at detailing and enlarging some selected JRC research subjects. An important and expanding activity of the JRC consists in providing the Commission with technical and scientific assistance in analysing technical problems required e.g. by the implementation of new regulations, by evaluating research proposals, by collaborating in the technical management of contracts, by comparing and synthesizing results etc.

1. Support to the Custom Union for the Import of goods.

One part of the work consists of giving scientific expertise to the Committee for Customs Franchise which is dealing with the complaints of importers of scientific instruments from non-Community countries. In close collaboration with the Services of the Custom's Union, a start was made with the revision of the rules regarding duty-free imports.

A second part of the activity consists of giving expertise as for chemical and biological products imported in the European Community.

2. Support to the General Directorate for Internal Market and Industrial Affairs

The management and updating of the World's Shipbuilding Data Bank has continued. A number of discrepancies have been found in the statistical tables related to the ships of the signatory and non-signatory countries of the "New I.M.O. Convention on Tonnage Measurements of Ships".

In the field of competence of the Task Force for Information Technologies and Telecommunications, technical support was given to the activity on real-time informatics.

A technical support was given to the COST-actions in the field of telecommunications and teleinformatics by providing the secretariat for the COST-TCT (Technical Committee Telecommunications) and for the management committee of project COST 211bis on "Redundancy reduction techniques for coding of broad-band video signals". In the informatics field the JRC also provide technical and secretarial support to the inter-service committee on norms and standards in information technology and tele communications.

3. Support to the General Directorate for Employment, Social Affairs and Education

This activity was dealing with biological monitoring, respiration protection, renal insufficiency and trace metals.

Biological Monitoring is one of the most promising techniques to achieve a systematic and comprehensive control of the hazards due to any type of exposure of men to chemicals.

Concerning the evaluation of the means for the respiration protection of workers within the EC a document was prepared by the JRC-Ispra on the protection of the respiratory tracts of workers with risk of being exposed to dangerous substances.

Recent studies on renal insufficiency and Trace metals have implicated a number of trace metals that could be responsible for some of the symptoms found in uremia. During the reporting period some in vitro studies have been carried out for the determination of the distribution of Cr and Se among the serum components of uremic dialyzed patients and of normal subjects.

4. Support to the General Directorate for Agriculture

An analytical procedure to detect the fraudulent addition of rennet and soluble caseinates in the natural skimmed milk powder was studied. Two methods have been investigated and the results obtained for the various samples of skimmed milk powder, rennet, alkaline caseinate and buttermilk have been reported.

The JRC activity in the field of sugar addition to wine consists only of a technical expertise in evaluating the results of the detection of the sugaring of wine, to be obtained under contract by two European laboratories.

The JRC-Ispra is charged to check periodically the quarterly reports related to the set-up of the Italian olive tree cultivation register. Up to now, about 60% of the Register has been achieved, while for the remaining 40 % there is a problem of refinancing with funds of the Commission. An implementation to the Greek olive tree cultivation register of a new methodology is being attempted.

5. Support to the General Directorate for Development

JRC was requested by DG XIII to organize courses on Nuclear Safety, in cooperation with the Atomic Energy Authority (AEA) Egypt.

A series of six courses will be given, of which the first one : "PWR Safety" was held in the period 16 November - 11 December 1985 at Cairo.

Under the request of DG VIII, the JRC-Ispra supervises and assists seven projects conducted by national laboratories under the general theme of Remote sensing and desertification of Sahara, covering a wide range of significant Sahelian problems. The reception of satellite data by the Maspalomas station since July 1, 1984, allowed during 1985 the analysis of West Africa scenes by the various projects involved.

The use of remote sensing for the research of the variability of fishery related phenomena in the upwelling regions along the Moroccan Atlantic coast was studied. 11 Coastal Zone Color Scanner images have been selected and processed. Other environmental data and fishing data have been collected and are in preparation for integration with the remotely sensed data.

6. Support to the General Directorate for Environment, Consumer Protection and Nuclear Safety

The JRC is in charge of the set-up and operation of the EINECS data bank. During the reporting period copies on tape and paper of the Provisional EINECS have been given to the Member States.

The second series of replacing forms have been received and processed and the general audit of the forms continued. The final issue of the EINECS inventory in the English language is foreseen before the end of 1986.

The EMEP (European Monitoring Evaluation Pollutants) monitoring network is the main European instrument for measuring air pollution and acid deposition in Europe. Following the resolution of the Council to finance the EMEP measurement activities, DG XI has decided to participate actively in this activity by setting up one measurement station in the JRC-Ispra. During the reporting period, the monitoring station has been installed and the measuring activity started.

7. Technological spin-off of JRC research results

The following projects were undertaken under request and with the active involvement of DG XIII.

7.1. Teleinformatics

Brochures of the SCRIBA message handling project were circulated at the Strasbourg exhibition of New Technologies organized for the European Parliament by the Commission and by the European Manufacturers. Promotional documentation has also been produced for the DUAL high speed network project. This product has been successfully presented at the "Local Area Network" Symposium in Aix-en-Provence, October 1985. For the X25/facsimile project it was decided to install an operational system in Luxembourg for test purposes and eventually to propose a INSEM-INSIS framework project on the subject. The licensing agreement to be concluded with PLESSEY or with other competitors will reflect the results of those preliminary tests. The VOICE Terminal project has produced satisfactory results : an industry standard personal computer has been equipped with voice messaging capabilities.

7.2. Passive downward heat transport

The quantitative measurements on the actual circuit have shown that the performances of the heat transport system were not modified after 1.5 year operation, and that the operation in faulty conditions (no cooling in the heat exchanger) did not affect the subsequent normal operation. The assembling of the twin circuits is progressing, with only some small delay.

7.3. Gas-controlled heat pipe furnaces

Some limitations of the conventional furnaces, presently used in thermal treatments of semiconductors, can be overcome by using gas controlled heat pipe furnaces. It has been suggested to develop one of these new furnaces for heat treatment of 200 mm wafers. Its design has been completed and the construction of a vertical prototype is planned for the next year. Some investigations are presently in progress on the life time and the safety of these furnaces.

7.4. Ultrasonic transducers

The reference transducers developed in the JRC laboratory permits to measure transfer functions of the emissions and receptions of ultrasonic transducers, working under immersed condition. In the reporting period the reference transducer itself has been improved in its mechanical and electrical parts and the electrical system, used in emission, has been modified. The contract for the collaboration with the partners, DASSAULT and INSA, was signed in November 1985. An agreement is now under negotiation with Northwest Battelle Institute (Richland), of which the scope is to prepare the commercialization phase of the system in the United States.

7.5. Spectral selective surfaces for the conversion of photothermal solar energy

For optimizing selective surfaces produced along a procedure developed in Ispra, an aging of 2 hours 30' in air at 400°C has been chosen. The thermo-optical properties showed a strong improvement after this treatment, however it is believed that the absorption is not arrived at maximum. An intensification of the aging treatment is proposed.

7.6. Superplastic stainless steel

A great interest exists for engineering applications of superplastic materials because of their capability to be formed at low pressure under various complex shapes at elevated temperature. Chromium-nickel stainless steels have been rendered superplastic by a thermochemical proces suitable to provide a very fine microstructure. Superplastic effects are reported for stainless steels containing manganese in substitution for nickel. This class of materials are explored at present time for their potential for thermonuclear fusion reactor applications.

7.7. The Mark 13A process for flue gas desulphurization

The Ispra Mark 13A process for the flue gas desulphurization is a new process where sulphur dioxide converted into sulphuric acid by reaction with a diluite bromine solution. The bromine is generated by electrolysis. The process does not consume reagents, it produced hydrogen and sulphuric acid, both valuable products, and it does not generate waste solids or liquids. A pilot plant is being realized by Industries, under the initiative and partial funding of the European Community, the JRC's Inventors acting as technical experts.

8. Support to the General Directorate for Energy

JRC is managing the EDSSES Data Base in the framework of the European Energy Bus Programme. The prospected exchange of data with the Canadian Department of Energy, Mines and Resources (EMR) has not been completed since the Commission is still waiting for the confirmation of the confidentiality measures to be adopted by EMR in managing our data. Ispra has, however, prepared a tape containing all the EDSSES data and a technical report for their use. In the framework of the Commission activity (leaded by DG XVII) in supporting financially a number of EC demonstration projects in the fields of energy saving and new energies, the JRC-Ispra has contributed to the work for the selection of the most interesting project proposals.

During the reporting period, the application of the energy demand model MEDEE-3 has been completed and the results published as an external report.

9. Support to Safeguards Directorate

Assistance is provided to the Safeguards Directorate for the development and testing of various techniques to be used for the control of fissile materials. It concerns in particular the field of containment/surveillance, of destructive and non-destructive analyses and of radioprotection. In particular, destructive analyses of samples, taken by the Safeguards inspectors for verification purposes at the various nuclear fuel cycle installations and laboratories were executed. This part of the JRC activity is coordinated by the ECSAM (European Commission Safeguards Analytical Measurements Committee) and includes three parts :

- . routine verification analyses
- . specific analytical development related to ECSAM samples and measurements
- . quality control programme.

A large-scale measurement evaluation programme, IDA-80, on the determination of element and isotope content of input samples of reprocessing plants was carried out with the participation of 33 laboratories of 15 countries or international organizations under the auspices of the European Safeguards Research and Development Association (ESARDA) and with the support of the International Atomic Energy Agency (IAEA). After the evaluation of 60.000 analytical data, the final meeting was held in 1984 in Karlsruhe. The final report (3 Volumes) was published in 1985.

10. Development of the "Euratom Supply Agency" Data Bank

The informatic system developed for the Euratom Supply Agency (which includes a data base called ESABANK) was put in routine operation during the first half of 1985.

In the second half of the year a training course was organized at Ispra for the agency's staff members, to give instruction on the use of TSO and the ESABANK loading procedure. Assistance was given to the agency in loading 450 new contracts into the data base.

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 * GLOSSARY OF ACRONYMS AND ABBREVIATIONS - JOINT RESEARCH CENTRES - EXECUTION REPORT 95 *
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PAGE 1

* AEA	* Atomic Energy Authority (Egypt)
* AFWS or AFS	* Auxiliary Feedwater System
* ALMOD	* Computer Code (Thermohydraulics Special Transients)
* AMCR	* Manganese Chromium Austenitic Steel
* AORS	* Abnormal Occurrences Reporting System
* ARCHIMEDES	* Project for oil pollution at sea
* BCR	* Bureau Communautaire de Reference
* BLOKKER	* Test Section of the FARO facility
* Brite	* Basic Research in Industrial Technologies for Europe
* BWR	* Boiling Water Reactor
* CAFTS	* Computer Aided Fault Tree Synthesis
* CATHARE	* French Large System Thermohydraulics Code
* CEDB	* Component Event Data Bank
* CGC	* Comité Gestion et Coordination
* CONTAIN	* Computer Code Name (Source Term)
* CORRAL	* Computer Code Name (LWR containment)
* COST	* Coopération européenne dans le domaine de la recherche scientifique et technique
* COVASTROL	* Computer Code (LWR end of life prediction)
* CRISP	* Creep Experiment at HFR with in-pile strain measure
* CTF	* Clear air reference Test Field at Ispra
* CZCS	* Coastal Zone Colour Scanner
* DRUFAN	* German Large System Thermohydraulics Code
* DUAL	* High Speed Network Project
* DYLAM	* Dynamic Logical Analytical Methodology
* EAC	* European Accident Code (LMFBR whole core accident)
* ECDIN	* Environmental Chemical Data Information Network
* ECSAM	* European Commission Safeguards Analytical Measurements Committee
* EDSES	* Data Base in the framework of the European Energy Bus Programme
* EINECS	* European Inventory of Existing Chemical Substances
* ELISA	* Experimental Laser Interferometry Strain Analysis
* EMEP	* Evaluation Monitoring European Pollution
* EMEP	* European Monitoring Evaluation Pollutants
* EMR	* Energy Mines and Resources of the Canadian Department of Energy
* ENI	* Ente Nazionale Idrocarburi ; Italy
* EPRI	* Electric Power Research Institute
* ERDS	* European Reliability Data System
* ESA	* European Space Agency
* ESARDA	* European Safeguards Research and Development Association
* ESRA	* European Safety and Reliability Association
* ESTI	* European Solar Test Installation
* EURATOM	* European Atomic Energy Community
* FARO	* Name of JRC facility (Safety)
* FIREXP	* Flammable Materials Dispersion Experiment (ENI)
* FORTRAN 77	* Computer Language (Formule Translation)

* FRUST	* Post-Examination and Tensile Tests of Irradiated	AMCR
* GELINA	* Geel Linear Accelerator	
* HFR	* High Flux Reactor	
* HT	* High Temperature	
* HTM	* High Temperature Materials	
* IAEA	* International Atomic Energy Agency	
* IDA-80	* Measurement Evaluation Programme	
* IEA	* International Energy Agency	
* IEC	* International Electrotechnical Commission	
* ILE	* Isotopic Lead Experiment	
* IMO	* Internal Market and Industrial Affairs Organization	
* INSEM-INSIS	* Framework Project	
* INTERSOL	* International Solar Energy Society	
* INTOR	* International Tokamak Reactor	
* ISIS	* IAEA Integrated Safeguards Information System	
* ITAC	* Instrumented Fuel Assembly	
* LACE	* LWR Aerosol Containment Experiment	
* LDTF	* Large Dynamic Test Facility	
* LINAC	* LINear ACcelerator	
* LISA	* Long Term Isolation Safety Assesment (Code)	
* LMFBR	* Liquid Metal Fast Breeder Reactor	
* LOBI	* LWR off Normal Behaviour Investigation	
* LOCA	* Loss of Coolant Accident	
* LWR	* Light Water Reactor	
* MARCH-2	* Computer Code Name (Service Accident Analysis)	
* MARK 13	* New flue gas desulphurisation process	
* MARS	* Major Accident Reporting System	
* MEDEE-3	* Application of the Energy Demand Model	
* MELUSINE	* French Thermal Reactor in Grenoble	
* METEOSAT	* Satellite for meteorology	
* MIRAGE	* Migration of Radioisotopes in the Geosphere	
* NATO	* North Atlantic Treaty Organization	
* NBS	* National Bureau of Standards	
* NET	* Next European Torus	
* NRM	* Nuclear Reference Materials	
* OECD	* Organization for Economic Cooperation and Development	
* OURS	* Operating Unit Status Report	
* PAGIS	* Performance Assessment of Geological Isolation	
* PASSYS	* Cost shared action project on solar systems	
* PERLA	* Performance Calibration and Training Laboratory	
* PETRA	* Project of equipment for treatment of radioactive waste in Adeco	
* PHENIX	* French Fast reactor in Marcoule	