ANNUAL·REPORT·89

# Environment Institute

JOINT RESEARCH CENTRE

COMMISSION OF THE EUROPEAN COMMUNITIES

EUR 12868 EN

A N N U A L · R E P O R T · 89

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**Published by the**
**COMMISSION OF THE EUROPEAN COMMUNITIES**
**Directorate-General**
**Telecommunications, Information Industries and Innovation**
**Batiment Jean Monnet**
**LUXEMBOURG**

**LEGAL NOTICE**



Cataloguing data can be found at the end of this publication.

Luxembourg: Office for Official Publications of the European Communities, 1990
Catalogue Number: CD-NA-12868-EN-C


*Printed in Italy*

# Contents

# The JRC Environment Institute

Environmental research at the JRC started as early as 1972 with some 15 professional staff in the fields of air pollution, water pollution and environmental chemicals. Initially the accent was on measuring techniques. By 1989 the professional staff has reached 65, without counting environmental research being carried out at the JRC's Institute for Remote Sensing Applications. In the eighties the research areas indoor air pollution and chemical waste were added to the fields of activity.

For the period 1975-1988 environmental research in Ispra was imbedded in a matrix structure with a *programme manager* in the horizontal line and items of research being done in vertical lines in the Divisions of Chemistry, Radiochemistry, Physics and Electronics. On 4th November 1988 this organisational form was abandoned and substituted by an Institute structure and the fore-mentioned activities were integrated in a newly created ***Environment Institute*** located at Ispra. The smaller groups from Electronics, Physics and other units were merged with the Chemistry and Radiochemistry Divisions. The nine Sectors of these two Divisions are shown in the organisation chart of annex B. The present organisational structure of the Institute is transitory and will be subject to change in 1990.

Moreover the Environment Institute was made the "Lead Institute" for the research on radioactive waste at the JRC. Its own activities in this field represent about 8 % of its overall research undertakings. The other Institutes involved are Safety of Technology at Ispra and the Transuranium Institute at Karlsruhe.

The research activities of the Institute are, as for the past, closely coordinated with the relevant shared-cost and concerted action programmes of the DG XII/E (Environment and Non-Nuclear Energies) and DG XII/D (Nuclear Safety Research - Nuclear Waste and Fuel Cycle) and particularly with the programme STEP (Science and Technology for Environmental Protection) and the "Radioactive Waste Management and Storage Programme".

The Institute constantly endeavoured at improving and extending the scientific support given to other Commission's services. Income from this source has now reached 30 percent; contract work for third parties is increasing but still too low. A project named *REM* (Radioactive Environmental Measurements), which analyses the contamination and contaminants transported by air after the Chernobyl accident falls into this support category.

Support is given to

| | |
|---|---|
| DG I | (External Relations) |
| DG III | (Internal Market and Industrial Affairs) |
| DG V | (Employment, Industrial and Social Affairs) |
| DG VI | (Agriculture) |
| DG XI | (Environment, Nuclear Safety and Civil Protection) |
| DG XIII | (Telecommunications, Information Industries and Innovation) |
| DG XVII | (Energy) |
| DG XXI | (Customs Union and Indirect Taxation) |
| CPS | ("Consumer Policy" Service) |

The great variety of these requests naturally induces a large number of individual projects.

The average number of persons working in the Environment Institute is about 280, 175 of whom are permanent and some 90 have contracts for a maximum of three years, which testifies to a staff mobility. The latter include different categories of scientific visitors, research fellows,auxiliary and seconded staff (see section 3 of this report).

Short descriptions, results and achievements of the numerous projects under study in this Institute are presented on the following pages. A high percentage of them is relevant with respect to their impact on environmental research in general, on other Commission's services and on industrial partners. To name just three of them, for instance, ECDIN, the on-line data bank on environmental chemicals, REM and the flue gas desulphurisation process Ispra Mark 13A.

# Executive Summary

# 1. Specific Research Programmes

## 1.1. ENVIRONMENTAL PROTECTION

Progress is reported on the research areas Environmental Chemicals, Air Pollution, European Monitoring Network, Water Quality, Chemical Wastes and Food & Drug Analysis. The new research areas Environmental Studies in the Mediterranean Basin and Genetically Engineered Substances are still in a preparatory and definition phase.

### Environmental Chemicals

For ***ECDIN*** (Environmental Chemicals Data Information Network) the only community-wide, publicly available, factual databank on environmental chemicals, new and updated data on toxicology, occupational health and safety, chemical economy, physico-chemical properties and legislation were implemented.
In order to extend the public use of ECDIN a new tarification policy is considered and for the commercialization of ECDIN through information brokers by CD-ROM a pilot disk has been realized. Special arrangements for a privilege use of ECDIN are under negotiation with the German Bundesministerium für Umwelt and the Italian FEDERCHIMICA.

In the framework of the JRC led COST concerted action ***"Indoor Air Quality and its Impact on Man"*** several working groups have been established which prepared a "practical guide for the investigation of causes of unspecific complaints in large buildings", a report on "strategy for sampling chemical substances in indoor air", a guideline for the "determination of the steady state formaldehyde concentration from wood based materials in test chambers".
Another working group is preparing a document on "biological effects in man related to indoor air pollution".
Four non-community countries have now joined the project and the secretariate is handling an increasing number of information requests. Standardization of measurement procedures and methods for the ***characterization of VOC source emissions*** is still of major concern for the comparability of results obtained at different times and locations. Therefore JRC participated in an international comparison of VOC emitted from several building/furnishing materials. A strategy for investigating the potential influence of VOC pollution on complaints in office buildings has been deviced and applied in six buildings of the European Parliament.

Within the activity on ***Exposure and Health Effects of Trace Metals*** a study on the biological monitoring of Co, Ta and W in the bronchoalveolar lavage, blood, urine, toe nails, pubic hair and sperma of hard metals workers suggested that especially meaurements on toe nails and pubic hair could be used as "early warning" indicators for hard metal dust exposures.
Trace metal determinations in the pleural-pulmonary tissue of malignant mesothelioma affected patients showed significant variations of Zn, Cu, Co and Cr compared to tissues of healthy subjects.
For the study of trace metal metabolism, the activity was focussed on the development and use of in vitro bio-assays (cell cultures) in order to reduce the use of test animals. In vivo experiments continued with the study of the distribution of thallium in rat brain following exposure to toxic doses. After one day exposure with 1 mg Tl/Kg the highest concentration was found in the hypothalamus and the lowest in the cortex, suggesting that many symptoms and histopathological findings in Tl-intoxicated humans may be related to a specific brain distribution.

### Air Pollution

The ***role of biogenic emissions (e.g. terpenes) in the dry deposition processes of $O_3$/$NO_2$/$SO_2$*** mixtures on forest trees was further investigated. Conversion rates of $SO_2$ are varying between 1.5

% to 3.5 % per hour in the β-pinene-$O_3$-$SO_2$ system and between 0.7 % to 2.3 % per hour in the terpene-$O_3$-$SO_2$-$NO_2$ system. In addition to $H_2SO_4$, the formation of organic acids and their corresponding aldehydes was also observed. From these findings the well known "Ispra hypothesis" that biogenic emissions may increase the overall acidity when reacting with an $O_3$-$SO_2$-$NO_2$ polluted forest air is finally confirmed.

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

The operation of the pilot plant for the demonstration of the ***ISPRA MARK 13A flue gas desulphurisation*** *process* at the SARAS refinery, Sarroch (Sardinia) started in the beginning of 1989. JRC staff surveyed the technical acceptance of the plant and followed the first operation phases; a total of 2.000 operation hours in 10 months is now achieved. For the development of a combined desulphurisation/denoxing process two processes are under study: catalytic reduction with hydrogen and cathodic electrolytic reduction. Screening tests for condidate catalysts were completed and a patent application for the cathodic reduction of NO to $N_2$ via an anodic ammonia conversion was filed.

## European Monitoring Network

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

## Water Quality

For the ***recovery project of Lake Varese*** the present lake condition was characterized by nutrient concentration, oxygen content, algal biomass, integral phosphorous loading and chemical composition of sediments. Modelling was applied to evaluate the need of daily oxygen supply to prevent P release and to predict lake recovery times.
For ***Lake Orta***, one of Europe's most polluted fresh water bodies, metal distribution maps for anthropogenic trace elements and nutrients were elaborated. Additionally, analyzed samples of seven contributing rivers, the outlet river, surface run-off and precipitations will allow to establish a total metal balane. A JRC developed dispersion model will be validated by the experimental data.
For the further development of pythoplankton analysis a suitable staining technique to distinguish algal species by blue nuclear and yellow granular fluorescense has been set up. The application of ***flow cytometry*** to the bacterial analysis of water has been tested. Cultured starins as well as fresh water bacterial populations were studied by epifluorescense microscopy as a reference method and compared to flow cytometry with a good agreement.

## Chemical Waste

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

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

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

In the frame of the EUREKA environmental project EUROENVIRON the Institute is developing a mobile analytical unit for in-field analysis of toxic wastes.

## Environmental Studies on the Mediterranean Basin

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

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

## Food and Drug Analysis

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

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

# 1.2. RADIOACTIVE WASTE MANAGEMENT

The programme is divided in four research areas:

1) operation of the PETRA facility;
2) actinide monitoring;
3) characterization of radioactive waste;

4) safety of final storage in geological formations.

Research areas 1) and 2) are treated by the Institute for Safety Technologies and research area 3) by the Institute for Transuranium Elements. They are described in the annual reports of the concerned Institutes.

The objective of research area 4), which is treated by the Environment Institute, with a small contribution of the Institute for Advanced Materials, is the assessment of the long-term safety of waste disposed in geological formations under conditions presently studied in the European Communities. Both theoretical and experimental activities contribute to the objective.

Main achievements for theoretical activities on ***safety assessment*** were:

- the preparation of a new version of the probabilistic risk assessment code LISA, especially developed for application to hard rock formations;
- a new driver for LISA, to enhance input flexibility;
- the successful participation in intercomparison activities organized by the NEA;
- organization of a seminar on techniques of risk analysis in nuclear waste management in the framework of the Eurocourses.

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

- the study of the influence of humic acids present in ground water on Pu migration, where an association of Pu with mobile humic acid particles (less than 600 nanometers in diameter) has been found;
- the study of the specific conditions of groundwater above the Gorleben salt-dome in relation to Pu and Np migration;
- transport processes in fissured media (in collaboration with CIEMAT/Spain);
- development of analytical techniques both for laboratory studies (laser spectroscopic techniques and mass spectroscopy) and for in-field investigations (geophysical and geochemical probes).

# 2. Scientific Support to Community Policies

According to a collaboration agreement signed between JRC and DG XI (Environment, Nuclear Safety and Civil Protection) the Environment Institute provides technical assistance and supports the implementation of EC-directives in the following fields: Chemicals, Atmospheric Pollution, Water Quality, Chemical Waste and Radioactivity Environmental Monitoring (REM). Other Commission services are supported with a minor effort and in many cases as a spin-off of existing specific research programmes (DG I: training of analytical techniques for scientists of developing countries; DG III: development of a prototype databank on pharmaceutical products; DG V: collection of biological data in the field of occupational health; DG VI: databank on European wines; DG XIII: technical supervision of the Ispra MARK 13A pilot plant; pilot scale demonstration of the JRC patent "Anti-oxidants for plastics"; DG XXI: characterization of not well defined chemical and biological imported products).

## Chemicals

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

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

For the implementation of the EC 79/831 directive on "testing requirements and testing guidelines for chemicals" the JRC has been proposed to take the technical and scientific responsability of the work: discussions are in progress to define practical arrangements.

## Atmospheric Pollution

The Central Laboratory for Air Pollution Measurements (CLAP) completed its second ***Quality Assurance programme*** with the quality control of network instruments at 27 selected Member States stations. A final report with a chapter on "Recommendations to the Member States" is in preparation. Main results are: 80 % of $SO_2$ instruments are within ± 20 % of the CLAP instrument and 80 % of the total supended particulate ambient measurements are within ± 15 % of standard methods.

For the preparation of a possible directive on ***volatile organic compounds (VOC)*** a meeting with European experts was convened at Ispra discussing a priority list of 25 VOCs on which abatement strategies should be focussed, state-of-the-art of sampling and measuring techniques and the organisation of intercomparison campaigns.

## Water Quality

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

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

## Radioactivity Environmental Monitoring (REM)

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

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

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

# 3. Third Parties Work

This chapter includes miscellaneous activities related to the Institute's analytical facilities and its expertise on waste disposal, the JRC contribution to the ATMES project and the ENRESA/JRC co-operation agreements. The total income by the end of 1989 amounts to approximately 350 KECU, while new activities for about 350-400 KECU are under discussion.

A collaboration agreement has been signed with the Italian Ministry for the Environment and negotiations are in progress to define first contract works on the recovery of the Po river basin and on the management of toxic wastes. The work will be done in collaboration with the JRC 's Institute for Systems Engineering.

## ATMES

An Atmospheric Transport Models Evaluation Study (ATMES) has been initiated jointly with the International Atomic Energy Agency and the World Meteorological Organization.

The project aims at utilizing the data on radioactivity levels in air and depositions after the Chernobyl accident to evaluate the models designed to be used for the management of nuclear accidents. An evaluation team has been especially assembled for that purpose. Over thirty institutions from twenty countries have positively responded to this initiative. Results should become available in fall 1990 and a workshop will be organized in spring 1991 to discuss the results and issue recommendations.

## ENRESA/JRC cooperation

Two cooperation agreements have been signed with the Spanish Agency for Radioactive Waste Management (ENRESA), one focussed on probabilistic risk assessment for the site-specific disposal of radioactive wastes, making use of the LISA code developed by JRC, the second an experimental study on the migration of radionuclides in crystalline rocks.

The latter confirmed the importance of humic substances (HS) for the radionuclide mobility. An increase of HS to 25 ppm decreases the 238-Pu distribution coefficient between groundwater and granite by the factor of 20.

# Main Achievements

# 1. Specific Research Programmes

## 1.1. ENVIRONMENTAL PROTECTION

The 1988-91 JRC Environmental Protection programme, adopted by the Council on 14 October 1988 (O.J. No L 286/29, 20.10.88), provides the following research areas:

1. Environmental Chemicals,
2. Atmospheric Pollution,
3. European Monitoring Network,
4. Water Quality,
5. Chemical Waste,
6. Environmental Studies of the Mediterranean Basin,
7. Food and Drug Analysis,
8. Genetically Engineered Substances.

The following paragraphs review the main achievements in the different research areas. The latter is still in a very preliminary phase and a feasibility study to consider the possibility for the JRC to enter this field is under way.

### 1.1.1. Environmental Chemicals

This research area includes three activities: ECDIN, Indoor Air Pollution and Trace Metal Health Effects.

#### 1.1.1.1. ECDIN

ECDIN (Environmental chemicals Data and Information Network) is a factual Data Bank on Chemicals which actually or potentially are affecting the Environment, or the Human Health. All relevant information suitable to forecast and/or to control any undesirable environmental effect of chemicals is stored in ECDIN, and can be retrieved by a sequence of menu-type searches. The adopted Data Base Management System is ADABAS, and the loading/searching programmes are written in Natural language. The European Inventory of existing Chemicsals (EINECS) is also stored in ECDIN.

For ECDIN a twofold goal has been envisaged: to constitute a scientific information tool for the Commission Services and for the interested national Authorities, and to become a public information facility offered onto the international information market.

Since 1983 ECDIN is available on-line through the International Computer Networks; the commercial distribution to public has been appointed to an external host computer, which at present is DATACENTRALEN IS, Copenhagen, Denmark. To-day more than 400 users have subscribed an on-line connection; half of them are industries, the rest being shared between public services and scientific Institutions.

In 1989 most of the activity has been devoted to the updating of existing data and the implementation of new ones.
The concerned data files were:

- Toxicological files, especially classical toxicity and Carcinogenic Effects
- Occupational Health and Safety files, with particular emphasis on Epidemiology
- Chemical Economics, mainly concerning Production and Consumption Statistics, Uses, Consumption Pattern
- Physical and Chemical Properties

- Legislation Files (in collaboration with IRPTC, Geneva).

In order to expand the public use of ECDIN, a twofold strategy is being implemented:

- A revision of the tarification policy, in order to make more interesting for the users a frequent connection to the information system; this revision is part of a new deal for the commercial distribution for which an official call for tenders has been launched.
- The recent significant growth in the use of PCs everywhere in the world, and the spectacular improvements in the CD features and capacity, have suggested the opportunity to distribute significant sectors of the ECDIN data base on CD-ROM, by the collaboration of commercial Information Brokers.
  A pilot disk has been realized allowing us to define the characteristics of the first commercial issue, foreseen before the end of 1990.

The problem of a data distribution in several languages is also being considered.

Negotiations are in progress with governmental Authorities (e.g. the German Bundesministerium für Umwelt) and private bodies (e.g. the Italian Federchimica) in order to join the efforts and share the costs to implement into ECDIN some special files, or to quickly update some sets of information of prioritary interest and/or concern. The first agreements could become operational in the early 1990.

As a spot service supplied to several Commision units, special data collections or data summaries on specific request have been made available. The more consistent questions came from DG V, DG XI, DG III, and from some research groups of the JRC.

### 1.1.1.2. Indoor Air Pollution

Indoor air pollution receives increasing attention because of the potentially high exposure of the population (high residence times indoors, concentrations of many pollutants higher indoors than outdoors) and the prevalence of susceptible groups (children, elderly, unhealthy people) in the non industrial indoor environment.

The JRC effort in this field consists in the management and scientific coordination of the COST–Concerted Action "Indoor Air Quality & Its Impact on Man" (COST project 613) and in research activity aimed at an assessment of organic indoor pollutants and their sources and is based on its European commitment on one side and on specific competence developed in the past decades on the other.

The following major results have been obtained in the reporting period.

#### *COST project 613 - Indoor Air Quality & Its Impact on Man*

COST project 613 is being very successful as documented by the following facts. Four non-Community Countries joined or are going to join the project and many information requests are arriving at the Secretariat.

The Community-COST Concertation Committee (CCCC) issued two reports, "Radon in Indoor Air" and "Indoor Pollution by $NO_2$ in European Countries", summarizing essential information on these two key pollutants in a concise form. In addition an inventory of ongoing or recently concluded investigations or research projects in the participating countries has been published .

Several working groups (WG's) have been established, three of which have already achieved their tasks:

- WG 1 has prepared a practical guide to the investigation of causes of unspecific complaints in large buildings.
- WG 2 has developed and described a "Strategy for Sampling Chemical Substances in Indoor Air".
- WG 3 has prepared Report No. 2: "Formaldehyde Emission from Wood Based Materials: Guideline for the Determination of Steady State Concentrations in Test Chambers". The

guideline is going to be validated by an interlaboratory comparison test organized on behalf of the Commission under the auspices of CEN.
WG 4 is preparing a document on "Biological Effects in Man Related to Indoor Air Pollution", a preliminary draft of which has already been discussed by the Committee. The document is aimed at summarizing available knowledge and providing the multidisciplinary indoor research community with a common understanding and language. It also focusses on methodological aspects in order to ease the identification of research needs.

Four further working groups have been or are going to be established.

### *Study of VOC emissions from indoor sources.*

Volatile organic compounds (VOC) are indoor pollutants of particular concern since many of them are known or suspected to cause carcinogenic, neurotoxic, allergenic, immunotoxic, irritating or sensory effects. Building and furnishing materials, household and hobby products are important indoor sources of these compounds (Fig. 1).

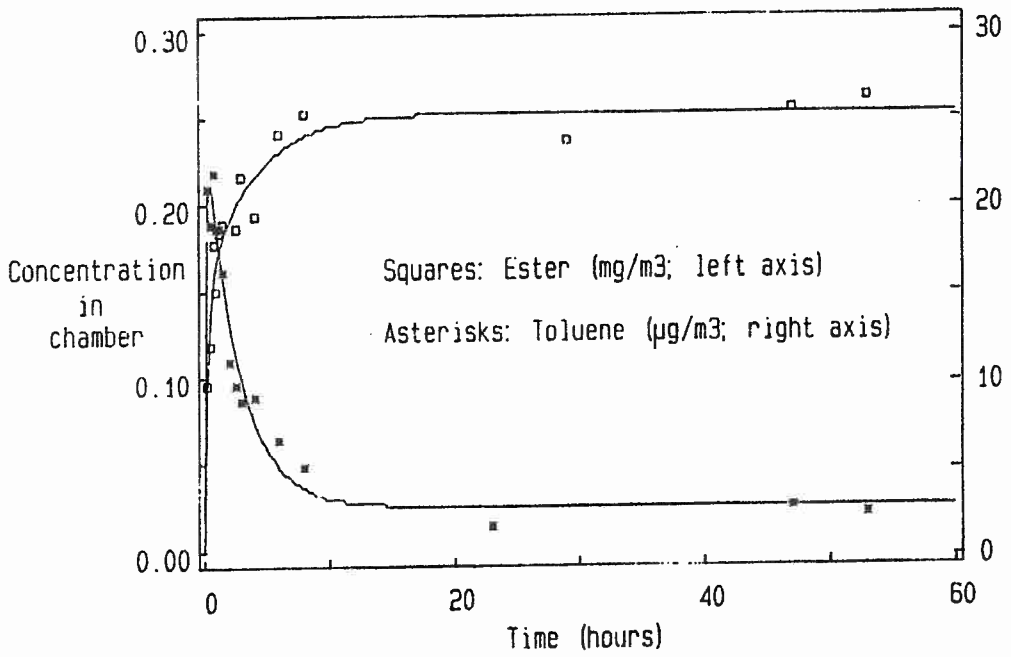



*Fig. 1 - Emission of volatile organic compounds from building material. Concentration-time curves of two compounds emitted from a gypsum board sample placed in an environmental chamber. The two curves show the range of observed emission-time dependencies for compounds emitted from building materials. The curves are interpolations of the measured concentration values by means of an empirical model.*

The characterization of VOC emissions from these indoor sources requires environmental chambers. During the reporting period a third small chamber (250 L volume) has been installed at the JRC.
A major difficulty in characterizing source emissions of VOC is the comparability of results obtained at different times and at different locations. This requires standardization of measurement procedures and methods and of the models describing the concentration/time patterns of the emissions.

The JRC participated in an international comparison of VOC emitted from several building/furnishing materials aimed at promoting standardization. An effort has been undertaken to model VOC emissions with various concentration/time patterns. An empirical model using two

exponential functions performs well for all observed patterns. Employed methods and obtained results have been reported.

As a first step towards biological tests of indoor source emissions acetaldehyde and methylglyoxal, constitutents of environmental cigarette smoke, have been studied for their embryotoxicity and for genotoxicity in various tissues. Results on acetaldehyde have been published. Methylglyoxal was found to be empbryotoxic in vitro but not in vivo, while preliminary experiments seem to put in evidence a genotoxic effect in male germ cells at the most advanced stages of maturation.

***Development of a strategy for VOC measurements in complaint buildings.***

A strategy for investigating the potential influence of VOC pollution on air quality complaints in office buildings aimed at minimizing the measurement effort has been deviced and applied in six buildings of the Europena Parliament. The strategy consists in the administration of a 2 page questionnaire asking for various types of complaints and in selecting a few measurement locations with high and low complaint levels. Preliminary results have been published.

### 1.1.1.3. Trace Metal Exposure and Health Effects

The activity intends to contribute to the technical and scientific information needed to determine sound dose-effect/response relationships in order to prevent potential health risks of trace metal (TM) exposure.

Major results can be summarized as follows:

***TM exposure in humans.***

The aim is to establish TM concentrations in body fluids and tissues of general population, professionally exposed workers and pathological cases in biomedical research on TM-related diseases.
Major achievements were:

- determination of background values of TM in urine, blood, serum as well as in the different lung regions of unexposed subjects to be used as reference baseline values to assess exposure and body burden levels;
- measurement of cobalt, tungsten and tantalum by neutron activation analysis in bronchoalveolar lavage, blood, urine, toe nails, pubic hair and sperma of hard metal workers to identify toxicological effects;
- determination of TM in the pleural-pulmonary tissue of patients affected by malignant mesothelioma but with no history of asbestos exposure. Significant variations of zinc, copper, cobalt and chromium were observed in the diseased tissues in comparison to healthy subjects;
- development of a radioimmunoassays method and neutron activation analysis to determine the metallothionein in the liver, lung and kidney of general population and its relation with TM able to induce this protein, and their content in these tissues.

***TM metabolism.***

In order to reduce the number of animal tests, this activity was focussed on the development and use of in vitro bioassays (cell cultures). These bioassays were used:

- To develop a pharmacokinetic metabolic model for vanadate in the BALB/3T3 cells which includes a biotransformation of pentavanadate to tetravalent vanadium as detoxification mechanism for vanadate.
- To establish the toxicity and the oncogenic action of vanadate in the same cell line at exposure concentrations higher than 3 µM.
  The correlation of the absorbed dose of vanadate and the toxic effects suggests a threshold for no toxic action of the element in the cell of 5 ft of V/cell.
- To study the cytotoxicity and the oncogenic effect induced in the BALB/3T3 by arsenobetaine (AsB), the organic form of As in certain seafoods, in comparison to inorganic arsenic ($As_i$). Cytotoxicity of AsB was more than 100 fold lower than for $As_i$ .

No oncogenic effect was found after exposure of the cells at concentrations up to 100 uM of AsB while a marked effect was observed for $As_i$ already at concentrations of 3 µM. This suggests that exposure to arsenic in the form of AsB, as present in seafood, does not result in cancer risk (Fig. 2).

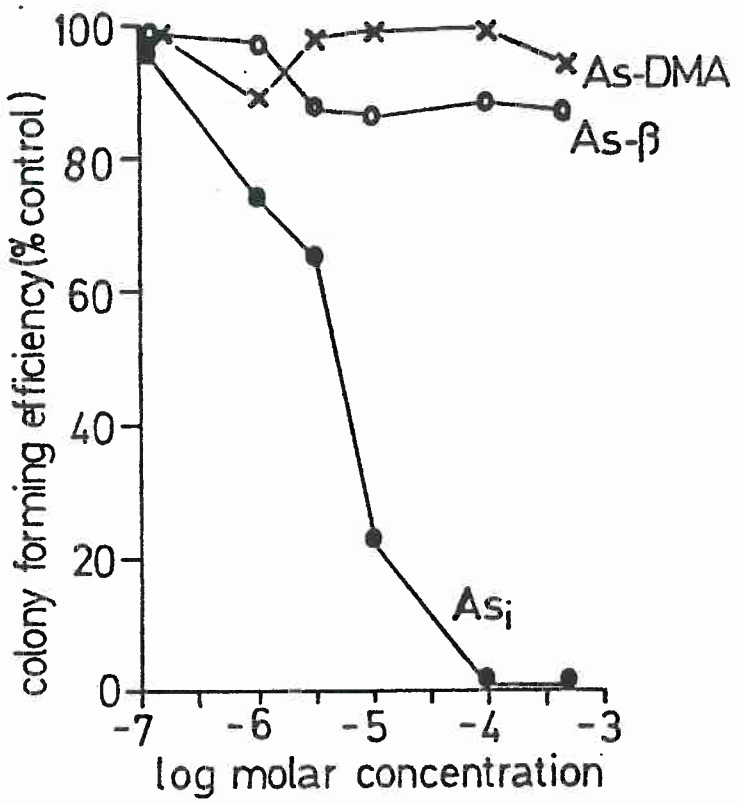



*Fig. 2 - Cytotoxicity of As-Compounds as determined by in vitro bioassays in BALB/3T3 cells. $As_i$: inorganic arsenite; As-β: arsenobetaine; As-DMA: dimethylarsinic acid.*

. To investigate the correlation of the uptake and the intracellular fate of manganese and its neurotoxic action in the PC 12 cell line in the context of a study on the role of this element in the Parkinson's disease which would involve the interaction with neuromelanin to induce cellular degeneration.

In vitro approaches were also used:

. To study the effect of TM on the motility of germ cells and their ability to incorporate toxic metals (spermiotoxicokinetics) in the male reproductive system; and
. To establish the inhibitory effect of vanadium on plant and mammalian peroxidase enzymes.

In vivo experiments carried out:

. Disposition of thallium in rat brain regions after exposure to low and toxic doses of thallium. At 1 day a thallium differential distribution was found among brain regions of the animals treated with high doses (1 mg Tl/Kg). The highest thallium content was found in the hypothalamus and the lowest in the cortex. This finding suggests that many of the symptoms and histopatological findings in humans after thallium intoxications may be related to a regional thallium distribution in human brain
. Limit of the capacity of the detoxification mechanism for inorganic arsenic (methylation) in rabbits, mice and hamster.

In mice, the methylation is linear with the dose of inorganic As administered from 0.2 to 7.5 mg As/Kg b.w. In the hamster and rabbits the formation of the dimethylated arsenic in urine is depleted at exposure of 5 mg As/Kg b.w. This suggests that different animal species would have different limits of capacity in arsenic biomethylation, which should be taken into consideration before establishing an animal model.

## 1.1.2. Air Pollution

This research area includes Air Chemistry and the Ispra MARK 13A flue gas desulphurization process.

### 1.1.2.1. Air Chemistry

The activity in this field is characterized by a priority given to chemical substances released by biological sources and to their interaction with anthropogenic pollutants.

Various aspects of the impact of these species on atmospheric chemistry have then been investigated, namely:

- in simulated atmospheric conditions, their contribution to transformation processes leading to acidic compounds,
- in laboratory studies, the kinetics and mechanisms of their chemical and photochemical reactions,
- in field campaigns, the evaluation and distribution of their sources.

In regard to the first item, the studies on the β-pinene-$O_3$.$SO_2$ have shown that the $SO_2$ oxidation yield and the subsequent $H_2SO_4$ formation was significantly affected by the presence of water vapour; as the r.h. increased the $SO_2$ oxidation yield decreased.Addition of $NO_2$ to the system terpene-$O_3SO_2$ led to higher terpene conversion rates while the $SO_2$ oxidation was decreased. Under the experimental conditions used (100 ppbv terpene mixing ratios), the conversion of $SO_2$ in the β-pinene-$O_3$- $SO_2$ system varied between 1.5 and 3.5 % per hour; in the system terpene-$O_3$-$SO_2$-$NO_2$, the conversion of $SO_2$ ranged from 0.7 to 2.3 % per hour. The formation of organic acids (e.g. HCOOH, $CH_3COOH$) as well as of the corresponding aldehydes was also observed in addition to $H_2SO_4$ in the reactions terpenes-$O_3$.
From these results it can be inferred that in forest areas the reaction of emitted monoterpene hydrocarbons with $O_3$-$SO_2$-$NO_2$ polluted air, might lead to an overall increase of the acidity.

Kinetics and mechanisms of atmospheric reactions have been investigated in the laboratory maintaining, as for the previous studies, the focus on the role of the $NO_3$ radical (nighttime atmospheric chemistry).
As part of a programme aiming at the understanding of the mechanisms involved in the atmospheric degradation of terpenes, products and mechanisms of the gas phase reactions between $NO_3$ and a series of alkenes in air have been investigated.The reactions were observed to produce nitroxy- carbonyl, nitroxy-alcohol and dinitrate species with a relative abundance dependent upon the alkyl substitution pattern at the double bond. The ratio between simple carbonyl and organic nitrate products was independent of the $NO_2$ concentration: it follows that the ratio measured in laboratory experiments can be considered indicative of that expected under ambient tropospheric conditions.The importance of organic nitrate products is related to their possible toxicity and their capability to act as a temporary reservoir for $NO_x$.The relatively stable organic nitrates may be transported over a long distance,e.g.to unpolluted areas, where $NO_x$ can be released by photolysis to subsequently trigger local photochemistry. Evidence was also found for a fast reaction between the nitrate radical $NO_3$ and peroxy-radicals which must be taken into account in modelling atmospheric chemistry.
The reaction between $NO_3$ and dimethylsulphide (DMS) in air has been investigated. DMS is emitted in large quantities from oceans (algae) and is estimated to account for 25% of the total, naturally and anthropogenically emitted sulphur. Evidence has been obtained for H-atom abstraction by $NO_3$ as the first step of the reaction. A complete mechanism for the reaction

DMS+$NO_3$ based on the identification of intermediates and end products has been proposed.$HNO_3$, $CH_2O$, $SO_2$ and methanesulphonic acid were found as main products; it appears that the formation of $HNO_3$, followed by removal of this species by deposition, represents an efficient sink for $NO_x$ in the marine troposphere (Fig. 3).

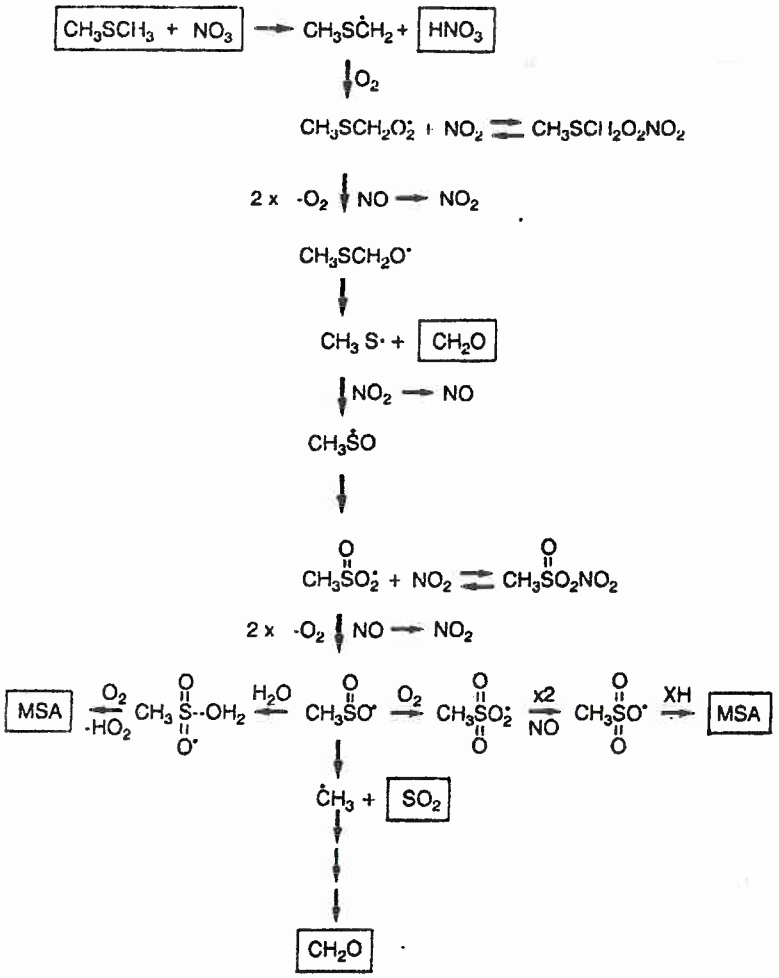



*Fig. 3 - Reaction mechanism for the night-time atmospheric oxidation of dimethylsulphide (DMS = $CH_3SCH_3$) by reaction with the nitrate radical ($NO_3$).*
*The proposed chemical scheme is based on the results of a laboratory study and accounts for the observed reaction products: nitric acid, methanesulphonic acid (MSA), formaldehyde and sulphur dioxide. DMS emitted from oceans (algae) is estimated for account for about 25 percent of the total emitted sulphur. Its transformation to any oxidized form of sulphur is considered a potentially important parameter in the planetary radiation budget. Methanesulphonic acid and sulphuric acid infact act as effective condensation nuclei capable to increase the number density of cloud droplets thus enhancing cloud albedo.*

Few studies on the reactions of $NO_3$ radicals with anthropogenic pollutants, characteristic of polluted local areas (e.g. halogenated alkenes, aromatic hydrocarbons) are in progress with the Universities of Göteborg,Oslo and Milano.

The Institute participated in two measurement and intercomparison campaigns in the Bavarian forest (May and September 1989); subject of these exercizes were the measurement of the concentration of terpenes, formaldehyde and other terpene-$O_3$ reaction degradation products.

### 1.1.2.2. Ispra Mark 13A Flue Gas Desulphurization Process and Removal of Nitrogen Oxides from Flue Gases

The Ispra Mark 13A process is a new flue gas desulphurisation process producing sulphuric acid and hydrogen, instead of gypsum, like most of to-day's industrially applied processes. The Commission is supporting the construction and operation of a pilot plant to desulphurise a flue gas throughput of 32 000 Nm3/h at the SARAS Refinery, at Sarroch in Sardinia (Italy). JRC Ispra bears the responsability for the technical supervision of this pilot plant project which is administratively under the responsability of DG XIII Luxemburg.

The pilot plant in Sarroch was completed during the year 1988 and the start-up and operation phase started in the first months of 1989. The work done by the JRC consisted of the technical acceptance of the commissioning of the plant, followed by the first phases of the operation stage. The operation of the process required the maximum of the know-how of the laboratory and bench-scale experience gathered during the previous research of the process by the JRC Ispra. The first period of operation was mostly dedicated to the testing of components, such as flowmeters, recirculation pumps... Also the performance of the main process items (electrolyzer, reactor, preconcentrator etc.) was tested under various process conditions. The plant was in full operation for more than 2000 hours during the first 10 months of the operation phase.

Besides the abatement of sulphur dioxide, the JRC conducts a research for the extension of the Ispra Mark 13A process to a combined desulphurisation/denoxing process.
Two promising possibilities are under study:
- the catalytic reduction with hydrogen
- the cathodic electrolytic reduction.

During 1989 both methods were investigated on a laboratory scale. For the catalytic reduction screening tests for candidate catalysts were completed. The poisoning of the catalyst by remnants of sulphur dioxide remains the main obstacle for the development of a successful process.
The electrolytic reduction process was studied in laboratory scale electrolytic cells. Here it was found that the direct cathodic reduction of NO to $N_2$ was not feasible, because the main reaction products were methylamine and ammonia. However, an attractive way to convert the formed ammonia anodically into nitrogen was found and a patent application was filed.

## 1.1.3. European Monitoring Network

In recent years the regional and transboundary transport of atmospheric pollutants is more and more considered as an important environmental issue. Problems like deposition of acidifying substances and the formation of troposheric ozone in remote rural areas are strictly linked to the combination of air chemistry and meteorological processes. The classical air pollution monitoring networks were however designed for urban and industrial areas with high pollution level so that the need for more sensitive instruments and new measuring strategies arose. With this in mind the Environment Institute Ispra tests and develops advanced tropospheric air monitoring systems which could become an integrated part of a European Monitoring Network, participates with its own staff and instrumentation in regional, national and international field campaigns and finally takes the lead in organising field campaigns and field measuring programmes with more general scientific objectives.

A commercial open path ***differential optical absorption monitor*** (DOAS from the firm OPSIS) has been installed at the vicinity of the JRC Ispra EMEP station and a good agreement for the species $O_3$ and $NO_2$ was found between the 700m optical path data and the conventional point data from the EMEP station. The sensitivity to measure atmospheric formaldehyde is not yet sufficient.

During the TRANSALP October 1989 field exercise the system was in operation for continuous long-path $O_3$ and $NO_2$ measurements (Fig. 4).

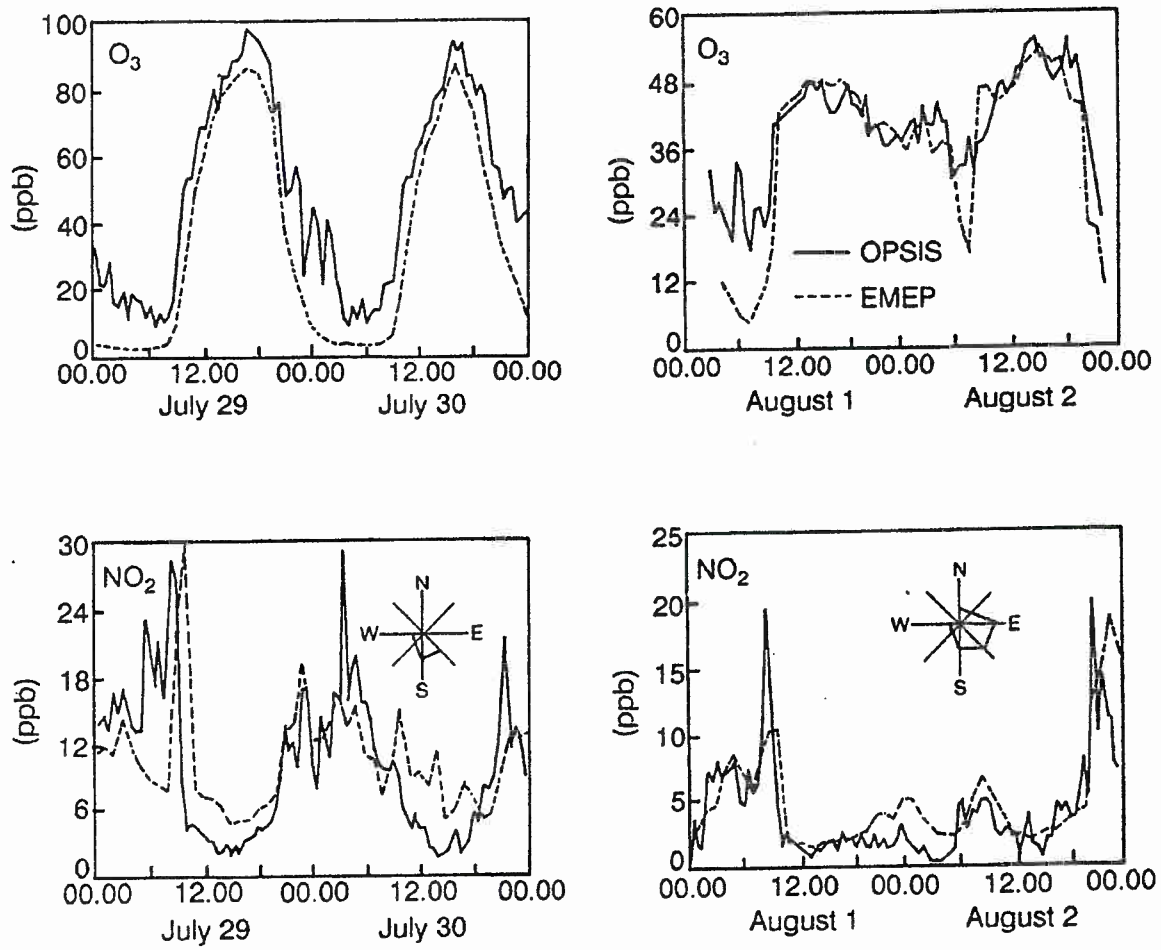



*Fig. 4 - Comparison of $O_3$ and $NO_2$ ambient air concentrations measured by long path differential optical absorption and by point sampling monitors.*
*The response of point monitors located at the EMEP Station of the JRC-Ispra is compared to that of a differential optical absorption spectrometer (DOAS). The point monitors are measuring at ground level while the DOAS is measuring over a beam pathlength of 729 mm 30 m above ground.*
*$O_3$ and $NO_2$ data are compared for two days under different meteorological conditions (see insert for the wind rose; the wind speed on 1-2 August was four times higher than on 29-30 July). The agreement is in general satisfactory and improves significantly, as expected, with air mixing. For $NO_2$ the comparison is more difficult since polluted air locally produced may influence in a different way the two monitors.*
*The ongoing study intends to evaluate the significance of point monitors as indicators of air quality in the area.*

***Passive diffusion tube samples*** for $NO_2$ prepared and analysed at Ispra have been shown to perform excellently in comparison with those prepared elsewhere and also with conventional $NO_2$ monitors. These very simple and inexpensive devices are consisting in small plastic tubes in which $NO_2$ is chemically absorbed on a triethynolamin film which is analysed in laboratory following a 3 days to 3 weeks exposure (according to $NO_2$ ambient level) and have been employed in $NO_2$ distribution studies in Athens, Paris, Varese and other places for the design of new sampling networks and the validation of existing ones.

***The ozone distribution*** around the southern edge of the Alps is of large concern as the maximum admitted concentrations (120 ppb in CEC, 60 ppb in Switzerland) are frequently exceeded and its impact on human health and the natural environment has raised major public interest. For this reason JRC Ispra, in collaboration with the Canton Ticino, conducted a systematic study with an ad-hoc monitoring network on the tropospheric ozone formation in southern alpine valleys showing that during summer extremely high values are due to the afternoon breeze transporting anthropogenic ozone formed mainly by automobile traffic up-valley.

JRC Ispra is the one and only European laboratory employing the ***perfluorcarbon tracer technique*** (developed by the US Broockhaven National Laboratory) on a routine basis. This technique allows to study atmospheric transport and diffusion over complex terrain in the mesoscale (100-200 km) giving a straight relation between the artificial tracer source and the down-wind concentration field (ground and aircraft sampling).

The following field exercises were conducted:

- Campo dei Fiori experiment, Varese, July 1988.
  Investigation of the atmospheric dispersion in a complex lake-mountain area. A strong vertical channeling effect on the plume is created by the heated mountain slope near the cold lake surface (Fig. 5).

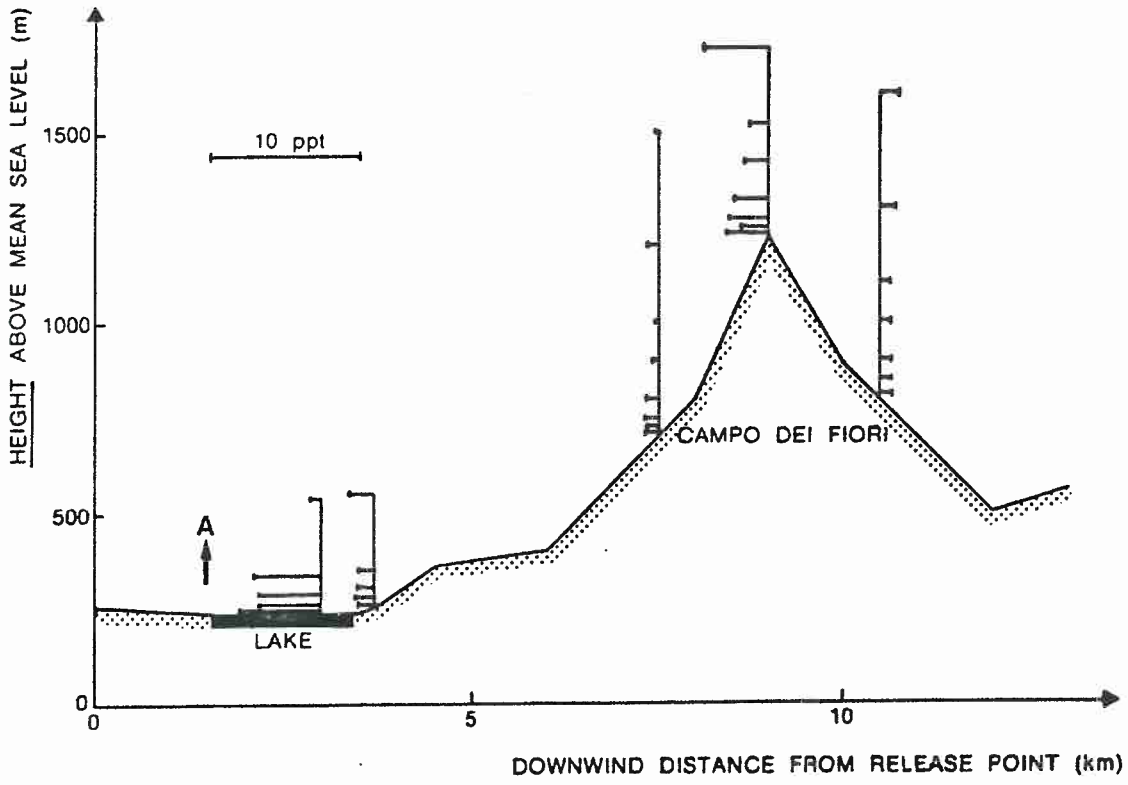



*Fig. 5 - Campo dei Fiori Experiment (july 1988).*
*Vertical concentration profile of the perfluorocarbon tracer (ppt). The tracer released from point A crossed the lake and overtook the mountain up to about 2000 m height.*

- MECAPIP experiment, Castellon, July 1989.
  Investigation of the atmospheric transport from eastern Spanish coast to the central Spanish plateau induced by mediterranean thermal lows. In the frame of this field exercise organised

by the Spanish CIEMAT Institute, the tracer plume was detected at high concentrations up to 80 km distance. Tracer sampling by an instrumented aircraft (under contract by Fraunhofer Institut, Garmisch-Partenkirchen) proofed to be an extremely powerful tool to describe flow over complex terrain if the aircraft is equipped with in-situ wind measurement and computerized navigation systems.

- TRANSALP pre-experiment, Canton Ticino, October 1989.
  In this first pre-experiment in the TRACT/TRANSALP-EUROTRAC proposal the channeling of air masses in the Ticino area was investigated in collaboration with Swiss and Italian laboratories. The tracer was detected up to the St. Gotthard and Lucomagno passes driven by local wind systems ("Inverna") developing under sunny conditions.

## 1.1.4. Water Quality

The Water quality Project is focussed on two main areas: lake recovery and applications of flow cytometry to aquatic sciences.

*Lake recovery*

***Lake Varese*** is a hypertrophic well buffered lake surrounded by a large belt of aquatic macrophytes. This was the first lake in Italy to experience problems of cultural eutrophication (middle 1950's).

The identified problems are dense algal blooms from March to November, great oxygen consumption in hypolimnetic waters and fish kills that hinder all uses of water.
The planned solution for the recovery of the lake foresees sewage diversion by means of two collectors and the waste water treatment in a centralised plant with P and N control whose effluents are discharged into the lakes's effluent.

A full-scale limnological research has been undertaken in collaboration with the Sanitary Engineering Institute of the Polytechnic of Milano aiming: to describe the present conditions of lake Varese for in-lake nutrient concentration, oxygen conditions, algal biomass and limiting factors; to quantify the internal P loading from sediments and to chemically characterize bottom sediments.

Modelling activities have consisted of applying the: eutrophication two-vertical box model, the one dimension heat diffusion model and the sediment model to evaluate epilimnetic P deficit due to existing algal biomass level; to predict the effect of hypolimnetic withdrawal; to evaluate daily oxygen supply necessary to prevent P release from sediments and finally to predict lake recovery time.

***Lake Orta***, one of Europe's most polluted lakes, suffering from massive metal (Cu,Cr, Ni) and ammonium contamination, coupled to extremely low pH-values and at present subject to an extended recovery attempt by the Italian government, offers an unique opportunity to study metal behaviour in a damaged freshwater ecosystem.

The present study started off in 1986 with an attempt to assess the sediment pollution status on the basis of a densily structured sediment sampling network (4samples/km$^2$).
Metal distribution maps were elaborated for a number of anthropogenic trace elements (Cu, Cr, Ni, Hg, Cd, Pb, Zn, B, As, Mo), nutrient and major elements.
One of the unespected results was the observation of strong focusing effects, accumulating the trace elements in a rather restricted area near to the North of the lake, far from the known input sources.
The evolution of metal accumulation in the sediments has been assessed by the analysis of six long-core sediments.
The metal dispersion model, developed earlier (Rossi et al., 1987) shall be applied to Lake Orta.

The data base has been built since autumn 1986, collecting cumulatively sampled water and suspended matter at monthly sampling frequencies in four sectors of the lake and at three different depth levels each.
Typical copper concentrations measured were 30 µg/L and 900 mg/kg in the water and suspended matter phase, respectively.
Additionally analyzed samples of seven contributing rivers, the outlet river, surface run-off and precipitations will allow a metal mass balance attempt.

*Flow cytometry*

- Phytoplankton

Major difficulties which presently exist in flow cytometric analyses of algal population include:
. intercalibration of cytometric parameters measured by different cytometers,
. staining techniques to distinguish algal species by blue nuclear fluorescence and yellow granular fluorescence,
. development of a suitable data analysis technique based on light scatter mesurements.

Calibration studies for the recognition of suitable parameters (morphological and cytological) acquired by JRC Ispra and Bruker ACR 1400 cytometers have been performed.
An analytical protocol for staining algae (Chlorella) with DNA stains (e.g. 4-6 di-aminido - 2 phenylindole), aiming to a better resolution of phytoplankton species, has been set up.

- Bacteria

During the last year the application of flow cytometry to bacterial analysis of water has been also investigated. The aims of this study carried out in collaboration with the Laboratory CNRS of Hydrobiology (Univ. Montpellier, France) are:
. to enumerate rapidly the bacterial communities in aquatic systems,
. to characterize bacterial populations inside these communities according to physiological activities (pathogenic or species characteristics),
. to access to the observation scale of the bacterial cell in its aquatic environment.

In order to verify the accuracy of flow cytometry to bacterial ecology, cultured strains and freshwater bacterial populations were studied by epifluorescence microscopy and compared to cytometric analyses. Bacteria have been stained with either DAPI (e.g. 4-6 di-aminido - 2 phenylindole), or acridine orange. Flow cytometric evaluations were in good agreement with those by epifluorescence microscopy in both cultured strains and freshwater samples.

## 1.1.5. Chemical Waste

Experiments on inorganic and organic pollutants in porous media have been carried out to support a ***dynamic finite element model for pollutant migration.***
In order to dispose of a homogeneous and well defined material a permanent soil sampling field station has been established at Ispra. A soil profile was cut down to the water table (1.5 m) revealing seven different horizons. The analysis of these horizons has characterized the soil as a Dystric Gleysol (FAO 1985) or Acquic Ustipsamment (USDA 1987). The soil is positioned on a coarse and glacial sediment.
Instrumental neutron activation analysis allowed the quantification of about 30 minor and trace elements contained in these soil horizons.
The adsorption of trivalent and hexavalent $^{51}Cr$ radiotracer by soil from the seven profiles was studied in batch experiments at various chromium concentrations, contact times and pH and the following conclusions have been drawn :
- Cr (VI) which can be easily reduced to Cr (III) by organic matter, is less strongly retained by the soil than Cr (III)

- Cr (VI) is adsorbed by the soil according to the Freundlich isotherm over a broad concentration range (0.06 - 343 µmol · l$^{-1}$) (Fig. 6).

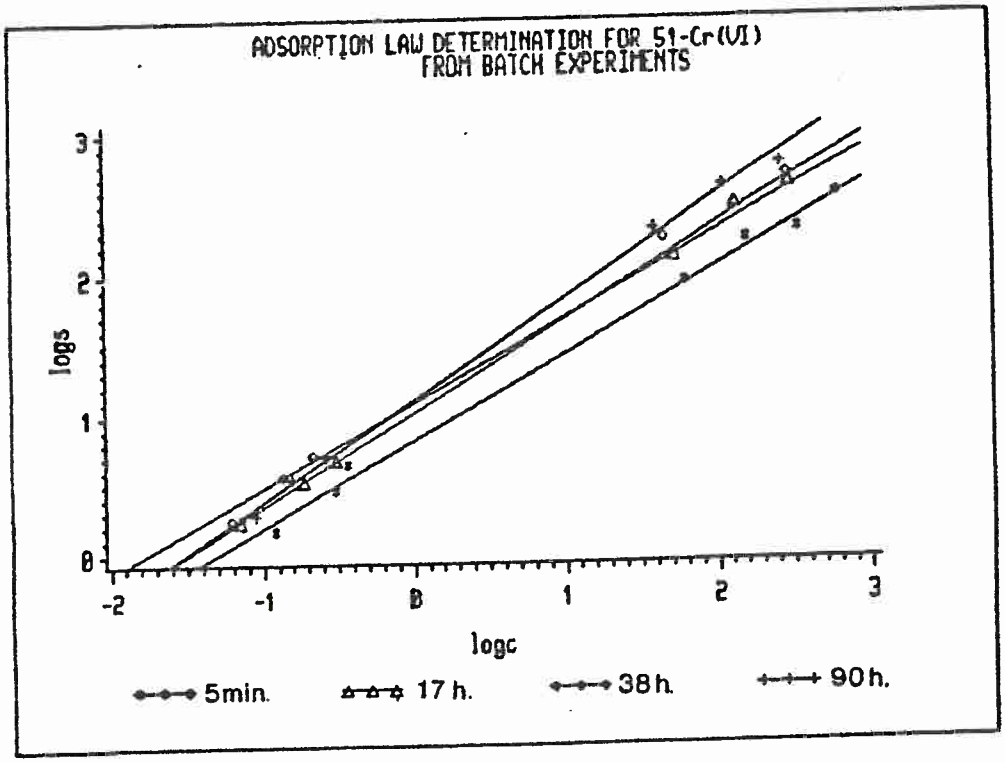



*Fig. 6 - Sandy loam soil: Freundlich law of sorption.*

- increasing pH decreases the adsorption of Cr (III), probably due to the formation of stable soluble organic matter - Cr (III) complexes.

Data from 33 soil samples were compared by plotting the calculated concentration of adsorbed Cr against the measured concentrations of Cr : a good linear relationship was obtained.
Soil sorption of As (III) and As (V) has been also studied in batch experiments at various contact times and pH. An initial aqueous arsenic concentration of 1 ppm was used, which corresponds to the tolerable level for irrigation water. Soil water distribution coefficients were determined for the seven soil horizons and they will be used as input to a dynamic model based on the finite element method in order to study the transport of As (III) and As (V) released from a hypothetical repository to groundwater.

Distribution coefficients have also been studied under dynamic conditions (column experiments) with $^{51}$Cr (VI) and tritiated water as tracers, and sand as medium. The pore velocity was varied from 0.27 to 16.2 cm · h$^{-1}$ which resulted in a significant variation of Kd (from 8.5 to 3.5 L · Kg$^{-1}$). A clear variation of the dispersivity and a significant retardation of Cr (VI) in comparison with tritiated water were also observed. In consideration of the distribution and dispersion coefficients obtained by column experiments which may be orders of magnitude different from those obtained in batch experiments, it can be concluded that studies of trace compound migration in soil should be carried out possibly under dynamic conditions. Furthermore the role played by the pore water velocity has evidentiated that the experiments should be carried out with non-water-saturated soils.
This type of studies has also been extended to organic compounds. The distribution coefficient between soil and water (Kd) for polychlorinated biphenyls has been proven to be an essential parameters for the transport of hydrophobic compounds from soil to water.

A linear relation between the organic matter content (% OC) and sorption (Kd) was obtained for all soil horizons with the exception of the first one (6% OC).

In the field of ***molecular dosimetry for the assessment of human exposure to genotoxic compounds*** arising from toxic chemical wastes a new methodology based on Constant Neutral Loss Mass Spectrometry has been developed. This technique allows a one step specific monitoring of classes of compounds (e.g. aminoacids) to perform screening of unknowns at trace level. Modified nucleotides formed in DNA and blood lymphocytes after exposition in vitro to styrene oxide, butadiene monoxide and other alkylated agents were isolated by HPLC and then measured by mass spectrometry at levels from 2 to 5 ng. An optimization of the mass spectrometric method is now under development in order to reach sufficient low levels for biomonitoring purposes. The same method has also found an inexpected application in the structure determination of biopolymers, as it allows rapid sequencing of peptides, nucleotides and oligosaccharides.
The method has been developed on a new high resolution mass spectrometer fitted with different ionization sources and sample introduction systems. Moreover a collision cell and a quadrupole were added to perform tandem mass spectrometry at high and low energy collision.

The ***Chemical Emergency Management (ChEM) decision support system*** has been further developed along two main lines.
The first one aims at developing a suite of cooperating expert systems modules for the management of emergencies generated by chemical accidents involving halogenated aromatic toxic compounds. A first module dealing with the evaluation of the threat is now available.
The second one, is a tool for the management of electrical equipment (transformers and other electrical devices) that could contain PCBs. It includes full text indexing of the data, support of mathematical models, extended implementation of the hypertext concerning literature on electrical machines and associated fluids.

In collaboration with four Danish Groups and within the framework of the EUREKA's environmental project EUROENVIRON (see chapter on EUREKA), the JRC is developing a mobile analytical unit for in-field measurements of toxic wastes.
A twin mobile unit should provide sampling and sample treatment capabilities on one side, and instrumental analysis on the other.
A preliminary report describing the layout of the Mobile Laboratory unit is being prepared.

## 1.1.6. Environmental Studies in the Mediterranean Basin

Already in the past the Environment Institute contributed to specific projects in Mediterranean countries (e.g. Athens Lead Experiment; measuring campaigns on air pollution episodes in Athens and Thessaloniki; Ispra Course in Madrid on "Methodology and Air Pollution in the Mediterranean Area").
Including a specific research topic on "Mediterranean Environmental Problems" in its programme decision, the Council emphasized that the JRC should further intensify its efforts in this direction.

As a starting point the JRC organised on 2-3 March 1989 a meeting with experts from Italy, Greece, Spain, Portugal and France to assess the interest and possibilities for joint mediterranean projects. As a preliminary conclusion the following research topics emerged which could eventually be further developed to well defined joint research projects in which, of course, already existing bilateral cooperations and contributions from the shared-costs action programme will be fully integrated:

a. Behaviour of atmospheric pollutants in Mediterranean areas
   - effects of thermal lows on transport and diffusion
   - fate of VOCs (distribution, photochemical episodes).

b. Groundwater quality
   - migration of pollutants through soil
   - transformation of pollutants from agriculture, power plants, industrial wastes.

c. Microphyte toxins in fresh and sea water
   . characterization by flow cytometric and fluorescence methods
   . sampling, preparation and storage of algae blooms for toxin extraction.

d. Harmonisation of analytical methods and sampling techniques for air (e.g. $O_3$, VOCs, PAN), fresh and sea water (biomass, sediments; biological indicators).

Whilst point b. is already sufficiently covered by ongoing activities of the Environment Institute on chemical wastes, expert meetings for the definition of cooperative joint mediterranean projects for points a.,c. and d. are organized towards the end of 1989 begining 1990.

As a substantial contribution to point a., the Environment Institute participated in the Spanish MECAPIP project (see 1.1.3. European Monitoring Network)

## 1.1.7. Food and Drug Analysis

The aim of this activity is the development of an European laboratory able to support some EC sectorial policies on agriculture, custom tariffs, consumer protection etc.

The laboratory, whose implementation started in 1988, has been equiped with analytical techniques such as: Nuclear Magnetic Resonance, infra red and ultra violet-visible spectroscopy, high performance liquid chromatography, gas chromatorgraphy, ion chromatography, polarimetry, refractometry, microscopy enzymatic and immunological methods, elemental analysis, electrophoresis and classical food analytical methods. Moreover, other existing analytical facilities of the JRC Chemistry Division will support this activity when needed .

Preliminary activities of the laboratory have been focused on:
- the detection of sugaring of wine ("chaptalization") and the development of a European data bank for the NMR fingerprints of European wines. A first batch of wine distillates from the area of Würzbug was measured to evaluate the dependance of grape ripening on the deuterium content of selected grape species (Müller-Thurgau, Riesling, Silvaner) (Fig. 7);
- the participation to the work of the EC expert panel on the evaluation of the content of sterol in butteroil;
- the determination of the purity of starches by different analytical methods (starch produced in EC must be $\geq 97\%$ pure to obtain EC financial supports): total saccharification, polarimetric and other enzymatic methods. Participation to the activity of the ISO Working Group TC 93 "Det. of starch in starch";
- testing of microscopic, ELISA and electrophoretic methods to detect vegetal proteins in meat extracts;
- the participation to the various EC expert meetings on dairy products, wine, analytical methods for cosmetics etc.

In collaboration with the responsibles of some interested EC Directorates (DG VI, Consumer Protection Service, DG XXI, DG III), work is in progress to define a more complete future programme for the food and drug analysis laboratory.

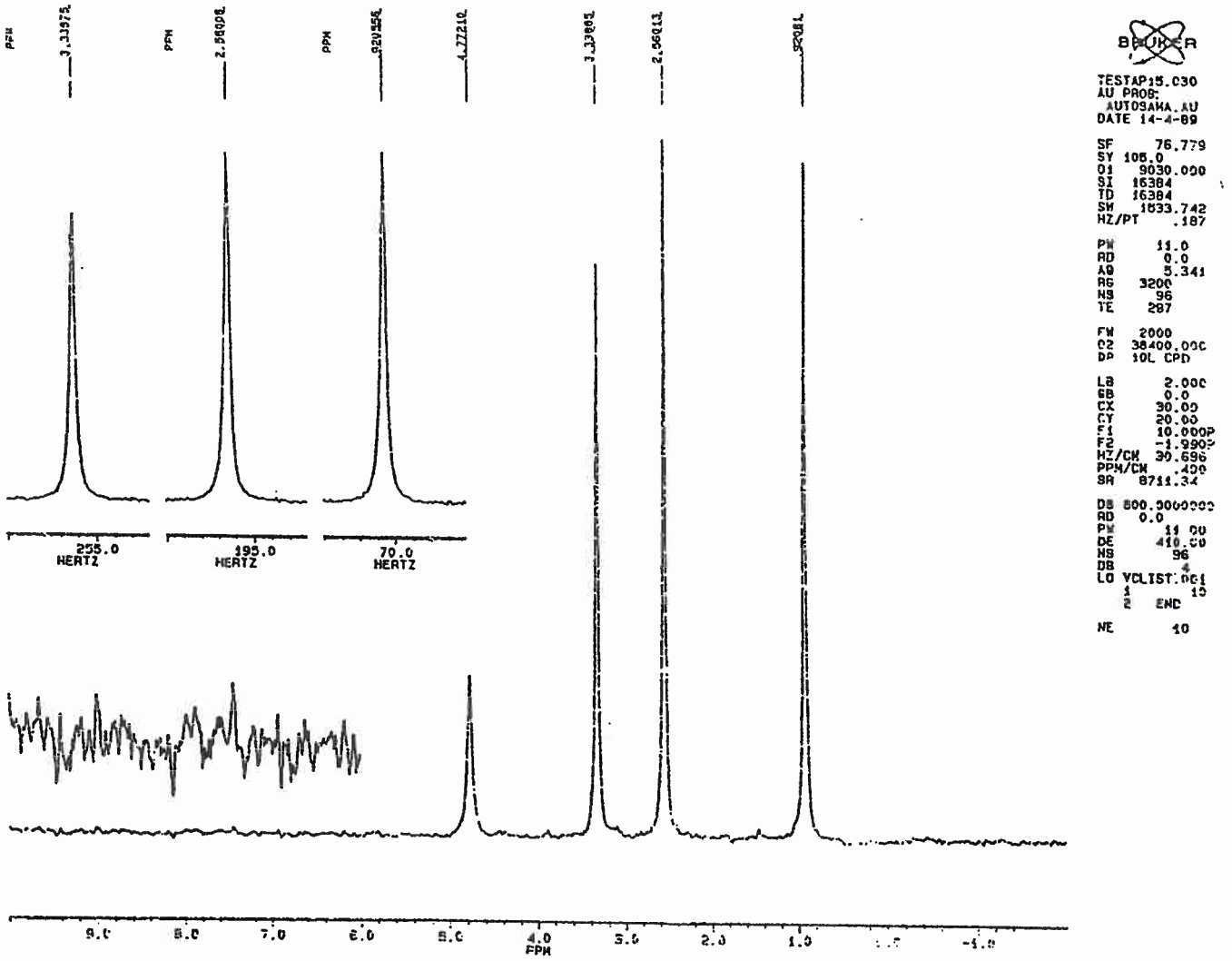



*Fig. 7 - Typical natural abundance deuterium NMR spectrum of ethanol with tetramethylurea as internal standard showing also expanded lines for half width ($\Delta_{\frac{1}{2}} = 0.3HH_2$) and enlarged noise pattern for signal to noise (248:1) determination according to O.I.V. specification.*

## 1.2. RADIOACTIVE WASTE MANAGEMENT

The 1988-91 JRC Radioactive Waste Management programme adopted by the Council on 14 October 1988 (O.J. No L 286/29, 20.10.88) is divided into four research areas:

1. Operation of the PETRA facility
2. Actinide Monitoring
3. Characterisation of radioactive waste
4. Safety of final storage in geological formations.

Research areas 1 and 2 are executed by the Institute for Safety Technology and research area 3 by the Institute for Transuranium Elements. They are described in the annual reports of the concerned Institutes.

Research area 4, which is executed by the Environment Institute with a minor contribution by the Institute for Advanced Materials, includes three activities (i) Risk Assessment, (ii) Analytical Development and (iii) Radionuclide Migration in the Geosphere whose main achievements are reviewed below.

### 1.2.1. Risk Assessment

The activity deals essentially with the development of probabilistic codes for safety assessment and their application to specific projects.

For what refers to ***code development***, a new driver for the LISA code is being elaborated by Toshimitsu Homma, from JAERI (J), presently visiting scientist at the JRC. The main characteristic of this code is an enhanced input flexibility. A new geosphere sub-module GTM (Geosphere Transport Module, release 1) has been included in LISA, replacing the previuos TROUGH code. The vault submodel has also been upgraded. This new version of LISA has been already tested in an international benchmark exercise with good results.

JRC has continued its code benchmarking activity within the NEA coordinated PSAC User Group. Our institute is among the leading parties of the latest group exercise (Level 1A).

One paper has been published and another is in progress on the use of non-parametric statistics in sensitivity analysis for the output from computer models (see references).

Regarding applications, during 1989 the ***PAGIS project*** has been completed and final report issued. PAGIS (Performance Assessment of Geological Isolation System for radioactive waste) is a large EC project which involved six years of work and a budget of approximately 10 million ECU. The essential aim of the project was to assess the general capability of possible waste disposal systems to confine radionuclides incorporated in conditioned high level radioactive waste after the closure of the repositories. This was done by evaluating the efficiency of the disposal systems in selected geological formations, coupling natural and man-made barriers in view of protecting present and future generations and their environment from possible deleterious effects due to high level waste repositories. Three host rock formations were considered: clay, salt and granite. Disposal into the sediment of the deep sea has also been added as an alternative to land based disposal. The conclusions of the study, worth several thousand pages, have been presented at the PAGIS information day in Madrid (30th of June). The report is organised in five volumes (one for each option plus a summary volume). JRC has contributed to this action, supporting the Radioactive Waste and Fuel Cycle division of DG XII in Bruxelles, with particular regard to the harmonization and application of stochastic codes.

***An advanced seminar on probabilistic risk assessment methodologies for nuclear waste disposal*** was held in summer 1988 in the framework of the Eurocourses. Proceedings have been published in 1989. They address issues such as risk perception and risk policy, methodologies and methods

for performance assessment, the modelling of geological events and the use of natural and archaeological analogues.

## 1.2.2. Analytical Developments

Under this heading different tasks are comprised:
- development of methods and analytical support for the control of PETRA
- analytical support to the various experimental activities of the Programme
- analyses in the frame of collaboration with external organizations.

Part of the activity is made on a routine basis and about 1000 samples of various origin and form have been analysed. The main ones can be classified as follows:
- groundwater collected during the in-field campaign on the "El Barrocal" site in Spain
- liquid-solid samples from migration experiments
- organic and aqueous samples from cold PETRA tests.

The elements determined are various and the analytical techniques used are mostly ICP-AES, GF-AAS, alpha and gamma spectrometry and electrochemical methods.

During this year, two new devices have been installed in the laboratory:
- a ICP-MS interfaced with a HPLC system to identify and determine chemical species at trace level, besides elementary analysis
- a TOC system mainly used for the determination of the humic acid content in various water samples from the migration experiments.

## 1.2.3. Radionuclide Migration in the Geosphere

In 1989 the activities centered around the following themes:
- Dynamic experiments on actinide migration
- Assessment of basic migration phenomena of actinides
- Field investigations.

*Dynamic experiments on actinide migration*

Strictly controlled column experiments have been performed to simulate the variability of natural parameters.

The influence of humic acids on Pu migration has been studied in conditions typical of the Mol aquifer. The Pu adsorption on a clayey-sand from the Mol aquifer in Belgium has been investigated as a function of pH and humic acid (HA) concentration. The surface redox reaction of Pu(V) appeared to control the Pu retention on electron-exchanging minerals. Percolation experiments showed that HA particles larger than 600 nm were retained in the column, while the HA breakthrough was characterized by an extended elution tailing. The chemical association of Pu with mobile HA, investigated by leaching of a $^{238}$Pu-doped borosilicate glass, enhanced the Pu release rate in HA solutions in comparison with HA-free water. Attack and dissolution of cations in the glass structure decreases the glass durability enhancing Pu release; the role of HA on the durability of nuclear waste deserves hence further examination.

Reaction rates in heterogeneous systems have been studied in conditions typical of the Gorleben aquifer. Column studies under reducing conditions using soil (id. Z263) and groundwater samples (id. Z251) collected at a depth of 140m near the Gorleben salt dome, have shown a constant column breakthrough of Pu and Np (10-20% of the input activity). Two factors may explain the observation: 1) species exist which are not in local equilibrium with the soil, i.e., they dissociate at a very slow rate; 2) Pu and Np transport may involve non-reactive colloidal-sized particles.

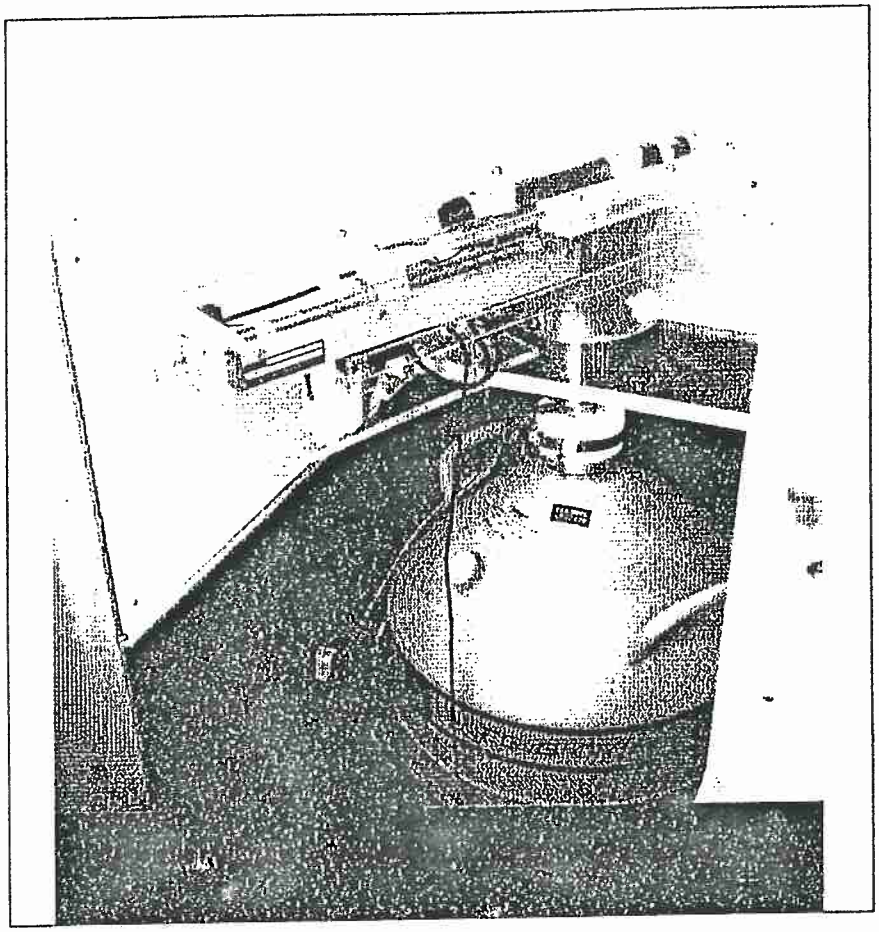


*Fig. 8 - Radionuclide migration through porous media. Gamma scanning equipment.*

Experiments resulting in different residence times of Pu and Np into the column bed are underway. These should clarify the nature of the mobile species (Fig. 8).

### *Assessment of basic migration phenomena of actinides*

This activity deals with the basic chemistry of actinides in natural aquatic systems. It includes the participation in the interlaboratory exercises coordinated by the CEC and the development of non-invasive analytical techniques.

Time Resolved Laser Induced Fluorescence (TRLIF) has been used to investigate Eu and Tb complexation with fulvic and humic acids present in groundwater samples. The excitation of lanthanide species has been provided by an excimer laser operated by XeCl mixtures and the short-lived luminescence of humic compounds has been eliminated by time gating. Eu concentrations in the order of $10^{-8}$ M could easily be measured. The conditional binding constants and the loading capacities of Eu(III) have been determined as a function of pH and ionic strength. Part of this work has been performed in collaboration with the Royal Institute of Technology (Stockholm). Kinetics of lanthanide complexation with natural organic ligands using a stopped-flow apparatus coupled with equipment for TRLIF have been determined. Kinetics runs at different pH and ionic strength for humic and fulvic acids of various origin have been performed. The addition of competitive cations has a marked effect both on the time dependence and the amplitude of the fluorescence signal. The kinetic method of speciation provides an approximation to the kinetic behaviour of metal species in natural waters, generally in dynamic rather than in equilibrium conditions.

Complex formation of Am(III) with phosphates has been studied using a solvent extraction technique. The stability constants of the $AmH_2PO_4^{2+}$ and $AmHPO_4^{+}$ complexes have been determined at 20°C, 3M $NaClO_4$ ionic strength, using TTA and HDBM as extraction agents, varying the total phosphate concentration and pH. Analogous experiments at different ionic strengths (I = 0.5 ; 1 ; 2 M $NaClO_4$) are under way.

*Field investigations*

The studies of geochemical and hydrogeological conditions of different permeable formations has been pursued in the frame of different contracts. Systems for data aquisition in boreholes, hydraulic testing and inspections have been assembled and tested in some experimental wells at JRC.

A preliminary survey of the El Berrocal site (Spain), aiming at achieving the profiles of several physical parameters (differential temperature, natural radioactivity, conductivity) has been performed together with the C.E.A. of Cadarache. A further survey performed by JRC Ispra allowed important goals to be achieved in the hydrogeochemical reconnaissance of the site. Twelve boreholes of different depth (5 to 70 m) have been investigated with a multi-sensor probe. Profiles of different parameters (redox potential, pH, oxygen concentration, conductivity and temperature) have been obtained. Negative values of redox potential have been measured along all the axis of one borehole. Thus a preliminary model for groundwater circulation has been obtained, by putting together geophysical and geochemical information.

# 2. S/T Support to Community Policies

A collaboration agreement has been signed between the JRC and Directorate General XI (Environment, Nuclear Safety and Civil Protection): the JRC is requested to support the implementation of existing Community directives and to contribute to the development of the new ones. The JRC Environment Institute is being supporting DG XI in the following areas: Chemicals, Waste, Water Quality, Atmospheric Pollution and Radioactivity Environmental Monitoring (REM). Moreover, JRC is also involved in other contributions to support Directorate Generals I, III, V, VI, XIII/C, XXI and the Consumer Protection Servive.

## 2.1. Chemicals

The work in support of the Commission's activities in the sector of chemicals evaluation and control focussed on certain aspects of risk assessment and on the finalization of the EINECS (European Inventory of Existing Chemicals Substances) inventory.

For the risk assessment of existing chemicals, the Institute participated in an OECD working party, which prepared a representative list of high production chemicals ($\geq$ 1000 t/y), based on national and a Commission list, and selected a listing of first priority chemicals. The work will continue in 1990 to assess data availability and develop assessment criteria. In this context, the Institute has initiated a collaborative study with GSF, Neuherberg (FRG) and the Danish Water Quality Institute to test and validate estimation methods to derive essential (mission) physico-chemical data.

For the publication of the EINECS inventory in the Official Journal of the EC, the Institute has prepared the final master version of the EINECS inventory, taking account of comments received from the translation services, the competent national authorities and the Chemical Abstract Service.

In the field of "testing requirements and testing guidelines for chemicals" (annex V, EC Directive 79/831), 70 testing methods for the evaluation of chemicals must be updated and new areas added to in the light of new scientific knowledge. DG XI has proposed that the JRC takes responsability for the scientific and technical part of the work: discussions are in process to define the practical arrangements.

## 2.2. Waste

In support to the implementation of the Community directives on PCBs, an analytical method for fast screening of PCBs at ppm level in used oil has been developed.

## 2.3. Water Quality

A project on adaptation to technical and scientific progress of EEC Directive 80/778 on the quality of water intended for human consumption has been carried out.

The final report includes:

- a full-scale comparative study of drinking water quality standards in Member States and outside the Community with those set in Annex I of EC Directive;
- a review of MACs and GLs set for parameters listed in Annex I, including a case by case analysis of substances under parameters which cover more than one substance. Summarized files have been compiled for each parameter, consisting of a general comment on values proposed and of a summary of salient elements for health assessment;

- a list of parameters considered in the legislations of Member States and non-Member States, not included in the EC Directive 80/778;
- recommendations for regulation of contaminants currently grouped under single parameters for new parameters to be considered for addition to the EC Directive and for parameters to be considered for a better specification and /or definition.

A study on the impact of non-point sources of trace elements to the aquatic environment has been started.
The objectives of the study are:(i) the input quantification of trace elements such as Mo, B, As, Ni, as well as Cu, Cr, Zn, Hg and Se from:non-point sources to the aquatic environment and (ii) the development of simple models.
The major non-point sources considered are: atmospheric deposition, surface run-off from agricultural land, motorways, buildings and urban areas, discharge from municipal sewage treatment works, spreading of sewage sludge and agrochemicals on land, leaching from waste deposists and mining residues, release from sediments.
Studies have been completed on the non-point sources of As, Ni, Zn, Cr and Cu.

Two other studies have concerned the ecological impact of heavy metals (Cr, Cd, Zn, Ni) on aquatic ecosystems and the preparation of eco-toxicological reports for dangerous substances (pesticides).

## 2.4. Atmospheric Pollution

Activities were focussed on the operation of the Central Laboratory for Air Pollution to support the implementation of EC directives in the field and on the contribution to the EMEP monitoring programme.

*Quality Assurance Programme (QAP) for Current Directives*

The quality control of the network instruments at 27 selected stations of the Member States in the frame of the Directive 80/779/EEC was completed. The final report, discussed with the Member Sates experts in march 1989, once completed with a chapter "Recommendations to the Member States", will be available in the first months of 1990. The intercomparison results of this 2nd QAP/2 can be summarised as follows:
- About 80% of the $SO_2$ specific monitors are in agreement with the Central Laboratory comparison instrument to within ± 20%. Referring to QAP/1, a lower reproducibility was observed in the networks. The offset and drift of the instruments were the first reasons for the large differences, relatively important at low ambient concentration.
- For $SO_2$ non specific methods, the differences in ambient measurements appeared to be due to differences in sampling flowrates (air leakages into the sampling train) rather than differences in analytical determinations.
- For black smoke sampling, main differences were due to the sampling tube materials, to air leakages and to the poor linearity of the reflectometers.
- For total suspended particulates, all balances were in good agreement with the standard weights provided. For ambient value intercomparisons, 80% of the station monitors showed results within ± 15%.

*Prepartory actions for new directive*

In view of possible future directive on volatile organic compounds (VOC) preliminary steps have been started to identify reliable monitoring methods and screening procedures for precursors of photochemical oxydants.
A first meeting of a working group of European experts met at JRC on may 1989 and the following points were discussed:
- definition of a list of VOC's on which abatement techniques should be focused (a preliminary list of 25 VOC's has been established);
- state of the art of the sampling and measurement techniques implemented in the Member States;
- monitoring protocols for VOCs and organisation of future intercomparison campaigns.

*EMEP Monitoring Programme*

The Evaluation and Monitoring of the European Pollution (EMEP) is a cooperative programme for the evaluation of the long range transport of atmospheric pollutants in Europe. Its main objective is to provide Member States with information on the deposition, concentrations and fluxes of atmospheric pollutants across national boundaries.

Following the Council Resolution No 81/462/EEC, article 9, DG XI proposed in November 1985 to the JRC Ispra an active participation to the EMEP programme by establishing a monitoring station at the Ispra site.

The following parameters are measured:
- In air: $SO_2$, $NO_2$ and $O_3$ , continuously; HCl, $HNO_2$ and $NH_3$ ,occasionnally.
  Monitoring of non methane hydrocarbons, methane and peroxyacetylnitrate (PAN) has started on summer 1989.
- In atmospheric particulate: $SO_4^=$, $NO_3^-$, $NH_4^+$, $Cl^-$, TSP and acidity.
  Heavy metals are measured with 3 to 5 days sampling periods.
- In precipitation samples (wet only): $SO_4^=$, $NO_3^-$, Cl , $NH_4^+$, $Na^+$, $K^+$, $Ca^{++}$, $Mg^{++}$, pH, electrical conductivity and strong acidity.
- Meteorological parameters.

The detailed results of all collected data are reported in annual reports.
In collaboration with the Norwegian Institute for Air Research (NILU) an EMEP "Expert meeting on sampling, chemical analysis and quality assurance" has been organised (Arona, 10-14 October 1988).

## 2.5. Radioactivity Environmental Monitoring (REM)

Following the Chernobyl accident, the Task Force created by the Commission in may 1986 evidenced the opportunity of storing in an easily accessible form the large number of radioactivity measurements performed in member Countries as well as elsewhere. The task of collecting the data in form of a data bank was given to the JRC. The task evolved into a more general activity dealing with environmental radioactivity monitoring and assessment of occupational radiation exposure.

REM consists of 3 main lines of research, which are closely linked together, with the basic goal to improve the overall preparedness of CEC in case of a nuclear accident :
- data bank development,
- modelisation of the atmospheric transport and dispersion of the radioactive nuclides,
- intercomparison of the radioactivity monitoring techniques, and experimental studies to improve input data of the models.

*Data bank development*

Three data banks are under development:
- REM : now hosting more than 300,000 data of environmental radioactivity levels for years 1984-1986, mostly generated by the national radioactivity networks of member countries.
  The air and deposition data of the period immediately following the Chernobyl accident has been thoroughly analysed. A subset of data from about 100 monitoring points has been selected as the data base for the ATMES exercise described under Third Parties Work. The bank will be successively updated on a routine basis and selected information from previous years will be added. A customer service is being organized by J.R.C.
- A data bank on liquid and gaseous effluents from nuclear power plants and reprocessing facilities has been established, with data for the period 1977-1986. This information will not be made accessible to external users directly. It will be used to produce official CEC reports on discharges from nuclear facilities. Subsequent extensions to previous and subsequent years will become available as foreseen.
- A data bank on the radiological exposure of personnel working in nuclear plants is in progress, including data of the occupational exposures of the Member Countries for the period 1976-

1987. They will form the basis of the second report on occupational dose statistics, to be issued during 1990. Possible extensions in terms of time and data will take place as the information becomes available.

### *Models of the atmospheric transport and dispersion of radionuclides*

One of the most immediate scopes of the data bank on environmental radioactivity levels is the development and validation of the models used to anticipate the radionuclide distribution in the environment following a nuclear accident. The availability in the REM data bank of a large set of validated data of radioactivity in air and deposition following the Chernobyl accident has allowed the launching of the intercomparison and evaluation study ATMES above mentioned (Fig. 9).

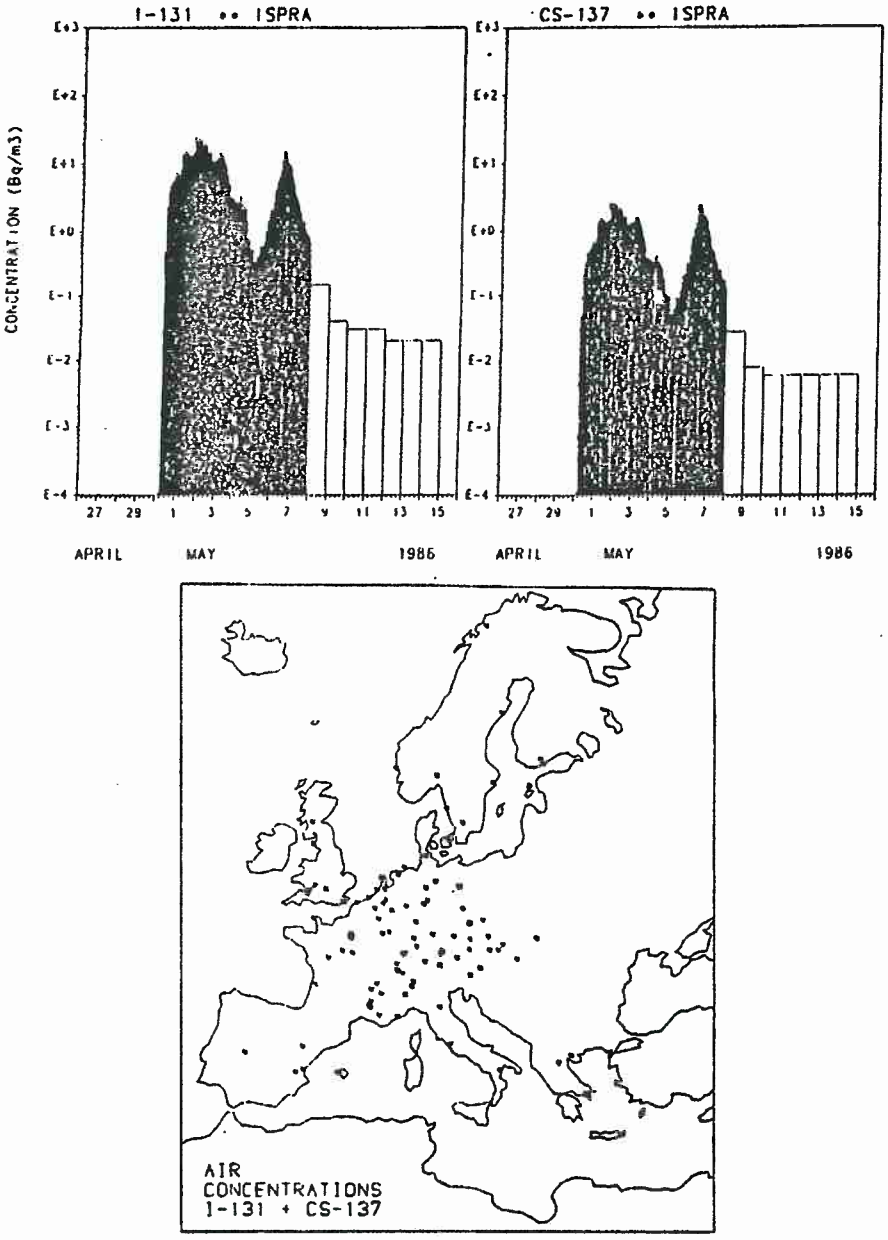



*Fig. 9* - *Evaluation of atmospheric dispersion models (ATMES). Sampling points and typical concentration profile for $^{131}I$ and $^{137}Cs$ from Chernobyl.*

The possibility to complement the ATMES study with long-range tracer experiments with perfluorocarbon tracers is presently being considered.

*Intercomparison of radioactivity monitoring techniques and aerosol research*

- Harmonization of environmental radioactivity monitoring techniques

A survey on methods used in the European Community to measure airborn radioactivity has been done. REM will further investigate development in the EC member states with respect to real-time monitoring of airborne radioactivity, and study the use of such real-time information in conjunction with atmospheric transport modelling.

- Physico-chemical behaviour of radionuclides in the atmosphere

At present, models are being developed for predicting accident consequences and to use information on the dynamics of radionuclides in order to predict dry and wet deposition, inhalation doses etc.

Research is planned on the partitioning of radio-iodine between the gaseous (iodine, methil-iodide) and the aerosol phases and on the below-cloud scavenging of gases and aerosols by rain droplets (especially iodine).

An aerosol laboratory with capabilities for generating, treating and characterizing radioactive as well as non-radioactive toxic aerosols is being set up.

## 2.6. Other Miscellaneous Contributions

| | |
|---|---|
| DG I | technical assistance to the IAEA programme "Assistance and Technical Cooperation (PACT)" in favour of developing Countries through the training at the JRC Ispra of scientists from these countries. |
| DG III | development of a prototype databank on pharmaceutical products. |
| DG V | assessment of trace metal imbalances in body fluids and tissues as indices of potential health impact; collection and review of biological indicators for human exposure to noxious chemicals in the occupational sector. |
| DG VI | databank on European wines based on nuclear magnetic resonance (NMR) measurements according to the Prof. Martin's method (see also chapter on Food and Drug Analysis). |
| DG XIII/C | technical supervision of the operation of the pilot plant Ispra MARK 13A (see also chapter on Ispra MARK 13A); demonstration at pilot scale of the JRC patent on "Anti-oxidants for plastics". |
| DG XXI | characterisation of not well defined chemical and biological products imported in EC. |
| CPS | Discussions are in progress with the Consumer Protection Service (CPS) to enlarge the support already given in the field of cosmetics. |

# 3. Third Parties Work

Work for Third Parties include a serie of miscellaneous activities, the JRC contribution to the ATMES study (Atmospheric Transport Models Evaluation Study) and the ENRESA:JRC cooperation agreements on risk assessment and migration study of radionuclides in crystalline rocks.

The total income foreseen by the end of 1989 amounts approximately to 350 KECU, while new activities for about 350-400 KECU are under discussion.

A collaboration agreement has been signed with the Italian Ministry for the Environment and negotiations are in progress to define first contract works on the recovery of the Po river basin and on the management of toxic wastes. The work will be done in collaboration with the JRC 's Institute for Systems Engineering.

## 3.1. Miscellaneous Activities

- Analysis of elements at trace level in different matrices such as airborne particulate, old paintings, wastes and autoptic samples.
- Analysis of polychlorinated dioxins and dibenzofuranes (isoler specific) in soils and of organic compounds in air samples (air quality measurements), in tobacco smoke and in old paintings.
- Support to studies on rate of synthesis and proteic degradation in muscles.
- Supply of analytical quality assurance test materials.
- Contribution to the development of an expert system for the management of industrial wastes.
- Management of a high school on civil protection (one of the member of the Institute is chairing the school, others are lecturing).

## 3.2. ATMES

The Chernobyl accident, which caused a widespread deposition of radionuclides over Europe, offered a unique opportunity for intercomparing and evaluating the predictions of the various theoretical models against the radioactivity levels which were measured in air or on the soil by hundreds of stations of the countries affected by the radioactive cloud.

The International Atomic Energy Agency (IAEA), the World Meteorological Organization (WMO) and the Commission of the European Communities (CEC) have joined their efforts in launching in spring 1989, after a careful and legthy preparation, a joint project named ATMES (standing for Atmospheric Transport Models Evaluation Study), which has indeed the purpose of comparing theoretical models' predictions against real radioactivity measurements.

ATMES is guided by a Steering Committee composed of representatives of the sponsoring Organizations, and including three experts, one of them acting as the project leader.

The Joint Research Centre of the CEC has prepared the radiological data set, assembled an Evaluation Team with the necessary competences in statistics, atmospheric physics and computer science, and manages the exercise on behalf of the three Organizations.

Over thirty Organizations from twenty countries (including Australia, Bulgaria, Canada, Czechoslovakia, Federal Republic of Germany, Finland, France, Hungary, Italy, Japan, Mexico, the Netherlands, the People's Republic of China, Portugal, Spain, Switzerland, Turkey, United Kingdom, United States of America and Yugoslavia) have joined the study as full participants, by accepting its protocol and technical specifications, while others will follow the exercise as observers.

Participants will obtain the radioactive release data, especially provided by the USSR, and meteorological and precipitation data for the period of interest, assembled for the exercise by Organizations in WMO.

Results will be transmitted by participants via magnetic tapes to the evaluation team at Ispra, where model results will be compared among themselves and with the radiological data set.

The exercise is particularly challenging, due to the high number of participants and the complexity of the statistical operations to be carried out on few millions data.

A workshop of participants and observers is foreseen in spring 1991 to discuss the results of the project and to draw the necessary conclusions and recommendations. The final report of the project will be published during 1991.

## 3.3. ENRESA/JRC Cooperation Agreements

Two cooperation agreements have been established in 1989: one focused on probabilistic risk assessment of geological disposal of radioactive waste, the second on the study of radionuclide migration in crystalline rocks.

Concerning the risk assessment, and in particular the application of the LISA code developed at the JRC to a granitic formation, the objective of the cooperation was to assist ENRESA in setting-up some of the conceptual and computational tools needed to perform a site-specific risk assessment on a potential disposal site. This also involved the customisation of computer codes available at Ispra (LISA, SPOP) in a joint development activity. The start-up of the project was in May 1988, and the report printing has been completed in October 1989 (ENRESA/JRC Co-operation agreement in the field of Nuclear Waste Management, JRC special publication No.1.89.36/I and II, 1989).

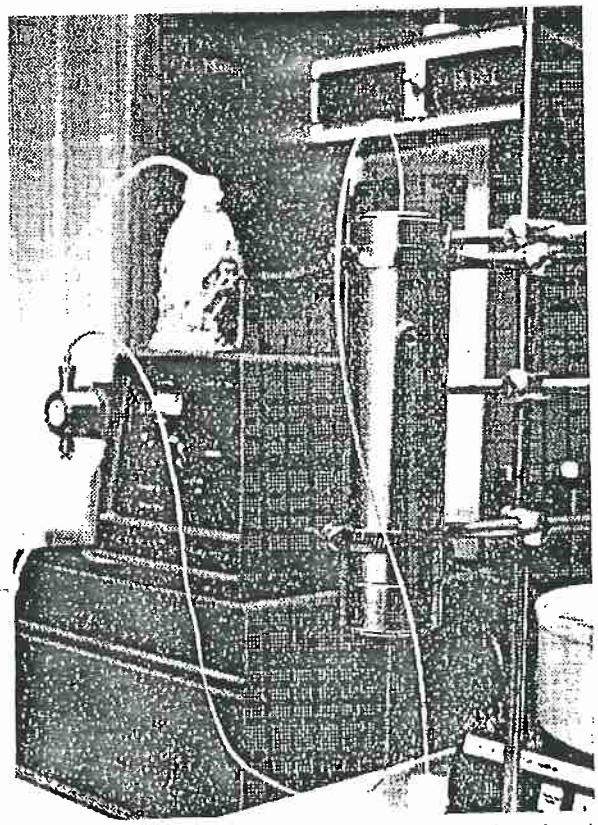


*Fig. 10 - Radionuclide migration through hard rocks. A flow-through experiment on granite from El-Berrocal - Spain.*

The second activity is performed in the framework of the contract No.3384-88-03 TG-ISP-E on geochemistry and migration behaviour of radionuclides in granitic environment.
Rock cored samples from the uranium mine El Berrocal (Spain) have been used to investigate the behaviour of actinides chemically associated with colloid and organic matter. Special pressure cells have been developed for migration tests through samples of low permeability. Hydrodynamic characteristics have been determined with non-sorbing tracers. Transport experiments with 99-Tc and 239-Np are underway (Fig. 10). In parallel, characterization studies of colloidal suspensions produced by contacting uraniferous lignites with groundwaters are also underway.
The study confirms that the presence of Humic Substances (HS) plays an important role on radionuclide mobility.

The following table clearly indicates the diminution of radionuclide interaction with granite when the organic content in groundwater increases. This effect is particularly important for Plutonium which undergoes a 20-fold decrease of the distribution coefficient at an organic concentration of 25 ppm.

Table 1. Distribution coefficient Kd (ml/g) of selected radionuclides on crushed granite at different Humic Substances concentrations

| | 238-Pu | 239-Np | 95m-Tc |
|---|---|---|---|
| Groundwater | 1150 - 1400 | 10 - 12 | 0.6 - 1.5 |
| Gd-water + 10ppm HS | 350 - 380 | 9 - 10 | - |
| Gd-water + 25ppm HS | 50 - 70 | 4.5 - 6 | - |

# 4. Participation to EUREKA and COST Concerted Actions

## 4.1. EUREKA

The Environment Institute participates in two EUREKA environmental projects: EUROTRAC and EUROENVIRON.

### 4.1.1. EUROTRAC

It is a joint European effort aimed at the study of the consequences of human activities on continental (Europe) tropospheric chemistry. As an interdisciplinary programme, it involves field measurement campaigns and laboratory studies as well as the development of advanced intrumentation and model simulations, in view of studying the transport, transformation and deposition of trace constituents -of natural and anthopogenic nature- closely connected with tropospheric ozone formation and acidic deposition.

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

- *TRACT*, which specifically addresses the study of the transport of trace pollutants from extended industrial areas over complex terrain such as the south-western part of Germany from Main river to the northern edge of the Alps and from the Swiss plateau to the north-western part of the Po valley in Italy.
  Measurement campaigns designed in 1989-90 are scheduled to be carried out in 1990, 1991 and 1992.
- *BIATEX*, which is focussed on the quantification of pollutants fluxes between atmosphere and biosphere and on the identification and understanding of the mechanisms responsible for these processes.
  Two field intercomparison measuring campaigns have been performed in the Bavarian Forest on the emission of terpenes and on the determination of their transformation products.
- *JETDLAG*, which is aimed at the development of special instrumentation based on Tunable Diode Laser Absorption Spectrometry for the measurement of atmospheric trace gases.
  JRC is particularly involved in the evaluation of high resolution spectral parameters, individual lines intensity and broadening coefficients.
  For the optimization of the operational characteristics of IR spectroscopy based ambient air monitors and for the analysis of experimental data to derive spectral parameters, a PC based computer programme has been prepared. The programme, to be used in connection with compiled bases of spectral data of atmospheric molecules, generates atmospheric spectra in different physical and instrumental conditions.
- *LACTOZ*, which is intended to provide a proper description of the complex chemical processes which lead to ozone formation and depletion in the troposphere. The main objective is to gather data for input in mathematical models describing the ozone budget.
  JRC is particularly involved in the reactions of the $NO_3$ radicals with alkenes, terpenes and dimethylsulfides (DMS).

### 4.1.2. EUROENVIRON

It is an "umbrella" project intended as the main source of a series of sub-projects aimed at developing processes, systems, services and technology of primary significance for the protection of the environment in Europe.

A non exhaustive list of covered areas includes: (i) industrial urban and agricultural wastes; (ii) air pollution; (iii) indoor environment; (iv) water quality; (v) noise pollution; (vi) pesticides and herbicides; (vii) environmental management; (viii) clean production technologies; (ix) environmental catastrophes.
Although at the time being the Commission is participating as observer, the Environment Institute of the JRC Ispra has introduced a sub-project proposal for the "development of a mobile analytical unit for in-field measurements of toxic wastes". A twin mobile unit should provide sampling and sample treatment capabilities on one side and instrumental analysis and analytical data handling on the other.

Four Danish groups showed their interest to join the JRC in this exercise and a preliminary report describing the layout of the mobile laboratory unit is being prepared.

## 4.2. COST Concerted Actions

The JRC Institute is deeply involved in two COST concerted actions: ***COST 611 "Physico-Chemical Behaviour of Atmospheric Pollutants"*** and ***COST 613 "Indoor Air Quality and its Impact on Man"*** which are both part of the shared-cost and concerted action programmes of DG XII/E.

COST 611 provides the coordination of more than 50 European laboratories and it is structured around three working parties dealing with (i) Development of Analytical Methods, (ii) Atmospheric Chemical and Photochemical Processes and (iii) Field Measurements and their Interpretation.
The JRC has organised the Second International Symposium on Monitoring of Gaseous Pollutants by Tunable Diode Lasers (EUR report no 11956, 1989) in collaboration with the Franhofer Institut für Physikalische Meßtechnik (Freiburg, FRG); an informal workshop on the state-of-the-art of the reaction $NO_3$ + alkenes and the Fifth European Symposium on "Physico-Chemical Behaviour of Atmospheric Pollutants" in collaboration with DG XII/E. This latter symposium was held in Varese on 25-28 September 1989 and included the discussion meetings of the EUROTRAC sub-projects HALIPP and LACTOZ (see above).One hundred eighty six scientists from sixteen countries attended the symposium and contributed one hundred ten papers representing a fairly exhaustive coverage of the European research in this field.

COST 613 is an integral part of the JRC specific programme on environmental protection and the work done has been reported under the chapter Indoor Air Pollution before described.

# 5. ASSOCIATED LABORATORIES

Other than with the different European laboratories involved in the EUREKA project, in theCOST Concerted Actions and in the Third Parties Work, the JRC Environment Institute has close collaborations with the following ones:

- ***Association pour une Recherche Coordonnée (ARC), Liège, Belgium.***

  Aim: Development of analytical methods for the determination at trace level of toxic and hazardous compounds.
  First priority on compounds revant to the industrial, agricultural and food sectors.

- ***Neurological Institute "C. Besta", Milan, Italy.***

  Aim: Evaluation of human exposure to toxic compounds by advanced analytical methods and mathematical models.

- ***French Atomic Energy Agency (C.E.A)., Cadarache, France.***

  Aim: Comparison of lab and field experiments on the underground migration of radionuclides involving the development of probes and techniques for in situ measurements of geochemical and hydrogeological parameters.
  This technique allows trace elements to be detected in deep ground waters with no sampling operations and possible bias due to transport and handling of samples.
  Experimental sites for model testing include the JRC boreholes for the simulation of deep geological conditions and CEA facilities for the study of shallow land burial.

- ***Aeronautica Militare Italiana, Rome, Italy.***

  Aim: Data on/ and analysis of the daily forecasted wind-fields over Europe from the European Centre for Medium Weather Forecast.

# Large Installations

# 1. Operation of large installations

The Environment Institute doesn't comprise installations which could be classified as large (e.g. accelerators, nuclear reactors) but a series of less conventional facilities which - by their nature - are worth of special mention.

These consist of four mobile laboratories which, within the framework of atmospheric pollution studies, are employed to accomplish the following tasks :

- Mapping of the total vertical burden and mass flow determination for $SO_2$ and $NO_2$ as well as tracking of plumes from tall stacks. For the purpose Correlation Spectrometry techniques are applied in combination with more conventional analytical monitors for NO, $NO_2$, $O_3$, $SO_2$, CO and aerosols;
- Detailed description of meteorological conditions, physics and chemistry of the atmosphere by means of a micrometeorological station including a three dimensional Doppler Sodar for wind field analysis in addition to more conventional instrumentation for traditional meteorological measurements;
- Study of the diffusion of pollutants in particular in complex orographical and different meteorological conditions. The experimental validation of mathematical models at both local and regional scale is achieved by releasing in the atmosphere inert chemical compounds such as $SF_6$ or perfluorocarbons ($C_7F_{14}$; $C_8F_{16}$) as tracer and by their subsequent sampling and analysis;
- Calibration of instrumentation and intercomparison of analytical performances at the various local measuring stations in EEC countries in view of the standardisation of the analytical procedures for determining $SO_2$ and suspended atmospheric particulate, and of implementing the EEC directive.

In addition, one has to mention a ground station for the continuous monitoring of meteorological and chemical parameters in air, atmospheric particulate matter and precipitation as well as the automatic data treatment.
The station is operated in the framework of the EMEP programme aimed at the monitoring and evaluation of long range transmission of air pollutants in Europe.

# 2. Construction of new installations

Four new facilities will be available in the next future in the Institute.

- The first facility is devoted to the study of depositon of pollutants (e.g. $SO_2$, $O_3$) as well as to elucidate the mechanisms governing the emission of terpenes from trees. It consists of a system of six chambers (each one 1.0 m diam. by 1.5 m high) which allow the fumigation of trees with air pollutants under simulated environmental conditions.
  The construction of the system has been concluded so that experiments can be started with in 1990.
- In the framework of the indoor pollution studies an Indoortron is ready for installation in the premises of the Institute. The Indoortron is a high volume (30 $m^3$) environmental test chamber consisting of two concentric stainless steel shells, designed for the study of the emission rates of volatile organic substances from indoor sources, and for the test of sorption characteristics of building/furnishing materials
  In addition, the exposure of humans and animals under strictly controlled environemntal conditions can be investigated. For the purpose calibrated concentrations of organic compounds can be generated into the chamber which is fed with "clean" air.

- Pollution problems related to airborne particulate matter and aerosols (radioactive or toxic) will be studied by means a special facility completely isolated from outdoor environment, and consisting of:
  - a 70 $m^3$ stainless steel chamber devoted to the study of the interaction between reactive gases and aerosols in realistic conditions, to testing aerosol monitoring equipment, and to detailed studies of buffered atmospheric aerosol volumes;
  - a 15 m high tower accomodating an assembly for the precipitation scavenging studies, and vertical laminar flow reactors aimed at specific studies of interactions of reactive gaseous species with different types of aerosols.

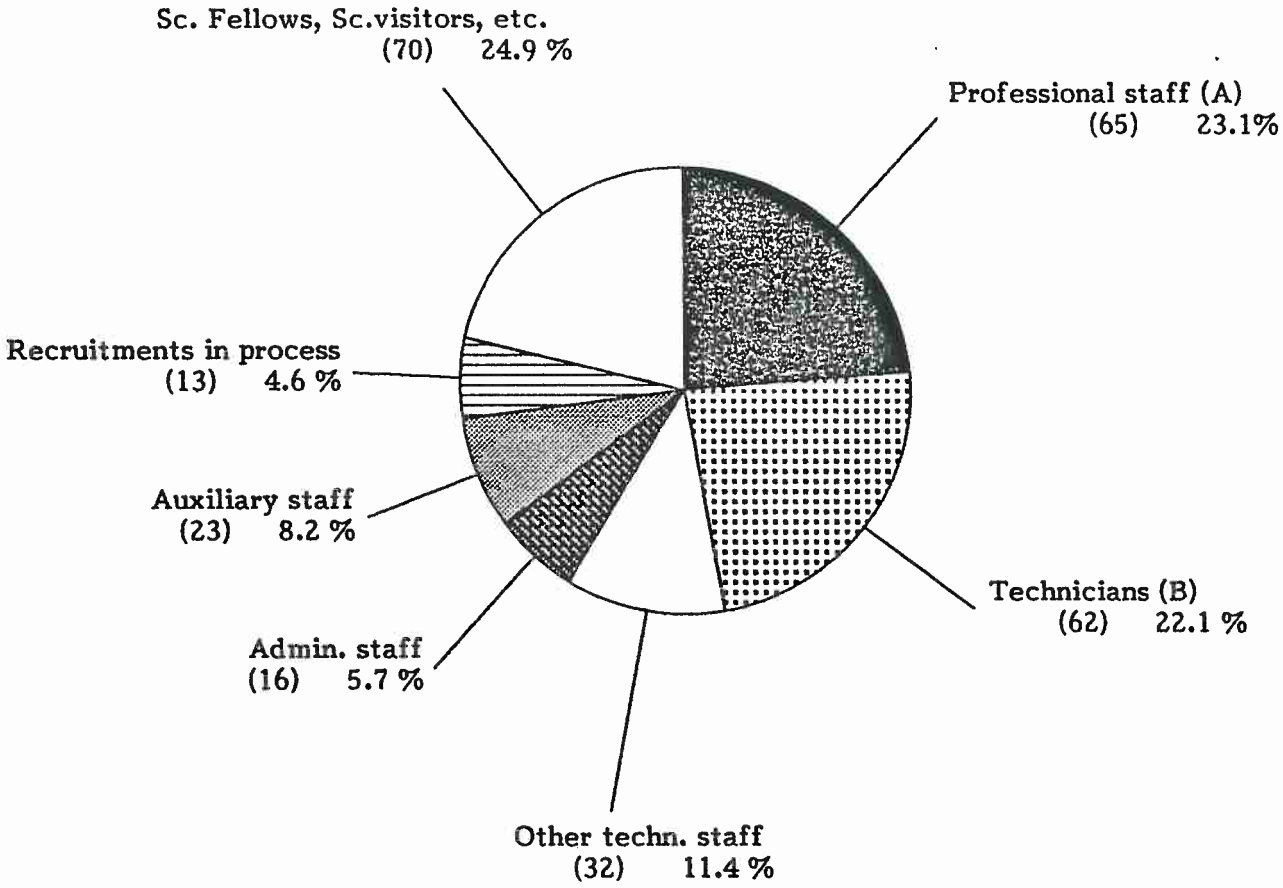
    The construction of this facility is planned in 1990.

As already mentioned in the chapter "Participation to EUREKA and COST" and "Chemical Waste", within the framework of the EUREKA environmental project EUROENVIRON, JRC has introduced a proposal for the "Development of a mobile unit for in-field measurements of toxic wastes". Four Danish groups showed their interest to join the JRC in this exercise and a preliminary report describing the layout of the mobile laboratory unit is being prepared.

# Human Resources

**Staff statistics**
**Environment Institute**

15.11.89




| | | |
|---|---|---|
| Total persons present: | 281 | |
| Regular staff: | 175 | 56.6% |

ENVIRONMENT INSTITUTE

## Staff with Short Term Contracts

| | RC | CH | Total | % |
|---|---|---|---|---|
| Auxiliary staff (≤ 1 y) | 6 | 17 | 23 | 24,7 |
| Scientific visitors (≤ 2 y) | 5 | 6 | 11 | 11,8 |
| Fellows (≤ 3 y) | 8 | 12 | 20 | 21,5 |
| Seconded staff (≤ 3 y) | 0 | 1 | 1 | 1,1 |
| Stagiaires visiteurs* (≤ 3 y) | 15 | 23 | 38 | 40,9 |
| | 34 | 59 | 93 | 100 |

RC = Radiochemistry
CH = Chemistry

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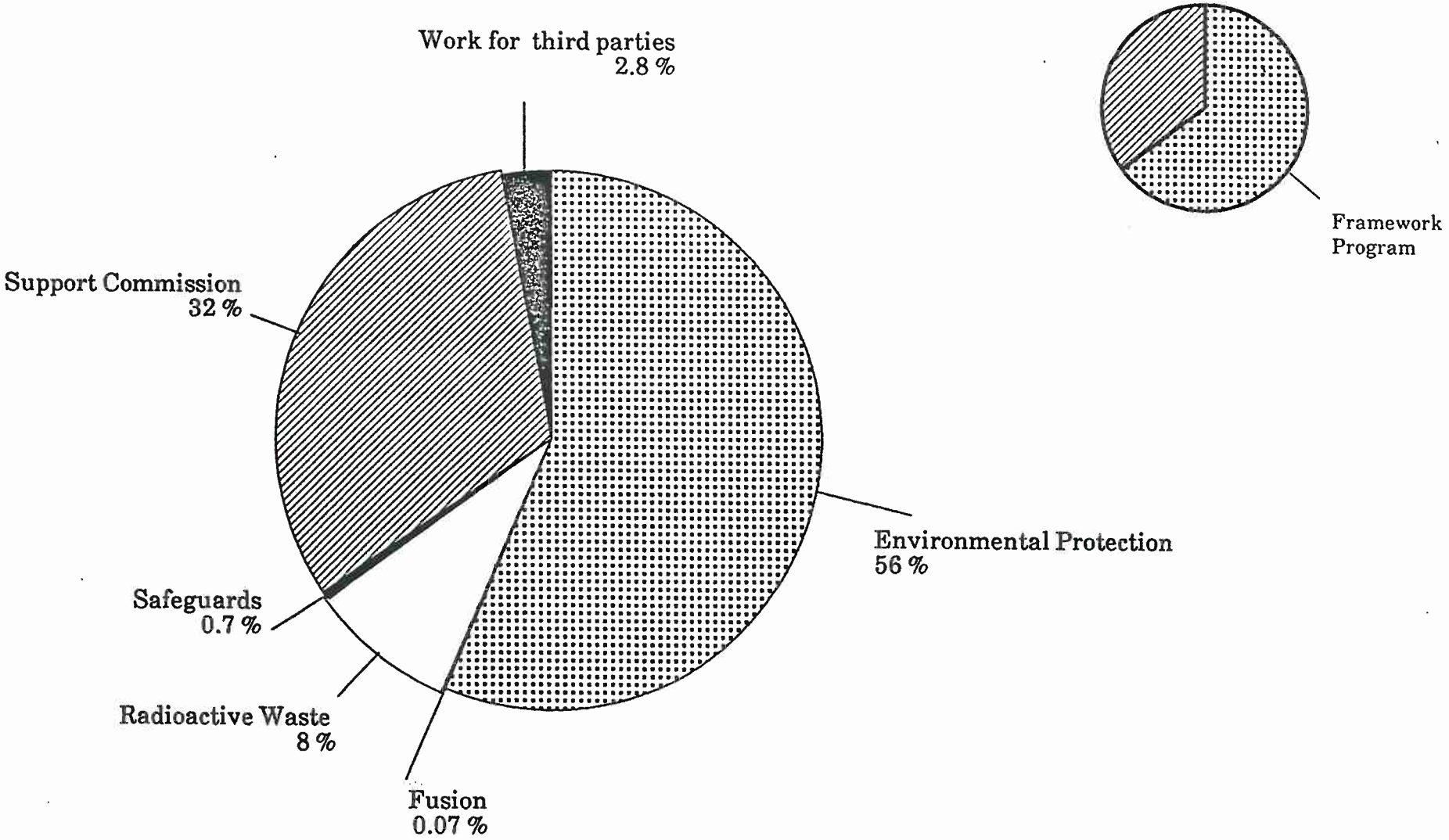
* not remunerated

# Finances

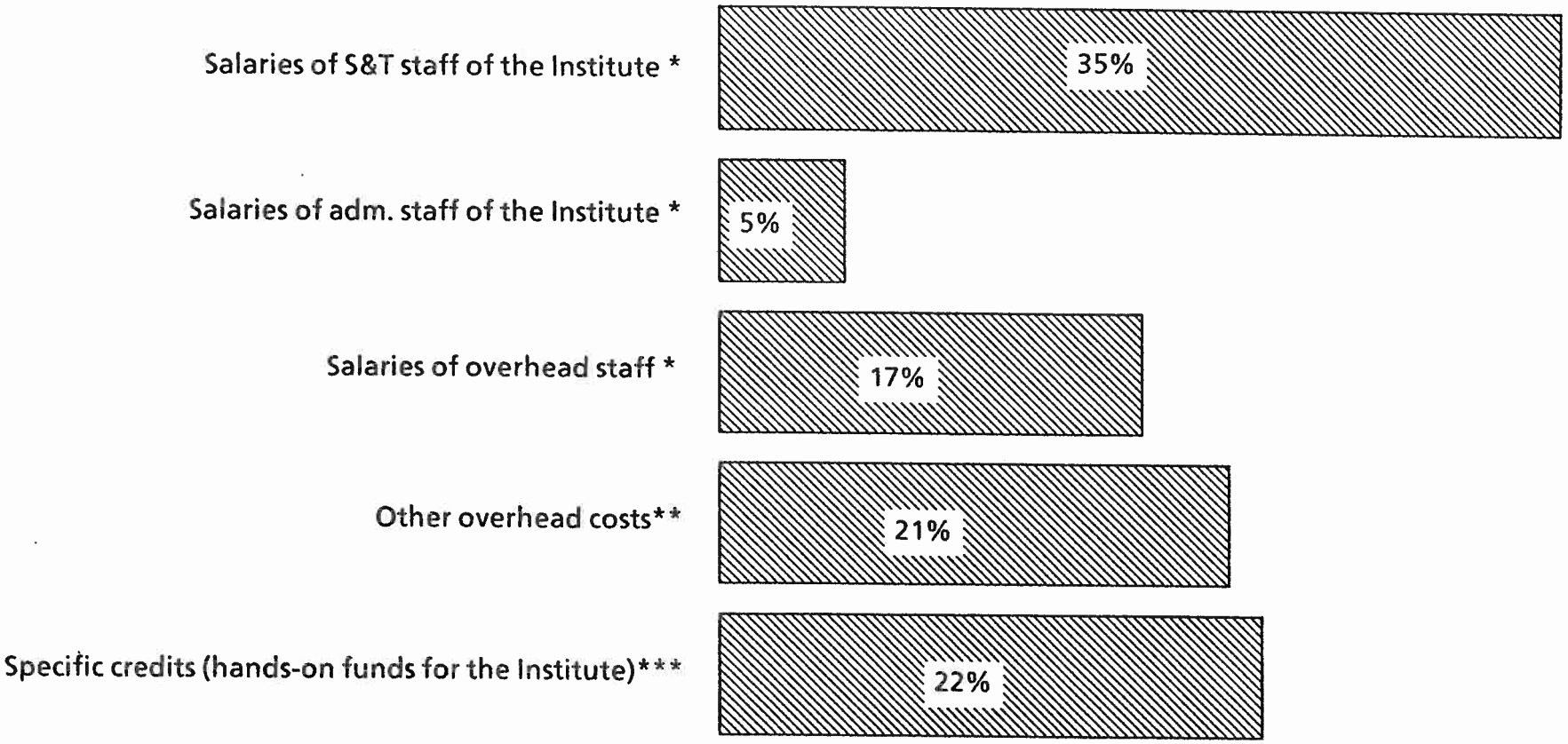
Environment Institute
Specific credits (hands-on funds) 1989

14.11.89



## Expenditures of the Environment Institute 1989

14.11.19




* Includes travel costs, social costs
** All infrastructure costs, energy, telephone, buildings, computer centre, workshop etc.
*** Instruments, chemicals, small expenditures, contracts

# Annexes

# Annex A: Publications, Patents

## 1. Specific Programmes

### 1.1. ENVIRONMENTAL PROTECTION

#### 1.1.1. Environmental Chemicals

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Project inventory COST project 613 - Report No 4. Prepared by Working Group 1 on behalf of the Community-COST Concertation Committee. S.P./1.89.33, 1989.

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*Caroli, S., Coni, E., Alimonti, A., Beccaloni, E., Sabbioni, E., and Pietra, R.* - Determination of trace elements in human lungs by ICP-AES and NAA, Analysis, 16, 75, 1988.

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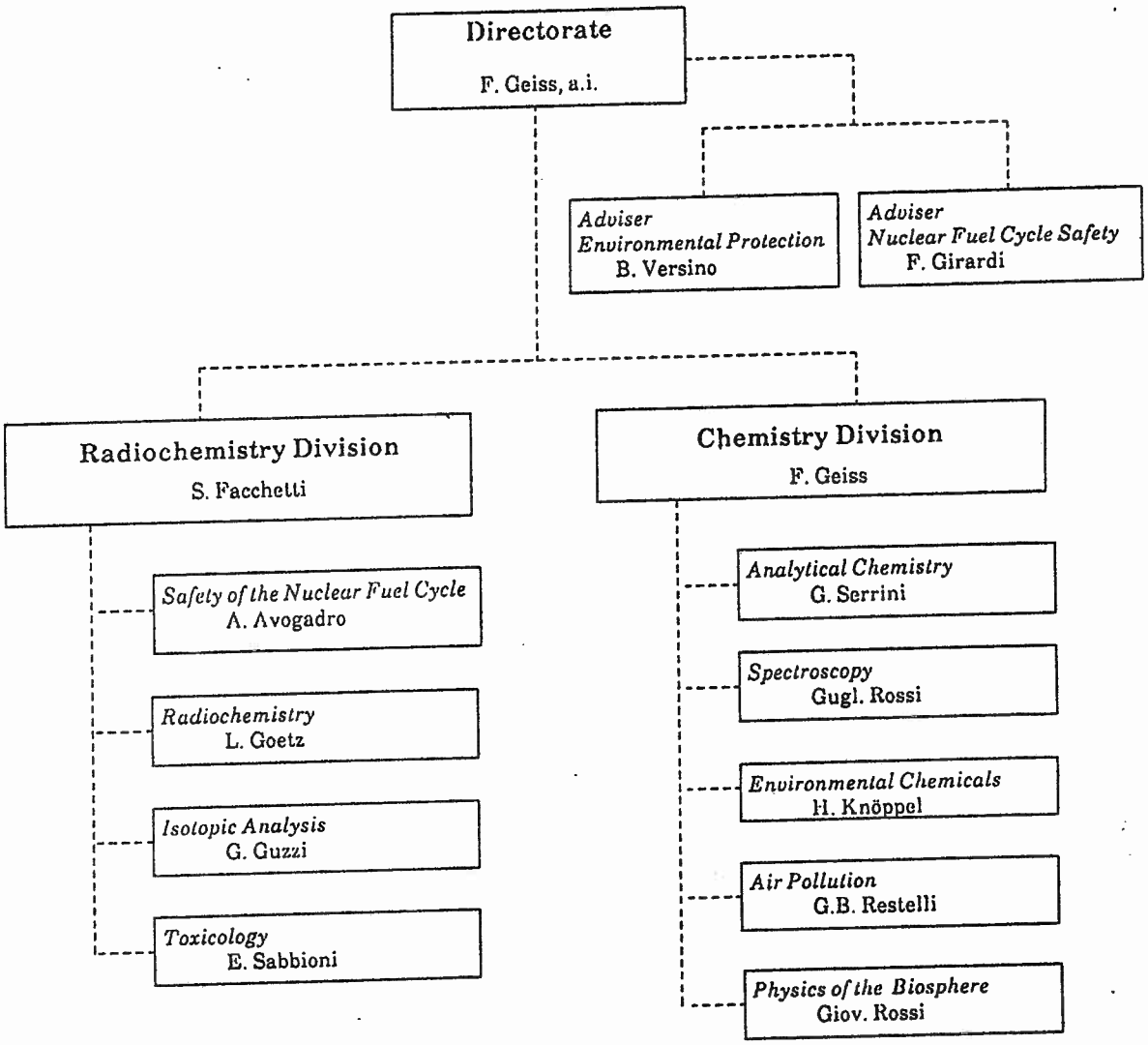
# Annex B : Organisation Chart

## Environment Institute



# Annex C : Glossary and Acronysms

| | | |
|---|---|---|
| ATMES | : | Atmospheric Transport Models Evaluation Study |
| BIATEX | : | Biosphere Atmosphere Exchange of Pollutants |
| C.E.A. | : | French Atomic Energy Agency |
| CD-ROM | : | Compact Disk Read-Only-Memory |
| CEN | : | European Committee for Standardisation |
| CIEMAT | : | Spanish Research Center on Energy and Environment |
| CNRS | : | French National Center for Scientific Research |
| COST | : | Scientific Technical Cooperation |
| ECDIN | : | Environmental Chemicals Data Information Network |
| EINECS | : | European Inventory on Existing Chemical Substances |
| ELISA | : | Enzyme Linked Immuno Sorbant Assay |
| EMEP | : | Evaluation Monitoring European Pollution |
| ENRESA | : | Spanish Agency for Radioactive Waste Management |
| EUROTRACT | : | European Experiment on Transport and Transformation of Environmentally relevant Trace Constituents in the Troposphere over Europe |
| GF-AAS | : | Graphite Furnace Atomic Absorption Spectrometry |
| GL | : | Guide Line |
| HALIPP | : | Heterogeneous and Liquid Phase Processes |
| HDBM | : | Dibenzoyl Methane |
| HPLC | : | High Performance Liquid Chromatography |
| ICP-AES | : | Inductively Coupled Plasma Atomic Emission Spectrometry |
| ICP-MS | : | Inductively Coupled Plasma Mass Spectrometry |
| IRPTC | : | International Registry of Potential Toxic Compounds |
| ISO | : | International Standard Organisation |
| JETDLAG | : | Joint European Development of Tunable Diode Laser Absorption Spectroscopy for Measurement of Atmospheric Trace Gases |
| LACTOZ | : | Laboratory studies of Chemistry related to Tropospheric Ozone |
| LISA | : | Long Term Isolation Safety Assessment |
| MAC | : | Maximum Admissible Concentration |
| MECAPIP | : | Mesoscale Cycles of Air Pollution on the Iberian Peninsula |
| NEA | : | Nuclear Energy Agency |
| NILU | : | Norsk Institut Luftorskning |
| NMR | : | Nuclear Magnetic Resonance |
| PAN | : | Peroxy Acetyl Nitrate |
| PCB | : | Polychlorinated Biphenyl |
| PETRA | : | Plant for Evaluation and Testing of Radioactive Waste Management Alternatives |
| PSAC | : | Probabilistic Safety Assessment Code |
| TOC | : | Total Organic Carbon analyser |
| TRACT | : | Transport of Air Pollutants over Complex Terrain |
| TRANSALP | : | Transalpine Transport of Air Pollutants |
| TSP | : | Total Suspended Particles |
| TTA | : | Tenoyl Trifluor Aceton |
| VOC | : | Volatile Organic Carbon |

European Communities - Commission

**EUR 12868 — Annual Report 1989 - Environment Institute**

*M. Borlé-Talpaert, F. Girardi, A. Stingele and B. Versino*

Luxembourg: Office for Official Publications of the European Communities

1990 - 78 pp. — 21.0 x 29.7 cm

Series: Environment and quality of life

EN

Catalogue number: CD-NA-12868-EN-C

This is the first annual report of the Environment Institute at the Joint Research Centre, Ispra Site of the Commission of the European Communities.

Progress is reported up to the end of 1989 for the Specific Research Programmes (1988-1991) **Environment Protection**, including research on environment chemicals, air pollution atmospheric transport, water quality, chemical waste, food and drug analysis, and **Radioactive Waste Management**, concentrating on safety assessment for final storage in geological formations. Moreover the Institute provided technical support to the implementation of EC directives in the fields of chemicals, atmospheric pollution, water quality, chemical waste and radioactivity environmental monitoring (REM). Finally, miscellaneous activities related to work for third parties are reported and the participation of the Institute in the EUREKA and COST projects outlined. A list of associated laboratories, large installations and tables of human resources and finances complete the report.

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