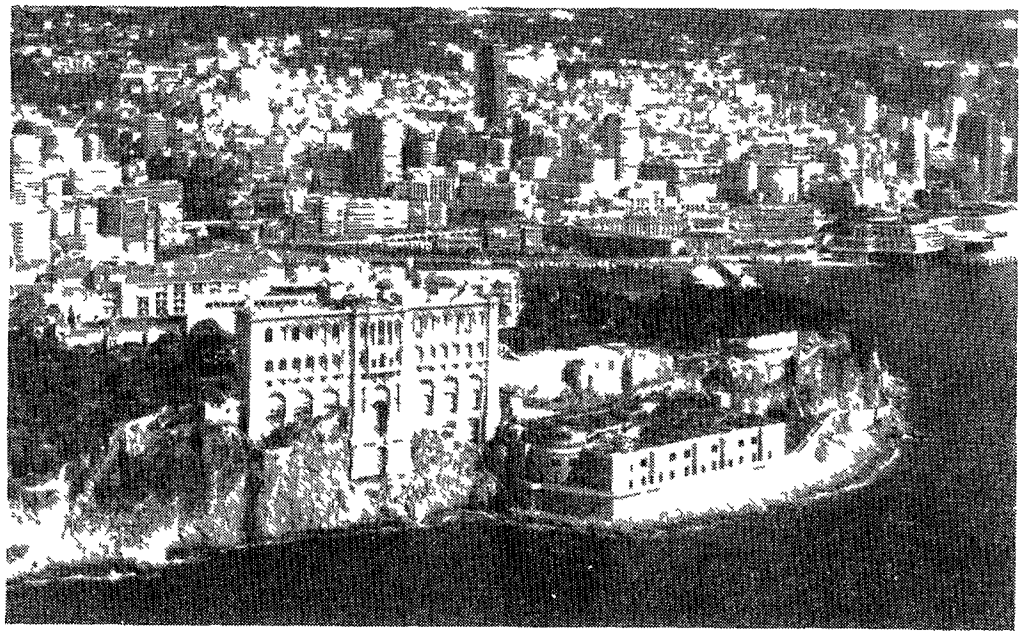
IAEA-TECDOC-438

INTERNATIONAL LABORATORY OF MARINE RADIOACTIVITY

Biennial Report 1985–1986



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INTERNATIONAL LABORATORY OF MARINE RADIOACTIVITY:
BIENNIAL REPORT 1985–1986
IAEA, VIENNA, 1987
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EDITORIAL NOTE

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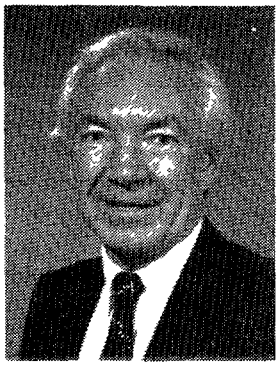
Overview



Dr. A.Walton

Director

The period covered by this biennial report is perhaps one of the most important in the history of the Laboratory. Since its modest beginnings in 1961 the International Laboratory of Marine Radioactivity in Monaco has, in fact, existed officially only as a project. In 1986, however, its presence in the Principality became "official", so to speak, with the signing of a seat agreement by the Agency and the Government of Monaco - an agreement which, because of the unique geographical location and the political relationships between the Principality and France, must also be recognized by the latter. The actual signing ceremony occurred in Monaco on 16 May 1986 in the presence of the Director General Dr. Hans Blix and the Minister of State H.E. M. Jean Ausseil and entered into force on 17 October 1986.

Although no longer a party to an agreement with the Agency following its long association of twenty-five years, the Musée Océanographique in Monaco continues to house the Laboratory and have close working relationships. These ties extend to the provision of vessel support and the use of the world-renowned oceanographic library. Contributions such as these to the programme of the Agency are indeed without parallel and remain indispensable to the continued success of the Laboratory.

Plans have been progressing quite quickly toward moving the Laboratory to new temporary facilities in Fontvieille. It was expected that the move would have occurred by mid 1987 but it would appear that this may be delayed for some months because of technical problems.

Outside support for the marine pollution studies and training programmes of the Laboratory continued to mature particularly with the United Nations Environment Programme and its regional seas activities. So as to facilitate working relationships the non-nuclear projects of the Laboratory have been grouped together in the Marine Environmental Studies Laboratory in the "Aigue-Marine" facility in Fontvieille.

Laboratory staff at the professional level continue to change with a number of new young staff joining in 1986 in the persons of Dr. C. Nolan (Ireland), Dr. A. Sanchez (Philippines) and Dr. E. Fogelqvist (Sweden). On the other hand it is with considerable pride that we note the deserved retirement of Dr. R. Fukai (Japan) the former Director after almost twenty five years of faithful service.

Dr. R. Fukai

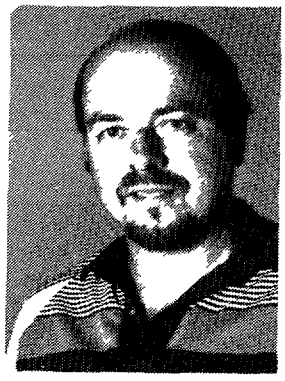
Sadly we mention the death of our colleague Dr. S.R. Aston (United Kingdom) on 7 December 1986 after a long and hard fought battle with illness.

Although fiscal restraint and zero growth are in vogue (in the United Nations system if not necessarily elsewhere) the Laboratory will continue its service role to the Agency in the marine sphere as efficiently as possible. The Chernobyl accident demonstrated the value of the Laboratory to those outside Vienna and its readiness to assist others - particularly an apprehensive public. The teamwork and dedication of all staff during the spring and summer 1986 should not go unnoticed.

The Director's Office

Scientific Programmes

Radiobiology Laboratory

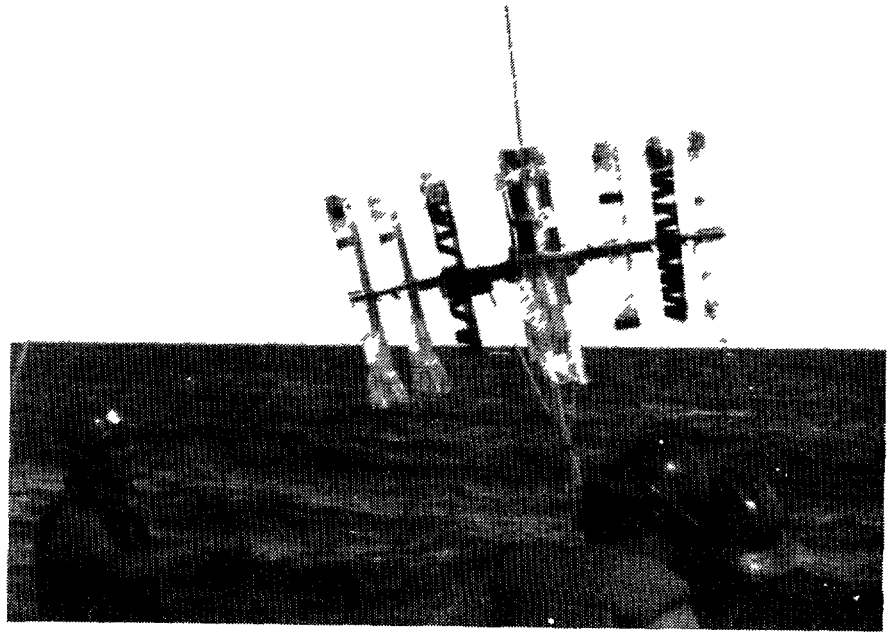


Dr. S.W. Fowler

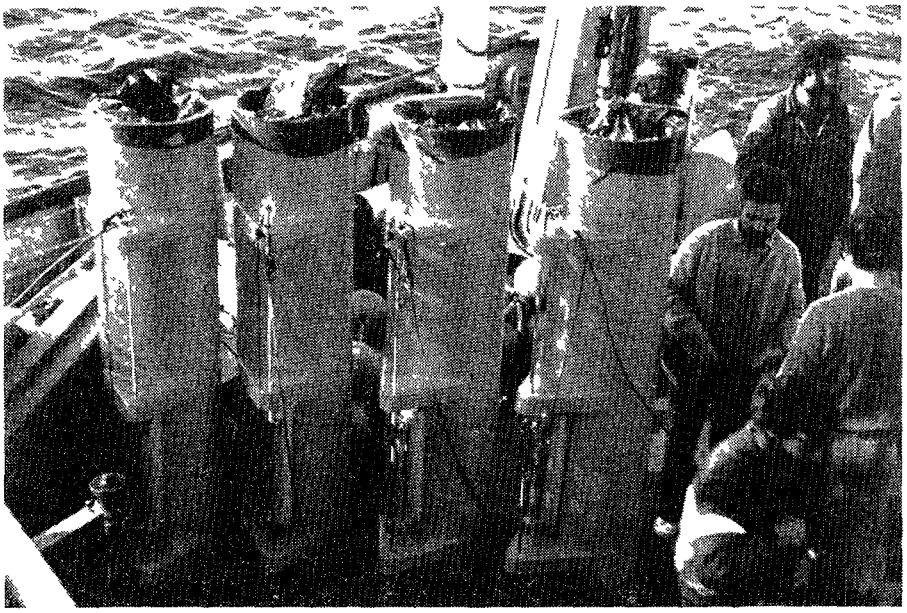
VERTICAL FLUX STUDIES

During the last biennium increased emphasis has been given to several field programmes dealing with the study of the vertical transport of radionuclides and other materials in the sea. One such joint study the U.S. National Science Foundation-sponsored VERTEX (Vertical Transport and Exchange) programme, has focused on the central North Pacific where radioactivity levels in waters are relatively high due to their proximity to former nuclear test sites. Previous work in this region has shown that minute plankton living in the upper water layers "package" transuranic elements sorbed to small food particles and eject them in the form of larger, rapidly sinking fecal pellets. Such biogenic detritus thus serves as a conveyer of the radioactivity to depth and eventually to the bottom sediments.

A new phase of the VERTEX study began in 1986 in which seasonal changes in the vertical transport of



Traps used in VERTEX Programme



Traps used in ECOMARGE and DYFAMED Programmes

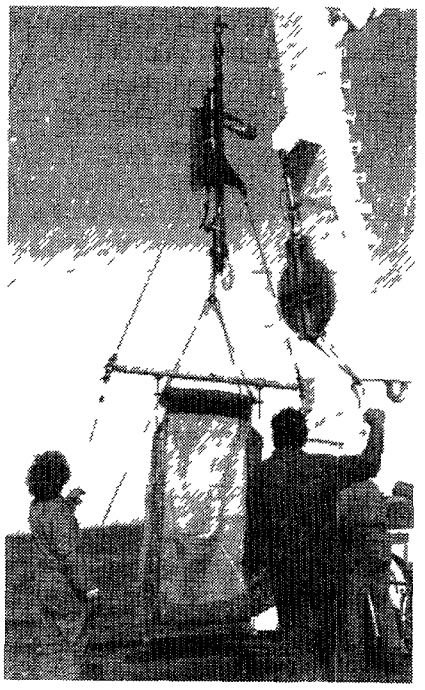
plutonium and americium on sinking particles will be followed in the upper 2 km of the ocean. During the first cruise, a floating array with sediment traps attached at several depths was released halfway between California and the Hawaiian Islands. The trap array which is outfitted with a satellite radio transmitter is scheduled to collect materials for transuranic analyses during three-month intervals. The particulate samples will be retrieved on quarterly cruises and analyzed for plutonium and americium at ILMR. Besides furnishing important information on the biogeochemical behaviour and oceanic removal time of these two actinides, results from this co-operative study are also applicable to coastal areas whose more productive waters may receive radioactive wastes from commercial nuclear activities.

Similar studies of somewhat wider scope have also been carried out in the Mediterranean in connection with two French national programmes. The project studying fluxes over the continental margin (ECOMARGE) has undertaken several seasonal cruises in the Golfe du Lion. Automated sequentially-sampling sediment traps with a 0.125 m^2 opening have been developed to collect time-series particulate samples. In these experiments the traps have been set to collect discrete samples every 15 days. Characterization of the material has indicated dramatic changes over time in the types of large particles sinking in this region. For example, a sample from 50 m collected in August 1985 consisted almost entirely of large (1-2 cm), bright orange, fish fecal pellets. An examination of migrating fish species occurring in the surface waters at the time indicated that horse mackerel and sardinella were producing these pellets. Such temporal changes in the

qualitative nature of the particulates also result in sharp fluctuations in chemical concentrations and fluxes as evidenced by our radionuclide and trace element measurements. Furthermore, ECOMARGE work has shown that such particles, particularly those rich in organic matter, may lose radioactivity associated with them as they degrade in the water column. For example, loss of ^{210}Po averaged approximately 8% from particles collected during a 15 day period at 50 m. In particles from deeper water which contained suspended sediments, the loss decreased to roughly 1% on the average. Ratios of ^{210}Po, ^{210}Pb and the thorium isotopes in large particles from various depths have been instrumental in demonstrating that particle flux from the upper 100 m is strongly tied to the biological activity in these layers while the much higher particle fluxes at 300 and 600 m measured at the same time, result primarily from lateral advection of resuspended sediments into this region.

The DYFAMED programme which began in 1986 is following the dynamics of the atmospheric input of contaminants and their downward transport in western Mediterranean waters. The principal aim of the project is to determine how rapidly and by what mechanism airborne trace elements originating from the Sahara dusts enter the sea and are transported to the sediments. In mid-April 1986, a time-series sediment trap at 200 m depth was moored several miles off Corsica for a period of 38 days. The trap samples, collected at 6-day intervals, are being analyzed by neutron activation for various elements and will be compared with air-filtered particulates taken at a nearby atmospheric sampling station in Corsica. During this experiment the nuclear accident at Chernobyl occured. Particulates collected in the trap during the intervals 26 April-2 May and 2-8 May, registered slight increases in ^{137}Cs and ^{103}Ru. Maximum concentrations of ^{141}Ce and ^{144}Ce, two radionuclides which are mainly associated with particles in marine waters, were found in the material trapped between 8-15 May after which time the levels dropped abruptly. Daily air measurements made at Monaco showed that the peak in atmospheric fallout in this region occurred on or about 3 May; thus, the arrival of contaminated particles at 200 m only a few days later clearly demonstrates the rapid vertical transport of these radionuclides. Furthermore, microscopic examination of the particles indicated that much of the sedimenting matter was in the form of zooplankton fecal pellets. The presence of similar radionuclide concentrations in fresh zooplankton excreta collected in the overlying waters at the trap site on 6 May confirmed that biogenic detritus was rapidly transporting surface-introduced artificial radionuclides to depth. Particle scavenging rates and residence times have also been derived from measurements of $^{234}Th/^{238}U$ disequilibria in suspended particles and sea water at this site.

Laboratory experiments have also provided useful information on mechanisms involved in vertical transport processes. For example, the surface-introduced cosmogenic radionuclide ^{7}Be has been proposed as a potential tracer for determining the settling velocities of large particles in the upper water layers. This requires, inter alia, a knowledge of the reactivity of ^{7}Be with biogenic particles in surface waters. Several species of phytoplankton were exposed to ^{7}Be in sea water under both light and dark conditions. The results indicated that uptake by cells is principally a passive process, with high volume/volume concentration factors (VCFs) ranging from 10^{5} to 10^{6}. Once bound to cell surfaces and ingested by zooplankton, the resultant fecal pellets do not readily lose the incorporated ^{7}Be (retention half-time - 13 days). These results suggest that the differences between levels found in trapped biogenic particles at depths of a few hundred meters and those incorporated in the particles in the surface waters should be due primarily to physical decay and, hence, indicative of the time needed to transit to the depth of collection. This hypothesis is currently being tested with sediment trap samples.



IOS-Type Plankton Net

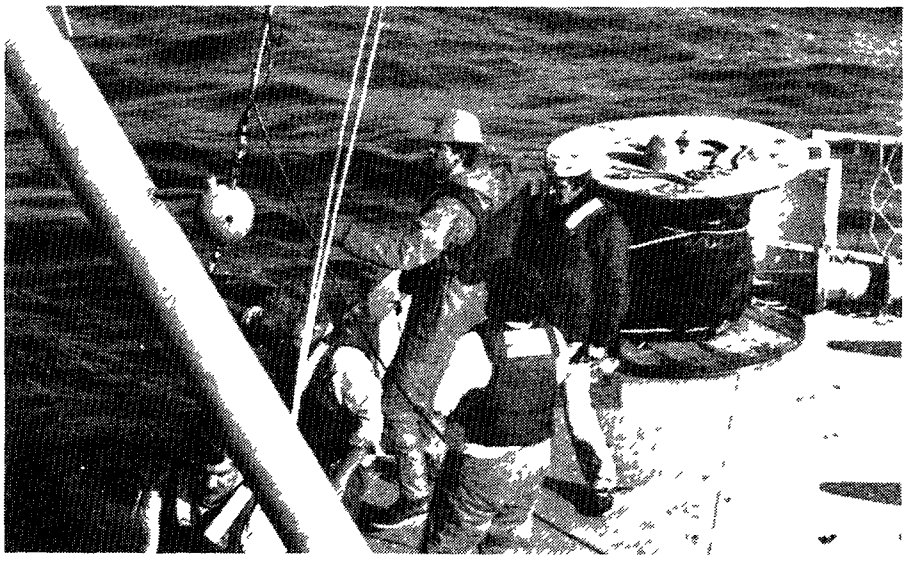
TRANSPORT PROCESSES WITHIN THE FOOD WEB

A variety of laboratory and field studies have been carried out to better understand the processes of biological uptake and transfer of natural and artificial radionuclides through marine food chains.

At the lowest end of the food chain, natural heterotrophic bacteria ranging in size from 0.2 to 0.6 um were isolated from Monaco coastal waters and exposed to ^{241}Am in sterile sea water under carefully controlled experimental conditions. Uptake was rapid reaching equilibrium concentration factors (VCF) ranging between 10^{5} and 10^{6} after 24 hours. These results confirm preliminary studies at ILMR which suggested that marine heterotrophic bacterioplankton concentrate Am comparably to the larger phytoplankton

and thus act as a first link in the transfer of transuranics to bacteriophages and higher tropic levels.

The bioaccumulation of ^{232}U, ^{228}Th, ^{228}Ra and ^{210}Pb in nanoplankton and picoplankton was also determined. Among the nanoplankton, differences of 1-2 orders of magnitude in VCFs were found for a given radionuclide, however, larger differences were observed among the four radionuclides with VCF values of Th Pb Ra U. The picoplankton species had the highest VCF values at 2×10^6. These observations suggest that these small phytoplanktonic forms or their sinking debris could account for much of natural series radionuclides sedimenting out of oceanic surface waters.



Sediment Traps Team at Work

At higher trophic levels several studies examined the transfer of radionuclides through commercially important benthic species such as mussels, prawns and fish. With mussels it was shown experimentally that ^{241}Am ingested with food is assimilated similarly in tissues irrespective of whether the food source is labelled phytoplankton, glass beads or pure protein particles. One possible reason for such nonspecificity in transuranic assimilation is that the acidity in the mussel's gut causes a rapide desorption or disassociation of ^{241}Am from all the food sources thus rendering the radionuclide in a similar chemical form for uptake. Furthermore, alpha autoradiographic techniques have shown that the internal distribution of ^{241}Am, ^{239}Pu and ^{237}Np in mussels is similar whether these molluscs accumulate the transuranics directly from water or from food. One exception appears to be the prawn Nephrops norvegicus in which gill contains the highest and lowest activity when labelled from water and food, respectively.

In another set of experiments, the behaviour of ^{106}Ru (one of the long-lived radionuclides which entered to Mediterranean waters following the Chernobyl accident) was examined in benthic species. Mussels exposed only to ^{106}Ru in water accumulated and retained the radionuclide in their shell, whereas those individuals fed labelled phytoplankton rapidly excreted ^{106}Ru in fecal pellets. Similar observations were made with contaminated fish. Retention of ^{106}Ru in excreted mollusc and fish feces is strong and related to the degradation rate of the pellets. After nearly 7 months pellets maintained at 15°C contained about 20% of the initial radioactivity, whereas those incubated at 4°C still retained 75%. Clearly, such biodetritus contaminated with ^{106}Ru could serve as a potential source of the radionuclide to detritivores long after it was produced, particularly in colder waters.

Transuranic and other long-lived radionuclides entering marine waters ultimately reach the bottom sediments. The question has been posed whether such contaminated sediments could be a source of radioactivity to organisms living in them. To test this possibility, benthic worms were exposed to two different sediment types which were contaminated naturally in the marine environment. The first was a fine, organic-rich mud from Thule Greenland which received plutonium and americum from a nuclear accident involving weapons materials in 1968. The second was a pulverized coralline sediment from Enewetak Atoll, the site of previous nuclear tests. Uptake of Am and Pu was low from both sediments, never surpassing 1% of the activity in the sediment. Plutonium and americium were taken up to roughly the same degree from Thule sediment whereas there was a somewhat decreased uptake of Am relative to Pu in Enewetak sediment. These differences are believed to arise primarily from the differing sediment geochemistries and resultant degree of radionuclide binding. Furthermore the large, radioactive particles which have been found in the Thule sediments could also effect the degree and pattern of uptake in benthic organisms.

Another aspect of the Food Web programme research has concentrated on developing the use of ^{210}Po and ^{210}Pb as natural tracers for food chain processes and relationships. Biological samples from the 1985 French FLUXATLANTE cruise in the NE Atlantic were analyzed for ^{210}Po and ^{210}Pb in whole animals, stomach contents and material excised from the posterior portion of the intestine which is considered to be analog for excreted fecal pellets. The range of ^{210}Po concentrations was large, but by grouping them in bands it was possible to show that the radionuclide concentrations depended both on animal weight and their diet. Using ^{210}Po concentrations measured in whole animals and their feces coupled with known assimilation efficiencies and

growth rates, semi-quantitative estimates have been derived for ^{210}Po concentrations in ingested food and then compared with the actual ^{210}Po concentrations in potential food sources. This approach has allowed identifying and tentatively quantifying the importance of coprophagy in certain types of deep living species as well as the relative importance of carnivorous and herbivorous feeding.

A similar theoretical approach was used to investigate the diet of two important commercial fish, anchovies and pilchards. Laboratory experiments were designed in which these fish were fed diets containing low and high natural ^{210}Po concentrations and the resultant changes in ^{210}Po levels in the fish were monitored over time. ^{210}Po in anchovies had, depending upon the diet, either increased or decreased to a constant level within only four days. With pilchards, however, the time to reach a steady state in ^{210}Po levels was two weeks. These experiments clearly demonstrate that food is the principal source of ^{210}Po measured in these fish. This finding was combined with field data from different geographic areas (Mediterranean sea, South Atlantic ocean) which always show higher ^{210}Po concentrations in anchovies than in pilchards (i.e. whole animal, stomach content and feces). Thus, it appears that phytoplankton is the more important component of the pilchard's diet while zooplankton and possibly some coprophagy are the major dietary components of anchovies.

Radiochemistry/Geochemistry Laboratory

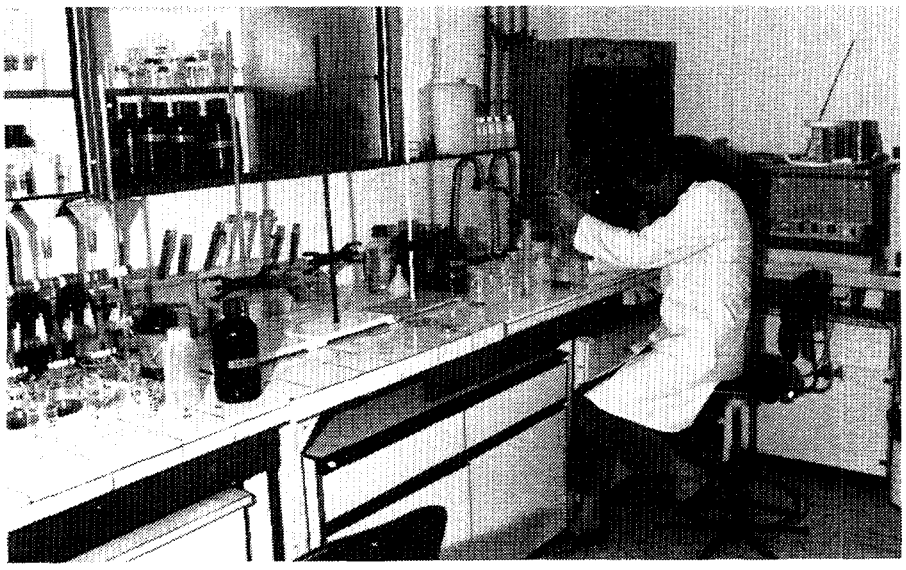
RADIOANALYTICAL METHOD DEVELOPMENT

Dr. E. Holm

During the early months of the biennium the radioanalytical methods for long lived radionuclides such as ^{99}Tc and ^{237}Np were significantly improved. Special emphasis was then devoted to preconcentration techniques in the field since large sample volumes are required. The new procedures also give possibility to sequential separation of plutonium and americium.

Nickel-63 is of special concern at the decommissioning of nuclear power plants. A radiochemical procedure has been developed using stable nickel as a yield determinant. The samples are then counted with open GM gasflow counters and ion implanted silicon detectors. The procedure is being tested on samples collected at different distances from a nuclear power plant. The relation between ^{60}Co and ^{63}Ni will be studied.

Actinium-227 is a member of the ^{235}U chain and has properties which make it attractive for studying



Radiochemistry Laboratory

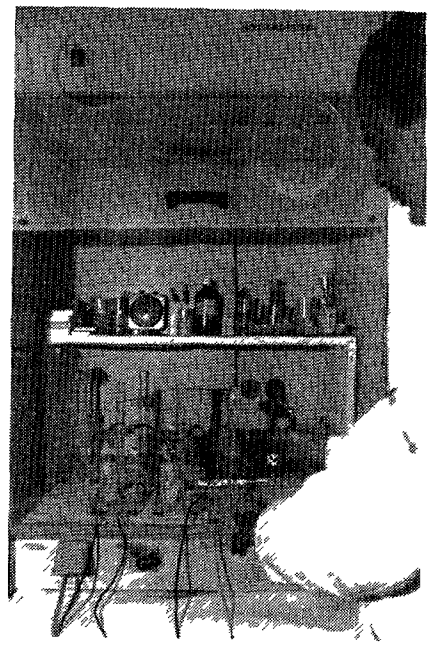
geochemical processes in aquatic environments. Using precipitation cycles and ion exchange a radiochemical procedure was developed followed by alpha spectrometric measurements.

Silicon surface barrier detectors, normally used for alpha spectrometry have been applied for beta spectrometry and low level measurements of pure beta particle emitters. General characteristics and performance as well as the improvement of resolution by cooling were investigated. The system has been proven to be especially useful for quality control for measurements of pure beta particle emitters such as ^{63}Ni and ^{99}Tc. Solid state ion implanted detectors have later been shown in this respect to be superior to surface barrier detectors.

The gamma spectrometry systems were upgraded with HP welltype detectors and at present 3 units are in operation.

ENVIRONMENTAL RADIO-GEOCHEMICAL STUDIES

Since the accidental loss of a nuclear device near Thule, Greenland in 1968 several scientific expeditions have taken place to the area to collect sediment, water and biological samples. In 1984 ILMR was invited to participate in the studies of this weapon grade plutonium. Within the framework of this programme ILMR is conducting chemical association studies of plutonium and americium by sequential leaching of collected sediments.



Electroplating Cells

ILMR participated in a sampling expedition to Fram Strait in July 1985 organized by DHI Hamburg, FRG. Such expeditions are performed annually by the German institute the purpose being to follow the transport of radioactive material especially radiocesium, transuranium elements and ^{99}Tc from European nuclear fuel reprocessing facilities into the Arctic Ocean.

Due to the Chernobyl accident a sampling expedition was organized by DHI Hamburg, FRG,

during October-November 1986 to the Baltic Sea in which ILMR participated. The purpose was to establish inventories of several radionuclides in the Baltic Sea after the accident. ILMR also intends to carry out studies of the geochemical distribution of americium, plutonium and curium in collected sediments. Excellent background data are available due to previous sampling expeditions in 1983 and 1984 and the results of a Coordinated Research Programme for the Baltic Sea carried out during 1981-1984 by the IAEA.

Americium Purification

THE CHERNOBYL ACCIDENT

In order to evaluate the delivery of radioactivity to the Mediterranean Sea a monitoring system was established on the roof of the Oceanographic Museum in Monaco in May 1986. The system consists of an air filtration unit and a rainwater collection system.

The Chernobyl accident on 24th April 1986 gave rise to the deposition of radioactive debris over most of Europe. The cloud was detected at Monaco on April 30th through the activity of particles on air filters. The spectrum of radionuclides was complex, and considerable effort was spent in evaluation. The imput from the Chernobyl accident was followed in water, suspended material, algae and mussels.

There were intense forest fires in surrounding areas in July 1986 after the accident, and the Laboratory was able to detect the further redistribution of radioactivity due to this event.

COORDINATED RESEARCH ON ENVIRONMENTAL SURVEILLANCE AND PROTECTION (CRESP)

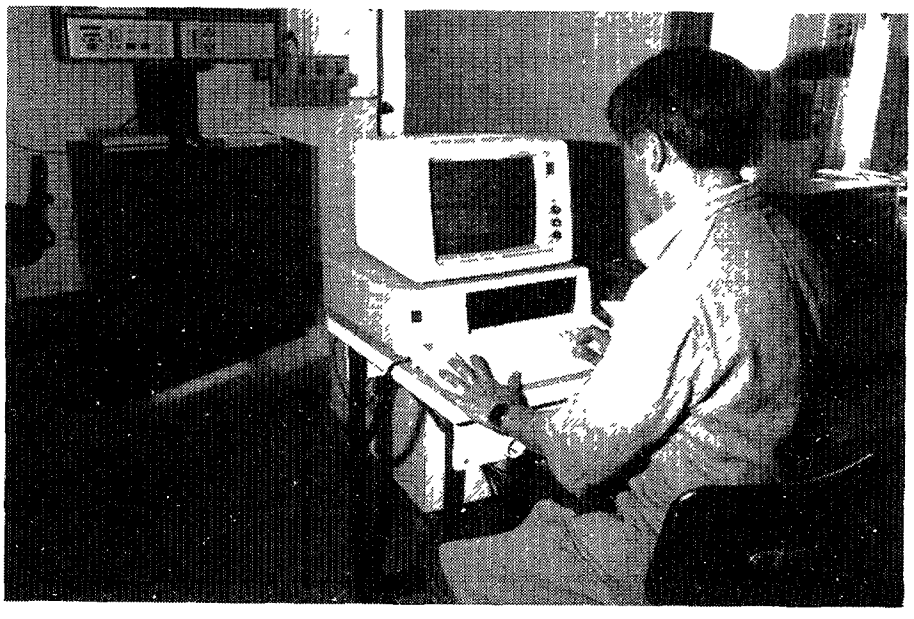
This group of international experts was charged with studying whether there were sound scientific reasons why sea-dumping of low level radioactive waste should not continue, following a moratorium agreed by the parties to the London Dumping Convention. The group worked for five years gathering available data, and

constructing models for the release and dispersion of radionuclides leached from waste drums in the Atlantic. ILMR's role in this work was to contribute data, evaluate the geochemical aspects of the model, and to conduct intercomparison exercises to ensure the radionuclide data used had been taken from trustworthy sources. The group members produced an unusually good set of data, showing their high analytical expertise.

The results of the modelling showed that the projected health effects were extremely small and concluded that no valid scientific grounds could be found for the prohibition of dumping. In spite of this, for other reasons, the moratorium has been continued.

UNITED NATIONS SCIENTIFIC COMMITTEE ON THE EFFECTS OF ATOMIC RADIATION (UNSCEAR)

A task assigned to ILMR was to assist UNSCEAR with the assembly of inventories of radionuclides in the marine environment together with information on inputs and outputs. The project is intended to be completed by 1991. During the review period data were assembled for ^{137}Cs, ^{134}Cs, ^{210}Pb, ^{210}Po, ^{238}Pu, $^{239,240}Pu$ and ^{14}C, and together with the data assembled in 1987, will be published in a document in the TECDOC series of the Agency. The compilations showed that data for the southern oceans are relatively scarce, and showed the direction some future research should take.



Data Processing Computer

ANALYTICAL QUALITY ASSURANCE PROGRAMME

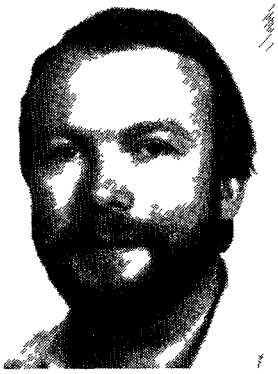
As in previous years the Laboratory continued its commitment to Member States by supplying them with intercomparison and reference samples of marine origin and by organizing intercalibration exercises on a worldwide basis as well as within the framework of special projects.

In 1985-1986 three worldwide intercalibration exercises were completed and reference values of activity concentrations were given for Potassium-40, Lead-210, Radium-226, Thorium-230, Thorium-232, Uranium-234, Uranium-238 in sediment SD-N-1/2, for Potassium-40, Cesium-137, Radium-226, Radium-228, Thorium-228, Plutonium-238, Plutonium-239+240, Americium-241 in sediment SD-N-2, and for Potassium-40, Manganese-54, Cobalt-60, Strontium-90, Technetium-99, Cesium-134, Cesium-137, Radium-226, Plutonium-239+240 in marine alga sample AG-B-1.

One other intercalibration exercise was carried out on a worldwide basis using a marine fish flesh sample MA-B-3. A provisional report was issued in May 1986 and data evaluation is now in progress. The sample will be available as reference material during the course of 1987. Finally, an intercalibration exercise for the determination of natural and artificial radionuclides in a deep-sea sediment SD-A-1 will be launched in April 1987, preparation and homogeneity tests having already been made.

Following the Chernobyl accident, we embarked on the development of three new materials for intercalibration and certification purposes. They are marine sediment IAEA No. 306 collected in the Baltic Sea in late 1986, a mixture of Mediterranean seaweeds IAEA No. 308 and a sea plant (Posidonia oceanica) IAEA No. 307 both collected in the Monaco area in late 1986. Preparation of these samples is progressing and distribution is scheduled for the second half of 1987 or early 1988.

Marine Environmental Studies Laboratory



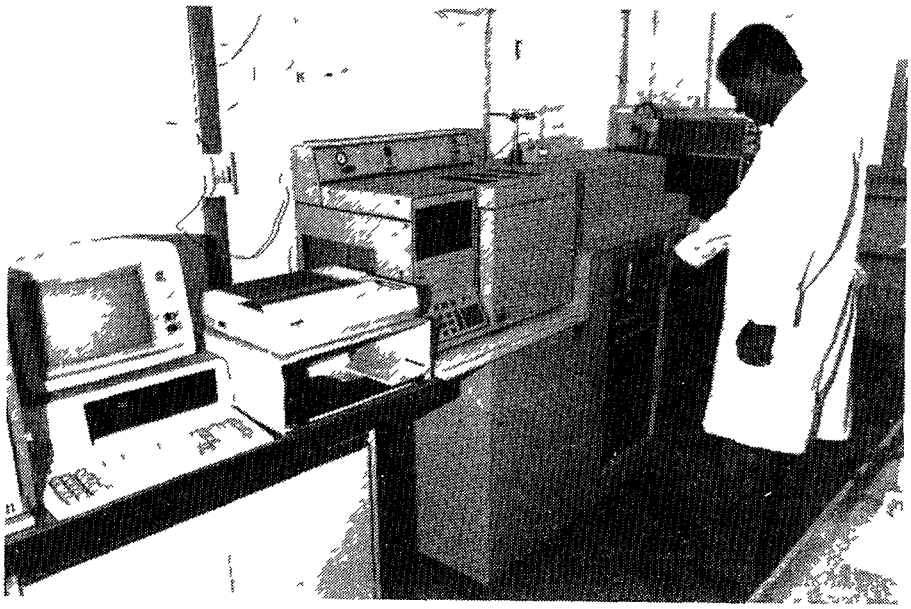
Late Dr.S.R.Aston

As a consequence of the Monaco Laboratory's increasing involvement in activities related to marine pollution research and monitoring of non-radioactive contaminants, a new section was organized in April 1986 viz., the Marine Environmental Studies Laboratory (MESL).

Operated as part of ILMR, the Section located in the Aigue Marine premises at Fontvieille, Monaco, receives considerable support through UNEP's Regional Seas Programme (now Oceans and Coastal Areas Programme Activity Centre, OCA/PAC) and from other outside sources.

The staff of the section, between April and December 1986, consisted of:

- An organic chemistry unit with two professional scientists and three technical staff members;



Mass Selective Detector

- An inorganic chemistry unit, led by the Section Head, with three technical staff members;
- An electronics engineer for instrument maintenance and repair services to participants in the Regional Seas Programme;
- A Section Head and a secretary.

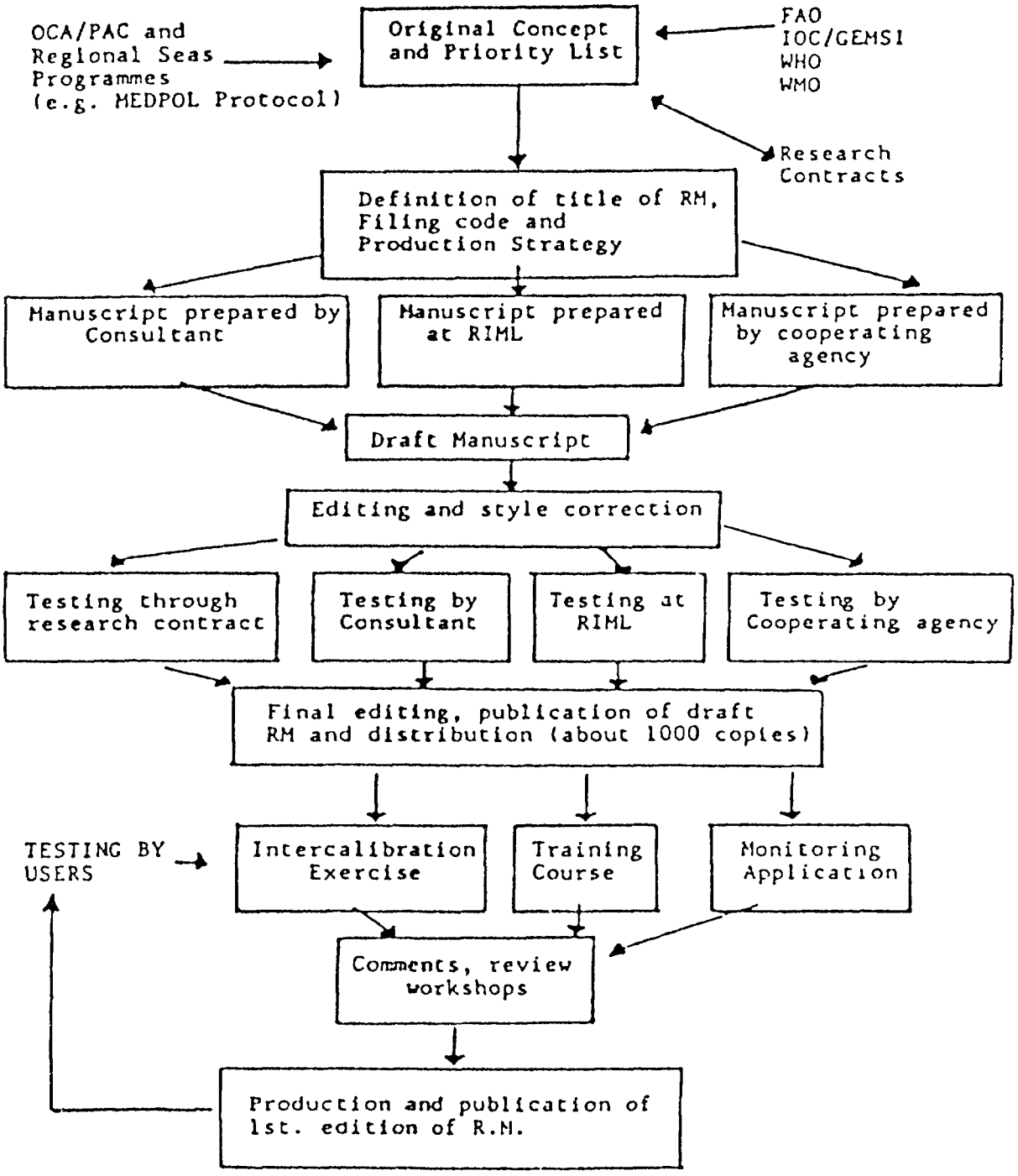
ANALYTICAL QUALITY ASSURANCE SERVICES

A precondition to any sound interpretation and application of results of marine pollution research and monitoring programmes is the reliability of the analytical data produced.

Though, for the determination of a given contaminant in a given matrix, several suitable analytical procedures may exist, it is difficult for every individual laboratory to develop on its own, or to select from the available literature, the most appropriate method. Hence, there is a need for widely available, accurate and regularly updated reference methods using easily available and serviceable equipment, which, particularly in international monitoring programmes, can also provide a commonly approved standard for evaluating legal disputes.

In 1984, an on-going comprehensive programme to produce a wide range of Reference Methods for Marine Pollution Studies was launched and funded by UNEP (OCA/PAC) and has since been co-ordinated within Marine Environmental Studies Laboratory, in close co-operation with IOC, FAO, and WMO. The steps involved in the production of these reference methods are illustrated below. Each method is designed to balance the current state-of-the-art with the reality of limitations in available equipment, personnel and laboratory facilities. To date a total of 20 reference methods and a catalogue have been issued (as drafts or first editions), and another eight were virtually ready by the end of 1986.

The use of calibrated reference solutions of analytes, whilst showing the analytical precision of the instrumental measurement itself, does not necessarily reflect the overall accurary of the method as applied to a sample matrix. The most convenient way of estimating overall accuracy of such a method is by employing a well established reference material of similar matrix to the environmental sample. Such a well established reference material can either be employed as a calibration standard or more conveniently as a "blind" sample for checking the data quality of the chosen analytical method and its calibration against chemical standards. Even these procedures do

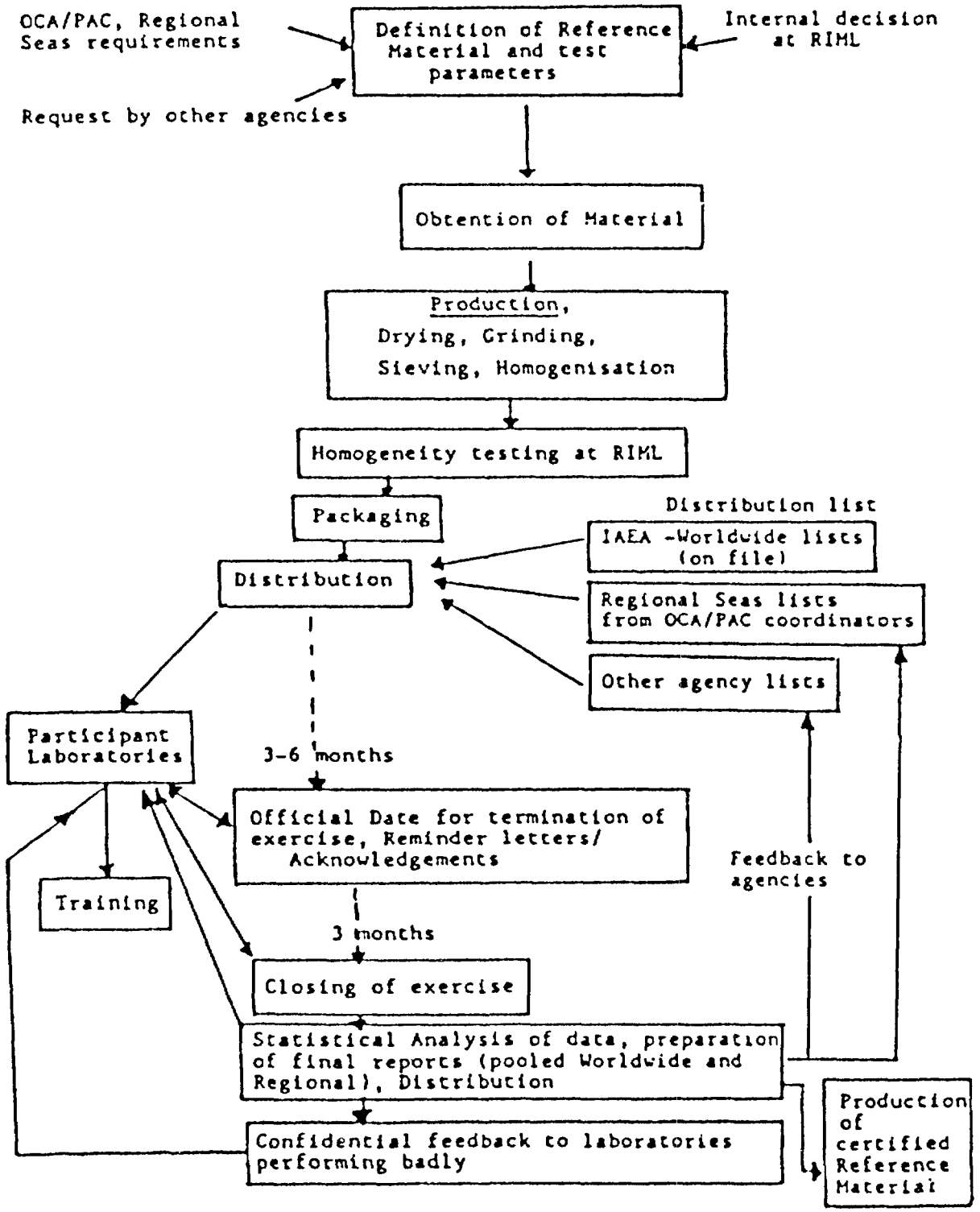


Production of a Reference Method

not permit a full knowledge of overall accurary which may depend on errors in sampling and storage that can only be determined through full intercalibration exercises from sampling to data workup.

In order to assist scientists in the Member States in these problems, the Marine Environmental Studies Laboratory within the framework of the IAEA's

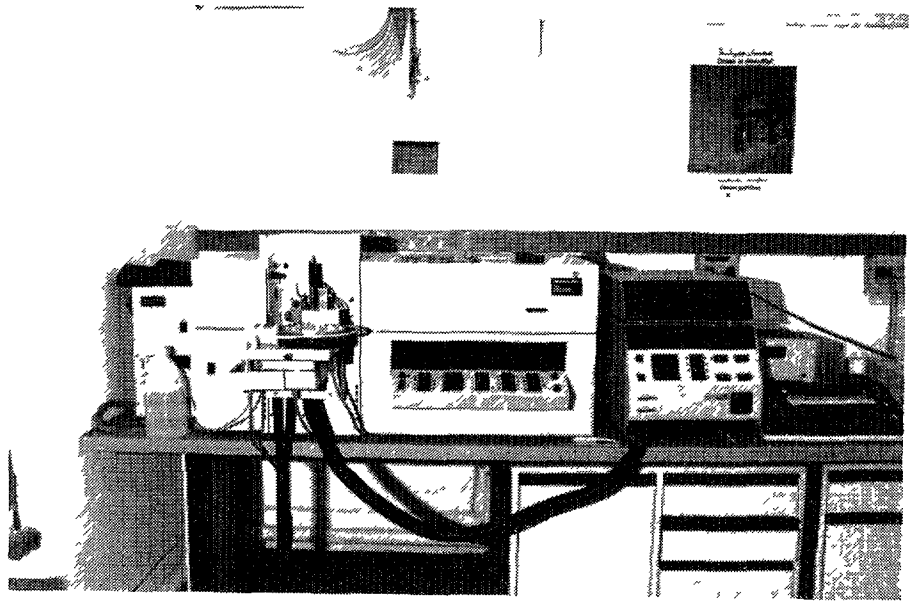
Analytical Quality Control Service and the regional Seas Programme of UNEP, again prepared and distributed marine reference materials analyses of non-radioactive contaminants. The procedural steps involved in an intercalibration exercise is illustrated as follows:



Intercalibration Exercise

During the biennium, a total of five world-wide intercalibration exercises on the determination of trace metals and four on the determination of chlorinated hydrocarbons in marine fish, bivalves and sediments were initiated, conducted and/or evaluated. In addition, regional intercalibration services with regard to trace metals, chlorinated and petroleum hydrocarbons were rendered in the framework of the Mediterranean, Kuwait, West and Central Africa and South East Action Plans.

The experience obtained in all of these intercalibration exercises showed the desirability of maintaining such services for the benefit of the scientific community involved in marine environmental studies. Attempts have recently been made to extend these services to the intercomparison of analytical results on splits of actual monitoring samples, particularly of bivalves. All these activities also serve the purpose of assessing further training needs, for which the Reference Methods form the basis.



Atomic Absorption System

TRAINING SERVICES

The Marine Environmental Studies Laboratory has carried out several training exercises for scientists participating as part of the UNEP Regional Seas Programme in the analysis of three compound classes: trace metals, petroleum hydrocarbons and chlorinated hydrocarbons. The training was organized in the Monaco Laboratory either as an individual on-job training for one month on each class of compounds or, as on two occasions, for groups of three and nine trainees,

respectively. A total of 19 persons have received such training in the laboratory during 1985 and 1986. In addition to this, MESL staff members have visited laboratories in the Kuwait Action Plan region to assist in sampling and analytical work in the local laboratories. These visits were accomplished in connection with joint scientific projects in the region on three occasions during the period.

ANALYTICAL AND INSTRUMENT MAINTENANCE SERVICES

Within the framework of the Kuwait Action Plan (KAP), MESL has participated in three missions to the region for the investigation of the contamination levels of petroleum hydrocarbons, trace metals and chlorinated hydrocarbon in the marine environment. Marine organisms, sediment and seawater were sampled for analysis both in the local laboratories and, for intercomparison, the Monaco Laboratory. This kind of joint exercise, combined with visits to the regional laboratories, is arranged not only for scientific reasons but as extended assistance to the host countries.

Under contract with the United Nations Environment Programme (UNEP) through the Co-ordinating Unit for the Mediterranean Action Plan (MAP), MESL installs and services equipment being provided or in use under the UNEP Regional Seas Programme. Maintenance services of analytical instruments and Data/Word processing systems were provided to the MAP participating institutions and Regional Activity Centres in various countries in the Mediterranean region. The maintenance engineer from MESL carried out 35 visits to 10 countries for regular maintenance as well as emergency repair services on instruments and computers supplied through, or used for, the MAP programme. Also, eight new instruments were installed and spare parts were supplied as needed.

SCIENTIFIC PROJECTS

Staff members of MESL have participated in scientific projects on non-radioactive contaminants in the marine environment mainly in the Mediterranean Sea but also in the Gulf region and the North Sea.

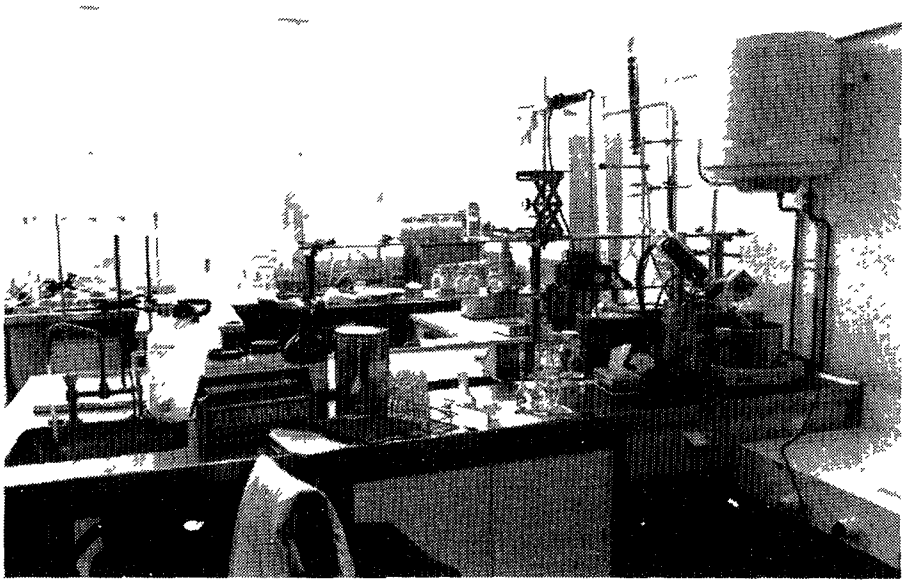
A study on the input of chlorinated hydrocarbons, pesticides and PCBs, through dry and wet deposition to the Western Mediterranean surface water was accomplished. It indicated that the dry deposition appears to be more important than the input by rain. In connection with the study of the input to the Mediterranean surface water through the atmosphere, lichens were sampled at different altitudes in the mountains close to Monaco. The conclusion of this

study is that chlorinated hydrocarbons are accumulated in the lichens to such an extent that they could be used as bio-indicators for the study of atmospheric pollution by chlorinated pesticides as well as PCBs.

The vertical flux through the water body of the same group of pollutants adsorbed onto particles was investigated by taking sediment trap samples at several depths off the coast of Monaco and outside the mouth of the river Rhône. The results on hexachlorobenzene (HCB) indicate that this compound is mainly removed from the surface water by faecal pellet deposition. However, before the particles reach the seabed, most of the HCB is either degraded or dissolved. The polychlorinated biphenyls (PCBs) appear to be removed from the euphotic zone more rapidly than the pesticides HCB and lindane.

In the Gulf area the concentration levels of chlorinated hydrocarbons in edible marine organisms are on average one order of magnitude lower compared to those in similar species in the Mediterranean Sea. A comparison between DDE as a representative of pesticides used in agriculture and PCB as a marker of industrial sources shows that the ratio between the two markers is similar to that in the Mediterranean Sea.

Volatile organochlorine compounds present in seawater as anthropogenic contaminants have also been used as tracers to study water movements in coastal waters. In collaboration with GKSS Geesthacht, FRG, and the Alfred Wegener Institute for Polar and Marine Research, FRG, the Elbe estuary was studied over a series of tidal

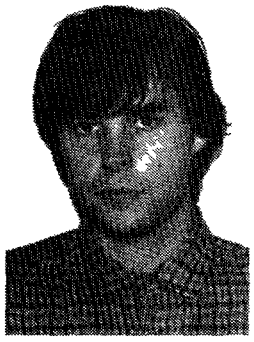


Organic Chemistry Laboratory

cycles. A survey was recently performed in the North Sea where the same compounds were determined in the surface water layer.

Support Services

Engineering and Electronic Services



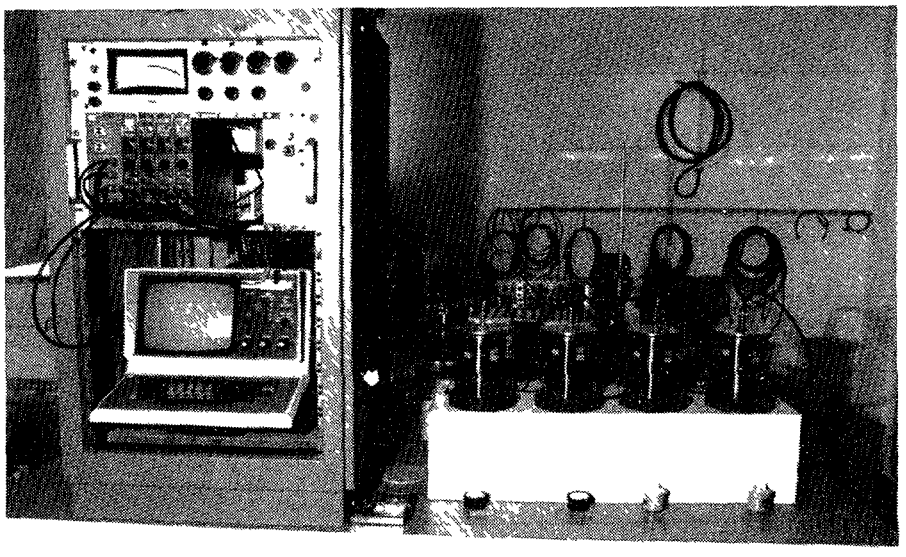
Mr.D.Maillard

The mission of this section consists of maintenance, improvement and updating of existing equipment and installations, and of creating new working tools and devices. The field is very wide and involves the following:-

- Electronical and mechanical systems used in the Laboratory as well as at sea.
- Nuclear counting equipment and gas chromatography, HPLC, mass spectrometer, AAS, ASV, etc.
- Various types of office automation equipment: photocopier, telex, facsimile, etc.
- Computing equipment for both scientific and administrative purposes.

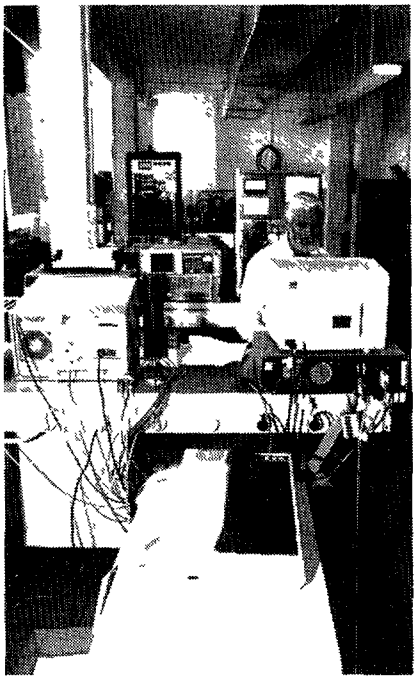
The nuclear facilities now include:-

- 1 gamma spectrometer, computerized, able to manage 4 Germanium detectors (3 now operating).
- 3 alpha spectrometers, partially computerized, involving 36 barrier-surface detectors.
- 1 alpha total counting system with 5 photomultipliers.



Alpha Spectrometry System

- 1 beta total counting set with 5 counters.
- 1 sample-changer for fast gamma counting.
- 2 liquid scintillation apparatus.
- Various assemblies for setting involving 3 NaI scintillators and 1 regrigerated beta chamber.



Counting Room

Since the beginning of 1986, an additional mission has been undertaken to improve and reinforce the general data processing capabilities of the Laboratory. In addition to the purchase of new material (hardware), the section has had to ensure the installation of new software as well as the training of future users. "OMNET" was also installed in early 1986.

At the present time, the most important task of the group is the design of installations for the future premises of the Laboratory and the organisation of the move.

Finance and Administration

Ms.R.Engemann

The Finance and Administration Section is responsible for all activities related to procurement of scientific and non scientific equipment and supplies, payment of invoices, reimbursement of VAT, inventory control, maintenance contracts, travel, communications, mail, staff attendance control, cleaning of premises, etc.

The total administrative budget for the Laboratory amounted to US$1,078,800 in 1985 and US$1,159,300 in 1986.

Extra budgetary funds from UNEP, Monaco Government, USA Government and the EEC totalling US$637,624 in 1985 and US$637,662 in 1986 were available and also support from the USA and the FRG for cost free experts who are presently working in the ILMR.

The Administration Section processed some 622 purchase orders and made 732 direct payments and 234 requests for payment through Headquarters in 1985. In 1986, 507 purchase orders were placed and 316 requests for payment through Headquarters. 603 payments were made directly through Monaco.

Early 1985 telex and photocopier machines were purchased to speed up the flow of information. An electronic mail system was set up in 1986 to enable the scientific staff to communicate with other oceanographic institutions throughout the world. The Laboratory has subscribed to the OMNET telemail service with the user name IAEA.MONACO.

Personnel

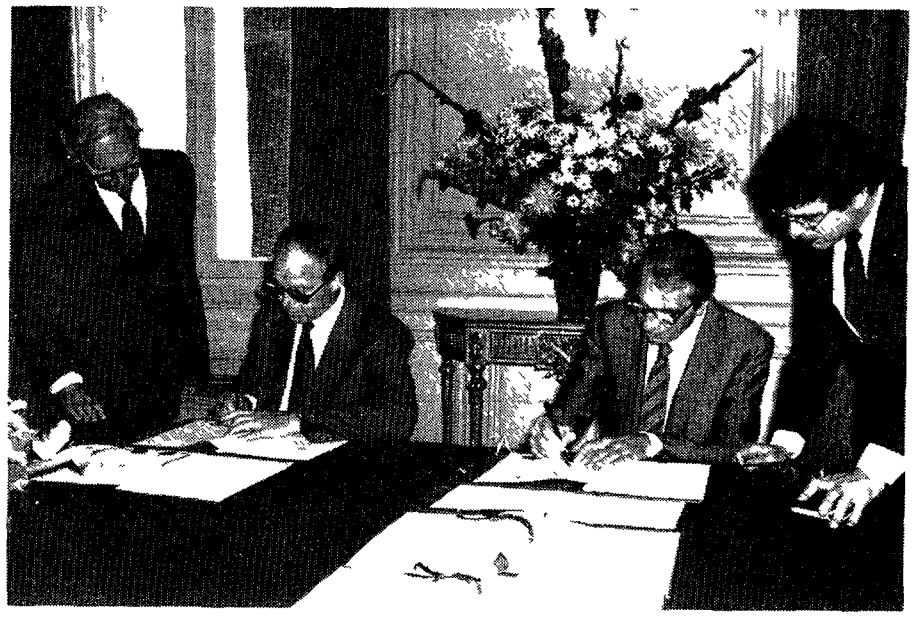
The Laboratory employed an average staff of 36 per month in 1985 and 38 per month in 1986, out of which the proportion of Temporary Assistants, funded through extra budgetary resources, amounted to 26%. The Personnel Section of the Laboratory processes all employment related matters such as contracts and their extension and termination in collaboration with the Vienna Head Office Personnel Department.

The Section deals with a number of visiting scientists and consultants, between 12 and 20 per year. In addition, a similar number of trainees and fellows, with a large fraction from developing Member States, come to the Monaco Laboratory every year to improve their capabilities. Language examinations for the staff were held three times during the year in the Laboratory in collaboration with the UN Training Centre in New York. During 1985 and 1986 up to 18 different nationalities worked together in the Laboratory.

Visa and residence permit questions have to be solved, as well as the many living and accommodation problems which arise with staff coming from other countries.

Secretary's Office

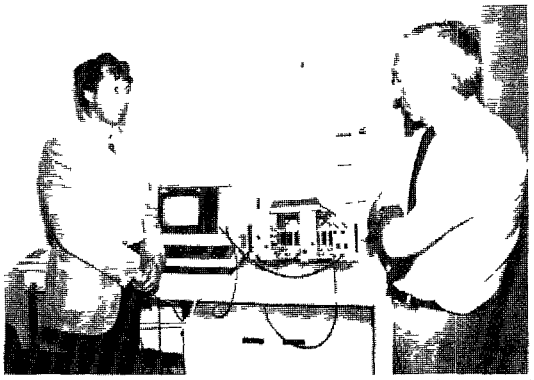
Special Events



The Signing of the New Seat Agreement between the International Atomic Energy Agency - Director General Dr. Hans Blix and the Government of the Principality of Monaco - Minister of State H.E. Jean Ausseil, Monaco 16 May 1986.

The Signing Ceremony took place in the Ministry of State, Monaco, in the presence of Mr. C. Herzig, Director Division of External Relations, IAEA, and Mr. R. Imperti, Secretary General, External Relations, Monaco.

Nuage radioactif et tremblement de terre : les chercheurs monégasques sur la brèche



MM Holmes et Walton devant le spectromètre à rayons gamma (Photos R Briano)

Nuage *radioactif* secousse tellurique tous les regards sont tournés à l heure actuelle en direction de Monaco comme en témoignent les responsables du Laboratoire international de radioactivité marine sollicités durant toute la journée d hier au téléphone par des journaux radios ou télévisions de toute l Europe ()

Il faut dire comme nous l avons annoncé que l un des chercheurs du laboratoire M Elis Holm chef de la section de radio chimie fut le premier à détecter *mercredi après midi des particules radioactives* provenant de la centrale nucléaire soviétique de Tchernobyl *« Nous avons* explique t il *placé l air ambiant sous haute surveillance en Principauté il y a en permanence deux pompes qui aspirent 300 m³ par jour pour celle placée sur le toit du musée oceanographique et 2 000 m³ pour celle installée au pied de cet établissement qui abrite les installations du laboratoire »* Il poursuit *« Quotidiennement j analyse le filtre placé à l intérieur des pompes au moyen d un détecteur destiné à amplifier les rayons gamma produits par les particules »*

Ainsi le spectomètre à rayons du laboratoire enregistre t il depuis mercredi des « pics » montrant à l œil du spécialiste la présence d isotopes radioactifs inhabituels

« Créé en 1961 à l initiative de l Agence internationale de l énergie atomique et installé en Principauté avec le concours du gouvernement princier le laboratoire international de radioactivité marine n a pas vocation d étudier systématiquement l atmosphère » souligne son directeur le docteur Alan Walton en ajoutant *« Notre rôle est d apprecier le comportement des matières radioactives dans les mers et les océans mais pour ce faire il faut de toute évidence discerner également les causes et l origine des pollutions Les études en cours sont particulièrement précieuses parce que tout à fait nouvelles et un jour ou l autre nous retrouverons dans le milieu marin les consequences de la catastrophe russe »*

Les scientifiques du laboratoire de radioactivité marine sont donc en alerte tout comme les chercheurs du laboratoire de séismologie du centre scientifique apres la secousse tellurique qui a secoué (légèrement) la région

J Ch PIERSON

(1) Voir en edition générale

Explaining the work of the Laboratory to local journalists, May 1986.

Visit to the new facilities in course of construction by the two directors of the Laboratory and Professor A. Oyama (Japan) - Member of Scientific Advisory Committee IAEA, 8 December 1986.

Visiting Consultants/Experts

Dr. A. AARKROG	Denmark
Dr. P. ABEL	United Kingdom
Mr. I. BIANGORO	Cameroun
Dr. B. BJURMAN	Sweden
Dr. R. CHERRY	South Africa
Dr. N. CUTSHALL	United States of America
Dr. J. DUINKER	Federal Republic of Germany
Dr. E. FOGELQVIST	Sweden
Dr. R. FUKAI	Japan
Dr. T. HAMILTON	Australia
Dr. H. KAUTSKY	Federal Republic of Germany
Dr. A. KNAP	Bermuda
Dr. S. KRISHNASWAMI	India
Dr. M. MOSELEY	United Kingdom
Mr. O. OLSSON	Sweden
Dr. G. RAU	United States of America
Dr. J. READMAN	United Kingdom
Dr. J. RIOSECO	Chile
Dr. R. RISEBROUGH	United States of America
Dr. P. SANTSCHI	Switzerland
Mr. G. SUNDERLAND	France
Dr. G. TOPPING	United Kingdom
Dr. J. VANDERMEULEN	Canada
Dr. H. VOLCHOK	United States of America
Dr. H. WINDOM	United states of America

Visiting Trainees/Fellows

Trainees

Ms. F. AL-HARTHY	Oman
Mr. S. AL-NUMAIRY	UAE
Mr. H. AL-REKABI	Iraq
Ms. H. ASSILA	Morocco
Ms. G. BARCI	France
Ms. M. BOTSIVALI	Greece
Mr. C. DESPETIS	France
Ms. L. DRAVEC	Yugoslavia
Mr. A. EL AOUFIR	Morocco
Mr. A. EL HRAIKI	Morocco
Ms. S.A.M. HAIDER	Kuwait
Mr. M. HASAN	Bahrain
Ms. H. IDRISSI	Morocco
Ms. T. JOUTER	Morocco
Mr. H. JUMA	Bahrain
Mr. M.H. MAHBOUB	UAE
Mr. P. McDONALD	United Kingdom
Ms. M. NAJDEK	Yugoslavia
Dr. O. OSIBANJO	Nigeria
Mr. R. RAQUIN	France
Ms. V. de SIMONE	France
Mr. F. WILMET	France
Ms. A.C. VISO	France

Fellows

Dr. A. BOLOGA	Rumania
Ms. A. BULOS	Philippines
Dr. P. ZOMBORI	Hungary

Ms.A.Bulos at Work

Publications and Meetings

Publications

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23rd Session of ICSPRO, Paris, France, January 1985. (R. Fukai).

MEDPOL Inter-Agency Meeting, Athens, Greece, February 1985. (S.R. Aston).

1st Meeting of "Alpha Spectrometry Group", CETAMA/CEA, Cadarache, France, March 1985. (S. Ballestra).

4th Nordic Seminar, Gol, Norway, February 1985. (E. Holm).

Seminar on Speciation of Fission and Activation in the Environment, Oxford, England, 1985. (N. Fisher and E. Holm).

ECOMARGE Workshop Meeting, Perpignan, France, March 1985. (S. Ballestra, S.W. Fowler and S. Heussner).

ENEA Seminar, St. Theresa Centre, Italy, 1985. (N. Fisher).

4th ROPME Council Meeting, Kuwait, April 1985. (S.W. Fowler).

CRESP Meeting, Lisbon, Portugal, May 1985. (N.E. Whitehead).

Annual VERTEX Principal Investigator's meeting, OSU, Corvallis, U.S.A. (S.W. Fowler).

III WGST and III IAAC of MEDPOL, Athens, Greece, May 1985. (S.R. Aston).

International Symposium on Nuclear Analytical Chemistry, Halifax, Canada, June 1985. (R. Bojanowski).

International Committee for Radionuclide Metrology Meeting, Grenoble, France, June 1985. (E. Holm and S. Ballestra).

GEMSI Meeting, Kiel, Germany, June 1985. (K. Burns).

UNEP Inter-Agency Meeting, Geneva, Switzerland, June 1985. (S.R. Aston).

International Symposium on Hexachlorobenzene, Lyon, France, June 1985. (S.R. Aston).

International Contact Seminar on Radioecology, Uppsala, Sweden, 1985. (E. Holm).

2nd VERTEX Organizational Meeting, Moss Landing, California, U.S.A., August 1985. (S.W. Fowler).

IOS Meeting, Paris, France, August 1985. (M. Heyraud).

International Conference on Basic and Applied Research on Actinides and their Compounds, Aix-en-Provence, France, September 1985. (E. Holm).

3rd International Symposium on Mediterranean Pollution, Istanbul, Turkey, September 1985. (S.R. Aston).

5th International Conference on Heavy Metals in the Environment, Athens, Greece, September 1985. (S.W. Fowler).

CRESP Executive Meeting, Paris, France, September 1985. (S.W. Fowler).

IAEA Board of Governors Meeting, Vienna, Austria, September 1985. (R. Fukai)

AQCS Meeting, Seibersdorf Laboratory, Vienna, Austria, October 1985. (R. Bojanowski and D. Vas).

Scientific Seminar on the Application of Distribution Coefficients to Radiological Assessment Models, Brussels, Belgium, October 1985. (N.E. Whitehead).

GEMSI Workshop, Washington, D.C., U.S.A., October 1985. (R. Bojanowski).

WACAF Workshop, Dakar, Senegal, October 1985. (N.E. Whitehead).

CNRS (PIRO) Planning Meeting, Paris, France, November 1985. (S.W. Fowler).

OCA/PAC Inter-Agency Meeting, Nairobi, Kenya, November 1985, (R. Fukai).

UNEP Reference Methods discussion and finalisation of report for VI Session of GEMSI, Geneva, Switzerland, November 1985. (S.R. Aston).

GESAMP WG Meeting, Moscow, USSR, December 1985. (S.W. Fowler).

5th ROPME Task Meeting, Dubai, December 1985. (S.W. Fowler).

CRP Meeting, Rome, Italy, December 1985. (N.E. Whitehead).

UNEP Expert Meeting, Athens, Greece, December 1985. (R. Schneider).

CNRS Meeting, Paris, France, December 1985. (S.W. Fowler).

MEDPOL Inter-Agency Meeting, Athens, Greece, January 1986. (R. Fukai).

AGU/ASLO Ocean Sciences Meeting, New Orleans, U.S.A., January 1986. (S.W. Fowler).

Inter-Agency Meeting, Rome, Italy, January 1986. (R. Schneider).

PMO Planning Meeting for CNRS "ANTARES" Programme, Paris, France, January 1986. (S.W. Fowler).

ECOMARGE-PELAGOLION Meeting, Barcelona, Spain, February 1986. (S. Heussner).

1st RCP ECOMARGE Meeting, Perpignan, France, March 1986. (S.W. Fowler and S. Heussner).

CETAMA-CEA Working Group No. 8 Meeting, Paris, France, April 1986. (S. Ballestra).

Meeting on "Low-level Measurements of Actinides and Long-lived Radionuclides in Biological and Environmental Samples", Copenhagen, Denmark, June 1986. (S. Ballestra).

MEDPOL WG for Scientific & Technical Co-operation, Athens, Greece, June 1986. (R. Fukai).

Workshop on "Particle flux in the Ocean", Izmir, Turkey, June 1986. (S. Heussner).

IAEA Inter-Agency Meeting, Vienna, Austria, July 1986. (A. Walton).

International Conference on Nuclear and Radiochemistry, September 1986. (E. Holm).

Expert Consultation Meeting, Copenhagen, Denmark, September 1986. (S.R. Aston).

21st European Marine Biology Symposium, Gdansk, Poland, September 1986. (S.W. Fowler).

CEC Seminar, Madrid, Spain, September 1986. (N.E. Whitehead).

IOC Symposium, Paris, France, September 1986. (R. Schneider).

International Symposium of Oceanography (CNRS), Villefranche, France, September 1986. (S.W. Fowler and S. Heussner).

IAEA Inter-Agency Meeting re Chernobyl accident, October 1986. (A. Walton).

GIPME Working Committee Meeting, Paris, France, October 1986. (A. Walton).

Symposium on Environmental Radiochemical Analysis, Oxford, England, October 1986. (E. Holm).

2nd MEDCAL Workshop, Barcelona, Spain, October 1986. (E. Fogelqvist).

Staff Council (General Assembly) Meeting, Vienna, Austria, October 1986. (J.P. Villeneuve).

5th ROPME Council Meeting, Kuwait, October 1986. (S.W. Fowler).

Committee on Marine Analytical Chemistry, NRC, Vancouver, Canada, October 1986. (A. Walton).

WACAF 2nd Inter-Agency Meeting, Rome, Italy, October 1986. (R. Schneider).

30th CIESM Congress, Palma de Mallorca, Spain, October 1986. (S. Ballestra).

Nordic Radioecology Meeting, Stockholm, Sweden, October 1986. (E. Holm).

Preparatory Meeting, Chesapeake Biological Laboratory, Maryland, U.S.A., November 1986. (R. Schneider).

2nd GESAMP WG Meeting 24, Moscow, U.S.S.R., November 1986. (S.W. Fowler).

American Geophysical Union Meetings, San Francisco, U.S.A., December 1986. (G. Rau).

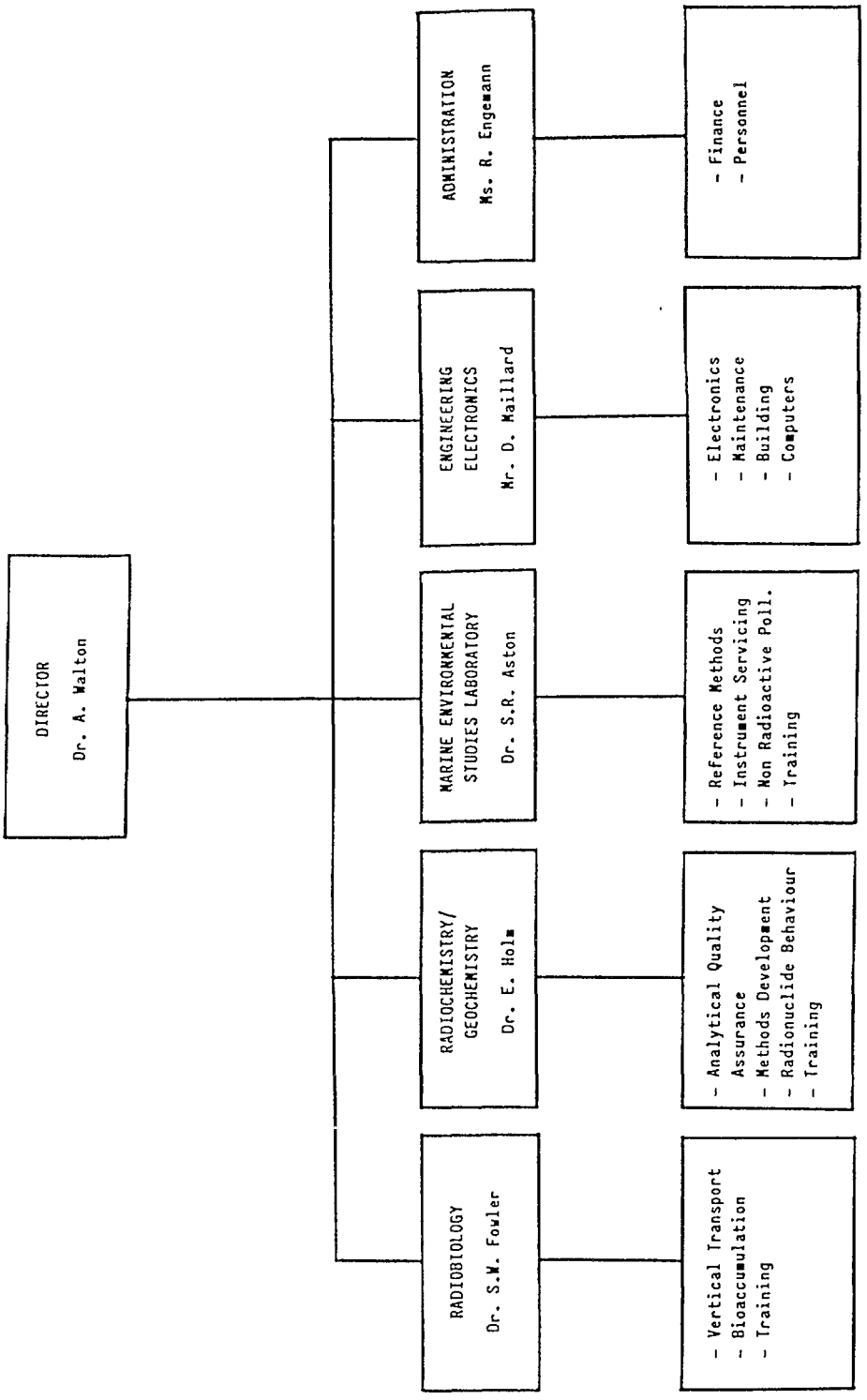
Meeting on Radioanalytical Methods, IAEA, Vienna, Austria, December 1986. (A. Walton and E. Holm).

Commitee/Expert Group Membership

S.R. ASTON	- Group of Experts on Methods, Standards and Intercalibration (GEMSI). - Journal of Environmental Radioactivity (Editorial Board). - Marine Chemistry (Editorial Board).
S.W. FOWLER	- Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). - Scientific Committee on Ocean Research (SCOR). - Regional Organization for the Protection of the Marine Environment (ROPME).
E. HOLM	- International Union of Radioecologists (IUR). - Nordic Society of Radiation Protection (NSRP), Affiliated to Health Physics Society. - Swedish Association for Radiation Physics (SARP). - International Committee for Radionuclide Metrology (ICRM).
A. WALTON	- Group of Experts on Standards and Reference Materials (GESRM). - Committee on Marine Analytical Chemistry, NRC Canada (CMAC). - Group of Experts on Methods, Standards and Intercalibration (GEMSI) - Journal of Environmental Radioactivity (Editorial Board). - Marine Chemistry (Editorial Board).
N.E. WHITEHEAD	- Committee of Radiological Evaluation Surveillance Protection (CRESP).

Organization/Staff List

Organizational Chart



Staff List

Director

Dr. R. FUKAI (until 86-02-16)		Japan
Dr. A. WALTON		Canada

Section Heads

Dr. S. FOWLER	(Radiobiology)	USA
DR. E. HOLM	(Radiochemistry)	Sweden
Dr. N. WHITEHEAD	(Geochemistry)	New Zealand
Dr. S. ASTON (deceased on 86-12-07)	(MESL)	United Kingdom
Dr. L. MEE	(UNEP)	United Kingdom

Scientists

Dr. S. BALLESTRA	France
Dr. R. BOJANOWSKI	Poland
Dr. N. FISHER	USA
Dr. E. FOGELQVIST	Sweden
Dr. M. HEYRAUD	France
Dr. L. HUYNH-NGOC	France
Dr. C. NOLAN	Ireland
Dr. A. SANCHEZ	Philippines
Dr. R. SCHNEIDER	Germany

Administrative Officer

Ms. R. ENGEMANN	Germany

Secretaries

Ms. M. COLLYER	Australia
Ms. S. CONSTANTIN	France
Ms. D. FONSECA	Spain
Ms. S. HENRY	USA
Ms. S. McMANUS	United Kingdom
Ms. M. RAZMJOO	Iran
Ms. P. SANNA	United Kingdom

Electronic Engineers

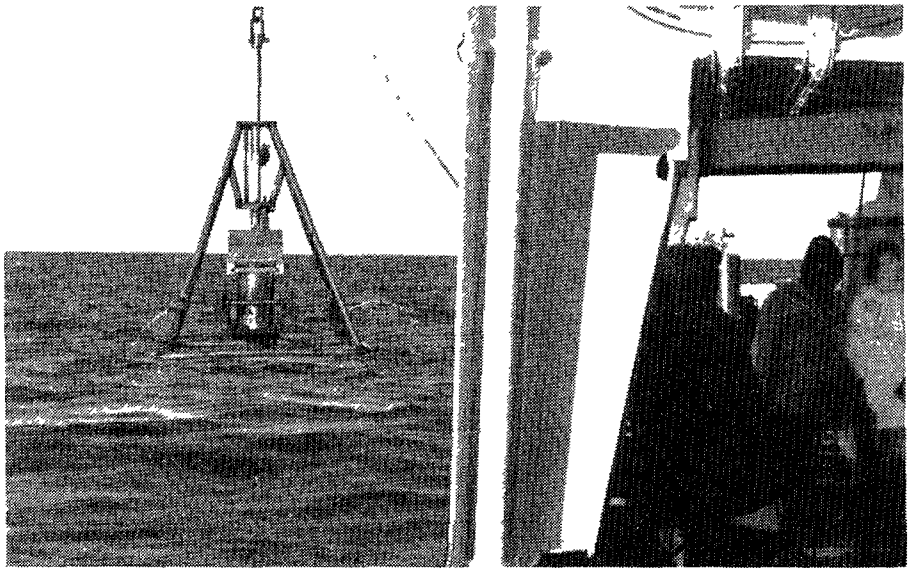
Mr. T. BARISIC	Yugoslavia
Mr. D. MAILLARD	France

Technicians

Mr. F. AVAULLEE	France
Ms. C. CATTINI	France
Mr. J. FARBER-LORDA	Mexico
Mr. J. GASTAUD	France
Mr. S. HEUSSNER	France
Mr. J. LA ROSA	France
Mr. J.-J. LOPEZ	France
Ms. M.-C. NAVARRO	France
Mr. B. OREGIONI	Italy
Mr. D. OUANICHE	France
Mr. P. PARSI	France
Ms. J. PASANAU	France
Mr. R. RAQUIN	France
Mr. J.-L. TEYSSIE	France
Mr. D. VAS	France
Mr. J.-P. VILLENEUVE	France

Appendices

List of Cruises



Sediment Corer

ARK III/2: on board R/V Polarstern, Fram Straight, between Greenland and Spitzberg, 3-29 July 1985, S. Ballestra.

ECOMARGE: on board R/V G. Petit, off Banyuls, Mediterranean Sea, 8-11 July 1985, S. Heussner, J. La Rosa, and J.L. Teyssié.

ECOMARGE: on board R/V G. Petit, off Banyuls, Mediterranean Sea, 24-28 September 1985, S. Heussner, J. La Rosa and J.L. Teyssié.

ECOMARGE: on board R/V G. Petit, off Banyuls, Mediterranean Sea, 12-14 November 1985, S. Heussner, J. La Rosa and J.L. Teyssié.

ECOMARGE: on board R/V G. Petit, off Banyuls, Mediterranean Sea, 16-20 December 1985, S. Heussner, J. La Rosa and J.L. Teyssié.

DYFAMED: on board R/V Recteur Dubuisson, Corsica, 5-7 May 1986, S. Heussner, J. La Rosa.

DYFAMED: on board R/V Korotneff, Corsica, 2-6 June 1986, J. La Rosa.

ECOMARGE: on board R/V Noroît, Rhône River Delta, August-September 1986, S. Heussner and J. Farber Lorda.

ECOMARGE: on board R/V Suroît, Rhône River Delta, 25 November-5 December 1986, S. Heussner and J. Farber Lorda.

North Sea: 19 August-1 September 1986, E. Fogelqvist.

Baltic Sea: on board R/V Gauss, 12 October-10 November 1986, L. Huynh Ngoc and J.J. Lopez.

VERTEX: off California Coast, 22 October-10 November 1986, S.W. Fowler and J. La Rosa.

Hamburg-Port Said: on board R/V Meteor, 29 December 1986 - 24 January 1987, R. Schneider and J.P. Villeneuve.

VERTEX Cruise, off California Coast

Research Contracts

K4-IND-3209	Krishnaswami	India
K4-ITA-3289	Tassi-Pelati	Italy
K4-ITA-3290	Gallorini	Italy
K4-ITA-3291	Frache	Italy
K4-TUR-3292	Salihoglu	Turkey
K4-YUG-3294	Pravdic	Yugoslavia
K4-YUG-3295	Branica	Yugoslavia
K4-YUG-3296	Ajdacic	Yugoslavia
K4-BRA-3441	Guimaraes	Brazil
K4-MEX-3491	Hansen-Zuniga	Mexico
K4-YUG-3896	Bilinski	Yugoslavia
K4-POR-4390	Bettencourt	Portugal
K4-GRE-4398	Florou	Greece
K4-GRE-4544	Grimanis	Greece
K4-ISR-4506	Wynne	Israel
K4-GRE-4547	Vasilikiotis	Greece
K4-GRE-4621	Karaiskakis	Greece

Technical Contracts

K4-AUS-4109	Gibbs	Australia
K4-NOR-4110	Palmork	Norway
K4-ITA-4312	Capelli	Italy
K4-IRQ-4313	Douabul	Iraq
K4-KUW-4399	Yousef	Kuwait
K4-NZE-4400	O'Brien	New Zealand
K4-FRG-4401	Duinker	West Germany
K4-NOR-4402	Carlberg	Norway
K4-SAU-4416	Ukayli	Saudi Arabia
K4-MON-4437	Vatrican	Monaco
K4-MON-4438	Veglia	Monaco

Obituary

Dr. Simon R. Aston, from the International Laboratory of Marine Radioactivity at Monaco, died peacefully on 7th December 1986 at the age of 39, following a courageous struggle with illness over the past two years. He is survived by his wife, Pauline and their two children, Katie and Robin and his parents, Robert and Hazel.

Born in Leeds and educated in Liverpool University he loved marine affairs. After graduating from J.P. Riley's renowned School of Chemical Oceanography, he worked briefly at the Imperial College of Science and Technology, before joining the young and growing School of Environmental Sciences at the University of Lancaster where he stayed for six years. It was here that he and his students contributed significantly to the problems of the behaviour of radioactive materials in the sea - a topic of obvious local interest.

His scientific talents were sought by the United Nations Environmental Programme, and it was in the International Atomic Energy Agency's Monaco Laboratory over the past six years that his dedication to improving science in developing countries, coupled with his marine science interests bore greatest fruit. A quiet and immense empathy for his fellow scientists - no matter what nationality - endeared him to all who met him.

A prolific author, editor of several international journals, an expert on trivia, a beloved husband, father and friend, he will be missed by so many.