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EDITOR: C.B.G. TAYLOR

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SEIBERSDORF LABORATORY

Annual report for 1982

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1. Introduction

The work of the Laboratory covers many fields. Research is mixed with routine work, and training is a constant theme. Equipment is prepared for Technical Co-operation programmes. Laboratory scientists visit Member States on advisory missions.

This report is in the form of short abstracts of the most important work carried out during 1982 by the various Sections. To avoid repetition from year to year only the briefest mention is given of the purpose or status of most of the projects. Fuller descriptions will be found in the reports of Advisory Groups, individual publications in IAEA reports and scientific journals, proceedings of symposia, and the many newsletters and information sheets prepared by the Headquarters technical staff of the Agency.

2. Plant Breeding

The Plant Breeding Section aims to improve nuclear techniques for mutation induction and breeding, trains IAEA Fellows and Training Course participants and provides seed irradiation services to plant breeders in Member Countries. Mutation breeding is an important tool for the creation of improved plant varieties to assure increased food supply in the world.

2.1 Research and development

Two projects with wheat were carried out in 1982. One project, first initiated in 1973, involved seeds of spring wheat which were either irradiated by gamma rays or treated with a chemical mutagen. Ten mutant lines were tested for improved agronomic performance and seed protein content. The improved lines were often taller than the original, had larger seeds and showed improved tillering with shorter spikes.

The second project aims to investigate the combination value of certain wheat breeding lines. Crosses were made between various wheat genotypes, some of them mutant lines. It proved possible to select transgressive recombinants with higher grain protein accumulation rates and longer nitrogen accumulation periods in developing seeds. The project will continue through 1983.

In a series of mutation induction experiments, with pepper, pollen was irradiated with heavy doses of gamma rays to test Pandey's method for radiation-induced transformation. The objective is to speed up the transformation of certain traits which are carried by the male to the female parent. Applying this procedure, a transfer can be expected within two generations whereas an ordinary back-cross programme takes six to seven generations.

2.2 Training

The first IAEA/FAO/SIDA Interregional Training Course on the Induction and Use of Mutations in Plant Breeding was held in May-June 1982 at Seibersdorf. 18 students from developing countries attended the course which lasted 6 weeks.

Two Laboratory staff members were lecturers/instructors at a two-week National Training Course on Radiation-Induced Mutations for Plant Improvement in Bangkok, Thailand.

Two fellows from Pakistan and Malaysia trained in order to improve their technical and scientific expertise in mutation induction and breeding.

2.3 Seed irradiation services

A large number of seed samples were received from Member Countries' institutes for gamma ray or fast neutron treatments.

3. Soil Science

The Soil Science Section continued to contribute to the co-ordinated research contracts programmes of the Joint FAO/IAEA Division by carrying out analyses of isotopes in plant samples and doing field, greenhouse and laboratory work.

3.1 Research and development

As part of the nitrogen fixation and mixed cropping programme a series of field experiments was carried out to determine the effect of root competition on symbiotic fixation by the legume crops Vicia Faba, Soybean and Alfalfa. It was found that under mixed cropping conditions the main cereal crop, due to root competition, will force the legume crop to fix symbiotic nitrogen and therefore more soil nitrogen will remain available for the non-legume crop.

As a service to the FAO Rockphosphate Testing Programme, greenhouse experiments were carried out in which the amounts of phosphorus available to the plant from these natural fertilizer materials were compared with those from P32 labelled superphosphate. This method was used to select the most promising of sample materials collected in Member States. These were then tested under local field conditions.

A series of field experiments with P32, and P33 and N15 labelled fertilizers was carried out with young apple trees to determine the best location for fertilizer placement and to determine the extent to which nitrogen from organic mulching becomes available to the trees. It was found that uptake of nitrogen and phosphorus from fertilizer placed on the interlines is very inefficient due to competition with the grass cover. When fertilizer is placed within the clean, weeded, planting row, more than ten times as much is taken up by the tree.

Vacuum equipment for use with emission spectrometers was assembled and tested. This equipment is used for the analysis of N15 in plant material to investigate nitrogen uptake from fertilizers. Technical staff of the Soil Science Section set up this equipment in several developing countries and trained local staff in its use.

3.2 Training

During April and May an eight weeks training course on the efficient use of fertilizers was given for 20 participants and 4 Agency Fellows from developing countries. The course included the planning and execution of field and greenhouse experiments using isotopically labelled fertilizers. The participants harvested the plant material, carried out the isotope analyses, and calculated and interpreted the results.

Future programmmes were discussed and several participants applied for participation in the Joint Division's Co-ordinated Research Contract Programmes. In addition, several Fellows received in-service training for periods lasting between 3 and 12 months.

3.3 Service work

Mass and emmission spectrometric analyses of N15 in samples from co-ordinated research contract programmes were carried through and the results sent back to the contractors. On average the Section makes 15,000 N15 analyses every year. Batches of N15 labelled fertilizers of the required enrichment were prepared and weighed out for dispatch to participants in field programmes.

4. Entomology

The work of the Entomology Section can be divided into two categories: an insect eradication programme, and a programme to investigate the use of isotopes in pest management operations.

The insect eradication programme, for both tsetse and Mediterranean fruit flies, uses the sterile insect technique (SIT). This method consists of rearing male insects, sterilizing them by radiation, and releasing them into their natural habitat. When the sterilized males mate, the female insects will lay unfertilized eggs. After this process has been repeated for several generations the pest population will be virtually eliminated.

4.1 Eradication programmes

- The Section's Tsetse Fly Eradication Programme focuses mainly on BICOT, a cooperative project between the IAEA and Nigeria. This project is attempting to eradicate a species of tsetse fly which carries agents causing trypanosomiasis in man and animals. In 1982, the fourth year of a six year project, preeradication field studies were completed in a test area located near Vom, Nigeria. Technical

problems arising in the preparations for the final eradication process were investigated at Seibersdorf and the results transferred to BICOT.

- Colonies of tsetse flies were maintained at Seibersdorf for experimental work and for transfer to Nigeria. 82,700 puparia were despatched.

- New techniques were tested for the production, packaging and shipping of dried blood to BICOT. This is reconstituted in Nigeria and used for feeding fly colonies. Production capacity was increased 15% by freeze drying whole blood in trays (previously glass bottles had been used). Acquisition of an additional freeze drier further increased overall capacity by almost 50%. A new packaging method using aluminium foil bags reduced shipping costs to Nigeria by 80%.

- To increase the supply of blood required for BICOT, different types of blood mixures were investigated. A new method was developed for freezing up to 100 liters of whole blood in a single batch.

- Quality control procedures were improved for slaughterhouse blood.

- Experiments showed that more flies could be reared per cage and that the time between feedings could be lengthened. This will reduce the cost of rearing tsetse flies. A new cage, in which 130 flies can be held, was designed and put into use in an experimental colony.

- Experiments measured the mating effectiveness of males exposed to sterilization through radiation, in comparison with normal males. Normal females which mated first with a sterile male did not become fertile by re-mating with a normal male.

- A simple device was developed which measures the fitness and competitiveness of irradiated males in a mass rearing programme. A winnowing device was constructed which separates out emerging puparia.

- Work was begun to develop a genetic sexing mechanism which would eliminate female fruit flies in their early life stage. Sterile females, while theoretically 'neutral' in a SIT programme, can inflict damage to fruit even though the eggs they lay are sterile. Costs will be reduced if females can be eliminated at the egg stage.

4.2 The application of isotope techniques to insect studies

Isotope methods were used to investigate the relationship between rice plants and brown plant hoppers (a major pest insect). Audioradiography was used to locate feeding sites, determine the frequency of feeding, and identify susceptible and resistant varieties of rice.

A vial was designed which allows the gamma activity of dry unprocessed insect samples to be counted in a beta spectrometer.

A counting technique was developed to allow the biological half-lifes of two different isotopes to be measured simultaneously in a live insect.

4.3 Training and technical assistance

Twelve Fellows received training in the Section.

Five staff members provided 65 man-weeks of technical assistance, in Nigeria and Mexico.

5. Agrochemicals

This Section is new in the Laboratory. Its first task is to develop and evaluate controlled-release formulations of pesticides in order to increase their effectiveness while minimizing the problems of residues.

The Section's laboratory now has the basic instruments for measuring chemical residues: gas chromatographs, a high pressure liquid chromatrograph, and a thin layer scanner. For its first experiments sodium alginate was used as a formulation agent to obtain slow release of two insecticides, endosulfan and dimethoate.

5.1 Endosulfan

Endosulfan is an insecticide often used in Africa as a substitute for DDT and dieldrin for tsetse fly control. The high dose rates of endosulfan necessary to produce insecticidal residues can also kill mammals, reptiles, birds and fish. Less hazardous and more efficient application methods are needed, to reduce the required annual dosage and to lower the frequency of application. The first results of work in the Laboratory show that the use of controlled-release formulations could reduce the required amount considerably, thus reducing both cost and environmental contamination.

5.2 Dimethoate

Dimethoate is an insecticide widely used for controlling house flies and other insects in farm buildings. As usually formulated with emulsifiable concentrates, as a wettable powder, or dust, dimethoate degrades and metabolizes into inactive compounds within a few days of application.

Using fruit flies, experiments in the Laboratory aimed at extending dimethoate's action period by incorporating it in a slow release formulation. Alginate formulations were tried, but produced no observable slow release of dimethoate. A search for other formulation media is therefore necessary.

5.3 Training

One entomologist from Bangladesh trained for four months in the Section's laboratory.

6. Human nutrition

During 1982 the Laboratory was engaged in a study of trace elements in human milk.

The importance of breast feeding is now widely recognized by medical authorities almost everywhere. However, human milk may not be a completely adequate food if, for example, the mother herself is poor or malnourished. To answer this question WHO initiated a study in 1976 into the volume and composition of breast milk in a number of different countries and socio-economic groups. The constituents chosen for study included not only the major constituents (e.g. protein, fat), but also the minor and trace elements. Responsibility for this last part of the programme was given to the Agency's Laboratory because of its long experience of trace element analysis, including the optimum use of data reported by laboratories which analyse the same material by different analytical techniques. Altogether 24 elements were selected for study. Neutron activation analysis was used for determining 15 of these.

Throughout this project the Laboratory has borne overall responsibility for all the analyses, especially with regard to the preparation and distribution of the specimens for analysis and the quality control of the results. The Laboratory itself has provided data for eight of the elements of interest. Most of the analytical work was done during 1982 and, by the end of the year, approximately 8,500 analytical results had been recorded in a computerized data file created for this purpose.

The main value of these results will be to throw new light on the nutritional significance of trace elements for young babies. Recommended dietary allowances (RDAs) have been published recently by such bodies as the US National Academy of Sciences for 15 of the 24 elements included in this study, and are widely quoted and used in other countries. For some of the elements, however, there are remarkable differences between the actual intakes observed in this project and the presently used RDAs. For manganese, actual intakes (median values for the six different countries included in the project) varied between 2.5 and 25 ug/day whereas the RDA is 500 to 700 ug/day. For iron, the actual intakes varied between 228 and 460 ug/day as compared to an RDA of 10,000 ug/day. Although the interpretation of these figures is not altogether straightforward, because of differences in bio-availability (e.g. an element such as iron is well absorbed from human milk but much less so from formula products) there nevertheless seem to be significant differences between actual intakes and the RDAs currently in use. This is a matter of no little importance since commercial manufacturers of formula milk supplement their products with trace elements such as

copper, iodine, iron, manganese, and zinc at levels corresponding to the published RDAs. In this respect these products appear to be of better nutritional quality than mother's milk, but this is almost certainly not true. This study will be useful, therefore, in providing definitive new data for setting the correct nutritional requirements for essential minor and trace elements in these important foodstuffs.

7. Radiation dosimetry

Activities centered on the postal dose intercomparison service and the training program for Agency Fellows.

7.1 Postal dose intercomparison service

Accurate dosimetry is essential for the radiation treatment of cancer. The difference between the minimum amount of radiation necessary to destroy the cancer and the maximum which can be tolerated by the surrounding healthy tissue may be uncomfortably small. Although this therapy is increasingly employed in the developing world, many countries have no facilities for the calibration of dosimeters. To address this problem the Laboratory's Dosimetry Section, in co-operation with the World Health Organization (WHO), provides a postal dose intercomparison service for cobalt-60 radiation therapy. Thermoluminescent dosemeter capsules are prepared in the Laboratory and distributed by the WHO to radiotherapy hospitals throughout the world. The hospital irradiates the capsules to a set dose and returns them to the Laboratory for evaluation. Out of a total of 102 evaluations made in 1982, 70% fell within the 5% acceptable deviation but some of the others varied widely. This service will be continued.

7.2 Network of dose standardisation laboratories

Some 1100 hospitals in developing countries are equipped with high energy radiation therapy equipment. In facilities of this type a dose verification should be conducted annually.

Since it is impossible to offer the postal dose service to all these hospitals the IAEA has helped to establish Secondary Standard Dosimetry Laboratories (SSDLs) in those developing countries which did not have adequate calibration facilities. The IAEA contributes towards these laboratories by providing equipment, expert services and fellowships for staff training.

In addition a smaller network of standard primary laboratories has been established with the Agency's dosimetry laboratory at its centre. This network provides training for SSDL personnel, develops equipment for the SSDL programme and organizes intercomparisons between network members.

7.3 Laboratory training

Three Agency Fellows from SSDLs in Indonesia, Pakistan and Thailand each received three months training in ionization chamber measurements and calibrations, and thermoluminescent and Fricke dosimetry. The Fellow from Pakistan stayed two additional months to conduct a further series of ion chamber measurements. Two Agency Fellows from North Korea were given a week's training course on radiation protection.

To aid further training of SSDL staff the first section of a training manual was prepared. The entire manual is scheduled to be completed in 1983.

7.4 Equipment development and calibration

Further improvements were made in the procedures and measuring equipment of the laboratory:

- Improved versions of the shutters and filter wheels required in the cobalt-60 and X-ray bunkers of an SSDL were designed and made.

- The laboratory's secondary standard dosimeter was recalibrated and compared with the other chambers in the cobalt-60 and X-ray beams.

- Five protection-level ionization chambers were calibrated for use by the Health Physics Section of the Laboratory.

8. Electronics

The following projects were executed in 1982:

- An automatic titrator control unit was built for the Agency's Safeguards Analytical Laboratory. This is used for the routine analysis of uranium.

- An "intelligent interface" was designed for use with chemical balances, and a prototype built for the Safeguards Analytical Laboratory.

- An automatic smear test sample measuring system was constructed for the Health Physics Section of the Laboratory. This system facilitates the measurement of large numbers of smear-test samples taken during the surveillance of laboratories.

- Work began on the computerization of an emission spectrometer for N15 analysis. The objective is to place as many functions as possible under the control of a microcomputer and to replace the analogue electronics used for signal evaluation with digital electronics.

- Commercial equipment which will be sent abroad for technical co-operation projects was checked and tested. Advice was given on the selection of equipment for these projects

- Electronic instruments in developing countries often suffer damage because of erratic mains voltage supply. A protective drop-out relay system was developed and various constant voltage transformers were tested for suitability in this application.

- The Section participated in a programme to design modular nuclear instruments (starting with a scintillation spectrometer) in the Eurocard system. These instruments, which will be simple and rugged, will be assembled in electronics laboratories in developing countries.

- The Section repaired and maintained electronic equipment for all sections of the Laboratory and for Technical Co-operation programmes.

9. Physics

Work done during the year included:

- Continued participation in international intercomparisons of calibrated radionuclide solutions.

- Installation of a scanning system for the determination of Pu239 in drums of low-level radioactive waste from the Safeguards Analytical Laboratory.

- Preparation of 377 calibrated radiation sources, of 15 different radionuclides.

- Testing a commercial software package for the evaluation of gamma-spectra.

10. Chemistry

In 1982 the Chemistry Section continued its work in analytical quality control, provided services for technical co-operation projects in the field of uranium prospection, and helped train scientists and technicians from Member States.

10.1 Analytical quality control services (AQCS)

Analytical quality control services help other laboratories in Member States to attain a high standard of reliability in their analytical work. Through intercomparisons and the provision of standardized reference materials the accuracy of trace-element analysis is improved.

Sixteen intercomparisons were conducted in 1982; eleven new intercomparisons were begun in 1982 while five others were continued from the previous year.

These intercomparisons included the analysis of thorium, determination of uranium content and isotopic composition in various uranium samples, measurement of strontium and caesium in milk powder, the investigation of trace elements in human bone, and investigations of marine sediments and natural sea water samples. A new study was begun on a reference material representing a mixed human diet.

New methods were used in evaluating element concentrations in the chosen materials:

- A non-parametic statistical method was used to determine the confidence interval of the mean and median. This method does not assume that the data received has a normal distribution.

- The median, rather than the mean, was used in estimating recommended values. The mean, particularly in small sets of data, may be grossly biased by one or two "high" results. The median is barely influenced by stray values.

A new graphical form illustrated the outcome of the intercomparisons; the results were first sorted according to magnitude and then presented in a frequency diagram.

These intercomparisons will result in a new set of reference materials which will be on sale to any laboratory which needs them.

In 1982, 20 different reference materials were available including uranium ores, biological materials for trace element studies, marine materials for radionuclide or trace element analysis and a complex gamma spectrum which tests computerized evaluation methods.

10.2 Assistance to Technical Co-operation Projects

Staff of the Chemistry Section supervised six technical co-operation projects, in Chile, Cameroon, North Korea, Mali, Syria and Yugoslavia, and also one large-scale UNDP project. This supervision consisted of sending missions to the various countries, giving advice on and evaluating projects, selecting experts, equipment and locations for fellowships, and assessing the projects' progress. For some projects, samples were analyzed and reference materials provided for intercalibration.

10.3 Training

The Section prepared a month-long training course on the determination of uranium. Nineteen fellows from 13 countries attended this course, which was held in Madrid.

Four Fellows received in-service training at the laboratory, working mainly in analytical chemistry as applied to prospection samples. Two trainees received instruction in environmental radionuclide monitoring techniques.

11. Isotope hydrology

The Hydrology Section contributes to a number of research contract and technical co-operation projects and provides facilities for training in isotope hydrology.

11.1 Research Contracts and Technical Co-operation Programmmes

The Section analyzed over 7000 water samples for tritium, C-14, O-18/O-16 and D/H ratios, and chemicals. IAEA Technical Co-operations Projects in developing countries supplied a major portion of these samples.

- The Section measured water samples for Research Contract holders in Costa Rica, Malaysia, Mexico, Thailand, Turkey and Korea.

- One third of the Section's analytical services were devoted to the measurement of tritium and stable isotopes in precipitation samples from IAEA/WMO meterological stations.

- Water standards and reference samples for stable isotope analysis were distributed to 27 laboratories in Member States.

11.2 Development of analytical facilities

- The laboratory's automatic sample preparation line for O-18/O-16 ratio determination was reconstructed and directly connected with the MAT 250 Mass Spectrometer. An interface was designed and constructed and the programme controlling the automatic operation of the system was revised. The system measures 48 samples nightly.

- Three proportional gas counters for measurement of tritium and C-14 were equipped with magnetic cassette data loggers. Programmes for reading cassette data, testing statistics and calculating the final tritium and C-14 results were prepared and brought into routine use.

- A new method of sample preparation for D/H ratio analysis was developed. Within small containers, water samples are converted into hydrogen using metallic Zn (instead of using a uranium furnace).

11.3 Training

Three fellows from India and Egypt were trained in analytical techniques.

12. Safeguards Analytical Laboratory (SAL)

While the major task of SAL is the performance of analytical services for the Department of Safeguards the expertise of its staff is also available for other activities of the Agency.

12.1 Analytical and other services for Safeguards Department

Analytical service was provided chiefly by radiometry, titrimetry, emission spectrometry and mass spectrometry. 870 inspection samples were analysed. Of these, 20% were from spent fuels, 20% were plutonium or plutonium/uranium product materials, and the remainder were unirradiated uranium products. Tracers required for isotope dilution analysis were prepared, characterized, and shipped to safeguarded reprocessing plants for use with LWR and FBR spent fuel samples. In addition, data were processed and reported for 61 spent-fuel and 12 plutonium-product samples which were sent to other laboratories for analysis because the capabilities of SAL's mass spectrometry laboratory were fully loaded.

The capabilities of SAL are limited not only because of a lack of instruments. The present size of the facility also limits SAL's capacity for doing work. Approval was sought for expanding the existing working area from 785 m^2 to 1055 m^2 in 1983/84.

SAL maintaines a measurement assurance program. Included therein are participation in the SALE program, collaboration with Japanese laboratories in the TASTEX-J follow-up exercise (utilizing the resin bead loading technique for mass spectrometry), and participation in the ESARDA interlaboratory experiment for the analysis of the UO_2 pellets.

The analytical capabilities of SAL were used for calibration of a K-edge densitometer and in verifying results obtained by non-destructive methods such as gamma spectrometry and the track-etch technique.

The staff of SAL has participated in accountability tank calibration experiments. An interlaboratory exercise (TIGR82) involving the resin bead loading technique was initiated; twelve laboratories are participating. Several demonstrations and oral presentations have been given to instruct inspectors in the sampling, packing and shipping of different types of inspection samples.

12.2 Development of analytical capabilities

A new thermal ionization mass spectrometer, type ISOMASS 54E, acquired through the United Kingdom's support program to the Agency, came on line as a routine instrument in March. SAL now has two mass spectrometers and has ordered a third for delivery in 1983. The expected Safeguards sample load will continue to saturate the capabilities of these machines.

An additional technician post was established and staffed to ensure full operation of the added instruments. Training in the operation of the new mass spectrometer was provided for one technician at the Institute for Radiochemistry, KfK Karlsruhe, through the Joint FRG/IAEA Program.

A Ge-Li well detector with a resolution of 2.3 KeV for Co60 was put into operation . Experimental results were comparable to those obtained by NaI scintillation gamma spectrometry. Better results are expected when the details for routine analyses have been worked out.

The Pu238/(Pu239 + Pu240) ratios of 210 samples prepared on high-fired porcelain supports were measured by alpha spectrometry. The results agreed well with mass spectrometric data.

A method was developed for the determination of the age of samples by measurement of Am241 using a Ge-Li detector. The technique yields results which agree well with the known ages of the samples.

The installation of a new glove box in the plutonium laboratory has doubled the capacity for dissolving samples.

A microprocessor was installed as the programming device for the automatic titration of uranium samples. Statistically unbiased results were obtained for the titration of standard reference materials. An automatic remote potentiometric titrator was put into operation early in the year and has continued to function well.

Tests were successfully performed demonstrating the applicability of reversed-phase extraction chromatography, using TOPO, to the sequential separation of Am, Pu, and U in U/Pu mixed oxide materials.

Conditions have been established for the routine quantitative determination of 11 impurities in nuclear grade PuO_2 by emission spectrometry. The impurity results are used to correct the weights of Pu obtained by ignition gravimetry. A set of impurity standards obtained from Los Alamos Scientific Laboratory was used for calibration. A PDP-11/05 equipped with dual floppy discs was installed to acquire data from the photo-plate reader and for the calculation of results.

Many of the instruments in SAL operate in conjunction with computers. These separate computers have been connected with a central computer in order to facilitate the storage of analytical data, the identification and control of samples, the proper documentation of analytical procedures, and the generation of reports. Several technicians received training in computer operation related to their work.

SAL has received, and hopes it will continue to receive, a great deal of assistance from Member States. Presently this help comes in the form of technical support, co-ordination, and training programs.

12.3 Participation in other Agency activities

As a contributor to the Analytical Quality Control Service (AQCS) of Chemistry Section, SAL participated in a program for the distribution of samples of fissile material. A natural uranium dioxide material was characterized for U-content and homogeneity, and distributed to 20 laboratories. At the end of the year sesquioxide samples were distributed to ten national laboratories. The sesquioxide samples had been characterized for the content of nine impurity elements with the cooperation of six analytical laboratories.

The Chairman of the CNEN (National Committee for the Nuclear Energy) of Brasil invited SAL through the IAEA Department of Technical Assistance to review the plans and the status of their project to install a National Safeguards Analytical Laboratory. The assistance given will facilitate the implementation of IAEA Safeguards in Brasil.

13. Health physics

The Health Physics Section is responsible for radiation protection and technical safety at the Laboratory.

13.1 Survey of personnel exposure to radiation - external dose

Thermoluminescent dosimeters were prepared, distributed, and read in the Health Physics Laboratory at IAEA headquarters. These dosimeters detect dosages above the natural background and determine the total annual dose for every radiation worker. The 1982 the findings were:

- The collective effective dose equivalent for exposed people was 1 manrem while the maximum individual annual dose registered was 230 mrem. The are very small figures.

- Workers from the Safeguards Analytical Laboratory (SAL) constituted the most exposed group.

- Highest individual exposures were found in employees working in plutonium chemistry, radioactive bookkeeping and storage, source preparation, and health physics.

Finger dosimeters were used by a limited number of Seibersdorf workers, particularly those who handle highly radioactive plutonium samples or prepare sources. This dosimeter, a stainless steel ring attached to a TL crystal with a plastic 'shrink hose', indicates radiation doses to hands and fingers. In 1982 the highest yearly finger dose was 3100 mrem.

All the dose levels observed were a small fraction of the maximum permissible dose levels for radiation workers.

13.2 Internal exposure

Internal contamination can be detected with the "whole body counter" or through urine analysis. The Laboratory's whole body counter measures radiation emitted from the body; it detects both the dose equivalent contribution caused by beta/gamma emitters and Pu239 in the lungs. No example of internal contamination was detected.

13.3 Working place survey

Routine surveys conducted in the Safeguards Analytical Laboratory in 1982 revealed only two surface contaminations out of the 22,000 smears taken from the floors, doors and walls. No activity was found in the 600 air filters checked for alpha contamination.

13.4 Environmental Survey

Environmental samples, to measure the radioactivity of soil, rainwater, and surface growth, were taken every three months in the surroundings of the laboratories (FZS, Neumuehle, Seibersdorf and Reisenburg). No detectable contamination was observed.

13.5 Decontamination

Decommissioning of the old plutonium laboratory in the main building of the Laboratory was completed in January 1982. No extra manpower or overtime was required and final costs were lower than originally estimated. The work involved no contamination of the workers.

13.6 Training

The Section provided advice on radiation protection matters at meetings and during international training courses. It also provided training in radiation protection to new IAEA staff members and Fellows.