Radiation protection services: From the laboratory to the field

From monitoring exposures to supporting cooperative projects, the IAEA's activities are being tailored to meet new demands

by
Robert Ouvrard and Fernando Lopez-Lizana

Developments commanding global attention over the past decade have elevated interest in issues of nuclear and radiation safety. In various ways, States today are placing greater emphasis on cooperative projects and services designed to establish or strengthen national capabilities for effective radiological protection.

At the international level, the Agency has long provided extensive safety-related services. In the field of radiation safety, the work has involved the formulation of standards and advisory missions, for example. In 1979, the IAEA set up a Radiation Safety Services Section (RSSS) to technically support activities in radiation protection. The work involves the operation of radiation protection laboratories, the provision of analytical and support services, and operation of an emergency response system. *(See box.)* In recent years, for example, these services have supported the Agency's post-Chernobyl radiological assessments, as well as its nuclear inspections in Iraq. This article takes a closer look at activities, specifically those related to radiation monitoring, field projects, and emergency planning and response.

Radiation monitoring services

The IAEA provides radiation monitoring services for its own staff whose work can involve exposure to radiation, and for personnel participating in Agency-supported projects, predominately in developing countries. The monitoring system covers external exposure as well as internal contamination, and it extends to laboratory and field services.

Mr. Ouvrard is Head of the Radiation Safety Services Section of the IAEA's Division of Nuclear Safety, and Mr. Lopez-Lizana is an IAEA staff member formerly in the Section.

External exposure monitoring. About 400 IAEA staff members are routinely monitored for external exposure, 300 from the Department of Safeguards and 100 from the IAEA's laboratories. Another 400 individuals typically are monitored in connection with particular assignments. These include about 150 technical cooperation experts, 150 specialists taking part in safety missions, and 100 scientific fellows and trainees.

The RSSS also provides dosimetry services to some Member States under technical cooperation projects or through a joint programme run with the World Health Organization (WHO). In total, about 2800 persons are monitored yearly. *(See table.)*

To strengthen its services, the RSSS recently acquired two new thermoluminescent dosimeter readers for the determination of external radiation doses. It is also working with the Hungarian Atomic Energy Research Institute on the calibration and development of a new specific algorithm for neutron dosimeters. Another area of development is computerized record-keeping, where a new system has been instituted. A data management system was created, for example, to efficiently monitor individual annual exposures and ensure that they comply with existing radiation protection requirements. The programme further enables analysis of trends in radiation exposures.

Radiation workers whose extremities may be exposed to high doses are provided with specific dosimeters. Such workers include, for example, those who handle solutions that emit high energy beta radiation (e.g. phosphorus-32), or medical staff involved in specific X-ray techniques. The dosimeters consist of lithium fluoride crystals mounted on finger rings which are assembled and processed at the Vienna International Centre (VIC) laboratory. Whereas the need for such dosimeters is relatively limited among IAEA staff, the demand from developing countries has increased during

IAEA Radiation Safety Services

The IAEA's Radiation Safety Services Section (RSSS) was created in 1979 to support its activities in radiation protection. Main tasks include:

- operating radiation protection laboratories to meet measurement requirements of the IAEA and its Member States;
- maintaining instrumentation capabilities for radiation protection purposes, and for supporting technical cooperation projects in areas of radiation safety;
- providing training and advisory services in radiation protection;
- operating an emergency response system to assist Member States in discharging their obligations under two post-Chernobyl conventions related to early notification of a nuclear accident and provision of emergency assistance.

To fulfill these responsibilities, the RSSS is structured into three units having interrelated support roles:

- **The Vienna International Centre (VIC) Health Physics Laboratory Unit.** Responsibilities cover personal dose records, external dosimetry; monitoring equipment loans; training in radiation protection; external support services; field missions; and technical cooperation projects.
- **The Seibersdorf Health Physics Group Unit**. Responsibilities cover laboratory surveys; internal dosimetry (whole body counting and bioassay); calibration of monitoring equipment; laboratory training in radiation protection; field missions; and on-call duties.
- **The Emergency Response Unit.** Responsibilities cover supporting IAEA obligations under relevant international conventions; operating the Agency's emergency response system; and supporting technical cooperation projects.

Countries receiving radiation dosimetry services in 1994

IAEA technical co-operation projects	IAEA/WHO joint dosimetry programme
Cameroon	Afghanistan
Cuba	Bangladesh
Niger	Djibouti
Panama	Egypt
Sierra Leone	Maldives Islands
Sri Lanka	Nepal
United Arab Emirates	Nigeria
	Pakistan
	Yemen

IAEA radiation safety services support training and related activities at the Agency's Seibersdorf Laboratories.

recent years. Up to 1600 dosimeters have been dispatched annually.

Internal contamination monitoring. The RSSS operates the whole-body counter, which is installed at the IAEA's Laboratories in Seibersdorf, Austria. Measurements are done using the stretcher geometry assisted by four sodium-iodine (NaI) detectors for gamma emitters and two Phoswich detectors for low energy photon emitters (which is the case for plutonium). To maintain the whole-body counter at the highest technical level, two new Phoswich detectors were purchased. Also acquired was a thyroid uptake monitoring system for surveys of radioactive iodine incorporation in the event of a nuclear accident.

This whole-body counter proved invaluable during the period shortly after the Chernobyl accident. From May to December 1986, a study was conducted on individuals working at the IAEA Seibersdorf Laboratories to assess the immediate impact of the accident in this area. This

study confirmed, as observed in other countries, that the actual individual intake was below the expected value (sometimes by a factor of three) obtained from practical environmental measurements and using theoretical models. During the same period, collaboration was initiated with the Austrian Research Centre for the measurement of various groups of the local population. In November 1986, seven months after the Chernobyl accident, a study was undertaken on the daily caesium-137 urine excretion from IAEA staff. The observed mean daily value was 12.2 becquerel per day (Bq/d), corresponding to 0.67% of the whole body content, in good agreement with the values reported in international surveys (range of 0.3% to 1.3 %). The result was also in good agreement with the calculated daily intake (from food) derived from body measurements done on the same subjects. In April 1990, at the request of the Byelorussian authorities, measurements were performed on four of their nationals.

Quality assurance. Quality control of measurements is periodically conducted through intercomparison exercises with external institutions. These have been done, for example, with institutes in Germany, namely the University of Saarland in 1985; the University of Frankfurt in 1989; and the nuclear research centre in Karlsruhe in 1992.

Support in field projects and missions

Two highly publicized cases have illustrated how the IAEA's radiation safety services are applied in the field: the International Chernobyl Project, and the nuclear inspections in Iraq under terms of UN Security Council resolutions.

Chernobyl project. During 1990-91, the RSSS was involved in the monitoring of individuals in nine selected villages affected by the Chernobyl accident. From May to December 1990, about 12,000 individual dosimeters were distributed in cooperation with Russian experts. At the same time, the instrument's purpose and the project's aims were explained to the people.

During the same period, the RSSS organized a campaign of internal contamination monitoring among the population. With a mobile whole-body counter provided by France, four teams worked in shifts and often under rather poor environmental conditions to conduct about 10,000 individual measurements. Results were used in subsequent studies.

Iraq. In May 1991, the RSSS was requested to take responsibility for radiation protection during IAEA missions in Iraq. The work involved providing equipment, advice, and assistance to team members, as well as ensuring that individual exposures were kept to a minimum. Major tasks during these missions dealt with the safe handling of nuclear fuel materials, and fresh or spent fuel elements. Agency radiation experts played a particularly valuable role in the operation to remove spent fuel from Iraq.* Individual radiation exposures among the 170 people involved in the mission were kept reasonably low, far below the level which could have been expected for such a difficult operation. This testifies to the cooperative preparatory work and the high level of expertise available during the operation.

Laboratories and related facilities

The IAEA operates a number of laboratories where radioactive materials are or may be handled. They are principally located in Seibersdorf and Monaco, with smaller facilities at approved locations in the Vienna International Centre.

A radio-chemical laboratory for the measurement of alpha emitters in urine has been operational since 1993 and located at Seibersdorf. About 350 samples are analyzed yearly for alpha contamination. In addition, a gamma spectrometry facility is used for analyzing more than 500 urine samples a year for gamma contamination.

The RSSS has set up a comprehensive monitoring programme to ensure compliance with good radiation protection practices and maintenance of proper working conditions. This programme concentrates on activities at the IAEA's Safeguards Analytical Laboratory (SAL) where plutonium and transuranium radioisotopes are handled. About 12,000 smears and 700 air monitoring filters are checked yearly for contamination.

The RSSS is also in charge of a scanner unit which measures the plutonium content of radioactive wastes generated by the Seibersdorf Laboratories and stored in drums. A special computer program has been developed that provides necessary data and results, together with graphs showing the physical distribution of activity and density in measured waste drums. This makes it possible to localize, if needed, higher activity "clusters" inside any drum. From 1981 to 1994, more than 250 drums were measured in this installation.

Radiation monitoring equipment

To fulfill its monitoring and assistance tasks, the RSSS makes use of various types of equip-

*See "Nuclear inspections in Iraq: Removing final stocks of irradiated fuel", *IAEA Bulletin* Vol. 36, No. 3 (1994).

ment. They include 50 contamination monitors, 45 dose rate meters, seven hand monitors, six count rate meters, three multichannel analyzers, and 100 electronic personal dosimeters. All equipment is checked and calibrated yearly, with the assistance of the Dosimetry Unit at Seibersdorf. A loan service has been established to respond to staff demand.

In addition, the RSSS provides users, as needed, with practical handbooks for specific equipment; tests new equipment loaned by suppliers, in view of their potential use either for internal purposes or in the framework of technical cooperation projects; develops special indigenous instrumentation, for its own use; and provides advice on radiation protection equipment. A database has been prepared for this purpose, and now contains more than 600 entries.

Training activities. IAEA training activities in radiation protection frequently draw upon the expertise of RSSS staff for lectures, practical exercises, and monitoring demonstrations, for example. This has been the case, for example, for introductory courses on IAEA safeguards, and for radiation protection courses under Agency technical cooperation projects.

In addition, new staff and visiting scientific fellows at the Seibersdorf Laboratories receive training tailored to the requirements of their tasks.

Emergency Response Unit

After the Chernobyl accident in 1986, States approved two international conventions which placed responsibilities on the IAEA for the establishment of an Emergency Response Unit. The unit, which is operated by the RSSS, additionally supports the efforts of IAEA Member States to meet their obligations under these conventions, which address the early notification of a nuclear accident and the provision of assistance in the case of a radiological emergency.

At the IAEA's headquarters, a dedicated facility contains communication and computer equipment, as well as the documentation and databases that would be needed to deal with an emergency.

Two exercises have been conducted, in April 1990 and in January 1992, involving Agency staff and those from Member States, other UN organizations, and diplomatic missions to the IAEA. Results were used to improve the emergency response system, in terms of its resources and facilities, operational procedures, and communication capabilities.

Other activities have included:

- assisting authorities in 1987 in connection with the accident in Goiania, Brazil, that involved a large caesium-137 teletherapy source. The IAEA provided both equipment and expert advisory services.
- coordinating the receipt, assessment, and dispatch of data in 1992 in connection with the widely reported incident at a nuclear plant near St. Petersburg, Russia;
- assisting Vietnamese authorities in March 1993 in dealing with the overexposure of an individual conducting research with a 15 MeV electron beam. The Agency arranged, through the ERU, for the patient to receive specialized treatment at an institution in France.
- transmitting notification that the IAEA received from Russian authorities in 1993 of the accident at the Tomsk facility. A team of IAEA experts was sent to the site to assess the situation.
- helping Estonian authorities in late 1994 to arrange for an international team of experts in connection with an incident involving a stolen caesium-137 source. The incident had resulted in one death and several overexposures among the general population.

Responding to new needs

Over the past 15 years, the IAEA's activities in areas of radiation protection have expanded considerably in the face of growing demands for expert assistance and services. Initially foreseen to deal only with the Agency's internal requirements, the RSSS increasingly is called upon to support cooperative projects and missions.

A number of developments today point toward new demands ahead. The implementation of the new *International Basic Safety Standards for Protection Against Ionizing Radiation and the Safety of Radiation Sources* is foreseen to demand the monitoring of a wider group of individuals and the study of new dosimetry concepts. Overall in areas of radiation protection, greater emphasis further is being placed on quality assurance and control. Also increasingly evident is a growing need for practical training and related services, especially in developing countries, where national radiation protection infrastructures are being established.

In these areas, among others, the IAEA's established radiation protection services provide a solid basis for responding to emerging requirements for technical expertise and support. ❐