INSIDE
TECHNICAL CO-OPERATION

International Atomic Energy Agency

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Global campaign to enhance radiation safety

In Mohammedia, Morocco, an iridium-192 source being used to radiograph welds at a construction site is inadvertently misplaced. A passing labourer picks up the tiny metal cylinder and takes it home. Within a few months, he and seven relatives are dead from radiation poisoning.

In Goiania, Brazil, a rotating head from a discarded cancer therapy unit is stolen from a storage facility and sold to a scrap metal dealer. The dealer breaks up the heavy shielding, and bits of the radioactive source, which glow in the dark, are taken by friends to various parts of the city. Within two weeks, 249 people are contaminated, four people die and more than 100,00 people must be screened.

Along the US-Mexico border, a heavy metal head from a radiotherapy machine is mistakenly melted down to make chair supports for a US fast food chain. The supports are trucked into the US, but the radioactivity triggers sensitive alarms at a nuclear research station as the vehicle passes the facility. Unknown numbers of hamburger lovers barely escape low-level radiation exposure.

Without proper management, radioactive sources can endanger the lives of the unsuspecting. (Credit: J. Cleave/World Bank).

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Old parts serve new purpose

One man's trash is another man's treasure. The dictum is being borne out beside the river Danube, some 150 kilometres south of the Hungarian capital Budapest. A mock nuclear reactor, made-up of never used parts of abandoned installations, is nearing completion at Paks, the site where four real reactor units now produce half of the country's total electricity. By the end of 1996 the dummy will have all the key components — pressure vessel, steam generator, circulation pumps, piping and other such internals — in place, identical with those of the working units. But it will never produce power.

The parts were manufactured for reactors of the same type (WWER 440/213 designed in the Soviet Union) to be built in East Germany and Poland. Both undertakings were cancelled, by unified Germany and post-Communist Poland, leaving the

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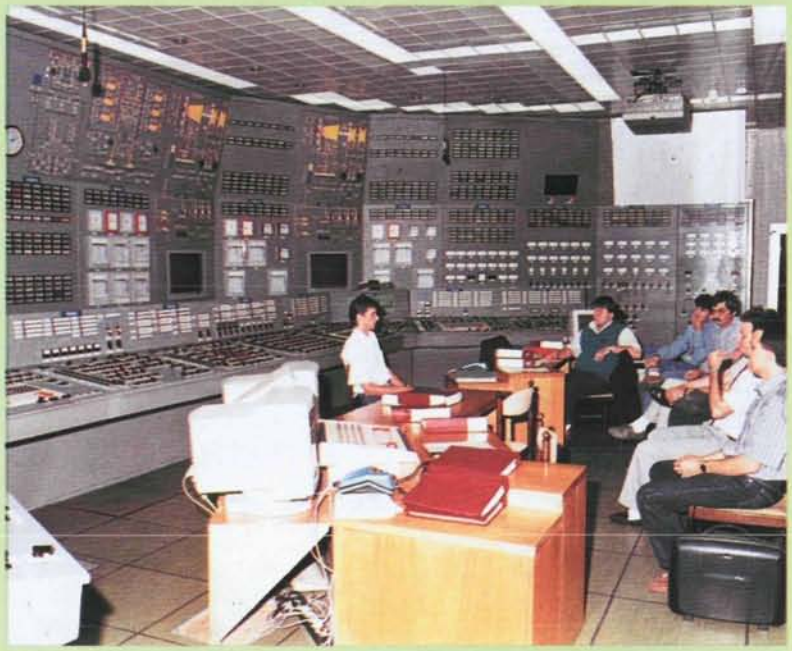
Old parts serve new purpose *(from page 1)*

components worth no more than scrap metal. The IAEA bought them at giveaway prices as part of a technical co-operation Model Project to strengthen operational safety at Paks. The imitation unit will be a Maintenance Training Centre (MTC), the first of its kind anywhere for water cooled and water moderated energy reactors (WWER), to be used for training and retraining of plant operators.

Paks has an operational safety record on par with the best in the world, but management is conscious that it needs to have systematic safety procedures of the highest international standard. The Model Project has three main objectives, which were developed by the Hungarian Atomic Energy Commission that oversees the Paks power plant: to set up the MTC; to upgrade overall safety culture practices in the plant and all organizations dealing with nuclear power in Hungary; and to introduce a systematic approach to training of plant personnel.

The MTC is particularly important because the WWER was not designed for regular safety inspections and maintenance, as is normally required worldwide. In fact parts of the core area cannot be reached by humans and, in earlier Agency projects, remote control devices were developed to reach otherwise inaccessible areas. But the safety standards to which Hungary aspires demand regular inspections as well. With its full-size core area the MTC can provide the hands-on feel and experience to enable maintenance workers to work quickly and efficiently. Hungary, moreover, views it as a regional centre, not only for itself but also for the seven other countries (which include Finland and Russia) with operating 440/230, 440/213 or 1000 type WWERs. Also important, many of the maintenance personnel at Paks will be retiring soon. Recruits can now get MTC training and some on-the-job experience to take their places in due time.



On-site simulator training at Paks NPP is building "safety culture" among staff and management at WWER facilities. (Credit: Paks NPP).

"Safety culture" is a recent and somewhat recondite concept. The essence of it is that everybody involved in nuclear activities — from gatekeepers to top managers at a plant, for example — should be part of a "culture" which has safety as its paramount goal. It calls for a questioning ethos, for reporting anything out of the expected so that it can be assessed for its safety significance and for preempting events that could threaten safety.

Industry people are now talking of a "global" safety culture, though it is not something that can be set up by edict. The Model Project aims to implant it ecumenically via workshops and seminars, bringing together Hungarian and international specialists to discuss Paks' shortcomings identified by Agency missions and other issues pertinent to safety culture. The idea is that the way of thinking will be absorbed and take hold.

The third component, systematic approach to training (SAT), is new for Soviet-built reactor operating staff. Different types of safety missions led by the IAEA have identified training as the most important element to be improved. The project is helping to upgrade all the written material, audio visual and computerized aids, as well as equipment - not only for Paks but for all the institutes that provide training prior to that provided in the plant itself. Experts will be sent in to review, modify and advise on the modifications done by the Hungarians, and the Agency will test and evaluate the systems designed to examine trainees during and after courses.

Hungary is investing some US $8 million in the Model Project due to be completed in 1997, several times the IAEA technical co-operation input. The payoff is measured in safety assurance as well assured power supply. There have been no safety threatening events in the four Paks units (started up in 1982, '84, '86 and '87 respectively) but there have been holdups; notably problems which extended refuelling outage periods, the most recent this September. With Paks providing 50% of electricity to the national grid, avoiding such delays is important to the economy and public welfare.

In Brief: News Events

Convention on Nuclear Safety Enters into Force

The Convention on Nuclear Safety — the first international legal instrument on the safety of nuclear power plants worldwide — entered into force, 24 October 1996. The Convention commits States Parties to ensure the safety of land-based civil nuclear power plants. This includes a legislative and regulatory framework; general safety considerations such as quality assurance, assessment, and verification of safety; human factors; radiation protection; emergency preparedness; and specific obligations on the safety of nuclear installations; siting; design; and construction; and operation. Among its requirements, the Convention obliges Parties to submit reports at periodic review meetings. These reports will focus on the measures each State has taken to implement obligations under the Convention.

So far twenty-nine States have consented to be bound by the Convention on Nuclear Safety. They are Bangladesh, Bulgaria, Canada, China, Croatia, Czech Republic, Finland, France, Hungary, Ireland, Japan, Republic of Korea, Latvia, Lebanon, Lithuania, Mali, Mexico, Netherlands, Norway, Poland, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom. The Convention has been signed by 65 States.

"The Convention marks a major step forward in strengthening international co-operation in the safety field," said IAEA Director General Hans Blix.

Regional course builds safety structures in Eastern Europe

At the Munich Summit of 1992, the G-7 declared three priorities for the revitalization of Central and Eastern Europe and the former Soviet Union. Paramount among them is the need to strengthen their nuclear regulatory bodies. An IAEA regional project was subsequently established for this purpose.

During the last two years, national programmes in Armenia, Bulgaria, Croatia, Czech Republic, Hungary, Kazakstan, Lithuania, Romania, Russian Federation, Slovakia, Slovenia and Ukraine have been developing regulatory bodies with the independence and fundamental powers backed by laws and regulations to license, inspect, order modifications and even shut down plants on safety grounds.

Special attention has been devoted to co-ordinating non-IAEA related bilateral and multilateral projects as well, and the project's success has led to its extension as a new technical co-operation project through 1998. The extension, especially requested by the recipients, has also attracted substantial special contributions, notably by the United States ($200,000) and the United Kingdom ($280,000) for 1997 alone, and as yet unspecified commitments by Finland and Germany.

Although organizational structures and regulatory processes vary from country to country (depending on existing constitutional, legal and administrative systems) this Model Project aims to tackle broad issues common to them by conducting regional workshops and training courses. In the process, national needs to be addressed separately are also identified. So far there have been 10 courses on specific themes, including regulatory control of nuclear power plants and on the general approach to nuclear safety principles and fundamentals, with 180 participants from the 12 countries receiving 250 person-weeks of training.

Nuclear regulatory infrastructures in the region have been significantly strengthened following the Chernobyl accident in 1986. (Credit: IAEA).

There have also been workshops on information for the public, safety culture, and commissioning/licensing. Two others scheduled for late 1996 on commissioning/recommissioning and on decommissioning nuclear power reactors are of special importance to the region. Many of the older reactors are nearing the end of design lifetimes, yet possible recommissioning and decommissioning have received little considered in their design and construction. A decade after Chernobyl — a period engrossed with intense assessment of the causes and consequences of the accident — the region's safety infrastructure is building toward internationally accepted standards through coordinated efforts by the international community to provide the required technical training and exchange of information.

Global campaign to enhance safety *(from page 1)*

Most countries with nuclear power plants and other advanced nuclear facilities have independent regulatory authorities backed by strict law enforcement, well-trained personnel and assured budgets. But as the incidents above illustrate, many developing nations still lack the radiation and waste safety infrastructures to properly manage the sources they currently use.

Indeed, despite fielding over 100 field missions and assisting almost 700 priority national projects since 1984, it became clear to IAEA officials by the early 1990s that safety systems in many developing countries had to be dramatically strengthened to meet the requirements derived from the Basic Safety Standards (BSS) *(see page 8)*.

Two technical cooperation Model Projects (MP) launched in 1994 aim to upgrade radiation protection and waste management infrastructures on a regional basis, with 5 to 6 countries targeted each year. But "Country Safety Profiles" subsequently assembled by the IAEA revealed that over 50 countries were in need of immediate assistance. Thus, the IAEA decided to accelerate implementation of these two projects toward a target date of the year 2000 and to set up four regional centres to manage infrastructure upgrading.

The most pressing needs of some 53 countries in four regional groupings have already been determined on the basis of BSS requirements and information gathering, including earlier missions by Radiation Protection Advisory Teams (RAPAT), the Waste Management Advisory Programme (WAMAP) and special expert teams. An action plan has been developed together with each participating country, setting out the key steps that must be taken. To date 28 countries have officially agreed to their action plan. To accelerate the upgrading process, time limited objectives and decentralized management have been established. Four regional field coordinators (RFC) have been appointed to manage offices recently opened in Addis Ababa, Beirut, Bratislava and San Jose.

Needs and infrastructure requirements differ dramatically from country to country and also between regions. Africa includes a number of countries that have no designated authority to keep records of where sources are. Many of the Asian project countries have not used many radiation sources in the past but are moving in this direction quickly. By contrast, once-extensive programmes in some Eastern European countries have been stopped, but the sources have remained and records are not properly maintained.

The project's first aim is to inventory what sources are being used, for which applications, and where, as well as where and how no-longer-used sources are stored. A computer database is being developed based on questionnaires sent to the countries about sources they know they have, and to manufacturers and suppliers on what they have provided in the past. The two-track findings — country records plus supplier information — should provide a comprehensive picture for national regulators, many of them only recently established.

Many countries simply have not known what they have because they lacked the mechanisms to keep proper inventories. As regulatory structures are built up, the records will provide a base to monitor, control, ensure safe licensed use and finally to store radioactive sources securely. The initial focus is on larger (more active) sources used for medical purposes such as cancer treatment and in industry (sterilization, food irradiation, radiography).

Establishing laws, regulations and other means of control over sources are only part of the process. In liaison with the technical staff in the IAEA's Nuclear Safety Department, the RFC's will work with the governments to set up infrastructures to keep good records, monitor radiation for workers and emissions that affect the public, and assure the quality of radiation used in medicine. The project will also help procure essential equipment, provide the training to utilize them and monitor the safe transport of sources and disposal and waste handling.

The new approach establishes the first global thematic plan involving country assessments and action plans in Technical Co-operation (TC). It also recognizes the value of developing self-reliance and common experience through technical co-operation among countries developing similar control systems. Thus national organizations and experts with experience gained via earlier IAEA training are recruited to provide technical support services to other countries developing safety infrastructures in the region. The Slovak Republic, for example, which developed a full-scope nuclear regulatory authority almost from scratch within a few years *(see page 6)*, is now helping Ukraine restructure its struggling system.

Besides the country-level information, a second international database is being developed on accidents and near accidents with sources. Three recent studies concentrated on "lessons learned" from mishaps in radiography, radiotherapy and at industrial irradiation facilities. They will help regulators and workers in participating countries as they analyze the causes of more than 100 accidents.

The overall goal is to help countries attain the infrastructure and expertise to avoid the kind of disasters described earlier. By the time the project ends at the turn of the century, those countries that fully co-operate will have everything in place to safely manage the use of ionizing radiation for whatever purposes they choose.

A matter of global safety

Natural sources of radiation occur everywhere on Earth. Our atmosphere protects us from cosmic sources of radiation such as the sun and other energy sources in the universe. In fact, the protective layer of ozone is so thin that radiation doses from cosmic rays increase with altitude as we jet for business or vacation. Radon is a naturally occurring radioactive gas that comes from decaying uranium which is common in the earth's crust. It is emitted from rocks or soil and usually disperses into the atmosphere, except when it encounters a building where it can concentrate. This "ionizing" radiation can cause human health problems and often requires monitoring and remediation. Since atomic energy was "discovered" some 75 years ago, nuclear technologies are applied to a spectrum of activities from processing toothpaste to producing energy.

Living with radiation is part of life on earth, and the IAEA is one of the key organizations with global responsibility for protecting and controlling radiation exposure from natural and man made sources. The Agency, in particular the Nuclear Safety Department has helped establish international standards to ensure safety of all types of radiation sources: industrial, medical, agricultural, environmental, and others. It also supports training activities and national infrastructure development to ensure that governments have the legal framework, experience, human resources, and tools to protect, control and exploit nuclear energy. IAEA Technical Cooperation helps to ensure that the diversity of technologies employing nuclear energy do so in a safe, effective and sustainable manner. This edition of ***INSIDE TC*** explains some of the activities that assist in meeting this challenge.

Radiation levels in schools and homes were surveyed in selected villages in three former Soviet republics under a major international project in the early 1990s on the health and radiological consequences of the Chernobyl accident. (Credit: IAEA).

Slovak regulators gain clout

The remarkable rise in stature of the Slovak Nuclear Regulatory Authority (SNRA) is one the most reassuring developments in Eastern Europe's nuclear power scene. Set up only in January 1993, shortly after the amicable dissolution of the federation of Czechoslovakia, SNRA personnel are now serving as experts in IAEA programmes to advance regulatory capacity in neighboring countries.

IAEA delegation visits SNRA headquarters. From left to right: Slovak Ambassador H.E. Daniela Rozgonova, IAEA Director General Hans Blix, SNRA Chairman Josef Misak, and former IAEA Assistant Director General Morris Rosen. (Credit: SNRA).

Many countries in Eastern Europe were not recognized for having independent regulatory bodies, amply staffed and financed, backed by laws and regulations that gave them authority to shut down power plants on safety grounds. In the case of Czechoslovakia, separation left Slovakia in a dire situation. Only six site inspectors of the former federation remained in the new republic, while it inherited responsibility for four operating power reactors, four more under construction, a research reactor (severely damaged in a 1977 accident) to be dismantled, as well as for fuel cycle, spent fuel and radioactive waste treatment facilities.

Slovakia did have some nuclear engineers and scientists and technical staff from nuclear power plants. Together with personnel from non-nuclear re-gulatory bodies, research institutes and various ministries, SNRA built staff strength to 50 by the end of 1993. But they lacked nuclear regulatory experience, and SNRA had to create, virtually from scratch, a new organization aimed at matching international best practice. An IAEA technical co-operation Model Project, begun in January 1994 provided assistance via foreign experts, training fellowships abroad and some equipment to rapidly meet this goal.

A team of senior regulators, organized by the European Union with IAEA participation, identified areas for improvement. The IAEA then recruited western experts to visit Slovakia to analyze, discuss and advise SNRA on emergency preparedness, radioactive waste control, quality assurance, site inspection, periodic safety assessment and training.

Nearly 30 Slovak regulators have been awarded fellowships (typically for two weeks, some for several months) with mature regulatory bodies in Europe and North America to see how things are done in those countries, take experience back and, where appropriate, absorb them into SNRA procedures. "The Slovak regulators' rapid advance is largely due to their own determination and drive," an IAEA technical officer says. SNRA is now a strong body with good practices, able to recruit and retain staff.

SNRA Chairman Jozef Misak acknowledges the Authority's new found stature in the country. What was once a solitary office in a ministry is now an independent legally constituted authority directly under the Prime Minister. It has more than 70 staff and an assured and adequate budget. Parliament has recognized it as equivalent to an international organization, and it has control powers over all nuclear activities and installations in the country. Arguably the crowning recognition has been the request for SNRA to assist the regulatory bodies of Armenia and Ukraine via IAEA projects. The Agency is convinced that both countries would gain much from the Slovak experience, particularly in handling the considerable amount of foreign assistance that is available. Advice they are likely to hear from SNRA is, "Don't take too much assistance at once, don't have experts coming in every fortnight, because you get overburdened with help". Slovakia got wise to that early in their programme. They were getting flooded, so they backed off, rescheduled and made the pace manageable.

Both Armenia and Ukraine are handicapped by language problems that the Slovaks did not have. Russian-speaking SNRA consultants could overcome that barrier, and already some have joined IAEA teams to the two countries. A team of SNRA experts produced a workplan for Ukraine under an IAEA technical co-operation contract. There have also been two-way visits between Armenia and Slovakia. In short, SNRA activities are helping to realize a major objective of IAEA technical co-operation — the promotion of technical co-operation among developing countries (TCDC).

Illicit trafficking

Since January 1993, just under 130 confirmed events involving illicit trafficking of nuclear materials and other radioactive sources have been recorded in the IAEA database. Most of these incidents have been innocuous. A number have involved plutonium and highly enriched uranium, generally in relatively small amounts, but two cases involved substantial amounts. Do these indicate that there is a lot of loose material for weapons out there waiting for a buyer? Are the small amounts just the tip of a fissile iceberg? Is the contraband, capable of killing or injuring people?

The IAEA launched a programme to address illicit trafficking of nuclear material and other radioactive sources in 1994. In this programme, the IAEA plays a small but vital part in the extensive number of bilateral and multilateral activities which are aimed at stopping the illicit trafficking. This programme is focused on four activities where technical co-operation plays an important role. *To prevent*: by helping countries to strengthen their basic nuclear laws and infrastructures, to upgrade their accounting, control and security of nuclear material and radioactive sources, as well as improve their control of the import/export of strategic goods and materials. *To respond:* by helping countries to detect and react to illegal cross-border movements of radioactive materials and analyze confiscated material; and by providing authoritative and timely information on trafficking incidents reported to the Agency's trafficking database. *To train:* by developing and providing training opportunities for both State regulatory and facility personne; and to enhance the *exchange of information* via international and inter-agency meetings and conferences.

Recognizing that the most important defense against smuggling may be better intelligence, the IAEA is encouraging closer co-operation and co-ordination between the scientific community, law enforcement organizations and transporters by helping to create a network of communication with such organizations as Interpol, Europol, Euratom, International Air Transport Association, International Road Transport Union, World Customs Organization the Universal Postal Union and other organizations concerned with this potentially dangerous new situation.

Millions of shipments of radioactive materials are made safely and legally every year. The IAEA is involved in efforts to prevent cases of illicit trafficking. (Credit: Mairs/IAEA).

Measuring radiation doses

The earth has always been enveloped in "ionizing radiation" which comes up from the earth's crust and down through the atmosphere from the sun. Despite this it can be harmful because it can penetrate matter and adversely affect biological processes in living tissue.

Dosimetry is the field of measuring ionizing radiation — including the instruments, measurement methods, and physical-chemical principles that determine interactions of radiation with matter. Its ultimate target is to determine the "absorbed dose" for people, which is the basic dosimetric quantity. Dosimetry is crucial in radiotherapy, in radiation protection and in radiation processing technologies; though typical doses and requirements for accuracy differ among them. In radiotherapy the dose delivered must be extremely precise. So dosimetric quality assurance (checks and recalibration of dosimeters) and other procedures have to be meticulously applied.

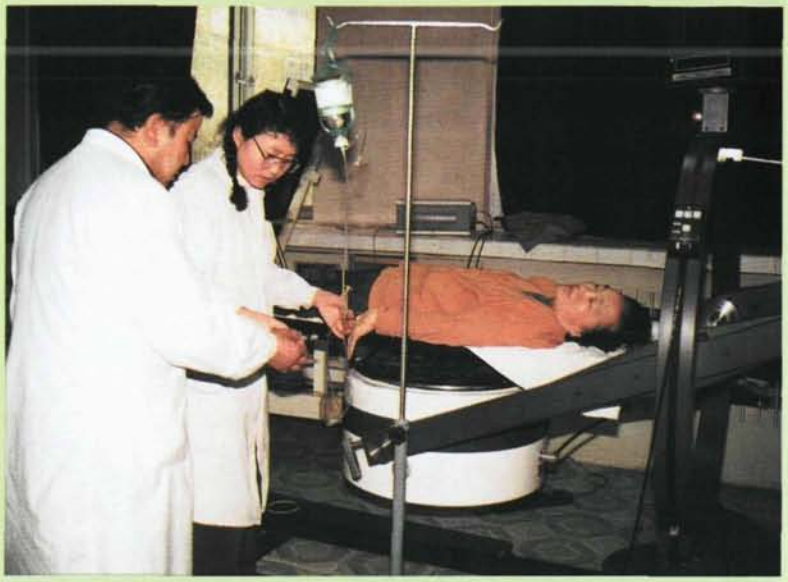
Anyone who works with radiation, however, should have their doses recorded and regularly compared with dose limits. This is done by wearing a dose meter for external radiation, or by checks to measure ingested activity, which requires special equipment and expertise. Except where there is a lot of "loose" radioactivity, less sophisticated methods can be used to work out whether any quantity has been ingested, such as by measuring activity in urine, which is a relatively simpler procedure. Most countries where IAEA has technical co-operation projects do not need the most sophisticated dosimetry. A number deal only with sealed sources, but all countries involved need some capacity in external dosimetry.

New safety standards are people friendly

Strawberries grown in a field straddling the Belgium/France border help to illustrate the chaos, in terms of protecting people from contamination, that followed the Chernobyl nuclear accident in 1986. Fruit from one side of a farm went to market while that of the other was buried; both obeying official edict in the two countries. There were many inconsistencies of that sort ten years ago. The *International Basic Safety Standards (BSS) for Protection Against Ionizing Radiation and for the Safety of Radiation Sources*, is the joint product of six international bodies: the Food and Agriculture Organization; IAEA; International Labour Organization; World Health Organization; Pan American Health Organization and the Nuclear Energy Agency of the Organization for Economic Co-operation and Development. All six sponsor organizations have now adopted the BSS and apply them in all their activities. Since the adoption of the new BSS, all countries now have clear guidelines on how to act in virtually every circumstance.

The standards prescribe safety requirements which, if followed, make accidents much less probable. And beyond guidance on preventing accidents, they also clarify in great detail what to do if an accident does occur in any of a full range of nuclear activities. Non-accident situations are also included, such as high levels of naturally occurring radon gas in a house. Radon is produced by the decay of uranium in the earth's crust and is both widespread and harmlessly dispersed into the atmosphere. But it can cause health problems when it accumulates inside buildings. The BSS explain when and how to intervene and at what radon level to evacuate a household.

Precise guidance and strong regulations are recommended for medical practices. A big problem area, particularly though not exclusively in developing countries, is the rapidly increasing use of medical sources for diagnosis and treatment. There have been many accidents in clinics, and even more occasions when they have been carelessly used or mis-used. One example is in cancer treatment, where the prescribed radiation dose has to be very precise to be useful on the one hand but not cause unnecessary injury to the patient on the other. The BSS cover all typical examinations as well as for nuclear medicine. Even the levels of residual radioactivity in patients, at the time they are discharged from the hospital after radiotherapy, are provided.



Quality control is very important in operating high technology medical equipment.(Credit: Y.Xie/IAEA).

A key group of standards spotlight activities related to security and detection. Among these applications is the quite common radiological examination for legal or health insurance purposes. Another practice is radiological examination for theft detection: people working with gold or diamonds who may swallow the odd stone. The BSS do not "ban" these applications, but suggest that justification is essential for certain conditions.

The Basic Safety Standards devote an entire chapter to occupational exposures from sources in industry. Industrial products that could cause radiation exposure shall not be supplied to members of the public. Suppliers must ensure that products for industrial use — that could cause exposure in normal use, misuse, accident or loss — satisfy a long list of conditions. Additionally, industrial sources should be properly labelled and accompanied by clear and appropriate information on installation, use, maintenance, servicing, repair and recommended disposal procedures.

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