Safety and Security of Radioactive Sources: Towards a Global System for the Continuous Control of Sources throughout Their Life Cycle

Proceedings of an International Conference, Bordeaux, 27 June–1 July 2005

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SAFETY AND SECURITY OF RADIOACTIVE SOURCES

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York: it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

PROCEEDINGS SERIES

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IN COOPERATION WITH THE
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THE EUROPEAN POLICE OFFICE,
THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION,
THE INTERNATIONAL CRIMINAL POLICE ORGANIZATION,
THE INTERNATIONAL LABOUR ORGANIZATION,
THE INTERNATIONAL RADIATION PROTECTION ASSOCIATION,
THE WORLD CUSTOMS ORGANIZATION AND
THE WORLD HEALTH ORGANIZATION,
UNDER THE AUSPICES OF THE GROUP OF EIGHT STATES
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FOREWORD

Radioactive sources are extensively used for beneficial purposes around the world in medical, industrial, agricultural and research applications. However, their safety and security remain a matter of concern. Loss of control, sometimes as a result of inadequate regulatory oversight, has resulted in 'orphan' sources. Such sources have led, in some cases, to serious injuries, even death. In recent years, additional concerns have emerged related to the possibility that sources might be used for malicious purposes. For example, dispersal of radioactive material in an urban environment could cause substantial social disruption. These concerns reinforce the importance of ensuring that proper control of radioactive sources is established and maintained throughout the world.

The International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (the BSS), established in 1996 by the International Atomic Energy Agency and other international organizations, include general requirements for the safety and security of radioactive sources. The IAEA assists its Member States in implementing the BSS through the Model Project on Upgrading Radiation Protection Infrastructure. A conference held in Dijon in 1998 discussed, for the first time, the need for a coordinated international approach to the safety and security of radioactive sources. A further conference, held in Buenos Aires in December 2000, focused on the responsibilities of senior regulators for dealing with this issue. A large international conference, convened in Vienna in March 2003, discussed the specific issues of the security of radioactive sources in the light of the concerns following the events of 11 September 2001.

In September 2003, the IAEA Board of Governors and the IAEA General Conference approved the revised version of the Code of Conduct on the Safety and Security of Radioactive Sources. Many States have already signalled to the Director General of the IAEA their desire to work towards implementing the requirements of the Code of Conduct. The Group of Eight (G8), in its statement made at the Evian Summit in June 2003, recognized "the essential role of the International Atomic Energy Agency in combating radiological terrorism", endorsed "its efforts to establish international standards that ensure the long-term security and control of high-risk radioactive sources", and indicated that it will "encourage all countries to strengthen controls over radioactive sources and observe the Code of Conduct", will "enhance international co-operation on locating, recovering and securing high-risk radioactive sources", and will "support and advance the IAEA's programmes to improve the security of radioactive sources".

The Vienna conference of 2003 concluded that the IAEA should organize a further conference in two years' time. Subsequently, a follow-up conference on the safety and security of radioactive sources was announced at the G8 Evian Summit, held under the French presidency.

The International Conference on the Safety and Security of Radioactive Sources: Towards a Global System for the Continuous Control of Sources throughout Their Life Cycle took place in Bordeaux, France, from 27 June to 1 July 2005. It was organized by the IAEA, in cooperation with the European Commission, the European Police Office, the International Commission on Radiological Protection, the International Criminal Police Organization, the International Labour Organization, the International Radiation Protection Association, the World Customs Organization and the World Health Organization, under the auspices of the G8 States, and was hosted by the Government of France. It was attended by 286 participants and two observers from 65 countries and 13 organizations.

Opening addresses were given by the Deputy Director General, Department of Nuclear Safety and Security, of the IAEA, the Resident Representative of France to the United Nations Office and the International Organizations in Vienna, the President of the Conference and representatives of the cooperating organizations. In the Background Session, the speakers addressed different political, scientific and technical aspects of the safety and security of radioactive sources. The second day of the conference was fully devoted to reviewing the experience of States in implementing the provisions of the Code of Conduct and the supplementary Guidance on the Import and Export of Radioactive Sources. In Technical Session 1, more than twenty countries volunteered to give short presentations about their experience, followed by extensive discussions. Technical Sessions 2 and 3 included presentations on national and international experience in dealing with vulnerable and orphan sources which were a legacy of past activities. The speakers in Technical Sessions 4, 5 and 6 addressed various aspects of the establishment of sustainable worldwide control of radioactive sources throughout their life cycle, such as control over import and export, management of disused sources and management of radiological emergencies involving radioactive sources. Five panel discussions addressed important aspects of the security of radioactive sources: continuous control of sources throughout their life cycle; inadvertent movement and illicit trafficking of radioactive sources; strengthening the inherent safety and security of radioactive sources; providing public information; and the way forward. The conference programme also included two poster sessions and two workshops on the International Catalogue of Sealed Radioactive Sources and Devices and on the Regulatory Authority Information System. All speakers and panel members had been invited by the

Programme Committee. The presentations were followed by open discussions with broad participation from the floor.

The conference generated an exchange of information on key issues related to the global implementation of the Code of Conduct and the Guidance on the Import and Export of Radioactive Sources, dealing with the legacy of past activities, the sustainability and continuity of control over sources, inadvertent movement and illicit trafficking, and emergency management. The most important ideas were summarized in Panel Session 5 by the panellists and the chairperson of that session. The conference also resulted in a number of recommendations, which were presented by the President of the Conference at the closing session.

These proceedings contain the opening addresses, the invited papers presented during the background and technical sessions and the panel discussions, and summaries of the discussions. The findings of the President of the Conference and the closing remarks are also included. The Programme Committee accepted a number of contributed papers, which were issued shortly before the conference. These contributed papers are also available on the CD-ROM that is attached at the end of this volume.

The IAEA gratefully acknowledges the support and generous hospitality extended to the conference participants by the Government of France.

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OPENING SESSION

OPENING ADDRESS BY THE REPRESENTATIVE OF THE FRENCH GOVERNMENT

P. Villemur
Ambassador, Resident Representative of France
to the United Nations Office and the
International Organizations in Vienna

I am particularly honoured to be with you today and to open the proceedings of this international conference of the International Atomic Energy Agency, which France — and the city of Bordeaux — have the pleasure to host. I should like to emphasize here the French authorities' interest in, and the importance they attach to, the activities of the IAEA. The technical cooperation programmes implemented by the IAEA, as well as the assistance that it provides in relation to nuclear safety and security, make an important contribution to raising the standard of living in the developing countries. These programmes also help to strengthen and enrich the dialogue between the North and the South, between the developed countries and the developing countries. Similarly, your attendance at this conference — which I know has some 300 participants — bears witness to the interest that you attach to this dialogue and to the issue of radioactive sources, which in recent years has acquired a special dimension.

This Conference on the Safety and Security of Radioactive Sources was decided upon by the G8 Heads of State and Government at the Evian Summit in June 2003. France was the moving force behind the action plan adopted on that occasion, aimed at strengthening the security of radioactive sources and preventing nuclear terrorism, and the highest French authorities were keen for the conference, which brings us all together today, to be held in France. This conference will address two seemingly — a priori — opposing sides of a single issue:

— Radioactive sources, like other nuclear techniques, are a vital tool for development and for raising people's standard of living. All the countries in the world, including France, use them. Need I recall the benefits brought by the use of radioactive sources in cancer therapy or as tracers in the body for diagnostic purposes, or their countless applications in research, industry, construction, food and agriculture, the environment and water resources management? France, which attaches a great deal of importance to international cooperation and government aid for development, to which it has always given high priority in its international activities, recognizes that the needs of the developing countries in the spheres that I have just mentioned are important. That is why it continues to contribute its full share, and frequently even more, to the financing and the implementation of international assistance and technical cooperation programmes at the IAEA and elsewhere.

— The other side of the issue is undoubtedly less pleasant. Radioactive sources pose risks, just like many other industrial products. But these risks are greater because of the 'invisible' nature of radiation. Radioactive sources therefore have to be handled with care in order to prevent accidents. Furthermore, the most powerful sources can, unless they are adequately protected, be used for malicious or — even worse — terrorist purposes. Our worst fears may never be realized, but recent events have taught us that the limits of the inconceivable can always be pushed back. For this reason, national authorities have a special responsibility to take steps to deal with the risk, to prevent accidents or malicious acts, and also to manage the consequences of such events. This is particularly true as regards the control and monitoring of radioactive sources. And it is specifically for this reason that the IAEA, at the request of its Member States, has been encouraged to develop a code of conduct on the safety and security of radioactive sources, to which nowadays every State should adhere.

Preventing radiological accidents, preventing senseless acts — of terrorism or pure maliciousness — involving radioactive substances, while at the same time facilitating access to these products for applications that benefit humankind: these are the challenges that we face in the exercise of our individual and collective responsibility.

For the duration of one week you will debate in detail all aspects of the utilization of radioactive sources and how, in the most appropriate way, to take into account and minimize the risks that I have just mentioned. I hope that in the course of discussion of this important topic you will not lose sight of two aspects which are, in my view, essential:

— The first aspect is the need to reconcile the two approaches:
  - To think in terms of development, because how in this day and age can we do without radioactive sources in most cases, and why should we not take advantage of their benefits?
  - And also to think in terms of security, a regulatory approach to the problem, because without control of sources, without monitoring how they are utilized and disposed of, how can we ensure the protection of

individuals, how can we prevent these sources being turned into a deadly weapon in the hands of terrorists? You see, an equilibrium needs to be found, but it will not be easy. Focusing all our attention on security cannot work but, on the other hand, we can also very easily fall victim to laxity or inertia in the face of an acknowledged risk.

— The second aspect that I would like to underline is the importance of, or rather the need for, more coordination of administrations at the national level and broader cooperation on the international front. There are some hundreds of thousands of radioactive sources in use worldwide. The vast majority of these probably do not pose any particular problem. But what about all the rest, those that are not controlled, or are inadequately controlled, by the national authorities, those that are quite simply 'orphans', forgotten in a corner and accessible to anyone who happens to pass by? As you and I know, these situations are not uncommon, and it is on these sources that the international community as a whole should focus its attention, because security is a matter that concerns us all. Special vigilance must be exercised by everyone in his or her own sphere, from the manufacturer of the source to the user, from the supervisory authority to the exporter, including the IAEA and the other competent international organizations. For this reason, I hope that this conference, which is bringing together all the parties interested in the issue, will lead to the identification of concrete measures to strengthen dialogue between all the stakeholders and effectively to consolidate the prevention and protection measures already in place. I also hope that, in the coming months, it will lead to the establishment of true international partnerships. Some initiatives have already been launched in this sphere, a point to which I shall return.

The safety and security of radioactive sources are not new topics. For a number of years, the IAEA has been making efforts to improve the safety of radioactive sources, particularly in the wake of the tragic accidents that have occurred in some developing countries. In 1998 in Dijon, France hosted the first IAEA conference dealing with both the safety and the security of radioactive sources. Other conferences followed: in Buenos Aires, Stockholm, Rabat and Vienna. Seven years after Dijon, we today have the opportunity not only to take stock of how far we have come, but also to move ahead.

I referred a moment ago to international initiatives. Allow me to enumerate some of them, known to most of you already, and which are all focused on making the world a safer place.

— Firstly, the work being undertaken by the IAEA in the framework of its programme for the prevention of nuclear and radiological terrorism, established after the events of 11 September 2001. The International Ministerial Conference on Nuclear Security held in London in March 2005 recognized the full importance of this programme, which has been implemented since 2002. Regarding radioactive sources, the adoption in 2003 of a strengthened code of conduct on the safety and security of radioactive sources, and the elaboration now under way of the implementation documents, should contribute to the progressive emergence of a safety and security culture in every State. The work of the IAEA is central to this topic.

— Next, the United Nations. France applauds the adoption by the Security Council, in April 2004, of a very important resolution, Resolution 1540. It comes under Chapter VII of the Charter, that is, the action the Council can take to maintain international peace and security. Resolution 1540 constitutes an important step forward in preventing the proliferation of weapons of mass destruction and their means of delivery, and in preventing terrorists from gaining access to such weapons and other related materials, including radioactive sources. In particular, it obliges all States to put in place and to implement domestic controls over materials, equipment and technology that could be used for the purposes of proliferation or terrorism, and it encourages States to cooperate with one another to attain the objectives envisaged.

— Another initiative is the G8 Global Partnership, launched in 2002, and its six associated principles, which aim to prevent terrorists, and those who harbour them, from acquiring or developing nuclear, chemical, radiological and biological weapons, missiles and related materials, equipment and technology. This framework includes actions aimed at securing nuclear and radioactive materials in the Russian Federation with a view to preventing trafficking in them and preventing them from falling into the hands of terrorists.

— Another G8 initiative, which I referred to earlier, is the action plan for the security of radioactive sources, adopted in Evian in 2003 under the French presidency; the Bordeaux conference is one part of that plan. It offers an opportunity, two years after Evian, to take preliminary stock of the implementation of the action plan and to identify opportunities.

— On the European front, I should like to mention the European Union strategy for combating the proliferation of weapons of mass destruction and their means of delivery, adopted at the end of 2003, which contains a large security element. It is in this framework that a joint European Union action, in support of the IAEA, was adopted in 2004. The security of radioactive sources and the prevention and detection of illicit trafficking in radioactive materials figure prominently therein.

— More recently, the Global Threat Reduction Initiative, or GTRI, has laid the foundations for broader cooperation in activities to secure nuclear and radioactive material.
— I would not want to close this list without mentioning the other international organizations that are making efforts, within their sphere of competence and sometimes in an unobtrusive way, to strengthen, directly or indirectly, the safety and security of radioactive sources. Many of these organizations are represented here today and they are better able than I to present their views and their activities in this area.

In conclusion, I should like to give you a brief outline of some of the activities that France has undertaken recently, or intends to undertake in the near future, to secure radioactive sources, with a view to — in consultation with its partners — enhancing nuclear security where improvements are needed.

Recently, France was asked by the IAEA to remove an irradiator and its sources, at the request of the Ivorian authorities, located at the University of Cocody in Abidjan. This irradiator, installed by France in the 1960s but which had not been used for a number of years, posed a potentially serious hazard if handled by an unauthorized and unsuspecting person. With exemplary cooperation between the Côte d'Ivoire, France and the IAEA, the irradiator and its sources were repatriated to France in October 2003. A detailed description of this operation will be presented to you in the course of the conference. Of course, France remains ready, whenever it may prove necessary, to consider a request made to it for assistance regarding radioactive sources that it could have exported in the past. The French authorities are particularly concerned about the safety and security conditions under which sources of French origin or sources exported by France are used.

In another context, the G8 Global Partnership, I should like to mention the cooperation that we are establishing with Norway, with the agreement of the Russian Federation authorities, to finance the removal and dismantling in Russia of RTGs — radioisotope thermoelectric generators — providing electricity to maritime navigation beacons in the regions of Murmansk and Arkhangelsk. France intends to allocate approximately 300 000 euros to this cooperation in 2005, and may continue this activity in 2006 and subsequent years, assuming agreement by the Russian authorities, in other regions of the Russian Federation and then, more extensively, in other States of the Commonwealth of Independent States. A number of countries, as well as the IAEA, are involved in this partnership with the Russian Federation on the

RTGs. In my view, it is one example of what needs to be done to eliminate radiological risks wherever they may be found.

Finally, I should like to announce that on 27 April France signed an arrangement with the IAEA for the development of even closer cooperation in the field of nuclear security. The French authorities intend to continue providing the utmost assistance to the Agency, either directly or within the framework of joint European Union action in support of the IAEA, so that the Agency can implement its programme to prevent nuclear and radiological terrorism and carry out successfully the tasks entrusted to it by its Member States.

Your presence in Bordeaux this week testifies to your interest in these issues. I invite you, under the leadership of the President of the Conference — Professor Lacronique — and other eminent individuals, to reflect on ways — on all possible ways — of introducing or strengthening safety and security cultures with respect to radioactive sources. Going forward together, undertaking initiatives, establishing international partnerships, strengthening the existing political and legal instruments, with respect for the interests of each and every one of you, without hampering technical cooperation or curbing economic development or holding back the rise in the standard of living of populations: this is the real challenge for us all. I am confident that your discussions on this issue throughout the week will bear fruit. Security is an issue that affects us all. Secure development can only be of benefit to us all, the North as well as the South. It is up to us to assume this responsibility, collectively.

OPENING ADDRESS BY THE IAEA DEPUTY DIRECTOR GENERAL

T. Taniguchi
Deputy Director General,
Department of Nuclear Safety and Security,
International Atomic Energy Agency,
Vienna

On behalf of the Director General of the IAEA, I have the pleasure of welcoming you to this important international conference on the safety and security of radioactive sources.

Practically all countries use radioactive sources for peaceful purposes. The use of such sources continues to grow, particularly in developing countries, where they contribute significantly to improving human health and providing social and economic benefits through many applications in medicine, industry, agriculture, resource preservation and environmental protection.

The vast majority of radioactive sources are controlled properly. However, radiological accidents have occurred in all regions of the world, which indicates that there is not always sufficient control of sources throughout their life cycle. Even advanced countries with developed regulatory systems lose track of sources each year, resulting in orphan sources with the potential to cause incidents or accidents. Actually, an increasing number of cases of uncontrolled movement of sources are reported to the IAEA's Illicit Trafficking Database.

The challenge is therefore to facilitate the continuing use of radioactive sources while ensuring that they are used in a safe and secure manner to protect individuals, society and the environment.

The events of 11 September 2001 led to an increased awareness of the possible use of radioactive sources for malicious purposes, for example by shrouding conventional explosives with radioactive sources to disperse the radioactive material in an urban environment. Although such radiological dispersal devices (RDDs) could cause major socioeconomic disruption, the effects would not be comparable to the detonation of a nuclear weapon; therefore RDDs should not be considered the same as nuclear explosive devices. Nonetheless, radioactive sources are more easily accessible, and their potential use by terrorist groups is a threat with higher probability that needs to be taken seriously and that requires a coordinated and international response. The International Conference on Security of Radioactive Sources, held in

Vienna in 2003, addressed these concerns and called for international initiatives, including the updating of the IAEA Action Plan for the Safety and Security of Radioactive Sources. As a direct result of the updated Action Plan, the Code of Conduct on the Safety and Security of Radioactive Sources was revised and was approved by the IAEA Board of Governors in 2003. Its supporting Guidance on the Import and Export of Radioactive Sources was developed and approved in 2004, and the Safety Guide on Categorization of Radioactive Sources was completed recently. All three documents were developed under the auspices of the IAEA to achieve international consensus, and they play a central role in this conference. It is worth noting that more than seventy countries have already expressed their intention to follow the guidance given in the Code of Conduct, and I would like to encourage more countries to do so.

The G8, at its meeting in Evian in 2003, expressed its full political support for the IAEA actions and for the Code of Conduct and encouraged all States to work towards increasing the safety and security of radioactive sources.

At Sea Island in 2004, the G8 gave its support to the guidance on the import and export of high risk radioactive sources, which was developed under the auspices of the IAEA and was subsequently endorsed by the IAEA General Conference in September 2004. United Nations Security Council Resolution 1540, in its preamble, recognized the recommendations given in the Code of Conduct.

The effects of radiation exposure are well documented and, as with all potentially hazardous materials, safety has always come first, as demonstrated by the comprehensive array of Safety Standards developed by the IAEA. Although security requirements have been included in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources since 1996, the emphasis was historically on prevention of unauthorized access without malice aforethought. The IAEA has actively promoted both the safety and the security of radioactive sources by organizing several major international conferences. The first of these was held in Dijon in 1998, on the Safety of Radiation Sources and the Security of Radioactive Materials, followed by the International Conference of National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Materials held in Buenos Aires in 2000. In addition to raising awareness and promoting information exchange, these conferences have given major direction to the IAEA's activities, especially by way of the Action Plan for the Safety and Security of Radioactive Sources, which was first approved by the IAEA Board of Governors and endorsed by the General Conference in 1999 and was subsequently updated in 2001, immediately before 11 September. Other related conferences include the International Conference on Measures to Prevent, Intercept and Respond to Illicit Uses of Nuclear Material and Radioactive Sources, held in Stockholm in 2001, and the conference on Nuclear Security: Global Directions for the Future, held in London in March 2005. The London conference considered the threat of malicious acts involving nuclear and other radioactive material; the experiences, achievements and shortcomings of national and international efforts to strengthen the prevention and detection of, and response to, malicious acts involving these materials; and the ways and means to achieve future improvements. The findings of the President of the London conference will be presented this afternoon.

The IAEA has been promoting for some time now the idea of a global nuclear safety regime. At the heart of this regime is a strong and effective national safety infrastructure where, as an overriding priority, safety issues are given the attention warranted by their significance. The need for a sustainable regulatory infrastructure for the safety and security of radioactive sources was discussed at the International Conference on National Infrastructures for Radiation Safety, organized by the IAEA in Rabat in 2003. Following that conference, an IAEA Action Plan was developed and was approved by the IAEA Board of Governors that includes actions to assist Member States in establishing sustainable regulatory infrastructures.

Playing a leading role in the global efforts to improve the global nuclear security framework has been included in the IAEA's Medium Term Strategy. It will focus on enhancing the sustainability of nuclear security programmes in Member States, complementing their nuclear safety programmes.

The IAEA has also conducted practical activities to promote safety and security in a synergetic manner. The Tripartite Agreement between the Russian Federation, the United States of America and the IAEA has successfully improved the situation in several countries of the former Soviet Union. An IAEA Technical Cooperation project, often called the Model Project, has helped more than eighty Member States improve their regulatory infrastructures. Upon request from Member States, the IAEA has provided more than a hundred expert missions in areas related to:

— National strategy development;
— Upgrading the safety and security of sources;
— Management of disused sources;
— Searching and securing orphan sources;
— Transport of radioactive material;
— Emergency preparedness;
— Appraisal of the regulatory infrastructure (RASSIA);
— Strengthening nuclear security (INSServ);

— Organizing workshops and training.

The IAEA's International Catalogue of Sealed Sources and Devices helps Member States' authorities identify orphan sources. The Regulatory Authority Information System (RAIS) helps regulatory authorities maintain up-to-date source inventories. The Illicit Trafficking Database (ITDB) lists hundreds of incidents that have occurred in the past decade. These incidents may not have had a malicious origin, but they do indicate that all is not well with the control systems, as will be explained later in this conference.

Recognizing that States other than IAEA Member States also use radioactive sources, the Agency is helping some of those countries.

Looking to this week, I hope that the focus of the discussions and the outcome of this conference will include concrete measures to:

(1) Encourage the wider implementation of the Code of Conduct and the Guidance on the Import and Export of Radioactive Sources. The conference will devote the whole of tomorrow to this topic.
(2) Enhance awareness and preparedness and a firmly rooted culture for safety and security at all levels, from senior officials and managers to those who work directly with radioactive sources.
(3) Promote improved continuity of control, so that there is no gap in control at any stage of the source life cycle and no lapse of security. Several sessions of this conference will address related topics, such as continuity of control; source manufacture, transport, import and export; and management of disused sources, including disposal.
(4) Consider what more might be done to ensure sustainability of the national system of control. Both the regulatory and the technical infrastructure must be sustained. In order to achieve sustainability, governments must give safety and security a high priority and ensure that sufficient resources are made available, taking advantage of bilateral, regional or other cooperative agreements. I hope that the understanding derived from this conference will help countries give higher priority to sustainability of the infrastructures required for the safety and security of radioactive sources.
(5) In recognizing the international nature of the use of radioactive sources and being aware that malicious acts involving sources could occur anywhere in the world, promote the development of a global network of control systems and information sharing.
(6) Lead to a fuller recognition that those primarily concerned with safety and those primarily concerned with security work cooperatively, and seek to strengthen the synergies that exist. We should remember that the

overall objective of our work is to protect people and the environment from the harmful effects of radiation and from its malicious use, without hindering its many beneficial uses. If we are to achieve this objective, we must further utilize the synergy between safety and security.

I hope that this conference will also generate new ideas and further initiatives to promote sustainable control of radioactive sources, to implement the Code of Conduct and to enhance international cooperation. We gratefully acknowledge the participation of 65 countries and 12 international organizations in this conference, which should help to strengthen such cooperation.

The IAEA is grateful to the Government of France for hosting this conference and to the cooperating organizations, whose representatives will speak to us this morning.

Now it is my pleasure to introduce Mr. Jean-François Lacronique, President of the Institut de radioprotection et de sûreté nucléaire, France, who has kindly agreed to act as President of this conference.

OPENING ADDRESS BY THE PRESIDENT OF THE CONFERENCE

J.-F. Lacronique
Institut de radioprotection et de sûreté nucléaire,
Fontenay-aux-Roses, France

It is a great honour for my country that I am here on this podium. First, I would like to thank the International Atomic Energy Agency for having worked to develop a rich programme that will last almost five days — five days in a magnificent place, the city of Bordeaux, barely one week after the great world viticultural event, Vinexpo. I hope that no one here got the date wrong, for we will certainly not be talking about the region’s main activity, although the nuclear medicine service of the Bordeaux teaching hospital, scientifically, has one of the best reputations in France. It doesn’t export, though.

A bit of history: This meeting is, I believe, the fourth in a series organized by the IAEA, the first of which took place in Dijon, as I recall, in 1998. Two years later, it was in Buenos Aires that Abel González hosted us grandly.

The tragic events of 2001 have unfortunately brought a new and pressing urgency to the in-depth study of the security of radioactive sources. I am of course thinking of the terrorist attacks of 11 September, but I am also thinking of another event which occurred not far from here, in Toulouse, ten days later — the explosion of a chemical factory situated in a residential area, causing the deaths of some 15 people, along with considerable damage and hundreds of injuries. I speak of this accident here because, in the hour that followed it, even as the first responders were rushing in to rescue the victims, we learned, thanks to a proven tracking system for radioactive sources, that 14 sources of various types were listed for this site and that it was very important to find them, as one of them was a cobalt-60 source of several thousand curies. As of the next day, all of these sources without exception were found in the factory ruins and secured, thanks to the system for declaring and tracking radioactive sources put in place 20 years earlier. Thus no rescuers were exposed. Incidentally, several days later, this event on the fringes of the explosion resurfaced in banners at a protest, but it came to nothing because the principles of security had been fully respected.

In fact, we have been confronted on numerous occasions with discoveries of sealed sources in the environment, most often abandoned, sometimes long before, such as hundreds of medical radium sources mostly predating the Second World War, gauges in discarded tanks, radon emitters, etc. For these, it is rare to find the owners of the sources. However, for 20 years, the inventory of radioactive sources in France, like that of sites polluted by radioactivity, has been continually updated, and it almost always enables us to quickly resolve problems of securing known sources, specifically in the aftermath of incidents, thefts or accidents such as the one in Toulouse.

This inventory allows us to estimate the number of sources in permanent use in France at roughly 30 000. We know that there are more than a million of them around the world, a worrisome proportion of which are still mobile and about which little is known.

Two years ago, the Summit of G8 Heads of State that met at Evian in France solemnly declared in a final resolution that particular attention should be paid to securing radioactive sources which could be used for malevolent purposes. It was then decided to hold a review meeting in France that would enable the progress of measures taken throughout the world to be determined. It is this meeting that we are holding this week. This means that we are addressing — beyond the community of specialists — the entire world, everyone for whom nuclear security is a subject of great importance.

To all of those who sometimes quite rightly use the term ‘political will’ in deploring its insufficiency or absence, I would like to give two examples from our field of activity. From 2000 to 2002, we launched a campaign in France for the recovery of radium objects which led to the discovery of more than 600 items, representing approximately four grams of pure radium. This weight, which some may consider minimal, nevertheless represents significant activity, since the residual balance worldwide, calculated on the basis of manufactured quantities, is currently estimated at ten or so grams.

The United States of America has undertaken a similar campaign, but on a larger scale, and I believe 3000 objects have been found over the past two years, including several strontium based power generators.

These figures illustrate several things and raise other problems. They show that the uses of radioactivity are very numerous and varied and that they have evolved significantly over time, without concealing the fact that certain techniques have had to be discontinued as their disadvantages outweighed their advantages. We remain in a discipline which is constantly changing, constantly being evaluated, and in which a critical mind is even more necessary than elsewhere, if only to regain the confidence which is granted to us by the public with increasing reluctance and which we must once again merit.

OPENING ADDRESS OF THE EUROPEAN COMMISSION

A. Janssens
European Commission, Luxembourg

It is my privilege to welcome you, on behalf of the European Commission, represented here by DG TREN. I am standing here as Head of the Radiation Protection unit; maybe Ms. Andrés-Ordax should have had this honour as a member of the Programme Committee. Together, Ms. Andrés-Ordax and I represent the units in the Directorate in charge of the HASS Directive: the Radiation Protection unit, TREN H4, as the initiator and the legal cell of unit H1, in terms of its transposition into national legislation and international liaison on the Code of Conduct on the Safety and Security of Radioactive Sources and the Guidelines on Import and Export.

Other DGs of the Commission are very active in this field also — ELARG, RELEX. On Wednesday I will present both the HASS Directive and the actions of the other DGs. On behalf of these different departments I am pleased to emphasize in this ceremony that for the European Community this conference is very important, and I congratulate the IAEA and our French hosts for putting so much effort into its success.

The emphasis of the Community actions is on the safety of sources. What about security? On the one hand, security concerns are met to a large extent if safety is properly addressed. On the other hand, in terms of subsidiarity of actions at Community and national level, security is largely a national matter, even though actions are undertaken to coordinate national initiatives. The fact that there is no explicit mention of security in our legislation relates to the legal basis of Directives and their binding character. It does not mean that it is ignored.

On the other hand, I feel (and this is my personal view, not an official position) that the possible impact of malevolent uses of radiation sources, causing societal disruption much more than a significant impact upon health, needs to be addressed in full transparency and empowerment of the citizen. Secrecy and confidentiality, while sometimes necessary, should not hinder the flow of information. We need facts to prepare for an emergency of this type.

I hope this conference will enhance significantly the political consensus towards ensuring the safety and security of sources and prompt countries to take all practical measures that are necessary to ensure proper control of sources in current use, to recover orphan sources, and to inform and train people so that they act responsibly.

INTRODUCTION TO EUROPOL

L. Salgó
Serious Crime Department, European Police Office, The Hague

First I would like to thank the IAEA for the organization of and the invitation to participate in this important international conference, and also the French authorities for hosting the event.

1. INTRODUCTION

The European Police Office (Europol) is based in The Hague, Netherlands. Our mission is to support the investigations of the European Union Member States in the fight against serious crime.

To this end, Europol is active mainly in the exchange of information and analysis of data in the field of organized criminality, in cases where at least two Member States are involved.

Europol is accountable before the Council Justice and Home Affairs Ministers, and works under the rules of the Third Pillar of the European Union, which relates to intergovernmental cooperation in judicial and police matters.

2. SC5 REMIT: COUNTER-TERRORISM PROGRAMME AND COUNTER-PROLIFERATION PROGRAMME

Among our mandated areas, two are of special interest in this forum: terrorism, and illicit trafficking of nuclear and radioactive materials.

In the field of counter-terrorism, we have developed partnerships beyond the European Union boundaries and established a permanent communication channel with the United States authorities, through two Europol liaison officers posted in Washington.

In the field of combating illicit trafficking, we are actively cooperating with the IAEA and the European Commission, especially with the Directorate-General for Energy and Transport, and the Joint Research Centre. We have also developed partnerships or projects with the International Technical Working Group on Nuclear Smuggling, the International Criminal Police Organization (ICPO-Interpol), the Organization for Security and Co-operation in Europe, the Southeast European Cooperation Initiative, the

United Nations Interregional Crime and Justice Research Institute, the World Customs Organization and, more recently, the European Network of Forensic Science Institutes.

Although we focus our efforts mostly within the European Union, the nature of this specific threat obliges us to keep a much broader view in order to understand and participate in the prevention of the phenomenon.

Consequently, in addition to other regional and international organizations, Europol is also developing cooperation agreements with other countries outside the European Union. These cooperation agreements allow us to exchange information of a strategic or operational nature (i.e. personal data).

3. EUROPOL PRIORITIES

Europol considers that its priorities are to facilitate the exchange of intelligence within the law enforcement community, and to bridge the gap between the law enforcement community and the scientific community.

The constraints are multiple:

— Scientists are not always able to provide law enforcement personnel with enough accessible information.
— The available information is often not detailed enough to discern a criminal intention behind the cases.
— Some police officers do not consider illicit trafficking a priority compared with other forms of crime, and furthermore consider it to be a matter for a specialist.
— Training provided by international agencies is usually given in English, so the audience is rather restricted in many countries.
— Detection devices, their maintenance, and training are expensive. The camouflage of smuggled radiological material by a legal radioactive shipment for industrial or medical purposes can be uncovered only by well trained, well equipped and motivated personnel.
— It is hard to keep front-line officers motivated in routine controls, as smuggling routes are chosen to carefully avoid stationary radiation monitors.

Our current activity consists of keeping a constantly updated knowledge of the threat, by collecting data from various sources and analysing them when it is possible. We also participate in seminars, technical workshops and field training in cooperation with the IAEA and the European Commission, and we produce strategic reports that are disseminated to our Member States. We have also contributed to various IAEA documents related to combating illicit trafficking,[1] and to the dissemination policy of the International Catalogue of Sealed Radioactive Sources and Devices. In addition to this, in 2004 Europol became a member of the Inter-Agency Committee on Response to Nuclear Accidents (IACRNA). The Incident and Emergency Centre of the IAEA provides the secretariat for this committee. The committee focuses on the preparedness for and response to an actual, potential or perceived nuclear or radiological emergency.

Europol has also been developing awareness and knowledge, and to this end, since the attacks of 11 September 2001 we have organized in The Hague two high level conferences and an experts' meeting on the Chemical, Biological, Radiological and Nuclear Threat; and a conference on Smuggling of Nuclear and Radioactive Materials. We are now preparing a second conference on this topic for the end of 2005. This conference, to be held in The Hague in cooperation with the European Commission and the customs authorities of the United Kingdom, will mainly focus on naturally occurring radioactive materials. We would of course welcome the support and involvement of the IAEA, which has always been much appreciated in the past.

4. CONCLUSION

The malevolent use of radioactive sources presents a potential for the disruption of economic and social life of varying magnitude. This can be severe in a scenario involving a radiological dispersal device (RDD). Despite a very limited actual impact on public health, the effects of RDDs may involve huge decontamination and medical costs, and lasting psychological and financial effects.

While the collection of human and electronic intelligence on terrorist and organized crime groups remains the best preventive action available, the sharing of information and experience is crucial in order to prepare an appropriate reaction by the authorities and the public. We strongly believe that a sufficient level of preparedness could limit the consequences of such an

[1] IAEA-TECDOC-1311, Prevention of the Inadvertent Movement and Illicit Trafficking of Radioactive Materials; IAEA-TECDOC-1312, Detection of Radioactive Materials at Borders; IAEA-TECDOC-1313, Response to Events Involving the Inadvertent Movement or Illicit Trafficking of Radioactive Materials; draft manual for law enforcement.

attack, the psychological impact of which could be as serious as any physical effects it may cause, if not more so.

This conference represents an opportunity for us to strengthen our cooperation framework and adds to our efforts in countering the threat and increasing our preparedness level. Therefore I would like to thank the IAEA again for its effort in bringing together such a wide audience around this extremely important issue.

OPENING ADDRESS OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

L.-E. Holm
International Commission on Radiological Protection

On behalf of the International Commission on Radiological Protection (ICRP), it is a great privilege and pleasure to welcome you all to the International Conference on the Safety and Security of Radioactive Sources here in beautiful Bordeaux.

The objective of the conference is to promote a wide exchange of information on key issues relating to the safety and security of radioactive sources, which will include finding a solution to situations resulting from past activities and defining a global cooperative approach to the continuous control of radioactive sources during their life cycle.

Radioactive sources are extensively used around the world in medicine, industry, agriculture, research and education. Loss of control over some radioactive sources has resulted in the spread of 'orphan' sources, some of which have caused serious injuries and death to people. The possibility that radioactive sources could be used for criminal purposes to contaminate the environment or densely populated areas has caused additional concern. All this highlights the importance of ensuring proper control of radioactive sources during their life cycle. The safety and security of radioactive sources therefore remain a matter of concern and high priority for international organizations dealing with the safe management of radiation.

The primary aim of the recommendations of ICRP is to provide an appropriate standard of protection for humans and the environment without unduly limiting the beneficial actions giving rise to radiation exposure. This aim cannot be achieved on the basis of scientific concepts alone. All those concerned with radiological protection have to make value judgements about the relative importance of different kinds of risk and about the balancing of risks and benefits. In this, they are no different from those working in other fields concerned with the control of hazards.

ICRP's recommendations presume that, as a precondition for proper radiological protection, sources of radiation exposure are subject to proper security measures. This presumption is reflected in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS) issued in 1996 by six international organizations. There has been a close connection between ICRP's recommendations and the

BSS, right from the early 1960s. The BSS have always followed the establishment of new ICRP recommendations; for example, the 1977 and the 1990 ICRP recommendations were the basis for the revised BSS published in 1984 and 1996, respectively.

ICRP has for a long time been concerned about radiation accidents, some of which have had very serious consequences. ICRP has published recommendations on how to prevent radiation accidents and how to mitigate the consequences in the event of such an accident. When ICRP's current recommendations were developed, measures to specifically protect against terrorism or other malicious acts were not in focus. However, much of the necessary security is already part of safety, and when it comes to a particular issue, it is a national decision as to whether additional security measures are required.

Great progress has taken place in the safety and security of radioactive sources over the last decade. ICRP welcomes the efforts that the IAEA has committed to this issue over the years, as reflected in the various conferences, particularly those in Dijon in 1998, Buenos Aires in 2000 and Vienna in 2003. The conference in Rabat in 2003 demonstrated that a good regulatory infrastructure is an important aspect of the safety and security of sources. The approval by the IAEA Board of Governors and the IAEA General Conference of the Code of Conduct on the Safety and Security of Radioactive Sources in 2003 was a major step forward. Since then, many countries have expressed their commitment to work towards implementing the requirements of the Code of Conduct.

ICRP has expressed its view on the need for control of radioactive sources in several publications. The Code of Conduct is in line with ICRP's views on safety and security, and adherence to these requirements will strengthen the control of radioactive sources. There is often a discussion about how security relates to safety. In the international standards, the BSS, security has always been an integral part of safety. The concept of safety means prevention of accidents and, should they occur, mitigation of their consequences. Security means prevention of unauthorized actions by ensuring that control is not relinquished or improperly acquired. A radioactive source that is secure (i.e. kept under proper control and physically protected) is not necessarily also safe (i.e. unlikely to harm people). Conversely, a radioactive source cannot be judged to be safe if it is not secure. Therefore it follows that, for radioactive sources, security is a necessary, but not a sufficient, element of source safety. Source security is a subsidiary to source safety.

I am pleased that so many delegates have been nominated by their governments to attend this meeting. This 2005 conference in Bordeaux will give us a better understanding of the risks posed by radioactive sources, and will help us find ways to reduce the likelihood of a radiological accident. I also hope that when we leave the conference we shall have a common understanding on the feasibility of creating a global system for ensuring the safety and security of radioactive sources.

OPENING REMARKS
OF THE INTERNATIONAL LABOUR OFFICE

Shengli Niu
International Labour Office

On behalf of the Director-General of the International Labour Organization (ILO), Mr. Juan Somavia, I welcome you all most warmly. The ILO is extremely pleased to join the European Commission, the European Police Office (Europol), the International Commission on Radiological Protection (ICRP), the International Criminal Police Organization (ICPO-Interpol), the International Radiation Protection Association (IRPA), the World Customs Organization (WCO) and the World Health Organization (WHO) in cooperating with the IAEA on this important international conference.

We need cooperation because the safety and security of radioactive sources throughout their life cycle require concerted efforts from all the relevant sectors and partners. I thank the IAEA for its commitment to interagency cooperation. I also thank the host of the conference, the French Government, for its hosting of this important event.

I am very happy that the safety and security of radioactive sources continue to be a priority endeavour of the IAEA. One sound workplace prevention and protection principle promoted by the ILO is to give priority to controlling the risk at source.

The ILO creates international labour standards, including standards on safety and health at work, and has a unique system to supervise their application. In June 1960, the International Labour Conference adopted a Convention concerning the Protection of Workers against Ionizing Radiation (No. 115) and its accompanying Recommendation (No. 114). The Convention applies to all activities involving the exposure of workers to ionizing radiations in the course of their work. Requirements concerning the safety and security of radioactive sources are included in these international legal instruments.

At the global level, we cherish our good cooperation with other relevant international organizations on setting up international guidelines and standards on radiation safety and protection. We believe that such cooperation not only facilitates the implementation of ILO Convention No. 115 by our constituents but also increases, at the national level, the synergy impacts of the relevant international policies on radiation safety and protection formulated by other organizations. Our common goal is that our activities be not only complementary but also mutually supportive.

The ILO also uses in a coordinated manner the various means of action available to it to provide support and services to governments and to employers' and workers' organizations in drawing up and implementing programmes which will contribute to safety and health at the workplace. Accidents occur not always because people don't know the safety rules. In many cases, people do know the safety rules but choose to ignore them or do not follow them strictly.

We in the ILO expect enterprises and workplaces to follow proper occupational safety and health management systems so as to avoid accidents, diseases and other problems at work. To achieve this, there is a need for:

— Clearly defined national policies, which should usually result in national standards and laws and their enforcement;
— National structures and mechanisms, i.e. who is in charge of what;
— Designation of responsibilities and accountabilities, and allocation of resources;
— National action plans and programmes;
— Follow-up, monitoring, review and feedback to enhance the process using selected indicators;
— Continuous improvement in measurable steps at the national level.

The International Labour Conference just finished a discussion two weeks ago concerning the development of an instrument establishing a promotional framework on occupational safety and health. This instrument will be finalized at the 2006 International Labour Conference and most probably will be in the form of a convention accompanied by a recommendation. This instrument will provide guidance on national policy, national systems and national programmes on occupational safety and health. This instrument, once adopted, will contribute to the launching of national comprehensive programmes on safety and health at work which will promote an integrated approach to address all workplace hazards, including radiation. We would be pleased to encourage our constituents, namely employers, workers and labour departments, to do their share in our concerted efforts for achieving a safer and healthier working and living environment for all workers and the public.

In conclusion, establishing a global system for the continuous control of radioactive sources throughout their life cycle will be an important step towards the prevention of unnecessary disability and suffering, including death, among the public and workers. Hence we shall continue our work for the safety and life of all people.

WELCOMING REMARKS OF THE INTERNATIONAL RADIATION PROTECTION ASSOCIATION

B. Dodd
International Radiation Protection Association

1. INTRODUCTION: ROLE OF THE INTERNATIONAL RADIATION PROTECTION ASSOCIATION

Little did I imagine when I wrote the organization of this conference down in the programme of work for my unit at the IAEA four years ago that I would be here helping to open the conference on behalf of the International Radiation Protection Association (IRPA). You can imagine my joy at being here and seeing this work come to fruition.

The role of IRPA is to provide a medium for communication and advancement of radiation protection throughout the world by encouraging: (a) the establishment of radiation protection societies; (b) professional enhancement, publications and the support of international meetings; and (c) the establishment, review and implementation of universally acceptable radiation protection standards and recommendations. The last two are of particular relevance here.

2. OUTLINE OF IRPA

IRPA is an association of national professional societies for those involved in radiation safety and is managed on a routine basis by its Executive Council, several of whom have been involved with the IAEA for many years. IRPA has grown over the years to now include about 45 associated societies and 20 000 members. It holds regional congresses frequently and international congresses every four years. It is appropriate to highlight the next regional congress, to be held in Paris in 2006, and the next international congress, to be held in Buenos Aires in 2008. Plan now to visit beautiful Argentina in 2008 and see how far we have come in implementing the findings resulting from this conference. More information on IRPA can be found on its web site (www.irpa.net).

3. IRPA, THE IAEA AND BORDEAUX

IRPA cooperates with many international organizations, particularly with regard to meetings such as this as well as the establishment, review and implementation of standards and recommendations. For example, it actively solicited member comments on the proposed revisions to the recent recommendations of the International Commission on Radiological Protection (ICRP) and had a major session on them at the IRPA-11 congress in Madrid.

Similarly, IRPA has been involved in international action plans, including the IAEA Action Plan for the Safety and Security of Radioactive Sources which led to this conference. IRPA and its members recognize the current importance of the safety and security of radioactive sources. Frankly, it is likely that the members of IRPA are the ones who will be trying to implement the findings of this conference. Therefore it is fitting that IRPA and its members be here to help formulate them.

IRPA's presence at this conference is also fully consistent with two aspects of its future focus: (a) the establishment of mechanisms to achieve globally accepted professional opinions, and (b) the provision of input to safety standards and recommendations from radiation safety professionals.

Hence on behalf of IRPA I would especially like to welcome all member participants and to wish the conference every success.

WELCOMING ADDRESS OF THE WORLD HEALTH ORGANIZATION

H. Zeeb, Z. Carr, S. Yamashita, M. Repacholi
Radiation and Environmental Health Unit,
World Health Organization, Geneva

It is with great pleasure that the World Health Organization (WHO), through its Radiation and Environmental Health Programme, has agreed to cooperate in this important conference.

The conference is expected to foster a better understanding of risks from radioactive sources and aims at identifying ways to reduce the likelihood of accidents or malevolent acts involving radioactive sources. This is in line with WHO's mandate to develop and implement evidence based policy for Member States aimed at reducing risks and protecting human health from exposure to ionizing radiation of any nature. Furthermore, preparedness and response to events involving such risks are among the topics addressed by both the conference and the WHO Radiation and Environmental Health Programme. A sustainable global safety and security system for the future can only be achieved through capacity building, partnership development and up-to-date information available to all stakeholders. This conference is an excellent opportunity, providing an international forum for implementing these requirements.

One of the key activities of the WHO Radiation and Environmental Health Programme is medical assistance to Member States in the event of a radionuclear emergency, implemented through WHO's Radiation Emergency Medical Preparedness and Assistance Network (REMPAN). In this field, WHO works in close collaboration with the IAEA. The network provides medical advice and assistance to minimize health risks to affected individuals and populations after an accident, as well as in terms of preparedness through special education and training. Currently there are 29 WHO collaborating centres and liaison institutions specialized in treatment of radiation injuries and acute radiation syndrome, biodosimetry, and long term follow-up and surveillance. Links have been established with the European Bone Marrow Transplant Network.

Under the leadership of the IAEA, WHO recently participated in a nuclear emergency exercise, CONVEX (3) 2005, to test the readiness of REMPAN, WHO's responses and communications with the press.

WHO collaborates with various agencies in the field of radiation safety. For example, through the Inter-Agency Committee on Radiation Safety, WHO is involved in the review and revision of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, and has co-sponsored the IAEA's Safety Guide on the Regulatory Control of Radiation Sources (IAEA Safety Standards Series No. GS-G-1.5), a matter of central interest to this conference, as well as numerous Safety Reports, Technical Documents and other publications.

Beyond these activities, WHO has also looked into the issue of radioactivity levels in food and water. For example, WHO has developed Guidelines for Drinking Water Quality, and has worked with the Food and Agriculture Organization of the United Nations on the updating of recommendations of the Codex Alimentarius concerning radionuclides in foods following a release of radioactive materials. These few points undoubtedly confirm the interest and support of WHO for this conference, to which WHO welcomes all participants wholeheartedly.

REVIEW OF THE POLITICAL, SCIENTIFIC AND TECHNICAL BACKGROUND OF THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

(Background Session)

Chairperson

T. TANIGUCHI

IAEA

THE ROAD FROM DIJON TO BORDEAUX

A.J. GONZÁLEZ
Autoridad Regulatoria Nuclear,
Buenos Aires, Argentina

Thank you for inviting me to present a brief history of our understanding in the area of the security of radioactive sources. Perhaps it would have been better to invite a historian for this, because I was part of that history and, of course, I have a biased opinion. The title of my presentation could give you the idea that I am going to talk about wine and mineral water (the road went via Evian), but in fact it shows the great commitment of the French Government to this issue. I believe we have to underline this — we have to be extremely grateful to the French Government, not only for hosting this conference, but for what has been done in this area over the years.

History always has a prehistory, which gives the context. Therefore let me talk a little about the prehistory as well. At the beginning of radiation safety, when the International Commission on Radiological Protection (ICRP) was formed, all the international recommendations and standards took the safety and security of sources for granted. The basic concept was that abnormal situations should be prevented, without it being clearly said what 'prevented' meant. In 1970, there was a brief moment of enlightenment when the IAEA issued a standard covering the security of thermogenerators operated by highly radioactive sources, the same thermogenerators that later caused so many problems because the guidelines were not followed. Certainly this concerned the few who were handling these thermogenerators, but it was not a universal issue. In 1988, there was a kind of awakening, at least for me. I believe that my professional life changed dramatically after this event. This event showed for the first time that this famous safety and security that we had taken for granted was not there.

Let me recall Goiânia. An insecure caesium source in a radiological clinic was scavenged and moved to a junkyard, the source capsule was ruptured with dispersal of caesium chloride, the city was contaminated, 14 people were exposed, four died, 112 000 were monitored, 85 000 were contaminated, and 5000 cubic metres of radioactive waste was produced. A similar scenario would apply to a case of malicious use, even to a terrorist attack. All this was caused by a source that was two inches wide, with 93 grams or 1000 curies of powdered caesium. That was a tremendous lesson for me.

The 1990s created an international reaction to this, establishing the basis, the fundamentals and requirements that are still in operation internationally.

They are the first international norms that recognize explicitly that the safety of radiation sources is essential for public protection and that the security of radioactive sources is a necessity for radiation safety. Safety, as was said at the beginning, means to constrain radiation harm; security means to inhibit unauthorized possession and unlawful use of radiation sources, for instance by ensuring that control over the sources is not relinquished or improperly acquired. In the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, therefore, security was, is and — I hope — will continue to be an integral part of safety, according to the IAEA Statute, which is the basis of all the work of the IAEA on safety.

Therefore, as was said this morning, safety and security are not separate issues, there is no question of synergies and interaction, security does not override safety, security is a part of safety, at least in international standards. This has to be underlined very clearly, and, as was said this morning, this is because of simple logic. While a radioactive source that is secure is not necessarily safe, a radioactive source cannot be safe if it is not secure. It follows that source security is a necessary but not sufficient condition for source safety. Within the context of radiation sources, security is just one element of safety.

Turning to the history from Dijon to Bordeaux, I can testify that reading history is less risky than making it. 1998, I would say, started an era of reason in this area. We started to understand issues with the famous Dijon conference, and I want to underline again the vision of the French Government at that time in initiating this conference at a time when many countries did not believe that this was an issue. The main message from Dijon, as you may read in the proceedings of the conference, was that keeping radioactive sources under control was a serious international challenge and that countries should undertake international obligations that guaranteed proper control. In 1998 we were saying this and we are still not there. In 1999, for the first time, we publicized the issues to a wider audience. This was in an IAEA Bulletin which can still be found on the IAEA web site.[1]

In the year 2000, action started with regulatory enlightenment. This was the conference in Buenos Aires. Not only Dijon and Bordeaux have good wine. In Buenos Aires we have a Malbec which is extremely good. The conference in Buenos Aires was attended by many top regulators, including the President of this present conference. The main message from Buenos Aires was one to the regulators: You have a serious, unresolved problem, which is under your

[1] GONZÁLEZ, A.J., Timely action: Strengthening the safety of radiation sources and the security of radioactive materials, Int. At. Energy Agency Bull. **41** 3 (1999) 2, http://www.iaea.org/Publications/Magazines/Bulletin/Bull413/article1.pdf

responsibility. What are you planning to do about it? To the international community, the message was: The time is ripe for a serious international action plan that allows all regulators to help their neighbours, which means mutual help. There were post-Buenos-Aires initiatives: strengthening national control infrastructures, appraising compliance with regulatory standards, regaining control of orphan sources, collaborating with the industry in marking sources and improving physical characteristics, and border crossing monitoring. The IAEA's international Action Plan for the Safety and Security of Radioactive Sources that had been drawn up in Dijon was finally formalized after the Buenos Aires conference. Unfortunately, 2001 was a year of terrorism and confusion, which produced a lot of obscurantism and dogmatism.

Just two events: On one day, 10 September 2001, the Action Plan was approved by the IAEA Board of Governors, and the next day, 11 September, we had the terrorist attacks. This had a tremendous impact and there were, I would say, five ingredients for obscurantism. First there was a lot of public concern and media hype. The issue went out of our hands and into the media's. There were a lot of political demands. Politicians wanted solutions for tomorrow. Before 11 September, they were ignoring the issue; after 11 September, there was a demand for solutions tomorrow. There was certainly a lack of strategic planning. Large amounts of money were involved, which is always dangerous in such circumstances because there are always huge personal ambitions. Interestingly, initially there was clarity. Immediately after 11 September, the IAEA Board of Governors approved a crystal clear document on possible scenarios, divided into three groups: detonating improvised nuclear devices, sabotaging nuclear facilities and misusing radioactive sources or material for a 'dirty bomb'. The Board recognized these were three very different issues for 'nuclear security'. However, this clarity quickly degenerated into confusion, because at the beginning of 2002 an obscure document from the same Board scrambled approaches to existing problems.

Two main questions that may have clarified the post-September-11 situation were not answered — really three, in fact. Are radiological dispersal devices (RDDs) weapons of mass destruction? Certainly not! They are an element of terrorism but not weapons of mass destruction. Are nuclear weapons weapons of mass destruction? Oh, certainly yes! Are nuclear weapons radiological weapons? Not necessarily, as you will see. Why are RDDs not weapons of mass destruction? It is enough to see the likelihood that something will happen to people. This is the United Nations policy on the likelihood of what will happen with a given radiation dose. We can see this clinically at very high doses, epidemiologically at lower doses to a given limit, and below that not even epidemiologically. We cannot see the effects in this area, which is where doses occur that an RDD would produce. The risk is far too low to call an RDD a weapon of mass destruction. People forget that we cannot even detect these effects. For the range of doses that will occur because of an RDD, you need millions of people to see anything. How can you call this a weapon of mass destruction? And nuclear weapons? Well, nuclear weapons are certainly weapons of mass destruction and they need very solid security, particularly for those who have them. If you consider the case of Hiroshima, you will find that the area wiped out by the weapon is much larger than the area of deterministic effects. Believe it or not, practically nobody died in Hiroshima because of radiation. Hiroshima was not a radiological problem. The problem was the fact that tonnes and tonnes of TNT equivalent were thrown into a city. Even for the long term, the United Nations has clearly assessed that there is of the order of five hundred extra cases of cancer for the full Hiroshima study of 80 000 survivors. Even the sigma value for detecting this is very small — at the moment 4.6 sigma.

Therefore the security of nuclear weapons and material is not comparable with that of radioactive material, but after the events of 11 September, the two were scrambled. Nuclear security experts started to play the role of radiological security experts. There was an invasion of 'radiological security experts' in the last two years. Some are experts in the security of nuclear weapons and material — a very important area where I am not sure that everything has been done that should have been done. Many are experts in criminal and forensic science. Most just aim to manage huge financial resources and few have experience with radioactive sources. The logic that was not followed was the relative importance of issues and solutions. Security of nuclear material is extremely important. There is a regime of safeguards and non-proliferation to which we have to adhere. Crime prevention is extremely important — not only for radioactive and nuclear material — and we have a very active organization in the United Nations system that deals with that and which is represented here at this conference. The security of radioactive sources is an issue for the radiation safety community and for the regulatory bodies because, as the representative from the International Radiation Protection Association said, in the end it is one of them that will make the source secure or not.

There are two confusing words in use: 'holistic' and 'comprehensive'. Every time that you see these two words in an IAEA document, read them with care. The last attempt at rationality was in the IAEA Bulletin in 2001[2], with very little success.

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[2] GONZÁLEZ, A.J., Security of radioactive sources: The evolving new dimensions, Int. At. Energy Agency Bull. **43** 4 (2001) 39, http://www.iaea.org/Publications/Magazines/Bulletin/Bull434/article8.pdf

Yet in 2003 there was something that could have been a renaissance. Many things happened in 2003. The first thing was the March 2003 Conference on the Security of Radioactive Sources, which tried to bring the situation into focus again. This was a very successful conference attended by some 800 people from all over the world. Many of you were there. The direction was very clear: to locate, recover and secure powerful radioactive sources still at large to ensure their global and sustainable control. This clear direction still holds. In June 2003, the political understanding was added. The time was ripe and the G8 summit in Evian, France, which was originally intended to enable these leaders to meet after the Iraq crisis, was a success. It was a success not by chance but because of the work of many people. The French Government and the State Department of the United States of America — in particular Warren Stern's group — did an enormous amount of work to make this a great success. For the first time, politicians took the matter seriously. The Tripartite Initiative was established at the same time and was a very good example of where we have to go in this area.

In July 2003, we reached a key technical consensus. For the first time, we agreed on the meaning of dangerous radioactive sources and we then knew what we were talking about in terms of curies or becquerels. Also, since September 2003 we have focused on the importance of strengthening national infrastructures. The Conference on National Infrastructures for Radiation Safety: Towards Effective and Sustainable Systems, held in Rabat, Morocco, focused clearly on what our future should be in this area. The political undertaking came the same year with the adoption of the Code of Conduct on the Safety and Security of Radioactive Sources. I will not talk about this because Mr. MacIntosh will address the issue in detail during this conference. You know that, though legally non-binding, the Code of Conduct is an important political agreement, emphasizing the importance of security from cradle to grave, which we were pushing from the beginning.

The international agreement on import/export came at the same time and was an important success as well. We arrive in Bordeaux after a brief stop in London, which Mr. Loy will talk about, and the issues continue to be simple to formulate and resolve. They are: prevalence, orphanage, loss of control and unconventionality. Prevalence: Radioactive sources are abundant and widespread all over the world. Solution: Internationalized control. There is no solution to an international problem that is not international. Orphanage: Many radioactive sources are strays. Solution: Find them and regain control. Loss of control: Control is relaxed even with those sources that are well regulated. Solution: Impose international prescriptive regulatory requirements for ensuring control; otherwise we are talking theory. Involve manufacturers: This conference should recognize and promote the recently created association of manufacturers. Unconventionality: Many orphan sources are special and powerful. Solution: Exert pressure on the developed countries that irresponsibly let these sources become orphaned. The 40 000 curies irresponsibly abandoned in poor countries are a problem created by developed countries, not by the developing world. Abandoned, powerful sources are not a universal problem. They are a problem existing in a few areas and created by a couple of countries.

Following Bordeaux? We should deal with the legacy of past activities. The time is ripe for international binding obligations to recover orphan sources. The same goes for sustainability and continuity of control. Tripartite and IAEA experience will be absorbed and further initiatives with a lot of money will be launched, but no international initiative can replace countries' own action.

The Code of Conduct has been a great achievement with wide political adherence which should lead to factual implementation. There is no follow-up mechanism. International appraisal can be one of them. There must be international binding obligations to ensure that the provisions of the Code are followed by all.

Outlook — what to do if something happens. The ICRP has prepared some recommendations, and Mr. Holm will present them this afternoon. However, you will have the problem of maintaining normality if there is a malicious act involving radioactive material, because the journalists will exaggerate, and we have not solved this problem yet.

In summary, the time is ripe for binding commitments for a harmonized, effective and sustainable international regime for the safety and security of radioactive sources. Let us not forget that the world has 192 States. Let us help them and persuade them to be committed to helping each other. Let us go back to our Dijon proposals and insist that our political masters work towards an international convention on the safety and security of radioactive sources, because there will be no safety or security for any of us unless there is for all. Epilogue: continuing to confront a difficult dilemma — overreaction and irresponsibility.

COMMENTS BY THE CHAIRPERSON

T. TANIGUCHI (IAEA): Mr. González' very frank view is of a personal nature rather than an official IAEA view. His points on 'obscurantism', 'confusion' and 'invasion by security experts' reflect an issue that the IAEA is addressing in a more constructive and synergistic spirit, but a frank view is always quite welcome at this kind of conference. As you know, Mr. González is the main driver — promoter — of the initiative for better control of radioactive sources.

FROM LONDON TO BORDEAUX: INFORMATION ON THE INTERNATIONAL CONFERENCE ON NUCLEAR SECURITY (LONDON, MARCH 2005)

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Abstract

The International Conference on Nuclear Security: Global Directions for the Future, held in London in March 2005, addressed a broad range of issues arising in nuclear security. It heard of the international, regional and national efforts to prevent, detect and respond to malicious use of nuclear and other radioactive material and the sabotage of nuclear installations. The paper explains the definition of nuclear security and the suite of relevant international instruments. It draws attention to the development of the Convention on the Physical Protection of Nuclear Material, the Code of Conduct on the Safety and Security of Radioactive Sources, regional and international cooperation, the 'people' issues of nuclear security and the ongoing role of the IAEA.

1. INTRODUCTION

This paper presents the author's view of the International Conference on Nuclear Security: Global Directions for the Future, which took place in London in March 2005. The paper gives emphasis to matters judged by the author to be of particular interest to participants in the present Conference on Safety and Security of Radioactive Sources. For a complete and authoritative view of the London conference, the reader is directed to the Findings of the President of the Conference and the conference proceedings, which may be found on the IAEA web site.

The London conference was organized by the IAEA in cooperation with a number of relevant international bodies also involved in supporting the Bordeaux conference. It was hosted by the Government of the United Kingdom.

The theme of the London conference was whether the international community is doing enough to address nuclear security. This theme was highlighted in the keynote address at the conference given by United States Senator Sam Nunn, who most forcefully illustrated the question by asking what would be the reaction of the world the day after the occurrence of various scenarios that resulted in the use by terrorists of a nuclear device or a dirty bomb.

2. WHAT IS NUCLEAR SECURITY?

As defined in the President's Findings, nuclear security is the set of measures aimed at preventing, detecting and responding to the threat that terrorists will acquire and use for malicious purposes:

- Nuclear weapons;
- Nuclear material (HEU, Pu), which they use to build an improvised nuclear weapon;
- Radioactive material, which they use to construct a radiological dispersal device (or use in some other way for malicious purposes);

or achieve the dispersal of radioactivity through:

- Sabotage of nuclear installations or other facilities, or of radioactive material in transport.

Thus, at one end of this definition, nuclear security relates to the goals of nuclear non-proliferation in its concern to limit the spread of nuclear material and access to nuclear weapons. At the other end of the definition, it meets 'classic' nuclear safety and radiological protection.

The relevant international instruments bearing on nuclear security in this broad definition include: safeguards agreements and additional protocols concluded by countries with the IAEA; the Convention on the Physical Protection of Nuclear Material (CPPNM) — the substantial strengthening of which will be the subject of a diplomatic conference to be convened in July; the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; and the Code of Conduct on the Safety and Security of Radioactive Sources.

Further, United Nations Security Council Resolution 1540 sets out measures to be taken by UN Member States to counteract the spread of weapons of mass destruction, which are taken to include radiological and nuclear weapons, through adoption and enforcement of appropriate legislation. Also, subsequent to the conclusion of the London conference, the UN General Assembly has adopted the International Convention for the Suppression of Acts of Nuclear Terrorism.

Other international initiatives bearing upon nuclear terrorism include: the G8 Global Partnership against the Spread of Weapons and Materials of Mass Destruction; the European Union Strategy against Proliferation of Weapons of Mass Destruction; and the Global Threat Reduction Initiative.

3. CONVENTION ON THE PHYSICAL PROTECTION OF NUCLEAR MATERIAL

At present the CPPNM — an international convention and thus a legally binding undertaking — is essentially applied as an international instrument to the international transport of nuclear material. The proposal currently under consideration is that it be extended to cover the physical protection of nuclear material in use and storage within a country, as well as in transport, and to cover the physical protection of nuclear facilities. This proposal is to be considered at a diplomatic conference convening in Vienna the week after this conference in Bordeaux.

The presentation at London on the CPPNM, together with subsequent discussion, drew out a few matters that may be of particular relevance to this conference as it considers future directions for undertakings for the safety and security of radioactive sources.

First, it has taken a long time from the point at which the need to amend the CPPNM was identified until now, when a specific set of amendments is ready for consideration. The discussions about amending the Convention and the subsequent negotiations have taken over seven years. The formal negotiations started just prior to the events of 11 September 2001; they reached their climax just as the war in Iraq was starting! Conventions are serious matters for States and are not rushed, at least in most circumstances.

Secondly, any issue involving security measures taken internally is sensitive for States. There was and is a strong resistance to any appearance or to the reality of international prescription of security measures and to sharing of security related material. The proposed amendment to the CPPNM does promote a number of fundamental principles for physical protection. It is instructive to compare the broad generality of these principles with the level of detail about safety included in the international safety instruments and the Code of Conduct for sources. The international peer review process included in the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management is certainly not acceptable to States when dealing with the sensitivities of security.

On the other hand, despite the sensitivities, there does exist long standing international guidance on physical protection of nuclear material and nuclear facilities — in INFCIRC/225/Rev. 4. Some of the framework in this document directed at the protection of nuclear material may be equally applicable to establishing the framework for the security of radioactive sources.

4. CODE OF CONDUCT ON THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

The Code of Conduct is obviously a centrepiece for this conference. In London, the emphasis in presentation and discussion was on the idea that the Code does contain quite an extensive and demanding set of purely security requirements, certainly for the higher risk category sources. It was acknowledged that these provisions of the Code will be challenging for countries to apply.

It is quite an achievement that less than two years after the Code was approved by the IAEA Board of Governors and endorsed by the General Conference of the IAEA, more than 70 countries have made a public political commitment to work towards implementing the guidance in the Code. This is certainly a much faster 'take-up' than is the experience for conventions.

There remains then the problem of implementation of the Code — and indeed of the enhanced CPPNM if it comes into effect. This will be a challenge for countries and will require the support of international and regional arrangements, including support by the IAEA, particularly through the development of more detailed security guidance documents.

5. REGIONAL AND INTERNATIONAL COOPERATION

The London conference heard about an increasing amount of nuclear security work performed through bilateral cooperation programmes and regional partnerships, and through international organizations, including those mentioned at the start of this paper and, of course, the IAEA. There is an emphasis in this work on cooperation in finding and securing dangerous radioactive sources that have fallen out of control. One of the principal lessons to emerge for these efforts is the need for close cooperation between regional programmes and wider international programmes to achieve the most effective results.

6. PREVENTION, DETECTION AND RESPONSE

The three elements of prevention, detection and response form the basis of the notion of nuclear security. The instruments and approaches that have the objective of prevention of terrorist acquisition of nuclear and radioactive material were a major focus of the London conference, but there was also material presented on countries' experience in the second line of defence — detection, and also on planning for emergency response. These presentations focused on the practicalities of just how to organize these arrangements to apply on the scale of a country or a very complex city, or in the context of a vast international event such as the Olympic Games. Much can turn on what might be seen as simple matters, such as the reliability of radiation monitoring equipment and the effectiveness of arrangements for handling false positive readings, while allowing normal life to proceed.

7. PEOPLE AND SECURITY CULTURE

It was agreed by several speakers that to put nuclear security on a sustainable basis required the development of a 'security culture' amongst operators, regulators and responders. The notion of 'safety culture' will be well known to most at this conference. What exactly security culture is and how it interacts with safety culture are clearly topics that need further exploration. It may also be one thing to talk about security culture within a large nuclear installation and quite another to address it in a hospital or a small industrial radiography business.

The human dimension of security is clearly just as central as the human dimension of safety. In security, the 'insider threat' is a major one, and there are sensitive issues of the trustworthiness of employees and how this is established and continually verified. Many institutions working with radioactive sources are not at all used to the idea of checking staff trustworthiness. And even with otherwise trustworthy employees, it is found that there are human networks that may mean, for example, that members of the security staff of a nuclear facility are forewarned of the details of an exercise to test their security by their friends in the security auditing organization.

8. ROLE OF THE IAEA

The IAEA has been involved in physical security issues for a number of years, but following 11 September 2001, high priority was given to it through the development and approval of the Plan of Activities to Protect against Nuclear Terrorism. Much important groundwork has been accomplished through the Plan since its inception in 2002. This has been a substantial growth area supported by the contributions of States to the Nuclear Security Fund.

For the future, it was agreed that there is a need to reduce the ‘alphabet soup’ of different assistance missions to Member States and a need to move to integrated nuclear security support plans that address country needs. The importance of working with other international programmes to avoid any overlap or duplication was stressed.

Importantly, a ‘security series’ of documents needs to be developed to play a role analogous to that of the international safety standards, bearing in mind the dictum that the State is responsible for security. This security series will need to cover topics relevant to the protection of sources and the guidance of the Code of Conduct, as well as nuclear facilities.

9. CONCLUSION

The London conference was valuable in clarifying and describing the ‘universe’ of nuclear security, of which the security of radioactive sources is one part. It emphasized that there are many efforts being undertaken by the international community to address nuclear security, particularly at its ‘high end’, namely the security of nuclear material and nuclear facilities. The international framework for the security of radioactive sources has been laid out in the Code of Conduct. The challenge now is to work towards implementing the guidance in the Code.

The London conference concluded with support: for accelerating efforts to develop and implement a fully effective global nuclear security framework based on prevention, detection and response; for the expeditious agreement among State Parties on amending the CPPNM; for full implementation of the Code of Conduct and an enhanced CPPNM; for enhanced cooperation and coordination at the global, regional and bilateral levels; and for the IAEA assuming — and being resourced to deliver — a leading role, specifically for supporting the Member States, and for furthering international cooperation.

COMMENTS BY THE CHAIRPERSON

T. TANIGUCHI (IAEA): The London conference is of particular importance for the IAEA Secretariat because it provided the basis for the preparation of the new draft of the nuclear security plan for the next four years.

In that context there was a new focus on the CPPNM in anticipation of its amendment in July 2005. There was an equally strong emphasis on the Code of Conduct and bilateral, regional and global cooperation in this area. The draft nuclear security plan for 2006–2009 emphasizes synergistic work covering not only the Office of Nuclear Security but also the Division of Radiation, Transport and Waste Safety. The findings and conclusions of this Bordeaux conference should serve as a basis for further improvement of the current draft of the nuclear security plan.

SAFETY AND SECURITY: SUSTAINABLE CONTINUOUS CONTROL OF THE USE OF RADIOACTIVE SOURCES

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There is now wide agreement that safe and secure use of radioactive sources can only be ensured by commitment to continuous control measures. So, what is meant by continuous control? It is the implementation of regulatory oversight of radioactive sources at every stage of their life cycle, i.e. from cradle to grave. An effective and comprehensive cradle to grave regime has to extend beyond national borders. It requires participation by the international community in ensuring safe and secure use of radioactive sources.

We cannot ignore the wide extent of the distribution and use of radioactive sources. Each entity involved in any stage of the life cycle of radioactive sources has roles and responsibilities for the assurance of safety and security. Hence there has to be engagement by regulators, manufacturers, distributors, users and transporters. A life cycle approach to radioactive source management is a cornerstone for successful and effective regulatory control over high risk radioactive sources. Each entity should play its role and discharge its responsibilities with a commitment to assurance of safety and security in the use of these substances.

Competent national authorities should implement their regulatory requirements in accordance with the risk posed by the radioactive sources that fall within their jurisdictions. Their regulatory systems should be risk-informed in order to optimize resource allocation and so enhance the regulatory oversight of radioactive sources. Continuous regulatory oversight introduces challenges that need to be addressed. A primary one is the challenge of achieving effective international regulatory control without unduly restricting the medical, industrial, academic or research benefits received from the use of radioactive sources. Nuclear regulators have differing mandates when it comes to regulating radioactive sources, and these differences should not be ignored when addressing the issues of life cycle control of sources. In Canada, the nuclear regulator, the Canadian Nuclear Safety Commission, has as part of its mandate the requirement to regulate the production, possession, use and transport of nuclear substances to protect health, safety and security. It carries out these functions via a comprehensive regulatory licensing regime. Licensees are required to conduct their activities within their authorizations and with due diligence.

There are unique control and security challenges that need to be addressed in each phase of the life cycle of a radioactive source. The first phase is the manufacture of the radioactive source and the design of the device in which it is installed. The concerns involve the risk of theft of the source, and the degree of dispersability of radioactive material if the sealed source is breached. Regulatory initiatives should be undertaken to reduce the production of easily dispersable radioactive material. Competent national authorities and manufacturers should collaborate in investigating how devices can be designed to make them less attractive for malicious use purposes. Radioactive source production is centralized in a relatively few countries which supply users throughout the world. Hence it may be possible to achieve relatively large benefits through focused efforts on the part of this small industry group.

The second phase of the life cycle of a radioactive source commences when distributors or manufacturers transfer or sell sources to users nationally or internationally. The nuclear regulator should require that anyone wishing to use a radioactive source be authorized to possess and use the source for a specific application. It also must ensure that the person is qualified to carry out this licensed activity and that the nuclear regulator with the jurisdiction in the location of use has in place a comprehensive compliance programme to verify that the licensed activity is carried out in accordance with the national regulations. Prior to authorizing the possession and use of a radioactive source, the nuclear regulator must verify that the prospective user is a legitimate entity with valid reasons for wanting to possess the source and that the prospective user will make adequate provisions to ensure health, safety and security. During this stage, the responsibility of the manufacturers and distributors is to verify that they transfer radioactive sources only to holders of valid authorizations. In some situations, the manufacturer or distributor will also install sources into devices and provide management oversight training regarding safety culture, worker training, and security measures and procedures.

In order to ensure continuous control and verify security during the transfer and use of sources, regulators must ensure that adequate source tracking is being carried out. This is accomplished by requiring the manufacturers and distributors to:

(a) Manufacture sources with unique identifiers;
(b) Obtain authorization information for the possession and use of the sources;
(c) Provide transaction records to the regulatory body;
(d) Maintain records of the disposition of returned sources.

Nuclear regulators must establish national sealed source registries for high risk radioactive sources. The sealed source registry will provide the nuclear regulator with a means to manage the risk posed by these radioactive sources. The existence of this registry will facilitate the tracking of high risk sources as they are being transferred, used, imported or exported. Periodic regulatory self-assessment must be carried out by the competent national authority to ensure that existing regulatory programmes are effective in ensuring regulatory oversight of radioactive sources. When needed, the competent authority should enhance its regulatory programmes so as to exercise control that is appropriate for the risk posed by the radioactive sources within national boundaries.

Consideration should also be given to requirements for manufacturers or suppliers to inform the regulator of unusual requests for the supply of radioactive sources. Examples are requests for sources with increased activity levels, requests for more sources than normal and changes in the frequency of orders.

These steps would improve the overall control over sources within national boundaries. However, countries that manufacture and supply radioactive sources are not able to exert the same level of regulatory control over buyers in other countries. In most cases, there is very little regulatory oversight in controlling the export of sources. Currently, exporting countries are only able to carry out a limited verification that buyers are authorized to possess the sources being sought. Clearly the verification of the legitimacy of end users and their possession of proper authorizations, and that adequate provisions for the safety and security of high risk radioactive sources are in place, can only be carried out by national regulatory bodies.

Acceptance of the principles for controlling the export of radioactive sources, by providing political commitment to the IAEA Code of Conduct on the Safety and Security of Radioactive Sources and its import/export guidance, will ensure international harmonization for continuous regulatory control over high risk radioactive sources. The implementation of this guidance through international agreements would enhance the overall control and security in both the short and the long term.

The final phase of the life cycle of a radioactive source is its disposal or recycling when it has reached the end of its useful life. The cost of properly disposing of an unwanted source is a financial burden users would rather not have. Manufacturers and exporting countries should be urged to facilitate the return of unwanted sources to entities that can provide the necessary controls. It will always be better to do so than to leave the sources in the possession of individuals with no desire or resources to implement adequate control over them. One issue that is an obstacle for manufacturers in readily accepting the return of unwanted sources is the uncertainty of future disposal costs.

In summary, efforts to enhance the control and security over radioactive sources cannot be carried out in isolation by the regulatory authorities. Collaboration with manufacturers and suppliers of sources is needed when developing and implementing an overall regulatory regime.

In addition, bilateral, multilateral and, where needed, regional arrangements will also enhance the control and security of radioactive sources. On the North American continent, there has already been some collaboration between Canada, Mexico and the United States of America for trilateral enhancement of the safety and security of radioactive sources used in the three States. Member States are encouraged to initiate regional discussions for successful implementation of the Code of Conduct and its guidance on the import and export of radioactive sources. They should capitalize on the experience of other Member States who have mature regulatory systems.

The IAEA offers several guidance documents that will aid competent authorities in facing regulatory challenges. Adoption of these principles will ensure international harmonization and promote international cooperation. The IAEA has in place several regulatory enhancement programmes. Member States are encouraged to embark on these programmes either to enhance their existing regulatory programmes or to establish new ones.

ISSUES IN THE MANAGEMENT OF ORPHAN SOURCES

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Abstract

In recent years, the number of incidents with orphan sources has been constantly increasing, with sources being found not only at customs border controls but also frequently in scrap and in other unexpected locations, thereby giving rise to growing social concern in view of the risks involved. The paper summarizes all phases in the management of orphan sources from detection to storage.

1. INTRODUCTION

According to the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS), a sealed radioactive source (SRS) is defined as “radioactive material that is (a) permanently sealed in a capsule or (b) closely bounded and in a solid form” [1]. SRSs find application in medicine, industry, research and agriculture as mobile and stationary devices. The size of SRSs varies in the range of a few centimetres. Despite their small size, many SRSs contain very high activities that vary from a few kilobecquerels to petabecquerels.

In the recent past, the number of incidents with orphan sources has been constantly increasing, with sources being found not only at customs border controls but also frequently in scrap and in other unexpected locations. For example, there are more than two million sealed sources in the United States of America [2], and an average of about 375 SRSs per year are lost, stolen or abandoned. Only 40% of lost and stolen sources have been recovered since 1986 [3, 4]. According to a European Union (EU) report [5], more than 500 000 sealed sources have been sold in the EU, and approximately 70 of them annually become orphaned from regulatory control and may be disposed of as scrap unintentionally or illicitly [5–7]. Orphan radioactive sources are a problem not only for developed countries but are also a widespread phenomenon in developing countries, especially in those of the former USSR [8–10]. In developing countries, source inventory is not high, as it is in the USA and the EU, but the risk that these sources become orphaned is greater owing to weak national regulatory infrastructures. For example, in the Republic of Georgia, about 280 orphan sources were found in the field in the last decade

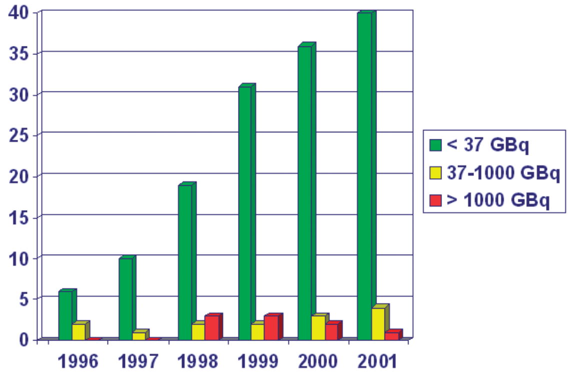

FIG. 1. IAEA database records of incidents involving radioactive sources [16].

with the assistance of the IAEA. Severe public exposure has been reported in some of these instances [8–12]. There have been instances in the world in which loss of control of SRSs has led to serious deterministic effects, death, environmental contamination, and social and economic consequences to the public and the environment [11–15].

The IAEA, along with 70 participating Member States, began a database to track illicit trafficking which includes incidents involving the unauthorized receipt, provision, use, transfer or disposal of nuclear material and other radioactive material. According to the records of this database, which are summarized in Fig. 1 [16], the number of incidents is constantly increasing, and in 2001 the number of incidents was four times that in 1997.

1.1. Problem: Disused sources

Many accidents involving orphan sources, such as the accidents in Istanbul [10] and Samut Prakarn [17], come about because SRSs that are no longer in use are eventually forgotten, with subsequent loss of control over the years. Therefore it is beneficial from both a safety and a security viewpoint for all disused sources to be identified and to undergo proper disposition. One of the difficulties is that SRSs do not usually become disused abruptly, but rather their frequency of use decreases gradually. Human factors should also be considered in a situation where the SRSs might be forgotten, especially as staff members leave the organizations that have such sources. In addition, licensees are discouraged from proper disposal of disused sources by the disposal cost, by the bureaucracy involved or by the lack of an available disposal option.

Regional and national search programmes have been found useful in reducing the number of disused sources in a country [18–22].

2. RETURN OF DISUSED SOURCES TO THE SUPPLIER

Year by year the SRS inventory in a country increases. In order to promote the establishment and maintenance of the safety and security of SRSs, States should make a concerted effort to follow the principles contained in the Code of Conduct on the Safety and Security of Radioactive Sources [23] and the Guidance on the Import and Export of Radioactive Sources published by the IAEA [24]. According to the Code of Conduct [23], the return of disused sources to the supplier or manufacturer for reuse or recycling should be encouraged. Financial provisions for returning the source to the supplier or manufacturer will be very effective. Some countries make the import of a source conditional on its re-export at the end of its useful lifetime, or when the task using it is completed [25]. France is a good example for this option. Sources supplied from outside France must be re-exported at the end of their useful lives [5]. The company in France supplying the source to the end user must include the disposal cost in the purchase price, and all other companies in the supply chain must agree to take back the source after use. For this reason, the concept of recommended working life (RWL) must be introduced as a control parameter. The RWL of a sealed source should be obtained from the major source supplier and also be given in the supplier's source catalogue. The regulatory body should establish a fund with the disposal costs provided by the suppliers. In the event of any difficulty in returning the source to the originating country, the resources of this fund could be used.

Some countries allow import of a source with the supplier's re-export assurance certificate or source acceptance letter. This kind of document alone and without financial enforcement of the return of the SRSs to their original supplier is almost useless.

3. MOVING TOWARDS TECHNOLOGIES THAT DO NOT REQUIRE RADIOACTIVITY

Technologies using radioactive sources should not be promoted, and wherever possible, preference should be given by users and in the original design of equipment to technologies that do not require radioactivity. Replacement of ^{241}Am in ionization smoke detectors and lightning rods with optical or electronic devices is a good example for this kind of replacement.

Radiation technologies, instead of technologies using radioactive sources, especially those requiring ^{241}Am and ^{244}Cm, should also be preferred, for example X ray detectors in process control applications. Ultrasonic methods of density and level gauging should replace use of ^{137}Cs, and linear accelerators should be used instead of ^{60}Co teletherapy [5].

In cases where use of radioactivity is irreplaceable, there should be a tendency to use radionuclides of shorter half-life. Although the sources will have to be replaced more frequently, they may not present the same magnitude of problems as long lived radionuclides with respect to eventual disposal [5].

4. ORPHAN SOURCES IN UNEXPECTED LOCATIONS

Although the locations where orphan sources might potentially be expected are places where flows of goods, vehicles and people are concentrated — for example border crossing points, ports of entry and other nodal transport points, as well as scrap metal yards and facilities — they can frequently be found in unexpected locations, for example on the tundra of Zemlya Bunge island in Siberia. Recently two radioisotope thermoelectric generators (RTGs) were being transported from the New Siberia island lighthouse. They were suspended from a helicopter by cables for transport to the Russian polar station at Bunge. When the helicopter ran into heavy weather, the crew was forced to jettison the two RTGs onto the tundra of Zemlya Bunge island [26].

Owing to their small size and mobile nature, small sources, such as brachytherapy sources, may easily become orphaned if not properly controlled. They might be found: in sinks and toilets attached to hospital wards and in their associated sewage systems; around hospital boundaries; at solid waste collection sites, septic tanks and incineration plants; or still implanted in a patient who has left the hospital. Radiation detectors should be installed at exit points from the facilities where brachytherapy sources are used [18–20].

Fixed sources, such as teletherapy sources, carry a high risk because their heavy shielding material may give rise to a perception of high scrap value; this has resulted in the (accidental) melting or other physical destruction of the housing, with the subsequent spread of radioactive contamination [18].

Mobile sources used in industrial radiography are another application where SRSs become easily orphaned. Owing to the highly competitive nature of the industrial radiography sector, with many small enterprises, some companies cease functioning or become bankrupt each year, and as a result there is an increased risk for SRSs to simply be abandoned, lost or stolen.

Mobile or fixed sources are used as industrial gauges to measure the thickness, density or moisture content of materials. Mobile gauges are obviously at a higher risk of being lost or stolen. For fixed gauges the greatest problem arises at the end of the useful life of the source itself or of the plant or equipment where it is installed. Worldwide there are many examples of cases where sources have been orphaned after being removed from equipment and placed in storage or left in the equipment in a disused plant [18].

Customs warehouses should be examined carefully for orphan sources. The sources in warehouses might remain unclaimed and become orphaned for a variety of reasons: bureaucracy, illicit trafficking, an unknown recipient, abandonment because of bankruptcy or other reasons, and finally a lack of desire or ability to pay any import duty owed [18].

5. ORPHAN SOURCES IN SCRAP METAL

Special attention should be given to scrap metal, either in the country or imported from neighbouring countries, since so many orphan sources have been associated with the various phases of scrap metal recycling. The recycling and reuse of materials and equipment have increased in recent years owing to recognition of their salvage values and an increased environmental awareness of conserving natural resources [14].

The location, recovery and securing of orphan sources throughout the world have become a more important issue, since more than one million tonnes of scrap are expected to enter the steel recycling process in the future [6, 7]. Another potential hazard for the scrap metal industry is that SRSs may be intentionally stolen for malicious use or illicit trafficking and may end up in scrap metal piles. This possibility heightens the need for proper security measures for all radioactive sources during national and international transport [27].

In the USA and Canada, 244 incidents involving SRSs were reported in recycled metal scrap plants between 1983 and 1998 [3, 4]. The problem of scrap metal contamination includes not only the potential consequences of exposure or the contamination itself, but also the fact that, once the source is melted, products, by-products and the whole system of the remelting facility become contaminated radioactive material. The costs from such an event can reach millions of dollars. The cost of decontamination, waste disposal and mill shutdowns for US metal mills that actually inadvertently melted radioactive materials averaged about US $10 million per accident. The cost of the Acerinox accident in Spain (source melted, 1998) was about $26 million [28, 29].

6. DETECTION OF ORPHAN SOURCES

Detection of orphan sources is a challenge. They can be found in unexpected locations, and therefore a monitoring system requires the use of different instruments in combination. The major instruments used in detection of orphan sources can be grouped as: (i) pocket sized instruments to alert and protect the radiation protection expert (high sensitivity is required for these instruments); (ii) handheld/mobile instruments to locate, identify and measure the dose rate of the source; (iii) fixed installed (‘portal’) systems to provide automated alarm at installed strategic points.

Since flows of goods, vehicles and people are concentrated at border crossing points, ports of entry (airports, seaports) and highway/railway checkpoints, regulatory authorities must install and use these monitoring instruments at these nodal points. In addition, scrap metal facility gates, strategic points of transport (e.g. the Bosporus bridges in Istanbul), and other similar points must also be equipped with such monitoring systems.

Installing monitoring systems at these nodal points to detect orphan and illicit trafficking radiation sources is not simple. Coordination is needed between border guards, police, customs officers and radiation protection experts. Protocols should be prepared that define the roles of the various authorities, such as the ministry of industry, the ministry of energy, the interior ministry, the nuclear regulatory authority and other organizations that are responsible for orphan source detection.

A formal agreement between regulatory authorities is necessary for: (i) strengthening measures to detect, interdict and respond to incidents; (ii) enhancing cooperation among governmental agencies, especially in the fields of information sharing, communications and training; (iii) pooling resources among competent authorities for the sharing of monitoring and detection equipment.

The content of the protocol should include: field of application; undertakings arising from the implementation of the protocol; actions in the event of the detection of an orphan source; apportionment of costs; detection procedures; and training and joint demonstration exercises. Spain provides a good example of such a protocol. After the Acerinox accident, a protocol entitled Collaboration on the Radiation Monitoring of Metal Materials was signed between the Ministry of Industry and the Ministry of Energy, the Ministry of Development, the Nuclear Safety Council and others.

7. IAEA MINIMUM PERFORMANCE RECOMMENDATIONS FOR MONITORING SYSTEMS

A fixed installed monitoring system is the main tool in the detection of orphan sources, and in the process of their selection, IAEA recommendations should be considered [30]. The main selection parameters for a fixed installed monitoring system are: (i) Sensitivity to gamma radiation. It is recommended that at a mean indication of 0.2 μSv/h, an alarm should be triggered when the dose rate is increased by 0.1 μSv/h for a period of 1 s. (ii) Search region. The volume in which efficiency of detection is maintained will vary according to the instrument. Table 1 summarizes the search region in which the performance characteristics for the given alarm levels should be applicable. (iii) False alarm rate. The false alarm rate during operation should be less than one per day for background dose rates of up to 0.2 μSv/h [30].

8. HANDLING ORPHAN SOURCES

Handling orphan sources requires expertise. Trained personnel and proper safety, isolation and notification procedures are the key elements for response to orphan source incidents.

A radiation protection officer (trained personnel) should take personal precautionary measures to prevent a second incident. When an orphan source is found, care should be taken to minimize external and internal radiation exposure. Before an orphan source is approached, a dose rate meter should be available and checked in its most sensitive range. Measurements should be started at least 10 m away from the source, and when the dose rate exceeds 0.1 mSv/h, additional precautions should be taken [30]. The first stage in the process of handling of an orphan source, as mentioned above, is isolation, identification and notification. A durable label should be installed on the

TABLE 1. PARAMETERS OF THE SEARCH REGION

	Vertical (m)	Horizontal[a] (m)	Speed
Pedestrian monitor	0–1.8	0–1.5	<1.2 m/s
Car monitor	0–2	<4	<8 km/h
Truck and bus monitor	0.7–4	3–6	<8 km/h

[*] Parallel to the direction of movement.

shielding of the source that identifies the important characteristics of the source. The second stage is that of temporary storage. The purpose of temporary storage is to provide safety, security and radiological protection temporarily. Once a suitable route has been identified for transport to interim storage, which is the third stage, it will be necessary to arrange the transport. Experience has shown that most accidents occur while sources are in temporary storage; therefore efforts should be made to transfer the sources at the temporary storage to an interim storage facility as soon as possible. When a source is received at a central facility, some level of treatment and conditioning may be required before it can be placed into interim storage [21].

9. CONCLUSION

In recent years, the number of incidents with orphan sources has been constantly increasing, with sources being found not only at customs border controls but also frequently in scrap and in other unexpected locations, thereby giving rise to growing social concern in view of the risks involved. For this reason, regulatory authorities and other competent authorities should increase monitoring and update their strategic orphan source search plans to: (i) establish or strengthen national systems of control for ensuring the safety and security of radiation sources; (ii) provide the regulatory authority and other competent authorities with sufficient resources, including trained personnel, for the enforcement of compliance with relevant requirements; (iii) consider installing and maintaining radiation monitoring systems at ports, at border crossings and at other locations where radiation sources might appear (such as metal scrapyards and recycling plants); (iv) develop adequate search and response strategies, and prepare and sign protocols between government agencies; and (v) arrange joint demonstration exercises for the training of staff.

Effective management of SRSs is vital to both safety and security, and we should always keep in mind that “prevention is better than remediation”.

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REFERENCES

[1] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

[2] GOVERNMENT ACCOUNTABILITY OFFICE, Nuclear Security: Federal and State Action Needed to Improve Security of Sealed Radioactive Sources, Rep. GAO-03-804, GAO, Washington, DC (2003).

[3] LUBENAU, J.O., YUSKO, J.G., Radioactive material in recycled metals — An update, Health Phys. **74** 3 (1998) 293–299.

[4] LUBENAU, J.O., STROM, D.J., Safety and security of radiation sources in the aftermath of 11 September 2001, Health Phys. **83** 2 (2002).

[5] ANGUS, M., CRUMPTON, C., McHUGH, G., MURETON, A.D., ROBERTS, P.T., Management and Disposal of Disused Sealed Radioactive Sources in the European Union, Rep. EUR 18186 (2000).

[6] KÖHLER, M., HULT, M., ARNOLD, D., LAUBENSTEIN, M., REYSS, J.L., Reference measurement of low levels of Co-60 in steel, Appl. Radiat. Isot. **61** (2004) 207–211.

[7] KÖHLER, M., SAUPE, M., Screening of primordial and artificial radionuclides in German steel by low-level gamma ray spectrometry in an underground laboratory, J. Radioanal. Nucl. Chem. **263** 2 (2005) 381–385.

[8] GONZÁLEZ, A.J., Timely action: Strengthening radiation safety and security, Int. At. Energy Agency Bull. **41** 3 (1999) 2.

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Lilo, IAEA, Vienna (2000).

[10] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Istanbul, IAEA, Vienna (2000).

[11] VICENTE, R., SORDI, G.M., HIROMOTO, G., Management of spent sealed radioactive sources, Health Phys. Soc. J. **86** 5 (2004).

[12] INTERNATIONAL ATOMIC ENERGY AGENCY, Handling, Conditioning and Storage of Spent Sealed Radioactive Sources, IAEA-TECDOC-1145, IAEA, Vienna (2000).

[13] MARLEY, M., Radioactive steel in Taiwan homes, Am. Met. Mark. (14 Sep. 1993).

[14] LEE, S.Y., LEE, K.J., Assessment of potential exposures by uncontrolled recycle or reuse of radioactive scrap metals, Wastes Manage. **19** (1999) 483–493.

[15] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Tammiku, IAEA, Vienna (1998).

[16] DUFTSCHMID, K.E., “IAEA Database on Illicit Trafficking in Nuclear and other Radioactive Materials”, paper presented at Illicit Trafficking Training Course, Ankara, 2003.
[17] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Samut Prakarn, IAEA, Vienna (2002).
[18] INTERNATIONAL ATOMIC ENERGY AGENCY, Strengthening Control over Radioactive Sources in Authorized Use and Regaining Control over Orphan Sources: National Strategies, IAEA-TECDOC-1388, IAEA, Vienna (2004).
[19] INTERNATIONAL ATOMIC ENERGY AGENCY, Nature and Magnitude of the Problem of Spent Radiation Sources, IAEA-TECDOC-620, IAEA, Vienna (1991).
[20] INTERNATIONAL ATOMIC ENERGY AGENCY, Management for the Prevention of Accidents from Disused Sealed Radioactive Sources, IAEA-TECDOC-1205, IAEA, Vienna (2001).
[21] INTERNATIONAL ATOMIC ENERGY AGENCY, Management of Spent High Activity Radioactive Sources (SHARS), IAEA-TECDOC-1301, IAEA, Vienna (2002).
[22] INTERNATIONAL ATOMIC ENERGY AGENCY, Management of Disused Long Lived Sealed Radioactive Sources (LLSRS), IAEA-TECDOC-1357, IAEA, Vienna (2003).
[23] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).
[24] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources: Guidance on the Import and Export of Radioactive Sources, IAEA, Vienna (2005).
[25] INTERNATIONAL ATOMIC ENERGY AGENCY, Return of Disused Sealed Sources to Suppliers/Manufacturers, Draft, IAEA, Vienna, 2001 (unpublished report).
[26] BELLONA FOUNDATION, www.bellona.no, accessed 16 June 2005.
[27] BARRETT, J.A., SRP Meeting on Radiological Terrorism: Prevention and Response, J. Radiol. Prot. **24** (2004) 331–332.
[28] RUIZ, J.T., CAMPAYO, J.M., Radiological protection in the radioactive incident of Acerinox in Spain, Eur. ALARA Newsl., Issue 8 (2000).
[29] RUIZ, J.T., et al., “Radiological protection system application in the radioactive incident of Acerinox”, in Proc. 11th Int. Radiation Protection Assoc. Congr. Madrid, 2004.
[30] INTERNATIONAL ATOMIC ENERGY AGENCY, Detection of Radioactive Materials at Borders, IAEA-TECDOC-1312, IAEA, Vienna (2002).

COMMENTS BY THE CHAIRPERSON

T. TANIGUCHI (IAEA): At the beginning of his presentation, Mr. Uslu showed a chart depicting the increase in the number of sources identified, detected and reported. The IAEA Secretariat sees a need to clarify and analyse the causes, because this represents not only a possible increase of sources crossing borders but also an improvement in detection systems, notification, reporting and networking. The Secretariat appreciates the Turkish Government's cooperation and also its support of work to identify sources in neighbouring countries such as Georgia.

USE OF RADIOACTIVE SOURCES TAKING ACCOUNT OF SAFETY AND SECURITY CHALLENGES

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Abstract

The use of radioactive sources has for the last several decades been subject to the requirement that the use should overall do more good than harm. This requirement has been called 'justification', and has been one of the three basic radiological protection requirements embodied in international and national standards and regulations. Decisions on justification have to take into account all the benefits and detriments of proposed uses, together with other inputs, using a decision framework. The paper examines how this framework should be used to accommodate security concerns, draws some broad conclusions as to the likely outcomes and indicates where reassessment of past decisions may be called for.

1. INTRODUCTION

The concept of 'justification' has been one of the three basic principles of radiation protection for many decades. The principle is simple in essence — that any practice involving radiation exposure should overall do more good than harm. This justification principle was described by the International Commission on Radiological Protection (ICRP) [1] and is an integral requirement of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS) [2] and other standards such as those of the European Union [3]. There is no doubt that the many uses of radiation in the medical field and industry are generally beneficial and economically viable, and enable processes to be carried out that could not be done using other techniques. Some major uses are more controversial, especially the generation of nuclear power, but in these cases the decisions on whether to carry out the practice have been taken at governmental level on strategic grounds rather than being primarily based on radiation protection considerations. There is also general agreement that some practices are not justified, such as the deliberate addition of radioactive substances to foods or what are called 'frivolous' uses in toys or jewellery.

Decisions on justification have to take into account all the benefits and detriments of proposed uses, together with other inputs, using a decision framework. In the context of this conference it is necessary to examine whether the extension of these inputs to the decision to encompass security concerns is likely to substantially change the justification decisions reached in the past for the major types of uses of radioactive sources.

2. JUSTIFICATION REQUIREMENT

The recommendations of the ICRP published in 1977 [4] introduced and formalized two new concepts. One of these was the idea of a 'practice' as giving rise to radiation exposures. The other was the need to 'justify' the introduction or continuation of such a practice.

The current embodiment of the justification principle was set out rather clearly and comprehensively in the 1990 recommendations of the ICRP, Publication 60 [1]. The key statement gives it as the first general principle of the system of radiological protection:

> "No practice involving exposures to radiation should be adopted unless it produces sufficient benefit to the exposed individuals or to society to offset the radiation detriment it causes (the justification of a practice)."

However, what is not provided in Publication 60 is any indication as to how the process of justification is to be carried out, other than an implication that the procedures used in optimization of protection may be applicable. The main discussion of justification in the IAEA Safety Series is found in the BSS, published in their latest form in 1996 [2], following ICRP Publication 60.

3. APPROACH TO JUSTIFICATION DECISIONS

3.1. A structured approach to justification

A justification decision requires a structured approach that should make it clear that all the relevant factors and inputs have been taken into account, and that should make the relative importance attached to particular inputs apparent. To do this an approach to justification is necessary that is similar to the structured approach to optimization of protection [5]. This approach has been adopted in recent justification decisions such as that carried out by the

United Kingdom Government [6]. An example of such a structured approach is shown in Fig. 1.

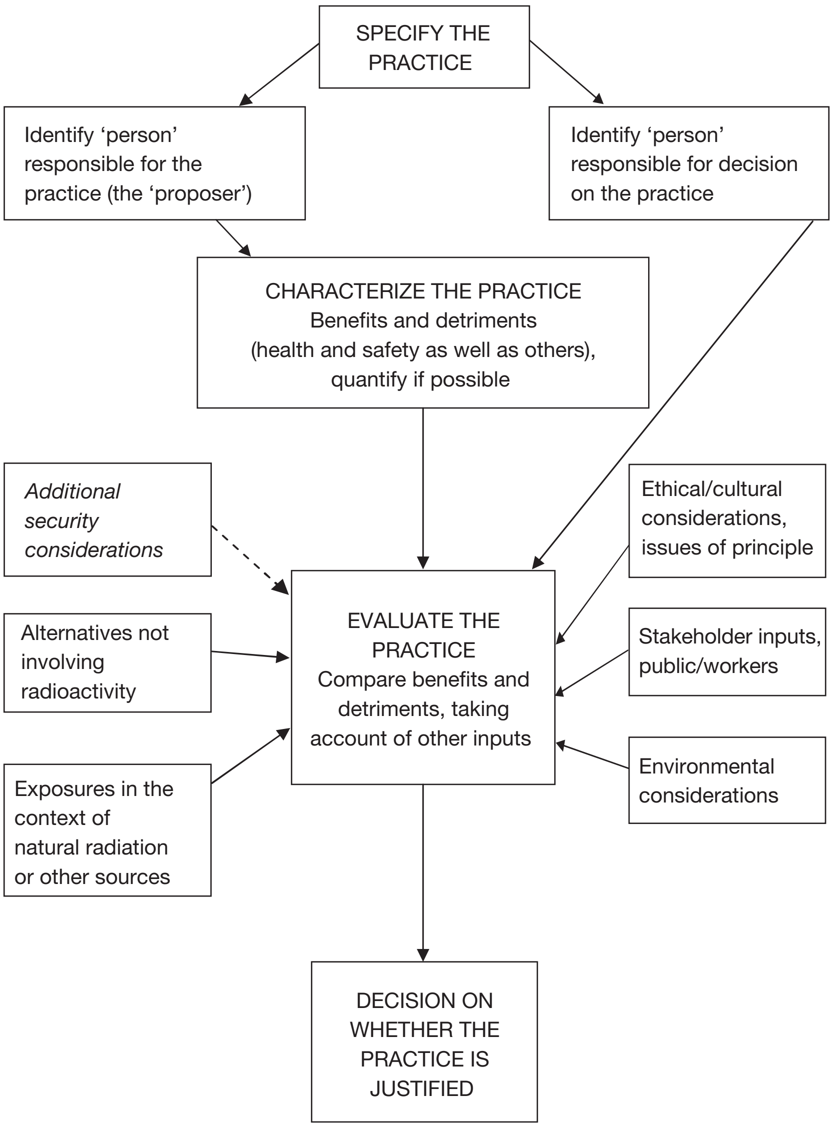

FIG. 1. Structured approach to justification.

3.2. Specifying the practice

Before any analysis of a proposed new practice can be undertaken, it is necessary to specify what it comprises as precisely as possible. The term ‘practice’ has been used within the radiation protection community for some time, its most recent definition being furnished by the ICRP in Publication 60 [1].

> “Those human activities that increase the overall exposure to radiation, either by introducing whole new blocks of sources, pathways, and individuals, or by modifying the network of pathways from existing sources to man and thus increasing the exposure of individuals or the number of individuals exposed.”

3.3. Identifying persons responsible

The first requirement for an agreed decision is to identify and agree on who is to make the decision.

For a practice to require some form of consideration it is implicit that someone wants to carry it out. This ‘person’, who may be a company, an operating organization or even a branch of government, is called the ‘proposer’ and is responsible for supplying all the necessary information as input to the decision making process. It is also necessary to identify the person, often a government department, with statutory responsibility for regulating the relevant practice, the ‘decision maker’. Reassessments will generally be initiated by the decision maker with responsibility.

3.4. Characterizing the practice

Characterization of a practice is where the factual information regarding the practice, mainly provided by the proposer, is brought together. The main focus will be on the benefits of the practice and the radiation detriments. The benefits from the use of practices include, for example, the saving of life, prevention of injury or illness, technical improvements and even security improvements. The detriments include the exposure of people and the attributable potential health detriments, characterized by the individual, and, if appropriate, the collective doses from application of the practice, both in normal situations and in the case of accidents or credible abuse, quantified as far as possible. These detriments are what have been broadly thought of as ‘safety’ concerns. Other detriments not related to radioactivity, e.g. social and ethical detriments such as the invasion of privacy, should be brought into the characterization of the practice.

3.5. Other inputs to decisions

3.5.1. Alternatives not involving radioactivity

Normally the motive for proposing to introduce a practice involving radiation is that there is not an alternative method for achieving precisely the same result that involves less radiation or no radiation at all. There will, however, often be alternative procedures that could achieve similar results and that are likely to have their own array of detriments and benefits. These should be taken into account as a legitimate input to the decision, so that the benefits and detriments of the alternatives are also quantified and weighed in the decision. However, the mere existence of an alternative is not a reason for deciding that the method involving radiation is not justified.

3.5.2. Ethical and legal aspects

In addition to the benefits and detriments associated with practices, ethical and legal aspects must also be taken into account in reaching a decision. The ethical questions can be divided into two broad types: those relating to the irradiation of individuals and largely centring on the matter of individual benefit and informed consent; and those relating to the irradiation of large numbers of people and largely centring on the independent balancing of detriment and social welfare.

3.5.3. Stakeholder inputs

It is in accordance with the inclusive approach to decision making that those affected by the decision should have some say in the reaching of the decision. These groups — loosely referred to as ‘stakeholders’ — may be, for example, workers, people living around a source, owners of installations or radiation protection professionals.

3.6. Additional security inputs

The question at issue is whether adding to these inputs the additional potential detriment that the sources involved in the practice may be diverted to terrorist or criminal ends is likely to change the currently accepted view as to those practices that are justified.

As noted in Section 3.4, the detriments from a practice have always included safety concerns. These cover, in addition to all the detriments from the normal use of sources, the possibility of accidents, their probability and the consequent detriments in terms of doses to people, environmental contamination, waste disposal, etc., and the possibility of what was called ‘credible abuse’. This concept was introduced to cover scenarios in which people mishandled sources either deliberately for some reason or inadvertently through ignorance. What this concept did not cover, however, were scenarios in which people used sources for criminal or terrorist purposes, nor did it envisage the recent development of suicide bombers or mass terrorism. It is these additional scenarios that have now to be included in any reappraisals of the justification of the use of large radioactive sources.

It is important that these scenarios be treated in the same conceptual manner as scenarios involving accidents or credible abuse. In particular it is necessary to take into account the probability of such events and not focus exclusively on their consequences. For example, we know that a reactor accident can occur with substantial consequences, but this has not resulted in the banning of nuclear power worldwide — nor should it have done. In the case of terrorist scenarios involving radioactive sources it is clear that these are rather improbable events, and this should form part of the input to the decision, together with some realistic assessments of the consequences from credible (given the new assumptions) scenarios. The costs associated with additional security measures are also a legitimate input to decisions on the detriment side.

3.7. Evaluating the proposed practice

Taking into account all the information and inputs that have been assembled, it is incumbent on the decision maker to reach a decision as to whether the practice continues to be justified — and is therefore permitted to continue — or not justified — and should therefore be prohibited.

3.8. International context

It is of course the case that national authorities have the responsibility for justification decisions. Nonetheless it would seem helpful for decisions that are likely to have international ramifications to be reviewed by an internationally agreed mechanism in the context of international standards.

4. CONSIDERATION OF TYPES OF PRACTICE

In deciding what types of practice need additional consideration from a security viewpoint, the revised IAEA Categorization of Radioactive Sources [7] was used. This is a simple, logical system for ranking radioactive sources on the basis of their potential to cause severe deterministic effects on human health in a short period of time. Those practices involving sources in Categories 1 and 2 are judged to be of most concern from a security viewpoint, on the grounds that for sources in the other categories the security implications, based on actual harm to health rather than disruption, would be most unlikely to significantly affect the justification decision. In this scoping paper it is clearly not possible to carry out the full reassessments that may be necessary, so the views stated are purely those of the author.

4.1. Medical practices

The most widespread medical practice that involves the use of large radioactive sources is teletherapy using single and multibeam (gamma knife) units that are sited in hospitals or other medical facilities. This is a directly life saving practice for which there is no alternative, and its general justification has never been in doubt [8]. While the sources are in full-time use, it would require a very determined attack to steal one. Sources are most vulnerable at the end of there useful life, when there have been cases of sources having been abandoned or put into poorly supervised storage. This is the point on which safety concerns have been focusing for some time — certainly since the Goiânia accident in 1985 [9] — and is arguably the point on which any additional security measures should focus. Given the very large number of lives saved each year, security concerns do not significantly affect the justification for use of this practice. A similar conclusion applies to brachytherapy, although only high and medium dose rate brachytherapy sources fall into Category 2.

4.2. Irradiator facilities

Irradiator facilities are relatively few in number but usually contain many extremely high activity sources. They are used to sterilize medical products, medical supplies and foodstuffs, for blood irradiation and for other specialized purposes. It is difficult or sometimes impossible to duplicate the effects of radiation sterilization by other means. The facilities have to be heavily shielded because of the size of the sources. As with teletherapy sources, it would be difficult to steal such sources during operation of the facility, so attention should be given to source exchange and storage. Given the small number of facilities and their inherent shielding, the addition of security measures to reduce the probability of theft to an acceptable level would seem feasible, and taking into account the difficulty of replacing these sources, this use seems to still be justified despite the size of the sources.

4.3. Industrial radiography sources and devices

Industrial radiography has become the most widespread industrial application of radiation because it provides a method of remote examination of structures, from pressure vessels to pipelines, which cannot be carried out so effectively by any other means. Radiography devices themselves are heavy owing to their internal shielding, although those for mobile radiography have to be transportable. The sources used in these devices are very small physically, and can be removed from the cables to which they are attached. There have been several instances in which sources have become detached accidentally and then picked up and carried off in pockets of clothing. Thus there is no doubt that individual sources could be stolen and readily transported away, particularly if the person doing it were unconcerned about irradiating him- or herself. However, the activity of these sources is orders of magnitude less than those used in irradiators or even teletherapy machines, so many would be needed for a credible terrorist device, and sources are normally kept in secure stores when not in use. Given the major contribution that industrial radiography makes to safety, it is likely to remain justified, although some steps could be taken to tighten security precautions.

4.4. Radioisotope thermoelectric generators

Radioisotope thermoelectric generators (RTGs) are used to provide low amounts of electric power. The heat generated by radioactive decay is directly converted to electricity. For this purpose very high activity sources are needed. These devices have mainly been used in space or military applications. There are small numbers of RTGs, and those under active military control or deployed in space should be immune to theft. Those at remote locations or that have been abandoned would, however, be prime targets for terrorists, and it may be that the justification for this usage should be reconsidered.

4.5. Optimization

None of the above means that attention should not be given to optimization of design, usage, regulatory control, storage and disposal to minimize the security threat from justified uses. The possibility of replacement of sources by radiation generators could be investigated more vigorously. From a design viewpoint there could be some review of the sources themselves, for example to replace dispersible materials by non-dispersible forms. Device design could be checked to increase the difficulty of unauthorized source removal. Procedures for use and for storage during use should also be reviewed from this perspective. Attention has already been focused from the safety viewpoint on the need for an effective regulatory infrastructure in countries, a complete and well maintained inventory of sources, regulation and control of practices, and maintenance of control at the end of the useful life of the sources, including storage, recycling or disposal. This is still important but no new initiatives are needed.

5. CONCLUSIONS

Very large numbers of radioactive sources are used for a wide range of different purposes throughout the world. All of these uses have been regarded as ‘justified’ in the sense of their doing overall more good than harm. It is a legitimate question to ask whether the recent additional security concerns have augmented the safety concerns over the use of these sources sufficiently to swing the balance such that these uses are no longer regarded as justified, with the implication that such uses should be prohibited. This paper has set out the way in which such additional concerns should be factored into the decision. A preliminary broad review by the author has concluded that in the vast majority of cases the benefits from the use would continue to outweigh the detriments, but has also identified situations in which more might be done to reduce the security threat.

REFERENCES

[1] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, 1990 Recommendations of the International Commission on Radiological Protection, Publication 60, Pergamon Press, Oxford and New York (1991).

[2] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

[3] EUROPEAN COMMISSION, Council Directive 97/43/Euratom of 30 June 1997 on Health Protection of Individuals against the Dangers of Ionizing Radiation in Relation to Medical Exposure, and Repealing Directive 84/466/Euratom, Official Journal L 180, 09/07/1997, Luxembourg (1997) 0022–0027.

[4] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Recommendations of the International Commission on Radiological Protection, Publication 26, Pergamon Press, Oxford and New York (1977).

[5] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Optimization and Decision-Making in Radiological Protection, Publication 55, Pergamon Press, Oxford and New York (1989).

[6] UNITED KINGDOM HOME OFFICE, Justification for the Use of X/Gamma Radiation Scanners by the Immigration Services for Detecting People Seeking to Enter the UK Illegally in Vehicles and/or Freight, by Clandestine Means, Home Office Immigration and Nationality Department, London (2004).

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA-TECDOC-1344, IAEA, Vienna (2003).

[8] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Radiological Protection and Safety in Medicine, Publication 73, Pergamon Press, Oxford and New York (1996).

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Goiânia, IAEA, Vienna (1988).

DISCUSSION

W. STERN (USA): You said that the main driver in developing and encouraging the use of less dispersible sources should be the manufacturers. What role should government play?

G.A.M. WEBB (United Kingdom): While those who make the sources would have the best idea how to make them less dispersible, government regulators could have a role in stimulating manufacturers to move towards such sources, thus reducing the terrorism threat potential.

THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION AND THE SAFETY AND SECURITY OF RADIATION SOURCES

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Abstract

The advice of the International Commission on Radiological Protection (ICRP) targets the regulators and implementers that have the responsibility for establishing radiological protection standards. The primary aim of ICRP's recommendations is to provide an appropriate standard of protection without unduly limiting the beneficial actions giving rise to radiation exposure. This aim is achieved through the combined use of scientific concepts and value judgements about the balancing of risks and benefits. The recommendations on radiological protection presume that radiation sources are subject to proper security measures, and security is therefore an essential component of safety. ICRP has expressed its view on the need for control of radioactive sources in several publications. The recently adopted international Code of Conduct on the Safety and Security of Radioactive Sources is in line with ICRP's views on safety and security, and ICRP expects that adherence to these requirements will strengthen the necessary control of radioactive sources.

1. INTRODUCTION

The objective of the recommendations of the International Commission on Radiological Protection (ICRP) is to provide an appropriate standard of protection for humans and the environment without unduly limiting the beneficial actions giving rise to radiation exposure [1]. This aim cannot be achieved on the basis of scientific concepts alone. All those concerned with radiological protection have to make value judgements about the relative importance of different kinds of risk and about the balancing of risks and benefits. In this, they are no different from those working in other fields concerned with the control of hazards. ICRP's recommendations are therefore relevant to the safety and security of radiation sources.

ICRP's recommendations presume that, as a precondition for adequate radiological protection, sources of radiation exposure are subject to proper security measures. ICRP's view is reflected in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS), issued in 1996 by six international organizations [2].

The BSS require that the control of sources shall not be relinquished under any circumstances and that sources be kept secure so as to prevent theft or damage. There is a close connection between ICRP's recommendations and the BSS, dating right from the early 1960s. The BSS have always followed the establishment of new ICRP recommendations; for example, the 1977 and the 1990 ICRP recommendations were the basis for the revised BSS published in 1984 and 1996, respectively.

Security of radioactive sources is a necessary, but not sufficient, condition to ensure source safety. Sources can be secure, i.e. under proper control, and still not safe. Thus radiation safety has long included aspects of security in its standards [1, 2]. In the context of safety, security provisions are generally limited to general controls necessary to prevent loss, access, and unauthorized possession or transfer and use of the material. Essential to safety are measures to ensure that control of radioactive material and access to radiation installations are not relinquished. A major step with Publication 60 [1] was the explicit reference to potential exposures, i.e. exposures to which one could assign a probability. When ICRP's current recommendations were developed, measures to specifically protect against terrorism or other malicious acts were not in focus. However, much of the necessary security is already part of safety, and when it comes to a particular issue, it is a national decision as to whether additional security measures are required.

Great progress has taken place in the safety and security of radioactive sources over the last decade. ICRP welcomes the efforts that the IAEA has committed to this issue over the years, as reflected in the various conferences, particularly those in Dijon in 1998, Buenos Aires in 2000 and Vienna in 2003. The conference in Rabat in 2003 demonstrated that a good regulatory infrastructure is an important aspect of the safety and security of sources. The approval by the IAEA Board of Governors and the IAEA General Conference of the international Code of Conduct on the Safety and Security of Radioactive Sources [3] in 2003 was a major step forward. Since then, many countries have expressed their commitment to work towards implementing the requirements of the Code of Conduct.

ICRP has expressed its view on the need for control of radioactive sources in several publications. The Code of Conduct is in line with ICRP's views on safety and security, and adherence to these requirements will strengthen the control of radioactive sources. There is often a discussion about how security relates to safety. In the international standards, the BSS, security has always been an integral part of safety. The concept of safety means prevention of accidents and, should they occur, mitigation of their consequences. Security means prevention of unauthorized actions by ensuring that control is not relinquished or improperly acquired. A radioactive source that is secure (i.e. kept under proper control and physically protected) is not necessarily also safe (i.e. unlikely to harm people). Conversely, a radioactive source cannot be judged to be safe if it is not secure. Therefore it follows that for radioactive sources, security is a necessary, but not a sufficient, element of source safety. Source security is a subsidiary to source safety.

ICRP has expressed its view on the need for control of radioactive sources in several publications. This paper focuses on ICRP's views regarding three types of situation: potential exposures, prolonged exposures and exposures with a malicious intent.

2. POTENTIAL EXPOSURES

The system of radiological protection divides situations affecting radiation exposure of individuals into two broad categories: practices and intervention [1]. Radiation exposure that might result from the introduction of a practice is further divided into normal exposure and potential exposure. Normal exposure is that which can reasonably be expected to occur. Potential exposures are those that may or may not occur. Such events can be foreseen and their probability of occurrence estimated, but they cannot be predicted in detail. There is usually an interaction between potential and normal exposures; for example, (a) actions taken to reduce the probability of a potential exposure may increase the normal exposures, and (b) storage of waste rather than its dispersal will reduce normal exposures but will increase the potential exposures [4].

Potential exposure covers three types of situation [5]:

- Situations where the potential exposures would primarily affect individuals who are also subject to the normal exposures in the practice. The number of individuals is usually small, and the detriment involved is the health risk to the directly exposed persons. The processes by which such exposures occur are relatively simple, e.g. the potential unsafe entry into an irradiation room.
- Situations where the potential exposures could affect a larger number of people and involve not only health risks but also other detriments, such as the contamination of land and the need to control food consumption. The mechanisms involved are complicated, and an example is the potential for a major accident in a nuclear reactor.
- Situations in which the potential exposures could occur far in the future and the doses be delivered over long time periods, for example in the case of solid waste disposal in deep repositories [6].

Before 1998, not much guidance was available on the matter and there was an implicit assumption that all was well. In Publication 76 [5], ICRP discussed protection from potential exposures in the first type of situation, which would primarily affect individuals who are also subject to the normal exposures in the practice. This publication and the Dijon conference in 1998 came about as a result of the increasing recognition of the problems that had been occurring with radioactive sources. The initial treatment of potential exposures should form part of the protection applied to practices, and it should be recognized that the exposures, if they occur, might lead to intervention. The objectives should be to reduce the probability of the events occurring, and mitigation to limit and reduce the exposures if any event were to occur [1].

3. PROLONGED EXPOSURES

In Publication 82 [7], ICRP provided guidance on the protection of the public against prolonged radiation exposures. The recommendations were based on assessments of the health risks associated with prolonged exposure levels and on the radiological protection attributes of various exposure situations. The principles of the system of protection for interventions are justification of intervention and the optimization of the protective actions. Security of sources deals with prevention, detection and response, i.e. the same as for safety of sources, intervention being an action taken on the basis of some detection and involving a response. National authorities or international organizations should predetermine specific reference levels (such as intervention levels or action levels) for particular prolonged exposure situations amenable to intervention.

ICRP recommends that an existing annual dose approaching 10 mSv can be seen as a generic reference level below which intervention is not likely to be justifiable for some prolonged exposure situations. However, protective actions to reduce a dominant component of the existing annual dose might still be justifiable below this level. Above 10 mSv, intervention may be necessary and should be justified on a case by case basis. Situations in which the annual (equivalent) dose thresholds for deterministic effects in relevant organs could be exceeded should require intervention. An existing annual dose of about 100 mSv will almost always justify intervention, and this may be used as a generic reference level for establishing protective actions under nearly any conceivable circumstance [7] (Table 1).

TABLE 1. GENERIC REFERENCE LEVELS FOR INTERVENTION [7]

Intervention	Existing annual effective dose (mSv/a)
Almost always justifiable	100
May be justifiable	>10
Unlikely to be justifiable	<10

4. EXPOSURES WITH MALICIOUS INTENT

Since the events of 11 September 2001, there has been increasing concern about the deliberate dispersion of radioactive material to cause panic and chaos. This has raised the awareness regarding the security of radiation sources. It has also triggered a widespread request for professional advice on measures aimed at preventing radiological attacks and on protective measures should such an event occur. Existing radiological emergency contingency plans have mainly focused on accident scenarios, rather than on radiological attacks designed to cause harm or fear.

The preparation for and the response to a radiological attack should be aimed at protecting people against arbitrary and unpredictable radiation exposure situations. ICRP will this year publish a report providing advice on protecting rescuers and affected members of the public against radiation exposure in the aftermath of such an attack [8]. The report does not give advice on actual security measures to prevent such events. Even though many aspects of emergency scenarios resulting from a radiological attack may be similar to those of radiation accidents, these two types of situation differ in several aspects. A radiological attack would most likely be targeted at a public area, where the presence of radiation or radioactive material is not expected and where there may be limited preparedness for responding with protection measures. The environmental dispersion conditions commonly assumed in planning for emergencies in nuclear facilities may not be applicable in this case. The characterization of the radiation source and its impact would probably be different as well.

ICRP's recommendations are generic in nature and may require modification depending on the social, political and economic circumstances. Although the recommendations have been tailored mainly to radiological attacks involving radiological dispersal devices, the recommendations are applicable to a wide range of conceivable attacks. It may be prudent to assume that any attack involves radiological, chemical and/or biological agents until proven otherwise. This calls for the adoption of an all-hazard approach to the response, which should be based on universal precautions combined with a prompt capability to identify all hazards present. Radiological attacks are likely to result in the dispersion of radioactive substances, and both members of the public and rescuers coming to their assistance may be exposed to radiation. The relationship between exposure routes, protective actions and response phases will vary depending on the circumstances of the specific radiological attack. An attempt is made in the report to identify some of the potential scenarios to be expected at various phases during the response.

In most scenarios associated with a radiological attack, radiation doses to the majority of exposed persons will be low, and probably not above 10 mSv. While these low doses have the potential to induce stochastic health effects, the probability of their occurrence is small. Conversely, a small number of people could be exposed to high radiation doses, for example of the order of thousands of millisieverts, and deterministic health effects are almost certain to occur.

The aims of radiological protection actions after a radiological attack are to prevent deterministic effects and to restrict the likelihood of stochastic effects. This includes minimizing the overall impact in terms of environmental contamination. The response must essentially be to identify and characterize the emergency situation, to provide medical care for injured persons, to attempt to avoid further exposures, to gain control of the situation, to prevent the spread of radioactive materials, to provide accurate and timely information to the public, and to institute a process for returning to normality, while dealing with psychological issues, such as distress and misattribution and fear of illness, which will be a major concern. In the immediate response phase, exclusion distances used in relation to explosions are a good starting point for controlling the site for radiation levels, and typical precautions at medical facilities for infectious agents are sufficient as a starting point for handling persons that may be contaminated with radioactive material. Taking actions to avert exposures is much more effective than medical treatment after exposure has occurred.

Responders undertaking recovery and restoration operations should be protected according to normal occupational radiological protection standards and the doses they receive should not exceed internationally accepted occupational dose limits. This limitation could be relaxed for informed volunteers undertaking urgent rescue actions following a radiological attack, and is not applicable for volunteered life saving actions whenever the benefit to others clearly outweighs the rescuer's own risk. There are specific recommendations for female workers who may be pregnant or nursing an infant, and they should not be employed as first responders undertaking life saving or other urgent actions. The recommended dose guidance values for constraining the occupational exposure of responders to a radiological attack are shown in Table 2.

TABLE 2. RECOMMENDED DOSE VALUES FOR CONSTRAINING THE EXPOSURE OF RESPONDERS TO A RADIOLOGICAL ATTACK [8]

<table>
<tr><th colspan="2">Type of emergency operation</th><th>Dose guidance</th></tr>
<tr><td rowspan="2">Rescue operations (except female workers who may be pregnant or nursing)</td><td>Life saving actions</td><td>In principle, no dose restrictions are recommended if the benefit to other people clearly outweighs the rescuer's own risk.</td></tr>
<tr><td>Other immediate and urgent actions</td><td>Every effort should be made to prevent serious deterministic effects by keeping effective doses below 1000 mSv.
All reasonable efforts should be made to keep doses below twice the maximum single year limits (see below) to prevent any deterministic effects.</td></tr>
<tr><td colspan="2">Recovery and restoration operations</td><td>Normal occupational dose limits apply:
An effective dose of 20 mSv per year, averaged over 5 years (100 mSv in 5 years), with the further provision that in any single year,
(a) the effective dose should not exceed 50 mSv, and
(b) the equivalent dose should not exceed
— 150 mSv for the lens of the eye,
— 500 mSv for the skin (average dose over 1 cm^2 of the most highly irradiated area), and
— 500 mSv for the hands and feet.</td></tr>
</table>

Urgent actions in the rescue phase include personal decontamination and temporary evacuation. Sheltering for a radiological dispersal device would be of value if there were a threat and the attack had not occurred. Iodine prophylaxis would be important if there were a significant release of radio-iodines, but this is less likely because iodine is not used in sealed sources. In the recovery phase, definitive relocation and resettlement may be needed in extreme cases. The recovery phase may require restoration and cleanup, the safe management of the radioactive waste remaining from these operations, management of corpses containing significant amounts of radioactive substances, and dealing with long term prolonged exposure situations caused by remaining radioactive residues. Each of these countermeasures typically would provide the most benefit if the reduction of the avertable dose for the affected population were greater than the levels given in Table 3.

The recommendations should be seen as a decision aiding tool to help the competent authorities prepare for the aftermath of a radiological attack. The quantitative recommendations given above should be used at the planning stage as the basis for developing operational intervention levels. In order to prevent overreaction, it is essential that radiological protection decisions are proportional to the magnitude of the radiological attack.

5. ICRP'S NEW RECOMMENDATIONS

ICRP's recommendations have evolved over time, and since the 1990 system of protection was adopted [1], ICRP has published additional numerical restrictions on dose based on different ideas and spanning several orders of magnitude.

New scientific data have also appeared, and the biological and physical assumptions and concepts need some updating, although they have proved robust in the main. ICRP has decided to develop new recommendations that will consolidate all existing recommendations to give a single unified set that can be simply and coherently expressed. In doing so, ICRP recognizes the need for stability in international and national regulations.

The international consultation on the draft recommendations was the culmination of several years of work and resulted in nearly 200 responses with some 600 pages of written text. Many comments necessitate some clarification of policy points, but most of the comments deal with issues that will be

TABLE 3. RECOMMENDED COUNTERMEASURES IN RELATION TO AVERTABLE DOSE [8]

Countermeasure	Avertable dose (for which the countermeasure is generically optimized)
Sheltering	~10 mSv in 2 days (effective dose)
Temporary evacuation	~50 mSv in a week (effective dose)
Relocation	~1000 mSv or ~100 mSv in the first year (effective dose)
Iodine prophylaxis	~100 mSv (equivalent thyroid dose)

explained in a series of building blocks on which to base the new recommendations. ICRP has currently approved five such documents for Web consultation. As a result of the consultation exercise, two other documents are considered necessary. The first document will deal with the protection of the patient in medical procedures, and the second one will concern the basis for judging the significance of the effects of radiation, i.e. an updated version of Annex C in Publication 60 [1]. This annex demonstrated that ICRP does not have a simple risk based system, but rather that there is a complex multiattribute assessment of the implications of exposure.

The next draft of the recommendations will be completed after the finalization of the building blocks and should be ready for ICRP's consideration in the early part of 2006. A second round of international consultation on the recommendations will be necessary, after which ICRP will need to complete them. The most likely consequence of this will be that the publication of the new recommendations will not be adopted until late 2006 or 2007.

6. DISCUSSION

Secured sources can, and have, become unsecured. Radiological accidents have occurred and they indicate what might occur if radioactive materials were used intentionally to cause harm, for example by deliberate dispersion of radioactive material in a public area. Such events have the potential for exposing people to radiation and causing significant environmental contamination, which would require specific radiological protection measures.

High activity radioactive sources that are not under secure and regulated control raise serious security and safety concerns. The International Conference on Security of Radioactive Sources, held in Vienna in 2003, recommended greater international cooperation in addressing the security concerns raised by insufficiently controlled radioactive sources, and pointed to the need to identify those sources which pose the greatest risks. Effective national infrastructures for the safe management of radioactive sources are essential for ensuring the long term security and control of such sources. The Code of Conduct [3] will enhance the safety and security of such sources, and to date a great number of States have made a political commitment to supporting and promoting the Code.

ICRP has a long standing commitment to the safety and security of radioactive sources, as expressed in its many publications and recommendations [1]. ICRP therefore supports the Code of Conduct and expects that adherence to its requirements will strengthen the control of radioactive sources, and thereby also radiation safety, which is a prerequisite for radiation security.

REFERENCES

[1] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, 1990 Recommendations of the International Commission on Radiological Protection, Publication 60, Pergamon Press, Oxford and New York (1991).
[2] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).
[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).
[4] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Protection from Potential Exposure: A Conceptual Framework, Publication 64, Pergamon Press, Oxford and New York (1993).
[5] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Protection from Potential Exposures: Application to Selected Radiation Sources, Publication 76, Pergamon Press, Oxford and New York (1997).
[6] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Radiation Protection Recommendations as Applied to the Disposal of Long-lived Solid Radioactive Waste, Publication 81, Pergamon Press, Oxford and New York (1998).
[7] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Protection of the Public in Situations of Prolonged Radiation Exposure, Publication 82, Pergamon Press, Oxford and New York (1999).
[8] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Protection of People against Radiation Exposure in the Event of a Radiological Attack, Publication 96, Pergamon Press, Oxford and New York (in press).

WORKING TOGETHER FOR CONTINUOUS CONTROL OF SOURCES THROUGHOUT THEIR LIFE CYCLE

(Panel Session 1)

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SAFETY AND SECURITY RELATED TO THE SHIPMENT OF RADIOACTIVE SOURCES

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1. REGULATORY FRAMEWORK (APPLICABLE WORLDWIDE)

1.1. Mandatory and legally binding regulations

1.1.1. Transport safety

The safety of transport of radioactive material, which includes radioactive sources, is the objective of the Regulations for the Safe Transport of Radioactive Material, 1996 Edition (Revised), IAEA Safety Standards Series No. TS-R-1.

The Regulations are taken over in the United Nations Model Regulations and from there into the International Maritime Dangerous Goods (IMDG) code (for maritime transport), the International Civil Aviation Organization (ICAO) and International Air Transport Association (IATA) technical instructions (for air transport), and the European Agreements Concerning the International Carriage of Dangerous Goods by Road (ADR) and by Rail (RID) in Europe.

In other regions, the Regulations are directly or indirectly used as a basis for domestic transport regulations. As such, the Regulations become mandatory and legally binding.

Safety in the transport of radioactive sources is attained through provisions:

- Concerning the source (special form requirements);
- Concerning the package design (type A, B or C);
- Concerning administrative requirements (approvals by the competent authority, quality assurance provisions, radiological protection programme, training programmes, etc.).

The Regulations ensure safety in normal and accident conditions and are, or should be, more or less harmoniously applied and implemented all over the world.

The graded approach used in the Regulations is based upon objective quantities (activity, A_2 value) such that the radiological consequences of incidents or accidents are at first approximation independent of the activity present in the package or consignment (dose limits, maximum leak rates, etc., are similar for all consignments and are independent of the activity or the isotopes present).

The scope of the IAEA Regulations (paragraphs 106–109) explicitly does not consider routing control or physical protection which may be instituted for reasons other than radiological safety, and does not take specifically into account protection against theft, sabotage or intentional dispersion.

1.1.2. Transport security

Security during transport is not formally within the scope or objectives of the IAEA Regulations. Although not explicitly indicated as security measures, some provisions of the IAEA Regulations have a positive influence on the security of shipments.

- Paragraph 635: The requirement of "a feature such as a seal, which is not readily breakable and which, while intact, will be evidence that it has not been opened";
- Paragraph 558: The requirement that shipments with an activity greater than $3000A_1$ or $3000A_2$, or 1000 TBq, whichever is the lower, shall be notified to the competent authority of each country through which or into which the consignment is to be transported.
- Paragraph 582: The requirement that where a consignment is undeliverable, the consignment shall be placed in a safe location and the appropriate competent authority shall be informed.

Security appeared only recently in the United Nations Model Regulations (13th Revised Edition) and the related regulations for the transport of dangerous goods (IMDG, ICAO, IATA, ADR and RID) as a specific and supplementary item.

The security provisions, as laid down in the United Nations Model Regulations and taken over in the international transport regulations for the different modes, are applicable for the transport of all dangerous goods, including radioactive materials, and, as such, also radioactive sources. There are provisions applicable for all modes of transport (Chapter 1.4) and mode specific provisions. There are provisions applicable for all dangerous goods, and there is a second level (higher requirements) for high consequence dangerous goods.

The general provisions applicable for all dangerous goods focus on identifying, training and assigning the responsibilities of all persons involved, and on securing and limiting access to transit sites or temporary storage zones.

The provisions for high consequence dangerous goods introduce the establishment and implementation of security plans, with specific allocation of responsibilities for security to competent authorities and all other services and persons concerned. Specific attention is given to limiting the distribution of information as far as possible. When appropriate, monitoring of movement shall be envisaged.

The limit above which radioactive material (including radioactive sources) has to be considered as being of high consequence is at present set at $3000A_1$ or $3000A_2$, as applicable, in Type B or Type C packages.

1.2. Recommendations

In the framework of commitments related to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), for specific radioactive materials (fissile materials), supplementary security provisions were introduced more than twenty years ago, not through the above mentioned Regulations but through guidance (Convention on the Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225 and associated documents).

Similar to these, in order to enhance the security of (use of) radioactive sources, an update of the Code of Conduct on the Safety and Security of Radioactive Sources has been approved by the IAEA and was issued early in 2004. Member States are invited to endorse and implement the Code of Conduct.

As supplementary guidance to the Code of Conduct, a guidance document, Guidance on the Import and Export of Radioactive Sources, was published in March 2005.

This guidance has a completely different legal value from the Regulations mentioned in Section 1.1.

- — The Code and Guidance are non-legally-binding documents.
- — The graded approach of the provisions is not universal and is directed not only by objective criteria such as the activity and radiotoxicity of the isotopes but also by an evaluation of the threat.
- — It is left to the discretion of the local authorities to evaluate the risk and the threat and to impose the level of protection required and the precautions to be taken. There can be substantial differences between countries for the same shipment.

The application of the Code of Conduct is limited to a definite number of isotopes, in principle only those isotopes that are used in sources with such activities that they are able to cause serious consequences to people or the environment if not safely managed or securely protected.

The Code of Conduct divides the sources into three categories as a function of the activity and the properties of the isotope concerned. This categorization is based upon the D values which define a dangerous source, i.e. a source that could, if not under control, give rise to exposure sufficient to cause severe deterministic effects.

Most of the provisions and requirements, as foreseen in the Code of Conduct and the corresponding guidance document, are more or less administrative (inventory, control, authorization, confidentiality of information).

2. REGULATORY FRAMEWORK (REGIONAL OR COUNTRY SPECIFIC)

To supplement the regulations, recommendations, etc., issued by the United Nations or related organizations that are applicable and to be implemented worldwide, national or supranational (regional) regulations can be issued. One example of this is the ADR convention that regulates the road transport of dangerous goods in Europe. For radioactive materials, it implements the IAEA Regulations and makes them mandatory and legally binding for all European countries (for international transport). Through a directive, the European Community made these regulations also mandatory for domestic shipments all over Europe.

Within the framework of the transport/transfer of radioactive sources between its Member States, the European Community issued specific directives. Euratom Directive 1493/93, issued in 1993, controls the movement of encapsulated radioactive sources between Member States and ensures the traceability of these sources. It is a purely administrative tool. Euratom Directive 2003/122/Euratom, concerning high activity sealed sources and orphan sources, is more or less in line with the Code of Conduct (although other isotopes and activities are considered) and will be implemented at the end of 2005. This directive also organizes financial security, in order to cover the financial consequences of interventions connected with restoring control of orphan sources.

Work has long been under way on the part of some individual countries to organize the physical protection of high activity sources in line with the physical protection of nuclear material.

3. ORGANIZATION OF THE TRANSPORT OF HIGH ACTIVITY SOURCES: A PRACTICAL EXAMPLE

Although not its core business, Transnubel has some experience in the shipment of sealed radioactive sources of different activity categories.

Within the framework of Transnubel's quality assurance management system and in conformity with its radiation protection procedures, such shipments are described in Transnubel's procedures. Several controls are executed during the process:

(a) Preliminary verifications

- Do package approvals, source certificates and shipment approvals, if necessary, cover the source (activity, isotopes)?
- Are the package and contents compatible with the available transport equipment (mass, dimensions, etc.)?
- Have the necessary permits and authorizations been delivered and are they valid?
- Is the consignee authorized to receive the source?

(b) Verification directly before the organization of the shipment

- Coordination between consignor and consignee (material ready for dispatch, consignor ready and in agreement to receive).
- Names of contact persons at consignor and consignee (people that will sign documents for dispatch and for receipt).
- Preparation of organization with driver(s): time schedule, itinerary, instructions, documents, names of contact persons.

(c) During transport (road transport)

- The driver verifies that he or she has been contacted by the correct person(s) and that the correct package accompanied by the proper documentation has been loaded on the vehicle. Turnaround inspection is performed to verify proper labelling, seals, absence of damage, etc.
- The driver informs the office and the consignee that the transport has started.
- The automatic tracking system will trace the vehicle during the whole journey.
- During the whole journey, a qualified radiation protection agent will be permanently present in the close vicinity of the tracking equipment in the office.

— There will be a permanent and close supervision of the vehicle during the whole trip. If necessary, two drivers will be used (exceptional for sources, general for fissile material). Only if necessary or mandatory will the vehicle be halted (sanitary stop, driving time).
— The doors of the vehicle (also of the cabin) will be closed during the whole journey.

(d) Arrival and delivery

— The driver will verify that the correct person is present at the destination to receive the source and sign the corresponding documents for receipt.
— Turnaround inspection will be performed to verify the absence of damage.
— The driver will inform the office that the material has been delivered.

4. REMARKS

Several different regulations, recommendations, directives, etc., have to be complied with when radioactive sources are transported, with the consequence that such shipments are sometimes difficult and complex to organize.

Care should be taken to avoid contradictions in regulations. For example, the IAEA Transport Regulations (TS-R-1) require the labelling of packages and overpacks with labels indicating openly the isotopes and activity present, while security recommendations require that such information be treated as confidential.

If tracking of shipments is done, care should be taken that this information is received only by the appropriate people and not disseminated or hacked (if transmitted over the Internet, for example). Hoaxes should also be a concern, as well as the fact that sometimes vehicles are tracked by organizations or authorities for reasons not at all related to safety or security. The misuse of information obtained by such organizations has to be avoided.

5. ONGOING WORK AND CONCLUSIONS

There are many ongoing activities in this field. For example, the IAEA is working on the development of guidelines for security in transport of nuclear and other radioactive materials.

It is important to be aware that, if supplementary constraints and obligations are added to the existing rules, this will not automatically enhance safety or security. Denial of shipment could be the first consequence.

The saying that “the safest shipment is that shipment that never takes place” is an oversimplification and is only valid for shipments that are not justified.

The goal of regulations should be to maximize safety and security with minimal constraints and complexity. This should be borne in mind in attempting to refine or rework the existing rules and regulations.

SYSTEM OF CONTROL OF RADIOACTIVE SOURCES IN THE CZECH REPUBLIC

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1. INFRASTRUCTURE OF REGULATORY CONTROL

In the Czech Republic, the regulatory/supervisory bodies controlling nuclear safety and radiation protection have been, by governmental decision and in accordance with Act No. 85/1995 of 1995, integrated into one office, the State Office for Nuclear Safety (SUJB). Thus the SUJB became an integrated central agency of the Czech Republic State administration, with an independent budget and clear, declared competences.

2. LEGISLATION

Act No. 18/1997 Coll. on the peaceful use of nuclear energy and ionizing radiation (Atomic Act), as well as all related decrees, are based on internationally adopted principles of nuclear safety and radiation protection, which are embodied in recommendations of the IAEA (Safety Series No. 115 of 1994), the International Commission on Radiological Protection (Publication 60 of 1990), the World Health Organization, etc. This new legislation complex was harmonized with the similar legislation of the European Union countries (Council Directives Nos 96/29/Euratom, 97/43/Euratom, etc.) during the years 2000–2002.

3. AUTHORIZATION

The authorization granted by the SUJB, among others, is required for the following principal activities and practices:

— Siting, construction, operation and decommissioning of nuclear installations or some specific workplaces with ionizing radiation sources;

— Handling of ionizing radiation sources and nuclear material, and radioactive waste management;
— Transport of nuclear material and specified radionuclide sources;
— Professional training of selected personnel.

During the licensing process, documentation on the following must be approved by the SUJB:

— Monitoring programme;
— (On-site) emergency plan;
— Controlled zone, control areas;
— Quality assurance programme.

The following documentation should also be submitted to the SUJB during the licensing process:

— Justification and optimization of the practice;
— Specification of the practice and sources;
— Description of the workplace (shielding, ventilation, sewerage, etc.);
— Operational radiation protection programme;
— Limits and conditions for nuclear facilities;
— Expected releases and/or radioactive waste;
— Method of decommissioning of workplaces and sources;
— Certificate of the person responsible for radiation protection.

4. REQUIREMENTS FOR HANDLING OF RADIOACTIVE SOURCES

The actions in the handling of ionizing radiation sources (IRSs) that require a licence under the Atomic Act shall include:

(a) *Manufacturing*. A licence to manufacture IRSs entitles the manufacturer to store them and to carry out the necessary testing and verification of the parameters of the IRSs produced, but it does not replace any other licence needed for the intended use of the sources. The IRSs produced shall be stored safely in accordance with the special provisions for storage of IRSs. The manufacturer shall only deliver an IRS to a person with the appropriate authorization.
(b) *Import*. Imported IRSs shall be transported and stored safely under the special provisions of the Atomic Act. The importer shall ensure that

during import only authorized persons will handle the IRS and that the IRS will only be delivered to a person with the appropriate authorization.

(c) *Export*. Exported IRSs shall be transported and stored safely under the special provisions of the Atomic Act. The exporter shall ensure that during export only authorized persons will handle the IRS and that the IRS will only be delivered to a person with the appropriate authorization. A certificate stating that the recipient is authorized to handle IRSs confirmed by a competent body of the recipient's country shall be required for IRS export.

(d) *Distribution*. IRSs may only be introduced into the market after their type approval, where required, and if conditions have been created for verification and evaluation of the parameters of an individual manufactured IRS, providing evidence that the individual IRS conforms to the type approved. The distributor shall ensure that the documentation for IRSs distributed includes their classification, proposed scope of acceptance tests and status tests set out in Decree 307, a safe conduct document for an unsealed source and a valid certificate for a sealed source issued by an authorized person. The IRSs distributed shall be transported and stored safely under the special provisions of the Atomic Act. The distributor shall ensure that during transport only authorized persons will handle the IRS and that the IRS will only be delivered to a person with the appropriate authorization.

A licence is also required for IRS installation or commissioning, storage, usage, testing (performance test, long term stability test, acceptance test) and repair.

If explicitly stated in a licence, an IRS for the use of which a licence is required may also be used at previously unspecified workplaces designed for work with IRSs for a period of time not longer than 30 days (hereinafter referred to as the 'temporary workplace'). The SUJB shall be provided in writing, by fax or by email, no later than one day in advance, with the date of work startup, the anticipated period of time of work at a temporary workplace, the location of the workplace, a description of the work to be performed and an overview of the IRSs used. Working teams at temporary workplaces shall comprise at least two members, while at least one person shall have a special professional competence. The SUJB shall be notified without delay of work termination at the temporary workplace.

An IRS for the use of which a licence is required may only be used at such workplaces that meet the technical and organizational conditions of safe operation set out by decree and that ensure that IRSs are secured against theft and handling by unauthorized persons, including during the time when the sources are not directly in use, where they are only used or switched on to perform the work tasks.

5. CATEGORIZATION OF SOURCES AND WORKPLACES

Pursuant to the Atomic Act, IRSs are classified according to increasing degree of possible personal health hazards and environmental hazards into five classes: unimportant sources, minor sources, simple sources, important sources and very important sources. For the higher classes of sources, more rigid and extensive requirements are defined for the assurance of radiation protection. The licensing procedure is more sophisticated and requires a thorough professional knowledge. Inspections are primarily focused on management of the potentially most hazardous sources, and the relevant inspections are more frequent, extensive and detailed. In a similar way, the workplaces with such sources are classified into four categories, from the first category (the least hazardous) to the fourth category (potentially the most hazardous). The categorization of sources is not at present fully compatible with the categorization used in the IAEA Code of Conduct on the Safety and Security of Radioactive Sources and in IAEA-TECDOC-1344, Categorization of Radioactive Sources. However, the parameters registered in the central register of sources enable us to introduce also this categorization into the system and to use the recommended D values. This will be done during 2005 together with implementation of the requirements of the European Union Directive on High Activity Sealed Sources (HASS) in Decree 307/2002 on radiation protection.

6. CENTRAL REGISTER OF IONIZING RADIATION SOURCES

The Central Register of Ionizing Radiation Sources (CRIRS) is a part of the complex information system of the SUJB which includes the register of licensees, sources, licences and controls.

CRIRS registers sealed IRSs, devices with sealed IRSs, generators and specifications of workplaces with unsealed IRSs. Users are obliged to report within one month information on new sources in use which are specified by the decree on radiation protection. Users shall also report all changes of registered data, including the transfer of a source to another user or to final disposal. The registration of a source is based on the registration of its type and serial number.

Special registration cards are distributed by the SUJB and filled out directly by users. The users send the completed cards to the SUJB and the data are introduced into the register. Manufacturers, importers, exporters and distributors report to the SUJB once per half-year the list of the sources delivered. This system serves as a control of the completeness of the register and allows monitoring of the movement of a source during its whole lifetime.

CRIRS is applied for registration of individual sources used in the Czech Republic and monitoring of their movement, statistical evaluation based on selected source parameters, information on the placement of sources for fire rescue brigades and information on possible producers of radioactive waste. At present 7550 generators and a total of 6350 sealed IRSs are registered in CRIRS. About 180 workplaces dealing with unsealed sources are also registered. Approximately 4500 sources (1957 sealed) of the total number are classified as important sources according to the categorization scheme given in legislation.

7. SECURITY OF SOURCES

Licensees secure sources for which they have a licence against burglary, damage or destruction (Atomic Law). In addition they ensure that:

— No unauthorized person handles the source.
— Any loss of control over the source, or its theft, loss, disappearance or destruction, is notified without delay to the SUJB and the police of the Czech Republic. The stipulation of immediate notification does not apply to insignificant sources.
— The source is not distributed or in any way transferred unless the person taking over the source has the relevant licence to handle such a source. This provision does not apply to insignificant and minor sources.
— The location, movement, consumption, and security against burglary, loss, disappearance or destruction of a source are controlled by physical inventory on a regular basis every six months.

The SUJB investigates carefully all events with IRSs that are seen as unusual, paying attention to the evaluation of root causes and presentation of lessons learned. For the case of discovery of an orphan source, the first step is searching for the owner. If the owner is not found, the government is responsible for the treatment and final disposal of the source. The SUJB authorizes companies which are able to manage all the necessary steps to perform these functions in such cases.

On the basis of a collaboration of the SUJB with the Czech police, the General Customs Directorate, the fire rescue brigade and the other responsible bodies, which was focused on the prevention of illicit trafficking of radioactive materials and the prevention of loss and misuse of IRSs, an emergency response system was established that includes the following:

Integrated Rescue System

- Alarm, information on misuse of radioactive material or a terrorist attack;
- First evaluation of the situation (extent, main risk, etc.), confirmation of alarm, identification of the source of the alarm;
- First aid to persons affected;
- Detection, measurement, implementation of stipulated procedures or measures using predefined reference levels, delineation of protective zones.

SUJB

- Evaluation of the situation and preparation of a proposal on countermeasures;
- Application of penalties in accordance with legislation;
- Registration and evaluation, reporting of radiological consequences of the event, public information and feedback for the future.

Local and national authorities

- Realization of countermeasures for the protection of people and mitigation of consequences of the event.

Authorized persons

- Detection;
- Isolation of the source of risk;
- Decontamination, mitigation of consequences of the event.

During the year 2002, the SUJB issued a special recommendation on the procedure to be followed in the case of seizure of radioactive materials. It contains the procedure to be followed in the case of a suspected presence of radioactive materials for different scenarios. It also contains very useful charts of decision procedures and pictures of many objects potentially radioactive or containing radioactive material which might be found. This information has been distributed to all involved parties and serves as a very useful tool in the system. All events evaluated as unusual are reported to the SUJB through a contact person on permanent standby duty. This contact person is a part of a national rescue system that includes the fire rescue brigade and the police, and he/she ensures the activity of the relevant regional mobile monitoring team if necessary, for example in the case of discovery of a suspicious object. These mobile teams are operated by the SUJB, the National Radiation Protection Institute and the National Institute for Nuclear, Chemical and Biological Protection, and also by customs and fire rescue brigades. They are supplied with the necessary monitoring devices and equipment and they are able to evaluate the situation on the spot and to manage further steps for identification of the found object and for its safe storage. They also participate in periodic exercises.

8. CONCLUSION

The system of radiation protection in the Czech Republic now, after its complete reorganization, fully reflects the international standards for radiation protection, including most of the requirements of the Code of Conduct on the Safety and Security of Radioactive Sources. CRIRS, the national central registration system of all ionizing radiation sources, has been established and is now in routine operation. Some additional modifications will be introduced into the legislation and practice during 2005–2006. It is also planned to complete a complex system for providing information to the responsible authorities, institutions and databases of events, and for the exchange of data and information at the national and international levels and with border crossing (stationary) and territorial control (mobile) groups, to ensure the whole chain of activities from detection and evaluation to disposal of the misused or orphan radioactive materials, decontamination and mitigation of event consequences, and a system for training of the involved staff.

PREVENTION OF SMUGGLING (CONTRABAND) DURING LEGAL SHIPMENTS OF FISSIONABLE AND RADIOACTIVE MATERIALS

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The threat of illicit trafficking of fissionable and radioactive materials (FRM) across borders can be minimized by the implementation of two tasks:

— Carrying out constant radiation control at customs checkpoints;
— Preventing smuggling (contraband) during legal shipments of radioactive sources and nuclear materials.

In practically all countries, the customs control of legal shipments of radioactive sources and nuclear materials has been limited to the following:

— Within the framework of export control, the customs inspector formally verifies the licence for FRM import/export against the information provided in the cargo customs declaration.
— FRM customs examination is limited to cargo package recalculation and verification of seals.

Examples from the experience of the Russian Customs Service are described below.

In 1995, at the Pulkovo customs checkpoint (St. Petersburg), an attempt at smuggling of radioactive materials was prevented. The Mayak production centre at Chelyabinsk was shipping ^{192}Ir in two containers to the United Kingdom. According to the customs declarations, the radioactivity was 8460 Ci [1] and the mass of ^{192}Ir was 13.32 g. The actual values were 16 390 Ci and 25.7 g.

Five cases of contraband were proven to have taken place during the fulfilment of the year's allotment. On three occasions, delivery of ^{192}Ir was carried out under the name of another isotope.

A second example occurred in 2001, when a metallic container for radioactive material transport, type 2835 A, was delivered by air from the

[1] 1 Ci = 3.7×10^{10} Bq.

United States of America to the Russian Federation. No radioactivity was declared, i.e. the container was declared to be empty. However, at the Koltsovo airport customs zone (Ekaterinburg, Ural Region), a stationary radiation monitor was in operation. The dose rate at the surface of the container was measured with a handheld instrument and was found to be 107 μSv/h. Preliminary identification carried out by the customs officers with a gamma spectrometer showed that the container contained ^{192}Ir with an activity of 6.7×10^7 Ci. An investigation is in progress and the customs service of the USA is kept informed.

These facts testify to the necessity of customs examination of FRM which is limited to measurement (without opening of the container) and of the comparison of the actual characteristics and parameters with those declared in documents.

The FRM characteristics and parameters which are important for customs control are: FRM name; isotope composition, for nuclear materials; and activity, for radioactive materials. The measurement of the actual FRM characteristics and parameters without opening the container is only possible by using special technical means — spectrometric equipment.

FRM customs clearance and customs control in the Russian Federation are organized as follows.

(a) FRM customs clearance is carried out only by those customs control points authorized to do so, these organizations having the necessary expertise and being equipped with the special spectrometric instrumentation required for FRM examination.

(b) FRM customs clearance is carried out only on the condition of presentation of documents prepared according to the customs law and rules, including an indication that the material to be cleared is not on the list of materials whose transport is prohibited, and on the condition that the requirements for the safe transport of FRM are fulfilled.

(c) Examination of radioactive goods is carried out only by experts of the FRM customs control service of a customs station, with observance of radiation safety measures.

(d) For the purpose of checking the declared FRM parameters without opening the transport container, the Russian Customs Service uses gamma spectrometers linked to an electronic database on transport containers certified for use in Russia (model, thickness of shielding and material of the design, recommended point of measurement) that provide accuracy of measurement and reliability of FRM parameter identification that are sufficient for customs purposes.

The problems facing us are:

(1) Containers of foreign manufacture are not included in the transport container electronic database of the gamma spectrometers.
(2) The IAEA now has the PACTRAM transport container database; however, the format of this database is not appropriate for customs purposes.

In this connection, the Russian Customs Service has addressed the IAEA with the proposal to organize work on the creation of an international transport container database and its maintenance in an up-to-date condition. Such a database will allow the accuracy of parameter measurements and the reliability of FRM identification to be increased in the case of shipments in foreign transport containers.

The Russian Customs Service has offered to distribute technology for performing FRM customs examination without opening the container. Such technology should become an instrument for prevention of smuggling (contraband) during legal FRM shipments.

The Russian Customs Service has further offered to cooperate with efforts of the IAEA and national organizations on modernization of the PACTRAM international transport container database with the aim of entering into the database information useful for customs purposes. The electronic version of this database should be suited for use in the software of the gamma spectrometers of manufacturers from various countries.

PREVENTION OF ILLICIT TRAFFICKING OF FISSIONABLE AND RADIOACTIVE MATERIALS ACROSS BORDERS

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The threat of illicit trafficking of fissionable and radioactive materials (FRM) across borders can be minimized by the implementation of two tasks:

— Carrying out constant radiation control at customs checkpoints;
— Preventing smuggling (contraband) during legal shipments of radioactive sources and nuclear materials.

The following may provide indications of a possible attempt at illegal transport of FRM through the customs border:

— Presence of radiation danger signs on external packaging.
— Transport through the customs border of protective containers and objects made of protective materials such as lead, concrete and polyethylene.
— Transport through the customs border of a large legal shipment with a high level of ionizing radiation, which may be used as a cover. Some examples of such shipments are shipments of scrap metal, granite and ceramic goods.
— Results of verification of accompanying cargo and customs documents.
— Obtaining of on-line information.
— Triggering of radiation control equipment.

Statistics show that, of the cases of illegal FRM transport discovered, 95% are revealed by technical means.

RADIATION CONTROL WITHIN CUSTOMS CONTROL

Taking into account the volume and character of the tasks to be solved, the level of customs personnel training and the category of the technical facilities, radiation control within customs control has the following stages:

— Primary radiation control;
— Additional radiation control;
— Advanced radiation inspection;
— Practices and procedures carried out by specialized organizations authorized for activities in this field.

Primary radiation control

The purpose of primary radiation control is to reveal goods and transport vehicles with high levels of ionizing radiation in comparison with the natural radiation background during the movement of goods and transport vehicles into the customs control zone.

The main way of realizing such control is the use of stationary radiation monitors with gamma and neutron channels for the detection of FRM.

The criterion for classification of a checked object as having a high level of ionizing radiation is the stable and not false triggering of a radiation control device, which is confirmed by the use of a second radiation control device.

Additional radiation control

The purposes of additional radiation control are:

— Determination of the reasons for the triggering of the stationary radiation monitor;
— Search and localization of objects with a high level of ionizing radiation in goods and transport vehicles;
— Measurement of radiation parameters, including the levels of surface contamination by alpha and beta emitting radionuclides;
— Evaluation of the radiation danger posed by the objects.

Additional radiation control is carried out by customs personnel who have undergone special training.

For additional radiation control, search instruments with gamma and neutron channels, as well as verified dosimetric and radiometric equipment, should be used. In the search mode, measurements should be made from as close as possible to the object. The recommended speed of the instrument movement should be about 10–20 cm/s.

Advanced radiation inspection

The purpose of advanced radiation inspection is the localization and primary identification of materials contained in the object.

Advanced radiation inspection is carried out by the personnel of the FRM customs control service of a customs station.

For the execution of advanced radiation inspection, verified spectrometric equipment should be used. During the execution of customs control, the major role is assigned to customs personnel who control the movement of goods and transport vehicles into the customs control zone and carry out customs inspection.

One should take into account the fact that customs personnel making decisions on releasing goods and transport vehicles are not specialists in the sphere of nuclear physics. However, the possibility of making a wrong decision should be minimized. Thus the most important element is a clear written procedure for the primary actions to be taken in a case where facts may indicate a possible attempt at illegal transport of FRM through the customs border.

The primary actions which are performed by customs personnel in the case of triggering of a radiation monitor include:

— Localization of the object in the customs control zone;
— If there is an opportunity, a second use of the primary radiation control equipment, with the purpose of obtaining assurance that the alarm is stable and not false;
— Control of cargo and customs documents;
— Placement of the object in a specified section of the customs control zone and provision of security;
— Performing an additional radiation control with the purpose of determining the reasons for the triggering of the primary radiation control equipment;
— Search and localization of material with a high level of ionizing radiation in goods and transport vehicles;
— Measurement of radiation parameters and evaluation of the radiation danger.

In the case of triggering of radiation monitors on the neutron channel, additional radiation control is realized with the use of portable equipment with detectors of neutron radiation.

CONCLUSION

The way to increase the effectiveness of customs control of FRM at State borders is to create a multilevel system of actions to be performed by various specialized customs organizations on the basis of the results of radiation control of goods and transport vehicles. A multilevel system implies a number of centres for collection of information about the results of radiation control: checkpoint, customs station, regional customs department, federal customs service.

The effectiveness of customs control of FRM will be increased by the following:

- Full control of customs personnel actions of a specialized customs organization;
- The possibility for recommendations, including recommendations from government organizations, to be submitted to higher customs organizations, giving a full account and evaluation of all the information obtained.

WORKING TOWARDS IMPLEMENTING THE CODE OF CONDUCT

(Technical Session 1)

Chairperson

W. STERN
United States of America

PLENARY SESSION

CODE OF CONDUCT ON THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES, AND THE ASSOCIATED GUIDANCE ON THE IMPORT AND EXPORT OF RADIOACTIVE SOURCES

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The Code of Conduct on the Safety and Security of Radioactive Sources (the Code of Conduct)[1] provides guidance, reflecting international consensus, on how States should safely and securely manage radioactive sources. This conference is all about the practical implementation of the Code of Conduct, but what is the Code of Conduct? What does it say? What is the Guidance on the Import and Export of Radioactive Sources (the Guidance)[2] about? How will it impact upon international trade in radioactive sources?

The drafting of the Code was an exercise in two parts — its initial drafting in 2000, and the extensive revision in 2002–2003. Between the two were, of course, the events of September 2001. While much of the original 2000 Code is still there in the 2003 Code, the revised Code is more substantive, particularly in the areas of security and international trade. In addition, the State level commitment requested by the IAEA General Conference takes the Code beyond the status of a mere recommendation, although it is not legally binding.

1. SCOPE OF THE CODE

Let's look at what the Code covers, and what it doesn't cover. The Code applies only to sealed radioactive sources, rather than to the wide range of radiation sources covered by the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources.

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[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources: Guidance on the Import and Export of Radioactive Sources, IAEA, Vienna (2005).

At the meetings organized by the IAEA Secretariat where the Code was drafted in 2000, there were lengthy discussions about its scope. While noting that radiation generators had caused a certain number of accidents, it was recognized that most of the accidents with serious consequences had been caused by radioactive sources. The Code therefore focused on “radioactive sources that may pose a significant risk to health and the environment”. In order to quantify what was meant by ‘significant risk’, the Code recommended that States should give highest priority to the radioactive sources belonging to Category 1 of the IAEA’s Categorization of Radiation Sources[3] (i.e. teletherapy sources, irradiators and industrial radiography sources). The Code did not cover nuclear materials (the protection of which is subject to a separate international regime) or radioactive sources within military or defence programmes (which are often not subject to the same sort of regulatory structure as sources in civilian use).

When the time came to revise the Code, States were concerned that given its more focused content and the importance of harmonized implementation, there should be a common understanding as to what sources it did and did not apply to. The revised Code focuses on sealed radioactive sources of Categories 1, 2 and 3 of the revised Categorization of Radioactive Sources[3] – that is, sources that could, if not under control, give rise to exposure sufficient to be fatal or life threatening, or result in a permanent injury that reduces quality of life. Indeed, the Code goes so far as to provide a list of typical uses of sources, radionuclides and activity levels of sources included within its scope. Furthermore, although the Code generally applies to sources in Categories 1, 2 and 3, those recommendations that relate to national registers and import/export controls are limited to sources in Categories 1 and 2. The exclusions referred to above continue to apply.

Given that the IAEA is an organization of States, and that the Code is primarily concerned with regulatory and administrative issues, the Code is addressed to States. I understand that many of the major manufacturers and suppliers of radioactive sources are currently negotiating among themselves on a draft Code of Good Practice intended to complement the Code of Conduct.

2. PROVISIONS OF THE CODE

The objectives of the Code of Conduct[4] are to:

[3] IAEA-TECDOC-1344.

[4] Code of Conduct on the Safety and Security of Radioactive Sources, paragraph 5.

— Achieve and maintain a high level of safety and security of radioactive sources;
— Prevent unauthorized access or damage to, and loss, theft or unauthorized transfer of, radioactive sources, so as to reduce the likelihood of accidental harmful exposure to such sources or the malicious use of such sources to cause harm to individuals, society or the environment;
— Mitigate or minimize the radiological consequences of any accident or malicious act involving a radioactive source.

To achieve those objectives, every State should:

— Establish an effective legislative and regulatory system, including a regulatory body. The system should, inter alia, place the prime responsibility for safety on the user, and minimize the likelihood of loss of control[5]. Paragraphs 18 and 19 of the Code provide details of the recommended content of such a system, while paragraphs 20–22 set out the recommended powers of the regulatory body.
— Ensure that appropriate facilities and services for radiation protection and safety are available, including those needed for searching for missing sources and securing found sources, for intervening in the event of an accident or incident and for personal dosimetry and environmental monitoring[6].
— Ensure that adequate arrangements are in place for appropriate training of staff of the regulatory body, customs officers, police and staff of other law enforcement agencies[7].
— Encourage bodies or persons likely to encounter orphan sources during normal operations to implement monitoring to detect such sources[8].

A range of provisions of the Code are relevant to maintaining control over sources. Some of those provisions explicitly refer to the needs of ‘security’. When the Code was first drafted, the focus of the Experts’ Group in this regard was very much on the prevention and mitigation of thefts in ignorance of the hazard, such as cases of persons stealing objects for scrap metal resale, as in Goiânia and a number of other places. At that time, high activity sources were thought to have a degree of ‘self-protection’, and the Group gave no

[5] Code of Conduct on the Safety and Security of Radioactive Sources, paragraph 8.
[6] Code of Conduct on the Safety and Security of Radioactive Sources, paragraph 9.
[7] Code of Conduct on the Safety and Security of Radioactive Sources, paragraph 10.
[8] Code of Conduct on the Safety and Security of Radioactive Sources, paragraph 13.

consideration to the possible deliberate acquisition of radioactive sources for malicious use.

When the Code was revised in 2002–2003, the situation was obviously very different. In the Technical Committee, there was, understandably, a high level of concern regarding the potential for malicious use of radioactive sources. Proposals for strengthened controls which had received little support in 2000 were now embraced. Consequently, the revised Code included new provisions relating to:

— National registers[9];
— International trade in radioactive sources[10];
— Strengthened security requirements;
— Confidentiality of information[11];
— Prompt notification to potentially affected States of incidents of loss of control or with potential transboundary effects[12].

The strengthened security provisions are wide ranging. Among the new or amended provisions are:

— States should ensure that radioactive sources within their territory, or under their jurisdiction or control, are safely managed and securely protected during their useful lives and at the end of their useful lives[13].
— States should promote security culture[14].
— States should establish an effective national legislative and regulatory system of control, recognizing that prime responsibility for the safe management of, and the security of, radioactive sources remains on the persons being granted the relevant authorizations[15].

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[9] Code of Conduct on the Safety and Security of Radioactive Sources, paragraph 11.

[10] Code of Conduct on the Safety and Security of Radioactive Sources, paragraphs 23–29.

[11] Code of Conduct on the Safety and Security of Radioactive Sources, paragraph 17.

[12] Code of Conduct on the Safety and Security of Radioactive Sources, paragraph 12.

[13] Code of Conduct on the Safety and Security of Radioactive Sources, subparagraph 7(a).

[14] Code of Conduct on the Safety and Security of Radioactive Sources, subparagraph 7(b).

[15] Code of Conduct on the Safety and Security of Radioactive Sources, subparagraph 8(a).

— Designers, manufacturers, suppliers, users and those managing disused sources have responsibilities for the safety and security of radioactive sources[16].
— National legislation and regulations should include requirements relating to the verification of the safety and security of radioactive sources[17].
— The regulatory body should consider the need for an assessment of the security of the source and/or the facility, in the light of the current national threat assessment[18].
— The importance of safe and secure management of disused sources[19].
— The need to establish the trustworthiness of individuals involved in the management of radioactive sources[20].
— The need to protect information relating to the security of sources[21].

3. STATUS OF THE CODE

The Code had its genesis in one of the major findings of the Dijon conference (Conference on the Safety of Radiation Sources and Security of Radioactive Materials, held in Dijon in 1998), subsequently taken up in the IAEA's Action Plan for the Safety and Security of Radioactive Sources (the Action Plan)[22], calling for the creation of an 'international undertaking' on the safety and security of sources. In implementation of this part of the Action Plan, meetings of legal and technical experts were held in March and July 2000. Those meetings developed the first Code of Conduct on the Safety and Security of Radioactive Sources. But whatever had been the views of those at Dijon and of the drafters of the Action Plan, there was no enthusiasm in the Technical Committee for any level of national commitment to the Code. The September 2000 meeting of the IAEA Board of Governors requested the Director

[16] Code of Conduct on the Safety and Security of Radioactive Sources, paragraph 15.
[17] Code of Conduct on the Safety and Security of Radioactive Sources, subparagraph 19(h).
[18] Code of Conduct on the Safety and Security of Radioactive Sources, subparagraph 20(b).
[19] Code of Conduct on the Safety and Security of Radioactive Sources, subparagraph 20(e)(vii).
[20] Code of Conduct on the Safety and Security of Radioactive Sources, subparagraph 20(e)(viii).
[21] Code of Conduct on the Safety and Security of Radioactive Sources, subparagraph 20(e)(ix).
[22] GOV/1999/46-GC(43)/10.

General to organize consultations on the application and implementation of the Code and make recommendations to the Board. The subsequent General Conference invited Member States to take note of the Code and to consider, as appropriate, means of ensuring its wide application. One would have been forgiven for believing that, like the Code of Practice on the International Transboundary Movement of Radioactive Waste adopted in 1990, this Code would largely gather dust on bookshelves[23].

However, two factors intervened. One was the determination of the IAEA Secretariat to strengthen national controls, particularly in developing countries, in order to prevent the recurrence of incidents such as those in Brazil, Thailand and elsewhere, where unsafe management practices had led to deaths, injuries and substantial economic loss[24]. To that end, the Code was incorporated into the then Model Technical Cooperation Project to Upgrade National Radiation Protection Infrastructure, in which most developing Member States took part. In that way, the Code's provisions were incorporated into national law in a number of States.

Secondly, as referred to above, the events of September 2001 galvanized developed States into realizing that inadequate controls over radioactive sources could pose a threat to them too. This meant that when the Technical Committee met again in 2002–2003, it was a much larger group than the 2000 Committee, and perhaps also more purposeful.

The text of the revised Code was finalized in July 2003. It was presented to the IAEA Board of Governors in September 2003. The Board approved it and decided that it should be provided to the IAEA General Conference. Later that month, the General Conference[25] welcomed the Board's approval of the revised Code, and endorsed the objectives and principles set out in the Code, while recognizing that the Code was not a legally binding instrument. Furthermore, the General Conference urged each State to write to the Director General stating:

- That it fully supported and endorsed the IAEA's efforts to enhance the safety and security of radioactive sources;
- That it was working towards following the guidance contained in the revised Code and encouraged other States to do the same.

[23] Perhaps the different fate of the two instruments reflects a real difference; in contrast to the outstanding safety record of transport of radioactive material, there had been a number of serious incidents involving radioactive sources (see footnote 24).

[24] For examples, see http://www-pub.iaea.org/MTCD/publications/accres.asp

[25] Resolution GC(47)/RES/7.

In addition, the General Conference requested the Director General, subject to the availability of resources, to compile, maintain and publish a list of States that made a political commitment by writing to him as urged by the General Conference. At the time of writing this paper, 72 States had made such a commitment[26]. Although encouraging, there are some regions where that commitment has not been widely made, and of course the making of such a commitment is just the start — the key lies in the practical implementation of the Code. The IAEA's projects to upgrade national protection infrastructures remain vital.

4. IMPORT/EXPORT GUIDANCE

The Code contains a general provision to the effect that import and export should be undertaken consistent with the provisions of the Code and with international transport standards. For Category 1 and Category 2 sources, there are provisions for explicit authorization, as appropriate, by both the importing and exporting States of the import/export. The Code recommends that the importing State consent to an import only if:

(a) The recipient of the source is legally authorized to receive and possess the source; and
(b) The State has the appropriate technical and administrative capability, resources and regulatory structure needed to ensure that the source will be managed consistent with the provisions of the Code.

The exporting State has the obverse obligations to assess the receiving State's authorization of the recipient and its regulatory capability. The Code also contains a provision allowing for exports and imports to take place otherwise than in accordance with the above provisions in exceptional circumstances.

Given the need to secure consensus in the Technical Committee, those provisions are somewhat general in nature. The potential for inconsistent interpretation — particularly in regard to the question of when prior consent from the importing State was required and to the application of the 'exceptional circumstances' provision — soon gave rise in capitals to concerns regarding the maintenance of a level playing field between the exporters of radioactive

[26] An updated list of these States can be found at http://www-ns.iaea.org/home/rtws.asp

sources. In order to address those concerns, and to develop mechanisms for exchange of information between the importing and exporting States, more detailed Guidance was developed by Member States and endorsed at the General Conference in 2004[27].

This Guidance establishes the mechanisms that should allow the import/export provisions of the Code to be applied in a consistent manner by Member States. They clearly set out procedures for the international transfer of sources under three headings:

— Transfer of Category 1 sources;
— Transfer of Category 2 sources;
— Transfer of Category 1 or 2 sources in exceptional circumstances.

The export of a Category 1 source requires the prior, explicit consent of the importing State. The routine export of a Category 2 source requires prior notification, but there is no need for prior consent. Any export under the 'exceptional circumstances' provision requires the consent of the importing State. These provisions should assist national regulators in ensuring that they are aware of the presence of all Category 1 and 2 sources on their territory — something which has not always been the case in the past.

The Guidance repeats the provisions of the Code concerning authorization and assessment of the importing State's capacity cited above. The question as to whether the proposed recipient of a source is authorized by the importing State is fairly straightforward. On the other hand, the judgement by the exporting State as to whether the importing State has the appropriate infrastructure to manage the source safely and securely could be more difficult. The Guidance allows for information provided by States to the IAEA on a voluntary basis to be taken into consideration, if agreed by the importing State. This information includes:

(a) Responses by the importing State to a brief 'Self-Assessment Questionnaire'.
(b) Whether the importing State has written to the Director General indicating that it is working towards following the Guidance contained in the Code.
(c) Whether an importing State that participates in the IAEA Model Project has met Milestone 1, which requires establishment of a basic legal and regulatory infrastructure. The recent replacement of the Model Project

[27] GC(48)/RES/10.D.

by a number of regional and national projects — although it has a range of benefits — has introduced some uncertainty in relation to this factor. That uncertainty may go beyond the replacement of the term 'Milestone' by 'Thematic Safety Area'. It is not clear to me whether States participating in such projects will still, once they satisfy the objectives for each Thematic Safety Area, be accredited as such. I hope that the project managers within the IAEA Secretariat are advising participating States that, should they satisfy the objectives of Thematic Safety Area 1, they should answer 'yes' to the question concerning Milestone 1 in the Model Project in the Self-Assessment Questionnaire.

In recognition of today's security concerns, the Guidance also calls upon both the exporting and the importing State to assess the risk of diversion of the source to malicious uses. The application of these provisions will necessarily be somewhat subjective; nevertheless, the Guidance's provisions relating to consultation (see below) and the reality of the commercial marketplace should mean that judgements are not made arbitrarily. In September 2004, the IAEA General Conference and Board of Governors underlined the importance of exporting States, in applying the Guidance, in particular these provisions, carrying out the information exchange and consultations foreseen in its paragraph 21[28].

Clearly, the effectiveness and practicability of these arrangements will be tested in the international marketplace. The General Conference in 2004 noted that more than 30 States had committed themselves to implementing the Guidance from 31 December 2005, and encouraged States to implement it on a harmonized basis and to notify the Director General of their intention to do so. Without harmonization, the implementation of the Guidance could lead to confusion and the application of inconsistent standards to decision making about exports. This could in turn lead to the breakdown of the system brought into being by the Guidance. Only three States have so far written to the Director General committing themselves to implementing the Guidance. It is to be hoped that those many other States which have already made political statements in support of the Code of Conduct will write to the Director General soon, especially those among the 30 States referred to in the General Conference resolution.

It must be stressed that the Guidance is not intended to hamper legitimate international trade in, and the range of beneficial uses of, radioactive sources. Indeed, the manufacturers of radioactive sources have recognized that

[28] GC(48)/RES/10.D, operative paragraph 9.

continued accidents involving, or the deliberate misuse of, radioactive sources would lead to further restrictions on their use and have therefore strongly supported both the Code and the Guidance.

In the light of concerns raised around the time of consideration of the Guidance by the IAEA Board of Governors in September 2004, I must emphasize that neither the Code nor the Guidance is intended to be used as a weapon in political disputes. Like other IAEA standards, both instruments are based on the concept of cooperation between Member States. It would not be in the interests of any State were they to be applied in an arbitrary or discriminatory way. As I noted earlier, the objectives of the Code are to be met "through the fostering of international cooperation". Paragraph 21 of the Guidance indicates that "In furtherance of harmonized action under this Guidance, States should, as necessary and appropriate, exchange relevant information and consult with other States." Should there ever be an attempt to misuse the Guidance for purely political purposes, the universal support which is essential for its implementation will break down.

5. CONCLUSION

Radioactive sources provide many benefits to society, but at the same time, serious accidents have occurred in the past. While their continued use should be encouraged, it must be accompanied by efforts to prevent or minimize such accidents. The Code and the Guidance represent a concerted attempt by IAEA Member States to address the failings which led to those accidents. They also represent an attempt to grapple with the threat of the malicious use of sources in radiological dispersal devices. Although people will inevitably be able to identify areas where the instruments could be further improved, I do not believe that that is a priority. The priority must be the effective implementation at national level of these standards, which is what we are here this week to discuss.

DISCUSSION

A.J. GONZÁLEZ (Argentina): Mr. McIntosh understands both the international legal aspects and the technical issues. The Code of Conduct was achieved because of this rare mixture of qualities. However, the Code is a moral obligation only; sooner or later we need a more binding commitment. The Code does not have an implementation mechanism such as any convention will have. Even the Convention on Nuclear Safety has review meetings attended by the parties. My question is whether we can ask the IAEA to consider introducing — as an intermediate step towards the horizon of binding obligations for the safety and security of sources — a mechanism for the implementation of the moral obligations that States have undertaken in the Code. It could even be a simple meeting of the 72 States that have written to the Director General where they could discuss their actions. This is happening to a small extent at this conference but it is not a formal mechanism.

S. McINTOSH (Australia): I am very interested to see how today's discussions go. Though clearly not equivalent to the Convention on Nuclear Safety or the Joint Convention process, the more informal nature of the discussions may encourage developing Member State participation. If today's experience is positive, I would support an ongoing series of meetings like this one where States can discuss their implementation of the Code. A more formal process could then be endorsed by the IAEA General Conference.

W. STERN (United States of America): I agree with Mr. González' observation that this is in essence the first review of the Code, and with Mr. McIntosh that one of the findings of this conference would be that we need a slightly more formal mechanism in order to proceed and review the Code in greater depth some years from now.

C. WILLIAMS (United Kingdom): I understand that assurance on preventing the diversion of sources for malicious use is provided by the Code through a system of self-assessment and declaration by each Member State. How effective do you consider this to be?

S. McINTOSH (Australia): This is not the whole picture. The Code stipulates that importers should assess the risk of diversion, which is the self-assessment, but exporters also have such an obligation. Exporters are requested to consult with affected States before making a denial on that basis, but ultimately it is their decision. If a situation arose where there was a Taliban-style regime, which said there was no risk of diversion, the exporting State would not be bound by that 'assurance'. It must make its own assessment.

W. STERN (USA): The Guidance on the Import and Export of Radioactive Sources derives from the Code. I would like to emphasize that so far only three States have written to the IAEA Director General committing themselves to implementing the Guidance. This could be because States are not aware that two separate letters are requested by the General Conference: one for the Code and the other for the Guidance with an implementation date. Last year the G8 countries made a commitment to implement the Guidance by the end of 2005. The European Union countries did likewise at the USA–EU summit in Shannon. A few days ago, the USA, Canada and Mexico committed themselves to implementing the Guidance by a set date and Asia–Pacific Economic Cooperation (APEC) leaders are considering a similar commitment.

So, although few States have written to the Director General, a lot are considering following the Guidance. Therefore I would encourage States represented here to notify the Director General so that we can start moving forward in implementing the Guidance.

As Mr. McIntosh indicated, in the last two years we have made great political progress on the Code of Conduct. Today we shall review what we have actually accomplished technically — what States have done to implement the Code. The objective is not just to hear how well things are going but also to learn what needs to be changed, what assistance should be provided and how States can help one another in implementing the Code.

TECHNICAL SESSION 1: GROUP A

Moderator

R. CZARWINSKI
Germany

ESTABLISHMENT OF REGULATORY CONTROL OVER RADIATION SOURCES IN THE REPUBLIC OF ARMENIA

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Abstract

The paper describes the work carried out in Armenia to establish regulatory control over radiation sources, including the development of legislation and regulations, the establishment of a national registry of sources, and the development of licensing procedures and training programmes in the area of radiation protection and the safe use of radiation sources.

1. INTRODUCTION

Since 2002, the Armenian Nuclear Regulatory Authority (ANRA), with support from the United States Nuclear Regulatory Commission (NRC) and the IAEA, has worked to achieve and maintain a high level of regulatory oversight and control of the safety and security of radiation sources in Armenia. The principal goal of this effort is to reduce the likelihood of the use of a radiological dispersal device (RDD, or 'dirty bomb') or radiological exposure device (RED). One mechanism by which Armenia intends to achieve this goal is through aggressive implementation of the IAEA Code of Conduct on the Safety and Security of Radioactive Sources. Specifically, ANRA has completed the development and implementation of the national radioactive source database (registry). ANRA now has current information (type, owner, use, etc.) on the approximately 1300 radioactive sources in use in Armenia. The disposition of these sources has been verified by ANRA through actual on-site inspections. ANRA developed an amendment to Armenia's basic nuclear law, which, among other things, endorses provisions of the Code of Conduct. The amendment was signed into law by the President of Armenia in December 2004. ANRA has also prepared, and is moving forward to adopt, several new regulatory requirements (rules and regulations) that identify safety and security requirements applicable to the use of radioactive sources in Armenia. ANRA is currently in the process of developing procedures to authorize (license) the use and handling of radioactive sources. In 2004 ANRA established two regional offices in the cities of Goris and Vanadzor from which it will conduct inspection and enforcement activities related to radiation sources. Lastly, ANRA has conducted several workshops to familiarize users of radioactive sources with these new safety and security requirements.

2. LEGISLATION AND REGULATION

The Code of Conduct establishes a need for each State to have legislation and regulations that prescribe and assign governmental responsibilities for the safe and secure use of radioactive sources, that provide for the effective control of radioactive sources, that specify the requirements for protection against exposure to ionizing radiation, and that specify the requirements for the safety and security of radioactive sources.

To accomplish this, ANRA has developed an amendment to the existing law, standards and regulations on radiation protection and the safe use of radiation sources and is currently in the process of developing procedures to license the operation of radiation sources, radiation generators and associated equipment.

2.1. Amendment to the nuclear law

The Amendment to the Law of the Republic of Armenia on Safe Utilization of Atomic Energy for Peaceful Purposes (1999) was prepared by ANRA in 2003, approved by the National Assembly in November 2004 and signed into law by the President of Armenia in December 2004.

The Amendment addressed the status of ANRA, i.e. its independence, clarified ANRA's basic responsibilities and authorities, and specifically authorized ANRA to conclude international agreements. The Amendment obligated the utility organization to allocate a normative quantity of revenue to safety improvement, physical protection, fuel storage and decommissioning.

The Amendment introduced, extended and clarified the existing law consistent with the Basic Principles of the Code of Conduct. The specific changes affecting radiation sources are given below. The Amendment:

- Explicitly identified 'ionizing radiation sources' as the subject and objective of the Law.
- Required "compliance with requirements…of Safety Standards of the IAEA" when developing or adopting legal acts.

- Required recognition and application of the IAEA Safety Standards with the purpose of bringing the level of safety into compliance with international criteria.
- Provided an extended definition of 'regulatory authority' to include "licensing and authorization in the field of atomic energy utilization" and "regulation of safety of…radioactive materials".
- Clarified the definition of the State regulation of safety in the field of atomic energy utilization to include:
  - Safety of radioactive materials and radiation generators;
  - Import and export of radioactive materials, radiation generators and associated equipment;
  - Accounting and control of radioactive materials, radiation generators and equipment containing radioactive material.
- Obligated the regulatory authority to:
  - Establish and maintain a State register for ionizing sources;
  - Coordinate the IAEA national and regional programmes in the technical cooperation framework, including the Model Project;
  - Cooperate with other international organizations and with the regulatory authorities of other countries on the exchange of information and safety related issues.
- Allowed for the involvement of international organizations and experts in regulatory supervision.
- Defined the place of technical support organizations in providing technical support in practices with accounting, control and conduct of the register of radiation sources.
- Established procedures for the issuing of licences for the import and export of radiation sources and associated equipment and of radiation generators.

2.2. Standards and regulation

The following documents were developed to support the regulation of ionizing sources in Armenia:

- Standard on Ionizing Radiation Protection and Safety of Ionizing Radiation Sources;
- Regulation on Ionizing Radiation Protection and Safety of Ionizing Radiation Sources.

The Standard defines the radiation protection principles, provides definitions and methods of calculating exposure, establishes dose limits for categories of personnel under normal conditions and in emergency situations, and establishes requirements for exposure of members of the public to human-made sources under normal conditions and to natural radiation sources, for medical exposure and for exposure in radiological emergencies. The Standard was developed in accordance with requirements existing in Armenia and consistent with international practice and IAEA recommendations in this area.

The Regulation establishes requirements for practices that handle ionizing radiation sources. It identifies the requirements for licensing and authorization for handling sources above the exemption threshold. The Regulation establishes requirements for siting, design, safe operation and decommissioning of facilities that handle sealed and unsealed sources and radiation generators. The Regulation defines processes associated with the purchase, accounting, transport and transfer of radiation sources and associated equipment. It provides requirements for monitoring of workplaces and personnel exposure, for radiation protection measures for staff and patients, and for protection of members of the public. The Regulation establishes the requirements for a radiation protection plan and emergency procedures.

3. NATIONAL REGISTRY OF RADIATION SOURCES

Consistent with the Basic Principles of the Code of Conduct, ANRA has established a national registry of radiation sources. The development of this registry is described below. This process includes an administrative search (paper records), inspection verification, and development of the registry as part of the ANRA Regulatory Information System (ARIS).

Effective control over radiation sources in Armenia was lost after the break-up of the Soviet Union. In 2002 ANRA was given the responsibility for regulatory control of radiation sources by the Government of Armenia. The first priority was to re-establish with some confidence the knowledge of the disposition of sources in Armenia, i.e. to perform an initial inventorization.

3.1. Inventorization process

During the administrative search, ANRA obtained records from the Ministry of Health and contacted local municipalities and regional offices of the Ministry of Health to obtain information on the organizations that were currently using (or had used in the past) radiation sources and generators. To facilitate this process, ANRA developed a form that was mailed to these organizations requesting up-to-date information.

ANRA received and analysed the information on radiation sources and concluded that on-site inspections would be required to confirm the data obtained up to that point. During the next phase of the project, ANRA inspected all the organizations in Armenia last known to possess radiation sources. This activity allowed information on the sources' disposition to be verified. The inspections identified approximately 2000 radiation sources. About two thirds of these were in active use, and the remainder were sent for long term storage at a RADON facility.

Of the 1257 radiation sources located at 285 facilities, there are four ^{60}Co sources of Category 1 (by activity), 42 ^{60}Co sources of Category 2 and eight sources of Category 3. All the data were entered into ARIS, which, in addition to serving as the national register for radiation sources, performs a number of other functions as described below.

3.2. ARIS

ANRA is in the process of developing an information system. The system is designed to perform process control and contain an information database. Process control includes ANRA's activities, such as authorization, licensing and inspection of all facilities subject to ANRA oversight, including that for radiation sources. The information database includes the following modules: NUCMAD (nuclear materials), RASOD (radiation sources), OCUDOS (occupational doses) and the Technical Library. Of these, RASOD has been developed and the licensing module is under development, with an anticipated completion date in 2005.

RASOD provides a capability of storing essential information on the radiation sources in Armenia, tracking disposition of the radiation sources and generators over their lifetime, maintaining an accurate inventory, recording any changes and providing a recoverable history of all transactions. Functionally it serves two main purposes: as a national register and (in the future) as a source of information for licensing and inspection activities. Consistent with the Code of Conduct requirement to harmonize the format of States' registers, RASOD has an internal record structure that is fully compatible with the latest version of the Regulatory Authority Information System (RAIS) software.

4. LICENSING OF RADIATION SOURCES

ANRA will begin formal licensing in 2005. To prepare for this activity ANRA is in the process of developing four licensing procedures for operations with radioactive materials, devices containing radioactive materials and radiation generators, for use, transport, storage and import/export activities. This effort will be completed in 2005.

To facilitate this activity ANRA has developed guidance on the standard form and content that will be used for development of the licensing procedures. This guide covers the essential elements of the licensing procedure, including application submittal and review, licence conditions, licence issuance and amendments, and suspension/revocation provisions. This guidance is based on experience gained in countries in central and eastern Europe as well as on IAEA recommendations.

5. ANRA INFRASTRUCTURE DEVELOPMENT

To provide effective control over radiation sources, ANRA has established two regional offices located in Goris and Vanadzor. The initial and main activity foreseen is to provide control on a local level over operations with radiation sources by means of inspections and enforcement of safe utilization of radiation sources consistent with conditions stipulated in the licence. The offices will have frequent interaction with the licensees and are expected to foster ongoing communication between the regulatory body and users as stipulated in the Code of Conduct. In the future the offices may provide additional functions in support of environmental monitoring and in support of the Additional Protocol to the Safeguards Agreement.

The offices are furnished and equipped with both regular office equipment and radiological equipment. They provide office space as well as living quarters for visiting personnel from Yerevan. The offices have their own staff that report to headquarters in Yerevan. It is noteworthy that ANRA is taking a different approach than that implemented in other countries of the former Soviet Union, where local control over radiation sources continues to be the responsibility of the regional offices of the Ministry of Health.

6. TRAINING

There continues to be a strong need for training in the area of radiation protection and the safe use of radiation sources. ANRA recognizes this need and has arranged for a number of seminars where domestic requirements and international practice are shared with the licensees in Armenia. These seminars are conducted by the IAEA under national and regional programmes, as well as by the NRC on a bilateral basis. In 2003 a seminar for medical practitioners addressed radiation protection and safety issues. Another seminar is planned to disseminate information and assist the users in licensing procedures. Separately, additional training is required for new ANRA inspection staff at the regional offices. Fellowships are contemplated at the regulatory authorities in countries with a successful record of handling radiation sources.

DISCUSSION

M.R. EL-SOUROUGY (Egypt): (1) What is the role of the Ministry of Health (MoH) in the use and regulation of sources? (2) Are there any transport regulations for radiation sources in Armenia or have you adopted the IAEA's regulations?

A. AMIRJANYAN (Armenia): (1) The MoH is a user of sources and has all responsibilities (i.e. for safety, emergency planning and security) set out in Armenia's Nuclear Law for users. ANRA is responsible for formulating regulatory documents, licensing and inspection. ANRA and the MoH have recently signed an agreement on the separation of responsibilities. (2) Transport regulations for nuclear and radioactive material are based on IAEA documents and are in force in Armenia.

IMPLEMENTING THE CODE OF CONDUCT ON THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES: AUSTRALIA'S EXPERIENCE AND PROGRESS

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1. INFRASTRUCTURE FOR REGULATORY CONTROL

1.1. Implementation

The acquisition, use, storage, transfer and disposal of radioactive material in all states or territories within Australia are regulated by specialist units within either a Department of Health (four states and two territories) or an Environmental Protection Authority (two states). The same activities at the national level are regulated by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) under the Australian Radiation Protection and Nuclear Safety Act 1998 (the ARPANS Act) and its regulations.

The legislation across Australia is not uniform, owing mainly to the age of the enabling legislation and assorted policy issues. It is evident from a recent study that, amongst other things, the levels of penalty for illegal possession and use of radioactive material should be made uniform across Australia.

One of the functions of the chief executive officer (CEO) of ARPANSA is 'to promote uniformity of radiation protection and nuclear safety policy and practices'. The Radiation Health Committee, established under the ARPANS Act, also has functions in support of national uniformity. The committee includes the CEO of ARPANSA and representatives from each state and territory radiation control authority.

In August 1999, a ministerial meeting endorsed the development of a National Directory for Radiation Protection as a means of achieving uniformity in radiation protection practices between jurisdictions. The meeting agreed that upon consideration and approval of the provisions of the directory by the Radiation Health Committee, the regulatory elements shall be adopted in each jurisdiction as soon as possible, using the existing regulatory framework of each jurisdiction.

The first version of the National Directory was accepted by ministers on 29 July 2004. By adopting the National Directory, each jurisdiction has an agreed set of terms and definitions to be embedded into legislation, thus providing a mechanism for uniform adoption of an approach to radioactive source security.

To address the security requirements of the Code of Conduct on the Safety and Security of Radioactive Sources, the Radiation Health Committee has endorsed the development of a Code of Practice for the Security and Physical Protection of Radioactive Sources. The intention is that Version 2 of the National Directory will refer to this code and hence provide uniform legislative source security requirements to all jurisdictions. A first draft of the Code of Practice has been completed.

1.2. Lessons learned

The draft Code of Practice for the Security and Physical Protection of Radioactive Sources contains requirements for a security plan, an information security plan, procedural and access controls, and background checks, as well as both detailed physical protection requirements and performance based security.

The existing radiation protection legislation in Australia is predominantly safety legislation, and some of the proposed security provisions (such as background checks on individuals having access to high activity radioactive sources) may require amendments to existing safety oriented radiation protection legislation.

The draft Code of Practice seeks to have security provisions in place commensurate with the current national risk assessment and arrangements to increase security should the threat level be assessed to have increased. This poses the risk of making the Code of Practice quite complex.

2. FACILITIES AND SERVICES AVAILABLE TO MANAGE SOURCES

2.1. Implementation

2.1.1. Searching for missing sources and securing found sources

For the case of a missing or uncontrolled radioactive source, current processes require the authorized person to notify the regulatory authority. In the case of theft, the police would also be notified. The timescales for this notification and the systems available for locating and securing missing sources vary across the regulatory jurisdictions within Australia. Portable vehicle mounted radiation search systems are available at the national level, and commercial aerial radiometric survey systems are available but are not configured for searching for missing sources.

The deployment of these additional systems and any assessment of the potential use for malicious purposes require an effective system for reporting to ARPANSA and to the intelligence networks. The development of these processes and links, which will ensure that a missing or stolen source is located and secured, is being progressed through consultation and agreement between the relevant agencies.

2.1.2. Intervention in the event of an accident or malicious act involving a radioactive source

The responsibility for emergency response and the implementation of protective measures following an accident or the malicious use of radioactive material rests with each state jurisdiction. First responders now have significant training and equipment to dealwith a range of chemical–biological–radiological (CBR) incidents, including those involving radiation. The radiation protection framework to assist in the decision for interventions is provided in an ARPANSA document published in December 2005: Recommendations on Interventions in Emergency Situations Involving Radiation Exposure, RPS7.

2.1.3. Personal dosimetry and environmental monitoring; the calibration of radiation monitoring equipment

There are a number of suppliers of personal dosimetry for external radiation exposure and calibration services for radiation monitoring equipment within Australia. The capacity for environmental monitoring exists both for routine monitoring of facilities using radioactive materials and for radiation emergency response. Australia is developing trained environmental monitoring teams, with equipment and procedures that are consistent with IAEA methods and compliant with the requirements of the IAEA's Emergency Response Network (ERNET).

2.2. Lessons learned

Ensuring efficient and timely reporting of missing sources is a slow process. For regulatory authorities, the development of a security perspective and better links with police, security and intelligence agencies takes time. For the police and intelligence agencies, radiation presents a new and technically complex area to be dealt with.

The development of the radiation emergency monitoring and the supporting radiation protection intervention framework is a complex process, with the elements derived from a range of guidance documents, including IAEA Safety Standards, TECDOCs and training material. There is currently no 'one stop shop' or roadmap, and this has slowed the process.

3. TRAINING: REGULATORY BODY, LAW ENFORCEMENT AGENCIES AND EMERGENCY SERVICES

3.1. Implementation

Staff within Australian regulatory bodies typically have appropriate radiation protection and scientific training to ensure the safe use of radioactive materials. The training of these staff on security issues has not been addressed at the national level at this stage, but is planned for 2005–2006.

As part of national programmes for CBR emergency response enhancement, law enforcement agencies, fire, hazardous materials and ambulance service personnel have developed and delivered training on radiation emergency response in conjunction with organizations offering radiation protection training. The training varies between jurisdictions but is coordinated nationally.

3.2. Lessons learned

Preparation of emergency personnel for radiation incidents is a significant task, owing to both the number of personnel and the technical nature of the training. The familiarization with radiation and radiation protection needs to occur across all levels of the response agencies, including the decision makers.

4. NATIONAL REGISTER OF SOURCES

4.1. Implementation

ARPANSA, working with the states and territories, has agreed to establish a national register of Category 1 and 2 radioactive sources. The register will eventually be in a 'virtual' electronic form drawing on the existing registers in each jurisdiction and will take account of the need for confidentiality. Currently ARPANSA is carrying out a trial of the IAEA's Regulatory

Authority Information System (RAIS) database for use as a national register of sources. Arrangements to ensure prompt reporting of changes to the national register are to be put in place.

As the Australian national register matures, it is planned to be extended to the lower categories of radioactive source. First, this is because it is possible to accumulate Category 3 sources to have an equivalent to a Category 2 source, and without adequate tracking of the Category 3 sources this accumulation may not be evident. Second, the chemical and physical composition of some sources, even at the Category 3 level, means that they may be able to be effectively used to expose humans to large doses of radiation.

As an interim measure, some jurisdictions are endeavouring to register or license all Category 3 and 4 radioactive sources and to monitor their locations and movements under existing radiation safety legislation.

4.2. Lessons learned

The challenge of a national register is to ensure that it is frequently and regularly updated. When the register itself is not a part of the regulatory process, there needs to be particular attention paid to the updating mechanism.

ARPANSA, working with the Australian Customs Service, is intending to review the approach to detection of the illegal entry of radioactive sources at various entry points into Australia. This would mainly involve an evaluation of the effectiveness of electronic monitoring under a range of conditions and would best be undertaken as some form of government funded scientific study.

5. NATIONAL STRATEGIES: GAINING OR REGAINING CONTROL OVER SOURCES

5.1. Implementation

Australia has a mature radiation regulation system that has the infrastructure in place to facilitate the safe use of radioactive material. The additional security requirements will build on this safety infrastructure, but there are significant difficulties in the transition to a security culture. The systems for the reporting of uncontrolled sources currently operate within the local jurisdiction, but a national source reporting system is under development, in parallel with the development of a national database of radioactive sources. This national system will provide links into the intelligence networks and would provide additional specialized source search teams if required.

Orphan or uncontrolled radioactive sources are uncommon in Australia and there are currently national programmes to promote awareness of the additional security issues across the broader community. With the increased focus on security, there is a need for interaction between many different agencies to extend existing infrastructure to deal with the security requirements. There has been extensive consultation between relevant agencies to establish priorities and strategies.

5.2. Lessons learned

In conjunction with the national register of sources, a national emergency hotline where reports of lost or stolen radioactive material can be reported is being developed that will allow persons to report such activities directly to the relevant state, territory or commonwealth regulatory body.

6. MANAGING SOURCES AT THE END OF THEIR LIFE CYCLE

6.1. Implementation

The Australian Nuclear Science and Technology Organisation (ANSTO) is the only organization in Australia that manufactures sealed sources, and all such sources are able to be returned to ANSTO at the end of their useful life. ANSTO is not able to store radioactive sources of other origins. In the case of radioactive material manufactured and distributed by ANSTO, under its licence, ANSTO is required to account for its inventory to ARPANSA, as the regulatory body, on a quarterly basis.

Some states do allow individuals to reseal used radioactive sources that are then useful to industry. This recycling of unwanted radioactive sources reduces the amount of radioactive waste stored in Australia. The manufacture and recycling of radioactive sources are controlled in Australia under the existing radiation safety legislation, which typically requires a specific licence allowing such activity.

6.2. Lessons learned

Only one state has an ultimate disposal option for radioactive sources; all other states and territories, and the Australian Government, rely on some form of storage.

In most other jurisdictions, disused and unwanted radioactive sources are stored in numerous locations throughout the state or territory. The condition of these stores, the knowledge of their contents, and the risk associated with their location and security measures vary widely. It is generally agreed that the storage of radioactive sources is an issue that needs to be systematically addressed across Australia to ensure that, amongst other things, adequate security provisions exist.

Under the source categorization adopted by the IAEA in its Code of Conduct, the accumulation of many small sources is to be regarded as being equivalent to a single (larger) source for security purposes. Thus, on the basis of this accumulation rule, many radioactive waste stores throughout Australia may require higher levels of security than currently provided.

The Australian jurisdictions are taking steps to ensure that adequate inventories of radioactive waste exist, that proper waste stores are constructed in each jurisdiction, and that comprehensive waste management plans are prepared and implemented to ensure that the number of radioactive sources available for malicious use is minimized.

The record keeping and reporting requirements associated with the manufacture and recycling of radioactive sources in Australia need to be made uniform. Although radioactive sources are relatively well controlled within each jurisdiction, their control as they move across state and territory borders, or into the jurisdiction of the commonwealth, varies markedly.

7. IMPORT AND EXPORT OF SOURCES

7.1. Implementation

Radiation protection legislation in all jurisdictions prohibits a person from receiving and possessing radioactive material without prior authorization from the regulatory body. In Australia an authorization from the regulatory body does not include the right to import or export radioactive material. An importer must obtain approval from the Australian Government under customs laws to import the goods prior to importation.

Australia is currently reviewing its customs laws with a view to:

— Amending the laws to introduce a requirement that a person wishing to export radioactive material must obtain permission to do so from the Australian Government prior to exporting the goods;
— Applying the procedures contained in the Guidance on the Import and Export of Radioactive Sources in the assessment of applications to import and export Category 1 and 2 sources;
— Implementing amendments to the laws by 31 December 2005.

7.2. Lessons learned

Laws relating to the transfer of radioactive sources may already exist, be numerous (for example in a federal system) and be complex. Making amendments to implement the Code of Conduct in these circumstances can prove complex and time consuming.

Procedures in the Code of Conduct and the Guidance may require information and types of expertise and resources not usually found in a regulatory body responsible for the safe management of sources. The Code of Conduct may require the regulatory body to form partnerships with other government entities or resources/expertise/providers in order to perform these actions.

Neither the Code of Conduct nor the Guidance specifies the nature of the authorization a recipient is to have in order to receive and possess an imported source. Requirements on the nature of such documents may vary between regulatory bodies, which may lead to one body accepting the authorization and another not accepting it.

As early as practicable, a State should identify the States with which it trades sources and initiate a dialogue in order to minimize administrative or technical misunderstandings or oversights in the implementation of the guidance in the Code of Conduct and the Guidance on Import and Export. In some instances the exporting facility may be performing some of the procedures in the Guidance in place of the regulatory body. It may be useful to extend the dialogue to those bodies.

Implementing the Guidance will have an impact on businesses that import and export radioactive sources. ARPANSA intends to consult with affected businesses as early as possible prior to implementing new legislation.

It is important to link records relating to the transfer of sources to the national register mentioned in the Code of Conduct, in order to clarify which sources should be residing and under regulatory control in a particular jurisdiction.

DISCUSSION

A.J. GONZÁLEZ (Argentina): Mr. Loy raised an important issue for countries with a federal structure: that of different application of the Code of Conduct in different jurisdictions. This should be reflected in the conclusions of this conference.

J. LOY (Australia): It is an important issue. In Australia, there is a high level process committing the Prime Minister and the first ministers of each state to the security of radioactive sources. Given this political commitment and the fact that security is a new issue for sources, at this stage we have not encountered non-conformity. The jurisdictions meet regularly.

K. MRABIT (IAEA): I am glad to hear that Australia is considering using the Regulatory Authority Information System (RAIS) as a national register or inventory. RAIS was upgraded last year, taking into account not only the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources but also the Guidance contained in the Code of Conduct. This system has been validated and translated into all official IAEA languages. Workshops have been organized for nearly 100 Member States. RAIS is designed not only for developing Member States but also for developed Member States such as Australia.

PROGRESS ON IMPLEMENTATION OF THE CODE OF CONDUCT IN THE REPUBLIC OF CROATIA

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1. INTRODUCTION

The Republic of Croatia adopted the radiation protection legislation from the former Yugoslavia and subsequently initiated modifications to meet the new circumstances. From the beginning, the requirements defined by the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS) were considered, and the legal solutions adopted relied upon proposals given therein, taking into account, however, the present infrastructure and actual circumstances.

The regulatory authority was traditionally the Ministry of Health (MH). In the first phase, changes were not possible, for various reasons. Therefore, as a temporary solution, with the intention of harmonizing the system with the requirements of the BSS as much as possible, the Croatian Radiation Protection Institute (CRPI) was founded as an institution subordinated to the MH. The CRPI was responsible for maintaining the central national register of radioactive sources, users and exposed workers; for supplementary education and the organization and supervision of other activities related to radiation protection; and for providing expert assistance to the MH.

The CRPI activities were supported by the Radiation Protection Act, which, among other things, stipulated the obligation of all relevant organizations to report to the CRPI. An information technology infrastructure and legal framework were established which enabled the database managed by the CRPI to become the basis for all activities related to the control and authorization of radiation sources. Simultaneously, CRPI staff members were educated through IAEA educational programmes.

Better cooperation with the IAEA, other relevant international organizations and similar institutions in other countries has been established, and consequently the conditions for the CRPI to take over the role of the regulatory body were met. This happened during the last year, when the Amendment of the Act on Protection against Ionizing Radiation was passed, giving the former CRPI, now the State Office for Radiation Protection

(SORP), all required authorities except inspection. A new act is in preparation and it is being suggested that the SORP should also take over inspection. The legal solution would thereby be harmonized with the requirements of the Code of Conduct on the Safety and Security of Radioactive Sources and the BSS in all their main elements. Further activities will therefore be focused on detailed elaboration and completion of the legal, organizational and technological prerequisites for the enhancement of efficient source control and coordination of the activities of the institutions in the international environment, as well as on complete harmonization with the Code of Conduct and the BSS.

2. SITUATION OVERVIEW

In Croatia, 519 sealed sources in 75 institutions, 1503 X ray units in 551 institutions and nine accelerators are in use. In industry and similar sectors, 323 sealed sources are in use, of which 113 are used for industrial radiography. Other sources are used in medical institutions and laboratories. X ray units are used for medical diagnostics (753), in dentistry (528), in veterinary medicine (27), for luggage and shipment control (114) and in industrial radiography (55). It is estimated that basically all sealed sources are registered and recorded in the SORP database. It is necessary to examine the sources that have not been used for a longer period of time and are not encompassed in regular annual surveillance checks.

Additionally, there are about 250 sources installed in lightning rods. These are primarily $^{152,154}Eu$ and a smaller number of ^{60}Co sources with activities ranging from 10 to 25 GBq. The legal obligation of the owners is to remove them by the end of 2005. The situation is relatively difficult because the records about them are out of date and a great number of sources are not regularly examined. The SORP has records on all sources installed in lightning rods, and these records are being updated to determine the present situation. The list is also compared with the list of sources disused and deposited in temporary storage. A special problem is that not all owners of these sources are known (some registered owners have ceased to exist for various reasons, e.g. bankruptcy), or the owners lack the financial resources to remove the sources installed in lightning rods as stipulated under the law.

Further, a certain quantity of radioactive material (unsealed sources) is used in nuclear medicine and research laboratories. The total quantity imported during the past year was 6613.04 GBq.

There is no nuclear facility in Croatia, nor is there production of or a depository for nuclear fuel, or production of other radiation sources. There are two temporary storages for radioactive material, one being still in use. It is properly organized and has accurate records on all the sources. About 300 sources deposited in other storage, as well as disused sources kept in hospitals (150) and in industry (30), have to be taken care of.

There have been four reports related to orphan and lost sources submitted since 2000:

— In 2002, 16 sources (^{137}Cs) were found in a small village. It was discovered that they had been used in a nearby factory (aluminium production) that was closed decades ago.
— In 2003, a lightning rod removed as a part of regular construction waste during the demolition of an old hotel in Dubrovnik was lost (and never found).
— In 2004, smoke detectors were found after a building renovation.
— In 2004, a lightning rod was discovered by Slovenian Customs and returned to Croatia. Its origin was found.

3. LEGISLATION

The regulations enacted cover the areas of authorization for use, surveillance, protection, transport, import and export of radiation sources. The areas of health surveillance and required qualification, including supplementary education for work with radiation sources, are also covered. Intervals and methods for personal exposure monitoring, reporting and response in the event of an accident have been defined. The regulation on radioactive waste management and the emergency preparedness law are in the phase of preparation. The Act on Protection against Ionizing Radiation and the Amendment of the Act on Protection against Ionizing Radiation define the State Office for Radiation Protection as an independent regulatory body and give it authority as defined in the BSS, paragraphs 19–22 of the Code of Conduct and IAEA-TECDOC-1067. Inspection is still within the competence of the MH. The new Act is in preparation, by which the SORP would take over these tasks. With that change, the legal framework would be harmonized with the requirements of the Code of Conduct and the BSS in all their main elements.

The following laws and regulations related to radiation protection are valid:

— Act on Protection against Ionizing Radiation (Official Gazette No. 27/99);
— Amendment of the Act on Protection against Ionizing Radiation (Official Gazette No. 173/00);

- Regulation on the Exposure Limits, on the Conditions of Exposure for Special Purposes and on the Intervention Levels (Official Gazette No. 108/99);
- Regulation on the Conditions and Measures for the Protection against Ionizing Radiation for Conducting Practices Involving X Ray Units, Accelerators and Other Devices Generating Ionizing Radiation (Official Gazette No. 84/00);
- Regulation on the Conditions and Measures for the Protection against Ionizing Radiation for Conducting Practices Involving Radioactive Substances (Official Gazette No. 84/00);
- Regulation on the Conditions and Manner of Obtaining the Professional Qualifications as a Precondition for Work with the Sources of Ionizing Radiation (Official Gazette No. 7/00);
- Regulation on the Health Conditions, Criteria, Contents, Methods and Intervals of Maintaining of the Records about Health Surveillance of Persons Who Operate Sources of Ionizing Radiation (Official Gazette No. 76/00);
- Regulation on the Conditions, Methods, Premises and Intervals of Systematic Environmental Radiological Monitoring (Official Gazette No. 86/00);
- Regulation on the Ionizing Radiation Protection of Patients in Medical and Dental Care (Official Gazette No. 113/99);
- Regulation on the Methods and Time Intervals of the Surveillance of the Sources of Ionizing Radiation, Personnel Monitoring, Monitoring of Exposure of the Patients, on Maintaining Records and Registers and on Reporting (Official Gazette No. 63/00).

The following documents are in the drafting stage:

- Regulation on Radioactive Waste Management;
- National Plan and Programme of Ionizing Radiation Protection in the Case of Emergency Situations.

4. INFRASTRUCTURE

The central institution for radiation protection is the SORP. It has been given the authority and the powers of a regulatory body as defined under paragraphs 20–22 of the Code of Conduct. The SORP manages the central national register of radiation sources. Besides the basic data about sources, data are kept about the equipment in which they are used, their location, all surveillance examinations and the decisions issued. By connecting with the office management module, an overview of all documents sent and received in relation to a source can be obtained. The SORP issues licences for performing practices with radiation sources, approvals for procurement and licences for the use of radiation sources. To obtain a licence, a user must submit a safety assessment and in some cases a security plan, as defined in item (b) of paragraph 20 of the Code of Conduct. The licence for use is renewed each year with submission of the regular surveillance examination report. The SORP may forbid use (suspend authorization) and order removal of a source, as well as request (according to the new law it will also conduct) an inspection. The user is obliged to report the end of use of a source, indicate the method of its disposal and submit the appropriate documentation.

An institution that manages a temporary storage where spent or disused sources are deposited is obliged to inform the SORP of the receipt of any source as well as to send once a year a report with a list of all deposited sources and their activities.

Three institutions are performing technical and expert tasks in the field of radiation protection, which includes regular examination of sources and the conditions of their use, as well as dosimetric surveillance (IAEA-TECDOC-1067). They are authorized to perform the activities of paragraph 9 of the Code of Conduct, except for intervention in the event of an accident or malicious act (which is within the competence of the SORP) and for calibration of radiation monitoring equipment. In connection with the latter, activities towards establishing a second standard laboratory have been initiated. It is expected to start operation this year.

There are 23 institutions authorized for import, export and transport of radiation sources, and 47 institutions are authorized for assessment of health conditions.

The qualification of workers to perform tasks with radiation sources has been stipulated. Supplementary education, as well as periodic knowledge renewal and examinations, are organized and conducted by the SORP in the form of regular courses.

5. MANAGEMENT OF SPENT AND DISUSED SOURCES

An approach to the management of disused sources includes resolving the present situation as well as creating provisions for efficient management in the future. Within the framework of the cooperation with the IAEA and the United States Department of Energy, Croatia has, through the activities of the SORP, been included in the project of orphan source searching, locating and identification. It has also been included in the project of the US Department of Defense and the Federal Bureau of Investigation, which is part of the international programme for preventing the spread of radiation sources. Within the framework of these projects, the sources for which the owners are known but which are not in use will also be collected and deposited in the temporary storage. As only one temporary storage for spent sources is in operation in Croatia, and considering all the problems that arise when trying to site such a facility, the SORP has launched an initiative on a regional level to find a solution for a joint depository. A new act is in preparation that will regulate the import and export of radiation sources. Croatia is not a producer of sources, so all the sources are imported. Any importer/user will be obliged to make a contract with the producer by which the producer will reimport the source after its use.

Croatia has signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

The project for the Management and Safe Storage of Spent or Disused Sealed Sources is in progress.

6. SOURCE SECURITY AND PREVENTION OF ILLICIT TRAFFICKING

The act on source security has not yet been enacted. The following documents regulate the transport of radiation sources:

— Transport of Hazardous Substances Act (Official Gazette No. 97/93);
— Amendment of the Transport of Hazardous Substances Act (Official Gazette No. 151/03);
— Regulation on Technical Requirements Which Must be Satisfied by Legal Persons Which Educate Drivers of Motor Vehicles for Transportation of Hazardous Substances and Persons Which Participate in Transportation of Hazardous Substances (Official Gazette No. 24/95);
— Regulation on Requirements to Be Met in Transportation of Hazardous Substances in Road Traffic (Official Gazette No. 79/96);
— Regulation on Requirements to Be Met in Transportation of Hazardous Substances in Sea Traffic (Official Gazette No. 79/96).

In the framework of international cooperation, the following projects have been initiated:

— IAEA project CRO/0/006, Prevention of Illicit Trafficking in Nuclear and Radioactive Materials (2003–2004);
— IAEA project RER/0/024, Capacity Building for Detection and Response to Illicit Trafficking of Radioactive Materials;
— National programme, Establishment of Control of Nuclear and Other Radioactive Material at the Borders of the Republic of Croatia (started in 2003).

Within the last project, electronic dosimeters have been distributed to border officers at a (pilot) crossing, and the officers have been trained to operate them. Portable detectors have been distributed to shift leaders, and they have also been trained. Fixed detectors have not yet been installed.

REGULATORY CONTROL OF RADIOACTIVE SOURCES IN LATVIA

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Abstract

The current system of regulatory control of radioactive sources in Latvia has been created in order to ensure radiation and nuclear safety in compliance with the IAEA recommendations and European Union requirements. The Radiation Safety Centre was established as an independent regulatory authority responsible for radiation and nuclear safety. It is responsible for the implementation of the provisions of the Law on Radiation Safety and Nuclear Safety and the related regulations. The Radiation Safety Centre is responsible for maintaining at State level a database containing an inventory of all ionizing radiation sources and a listing of all licensed practices. The operators of ionizing radiation sources are obliged to maintain a local database of radioactive materials in their possession and are responsible for their physical inventories. The regulatory system is continuously being improved and it now provides an efficient control over radioactive sources in current practices, and at the same time it provides for an adequate handling of consequences of the legacy of the past.

1. INTRODUCTION

Since Latvia regained its independence in 1991, the Parliament and the Government of Latvia have devoted a great effort to establishing a solid framework of legislation and control in various fields where the previous system had certain obvious deficiencies. One of these areas was radiation and nuclear safety, with a particular emphasis on the control of nuclear and radioactive material. As a result of more than a decade of continuous improvement, the current Latvian regulatory control system complies with international requirements and recommendations and meets the European Union standards. This is clearly reflected in Latvia's successful accession to the European Union in May 2004.

2. LAWS AND REGULATIONS

Article 111 of the Constitution of the Republic of Latvia stipulates that "the State shall protect human health and guarantee a basic level of medical assistance for everyone." Article 115 states: "The State shall protect the right of everyone to live in a benevolent environment by providing information about environmental conditions and by promoting the preservation and improvement of the environment" [1].

Following the principles set out in the Constitution, the new Law on Radiation Safety and Nuclear Safety [2], promulgated by the Parliament of Latvia in 2000, defines the legal framework of the regulatory control of ionizing radiation sources (including radioactive sources and nuclear material) in the Republic of Latvia. The new Law, which is fully compatible with the international requirements and recommendations, replaced the previous one (from 1994), in order to harmonize the Latvian legal system with that of the European Union and with the obligations under the relevant international nuclear safety conventions to which Latvia is a party. The Law establishes an independent regulatory authority, the Radiation Safety Centre (Radiācijas Drošības Centrs, RDC).

Building upon the Law [2], several regulations issued by the Cabinet of Ministers define the procedures of licensing and regulatory control of practices involving the various sources of ionizing radiation [3–7]. The requirements follow the IAEA recommendations [8, 9] and are compatible with the relevant legal instruments in force in the European Union [10, 11].

3. REGULATORY AUTHORITY — THE RADIATION SAFETY CENTRE

The RDC was established in 2001. It is an independent regulatory authority reporting to the Ministry of Environment. It is responsible for the implementation of the provisions of the Law [2] and the related regulations. Its major tasks [2] are to:

- Supervise and control practices involving sources of ionizing radiation;
- Issue licences for practices involving sources of ionizing radiation;
- Maintain databases on practices, sources and exposures;
- Coordinate the combat against illicit trafficking of radioactive and nuclear materials;
- Operate the emergency preparedness organization for the early notification of a radiological or nuclear accident;

— Provide for the identification, investigation and assessment of unknown radioactive sources discovered on the territory of Latvia, or of undeclared radioactive sources discovered at the State's border, and to provide for safe disposal in cases when the user or the owner of the radioactive source cannot be identified.

The RDC consists of the following main sections: Licensing, Inspection, Early Warning (radiation and nuclear emergency preparedness), Radiation Safety and Dosimetry. These operational sections have a staff of about thirty specialists with a high level of competence in radiation and nuclear safety. The Administrative, Legal and Public Affairs sections support the work of the operational sections.

The RDC is entitled to immediately receive information about any accidents and incidents that may have an impact on radiation and nuclear safety, as well as to request and receive from other State institutions, authorities and the operators themselves any information relevant to radiation safety and nuclear safety in order to carry out its functions [2].

In the field of combating illicit trafficking and regaining control over radioactive sources, the RDC cooperates with various other authorities and organizations (the State border guards, customs, State police, security police, etc.) [2].

4. PRACTICES, OPERATORS, RADIOACTIVE SOURCES

Practices involving ionizing radiation sources are subject to licensing. Licences are issued by the RDC on the basis of a decision made by the Licensing Commission. In the licence the RDC identifies which practices are allowed for private persons or legal entities. A licence may be revoked or suspended if there is a failure to meet requirements of the regulations relevant to radiation and nuclear safety, or any special requirements which might have been prescribed in the licence itself. Licences are issued for a maximum period of five years, the actual period of a licence depending on the type of practice [3].

There are some 680 operators who have licences for practices, under the supervision and control of the RDC. The largest numbers of sealed radioactive sources used by operators are in industry (about 540), science (about 130) and medicine (more than 10). The medical sector uses a significant amount of open radioactive substances (radiopharmaceuticals and diagnostics) and also ionizing radiation equipment/apparatus that does not contain radioactive substances. The number of radiation workers in Latvia exceeds 2000 [12].

The operators are responsible for their inventories of radioactive materials and they should ensure that all radioactive waste is collected, isolated, stored, treated and if necessary disposed of, without causing risk to workers, to members of the public or to the environment [2].

5. REGULATORY CONTROL

According to the Law [2], the RDC is responsible for maintaining at State level a database containing an inventory of all ionizing radiation sources, and a listing of all licensed practices. All operators should maintain up-to-date accounts of all radioactive sources in their possession and are obliged to perform physical inventory taking annually. The results of inventory taking should be reported to the RDC. The disposal of disused radioactive sources and any changes in the practice are also to be reported. The operators are regularly notified about their reporting obligations in various ways: in notification letters sent to the operators annually requesting the provision of information, at the time of application for a licence and during on-site inspections. The operators should inform the RDC in writing about any changes relating to ionizing radiation sources and practices. The import and export of ionizing radiation sources are reported to the RDC by the customs authority.

The new amendments to the Law [2], which are expected to be approved by Parliament in the near future, are designed to further improve the quality and reliability of the reporting system. The scope of the information to be reported will be significantly widened to include not only changes in the inventories and practices, but all circumstances which may have an impact on radiation and nuclear safety (changes in staff, education, training, etc.). The frequency and deadlines for reporting have also been revised.

The State inspectors of the RDC perform regular on-site inspections at the premises of operators of ionizing radiation sources. The inspections are based on an annual inspection plan, which is designed on the basis of the type of practice and the associated risk, the performance record of the operators, the statistics of previous offences and the annual plan of activities of the operator (if available). The inspection frequency ranges from one inspection every two years (very low risk practices, scrap metal yards, etc.), through one inspection every half-year (nuclear materials, most radioactive sources, State borders) and up to one inspection in every quarter (significant radioactive sources, radiation service providers) [11]. During their inspections the RDC inspectors, together with personnel of the Laboratory Section, carry out a large number of radiation measurements, not only in the controlled areas of operators but also in the environment, for the possible detection of orphan sources (about 60% of the approximately 2000 measurements carried out during 2003 were aimed at searching for orphan sources) [12].

In its regulatory work, the RDC extensively uses the computerized database system RAIS (Regulatory Authority Information System), which was developed by the IAEA in the framework of a Technical Cooperation programme aimed at helping Member States to establish and improve the regulatory control of radioactive sources. The RDC currently uses RAIS for managing the national inventory of all ionizing radiation sources (including radioactive sources), as well as for recording licences and operator data. RAIS has proved to be a very useful tool also in the planning of inspections and in the evaluation and handling of the results and findings of the inspections.

6. REGAINING CONTROL OVER ORPHAN SOURCES

Owing to the legacy of the past, the possibility of orphan sources existing in Latvia still cannot be ignored. However, the current situation is fully under control. The legal and regulatory system provides a firm framework and the responsible organizations have appropriate procedures and equipment for the efficient management of possible situations associated with orphan sources.

This is clearly demonstrated by a recent case. In November 2004 the RDC staff carried out background measurements in the environment in the area of a hospital. In the office of the bookkeeper the radiation detectors indicated a highly elevated radiation level. As a result of a systematic search, a number of ^{226}Ra pins were discovered in an unused safe in the office. These sources were used for medical treatments during the 1960s and no one had any information on how and when they ended up in the bookkeeper's office. The sources were transferred to the radioactive waste disposal facility and the personnel who might have been affected by the incident were sent for health examinations.

7. CONCLUSIONS

The current system of regulatory control of radioactive sources in Latvia meets the international requirements and is compliant with Latvia's international obligations. However, the Latvian Government and the regulatory authority are committed to further improving the reliability and confidence of the system. As an example, recently the Government decided to introduce a quality management system based on the ISO 9001:2000 standard at the regulatory authorities. On the basis of the Government's decision, the radiation and nuclear safety authority, the RDC, is among the first authorities to begin the preparatory work to implement the ISO standards.

The efficient operation of the regulatory system provides sufficient assurance that current applications of high activity radioactive sources do not pose an unacceptable risk to society. At the same time, the continued high awareness of the legacy of the past provides a guarantee that its possible consequences for the present and the future are adequately managed.

REFERENCES

[1] Constitution of the Republic of Latvia, Adopted by the Constitutional Assembly of Latvia on 15 February 1922, as amended by the Law of 8 May 2003.

[2] Law on Radiation Safety and Nuclear Safety, 26 October 2000.

[3] Procedures for Issuing Special Permits (Licences) and Permits for Practices Involving Ionizing Radiation Sources, and Procedures for Public Dispute on the Establishment of Ionizing Radiation Facilities of State Significance or on Essential Modifications thereto, Regulations of the Cabinet of Ministers No. 301, 3 July 2001.

[4] Regulations on the Protection against Ionizing Radiation, Regulations of the Cabinet of Ministers No. 149, 9 April 2002.

[5] Requirements for Physical Protection of Ionizing Radiation Sources, Regulations of the Cabinet of Ministers No. 129, 19 March 2002.

[6] The Procedure of Practices with Nuclear Material, Related Material and Equipment, Regulations of the Cabinet of Ministers No. 398, 22 April 2004.

[7] Regulations on the Protection against Ionizing Radiation during Transport of Radioactive Material, Regulations of the Cabinet of Ministers No. 307, 3 July 2001.

[8] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).

[10] Euratom Regulation 1493/93, On the Transport of Radioactive Materials between Member States of the European Union, Luxembourg (1993).

[11] Euratom Directive 2003/122, On the Control of High Activity Sealed Radioactive Sources and Orphan Sources, Brussels (2003).

[12] RADIĀCIJAS DROŠĪBAS CENTRS, Public Annual Report of the Radiation Safety Centre, RDC, Riga (2003).

DISCUSSION

P.E. MONALE (South Africa): How are scrapyards licensed?

A. SALMINS (Latvia): Licensing of scrap metal companies — as a special commercial activity — is the responsibility of the Ministry of Economy. To maintain its licence, a scrapyard must ensure the control of scrap metal to prevent radiation incidents occurring with radioactive sources or contaminated scrap metal. As the regulator, we provide training, advice and assistance for dealing with imported scrap metal containing radioactive sources.

POLISH EFFORTS IN THE FIGHT AGAINST ILLICIT TRAFFICKING IN RADIOACTIVE SOURCES

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Abstract

The paper presents an overview of Polish progress in the fight against illicit trafficking in radioactive sources. Although a requirement for the security of radioactive sources to protect them against damage, theft or falling into the hands of wrongdoers has been legally in effect since 1 May 2004, the registration of and control over these sources date back to the mid-1960s in Poland. National efforts aimed at interdicting the illegal movement of radioactive materials across the borders or inside the country resulted in deployment or modernization of equipment for detecting such materials. In addition to the work undertaken to combat illicit trafficking in radioactive materials and to avoid the presence in the metal recycling industry of an unwanted radioactive component in metal scrap, some further steps have been taken to increase awareness and effectiveness in responding to events involving radioactive sources of unknown origin. To this end, a demonstration exercise of the response to illicit trafficking in radioactive materials combined with explosives was held on 28 September 2004 in Poland. The exercise contributed to the enhancement of cooperation among all the authorities and services involved. Analysis of the exercise, the experience gained and the gaps revealed can be used for system improvements so that similar situations can be avoided in the future.

1. BACKGROUND

Since 1964 activities involving radioactive sources have been subject to licensing, accounting and national control in Poland. In spite of its well developed accounting and control systems, the country experienced some radiological emergency events involving orphan sources and cases of illicit trafficking in radioactive materials. The first such incidents registered took place in 1992 both at the borders and within the country, and included the accidental smelting of radioactive caesium sources in the steel plant at Ostrowiec. A total of about forty sealed radioactive sources (^{137}Cs, ^{60}Co, ^{90}Sr) were seized in the period 1992–2001, when such cases occurred. All seizures were carried out by the law enforcement services with the assistance of the

24 hour National Emergency Service for detection and response actions. It was decided in 1990 to gradually equip all border checkpoints with portal radiation monitors to detect any attempts to import commodities with abnormal radiation levels. The border guards operating portal gamma radiation devices at the borders detected such cases as a deliberate attempt to smuggle radioactive materials, radioactively contaminated products, radioactive materials without the obligatory transport documents, and persons who had undergone isotope diagnostics or therapy, to mention but a few. Inside the country some lost or abandoned radioactive sources, or sources buried in the forest, appeared to be, inter alia, the legacy of the former Soviet/Russian military bases deployed in Poland.[1] Since 2002, activities to support the countermeasures against illicit radioactive trafficking have been intensified and tightened in Poland with respect to all three systems: prevention, detection and response. Adjustment of the newly revised Atomic Law to the European Union legislation, technical modernization of the equipment used by the law enforcement services and testing of the services' capabilities in detection of and response to illicit trafficking in radioactive materials have contributed to the whole security system for radioactive sources in Poland. Apart from the work done by the services in charge of combating illicit trafficking, some further steps have been taken to increase awareness and effectiveness in responding to events involving the detection of inadvertent and illicit movement of radioactive materials or orphan sources. Given the consequences of the explosion of a radiological device, the preparedness against such threats has had to be augmented.

2. LEGISLATION AND REGULATORY ASPECTS

The regulatory infrastructure for radiation safety and the control of radioactive sources is founded upon the Act of Parliament of 29 November 2000, the Atomic Law[2] as amended. The Law follows the provisions of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, and it had to be harmonized with the

[1] The withdrawal of Russian troops was completed on 17 September 1993. In May 1995, the police found a container with two ^{137}Cs sources, with activities of 1.9 GBq and 78 MBq, that had been stolen in 1992 from the Russian military base in Borne–Sulinowo. The seizure was in a private apartment.

[2] Dziennik Ustaw (Journal of Laws), 2001, No. 3, item 18. It has since been amended seven times, most recently in 2004, Dziennik Ustaw No. 70, item 632.

provisions of the European Union legislation before Poland became a Member State of the European Union on 1 May 2004. As a general rule, a licence application for the peaceful use of radioactive sources is examined with respect to the requirements of nuclear safety and radiation protection provisions. The requirement for the security of radioactive sources to protect them against damage, theft or falling into the hands of wrongdoers has been in effect since 1 May 2004, the date of ensuring full compliance of the Polish Atomic Law with the European Union legislation. This complies also with the provisions of the Code of Conduct on the Safety and Security of Radioactive Sources. Another matter of concern in the Code of Conduct, the control over the export and import of sealed radioactive sources, is also regulated, and an accompanying document is required for shipment of a sealed radioactive source where there is a need for prior authorization for its use.

The president of the National Atomic Energy Agency (NAEA) and its safety inspectors are responsible for the State control of all aspects of nuclear safety and radiological protection.

3. CONTROL AND DETECTION PRACTICES

The early recognition of the illicit trafficking issue, and domestic cooperation among the law enforcement forces and the nuclear safety and radiological protection bodies, have contributed to preventive measures and to diminishing the number of occurrences. Since 1990 the border guards have been systematically increasing the national control and detection system at the border checkpoints, especially on the eastern border, which is also an external border of the European Union. In addition to portal radiation devices, the border guard staff is equipped with personal radiation signalling devices and more sophisticated instruments for searching for the source of radiation.

Control also rests with the manager of the metal recycling industry, who is to organize in situ metal scrap control for radioactivity and, if necessary for object identification, to request the assistance of experts in nuclear safety and radiation protection. In December 1999, the Minister for Economy issued the regulation on the Safety and Hygiene of Work when Eliminating Hazardous Material in Metal Scrap, which imposed an obligation to control radioactivity in metal scrap. The smelting case of 1992 in the Ostrowiec steel plant and international pressure to produce clean metal commodities were also taken into account in establishing the control of radioactivity in metal scrap.

Since 2001 the Mobile Spectrometric Laboratory has been used for searching, locating and identifying lost or abandoned radioactive sources. The issue was an element of the international intercomparison exercise of the

Mobile Spectrometric Laboratories held in Turawa, Poland, in September 2003. The task of the participating teams was to estimate the distance to the hidden radioactive sources of unknown isotopic identity and activity. Four radioactive sources were used during the exercise (^{75}Se, ^{137}Cs, ^{192}Ir and ^{60}Co).

4. EMERGENCY RESPONSE MANAGEMENT

Management of radiological emergencies involving radioactive sources of unknown origin rests with the regional and local administration. For a potential radiological emergency involving radioactive sources, the user of such sources and the governor of the province[3] are obliged to prepare an emergency response plan for the facility and the region, respectively, and to verify the plan by testing and exercises.

In the event of a radiological emergency caused by an unknown perpetrator, the service which first obtained the information or detected the radioactive source secures the emergency site and notifies the president of the NAEA through the 24 hour National Emergency Service and the governor of the affected province through the 24 hour Crisis Management Service in the province. If the governor finds it indispensable, he or she is to request assistance from the president of the NAEA, defining the scope of this assistance.

A demonstration exercise of the system of response to incidents of illicit trafficking in nuclear and radioactive materials was held on 28 September 2004 at the border crossing in Bobrowniki and its surroundings in the Podlasie province in Poland. The exercise was the last element of activities within the PECO project (Pays Europe Centrale Orientale, a programme of assistance to the central and east European countries) related to its final product, a handbook for the response system RITNUM (Response to Illicit Trafficking of Nuclear Material), developed on the basis of the model action plan by the Central Laboratory for Radiological Protection (CLOR), Polish executor of the project. In conformity with an agreement signed in 2001 by the president of the NAEA and the director of the Institute for Transuranium Elements (ITU) in Karlsruhe, representing the European Commission, the handbook is subject to verification through the conducting of a field demonstration exercise.

It was found appropriate to accept a scenario that would verify the collaboration and competence of various services for two related sites of incidents — a border crossing and an area which is not directly controlled by border guards,

[3] Poland is administratively divided into 16 provinces.

i.e. not located in the border zone. The exercise was held with the use of samples of real nuclear and radioactive materials that had been taken over in a similar incident in the past. The quantity and activity of the nuclear and radioactive materials were selected in such a manner that the materials did not emit ionizing radiation that would be dangerous to participants in the exercise or to observers. Safety conditions planned by CLOR were formally approved by the NAEA in the form of an administrative decision authorizing the use of such materials in the exercise (Notification No. R-7611). The incidents provided for a possibility of combining radioactive materials with explosives or explosive devices as well as with 'blocking of the object' by a group of criminals.

The exercise was hosted by the Voivod (governor) of Podlasie and organized by CLOR in collaboration with the NAEA and the Podlasie Voivodship (province) Office in Bialystok. The entities participating in the exercise were services of Podlasie province, in accordance with the accepted scenario of the exercise. The exercise was joined and supported by the 24 hour National Emergency Service, CLOR specialists in the areas of categorization of nuclear and radioactive materials and measurement of environmental contamination, and a transport team from the Radioactive Waste Management Plant in Swierk. The exercise was observed by representatives of authorities and services from Podlasie, central administration, specialist institutions and public mass media, as well as invited foreign representatives from the European Commission, including ITU, and from the IAEA, the European Police Office (Europol), the Republic of Belarus and the United States of America. Jointly the practical activities of the services were observed by a group of over 100 persons representing 31 national institutions and five international organizations or foreign countries, as well as by a group of journalists from the public mass media of Podlasie.

The scenario of the exercise assumed two related incidents:

— At the border crossing, after receiving information from the police of a planned illicit transport of nuclear and radioactive materials through Poland's eastern border, an officer of the border guards, after activation of his personal radiation signalling device, stopped a vehicle suspected of carrying radioactive materials or of radioactive contamination. In a search of the vehicle, a metal object emitting ionizing radiation was found, along with two small metal pieces (pellets) with an increased level of radiation, hidden in a pallet of transported goods.
— About 30 km from the border crossing, on an abandoned farm from which the objects found at the border crossing in Bobrowniki were collected, it was suspected, on the basis of the account of the detained driver, that persons staying there were armed and that other radioactive,

nuclear and explosive materials of illicit origin might be stored on the premises.

In the first case the responders were border guards and customs service personnel, with assistance from the province Sanitary Epidemiological Station. In the second case the Podlasie governor activated the emergency response plan with all local services involved and with the police being the main player. In both cases the assistance of the president of the NAEA was requested.

In a summary discussion of the exercise, an evaluation was performed and preliminary conclusions were drawn, which included, inter alia, the following:

— There was close conformity of the procedures of specific services with the law in force and with provisions of the handbook developed for the response to illicit trafficking in radioactive materials.
— The categorization of radioactive materials during the exercise was made with very simple equipment, 'minispectrometers', based on scintillation detectors, with resolution insufficient to identify a mixture of radioactive or nuclear materials. This was due to the existing limitations in the availability of measuring equipment for such tasks.
— The experience gained will also be used by other institutions, such as the NAEA, to introduce appropriate amendments to the existing bilateral agreements between the services and the NAEA.

5. CONCLUSIONS

— A consolidated action and cooperation between all institutions involved in prevention, detection and response with respect to orphan sources or illicit trafficking in radioactive sources leads to effective prevention and elimination of hazards.
— The PECO project has contributed to Polish developments in combating illicit trafficking of nuclear and radioactive materials.
— The applied procedures should be verified in practice with the use of the real materials.
— The increased awareness of the law enforcement forces and well protected borders might be the explanation for the diminishing numbers of occurrences at the borders.

BIBLIOGRAPHY

Handbook for the Response to Illicit Trafficking or Inadvertent Movement of Nuclear and Radioactive Materials in Poland, CLOR, Warsaw (2004).

ISAJENKO, K.A., LIPINSKI, P., Exercise Turawa 2003, 2002–2003 Research and Operational Activities, CLOR, Warsaw (2004).

Report on Hands-on Workshop on Response to Illicit Trafficking or Inadvertent Movement of Nuclear and Radioactive Materials in Poland, Bobrowniki, 2004, CLOR, Warsaw (2004).

SMAGALA, G., TANCZYK, R., "Domestic cooperation in combating illegal nuclear traffic: Experience of the Emergency Service Centre", Measures to Prevent, Intercept and Respond to Illicit Uses of Nuclear Material and Radioactive Sources (Proc. Int. Conf. Stockholm, 2001), C&S Papers Series No. 12/P, IAEA, Vienna (2002) 442.

DISCUSSION

G. SMAGALA (Poland): As a representative of the Central Laboratory for Radiological Protection, which is responsible for licensing and control of sources, I would like to provide some additional information and clarification. Poland is currently amending its Atomic Law to implement the European Union Council Directive No. 2003/122/Euratom of 22 December 2003 on the control of high activity sealed sources and orphan sources. The NAEA — the regulatory and control body — has delegated the responsibility for searching for orphan sources to the border control agencies and local governments. The governor of each of Poland's 16 provinces is responsible for preventing incidents involving orphan sources and for mitigating consequences should such incidents occur. The role of the NAEA is to provide assistance if local capabilities cannot cope.

R. CZARWINSKI (Germany): (1) Do the 16 administrative regions each have their own responsibility for the safety and security of radioactive sources? (2) Is the radiation emergency centre also the contact point for issues concerning radioactive sources?

T. DZIUBIAK (Poland): (1) No, only the President can issue authorizations. (2) Yes, as of this year.

TECHNICAL SESSION 1: GROUP A DISCUSSION

R. CZARWINSKI, Group A moderator (Germany): This morning's presentations showed a broad spectrum of efforts, results and achievements by different countries in implementing the Code of Conduct. Some countries started implementing measures very early for the safety and security of radioactive sources in accordance with the Code. Other countries are at an intermediate stage and a few are still in the process of establishing their regulatory system, as we heard from Montenegro. Those countries, especially, need our help. Most countries have a registry of sources, sometimes also a registry of practices, or are developing one. Sealed source tracking systems, as described by our Canadian colleague, should be finalized, as this is also very important in managing a registry. We do not want a 'dead' registry. We would like recommendations from the international community on implementing the measures of the Code, which would help us to move forward.

(1) Were deficiencies recognized in your legislation and regulations as a consequence of implementing the Code of Conduct?

Y. BOUABDELLAOUI (Morocco): The Code of Conduct will help us to implement regulatory legislation but not sufficiently because it is not obligatory. Therefore the various government departments are not inclined to implement it despite active promotion on our part. Also, Article 20 mentions "regulatory bodies of other countries" as opposed to "regulatory body" in Article 19 (and elsewhere throughout the Code), so this ambiguous text could allow for a country having more than one regulatory authority. This is not good for a developing country. It is more efficient for the State to have only one regulatory authority for the safety and security of nuclear material and radioactive sources.

A.J. GONZÁLEZ (Argentina): J. Loy presented two important problems relating to regulation and legislation linked to the Code of Conduct. Firstly, the problem of jurisdiction does not have an easy solution, particularly in federal countries where, mostly, health — along with responsibility for radiation safety issues — is delegated to the states. Commitment to the Code, however, is made by the country. This will create problems of implementation, which will need to be assessed. Secondly, usually national legislation concerning radioactive sources is on radiation safety. If we are not clear that source security is part of radiation safety — and the IAEA Secretariat has been extremely obscure on this — it will be difficult to test security requirements in a court of law, particularly in countries with Napoleonic codification. It is different for nuclear material because this is recognized as a State activity worldwide. This is not the case for radioactive material — in hospitals, factories, etc. — so security requirements must be legally validated as part of safety requirements. This should be underlined in the conclusions of this conference.

R. CZARWINSKI, Group A moderator (Germany): I agree that these points are very important. I also come from a country with a federal system.

M.J. AL-ATIA (Iraq): I also find certain terminology in the Code of Conduct needs to be revised. In particular, the terms 'safety' and 'security' should be well defined since there is no distinct technical difference between them. Moreover, translation into other languages creates confusion. For instance, in Arabic the words have a similar meaning.

K. ULBAK (Denmark): In Denmark, the radiation protection legislation regulates security of sources as part of overall source safety regulation. This is the way security is treated in general in Denmark — by taking established safety regulations and putting in security provisions. Regarding gaps in legislation, our major problem has been the question of financial provisions, which we shall address through amended regulations. In the presentation on systems for financial provisions, we heard very little about those for disused sealed sources. This is a very important issue.

R. CZARWINSKI, Group A moderator (Germany): A very important point — financial provisions for dealing with disused sources and also with orphan sources, a different issue. We shall come to them later.

J. PEREIRA (Canada): Changes are required in our nuclear safety regulations to fully incorporate the requirements of the Code of Conduct in Canada. We are fortunate in having a single federal regulatory agency with oversight responsibilities for safety, security, and the protection of health and of the environment in the nuclear industry (i.e. nuclear energy production and use of nuclear substances and material).

R. CZARWINSKI, Group A moderator (Germany): Coming back to Mr. Bouabdellaoui's remark, should there be just one regulatory authority or separate ones for safety and security? I think that there are fewer problems with just one authority.

A. SALMINS (Latvia): From the radiation safety viewpoint, it is preferable to have one regulatory body for both safety and security. However, for security we need support from the police and other specialized organizations to get information for the design basis threat and to assess personnel trustworthiness, for example. Then we can work together for verification, practical implementation and development of the system.

A.J. GONZÁLEZ (Argentina): Mr. Salmins' comment touched on the real issue, depending on what we mean by 'security'. We are discussing not overall national security here but security of radioactive material. To keep this material under control — and I agree with Mr. Bouabdellaoui here — you need one regulatory body with full authority for control. Of course, this body will not have authority for other security issues, such as crime prevention, for which the police, intelligence and so on are responsible. The regulatory body can cooperate with these other entities. We should not confuse the issue.

R. CZARWINSKI, Group A moderator (Germany): There should be a single regulatory authority with full power, I believe.

K. MRABIT (IAEA): Returning to the question of countries having difficulty in implementing the Code of Conduct because it is not binding, I would like to clarify this by mentioning the IAEA's experience with developing Member States. Currently, IAEA regional technical cooperation projects are assisting many of them — nearly 100 Member States in all — in implementing the Code as a standard, i.e. with a binding status. According to the IAEA Statute, our standards are binding to activities under IAEA supervision, including those projects in Member States through which we provide sources. So de facto — at least for this large group of countries — the Code is being implemented as a standard and is, therefore, binding.

R.F. GUTTERRES (Brazil): There is an identity problem in this discussion about the status of the Code of Conduct related to the 'non-binding' aspect. Some points in the Guidance on Import and Export of Radioactive Sources should be seen as binding. If one country — or a group of countries — adopts the Guidance, the trade in sources will thus be regulated. Therefore this 'non-binding' document has strong consequences, which should be viewed at a diplomatic level, not just at the technical level under discussion here. The consequences of non-adoption of the Code, particularly with regard to the import and export of sources, need to be considered.

R. CZARWINSKI, Group A moderator (Germany): Although the discussion here is at a technical level, it is very important to convince our governments of the necessity of a binding document. Beforehand, however, we have to know where the gaps and problems are and how to manage them at a national level. This must all be clear before we urge our governments to find a way to make the Code of Conduct binding.

A. DELA ROSA (Philippines): I have some reservations concerning the language used, especially that in the provision for the exporting State to evaluate the regulatory body of the importing State. What criterion will be used? This is not clear in the text.

R. CZARWINSKI, Group A moderator (Germany): I should have mentioned that I have divided our session into three parts: first, the legislative and regulatory process; second, import/export issues; and last, overall impact and security aspects. I would like to move on now. We should discuss this question a little later.

(2) Do you have a national registry for radioactive sources? Principle of cradle to grave?

R. CZARWINSKI, Group A moderator (Germany): Many countries have a registry for radioactive sources. Canada also has a tracking system for sealed sources, which is a good thing. We don't need a dead registry; we must have a living one to be able to locate sources at any given moment. Also, we should discuss interaction with the registry and confidentiality.

Y. BOUABDELLAOUI (Morocco): This question can be viewed in the context of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), an obligation for all States Parties. There are two options: Either we stay within the United Nations system or we go out to the Proliferation Security Initiative and suppliers group. This involves a risk, so it is better to stay within the United Nations family — the Security Council and the IAEA. Otherwise we can no longer negotiate but will be subject to the good faith of the suppliers, and others will pay the price for that.

As to strengthening the safety and security of radioactive sources, if we ask industry not to let radioactive material become accessible for malicious use, this will mean a surcharge. Who will pay that? The end users. Then, that overlaps with the transfer of technology, which is the purview of the IAEA. We need to take this dimension into account, including its impact, which is long lasting. A registry is necessary, requiring knowledge and technology to maintain and use. There is a security aspect: If all your source information is put on the database, the data and the computer system need protecting as much as the sources do. This requires money, know-how and maintenance. Through the Risk Assessment Information System (RAIS), we have an IAEA tool to set up a network. Though this is good, it will carry extra costs. Furthermore, if the IAEA provides assistance, will it help to maintain and upgrade the technology?

C. ENGLEFIELD (United Kingdom): The United Kingdom has no registry but it is building one for HASS — high activity sealed source — Directive implementation. Broadly speaking, it will cover sources in Categories 1–3. We have a large number of sources in the United Kingdom and it would be difficult to include all Category 4 and 5 sources and to regulate, track and control them as we do for the higher risk sources. We expect five — maybe up to ten — regulatory/government bodies to use the registry. Confidentiality is an issue. In the United Kingdom, information on authorizations has been in the public domain for many years, and now our Government has directed the regulators to take it out. This is a major cultural change that has to be managed.

A.J. GONZÁLEZ (Argentina): Keeping a national registry for radiation sources is a big problem not in the developing but in the developed world. In developed countries there are large numbers of sources and no tradition of keeping a national registry. In Argentina, we have had a national registry since 1950 so we have half a century's experience in registering radioactive sources. However, this is not the case around the world. We cannot apply the principle of cradle to grave if we do not know how many sources we have. This problem will be solved not by technical cooperation but only by real commitment, without which letters to the IAEA Director General have zero value.

R. CZARWINSKI, Group A moderator (Germany): I know this problem because we are in the same situation in Germany. For the future, we should strictly follow the principle of protection from cradle to grave.

(3) Do you have a national strategy for detecting, locating and managing orphan sources? Bilateral, regional, international strategies?

R. CZARWINSKI, Group A moderator (Germany): What do you do when you suspect the presence of orphan sources in your country? Have you a national strategy for managing them? Here I remind you of IAEA-TECDOC-1388, which can help in the creation of such a plan.

A. SALMINS (Latvia): Latvia has a draft national strategy, which is still waiting for approval at government level. Nevertheless, in 2002–2003 we screened all roads; since then we have been investigating municipal waste disposals and old military sites. Thus, even without the strategy legislation in force, we are implementing it.

V. FRIEDRICH (IAEA): IAEA-TECDOC-1388 gives advice on how to set up a national strategy for dealing with vulnerable and orphan sources, which need quite different approaches. Vulnerable sources are known but the control is so weak that they could easily become orphaned. Nevertheless, they can be secured and managed as disused sources, for example, and relegated to long term storage. Orphan sources, on the other hand, must be found before they can be managed. IAEA-TECDOC-1388 gives advice on setting up search teams and describes the methodology for an administrative search to identify possible locations, e.g. abandoned medical/industrial facilities and former military sites, before beginning a physical search on-site. However, although the IAEA and experienced donor countries can assist in establishing a strategy for search, location and management, the actual screening, searching and managing can only be done by the countries themselves.

J. LOY (Australia): I am not clear as to where the definition of 'orphan source' begins and ends. I go to conferences and frequently see the slide of the radioisotope thermoelectric generators (RTGs) in a backyard shed with people nearby — I am sure this does not happen in Australia. On the other hand, I hear assertions that hundreds of sources go 'missing' each year in the United States of America. Every regulatory system has a margin of error, and the ‘search and redeem’ approach for RTGs cannot be applied in the case of regulatory uncertainty. Is the orphan source problem one for Australia or only for eastern Europe?

R. CZARWINSKI, Group A moderator (Germany): To discuss your question, we would need the whole afternoon.

A.J. GONZÁLEZ (Argentina): Maybe, but it is a very important question, linked with the second one (registry, cradle to grave control). We need to differentiate between the different kinds of orphan source. Firstly, there is the problem of missing sources — missing owing to faulty regulation or standard deviation, for instance — in a country where they were regulated. Secondly, there is the problem of countries that had orphan sources — of which they were not aware — on their territory when they were created, typically former Soviet countries. Then there is the problem of orphan sources on territories that are not under any regulatory control. For example, in the Antarctic some big powers have lost sources and nobody knows where they are. Who is the responsible authority? Who will make the financial provisions? Or — at the other extreme — sources were found in Transdnistria, theoretically under the jurisdiction of Moldova, but in practice, the Moldovan authorities cannot control Transdnistria. So there are some very different problems under the name of ‘orphan sources’. Also, these sources vary greatly in level of radioactivity. Here, too, differentiation has not been made and is essential.

R. CZARWINSKI, Group A moderator (Germany): Returning to the comment by Mr. Friedrich on ‘administrative search’, I would like to remind you that often sources have been lost on paper only. We also have to be careful with documentation of sources.

(4) What kinds of financial provision are in place for addressing issues relating to orphan sources and disused sources?

R. CZARWINSKI, Group A moderator (Germany): There are two kinds of financial provision to consider: one for disused sources and the other for orphan sources. Who should pay for which? What could a solution be? What do you (intend to) have in your legislation/regulations?

R.F. GUTTERRES (Brazil): The Brazilian regulatory body, CNEN, assumes — if the facility cannot — the cost of collecting disused sources, because the cost of an accident with disused or orphan sources would be much greater.

R. CZARWINSKI, Group A moderator (Germany): We can return disused sources to the producer, sell or give them to another licensee, or dispose of them. In the case of selling them or giving them away, we come to the problem of second hand equipment and sources. Should this be allowed? How would you handle the problem? Here it is of national concern, but with regard to import/export it will be of international concern.

A.J. GONZÁLEZ (Argentina): ‘Financial provisions’ take on a wider meaning when we ask what we should do with sources. The President of the conference, Mr. Lacronique, mentioned that this was one of the biggest problems — what to do, where to put disused radioactive sources. You oversimplify the solution by presuming that sources can be returned to the manufacturer. In very few cases is this an option. Some countries forbid it in their constitution. So we dispose of the sources — where? Where is there a repository for radioactive sources? Dealing with disused sources is a serious problem that has not been addressed by the international community. The IAEA should search for a global solution, perhaps an international funding system. Now orphan sources are ‘secured’ by finding them and shielding them on the spot to protect people from radiation exposure. This is security for a limited time. So ‘financial provisions’ must mean all the resources needed to deal with orphan and disused sources. It would be a very good thing if this conference could trigger the IAEA to think about the problem.

M.J. AL-ATIA (Iraq): We think that financial provisions for orphan and disused radioactive sources should be a governmental responsibility. The government authority responsible for protecting society and the environment from radiation exposure contracts personnel from another ministry to search for orphan sources and finds storage locations for disused sources. National legislation could include certain measures and fees for compensation by the source owners for such expenditures.

G. TURQUET DE BEAUREGARD (France): As a manufacturer, I can tell you of our practical experience. In France, we have to keep track of and recover all the sources we sell. However, the owner (e.g. a hospital) of a source can resell or export it, risking that it becomes orphaned without the knowledge of the original manufacturer. There should be some international solidarity to eliminate this risk, for example by forbidding the purchase of second hand sources from hospitals outside the country. As to orphan sources in France, an association — called Resources — of manufacturers and distributors acts as a mutual fund for the recovery of small orphan sources.

F.A. MIANJI (Islamic Republic of Iran): In Iran, financial provisions for dealing with disused sources are made by the users, for orphan sources by the Government. Second hand sources may be used under special conditions, including authorization after the new user has produced quality control certification. On acquiring a new source, an authorized user has to officially commit to disposal by either returning the source to the supplier or delivering it to the State waste management centre.

R. CZARWINSKI, Group A moderator (Germany): Is this part of your authorization for the licence?

F.A. MIANJI (Islamic Republic of Iran): Yes, and it has to be renewed every time that new sources are acquired.

R. CZARWINSKI, Group A moderator (Germany): Returning to Mr. González' suggestion about the international community creating a fund or initiating other measures to provide for the disposal of disused sources, I would like to ask if the conference participants have thought of that. Do you intend to recommend it to the IAEA?

S.B. ELEGBA (Nigeria): There is a need for this international fund, which would be the beginning of a solution to the problem of dealing with orphan sources in developing countries. Mr. Turquet de Beauregard's comments make me wonder about the responsibility of the regulatory authority in France. Coming from Nigeria, a user country that imports all its radioactive sources, I can believe that some may have ended up in my country without a trace — even in the country of origin — if they have been sold in such a casual manner. An IAEA organized fund could be used for a project to gradually develop the capacity for disposal of such sources at least at regional level. Regulatory authorities could cooperate with the international community to bring these sources under control.

(5) How can experience be shared among regulatory bodies that have different levels of implementation of the Code of Conduct?

R. CZARWINSKI, Group A moderator (Germany): This goes further than sharing experience just at a technical level. What possibilities do you see for interaction — apart from that at conferences and workshops — between countries with different levels of implementation to help those countries with a lower level to catch up?

Y. BOUABDELLAOUI (Morocco): The obvious place would be at the annual meeting of senior regulators, parallel to the IAEA General Conference. There any relevant subjects in relation to implementing the Code of Conduct could be discussed.

R. CZARWINSKI, Group A moderator (Germany): The question was: How could it be done?

A.J. GONZÁLEZ (Argentina): I agree with Mr. Bouabdellaoui that the senior regulators' meeting is a good opportunity to bring up the subject of the progress of individual countries in implementing the Code of Conduct, so it should be regularly included. Another body that could serve as an example for other regions is the Ibero-American Forum, which comprises all Latin American countries and also Spain and Portugal. They meet at least once a year and are currently discussing the implementation of the Code and sharing experience. I believe there would be similar opportunities for groups of countries with common ground, such as regional proximity, a common language or similar legislative organization, to establish forums for such exchange. As far as I know, the Ibero-American Forum is the only one of its kind in operation.

S. JOVANOVIC (Serbia and Montenegro): Montenegro participates in IAEA regional projects, which — through modalities such as scientific visits and workshops — facilitate the sharing of experience. In Europe, European Union Member States with the relevant experience could help new and candidate Member States to establish efficient regulatory authorities.

K. MRABIT (IAEA): The IAEA is encouraging and promoting such mechanisms as the one Mr. González described. It has contacted its Member States asking them to nominate people from their regulatory authorities to participate in an international network that will start functioning in a few weeks. The idea is to share experience on all regulatory issues, including implementation of the Code of Conduct, national inventories of sources, experience with RAIS, and training for inspection, authorization and so on. The challenge is how to make such mechanisms systematic and focused on the important issues. Also, there is still the question of whether to make the Code binding or not. Exchange of information is crucial but a binding commitment is another matter.

J. LOY (Australia): Would countries support a recommendation that in three years' time, a full scale review meeting devoted entirely to the implementation of the Code of Conduct be convened? The format might draw on the approach taken by review meetings for the Convention on Nuclear Safety and the Joint Convention, with a national report submitted in advance by each involved State and reviews in country groups for a week or so at the meeting.

R. CZARWINSKI, Group A moderator (Germany): I fully agree with this proposal and I hope you all do, too. At the end of the meeting today we could discuss the future of the Code of Conduct, possibly a convention.

K. ULBAK (Denmark): Mr. Loy's idea is good but I do not totally agree. The Joint Convention meeting is a good example up to a point but we should not copy it, as the Code of Conduct is a different type of regulatory mechanism. A review meeting on the status of the implementation of the Code should be carefully planned, taking the legal status into account in order to be efficient and helpful to individual countries.

A.J. GONZÁLEZ (Argentina): Mr. Loy's proposal represents a fundamental step, which should also be discussed in plenary. Even if the conference can agree only on this, it will have been worth while. My delegation completely supports it. I agree with Mr. Ulbak that it has to be organized very carefully. We need to take into account the fact that we do not have a convention, so we would be acting more or less de facto. However, this step would facilitate implementation rather than just discussion.

(6) Are your legislation and regulations adequate for protecting against malicious uses of radioactive sources?

R. CZARWINSKI, Group A moderator (Germany): Reminding you of our initial discussion about security being part of radiation safety, I would like you to comment on the relevant legislation in your country. Does it cover protection against malicious use?

S.B. ELEGBA (Nigeria): The Nigerian Nuclear Safety and Radiation Protection Act of 1995 aims to ensure the safety and security of sources of ionizing radiation, but not explicitly against malicious acts. Since it was passed, however, sources have been stolen with malicious intent. Consequently there is now a draft regulation for the safety and security of radioactive sources that attempts to criminalize their malicious use. The path of using regulation was taken rather than amending the law.

A. DELA ROSA (Philippines): The present regulations of the regulatory body do not include protection against malicious acts using radioactive sources. However — upon representation of my institute — a draft anti-terrorism bill, now before our Congress, includes a provision making the use of nuclear and radioactive material as weapons of mass destruction a criminal act.

A.J. GONZÁLEZ (Argentina): I cannot imagine legislation against malicious use. The real question is whether or not the scenarios that we can forecast are covered by current legislation. If not, which is probably the case, a lot of work needs to be done. For all abnormal situations that we can envisage, we believe that there are emergency plans and systems to carry them out. But a scenario involving malicious use probably will not be covered. Probably firefighters will have to intervene and will wonder whether they should go in or not. Should female firefighters be included in the response team? International legislation does not have clear answers. How should we adapt our regulations to cover conceivable representative scenarios involving malicious use? This is the relevant question. Legislation simply against malicious use is like legislation against meteorites.

R. CZARWINSKI, Group A moderator (Germany): I agree that not every malicious use can be prevented. We need an optimized system.

M.B. BRAVO SALVADOR (Ecuador): It is very difficult for the law to protect against the malicious use of radioactive sources. But if there is a regulatory authority, and strict regulations covering transport, sale, use, licensing and so on, the law can restrict the possibilities of misuse.

J. PEREIRA (Canada): Legislation and regulations alone are not sufficient to prevent malicious use. There is a need for regulatory oversight for assurance of compliance and enforcement action when contraventions are discovered. This will serve to reduce the risk of malicious use.

(7) How many national authorities in your country are responsible for the safety and security of radioactive sources?

R. CZARWINSKI, Group A moderator (Germany): We can skip this question as it has already been discussed. I simply repeat that it would be best to have only one national regulatory authority.

(8) Has your State established a regulatory framework covering at least Category 1 and 2 sources for import/export control?

(9) Do you already have contact points?

A. DELA ROSA (Philippines): I have some reservations concerning the language used in the import/export Guidance, especially in the provision for the exporting country to evaluate the regulatory body of the importing country. I would like clarification on the criteria to be used for this evaluation.

C.E. NÖLLMANN (Argentina): We have been applying the criteria from the import/export Guidance for about one year. Our regulatory framework covers Category 1 and 2 and also some Category 3 sources. Our experience in applying the Guidance has been positive so far.

A.J. GONZÁLEZ (Argentina): I was present when the wording (mentioned by Ms. Dela Rosa) was debated in the IAEA Board of Governors. It was a difficult compromise, reached after one week of negotiations, which included the Governor of the Philippines. It would not be easy to change that compromise now.

R.F. GUTTERRES (Brazil): A clear answer would be that we cannot evaluate this. I agree with Ms. Dela Rosa and with Mr. González that we have to create objective steps to evaluate the level of implementation of the Code of Conduct, which is not really clear on import/export. Therefore we must create an instrument (maybe a checklist) to enable countries to evaluate whether the importing country is complying with the Code.

R. CZARWINSKI, Group A moderator (Germany): Could the Guidance on import/export hinder the adoption of the Code of Conduct?

C. ENGLEFIELD (United Kingdom): Returning to the previous question and broadening it, I think that countries are going to need processes for import/export controls, which will have to be interdependent. Whether concerning evaluation of regulatory bodies or other issues, some coordination is needed. Otherwise a process used in country A may demand information that is not provided by country B.

A.J. GONZÁLEZ (Argentina): Mr. Englefield has raised a good point. I would like to clarify something that Mr. McIntosh implied in his presentation. This was that because only three of the 70 some countries supporting the Code of Conduct sent a letter to the Director General in relation to the Guidance, the remaining ones supported only the Code, because they had not sent the second letter. I think this interpretation is wrong. My Government, for example, once it had approved the Code and had participated in the agreement on the Guidance, automatically applied the Guidance. A second letter was not necessary. Therefore not sending a second letter does not mean that you will not follow the Guidance.

K. ULBAK (Denmark): I would like to add to Mr. González' comment, that in Denmark, we waited for the letter from the IAEA, which was sent out in April this year, asking for the letter to the Director General before we responded. Now it is on the way.

D.J. TREDINNICK (Australia): Reinforcing Mr. González' words, I point out that one of the principles of endorsing the import/export Guidance is an internationally harmonized implementation date — 31 December 2005. This is critical to the system: as many people as possible coming on line with the same type of data at the same time.

Y. GROF (Israel): I do not think it is important for all countries to meet the implementation deadline. There is an economic consideration promoting implementation. On implementing the Code of Conduct, an exporter is obligated to sell sources only to countries that have a properly functioning regulatory body. Any potential importer wanting the source will have to comply in the end, which will result in harmonization.

R.F. GUTTERRES (Brazil): I agree with you that there is a difference between a non-binding document and the status of the Code of Conduct. Clearly, if the harmonized implementation date is approved/implemented, the non-compliant countries will not be able to import sources. If it were completely non-binding, we could not have this complicated situation.

R. CZARWINSKI, Group A moderator (Germany): The Code of Conduct, though non-binding, is on a higher level than an IAEA-TECDOC or Safety Guide. We signed our agreement to it.

A.J. GONZÁLEZ (Argentina): I am sorry, but you are wrong. A Safety Guide is part of the IAEA Safety Standards, which consist of Fundamentals, Requirements and Guides. The safety standards are referred to in Article III.A.6 in the IAEA Statute and they apply as mandatory to any activity involving the IAEA. So the standards have a very high status. The Code of

Conduct, on the other hand, is not binding. Nobody really knows what it is. Like the catechism, if you do not follow it, you will go to inferno in the afterlife but nothing will happen to you in this life. It has no status and is at a much lower level than the standards from a purely judicial standpoint. This is why, until we introduce a process to make the Code legally binding, we will be in limbo.

R. CZARWINSKI, Group A moderator (Germany): Let me be provocative: Why did you not put the Code of Conduct into a Safety Guide?

A.J. GONZÁLEZ (Argentina): That would have been perfect since commitment by politicians has no value. For example, a very important country — whose name I will not mention — sent the letter, signed by a top politician, to the IAEA endorsing the Code of Conduct. However, it is clear that the country is not complying. Therefore these letters — though of great moral value — in practice are worth nothing.

Y. BOUABDELLAOUI (Morocco): Can you clarify ‘evaluation’? You mentioned setting up a blacklist of countries not complying with the Code of Conduct to which sources should not be sold. Maybe I do not understand the process well. A sale of sources could go through the regulatory bodies of both the exporting and the receiving country. However, a sale of sources by a commercial supplier without the involvement of the regulatory body would create a problem.

R. CZARWINSKI, Group A moderator (Germany): We shall address this important question in a discussion with the whole audience.

K. MRABIT (IAEA): I do not have an answer to Ms. Dela Rosa’s question about harmonizing judgement, meaning that the same references should be used and that assessment methodologies should produce consistent results. However, the IAEA has developed and is now promoting a methodology to help its Member States make self-assessments of their regulatory effectiveness. If all Member States use it, we will have a harmonized means of yielding acceptable results. Thus we have a peer review system and quality assurance available for use. The real question is still whether the Code of Conduct is binding or not.

(10) What is your national experience of the roles and responsibilities of users, manufacturers, distributors or other entities involved in the management of radioactive sources?

(There were no comments.)

(11) Do you consider that confidentiality regarding the security of radioactive sources could have a negative effect on safety?

A.J. GONZÁLEZ (Argentina): Because of the confusion — created mainly by the IAEA — between the security of radioactive sources and the security of nuclear material, confidentiality — which is very proper for nuclear material and weapons — has infiltrated into the area of radiation safety, where it is completely counterproductive. We should not confuse the two issues. For instance, when we transport radioactive material, are we going to fail to label it with the radiation warning sign because of confidentiality? This would be a nightmare.

C. ENGLEFIELD (United Kingdom): I disagree slightly with Mr. González. As we develop a new security regime in the United Kingdom, we have found that there are ways around these problems. For example, we have taken information out of the public domain but have continued to provide it to fire services. We require people who have licences to protect their information as a licensing condition. We have held discussions with police colleagues who are part of the system about safety signage and we believe that we can work out sensible compromises, meaning that signs are positioned in such a way that they can deliver their message without being unduly available to the public.

A. JANSSENS (European Commission): It is important to maintain confidentiality of certain information but, in my experience, it is certainly detrimental to safety. Abuse of confidentiality in not sharing information essential to emergency preparedness, for instance, is detrimental. An even more perverse abuse of confidentiality is that some people, claiming to be experts in the field, do not seek advice from other concerned bodies, do not undergo peer review and, consequently, produce extremely poor quality work. Therefore I think that generally it is better to lift confidentiality except in very specific cases where it is really necessary.

A.J. GONZÁLEZ (Argentina): Although I fully agree with Mr. Janssens, I do not find myself in disagreement with Mr. Englefield. He refers to issues that are obviously confidential. Of course you do not publicize everything that the regulator has. I am referring to the infiltration of a CIA mentality by experts from the nuclear weapon States into the area of radioactive sources. My experience in Argentina and at the IAEA has shown this to be extremely detrimental.

TECHNICAL SESSION 1: GROUP B

Moderator

R. JAMMAL
Canada

REGULATORY CONTROL OF RADIOACTIVE SOURCES IN FINLAND

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Abstract

The paper describes the infrastructure for regulatory control of radioactive sources in Finland, including legislation, the regulatory authority, regulatory staff training, authorization and inspection, and the database of radioactive sources. The paper also discusses services available to users, such as training, dosimetry and calibration; the management of disused sources; and orphan sources.

1. INTRODUCTION

Regulatory control of radioactive sources in Finland is based on national radiation safety legislation, the evolution of which, starting from the very first Radiation Act of 1957, has always taken into consideration internationally recognized recommendations on radiation safety. The latest major revision of the Radiation Act, taking into consideration also the 1990 Recommendations of the International Commission on Radiological Protection, took effect in 1992 [1].

Finland became a Member of the European Union in 1995 and since then the legislation has evolved under the Euratom framework. The latest step of this development is the currently ongoing implementation of the HASS Directive [2] in the national legislation to be completed by 31 December 2005. In conjunction with this process, some provisions in the Finnish legislation on the import and export of radioactive sources are being particularized to better reflect Articles 23–29 of the Code of Conduct on the Safety and Security of Radioactive Sources [3], as well as the supporting Guidance on the Import and Export of Radioactive Sources [4]. In all other respects, Finland already broadly follows the Code of Conduct.

2. INFRASTRUCTURE FOR REGULATORY CONTROL

2.1. Legislation

The Finnish radiation safety legislation has a hierarchy of three levels. The Radiation Act [1] is enacted by the parliament and it establishes basic structures for radiation protection, radiation safety and regulatory control of the use of radiation. These include, for example, the system of licensing and the system of protection of workers. It also defines the regulatory authorities and supervisory rights and the mechanisms of enforcement and appeal, as well as setting the general obligations of a responsible party and the general requirements for different types of practice.

The second level is composed of the Radiation Decree [5], which is issued by the President of the Republic at the proposal of the Minister of Social Affairs and Health. The Radiation Decree establishes, inter alia, numerical values for dose limits, and it sets more detailed provisions for the monitoring of exposure, the licensing system, radioactive waste and exposures to natural radiation.

The Radiation Act authorizes the Radiation and Nuclear Safety Authority (STUK) to issue general instructions on how to attain the level of safety defined by the Act. The third level in the hierarchy of legal instruments is thus composed of a set of Radiation Safety Guides (ST guides), which include both practice specific as well as generally applicable thematic guides. The full list of the ST guides (as well as most of the guides) currently in force is available at http://www.stuk.fi/english/regulations/st-guides.html.

2.2. Regulatory authority

The Ministry of Social Affairs and Health is the supreme authority on compliance with the Radiation Act, except that in matters concerning commercial manufacture of, trade in, and import and export of radiation sources, the supreme authority is the Ministry of Trade and Industry.

The Radiation Act defines STUK as the regulatory authority overseeing adherence to the Act and other regulations issued in accordance with it. Within STUK, all functions relating to regulating radiation practices are placed in one department, Radiation Practices Regulation, whose core processes include preparation of ST guides, authorization, inspection, enforcement and maintaining records of these activities (including records of sources) and maintaining a national dose register.

Concerning import from outside the European Union, Finnish Customs is responsible for controlling that importers of radioactive substances hold a safety licence issued by STUK. Within the European Union, shipments of radioactive substances are controlled according to Council Regulation 93/1493/ Euratom [6]. STUK is the competent authority in the meaning of the regulation.

The control of nuclear material is based on the Nuclear Energy Act, international treaties (IAEA and European Union) and contractual arrangements, and is not discussed further in this paper. The transport of radioactive substances is regulated in accordance with the legislation for transport of dangerous materials, and issues related to transport are also not discussed further here.

2.3. Regulatory staff training

The qualification and training requirements of the staff participating in regulatory functions are defined in an internal guide on staff competences and in individual job descriptions. The STUK quality management system includes an ongoing process where the skills and know-how needed for successfully conducting all the functions of each section, and of the department as a whole, are being assessed in order to identify possible gaps in know-how, either now or in the near future. The results of this assessment are turned into specific training plans.

2.4. Authorization and inspection

Prior authorization is required for the use[1] of radioactive sources. A licence is granted by STUK upon written application. General conditions for granting a licence are laid down in the Radiation Act, and the licensing procedure is prescribed in more detail in the Radiation Decree. The applicant must provide STUK with various information, depending on the nature and extent of the practice. This includes:

— A description of the user's organization defining responsibilities related to radiation protection and safety as well as the competences of the personnel involved;
— Purpose of using a radioactive source;
— Places where radioactive sources are employed;
— Protective and safety systems to be used;

[1] The Radiation Act defines the word 'use' in its broadest meaning, covering also holding, storing, importing, exporting, handling, etc.

— Systems for monitoring radiation exposure;
— Plans for rendering harmless disused sources and other radioactive waste;
— Any other information concerning arrangements ensuring radiation safety.

The name of a radiation safety officer responsible for the safe use of radiation must be included in the description of the organization. The officer must have undergone radiation safety training, including a qualifying examination acceptable to STUK. The curriculum of such training is subject to approval by STUK. In addition to being qualified in this manner, a radiation safety officer must have sufficient authority within the licensee's organization to perform his or her duties.

Whenever major changes are planned within a practice, the licensee must apply for an amendment to the safety licence. Typical changes requiring an amendment are:

— A new radioactive source is to be taken into use or a source will be taken out of use.
— A fixed radioactive source is relocated.
— The legal name of the licensee has changed.
— A new radiation officer is appointed.

Normally a licence is granted until further notice. A licence will expire when the licensee states in writing that the use of radioactive sources has ceased and it provides sufficient evidence that radioactive sources and waste have been transferred to another licensee, returned to the manufacturer or delivered to an installation authorized for long term storage or final disposal.

All premises where radioactive sources are employed are inspected by STUK regularly, every 1–5 years, depending on the type and extent of the practice. The main objective of an inspection is to verify that radioactive sources are used safely and in accordance with legislation and the conditions set in the licence. Among other verifications, the inspector must locate and identify each sealed source. Any discrepancies with the licensing information concerning placing of sources, new sources and sources taken out of use are recorded for amending the licence accordingly.

2.5. Database of radioactive sources

Licensing information is stored in a database maintained by STUK, including also source specific information on all sealed radioactive sources in a licensee's possession. Source specific information is updated continuously according to licensees' notifications and observations made during inspections. Statistics on the licences, uses, devices and sources, as well as imports and exports, are published regularly in STUK's Annual Reports on Radiation Practices. The reports (in English) can be found at http://www.stuk.fi/english/publications/list.php?series=STUK-B-STO.

3. SERVICES AVAILABLE TO USERS

3.1. Training

Various universities, educational institutions and training organizations provide training in radiation protection and safety. STUK has provided guidance on appropriate radiation protection training for professionals in health care (ST Guide 1.7, available in English at http://www.finlex.fi/pdf/normit/17536-ST1-7e.pdf). Although not legally binding, because universities and educational institutions have autonomy in deciding on their curricula, the guide was prepared in close cooperation with them and the Ministry of Education and thus is now widely accepted.

The requirements for radiation protection training for radiation safety officers are defined in ST Guide 1.8 (http://www.finlex.fi/pdf/normit/20016-ST1-8e.pdf). In addition, the guide defines requirements for regular updating training for all personnel involved in the use of radiation, including the radiation safety officer. Various organizations having STUK's approval provide training and qualification examinations as defined by the guide. A complete list of approved training organizations is published regularly as an annex to STUK's Annual Reports on Radiation Practices (http://www.stuk.fi/english/publications/list.php?series=STUK-B-STO).

3.2. Dosimetry and calibration

At present, personal dosimeters are provided to the users of radiation by one approved dosimetric service (Doseco Oy). Another dosimetric service is operated by a nuclear power company, but it provides services only to the nuclear facilities. STUK operates a secondary standards dosimetry laboratory which also provides calibration services.

4. MANAGEMENT OF DISUSED SOURCES

As defined in the Radiation Act, radioactive sources that have no use and must be rendered harmless owing to their radioactivity are radioactive waste. The licensee is required to take all the measures needed to render harmless radioactive waste arising from its operations. Should the licensee not meet the requirement, or if the origin of the waste is unknown, the State has a secondary obligation to render the radioactive waste harmless. In such a case, the licensee or other party who has taken part in producing or handling the waste must compensate the State for the costs incurred in such action.

Despite the requirement in place that disused sources must not be stored unnecessarily, it is sometimes difficult to define whether a stored source might have some use in the future. The annual fee for holding a licence depends on the sources in a licensee's possession, and since all storages are inspected regularly, there is some financial incentive to dispose of disused sources.

There is a national long term storage for disused sealed sources located at the Olkiluoto Nuclear Power Plant site. Effectively, the storage is a side tunnel in an underground disposal facility for low and intermediate level nuclear waste. The plan is that, in practice, the storage will also be the place of final disposal for almost all of the sources stored there, except for some alpha emitters whose activities exceed the limits set for the final disposal. The destiny of these sources will be reconsidered at the time of final closing of the facility (after some decades).

5. ORPHAN SOURCES

The cornerstone for maintaining radioactive sources under control in Finland is that all practices involving sources are subject to authorization and all licensing information, including information on each individual source, is entered in a register which is continuously updated on the basis of applications and notifications received from licensees. The correctness of the data is continuously validated by regular inspections at places of use, as well as by other means, such as comparison of information received from different sources (especially suppliers). The licensing system has been in operation since 1957, but source specific information has been included in a database only since the beginning of the 1980s. Therefore the likelihood of control over sources being lost was much higher some twenty years ago or earlier than it is today.

Finnish Customs and the metal recycling industry significantly intensified the radiation monitoring of scrap metal after the Chernobyl accident and because of a rapid increase in the import of scrap metals from the former East

Bloc countries in the early 1990s. Fixed monitors for vehicles and railway traffic have been installed at all major crossing points at the Finnish–Russian border and at Helsinki harbour. Other crossing points have handheld monitors at their disposal. All important users of scrap metal have installed fixed monitors at the gates of their installations. In addition, STUK has provided information to scrapyards on how to identify an orphan source and on procedures to follow if one is suspected to have been found. STUK cooperates with Customs and the metal industry on questions such as measurement arrangements and training of personnel. STUK also provides expert help in cases where exceptional radiation is detected.

So far, on the order of ten sealed radioactive sources have been found among scrap metal. In most cases the origin of the source was unclear; either it originated from some other country or it was an old source probably used over twenty years ago. The number of lost registered sources (i.e. sources registered after the early 1980s) is very low, only a few exceptional cases. Orphan sources whose owner cannot be identified are delivered to the long term storage at Olkiluoto.

Experience during the past twenty years has shown that source specific records of sources, combined with regular inspections at the places of use, have efficiently prevented loss of control over sealed radioactive sources.

REFERENCES

[1] Radiation Act (592/1991) and its amendments, Statutes of Finland, available in English at http://www.stuk.fi/saannosto/19910592e.html

[2] Council Directive 2003/122/Euratom of 22 December 2003 on the Control of High-Activity Sealed Radioactive Sources and Orphan Sources, OJ L 346 (2003).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources: Guidance on the Import and Export of Radioactive Sources, IAEA, Vienna (2005).

[5] Radiation Decree (1512/1991) and its amendments, Statutes of Finland, available in English at http://www.stuk.fi/saannosto/19911512e.html

[6] Council Regulation 93/1493/Euratom of 8 June 1993 on Shipments of Radioactive Substances between the Member States, OJ L 268 (1993).

DISCUSSION

V. HOLUBIEV (Ukraine): How frequently are source inspections carried out, and do the inspectors get to see every source?

M. MARKKANEN (Finland): The periodicity of inspections varies from one to five years, depending on the type of practice. With a practice involving only level gauges, for example, inspections are carried out every five years. The inspectors, who look at the on-site practice as a whole, are required to locate and identify each source.

PROGRESS IN IMPLEMENTING THE CODE OF CONDUCT ON THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

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1. STRUCTURE OF REGULATORY CONTROL

The basis of government regulatory control over the management of radioactive materials and ionizing radioactive sources in the Russian Federation is:

— The Federal Law of the Russian Federation on Use of Nuclear Power;
— The Federal Law of the Russian Federation on Sanitation and Epidemiological Well-Being of the Population.

The Federal Law on Use of Nuclear Power establishes key provisions regulating activities related to the development, manufacturing, disposition and use of radioactive materials in different spheres, and to their accounting and control, physical protection and import/export regulation.

To implement the provisions of the Federal Law on Use of Nuclear Power, the Government of the Russian Federation has endorsed a number of regulations:

— Regulation on Licensing Activities in the Field of the Use of Nuclear Power;
— Regulation on Government Accounting and Control of Radioactive Substances and Radioactive Waste in the Russian Federation;
— Regulation on the Establishment of Rules to Structure the System of Government Accounting and Control of Radioactive Substances and Waste;
— Regulation on Ensuring Nuclear and Radiation Safety and Physical Protection during Transportation of Nuclear Fissile and Radioactive Substances;
— Regulation on Importing to the Russian Federation and Exporting from the Russian Federation of Radioactive Substances and Goods;

— Legal and technical documents that give requirements and rules on the management of sources, such as requirements for design, manufacture, storage and term of useful life.

Currently the executive authorities in charge of regulatory control over radioactive sources in the Russian Federation are:

— Federal oversight service in the area of protection of consumers' rights and individual well-being, which provides government registration of potentially hazardous products and facilities, as well as issuing permits for their use at facilities after examining the conditions in which they are to be used;
— Federal service for environmental, technological and nuclear oversight (Rostechnadzor), which carries out the functions of adoption of legal bills, control and oversight in the field of safe use of nuclear power, in particular the licensing of activities related to the use of sources, as well as control over compliance with licensing requirements;
— The Federal Atomic Energy Agency (Rosatom), which exercises governing of the State system of accounting and control of nuclear material, radioactive substances and waste, including management of the corresponding registers and records.

In accordance with the Provision on the Federal Atomic Energy Agency adopted by the Government of the Russian Federation, Rosatom is an authorized federal entity of the executive power that carries out the functions of conducting government policy, legal regulation, rendering government services and managing government property in the field of nuclear power use, development and safe operation of nuclear power production, the nuclear weapons complex, the nuclear fuel cycle, nuclear science and technology, nuclear and radiation safety, and non-proliferation of nuclear material and technology, as well as international cooperation in this area.

Rosatom is a government entity managing nuclear power use, and the competent government entity on nuclear and radiation safety during transport of nuclear materials, radioactive substances and waste. It is the principal government entity and communications office in accordance with the Convention on the Physical Protection of Nuclear Material, and the authorized national agency for implementation of the commitments of the Russian Federation in the field of physical protection of nuclear material at the IAEA and other international organizations.

Rosatom performs the following key functions:

— Managing the system of government accounting and control of nuclear materials, radioactive substances and waste, including management of relevant registers and records;
— Ensuring nuclear and radiation safety;
— Coordinating management of nuclear materials, radioactive substances and waste;
— Coordinating and controlling activities on site selection, design, construction, operation and decommissioning of nuclear installations, radioactive sources, nuclear materials and radioactive substances storage stations, and radioactive waste storage facilities;
— Ensuring physical protection of nuclear installations, radioactive sources, nuclear materials and radioactive substances, nuclear materials and radioactive substances storage stations, and radioactive waste storage facilities;
— Arranging the export and import of nuclear installations, equipment and technology, nuclear materials, radioactive substances, special non-nuclear materials and services in the field of nuclear power use.

2. PERSONNEL TRAINING

The national nuclear industry puts special emphasis on personnel training and qualification upgrading in such areas as security culture, basics of accounting and control of radioactive substances, and a number of other qualifications. Rosatom maintains a number of government and regional professional educational and training institutions. Managers and specialists of all levels upgrade their qualifications in special advanced training institutions, both central and regional.

3. PROGRESS IN DEVELOPING A NATIONAL REGISTER OF RADIOACTIVE SOURCES

The structure of government accounting and control of radioactive substances and waste includes:

(a) Rosatom and its leading Informational and Analytical Center, which ensure accounting and control of radioactive sources (RS) and radioactive waste (RW) on the federal level.

(b) Federal entities of executive power and their Informational and Analytical Centers. These entities provide accounting and control of RS and RW to organizations under their supervision. They are government unitary enterprises and government agencies.
(c) Executive power entities in the regions and their Regional Informational and Analytical Centers. These entities are responsible for accounting and control of RS and RW everywhere in the region with the exception of organizations subordinate to federal authorities.
(d) Regulatory and law enforcement agencies that ensure oversight of the system operation throughout all the levels, as well as the investigation of incidents and taking measures to prevent theft of sources, etc.
(e) Organizations that are involved in direct use of RS and RW. These organizations provide initial accounting and control of RS and RW. They are responsible for observing requirements set by legal bills and other documents on safe operation, security and physical protection, etc.

Informational and Analytical Centers arrange and carry out accounting and control of RS and RW, including:

— Collecting information on RS and RW from subordinate organizations, including data from regulatory authorities, inventory results at locations and inspections;
— Processing and analysing the validity of the collected data on accounting and control of RS and RW;
— Creating and operating a database (registers and records) on accounting and control of RS and RW;
— Preparing in proper order the data on accounting and control and their transfer to the principal Informational and Analytical Center;
— Participating in inspections of an accounting and control nature at different organizations in accordance with rules set by the federal authority;
— Arranging training of experts on accounting and control at subordinate organizations.

The functioning of the system of government accounting and control of radioactive substances and waste is based on legal bills and methodological documents that are constantly being updated.

The accounting of ionizing radioactive sources in the system begins from the moment they are delivered to the goods storehouse of the manufacturer (later all the transits of the source are registered) and continues up to the moment of their disposition and storage. Currently organizations provide

Informational and Analytical Centers with information on the transit of the sources in accordance with set notification rules. Both the supplier of the source (after its shipment) and the recipient (after its receipt) must submit relevant data.

The functioning of the system has significantly improved the prospects of:

— Identifying those responsible for loss of control over sources;
— Control over timely decommissioning and disposition of expired sources.

The overall inventory of radioactive sources and upgrading of the part of the legislation that regulates the issuing of permits for dealing with sources of Categories 1 and 2 (of IAEA-TECDOC-1344, Categorization of Radioactive Sources) are scheduled in the Russian Federation for 2006.

4. APPROACHES TO THE MANAGEMENT OF RADIOACTIVE SOURCES THROUGHOUT THEIR LIFE CYCLE

In the Russian Federation, expired radioactive sources are returned by the customer to the manufacturer or sent for long term storage to territorial specialized production facilities of the RADON system. If necessary, the operating organization may extend the operating time of the source if it obtains approval from the relevant commission comprised of representatives from Rostechnadzor, the government sanitation and epidemiological oversight authority and operating organization.

When expired radioactive sources are returned to the manufacturer, radioactive material is, if necessary, extracted from the sources for further use. In cases of a lack of reprocessing technology or if reprocessing is economically inefficient, the expired source is disposed of.

Currently, in accordance with Article 48 of the Federal Law on Environment, the import of radioactive sources to the Russian Federation is prohibited. However, Rosatom, realizing the importance of observing item 27 of the Code of Conduct, is preparing proposals to the Government of the Russian Federation on repatriation of expired radioactive sources for reprocessing.

5. PROGRESS WITH ARRANGEMENTS FOR IMPLEMENTING THE IMPORT AND EXPORT PROVISIONS OF THE CODE OF CONDUCT

The Russian Federation is one of the largest exporters of radioactive sources (including Categories 1 and 2) based on ^{60}Co, ^{75}Se, ^{192}Ir, ^{241}Am, ^{252}Cf, etc.

Currently the export and import of radioactive substances and products based on radioactive substances is a licence based activity. Licences are issued by the Ministry of Economic Development and Commerce of the Russian Federation. Rosatom conducts technical assessment of materials proposed by the Russian participants for export.

The participant requesting import/export licences must submit to Rosatom copies of Rostechnadzor licences for the management of radioactive substances (production, storage, transport, use, rendering of intermediary services on sales of radioisotope products). In the event of a lack of a licence for any one kind of activity, the participant submits a contract/agreement with a production facility that has the required licence.

When radioactive sources are imported, copies of the manufacturer's certificates are to be submitted, as well as other materials necessary for conducting an assessment (expertise).

In accordance with Article 64 of the Federal Law on Use of Nuclear Power, the export and import of radioactive materials are subject to the rules set in provisions on the export and import of radioactive sources and goods.

The existing system of control over the management of nuclear and radioactive materials in the Russian Federation provides for extensive control over the sales of such materials inside the country, as well as their import and export.

DISCUSSION

M.S. KRZANIAK (International Organization for Standardization): In your presentation, you indicated that Rosatom was making representations to the Russian Government with a view to bringing about a change in Russia's policy regarding the return of disused sources to Russia from abroad. How long, in your opinion, will the process of bringing about that change take, so that it becomes easier to return disused sources to Russia?

L. ANDREEVA-ANDRIEVSKAYA (Russian Federation): I think the process will take about two years.

G. PRETZSCH (Germany): What is the division of labour between Rosatom, Rostechnadzor and RADON?

L. ANDREEVA-ANDRIEVSKAYA (Russian Federation): Rosatom is responsible for running our State system for radioactive source accounting and control, for arranging the export and import of radioactive sources, for managing radioactive source registries and records and for providing technical expertise in connection with licensing. Rostechnadzor is involved in the preparation of draft laws, in oversight in the field of nuclear power safety, in the licensing of radioactive source manufacturing, transport and storage operations, and in the verification of compliance with licensing requirements. RADON is responsible for long term storage.

I. USLU (Turkey): Will the Russian Federation be notifying the IAEA's Director General of its intention to work towards effective import and export controls in the light of the Guidance on the Import and Export of Radioactive Sources?

L. ANDREEVA-ANDRIEVSKAYA (Russian Federation): Yes, it will.

NATIONAL STRATEGY FOR THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES IN THE UNITED REPUBLIC OF TANZANIA

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Abstract

In the United Republic of Tanzania, practices involving radioactive sources are found in medicine, agriculture, industries, research and education. Apart from known stochastic and deterministic effects, it is now of great concern that radioactive sources can also be deployed in terrorist activities if effective safety and security mechanisms are not instituted. Therefore it is necessary to ensure that, from the initial stage of use of the source to its final disposal, adequate security measures are put in place to prevent any related malevolent acts. The paper describes Tanzania's national strategy to meet this objective. The strategy involves the institution of regulatory control, the education and training of regulatory staff and stakeholders, the collection of disused sources, the security upgrading of facilities with high risk, emergency preparedness and international cooperation. While the situation is encouraging, future needs have been identified as searching, locating and recovering orphan and disused sources, monitoring of border crossings to detect illegal source movements, strengthening security during the transport of radioactive sources, increasing the capability and basic knowledge of first responders, collection and conditioning of sources no longer being used, and scrap metal monitoring.

1. INTRODUCTION

Radioactive sources have diverse applications in the United Republic of Tanzania, including medical, agricultural, industrial, research and educational uses. Medical uses include radiotherapy, brachytherapy and nuclear medicine, while industrial applications include non-destructive testing (NDT) and various types of gauges. The use of radioactive sources in research and education encompasses radiotracer techniques, Mossbauer spectroscopy, calibration and blood irradiators. The radioactive sources in current use are summarized in Table 1. Disused and spent sources result when sources reach the end of their useful lifetime, and many of these sources are still strong enough to be of radiation protection concern. In addition to these, Tanzania has also experienced a number of cases of orphan sources and a series of cases of illicit trafficking and inadvertent movements of sources (Table 2). Both disused sources and those in use need to be well secured.

The usefulness of radioactive source applications cannot be overemphasized, but the sources are also believed to induce cancer and hereditary disorders [1]. Experience has shown that the loss of control over sources, whether in use, spent or disused, has led to these health effects [2]. It is therefore necessary to enforce suitable radiation protection measures to minimize radiological accidents or mitigate their consequences should they occur. In addition to these effects, recently there has been increasing global concern about the possible deployment of radioactive sources in terrorist activities if strict control of the sources is not exercised. This paper presents and discusses the national strategy in Tanzania's effort to ensure the safety and security of radioactive sources.

2. NATIONAL STRATEGY FOR THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

2.1. Regulatory control

The control of radioactive sources is governed by the Atomic Energy Act of 2003 and Atomic Energy (Protection from Ionizing Radiation) regulations of 2004 [3, 4]. Under this legislation, the Tanzania Atomic Energy Commission (TAEC) is the sole regulatory authority and oversees all practices involving peaceful applications of ionizing radiation. The main functions of TAEC are to:

— Issue authorization for the export, import, possession and use of radioactive sources;
— Promulgate regulations and codes of practice for ionizing radiation;

TABLE 1. SUMMARY OF RADIOACTIVE MATERIALS IN USE IN TANZANIA

Radionuclide	Number of sources	Uses
Cs-137	29	Medicine, industry
Ir-192	10	Industry
Ra-226	1	Industry
Am-241–Be	23	Industry
Co-60	7	Medicine, industry
Sr-90	14	Medicine, industry

TABLE 2. INVENTORY OF RADIOACTIVE WASTE AT THE CENTRAL RADIOACTIVE WASTE MANAGEMENT FACILITY (SPENT, DISUSED OR ORPHAN SOURCES AND INADVERTENT MOVEMENTS OF SOURCES)

Radionuclide	Number of sources	Previous application	Conditioned?
Ra-226	32	31 brachytherapy 1 captured by police	Yes No
Cs-137	Several	Brachytherapy, research, non-destructive testing, density gauges, 1 captured by police	No
Co-60	Several	Brachytherapy, 1 calibration facility	No
Sr-90	3	Research, gauges	No
Am-241	4	Gauges	No
Unknown	1	Captured by police	No
U-238	2	Captured by police	No
P-32	1	Unknown	No
I-125	4	3 unknown 1 research	No No
C-14	Solution	Research	No
H-3	Solution	Research	No
Ir-192	1	Non-destructive testing	No

— Carry out regulatory inspections and the necessary enforcement;
— Disseminate information through education and training to workers and members of the public;
— Advise the government on international agreements and promote international cooperation;
— Coordinate the national radiological emergency plan and preparedness.

For smoother execution of its functions, TAEC maintains inventories, such as those of sealed sources in use, disused sources at premises around the country, disused sources at an interim storage facility, sources involved in illicit trafficking, sources which have been lost and unsealed sources. Some gaps in information, e.g. characterization and previous uses, exist in the inventories, and related investigations are in progress to fill the gaps. The presence of legal backing in safety and security issues implies that appropriate enforcement can be carried out as necessary.

2.2. Education and training programmes

As is globally recognized [2], education and training programmes form an essential component of radiation protection and safety. TAEC implements its training programme for its staff, occupationally exposed workers and members of the public at large. Training of regulatory staff is supported by the IAEA. Already about twenty staff members have received relevant training, and more such training is envisaged. Training of specialized staff for users is also supported by the IAEA, and more than a hundred workers have obtained such training. Through the IAEA programme on training of the trainers, TAEC offers training to occupationally exposed workers and disseminates radiation safety and security information to members of the public through seminars, mass media, posters and flyers. Significant progress has recently been achieved whereby training to raise the level of awareness of front-line officers, such as police, customs, clearing and forwarding, and harbour and port officers, has been carried out with IAEA assistance. More requests from users for such training have been received by TAEC.

2.3. Collection of disused radioactive sources and their transfer to the Central Radioactive Waste Management Facility

Timely management of spent and disused sources is key to the national strategy for safety and security issues. More than 58 disused sources have been collected in the country and transferred to the Central Radioactive Waste Management Facility (CRWMF, Table 2). There are still about 13 known disused sources at various premises around the country and the plan is to transfer them to CRWMF. These include three ^{137}Cs brachytherapy sources, one ^{60}Co teletherapy source, one ^{137}Cs blood irradiator, and three neutron activation facilities, one each of ^{226}Ra, ^{90}Sr and ^{241}Am. It is assumed that there are still other disused sources, and efforts are being made to search and locate them and transfer them to CRWMF. This activity is prioritized for disused sources of Categories 1 and 2 of the IAEA categorization of radioactive sources [5]. The IAEA is assisting the national efforts in this endeavor.

2.4. Security upgrading of facilities with high risk sources

With the assistance of the United States Department of Energy (USDOE) through the Basic Order Agreement (BOA), Tanzania is upgrading the security of facilities with high risk sources (Categories 1 to 3) in use and with sources still not transferred to CRWMF. The security upgrading includes the installation of active response systems for cases of unauthorized intrusion, radio communication systems, and reliable padlocks and fences where other means are not available. Such improvements have been implemented at CRWMF, the cancer institute, the sterile insect technique centre and the neutron activation analysis facility. Some of these facilities will be under 24 hour surveillance.

2.5. Development and establishment of emergency preparedness and response plans

Emergency response plans are being developed at each centre using radioactive sources. This exercise is currently being coordinated by TAEC and the final plan is to establish the national emergency response team, which will be part of the national disaster team that is under the prime minister's office. The eventual objective is to mitigate the effects of any accident or incident involving radioactive sources should one occur. The country has so far not experienced any radiological accident.

2.6. International cooperation

Since 1984 Tanzania has enjoyed close ties with the IAEA, without whose technical assistance the country's radiation protection infrastructure could not have reached the present stage. The county has participated in a number of IAEA radiation protection projects. Presently, model projects, nuclear security projects and waste management projects are among the projects being implemented. Tanzania has signed international conventions such as the Treaty on the Non-proliferation of Nuclear Weapons and an additional protocol to its safeguards agreement, and is also participating in the IAEA's early notification of radiological accidents scheme and Illicit Trafficking Database (ITDB). Furthermore, Tanzania is implementing a project supported by the USDOE through the BOA as mentioned above.

3. EXPERIENCE

The major achievements of the national strategy for the safety and security of radiation sources may be summarized as follows:

— Collection of legacy radium sources and their conditioning;

- Training of front-line officers at borders and entry ports to identify, detect and respond to illicit trafficking incidents;
- Invitation to INNSERV mission to assess and advise on the State control and accountability of radioactive materials with regard to the ‘cradle to grave’ concept;
- Security upgrades of facilities with high risk radiation sources of Categories 1 to 3, with the assistance of the USDOE.

Despite these achievements, there is a need to strengthen efforts in the following areas:

- Search, location and recovery of orphan and disused sources;
- Monitoring of major border crossings to detect illegal movement of sources;
- Strengthening of security during the transport of radiation sources;
- Increasing the capability and basic knowledge of first responders;
- Collecting, conditioning and securing at CRWMF sources no longer used by institutes;
- Scrap metal monitoring;
- Combating illicit trafficking;
- Full implementation of the IAEA’s Code of Conduct on the Safety and Security of Radioactive Sources [6] as well as the Guidance on the Import and Export of Radioactive Sources [7].

4. CONCLUSION

This paper has presented the national strategy for the safety and security of radioactive sources in Tanzania. The status of implementation is encouraging, with significant achievements as noted. Behind this success is the support of the IAEA and other international organizations, as well as the good political will of the Government of Tanzania. Despite the recorded achievements, some areas for improvement have been identified.

REFERENCES

[1] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

[2] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, 1990 Recommendations of the International Commission on Radiological Protection, Publication 60, Pergamon Press, Oxford and New York (1991).

[3] UNITED REPUBLIC OF TANZANIA, Atomic Energy Act No. 7 (2003).

[4] UNITED REPUBLIC OF TANZANIA, Atomic Energy (Protection from Ionizing Radiation) Regulations (2004).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA-TECDOC-1344, IAEA, Vienna (2003).

[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources: Guidance on the Import and Export of Radioactive Sources, IAEA, Vienna (2005).

DISCUSSION

R. JAMMAL, Group B moderator (Canada): Could you say more about the sources found in your country?

W.E. MUHOGORA (United Republic of Tanzania): Most had been used in industry, and they were intercepted during illicit trafficking. A few were imported, for medical and industrial uses, before our radiation protection legislation was passed, so there were no contracts for their management after their useful lifetimes.

SAFETY AND SECURITY OF RADIOACTIVE SOURCES: SHARING THE EXPERIENCE

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The Code of Conduct on the Safety and Security of Radioactive Sources[1] serves as guidance to States for the development and harmonization of policies, laws and regulations on the safety and security of radioactive sources. The Code of Conduct applies to all radioactive sources that may pose a significant risk to individuals, society and the environment.

The Turkish Atomic Energy Authority (TAEA) is the regulatory body of Turkey in radiation and nuclear safety. All radiation and nuclear related activities are regulated and registered/licensed by TAEA. The import, export and transport of radiation sources are strictly regulated. All radiation sources are inspected and licensed, and the licence is issued for a five year period, after which it must be renewed. Maintaining a high level of safety and security of radioactive sources is one of the main tasks being performed. Some of the related activities are given in this paper.

The new criminal law also includes three articles concerning radiation. According to the new criminal law, any person responsible for the uncontrolled exposure the radiation or for a malicious act involving radiation will be sentenced to jail.

Since Turkey is a large importer of scrap metal, TAEA imposes the use of radiation detection equipment for all scrap smelting factories and all harbours, and the entrances of scrap metal smelting factories are equipped with radiation detection instruments. Moreover, border gates are also equipped with radiation detection equipment to prevent illicit trafficking of nuclear and radioactive materials.

Cooperation with the other parties involved is one of the main concerns of the activities being carried out. Some customs and police staff members are being trained, and some staff are taking part in international training courses.

Radiation safety committees have been established in all the universities to trigger the improvement of the radiation safety culture, and workshops have

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[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).

been organized to share experience. Training materials (brochures, films, posters) have been prepared and distributed.

Radioactive waste is treated, conditioned and stored in a safe and secure condition. Draft legislation on the management of non-fuel-cycle radioactive waste has been prepared.

International cooperation is being supported. Turkey is also involved in the IAEA's technical cooperation programme, and there are ongoing projects. One of them, related to the scope of the Code of Conduct, is the project on Implementation of National Strategies for Regaining Control over Orphan Sources.

DISCUSSION

N.E. ABU TALIB (Jordan): What do you do if you discover radioactive material in scrap at your border crossings?

T. ÖZDEMIR (Turkey): We either return the radioactive material to the country of origin or put it into safe and secure storage at a radioactive waste management facility.

UKRAINIAN REGULATORY AUTHORITY POLICY FOR REDUCING THE QUANTITY OF RADIATION SOURCES REQUIRING PROCESSING, STORAGE AND DISPOSAL IN UKRAINE

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Abstract

The problem of the safe management of disused radiation sources generated from the use of radionuclides in industry, research and medicine is very important for Ukraine. The paper discusses some methods of solving this problem. These methods can be considered preventive and are aimed at developing and implementing an appropriate national regulatory policy in the sphere of activities with sealed sources. This policy includes a wide spectrum of measures, from political steps to the creation of a State computerized inventory system, and leads to a reduction of the quantity of radiation sources that require processing, storage and disposal in Ukraine. The content, purpose and phases of realization of each component of this policy in Ukraine are discussed.

1. INTRODUCTION

According to estimates by Ukrainian regulatory authorities, more than 80 000 sealed radiation sources are in use in the country. The overwhelming majority of them were produced in Russia and have been in operation for 5–20 years. Since the technical specifications for sources that are produced in Russia establish the longest term of their use independently of their technical condition, thousands of such sources annually should be withdrawn from operation and be transferred to disposal facilities or to production plants for reprocessing. Ukraine has no enterprises for producing sources; therefore the possibility of Ukraine reprocessing disused sources on its own is excluded. Now Russian manufacturers do not accept disused sources for reprocessing from abroad, so the quantity of sources that need to be disposed of at Ukrainian disposal facilities has appreciably increased.

2. MAIN COMPONENTS OF REGULATORY POLICY FOR REDUCING THE QUANTITY OF RADIATION SOURCES REQUIRING PROCESSING, STORAGE AND DISPOSAL IN UKRAINE

Taking into account that the projects and technologies of disposal for disused sources in Ukraine are out of date and that their modernization will require significant time and capital financing, the regulatory authority should form a new policy concerning activities with radiation sources. The basic components of this policy are the following:

(a) Creation of an effective inventory system for radiation sources, their location and technical state.
(b) Licensing of activities with sources.
(c) Conclusion of bilateral agreements with the States that are basic suppliers of sources to provide the legal basis for return of the sources to the enterprises/manufacturers.
(d) Establishment of restrictions for import into Ukraine of sources without the obligation of the supplier (enterprise/manufacturer) to take back the sources on demand of the user.
(e) Improvement of the efficiency of use of the sources that are already in use in Ukraine, by means of the creation of a database that will be accessible for potential consumers. Such a database should contain information on sources that are not being used by their present owners but that could be used in the future.
(f) Creation of a system for re-examination of sources in order to extend the terms of their use.

This policy does not include the replacement of radioactive sources by radiation generators where possible, though for Ukraine this is more a financial problem than a regulatory one.

3. REGULATORY MEASURES

3.1. Creation of a State computerized inventory system

One of the important elements that allow the regulatory authority to plan and to carry out the policy directed towards reducing the quantity of disused sources is the system for accounting of radiation sources and checking their location. In accordance with a governmental decision, such a system is now being developed in Ukraine in the form of the State register of sources [1]. It is planned that this system will allow the supervision of the location of each registered source. Further, if the registered number of a source is known, this system will allow the owner of the source to be identified in the event that the source is discovered in illicit trafficking.

This system will provide an account of sources that are in working order but are no longer being used by their owners, and these sources may be sold to other enterprises. Such an exchange of sources within the country will contribute to reducing the entry of new radioactive substances into Ukraine. In addition, the register of sources is intended to promote reduction of the quantity of orphan sources and sources which are in illicit trafficking [2].

Planning for the quantity of sources that will be transferred to disposal facilities in the future will also be made possible by using the database of the register. This prognosis is important for planning the construction of new facilities for conditioning and disposal of spent sources.

3.2. Bilateral agreements

In order to restrict the accumulation of disused sources in Ukraine, it would be logical to conclude a special agreement with the Russian Federation concerning the return of disused sources to the enterprises that produce and reprocess such sources. The Government of Ukraine has given this commission to the Ministry of Industry and to the Ministry of Foreign Affairs. At the same time, the regulatory authority is to establish the requirements for the Ukrainian suppliers of radioactive sources concerning the conclusion of contracts for the import of sources into the country only with the obligation of the foreign enterprise (supplier) to accept the return of disused sources. It is proposed to apply such a requirement to Category 1 and 2 sources according to the categorization in the Code of Conduct on the Safety and Security of Radioactive Sources [3]. Such a requirement relates to Code of Conduct principles concerning:

— Encouraging the reuse or recycling of radioactive sources, when practicable and consistent with considerations of safety and security (para. 14 of the Code of Conduct);
— Allowing for re-entry into its territory of disused radioactive sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer authorized to manage the disused sources (para. 27 of the Code of Conduct).

3.3. Extension of the term of use of sealed sources

Another way to reduce the quantity of sources that require disposal is to extend the term of their use. The sources' radiation characteristics relevant to their further use in devices or technological processes can be put to the test by checking their leaktightness and other properties that are important for confirmation of the safety of further use. The regulatory authority is now elaborating an appropriate procedure based on Ukrainian standards that are suitable for certification of production. According to this procedure, in order to make a decision about extending the working life of a source, realization of the following measures is assumed:

(a) Assignment of the service centres that will carry out all sets of tests for the recertification of sources;
(b) Test of source tightness (leakage test);
(c) Test of other characteristics of sources according to the full schedule stipulated by the technical specifications of the manufacturer;
(d) Leakage test of the source after each kind of test;
(e) For those sources whose characteristics meet the accepted safety requirements, setting of a new term of operation that should not be longer than half the term originally established by the manufacturer;
(f) Issuing of the certificate for the source;
(g) Providing of periodic technical supervision of sources in situ.

Such a procedure, despite its relative complexity and the necessity of providing the service centres with special protective equipment, will allow the regulatory authority to be sure that, provided periodic leakage testing of sources in situ is performed, such sources can be used with an acceptable level of safety.

4. CONCLUSIONS

Implementation of all the measures mentioned above will give the regulatory authority the possibility to realize the policy of preventing the import into the country of an unnecessary quantity of sources, as well as reducing the number of sources that will require disposal.

REFERENCES

[1] HOLUBIEV, V., "Inventory of radiation sources in Ukraine", paper presented at Regional Seminar on Approaches and Practices in Strengthening Radiation Protection and Waste Management Infrastructure in Countries of Eastern Europe and the Former USSR, Bratislava, 1998.

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, The Safety of Radiation Sources and the Security of Radioactive Materials, GOV/1999/16, 25 Feb. 1999.

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).

SAFETY AND SECURITY OF RADIOACTIVE SOURCES IN URUGUAY

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Uruguay is not a nuclear country. There is no nuclear material and the radioactive sources are all imported. About 80% of the sources are for medical applications, 16% for industrial applications and 4% for other applications, such as research and agriculture.

In March 2004, Uruguay gave its support to the new Code of Conduct on the Safety and Security of Radioactive Sources, and in December 2004, an agreement was signed between the National Nuclear Authority and the National Customs taking account of the guidelines of the Code of Conduct.

The introduction to this agreement states: “For the execution of the present Cooperation Agreement, the parties will always consider the Code of Conduct on the Safety and Security of Radioactive Sources according to their possibilities and within the limit of their respective attributions.”

In April 2005, Norm UY 117 on Uruguay’s new Categorization of Radioactive Sources and Practices, based on IAEA-TECDOC-1344 and the Code of Conduct, was approved.

The National Nuclear Authority controls all matters related to import and export, and in that field work is being carried out according to the section entitled Import and Export of Radioactive Sources (paragraphs 23–29) of the Code of Conduct, and the Guidance on the Import and Export of Radioactive Sources.

In spite of the fact that in Uruguay all the sources are under regulatory control, the National Regulatory Authority is focusing on the development and implementation of a National Plan for Regaining Control, to prevent sources from becoming orphaned.

In Uruguay it is understood that the way to achieve continuous control of radioactive sources is through the permanent upgrading of the national regulatory infrastructure, and that is Uruguay’s national strategy.

Three milestones in this national strategy are:

— Permanent upgrading and updating of the regulatory body in accordance with the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources;

— Control of import and export according to the Code of Conduct and its guidelines;
— Consolidation of the security of the national radioactive waste storage.

The following IAEA related projects are under way in Uruguay:

— Model Projects RLA/9/041–944;
— Project RLA/9/050 (from 2005);
— Development of a national strategy based on IAEA-TECDOC-1388, Strengthening Control over Radioactive Sources in Authorized Use and Regaining Control over Orphan Sources: National Strategies.

DISCUSSION

I. USLU (Turkey): In your presentation, you said that Uruguay's radiation protection legislation was prepared in 2002. That is surprisingly late. After all, Uruguay is a party to ARCAL (Cooperation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean). Why was the legislation prepared so late?

A. NADER (Uruguay): You would have to put that question to my predecessors. I did not take up my present position until 2001, the year in which Uruguay started participating in one of the IAEA's model projects for upgrading radiation protection infrastructure.

A.J. GONZÁLEZ (Argentina): I would mention that Uruguay was the first country in the world to adopt legislation in the field of radiation protection. The legislation, covering X rays and ionizing radiation from radium, was adopted in the 1920s. However, the regulatory structure established in Uruguay at that time was allowed to deteriorate — a good example of the importance of sustainability. Fortunately, Uruguay has made a great deal of progress in recent years.

THE NRC'S IMPLEMENTATION OF THE CODE OF CONDUCT ON THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES
Revision to the NRC's export/import regulations

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Abstract

The United States Nuclear Regulatory Commission's (NRC) regulations governing the export and import of radioactive material are contained in Title 10, Part 110 of the US Code of Federal Regulations (CFR). The NRC is amending its export/import regulations in 10 CFR Part 110 (Part 110) to reflect recent changes to the nuclear and radioactive material security policies of the Commission and the Executive Branch, and to implement the IAEA's Code of Conduct on the Safety and Security of Radioactive Sources (the Code) for the import and export of radioactive material. The revisions to Part 110 include enhanced tracking of certain exports and imports of radioactive materials through new requirements for specific licences, advanced notification procedures prior to shipment, verification of the recipient facility's licensing status, and review of the adequacy of the receiving country's controls on radioactive sources. The proposed changes to the NRC's export/import regulations in Part 110 apply to radioactive materials when exported or imported in amounts exceeding clearly defined limits. The NRC's limits are based on those contained in the Code, but also include bulk radioactive material. The regulation changes also provide the NRC with flexibility to treat each export and import licence application on a case by case basis, with the ability to accommodate the still evolving domestic and international security measures for radioactive material. The implementation date of this rule would allow a period of six months for exporters and importers to apply for and receive the required specific export and import licences.

1. INTRODUCTION

On 16 September 2004, the United States Nuclear Regulatory Commission (NRC) published a proposed rule for public comment that would amend the NRC's export/import regulations contained in Title 10, Part 110 of the US Code of Federal Regulations (CFR) (Part 110). The public comment period expired on 30 November 2004. The NRC staff is currently considering the comments received and plans to address the comments in a final rule which will be published in 2005. The rule implements the guidance in the IAEA's Code of Conduct on the Safety and Security of Radioactive Sources (the Code) for the import and export of radioactive material, which the USA and many other countries have committed to support and implement. Paragraphs 23–29 of the Code are intended to guide countries in the development and harmonization of policies and laws on certain exports and imports of radioactive sources, which, if handled improperly, pose a safety and security risk to individuals, society and the environment. The Code ensures that such sources are only exported to authorized end users in countries with adequate regulatory controls, and that they are not diverted for illicit use.

2. DISCUSSION

The proposed amendments to Part 110 would require NRC authorization of certain exports and imports of radioactive material by specific licence. Exports and imports of such radioactive sources would take place with the awareness of and prior notification of the NRC and the importing country authority. Exports of the Code's Category 1 quantities of such material would require the prior consent of the importing country. While prior notification to the importing government authority may originate from either the exporting licensee or exporting government authority, consents to the import of Category 1 sources are to be provided on a government to government basis. In cases of exceptional circumstance, such as a health or medical need, the import or export of Category 1 and 2 radioactive material would be authorized by the NRC only if the Commission is satisfied that the recipient is authorized to receive and possess the radioactive material and the importing country has the technical and administrative capability, resources and regulatory structure needed to ensure that the radioactive source will be managed in a manner consistent with the provisions of the Code.

The specific radioactive material and amounts that would be covered by this proposed rule include sealed sources and bulk radioactive material (e.g. spent nuclear fuel shipments which contain quantities of radioactive material covered by this rule). The materials and amounts are listed in a new Appendix P, Table 1, to Part 110. Appendix P, Table 1, is essentially identical to the list of radioactive materials in Categories 1 and 2 in Table 1 of the Code. The threshold amounts are specified in terabecquerels (Tbq), the regulatory standard. Curie values are provided by the NRC for informational purposes only, since the values have been rounded after conversion. With the exception of plutonium, the radioactive materials listed in Appendix P are categorized as by-product material as defined in the Atomic Energy Act of 1954, as amended. Although ^{226}Ra is encompassed by the Code, it is not listed in Appendix P or covered by the proposed regulation because radium, as a naturally occurring radioactive material, is subject to export/import controls administered by the US Department of Commerce. Yttrium-90 has been added to Appendix P as a decay product of ^{90}Sr, consistent with Table 1 of the Code. Appendix P also prescribes the methodology, 'sum of fractions', to be used for calculating the shipment of multiple radionuclides. This methodology is used in 10 CFR Part 71, Appendix A, for calculating the transport of multiple radionuclides.

3. EXPORTS

Under the Atomic Energy Act and Part 110, the principal criterion for approving exports of the materials listed in Appendix P is a finding that the export is not inimical to the common defence and security of the USA. The non-inimicality finding is relevant to both the nuclear proliferation significance of exports and the related security concerns of high risk radioactive material falling into the hands of non-State organizations, including terrorist groups. In making its inimicality determination, the NRC will, consistent with the Code's guidance, consider whether the importing country has the technical and administrative capability and the resources and regulatory structure to manage the radioactive material in a safe and secure manner, and has authorized the recipient to receive and possess this material. Under the rule, the Commission will require the applicant for the export licence to provide the NRC with pertinent documentation demonstrating that the recipient of the radioactive material has the necessary authorization under the laws and regulations of the importing country to import, receive and possess the material. For proposed exports of Category 1 amounts of radioactive material listed in Appendix P, the NRC will also assess whether the government of the importing country has provided its consent to the import.

4. IMPORTS

For imports, the licensing criteria are non-inimicality to the US common defence and security and a finding that the import does not constitute an unreasonable risk to the public health and safety. Since all recipients in the USA must be properly authorized by the NRC, an Agreement State or the Department of Energy to possess such radioactive material, imports under the NRC's licensing authority of radioactive material will simply require: (1) that the US recipient is authorized to receive and possess the radioactive material, and (2) prior notification to the NRC of individual shipments. The NRC will expect the applicant for the import licence to provide pertinent documentation that each recipient of the radioactive material has the necessary authorization to receive and possess this material. For proposed imports into the USA of Category 1 amounts of radioactive material, specified in Appendix P to the proposed rule, and for proposed imports allowed under provisions for exceptional circumstances, the NRC will be responsible for providing the necessary formal US Government consent to the export authority of the exporting country.

5. FLEXIBILITY

The revised Part 110 will provide the NRC with the necessary flexibility to process each application on a case by case basis. For example, the NRC may wish to limit exports to new recipients or to a country/destination with limited experience with its regulatory infrastructure to single shipments of radioactive material. On the other hand, in States with mature regulatory infrastructures with known and competent recipients, the NRC intends to use the provisions of §110.31(e) by issuing broad specific export and import licences for multiple radionuclides, shipments, destinations and authorizations for up to five years or more. The duration of the import or export authorization will be consistent with the expiration date of the recipient's authorization to possess or use the radioactive material. In examining these and other factors that may be pertinent to assessing whether the proposed export will be inimical to the US common defence and security, the NRC may seek the advice of the Executive Branch and will take into account information it receives as part of regular interactions with its foreign regulatory counterparts, the IAEA and the Executive Branch. If, after considering the above information, the NRC authorizes the export, then export licensees will be required to provide prior notification to the importing country authority and to the NRC of individual shipments.

6. PUBLIC COMMENTS

The most significant public comments received thus far relate to one of the following areas:

Comment: Specific licences will adversely affect short turnaround requests that are currently done under general licences.

Response: This concern can be accommodated by the NRC's willingness to issue broad specific export licences to actual and potential users abroad. Depending on the importing countries involved, such licences could be valid for several years.

Comment: The NRC's proposed rule goes beyond the requirements of the Code by including bulk radioactive material and not just radioactive sources.

Response: Bulk material, if left out of the NRC's export/import regulations, would create a major loophole with significant security concerns. While international guidelines do not as yet cover such exports or imports, the NRC does not anticipate any difficulty in processing such export or import requests since they are likely to be rare (compared with radioactive source exports and imports) and each request can be handled on a case by case basis with appropriate interaction between the NRC and the foreign importing State and recipient facility.

Comment: The ability of the receiving countries to upgrade their capability to meet the proposed new export licensing criteria in a timely manner may cause supply disruptions.

Response: The NRC recognizes this uncertainty and plans to address it in two ways: (1) by initiating contact with the NRC's foreign regulatory counterparts in several key countries in an effort to obtain information on their capabilities in handling high risk material, and (2) by anticipating the initial use of the authority to rely on 'exceptional circumstances' to issue any necessary specific export or import licences in order to avoid supply disruptions. However, the NRC will insist that these alternative arrangements must satisfy international security concerns.

Comment: Certain information required by the NRC in connection with the processing of high risk material export and import licences should be withheld from the public owing to security or business proprietary concerns.

Response: Business confidentiality and security requirements will be the same under the proposed high risk material regulations as under the current Part 110 requirements. Exporters can request to withhold proprietary information from the public under the revised rule. The NRC staff will ensure that sensitive security information is not available to the public.

Comment: The NRC's regulations need to be implemented in a harmonized international manner in order to avoid confusion and maintain fair trade for radioactive materials.

Response: The NRC is working closely with the IAEA and the Commission's counterparts in other countries to develop harmonized procedures that would avoid unfair trade issues. Furthermore, the NRC intends to use the provisions for 'exceptional circumstances', where warranted, to maintain a level playing field among foreign and domestic companies.

7. COORDINATION WITH MAJOR TRADING PARTNERS

The NRC will send letters to the USA's major nuclear material trading partners, the IAEA and the OECD Nuclear Energy Agency informing them of the NRC's progress made to date. The letters will also request initiation of dialogue between the NRC and its trading partners on implementation of the Code. The NRC is interested in knowing more about complementary activities which are being undertaken in other countries that have been identified as either an importer of US high risk sources, or an exporter to the USA. To allow for the least impact on ongoing commerce in high risk sources while continuing to enhance security controls, the NRC has requested to receive information on relevant policies and procedures before June 2005.

8. CURRENT STATUS

The NRC is currently considering and developing responses to the comments received on the proposed rule. The NRC plans to resolve the comments and publish a final rule before June 2005. This will allow for a six month implementation period before the December 2005 goal for having the rule fully effective. This will allow licensees to apply for licences well in advance of the rule becoming effective. The NRC will hold public meetings as necessary to ensure that the exporters, importers and other stakeholders are aware of the requirements of the revised Part 110.

THE IAEA'S CODE OF CONDUCT ON THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES: MOVING TOWARDS IMPLEMENTATION WITHIN THE UNITED STATES OF AMERICA

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Abstract

The IAEA's Code of Conduct on the Safety and Security of Radioactive Sources was published in final form by the IAEA in January 2004. The Code prescribes legislative frameworks, regulatory programmes and import/export provisions for IAEA Member States. Following the IAEA General Conference in September 2003 at which the Code was formally adopted by Member States, the United States Government (through the State Department) indicated that it would implement the Code's provisions, even though the Code is not legally binding on IAEA Member States. Because of the mature state of the regulatory programme for commercial uses of radioactive material within the USA, most of the Code provisions applicable to the regulatory programme of the Nuclear Regulatory Commission (NRC) either have already been met or only relatively minor programmatic adjustments are needed to meet them. In two areas, however, programmes are being developed: a national source registry and modification of import/export controls. Development of the National Source Tracking System (NSTS), which will serve as the source registry, has begun. The effort to populate the NSTS is expected to be initiated by late 2006. In the meantime, the NRC has developed an interim database (updated annually) as a precursor to the NSTS. A rule-making effort to modify import/export controls is also under way. Areas of additional attention include the proper management of disused sources (to minimize the potential for their becoming orphaned) and the reuse/recycling of sources. The paper describes the programme of the NRC in relation to the implementation of the Code.

1. INTRODUCTION

The Code of Conduct on the Safety and Security of Radioactive Sources was published in January 2004 [1] by the IAEA. The scope of the Code applies to all radioactive sources that may pose a significant risk to individuals, society and the environment when not safely managed or securely protected.

‘Significant risk’, as used in the Code, refers to severe deterministic health effects, including permanent injury and death.

2. SHORT HISTORY OF THE CODE’S DEVELOPMENT

The IAEA sponsored the first International Conference on the Safety of Radiation Sources and the Security of Radioactive Materials in Dijon in September 1998. The Action Plan which followed this conference [2] led to the publication of IAEA-TECDOC-1191, Categorization of Radioactive Sources [3]. Subsequent IAEA technical meetings and conferences were held to further develop the international framework and posture for the safe and secure management of sources. Key activities included the International Conference of National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Material, held in Buenos Aires in December 2000, and a technical meeting held in Vienna in July 2003. The Buenos Aires conference led to a revised Action Plan [4]. At the time of the July 2003 technical meeting, the IAEA published IAEA-TECDOC-1344, Categorization of Radioactive Sources [5]. Following the terrorist events of 11 September 2001, the source security aspect of these efforts was strengthened. The centrepiece of these efforts became known as the Code of Conduct on the Safety and Security of Radioactive Sources. The July 2003 technical meeting produced the final draft of the Code. This draft was presented at the IAEA’s General Conference and Board of Governors meeting in September 2003. The Code was officially adopted as a result of these meetings. Although the Code has not been enacted in the form of an IAEA convention (and is therefore not legally binding on Member States), many countries have formally indicated their willingness to implement the spirit and letter of the Code. The United States of America has provided such a commitment by letter from the Department of State to the IAEA.

3. SCOPE OF THE CODE AND PROVISIONS OF IAEA-TECDOC-1344

The Code applies to all radioactive sources that may pose a significant risk to individuals, society and the environment. The IAEA has defined five categories of sources in terms of a ‘D’ value. As defined in Ref. [5], a D value is that quantity of radioactive material which has a significant potential to cause severe deterministic health effects if not managed in a safe and secure manner. Annex I of the Code states that it applies to the top three source categories (the highest risk sources) defined by IAEA-TECDOC-1344, i.e. D, 10D and 1000D. These D values are provided in Table I of annex I. The Code's scope is further limited to Categories 1 and 2 for the national source registry and to import/export provisions.

IAEA-TECDOC-1344 ranks sources in terms of potential risk associated with malevolent use, considering the normal quantity used in various applications:

— Category 1: radioisotope thermoelectric generators, irradiators, teletherapy...
— Category 2: industrial radiography, high dose rate brachytherapy...
— Category 3: fixed industrial gauges, well logging...

Malevolent use considers radiological dispersal devices (RDDs) and radiological exposure devices (REDs). The top three categories can result in severe deterministic effects, including permanent injury (Category 3 sources) and even death (Categories 1 and 2).

4. PRINCIPAL FEATURES OF THE CODE

The Code prescribes an infrastructure in terms of legislative elements and regulatory programmes to be developed and promulgated by regulatory agencies within all Member States, ranging from developing countries to those with mature programmes. The Code is divided into 23 general principles, 13 principles for legislation and regulations, 36 principles which apply to the regulatory body and 7 principles for the import and export of radioactive sources. All principles are directed towards ensuring that an adequate legislative programme exists to support a regulatory programme which ensures that sealed sources are managed and controlled in a manner that minimizes the potential for unsafe management and malevolent use.

5. CHALLENGE OF CODE IMPLEMENTATION: WITHIN THE USA

Although the programmes of the Nuclear Regulatory Commission (NRC) and 33 Agreement States are reasonably mature, additional attention is needed, primarily from a security perspective, to ensure that provisions of the Code will be met. The areas needing the most attention include the following:

— Development of a national source registry;
— Modifying import/export programmes to ensure that additional measures prescribed by the Code are in place;
— Improving control over orphan sources, including promoting awareness of orphan source issues amongst external stakeholders;
— Management of disused sources, including the establishment, where applicable, of agreements for the return of such sources to the manufacturer;
— Continued promulgation of Additional Security Measures to licensees possessing sealed sources in quantities of interest (irradiators and manufacturers/distributors have been completed as of December 2004).

Regarding the development of a national source registry, the NRC, in cooperation with the 33 Agreement States, developed an interim database of licensees possessing IAEA Category 1 and 2 sources as of mid-2004. This database was intended to be a ‘snapshot’ of material actually possessed at the time compared with licensed authorizations. The database is being updated during 2005 and 2006. It will serve to meet the US commitment for a national source registry until the Web based National Source Tracking System (NSTS) is operable, beginning in late 2006 to early 2007. The NSTS will include individual Category 1 and 2 sources possessed by each licensee and will be required to be updated following the acquisition, transfer or disposal of a source.

The regulatory infrastructure for source imports and exports is being codified through a rulemaking to 10 CFR Part 110. This rule will require specific licences (currently a general licence is sufficient in most cases) for the import or export of IAEA Category 1 and 2 sources. Notification of the receiving country will be required for movement of such sources. In addition, the prior consent of the receiving country will be required for Category 1 sources. The Part 110 rule was published in the Federal Register for public comment on 16 September 2004. It is scheduled to be published in final form in December 2005.

The NRC’s efforts to improve control of orphan sources and to manage disused sources have two principal components: (1) keeping sources from becoming orphaned by maintaining control; and (2) recovering sources that become orphaned. The NRC’s efforts in the control of sources have several facets. First, the General License Tracking System was initiated in 2002. This increased tracking and licensee awareness of generally licensed sources. Secondly, the final rule on portable gauges (under development) should increase control of portable gauges in field situations. Thirdly, as previously mentioned, the NSTS, which will be operational in late 2006 to early 2007, will increase tracking and NRC awareness of materials of concern. Finally, the

NRC's Lost Source Enforcement Policy (2001) provides an incentive to ensure proper control, transfer and disposal of sources by ensuring that civil penalties outweigh the costs of direct disposition. Civil penalties are assessed at three times the cost of authorized disposal in order to encourage proper management.

Sources that become orphaned are handled by one or more of several approaches. First, there is a Trilateral Initiative between the USA, Mexico and Canada which was signed in 2002. This initiative provides for notification when sources are lost or stolen near a common border. Secondly, the US Department of Energy's (USDOE) Offsite Source Recovery Program, which has been in effect since 1990, provides for the recovery of unwanted sources with no disposal pathway (primarily greater than Class C — 10 CFR 61.55 — or near those values). During 2002–2004, the USDOE recovered 5000 sources at the request of the NRC. Such requests are facilitated by a Memorandum of Understanding with the USDOE on Management of Sources (June 1999). Thirdly, the NRC provides financial support to the Conference of Radiation Control Program Directors in their National Orphan Radioactive Material Disposition Program. Finally, the NRC fosters an open forum for individuals who find a source to come forward. The NRC believes that "Non-licensees who find themselves to be in possession of radioactive sources that they did not seek to possess should not be expected or asked to assume responsibility and cost for exercising control or arranging for their disposal."

Additional Security Measures (ASMs) have been promulgated by NRC Orders issued to panoramic irradiator licensees (June 2003) and source manufacturer/distributor licensees (January 2004). These ASMs require background investigations, protecting sensitive information, licence verification, protecting shipments and transfers (domestic), and establishing means for intrusion detection and response. They also require the establishment of a security zone or zones, means for access control, coordinating with local law enforcement authorities to ensure a timely response when needed, conducting background investigations for certain employees and protecting sensitive unclassified information. Similar security measures are being developed for medium priority materials licensees.

6. CONCLUSION

The existing NRC programme, as enhanced by security improvements since 11 September 2001, largely meets the provisions of the Code, except for additional import/export controls which are scheduled to be completed by

December 2005. In addition, the NRC is developing a National Source Tracking System which will provide improved long term monitoring.

REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).
[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Proposed Action Plan for the Safety of Radiation Sources and the Security of Radioactive Materials, Attachment 2 to GOV/1999/46-GC(43)/10, IAEA, Vienna (1999).
[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA-TECDOC-1191, IAEA, Vienna (2000).
[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Revised Action Plan for the Safety and Security of Radiation Sources, GOV/2001/29-GC(45)/12, IAEA, Vienna (2001).
[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA-TECDOC-1344, IAEA, Vienna (2003).

DISCUSSION

T. VIGLASKY (Canada): How will the NRC consolidate the regulatory oversight exercised by Agreement States and non-Agreement States in order to achieve a comprehensive national regulatory programme?

P.K. HOLAHAN (USA): Although we relinquish authority to the states, we ensure that they comply with NRC regulations.

We have issued orders to NRC licensees and Agreement State licensees with high risk sources, and both the interim database and the future NSTS will include information from NRC licensees and Agreement State licensees.

A. JOUVE (France): As the NRC has no jurisdiction over accelerator produced sources, how does it enforce regulations in the case of such sources?

P.K. HOLAHAN (USA): There is currently legislation before the US Congress seeking authority for the NRC to regulate naturally occurring and accelerator produced radioactive material (NARM), specifically ^{224}Ra (the only source listed in the Code that the NRC does not have regulatory authority over).

The states have regulatory authority over accelerator produced sources.

TECHNICAL SESSION 1: CONCLUDING DISCUSSION

Chairperson

W. STERN
United States of America

Group A Moderator

R. CZARWINSKI
Germany

Group B Moderator

R. JAMMAL
Canada

TECHNICAL SESSION 1: CONCLUDING DISCUSSION

W. STERN, Chairperson (United States of America): I invite the moderators of today's two working groups to summarize their conclusions, which will be incorporated into the findings of the conference. I call upon Ms. Czarwinski to present her summary of the Group A discussion, and participants in both discussion groups to comment afterwards.

R. CZARWINSKI, Group A moderator (Germany): Our group had a good, effective discussion, which yielded proposals for ongoing and future work. Eleven presentations from different countries represented a broad spectrum of the efforts, results and achievements concerning the implementation of the Code of Conduct on the Safety and Security of Radioactive Sources. While some countries have found the implementation unproblematic, a few are still at the beginning. These countries need our help.

We discussed 'security versus safety' at length and agreed that security is really part of safety but that better definitions of the two and their interrelations are needed, which should be a future task. We discussed the registry of radioactive sources (not nuclear material) and the cradle to grave principle. The problem of establishing a central national registry was recognized as being less one of developing than of developed countries, which have large numbers of sources in use. We had a long discussion on the financial provisions concerning orphan and disused sources, for which we agreed that the IAEA should develop further advice and requirements. How can we proceed? Should the IAEA create a fund? Are there any other proposals that would reach international consensus?

We also discussed experience sharing between regulatory bodies with different levels of implementation of the Code of Conduct, and agreed that the status of implementation should be reviewed every three years through national board representation. Now the next step should be a meeting held within three years that should be the basis for a decision as to whether the Code should become binding. Here we can learn from the discussions held on the Nuclear Safety Convention and the Joint Convention.

Security as part of safety was intensively discussed and — although you cannot cover total protection against malicious use in legislation — we thought that the main scenarios should be covered in laws and regulations. We also agreed that, ideally, there should be only one national regulatory authority with responsibility for the safety and security of radioactive sources, though this was difficult to realize. Also, the problem of confidentiality was discussed with regard to where it can do more harm than good, such as in obstructing emergency preparedness and response, and in allowing self-styled safety/security experts without experience to operate.

Finally, a key question, which I would like to put to Mr. McIntosh, is: How is the interpretation of the import/export Guidance of the Code of Conduct related to exporting countries evaluating importing ones?

S. McINTOSH (Australia): I understand your question as: How is the exporting State to evaluate the adequacy of the importing State's regulatory infrastructure? The Guidance suggests that the exporting State take three factors into account: the answers to the questionnaire at the end of the Guidance; whether the State has written to the Director General, as requested; and whether the State is participating in the model project and how far it has progressed.

Moreover, the Guidance stresses consultation. That means that if the exporting State is unsure as to whether the importing State has the capacity to safely manage sources, it should contact the counterpart organization. The Code of Conduct and the Guidance advise States to provide points of contact so that information exchange on legislation, personnel skills and so on can be facilitated to help the exporting State reach its decision. That is where the greatest potential for differential application by exporters lies. I hope that a peer review system can soon be instituted to enable IAEA missions to assess, possibly in a similar way to TranSAS, the regulation of a country's sources, and to make the appraisal results available to Member States to assist them in building consistent guidelines. Periodic meetings like this one can provide an opportunity for wide discussion on how countries are implementing the Code, and people can make their own judgements. That is one of the reasons we are here.

K. MRABIT (IAEA): Regarding peer review of regulatory infrastructure effectiveness in importing States, we do have a methodology based on international standards, the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS). In the Guidance to the Code of Conduct, there is a reference to Milestone 1 or thematic safety area 1. This means it has been checked that the importing country has legislation and regulations; systems of notification, authorization and inspection; and an inventory of radioactive sources — all based on the BSS and also on legal and governmental infrastructure requirements. This methodology has been established and validated. Member States, on request, can receive peer reviews to make that assessment. At the same time, we are promoting self-assessment, the methodology for which is available to Member States. The results of a self-assessment or peer review could be used to check whether the regulatory infrastructure is effective or not, to answer the questionnaire in the Guidance to the Code of Conduct.

S. McINTOSH (Australia): The model project and its successors provide a mechanism for participating States, which means most developing Member States of the IAEA. However, there are still a number of States that are not IAEA Member States, and assessing the sufficiency of their regulatory structure will be a difficult job.

S.B. ELEGBA (Nigeria): Possibly the exporting country may not be as prudent as expected. Therefore it is necessary also for the importing country to evaluate the exporting country. The exporter may not be the manufacturer and the regulatory body may not be aware of the transaction. Moreover, some countries have no disposal facilities for disused sources. This is the case in Nigeria, so we need to ensure that they are returned to the exporter or manufacturer.

W. STERN, Chairperson (USA): That is certainly true. I am aware that some regulators and some national laws stipulate that sources may not be imported without an agreed disposal path. You made an excellent point — that it is within the scope of the importer to insist on that requirement.

One of Ms. Czarwinski's first findings was that there was a need for more cooperation and assistance. Was any of the discussion more specific, for example about what type of assistance or whether the existing assistance programmes related to the Code of Conduct were adequate or needed to be accelerated? You also mentioned that there needed to be more interaction between regulators. The European Union has its 'concert group' where east and west exchange information. Possibly similar exchange groups could be created where different countries could, more often than every three years, exchange information, regionally or globally, on implementation of the Code and associated regulatory activities.

R. CZARWINSKI, Group A moderator (Germany): There were some proposals that should be discussed and put into practice. One was to have a group, like the Ibero-American Forum, based on common interests such as regional or linguistic. Another was to have bilateral cooperation between countries with different levels of implementation.

W. STERN, Chairperson (USA): Can the IAEA do something to follow up on this?

R. CZARWINSKI, Group A moderator (Germany): Of course, the IAEA conducts its peer reviews and other missions to help those countries. In addition, it could help to create such a forum, which would then run independently.

A.J. GONZÁLEZ (Argentina): A very important proposal was that the IAEA convene a meeting — with a format similar to that used for the Nuclear Safety Convention or the Joint Convention — of all countries that have endorsed the Code of Conduct. They should produce national reports on what they have done, which should be appraised by the meeting. This would be concrete action on the part of the IAEA.

W. STERN, Chairperson (USA): A number of people have commented in favour of such action, which is a process for implementing the Code of Conduct short of making it legally binding. On the surface, this seems very reasonable. In the interim between these reviews to be held at intervals of three to five years, is there a way that the IAEA could help spur less formal interaction between regulators? Some activity is already going on. How can the IAEA help to coordinate this and ensure that the initial discussion proceeds to actuality?

I. OTHMAN (Syrian Arab Republic): Seventy-two countries have endorsed the Code of Conduct in one year although — but also because — it is not legally binding, i.e. because they do not have to undergo a lot of complicated national procedures in order to join. A second reason is that many countries, with the help of the IAEA, have acquired the foundation for some of the legal requirements and for related activities such as monitoring. The IAEA should not go the 'hard' way. Since 11 September 2001, interest has been clearly focused on the possible malicious use of sources. The Code, through a flexible procedure, has been supporting that interest. If we continue this way, I think, with all due respect to lawyers, that we shall have more success than by making it legally binding. Having 72 countries exchange information and conduct peer reviews will attract other countries to apply the Code. Also, we should remember that countries with about one third of the world's population do not need the Code because their use of radiation is negligible.

W. STERN, Chairperson (USA): I think you are right: There's a trade-off. Had we pursued a legally binding agreement at the outset, we would not have 72 countries adhering; perhaps even many of the larger ones would not have endorsed it. I can conclude the discussion by saying that most of today's questions have been resolved. I now call upon Mr. Jammal to present his summary of the Group B discussion.

R. JAMMAL, Group B moderator (Canada): Our session started with countries' presentations, followed by open discussion covering a variety of topics. In the presentations, new regulatory issues due to the implementation of the Code of Conduct came to light. Sources were found when registries were established and source tracking came into effect, as did import/export controls. A need was found for national regulatory infrastructure upgrades in order to implement the Code. Engagement and participation in IAEA regulatory improvement programmes were active and well appreciated. Collaboration and initiatives existed at bilateral, trilateral and regional levels. It was found that in import/export, sometimes the importer became the exporter regarding the acceptance or refusal of sources from the country of origin.

In the discussion, overall there was concern about the end-of-life-cycle management, including storage, financial provisions and responsibility. (Users are responsible, but when not available, what is the role of the regulatory body?) There was a detailed discussion on dealing with orphan sources — on prevention, costs, detection, containment and disposal.

Training and education of the public and of government agencies were discussed. There was a call for collaboration with other law enforcement agencies or regulatory bodies and for initiating related discussion on the national, regional and international levels. There was discussion about the apprehension of manufacturers and exporters regarding implementation of the import/export Guidance and about approaches taken by regulators to put them at ease.

We found no magical balance to resolve the issues of confidentiality versus provision of information, or of safety versus security. Finally we discussed the pros and cons of sustaining the current momentum of the Code of Conduct with governments vis-à-vis making it a binding convention, and the timing of such a step.

W. STERN, Chairperson (USA): I would like to open the discussion to the floor. In particular, I would be interested to know if Mr. Jammal's summary is adequate — if there are any missing elements or inaccurate representations — and also to hear any other comments. First, I have a question. You mentioned that the group had commended the IAEA for its regulatory assistance programme, which I assume meant the model project that has recently changed names. Last year, the IAEA General Conference endorsed a vision for the model project that would lead to its expansion and upgrading to address all elements in the Code of Conduct, including security, which was a major step and illustrates how the Code has become a cornerstone of our efforts. Was there any discussion on this upgrading process?

R. JAMMAL, Group B moderator (Canada): Thanks were expressed for the model project, through which Member States built their regulatory infrastructure as such. Comments were made on the need for the model project to be upgraded to facilitate implementation of the Code of Conduct. We did not go into greater detail.

W. STERN, Chairperson (USA): So, according to the discussion, the ball is back in the IAEA's court to take the necessary steps to upgrade the model project. Perhaps at the next conference, there will be additional comments on the adequacy of those steps.

S. McINTOSH (Australia): I have some sympathy for the IAEA here. The Code of Conduct has set out the principles — the bones — of the obligations regarding source safety and security, but the flesh on those bones is the detailed guidance, which is still in draft form and needs to be finalized and agreed on with the IAEA before the Department of Technical Cooperation can be expected to incorporate it into the model project.

M.S. KRZANIAK (International Organization for Standardization): Our session also considered the implementation of the Code of Conduct's disposal provisions for disused sources and the concept of a level playing field with regard to export control. These are significant issues limiting the harmonized implementation of the Code. Could Mr. Jammal comment on them?

R. JAMMAL, Group B moderator (Canada): The level playing field of the Code of Conduct was brought up from the viewpoint of consistency of implementation. We are as strong as our weakest link, an issue present from day zero of the Code. The question that arose regarding import/export control was: If an exporting country refuses to supply a Member State, what guarantees are in place to ensure that no other supplier will provide the importer with the sources?

NATIONAL STRATEGIES AND EXPERIENCE FOR REGAINING AND MAINTAINING CONTROL

(Technical Session 2)

Chairperson

A.-C. LACOSTE
France

SUPERVISION OF RADIOACTIVE SOURCE SAFETY IN CHINA

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Abstract

The paper presents recent work in China related to radioactive sources, including the setting up of a legal infrastructure for radioactive source safety, the establishment of supervision organizations, a special action to check radioactive sources and the establishment of a regulatory authority information system.

1. INTRODUCTION

With the flourishing economic development in China, radioactive sources have been increasingly utilized in a wide variety of fields, such as industry, agriculture, scientific research and teaching. By the end of 2004, there were more than 14 000 facilities nationwide with more than 102 000 sources. In addition, there are 26 300 waste radioactive sources to be disposed of, among which 2000 are orphan sources [1]. It is estimated that the number of radioactive sources is increasing at a rate of about 10% every year in China.

During the 11 years from 1988 to 1998, 323 radiological accidents occurred in China, an average of about 30 cases each year. Among these accidents, theft and loss of radioactive sources accounted for up to 80% [2]. In recent years, the Chinese Government has given much attention to reducing the frequency of radiological accidents. So, granted by the government, a great deal of work was conducted on radioactive sources, for example compiling the law on supervision of radioactive source safety, setting up supervision organizations and hiring staff, and establishing the regulatory authority information system on radioactive sources. All of these actions have improved the level of safety management for radioactive sources.

2. BUILDING THE LEGAL INFRASTRUCTURE FOR RADIOACTIVE SOURCE SAFETY

The Chinese legal infrastructure for supervision of radioactive source safety was divided into five levels, i.e. the national law, State Council regulations, ministry regulations, standards and guides, and technical documents.

2.1. National law

The People's Republic of China Law on the Prevention and Control of Radioactive Pollution was adopted on 28 June 2003 at the third session of the tenth National People's Congress Standing Committee. It is the first law on radiation safety. The purposes of the law are to prevent and control radioactive pollution, to protect the environment and human health, and to promote the development and peaceful utilization of nuclear energy and nuclear technology. The National Nuclear Safety Administration (NNSA) of the State Environmental Protection Administration (SEPA) was authorized to implement inspection of the unified regulations on radioactive pollution prevention, and to control work in the whole country in accordance with this law, including the manufacture, import/export, sale, use, transport, storage and disposal of radioactive sources, as well as to establish a national regulatory authority information system on radioactive sources [3].

2.2. State Council regulations

In accordance with the People's Republic of China Law on the Prevention and Control of Radioactive Pollution, work was begun to modify the Regulations on Radiation Protection for Radioisotope and Irradiation Apparatus issued in 1989. Many requirements in the IAEA Code of Conduct on the Safety and Security of Radioactive Sources are assimilated in the new version. The new rules have the following characteristics:

(a) Uniform supervision. The competent environmental protection administrative department under the State Council takes charge of the uniform supervision of the safety of radioactive sources nationwide.
(b) Whole process supervision. The 'whole process' means steps such as producing, importing/exporting, selling, utilizing, shipping, storing and

disposal. Thus whole process management is management ‘from cradle to grave’.

(c) Classified management. Radioactive sources are managed according to source category, which follows the principles of the IAEA’s Categorization of Radioactive Sources [4].

(d) Licence management. Those facilities engaged in the manufacture, import/export, sale, utilization, storage and disposal of radioactive sources must obtain licences according to the relevant law. No facility may hold radioactive sources without a licence. Facilities should set up a safety organization and train the workers in source safety and protection.

(e) Import and export management. Imported radioactive sources must be authorized by SEPA beforehand, and in the case of imported radioactive sources of Categories 1–3, the exporter must promise to reclaim the disused sources.

(f) Identity management [5]. Radioactive sources should be coded uniformly by the State. It is forbidden to produce, import, export, sell, use and store radioactive sources without identification.

(g) Recording and registering management. Any activity such as the manufacture, import/export, sale, transfer and disposal of radioactive sources must be recorded with the regulatory authority within a limited time.

(h) Managing abandoned radioactive sources. Unused and abandoned radioactive sources should be sent to a special repository in a timely manner.

(i) Collecting and storing orphan radioactive sources. The regulatory authority should establish a procedure to search and collect orphan sources.

(j) Information system. The regulatory authority has set up a national information system related to the supervision of radioactive sources and shares this information with other regulatory departments.

(k) Supervision and inspection. The regulatory authority should periodically inspect licensed facilities with respect to source safety and protection, and take corresponding enforcement actions when a problem is discovered.

2.3. Ministry regulations

SEPA compiles corresponding administrative rules according to the national law and State Council regulations. Five ministry regulations have been issued, for example the guideline on the management of radioactive source safety and the regulation on managing radioactive source accidents, while another ten department regulations are still being compiled.

2.4. Standards and guidelines

Many technical standards and guidelines related to the safety and protection of radioactive sources have been drawn up in China. Among these, the most important are the Chinese Basic Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources issued in 2002. These standards are based on the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources and on ICRP Publication 60 recommendations, and are closely linked with our relevant practical experiences and regulation situation.

3. BUILDING THE ORGANIZATION AND PERSONNEL RESOURCES FOR RADIOACTIVE SOURCE SUPERVISION

The national and local regulatory authority for radioactive source supervision has now been set up in China. The administrative division for radioactive sources has been set up under SEPA/NNSA, and the Nuclear Safety Centre provides its technical support. Radioactive source supervision organizations and technical support units have been established in 31 provinces of China, and there are more than 1000 trained employees.

4. SPECIAL ACTION TO CHECK RADIOACTIVE SOURCES

In order to implement the unified regulation of radioactive source safety and protection in China, and to improve the level of supervision, SEPA, in association with the Ministry of Public Security and the Ministry of Health, launched a special action entitled Check the Radioactive Sources to Set the Civilian's Heart at Rest. This action aimed at checking the current status of radioactive sources in the country, reclaiming and storing waste radioactive sources safely, mitigating the harm caused by radioactive pollution, setting up an effective regulatory system, promoting the safe utilization of nuclear technology, protecting people's health and maintaining the stability of society. Through this special action, the amount, category and distribution of radioactive sources nationwide were determined; the safety problem of radioactive sources in facilities carrying out manufacture, import, export, sale, transport, storage and disposal was solved by on-site inspection and time limited correction; and many hidden safety problems were eliminated by forcibly reclaiming unused and spent radioactive sources.

5. BUILDING THE REGULATORY INFORMATION SYSTEM FOR RADIOACTIVE SOURCES

In 2004, SEPA established a regulatory information system for radioactive sources. We adopted the RAIS 3.0 of the IAEA and adjusted it according to the local realities of China. The regulatory authorities of each province take charge of inputting data on the radioactive sources in their territory, while the manufacturers report their data periodically to SEPA.

SEPA established a National Data Centre for Radioactive Sources to gather data from provincial environmental protection bureaus and manufacturers. These data are to be analysed, compared and consolidated into a national inventory.

6. FUTURE WORK

A safety regulation system for radioactive sources has been established in China. The ability to secure radioactive sources has been improved. However, the following actions should be taken to achieve still further improvement:

(a) Continue to amend the legal system for radioactive source supervision;
(b) Continue to strengthen the supervision organizations and the supervision capability;
(c) Reinforce control of the import and export of radioactive sources;
(d) Reinforce personnel training and public information;
(e) Improve the safety culture of licensees;
(f) Improve the emergency response capability for radiological accidents.

7. CONCLUSION

The Chinese Government has given increasing attention to radioactive source safety and protection, and we believe that, through the efforts of all the supervision staff, the supervision of radioactive sources in China must be continuously improved.

REFERENCES

[1] STATE ENVIRONMENTAL PROTECTION ADMINISTRATION, Special Action: Check the Radioactive Sources to Set the Civilian's Heart at Rest, 2004.
[2] NATIONAL NUCLEAR SAFETY ADMINISTRATION, Supervision of Radioactive Sources in China, NNSA, Beijing (2004).
[3] People's Republic of China Law on the Prevention and Control of Radioactive Pollution, 2003.
[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA-TECDOC-1344, IAEA, Vienna (2003).
[5] STATE ENVIRONMENTAL PROTECTION ADMINISTRATION, Code for Radioactive Sources, SEPA, Beijing (2004).

DISCUSSION

A.-C. LACOSTE, Chairperson (France): I would like to mention, firstly, that the Chinese administration has recently been reorganized with regard to radiation protection. We will find other cases of such reorganization in later presentations. Secondly, China is conducting a 'work in progress' to regain control over radioactive sources in the country. We shall find also this feature in following presentations.

FRENCH REGULATORY SYSTEM TO CONTROL PRACTICES INVOLVING RADIOACTIVE SOURCES

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Abstract

The French national regulatory control system for radioactive sources has been in place for more than 50 years and was recently updated to take into account European Union requirements. This system relies on a licensing process (for manufacturers, vendors and users of radioactive sources) and a registering process of individual radioactive sealed source transfers between vendors and end users. The key requirements and specific provisions of the French system are: the return to the vendor of any sealed source after use, a maximum use of ten years for a sealed source, and the financial provisions associated with each sealed source. The paper gives a brief overview of the French regulatory framework and the authorities implementing it, as well as the principles guiding the licensing process. The prevention and management of orphan sources, as well as inspection provisions, are also mentioned.

1. INTRODUCTION

France has long been aware of the need to maintain control over radioactive sources to protect human health and the environment. A regulatory body dedicated to this task was established more than 50 years ago.

From an international standpoint, France has been promoting a greater awareness for many years: the 1998 Dijon conference and the 2005 Bordeaux conference, are perfect examples of French initiatives.

This paper gives a brief overview of the French regulatory framework and the authorities implementing it, as well as the principles guiding the licensing process. The prevention and management of orphan sources, as well as inspection provisions, are also mentioned.

2. FRENCH NATIONAL REGULATORY SYSTEM

The French regulatory system has been in place for more than 50 years and was recently updated to take into account the 1996 European Union directive laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation.

The system regulates the whole life cycle of a radioactive source, from its manufacturing (or import into France) until its disposal (or export out of France). Of course, low risk sources are exempted from this system, as the European directive allows.

2.1. Legal and regulatory bases

2.1.1. European framework

Three European directives have been taken into account to establish the revised French regulatory system:

- Council Directive 1996/29/Euratom of 13 May 1996 on basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation;
- Council Directive 1997/43/Euratom of 30 June 1997 on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure;
- Council Directive 2003/122/Euratom of 22 December 2003 on the control of high activity sealed sources and orphan sources.

The first directive establishes the basic norms concerning the sanitary protection of workers and the general public against the dangers arising from ionizing radiation. The main provisions are the following:

- The European Union Member States are required to submit practices involving ionizing radiation sources to a system of reporting and prior authorization; exemption levels are established, especially if the total activity or activity concentration of the source is under values established by the directive.
- The principles of radiation protection for practices must be established (justification of exposure, optimization of protection and dose limitation).
- The Member States must establish a system of inspection to keep under review the radiation protection of the population and to check the compliance with the basic standards.

The second directive supplements Directive 96/29/Euratom and lays down the general principles of the radiation protection of individuals exposed to ionizing radiation for medical purposes. Some of its provisions are:

- Member States shall take steps to avoid unnecessary proliferation of radiological equipment.
- Radiological equipment in use is to be kept under strict surveillance regarding radiation protection, and an up-to-date inventory of radiological equipment for each radiological installation is to be maintained.
- Appropriate quality assurance programmes, including quality control measures, are to be implemented.

The third directive concentrates on the control of high activity sealed radioactive sources and orphan sources. The French regulatory system is currently being modified to comply with this directive, whose main provisions are:

- Member States shall require the holder to obtain prior authorization for any practice involving a source, including taking possession of a source.
- Member States shall ensure, before issuing authorization, that adequate arrangements have been made for the safe management of sources (marking, registration, inventory, record of location and transfer, etc.), including the management of sources when they become disused (transfer of the sources back to the supplier or placement in a recognized installation, obligation for the manufacturer or the supplier to receive these disused sources).

— Adequate provision (financial security or equivalent) must be made for the safe management of sources when they become disused, including the case where the holder becomes insolvent or goes out of business.
— Provision must be established for the detection and the recovery of orphan sources (technical and financial provisions).
— International cooperation must be established, including cooperation for information exchange in the event of the loss, theft or discovery of radioactive sources.

2.1.2. French overall regulatory framework

The French legal and regulatory framework in the field of control and use of radioactive sources is described in the Public Health Code and the Labour Code for provisions related to occupational exposure. These codes were revised at the beginning of the 2000s to take into account the abovementioned European directives (mainly in 2001 for the legal basis, and in 2002 and 2003 for the regulatory basis).

This extensive revision supports and extends the previously existing system: an extension to cover radioactive sources made of natural radionuclides, and an extension to all devices generating ionizing radiation.

Some key provisions of the regulations are:

(a) They put into force a licensing process. A licence is required to manufacture, possess, use, sell, import or export radioactive sources. The licensing process includes the review of basic provisions against source theft (such as storage of sources in a safe while they are not in use) and the review of the user's source inventory. Provisions designed for radiation safety, such as limited access to trained workers, storage in a cabinet or safe of unused sources, and wall shielding, also contribute to source security.

(b) Sealed source transfers between vendors and users or between users shall be registered. This registration:
   — Allows it to be verified that the buyer has the required licence;
   — Is an input to a national register of radioactive sources. The Institute for Radiological Protection and Nuclear Safety (IRSN) is in charge of the management of the national register, as well as the registration process.

(c) A vendor is required under the law to recover used sealed sources on the request of the user or at least ten years after the source was first registered. This requirement is designed mainly to limit the potential for orphan sources. This general rule allows for exemptions and possible requests to extend the duration of use of sealed sources beyond ten years.

(d) Vendors have to subscribe to a financial security fund in order to ensure the proper management of the sealed sources they distribute (e.g. in the case of bankruptcy, where the recovery process mentioned above would no longer be in place). Currently two systems enable vendors to fulfil this regulatory requirement: to give a deposit to the national agency of nuclear waste management (ANDRA) or to join the French vendors association, Ressources.

2.2. French authorities

The authorities in charge of the control of practices involving radioactive sources are the following:

(a) The nuclear safety authority (ASN), which relies on the DGSNR (General Delegate for Nuclear Safety and Radiological Protection) and its regional departments (DSNR), is the main authority that authorizes and controls:
   - On behalf of the ministers in charge of environment and industry, sources used in civil nuclear installations. (For installations concerning defence, this role is taken over by the Delegate for Nuclear Safety and Radiological Protection for Activities and Installations Concerning Defence (DSND) on behalf of the ministers in charge of defence and industry.);
   - On behalf of the minister in charge of health, the manufacturing, distribution and use of sources in industry and for research (except when otherwise regulated by the prefect (local authority representative of the French Government in the French districts — France is divided into roughly 100 districts called ‘departments’));
   - On behalf of the minister in charge of health, the use of sources for medical diagnosis or treatment purposes.

(b) The prefect, if the sources are used in installations classified for environmental protection purposes (Installation Classified for Protection of the Environment, ICPE) and subject to the authorization procedures (this concerns the most dangerous installations).

(c) The French Agency for Sanitary Security of Health Products (AFSSAPS), for the manufacturing and distribution of sources for medical use.

(d) The Delegate for Nuclear Safety and Radiological Protection for Activities and Installations Concerning Defence (DSND), already mentioned above.

The Ministry of Labour has the general duty of regulating safe working conditions at the workplace, including conditions arising from ionizing radiation.

2.3. French technical support body

IRSN plays the role of expert for the different authorities mentioned above, in order to assess security and radiological protection for activities involving radioactive sources.

More specifically, IRSN has the mission of maintaining national databases, such as the national inventory of radioactive sources (the SIGIS computerized database), the national dose registry and the national database for environmental monitoring.

3. PRINCIPLES AND MODALITIES OF PRIOR AUTHORIZATION

According to the Public Health Code, the following activities are subject to prior authorization (except if the exemption criteria apply):

— Manufacturing of radionuclides or of products or devices containing them;
— Distribution of radioactive sources;
— Import or export of radioactive sources;
— Holding or use of radioactive sources.

During the consideration of an authorization request for such an activity, the competent authority pursues the following objectives:

— To verify that the practice is ‘justified’;
— To be sure that security and radiological protection measures are implemented during the use of the sources;
— To notify general or specific prescriptions to be followed by the recipient of the authorization.

The applicant has to establish and submit an application containing the necessary administrative (location, radiation safety officer’s name, etc.) and technical (devices used, environmental impact assessment, etc.) data needed for an evaluation to be made of the applicant’s aptitude to run the intended practice with sound radiation and environmental protection provisions. In the case of a technically complex file, the competent authority can ask for the technical support of IRSN.

After the application is assessed, the authorization is delivered under the form of a ministerial notification or a prefectorial order. Licence conditions include, for example, the maximum activity for each radionuclide held or used in the form of a sealed or an unsealed source, and the purpose of the source's use.

A licence may be issued for a limited time (no more than five years if it is a ministerial notification, but the licence can be renewed on request) or an unlimited time (prefectorial order) if decommissioning provisions are notified to the prefect.

Import and export licences, as well as distribution licences, are issued by AFSSAPS (for medical devices or radioactive sources) or the ASN (on behalf of the minister for health for the other devices and sources).

Each regulator has to forward to IRSN the list of the licences it has issued as inputs to the source transfer registration process.

4. NATIONAL INVENTORY OF SEALED RADIOACTIVE SOURCES

4.1. Source transfer registration

(a) The transfer to or the acquisition by a person of radionuclides (sealed or unsealed sources), as well as of products or devices containing such radionuclides, is forbidden if this person does not have the required prior authorization.

Before each transfer or acquisition of a sealed radioactive source, a registration form must be filled in and sent to IRSN. Specific registration forms are to be used according to the various types of source and transfer. For example:

— A dedicated form is to be filled in for exporting radioactive sources, importing radioactive sources, purchasing sealed sources and purchasing unsealed sources.
— For sealed sources, with a few exceptions, this registration is made for each individual source (or possibly for a batch of identical or calibration sources).

The form must be filled in by the supplier and by the purchaser of the source, both of whom must give the references of the authorization they possess and the characteristics of the source to be transferred.

After registration, IRSN stamps the form and sends back a copy to the purchaser of the source in order to attest that the prior registration of the transfer has been made. In the case of any anomaly (for example an unauthorized person, or an activity higher than the authorized limit), IRSN informs the competent authority for further action and holds back the form until the authority makes a decision.

(b) All information concerning the authorizations delivered to the suppliers and users of sources and all the registrations of movements of sources are kept in a computerized database called SIGIS (Information and Management System of the Source Inventory) managed by IRSN.

Thanks to SIGIS, it is possible to oversee source transfers, create a national inventory and extract statistical data concerning the inventory and the movements of sources, especially to support controls by the competent authorities.

(c) The registration procedure is currently under revision, in order to fully meet the requirements of the new French regulatory framework, and also to comply with the new international recommendations (European Union directive on high activity sources and IAEA publications) concerning the control of import and export of radioactive sources.

4.2. Deliveries by suppliers and holder inventories

In order to confirm the information collected in the SIGIS database through the transfer registration process, the suppliers of radioactive sources must send quarterly to IRSN the list of the sources delivered.

In addition, the holders of sources must send annually to IRSN their inventory of all radiation sources. This provision was established in mid-2003 and is not yet widely effective.

4.3. National inventory: key figures

The national registry of sources is a good tool to obtain an overall picture of all activities involving radioactive sources in France:

- There are 220 licences for suppliers, most of them operating in the industrial sector.
- There are about 6000 licences for practices involving radioactive sealed and unsealed sources for medical, industrial and research purposes.

Each year, about 4000 transfers of sealed sources (from suppliers to end users) are registered by IRSN. About the same number of sources are returned from users to suppliers.

About 30 000 sealed sources are registered in the national inventory:

- The main radionuclides are ^{137}Cs (32%), ^{60}Co (20%), ^{57}Co (12%) and ^{241}Am (12%).
- The major practices relying on these sources are calibration (42%), analytical characterization (10%), industrial irradiation (6%), industrial gauges (27%), medical applications (12%) and industrial radiography (3%).
- About 10% of these sources are either high activity sealed sources according to Directive 2003/122/Euratom or Category 1, 2 or 3 sources as defined by the IAEA categorization scheme.

5. MANAGEMENT OF LOSSES AND THEFTS, AND RETURN OF SEALED SOURCES

The French regulatory framework establishes the preventive and reactive measures to be implemented in the event of loss or theft of a radioactive source and, more generally, establishes the rules aimed at reducing the risk of radioactive sources being abandoned, which could lead to accidental exposures of individuals through acts of carelessness or of malevolence.

5.1. Return of disused sources

(a) In order to prevent all risk of sources being abandoned, each holder of radioactive sources is obliged to return those which are ‘administratively expired’ (ten year limit following its registration at IRSN unless otherwise authorized by the regulator) or for which the owner has no further use, except if the short half-life allows on-site decay. It is mandatory for a supplier to notify IRSN of each sealed source which has not been returned at the appropriate time.

In order to make this measure more efficient, the rules in force oblige the suppliers of sealed sources to accept on request, without any condition, sources that are returned by their end users (useless or no longer valid sources). The supplier may either ask for the removal of the source by an appropriate company or return it to the manufacturer. The supplier must arrange the necessary installations for the temporary storage of the sources up to their removal or their recycling.

(b) Although this system for taking care of the sealed source end of life has been operating since the very beginning of the 1990s, the ASN has decided to review this process as part of a broader initiative called the National Plan for Radioactive Waste Management (PNGDR). This plan is currently being established. Its general goals are to identify the radioactive waste generated in France, to estimate its quantity (activities and volume) and to establish whether disposal processes are in place or need to be created (for example building a disposal facility for long lived sealed radioactive sources).

5.2. Loss or theft of a source, orphan sources

Each holder of radioactive sources has to establish a follow-up system that allows the inventory of the sources to be known at any time, and to justify their origin and purpose. Storage provisions are also part of the licence application, and if necessary, of the licence conditions.

Each holder of sources must immediately notify the prefect of any loss, theft or unauthorized use of a source. The prefect informs the authority who delivered the authorization and IRSN. If necessary, actions are conducted (intervention, police investigation) in order to recover the lost or stolen source.

France owns and operates specific equipment to detect radioactive sources which were never or are no longer under regulatory control. The Commissariat à l'énergie atomique (CEA), IRSN and some private companies have developed capabilities and experience in this field, for example by installing equipment at some border crossings or performing aerial surveys by helicopter.

Despite the processes and features in place to prevent them, incidents or accidents involving radioactive sources may occur. France has capabilities to deal with such accidents and relies firstly on general provisions, for example specifically trained firefighters at various locations across France, and secondly on specialized teams and equipment operated mainly by CEA and IRSN. The national crisis management organization, mainly set up for large nuclear installations, can also be triggered, if necessary, to manage accidents caused by radioactive sources.

If these accidents compromise worker or public health, internationally known medical experts and facilities are available, and the IAEA has previously used these French resources.

6. INSPECTIONS

AFSSAPS issues manufacturing or wholesale distribution licences for medical products and devices containing radionuclides (Council Directive 2001/83/EC of the European Parliament and of the Council of 6 November 2001, and the public health code) and ensures, by inspections, that manufacturing or commercial companies comply with the legal requirements governing medical products such as radionuclide generators, radionuclide kits or medical devices. AFSSAPS could legally suspend or revoke a licence if the manufacturer or the wholesaler does not comply with the public health code or the licence conditions.

From a broader point of view, according to the public health code, the ASN is in charge of the organization of inspections ensuring the control of radiological protection measures in industry and at medical care and research premises, including the follow-up of the radioactive sources used. This is an important provision that was introduced during the reform of the French regulatory framework in 2002 (before 2002, control of the use of sources was implemented only through the system of preliminary authorizations, their periodic renewal and the visa system in the case of transfer of the sources).

As a matter of fact, a specialized inspection force, the radiation safety inspectors, was established by law in mid-2004, and the first inspectors are to be nominated in 2005. They will perform inspections in addition of those already performed by the labour inspectors, who are usually not specifically focused on radiation safety issues.

On-site inspections will allow it to be verified that authorized holders follow the prescriptions that are defined in the authorization that has been delivered and maintain an up-to-date inventory of the sources they hold, similar to the data collected in the SIGIS database.

7. CONCLUSIONS

The French system for the control of radioactive sources is based on three essential pillars:

— Identification of source holders through the system of licensing (prior to the beginning of the practice);
— Oversight of source transfer on French territory through a registration process and a national computerized database (SIGIS);
— On-site inspection in order to verify compliance with the regulatory provisions and the source inventory.

Each pillar has its own importance and the pillars complement each other. In particular, the priority of the ASN and other competent authorities is to establish, at the appropriate level, a comprehensive inspection system which, up to now, has not been sufficiently developed.

One of the advantages of the French system is that for several years it has had a computerized centralized information system for the follow-up of sealed source transfers. It allows knowledge of the stocks and transfers of sources on French territory and allows early identification of suspicious transfers.

DISCUSSION

A.-C. LACOSTE, Chairperson (France): I shall make three comments: (1) One can recognize the same two features as in the Chinese presentation: a recent reorganization in the administration supervising radiation protection, and work in progress on the control of radioactive sources. (2) I like the idea of the three pillars in the conclusion: a licensing process, an on-site inspection system and a national inventory with source transfer monitoring. (3) Learning from international experience evokes a personal anecdote. Some years ago, in order to prepare the French regulatory authority for taking charge of radiation protection issues, I decided to send staff to gain experience in other countries. They went to Scandinavia, Germany, North America, the United Kingdom and so on. Mr. Féron spent three years working at the Canadian nuclear safety authority. In this way we did our best to acquire international experience.

W. STERN (United States of America): One of your pillars is source transfer monitoring, presumably between end users or supplier and end user. Does France's radioactive source transfer tracking system include information on the geographical location, and if so, how do you deal with mobile sources?

F. FÉRON (France): The source transfer registration process is designed to provide knowledge of who is responsible for the radioactive source, not where it is. If we want to locate a mobile source, we have to ask the licensee. It is a regulatory requirement for the source holder to know where the sources are located at any time.

N.E. ABU TALIB (Jordan): What do you mean by ‘case by case’ in dealing with orphan sources?

F. FÉRON (France): When an orphan source is discovered, the first action will be to ensure that it does not create a risk to the public or the environment. The next step will be to identify the source (radionuclide, activity, manufacturer, supplier) and to search the national inventory to try to locate the person responsible for it. If this person is found, it is no longer an orphan source. If not, storage or disposal will be arranged.

GERMAN ACT ON THE CONTROL OF HIGH ACTIVITY RADIOACTIVE SOURCES

Implementation of the European Union Directive 2003/122/Euratom requirements in a federal legislation system

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Abstract

Concern about orphan sources arising from the poor safety and security of radioactive materials around the world has resulted in intensive global actions, especially in the light of the present precarious security situation. The improvement of regulatory control, for example stricter controls on high activity sealed sources, is one of the key elements in preventing people, goods and the environment from being exposed. On the basis of the requirements of European Union Directive 122/2003/Euratom on the control of high activity sealed sources, Germany has initiated a draft of an Act on that topic. Most of the requirements of an adequate regulatory infrastructure are already fulfilled by the German legislation. The main focus of activities in the near future is the establishment of a national register of high activity sealed sources based on a common European protocol. The information presently available for a substantial number of competent authorities of the federal states ('Länder') has to be collected in a central register. A very important issue is the efficient functioning of the data flow to and from the register. These issues and other cornerstones of the draft Act are described in the paper.

1. GENERAL

In the light of the uncertain security situation worldwide, substantial efforts are being made by governments to prevent the uncontrolled spread of radioactive substances. The goal of such efforts is to maximize the effectiveness of restrictions on the availability of radioactive substances that could be misused. Introducing stricter controls on high activity sources is therefore one of the cornerstones of proliferation prevention.

In fact, high activity sources that are no longer subject to control may cause serious damage to the health of workers and of members of the public, who usually have little or no knowledge of the serious risks posed by a radioactive source or of ways to deal with these risks. If such a radioactive source is destroyed, significant radiation exposure of workers and serious contamination of materials and soils in the environment may be the result.

In response to these hazards, Germany has tabled a draft Act on the Control of High Activity Radioactive Sources, which transposes European Union Directive 2003/122/Euratom into national legislation.

In addition to the need to establish and operate a national register of high activity sources, the bill contains further provisions based on the control system established in Germany under the Atomic Energy Act and the Radiological Protection Ordinance.

2. CENTRAL REGISTER OF HIGH ACTIVITY SOURCES

2.1. Concept

The centrepiece of the bill is the establishment and operation of a central register at the Federal Office for Radiation Protection. The purpose behind the central registration of high activity sources is to improve the control of sources and to provide information concerning their actual location at any time. Central registration thus provides an important basis for the control of high activity sources from ‘cradle to grave’, in other words, from manufacture to final disposal.

The register will provide the following information on the various radioactive sources:

(a) Unique identification number;
(b) Information on source strength, the radionuclide and technical characteristics;
(c) Information on authorization to use or import the source;
(d) Information on continuous control of the source;
(e) If necessary, reporting of loss, theft or discovery.

In accordance with the German Atomic Energy Act, the control of high activity sources is a responsibility of the federal states (‘Länder’). However, if such radioactive sources are shipped across state borders as a result of the business cycle, the most effective way of tracking the radioactive source throughout its life cycle is by means of a central register.

National registers are also part of the concept advocated in the Code of Conduct on the Safety and Security of Radioactive Sources. Along with the other G8 States, Germany declared its political support for implementation of this recommendation at the G8 summit in 2003.

The creation of a central register will thus help to improve Germany's internal and external security. The national security agencies must be in a position to quickly retrieve information on the actual location of high activity radioactive sources as well as details on ownership and authorizations granted. Centrally stored and thus quickly available information can help to reduce the misuse of such high activity sources.

2.2. Information flow to and from the register

Under the new regime, the holder of an authorization for managing high activity radioactive sources ('licensee') will be required to provide the register operated by the Federal Office for Radiation Protection with all the information specified in the EU Directive. The Länder verify the data for compliance with the previously granted authorization and declare them as 'verified'. If the data provided for the register are incomplete or do not conform with the authorization granted, the competent authority will ensure that the holder of the authorization conveys new, corrected information to the register. In this way the responsibilities of the Länder pursuant to the Atomic Energy Act remain unaffected.

Reporting duties include the reporting of any loss or theft of high activity sources. If a high activity source is discovered, the responsible competent authority must inform the register thereof no later than the following working day. This helps to ensure that the relevant information is passed on to the authorities responsible for security at the national level in a fast and comprehensive manner. In the same way the high demands for information on the part of foreign institutions and authorities can be met.

The following will have direct access to the data stored in the registers: the Federal Office of Economics and Export Control (BAFA), responsible for transboundary shipments and the control of radioactive materials in Germany; the Federal Railway Authority (EBA), supervising transport by rail; the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU); and the German safety authorities. The BAFA will inform the register of any import authorizations granted for high activity sources from States outside the EU, in order to ensure complete traceability of high activity sources.

Information will also be provided for relevant international institutions such as the European Police Office, the European Commission or the IAEA.

In accordance with the German Federal Data Protection Act, the holders of an authorization are free at any time to request information about the data of relevance to them which are stored in the register.

The data on high activity sources will be stored in the register for a period of 30 years from their last update. This period is sufficient to guarantee reliable knowledge of the location of high activity sources or former high activity sources.

3. REQUIREMENT TO MARK HIGH ACTIVITY SOURCES

In future, each high activity source will be marked at the time of manufacture not only with the radiation hazard warning sign but also with a unique, instantly recognizable identification number. The Federal Office for Radiation Protection will keep a central list of such identification numbers as part of the register if no serial number is given by the manufacturer or supplier.

4. AUTHORIZATION REQUIREMENT FOR HANDLING

The currently applicable exemptions from the requirement to obtain an authorization for the use and transport of radioactive sources not exceeding a given source strength, laid down in the Radiological Protection Ordinance, will be restricted. The use and transport of high activity sources will be subject to authorization. The aim is to ensure that a person is allowed to handle high activity sources only after his or her reliability, financial security and technical competence, as well as the radiation protection measures taken, have been examined by the competent authorities.

5. AUTHORIZATION REQUIREMENT FOR IMPORT FROM OR EXPORT INTO STATES OUTSIDE THE EUROPEAN UNION

In future, the import or export of certain high activity sources from or into States that are not members of the EU will be subject to authorization. This new provision concerns approximately 5% of the relevant import and export volume of sources which are already subject to a reporting requirement. This is in line with the declared political intentions of the G8 States, and especially Germany, to implement the recommendations of the Code of Conduct and thus with the idea of proliferation prevention.

6. REQUIREMENT TO RETURN OR RECEIVE HIGH ACTIVITY SOURCES

High activity sources that can no longer be, or are no longer intended to be, used as permitted in the authorization obtained will in future be returned to the manufacturer, to the supplier or to another authorization holder (licensee), or disposed of as radioactive waste. They are not allowed to remain with the authorization holder. The purpose of this new requirement is to ensure that a loss of knowledge about radioactive sources which are no longer in use (and which, under the previous regime, were allowed to remain with the (former) authorization holder (licensee)) does not lead at a later stage to any persons not having the necessary knowledge about radiation protection being exposed to these sources, or result in the sources being disposed of inadequately (e.g. scrapping). Along with this obligation, manufacturers and importers of high activity sources will be required to accept the return of sources.

7. FINANCIAL SECURITY FOR ORPHAN SOURCES

The EU Directive requires Member States to establish a system of financial security to cover intervention costs relating to the recovery of orphan sources. Under German legislation (Nuclear Financial Security Ordinance), the amount for the standard coverage for attributable high activity sources, in other words those that were used under a German authorization, will be increased. Any costs resulting from other orphan sources that are not registered in the central register (e.g. illegally imported radioactive sources) are already covered by the State under the current regime.

8. SCHEDULE

In the light of the joint political will manifested by the German Federal Government and the Länder with regard to the creation of a central register, work on the development of the register is expected to begin in early 2005, so that the register is likely to be in place when the Act enters into force on 1 January 2007, in agreement with the requirements of EU Directive 2003/122/Euratom.

DISCUSSION

L.A. BOLSHOV (Russian Federation): Does the new law put the burden of taking back unused sources on the manufacturer or the importer? Who pays for this?

W. WEISS (Germany): As a general principle, it is up to the user to make sure that financial provisions exist in the event that something goes wrong. If the user cannot be found, the Government has to pay, but this is not the idea of the legislation.

L.A. BOLSHOV (Russian Federation): How about retroactive application of the law?

W. WEISS (Germany): The requirements of the new law are binding from the day it enters into force.

A.-C. LACOSTE, Chairperson (France): Do you mean that the law will be enforced only for new authorizations of sources?

W. WEISS (Germany): Yes.

K. MRABIT (IAEA): I understand that Germany is establishing a new database for its national registry. The IAEA has a database that is not only a registry but also a management tool for a system of notification, authorization, inspection and enforcement. It is free of charge and is being used by more than 100 Member States, and we would be pleased to share our experience with you.

W. WEISS (Germany): Germany would be happy to exchange ideas of mutual interest. Our system has been tailored to our national needs and to the requirements of our federal system for data on safety and security.

C.G. JONES (United States of America): My question concerns the differences between the EU Directive and the Code of Conduct. Do you see any difficulties for countries that have implemented the Code of Conduct in importing into the EU?

W. WEISS (Germany): This afternoon, an EU representative is giving a presentation on the Directive. I have my personal opinion but I think it would be fair to let him answer that question.

A.-C. LACOSTE, Chairperson (France): Also, keep in mind that the Directive is legally binding for EU Member States while the Code of Conduct is applied at a country's discretion.

MANAGEMENT OF RADIOACTIVE SOURCES ENSURING SAFETY AND SECURITY: THE INDIAN SCENARIO

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1. INTRODUCTION

Extending the benefits of radioisotopes and radiation technology to the common people has been a well recognized priority of the Indian atomic energy programme right from the stage of its inception about fifty years back. In areas of health care, industry, agriculture and research, steady support has been provided in a safe manner, keeping pace with international developments in this field.

The Board of Radiation and Isotope Technology (BRIT), which was carved out of the Bhabha Atomic Research Centre (BARC) about sixteen years back, is responsible for supplying products and services to society based on the R&D activities carried out at BARC.

A well established regulatory control system right from the initial stages has enabled the Department of Atomic Energy to serve society with an impeccable safety record established over the past several decades. In fact, the self-imposed regulatory programme was established in India even before such programmes were finalized in many other countries.

2. SEALED SOURCES IN USE IN INDIA

BRIT supplies various types of sealed source for diverse applications in medical, industrial and research areas. Some users also import sealed sources along with radiation technology equipment, with the prior approval of the regulatory body.

Table 1 provides a list of sealed sources in use in medicine, industry and research.

TABLE 1. SEALED SOURCES IN USE IN INDIA AS OF 31 DECEMBER 2004

Devices	Sources	Number
Telegamma units	Co-60 (plus depleted uranium used as shielding material in certain cases)	272
Brachytherapy units	Co-60, Ir-192, Cs-137, Sr-90	229
Gamma irradiators	Co-60	12
Gamma chambers	Co-60	110
Industrial gamma exposure devices	Ir-192, Co-60 (plus depleted uranium used as shielding material in certain cases)	1182
Nucleonic gauges, including well-logging sources	Am-241, Am-241–Be, Cs-137, Co-60	7072
Medical and industrial linacs	Depleted uranium used as shielding material	64

3. EXISTING REGULATORY FRAMEWORK IN INDIA

The basis of legislative control of the use of radiation in India is the Atomic Energy Act 1962 [1], which provides the basic regulatory framework for all activities related to the use of ionizing radiation. It empowers the central government to exercise control over radioactive substances and special provisions for safety.

Exercising the powers conferred by the Atomic Energy Act 1962, the central government promulgated the following rules related to radiological safety:

— Radiation Protection Rules 1971 [2];
— Atomic Energy (Safe Disposal of Radioactive Wastes) Rules 1987 [3];
— Atomic Energy (Control of Irradiation of Food) Rules 1996 [4].

The abovementioned rules specify, inter alia, the requirements of:

— Licensing or authorization;
— Power to revoke, modify or withdraw licences;
— Duties and responsibilities of radiological safety officers and their qualifications;

— Radiation surveillance procedures [5–7];
— Power of inspection of radiation installations;
— Power to seal and seize radioactive material.

These rules also confer on the central government powers to designate a competent authority to enforce relevant rules.

The Chairperson of the Atomic Energy Regulatory Board (AERB) is designated as competent authority. AERB prescribes the regulatory requirements for the safety and security of radioactive sources.

Regulatory consent is the principal mechanism connecting the legal framework of the regulatory system, namely the acts and rules made under them, with the responsibilities of the principal parties, namely the regulatory body and the consentee.

4. ‘CRADLE TO GRAVE’ CONCEPT OF THE MANAGEMENT OF THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

Control over radiation sources from ‘cradle to grave’ is exercised in three stages: pre-licensing stage, during the useful life of sources and after the useful life of sources.

4.1. Pre-licensing stage

In the pre-licensing stage it is ensured that the user has a qualified radiation safety officer, type approval of the radiation equipment, a safe and secure storage facility, a workplace radiation monitoring facility, personnel monitoring facilities, an approved installation for use of the source and a commitment by the licensee that the source, at the end of its useful life, will be returned to the original supplier for safe disposal.

4.2. During the useful life of sources

During the useful life of sources, all licensees are required to send periodic safety status reports. Regulatory inspections are conducted prior to and following the issuance of an authorization or licence. Surprise inspections are also carried out to ensure compliance with standard regulatory procedures.

The licensee’s responsibilities include safe use of the source as per the procedures, training of personnel, submitting periodic status reports and reporting of abnormal incidents to AERB.

4.3. After the useful life of sources

Upon completion of the useful life of the source, the licensee is required to return the source to the original supplier. In the case of imported sources, if there is for some reason any genuine difficulty in the export of sources, such sources would need to be sent to an authorized national waste disposal facility. The Waste Management Division of BARC, Mumbai, is the body which has been entrusted with this responsibility. It is mandatory for every user of radioactive material to obtain authorization from AERB for disposal of disused sources or waste.

The sources are disposed of according to the set procedures, which include permission for decommissioning of the source installation, packaging and transport of the sources as per the transport regulations, verification of the safe arrival of the disused source at its destination and updating of the inventory of sources.

5. INVENTORY OF SEALED SOURCES

A computerized national register of sealed radioactive sources is maintained by AERB. The record is continuously updated on the basis of reports received from the licensees. This includes sources involving nucleonic gauges, industrial radiography, gamma irradiators, gamma chambers (laboratory research irradiators), and teletherapy and brachytherapy sources.

The periodic status reports received from the licensees are verified against the computerized database for discrepancies. Additionally, BRIT maintains its own database on sources supplied by it to users.

6. AWARENESS AND TRAINING PROGRAMME

A variety of training programmes are conducted periodically for enhancing awareness of related areas for different groups by AERB with the assistance of BARC and BRIT. This includes safety related courses for operators and supervisors in industrial radiography, industrial irradiators and nucleonic gauging, and post-graduate diploma courses for qualifying suitable candidates as radiological safety officers. Special courses have from time to time been organized for groups such as customs officials, officials from the central industrial security force, the border security force, police, airport authorities and officials from the seaports.

7. PARTICIPATION OF INDIA IN THE IAEA'S PROGRAMME ON THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

A significant contribution has been made by India in international programmes for the safety and security of radioactive sources. Some of the highlights are mentioned below:

(a) India has organized an IAEA Workshop on the Development of National Strategies for Improving Control over Radiation Sources, Including Orphan Sources, held in Mumbai from 24 March to 1 April 2004. It was attended by 20 participants, 12 of them from abroad.
(b) India has participated in the preparation of IAEA-TECDOC-1388, Strengthening Control over Radioactive Sources in Authorized Use and Regaining Control over Orphan Sources – National Strategies.
(c) India has organized an IAEA Regional Workshop on the Regulatory Authority Information System (RAIS), held in Mumbai from 26 to 30 July 2004. It was attended by 38 participants, 28 of them from abroad.
(d) India has actively contributed to the development of the IAEA Code of Conduct on the Safety and Security of Radioactive Sources.

8. IMPORT AND EXPORT OF RADIOACTIVE SOURCES

Procedures for import and export are well established, and every consigner has to obtain a 'No Objection Certificate' from the competent authority for the import or export of any radioactive material. The transport of radioactive material is governed by the AERB Safety Code, which is based on the IAEA Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standards Series No. TS-R-1. Through a case by case licensing process, AERB ensures that imports and exports comply with applicable health, safety, security and environmental requirements.

9. EMERGENCY PREPAREDNESS

India has a centralized Emergency Communication Room (ECR) which works on a 24 hour basis. All transport consignments carry Transport Emergency Cards (TREM Cards) bearing the contact details of the ECR. A network of 15 Emergency Response Facilities (ERFs) has been created all over the country. In the event of an emergency, the ECR will contact the ERF nearest to the site of the incident so that appropriate response action can be implemented within eight hours. This is triggered by the report of an accident or the discovery of an orphan source by the local public functionary.

10. CONCLUSION

On the basis of the account presented here, it can be seen that India has in place a well maintained regulatory control system for ensuring the safety and security of radioactive sources. This fact has manifested itself in the overall safety record demonstrated over the years. As a responsible member of the community of users of radioactive sources working towards extending the benefit of the sources, India has played a proactive role in international forums in evolving the Code of Conduct. India is willing to share the expertise and experience it has developed over five decades in this field with countries that may benefit from such assistance, and it will be willing to help the IAEA in organizing such programmes.

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REFERENCES

[1] Atomic Energy Act 1962 (33 of 1962) (15 Sep. 1962).
[2] Radiation Protection Rules 1971, GSR 1061, Gazette of India, Part II, Section 3(1) (30 Oct. 1971).
[3] Atomic Energy (Safe Disposal of Radioactive Wastes) Rules 1987, GSR 125, Gazette of India, Part II, Section 3(1) (28 Feb. 1987).
[4] Atomic Energy (Control of Irradiation of Food) Rules 1996, GSR 254, Gazette of India, Part II, Section 3(1) (22 June 1996).
[5] Industrial Gamma Radiography (Radiation Surveillance) Procedures, GSR 735, Dept. of Atomic Energy, Mumbai (1980).
[6] Radiation Surveillance Procedure for Medical Applications of Radiation 1989, GSR 388, Gazette of India, Part II, Section 3(1) (3 June 1989).
[7] Radiation Surveillance Procedures for Safe Transport of Radioactive Materials 1987, GSR 125, Gazette of India, Part II, Section 3(1) (28 Feb. 1987).

DISCUSSION

S. McINTOSH (Australia): Are there any areas where India sees that further improvement is necessary?

J.K. GHOSH (India): In fact, India has been following self-imposed regulatory practices in many important areas since long before the Code of Conduct spelled out its requirements. So a registry for sealed sources, for example, is already in place. Nevertheless, we are working towards fine tuning some of the existing practices to suit the exact needs of the Code.

A.J. GONZÁLEZ (Argentina): To comment on what Mr. Ghosh has said, I believe that there is a misconception about following the Code of Conduct. In developing countries involved, such as India, Argentina and others, we have been applying the provisions of the Code for many years. The Code's provisions would be important for those developed countries that have not been controlling their radioactive sources properly.

JAPAN'S ACTIONS TOWARDS THE IMPLEMENTATION OF THE CODE OF CONDUCT ON THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

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Abstract

It is important to control radioactive sources throughout their life cycle, from 'cradle to grave', not only for the sake of safety but also to protect the sources against malicious acts such as theft and sabotage. The paper outlines the current situation of regulatory control of radioactive sources in Japan, and specifies some actions that will be taken for the implementation of the Code of Conduct on the Safety and Security of Radioactive Sources. In the implementation of the Code of Conduct, security measures have to be devised giving due consideration to the diversity in the uses of radioactive sources.

1. INTRODUCTION

It is important to control radioactive sources throughout their life cycle, from 'cradle to grave', not only for the sake of safety but also to protect the sources against malicious acts such as theft and sabotage. The Code of Conduct on the Safety and Security of Radioactive Sources is an instrument of universal applicability which provides the requirements for good control of radioactive sources. Japan contributed to the development of the Code of Conduct and has committed to its implementation.

In this paper, I will outline the current situation of regulatory control of radioactive sources in Japan, and will specify some actions that Japan will take for the implementation of the Code of Conduct. I hope that this information will be useful to others who are working to implement the Code of Conduct.

2. CURRENT SITUATION OF CONTROL OF RADIOACTIVE SOURCES IN JAPAN

Since the early days of utilization of radioisotopes in the mid-1950s, Japan has established and developed legislation and regulation for the control of radioisotopes. The framework also specified the government agency responsible for the regulatory control of radioisotopes: the Science and Technology Agency (STA) until 2000, and the Ministry of Education, Culture, Sports, Science and Technology (MEXT) since 2001. Now radiation is indispensable in medicine, industry, research and other areas, and there are approximately 4800 licensees in Japan. One of the characteristics of Japan's legislation and regulation for the control of radioisotopes is that the regulatory requirements are prescriptive. The prescriptive requirements seem to ensure generally good control of sources in Japan. There has never been an incident where Category 1 or 2 sources (according to the IAEA classification) were out of control.

Nevertheless, there have been some cases of orphan sources. One example is unsealed β radionuclide sources of the order of kilobecquerels or megabecquerels, most of which are used as tracers in biomedical research. In order to avoid the occurrence of this kind of orphan source, it is essential that licensees think about their security situation and implement a robust control scheme for the radioisotopes. With a view to fostering a positive attitude towards robust control in all licensees, MEXT has called upon them to check and report back whether there is any radioisotope out of control and, if there is, to institute improvements based on lessons learned. Good practices will be recognized and communicated to all licensees. Another example of orphan sources is sealed sources found in scrap metals. Around 2000, we faced some incidents where the activity of the orphan sources discovered was of the order of megabecquerels or gigabecquerels. Responding to this series of incidents, STA and other relevant ministries developed a scheme to deal with such sources, and on this basis metal scrap industries and expert organizations developed their manuals. The framework has been working effectively, without any confusion or radiation exposure in recent incidents.

In addition, Japan experienced the sarin gas attack on the Tokyo subway in 1995 and the nuclear criticality accident at JCO (Japan Nuclear Fuel Conversion Corporation) in 1999. Various measures for responding to an emergency situation have been established following these events on the basis of lessons learned from the experiences.

3. ACTIONS OF JAPAN TOWARDS IMPLEMENTATION OF THE CODE OF CONDUCT

Japanese regulatory control appears to satisfy the Code of Conduct as far as safety aspects are concerned. It also seems to satisfy security requirements to a large degree, since some safety measures work as security measures as well. However, three actions have been identified for Japan to take to ensure full implementation of the Code of Conduct.

(a) To make it a legal obligation for licensees to take security measures. So far the licensees are advised to take security measures by administrative guidance, and they are not legally obliged.
(b) To introduce a national registration system for radioactive sources. The movement of radioactive sources can in practice be followed; however, a systematic national approach has not been established.
(c) To develop an export control regime for radioactive sources in accordance with the IAEA Guidance on the Import and Export of Radioactive Sources. Export control for radioactive sources has not been established, since there have been few instances of export of radioactive sources from Japan except for the return of sources to their manufacturers.

These three actions are discussed below.

3.1. Legal obligation for security measures

It is important to take into account the diversity of radioactive sources and the variety of licensees in discussing specific security measures for radioactive sources.

Japanese licensees of Category 1 and 2 radioactive sources are divided into two groups. One includes research and industrial use facilities, the other hospitals, comprising 53% of the Category 1 and 2 licensees.

The features of research and industrial use facilities are as follows:

(a) The facility is off-limits to the general public, and access to the radioactive sources is restricted to designated persons.
(b) When not in use, sources are stored with locks.
(c) Physical barriers already exist for radiation protection purposes.

These features would make it possible to apply to research and industrial use facilities the underlying principles of physical protection of nuclear materials and nuclear facilities, that is, to designate protected areas and to take several protective measures.

On the other hand, the features of hospitals are as follows:

(1) Information on the specifications, location and position of equipment installed with radioactive sources is easily found.
(2) Patients and visitors can have access to the equipment and sources.
(3) Physical barriers cannot be set up, for medical emergency reasons.

Therefore it is difficult to apply the concept of physical protection for nuclear facilities to hospitals. Rigid application would hinder the work of medical institutes.

The distinctive features of hospitals are an example of the diversity of facilities and uses connected with radioactive sources. Specific security measures for a radioactive source have to correspond to the specific environment of the source — where and how it is used. Because of this, the regulatory body would be not wise to universally impose specific security measures on licensees. Rather each individual licensee is allowed to devise its specific security measures, taking into account its facility and its use of the sources. In this connection, it is hoped that IAEA-TECDOC-1355 will illuminate this aspect and provide more specific guidance, and Japan would like to contribute to this effort.

In having licensees devise their own security measures, there are, however, certain challenges:

— Specific security measures for radioactive sources have been less discussed than those for nuclear material and nuclear facilities, even in the IAEA.
— Awareness of security is lower among licensees of radioactive sources than among nuclear facility operators.
— The wide range of facilities entails various possible threat scenarios.

Consequently, in the implementation of threat assessment, regulatory authorities should provide threat information that is specific enough to make licensees think seriously about devising their security measures, and that reflects use and other specifics of the source. It is important for the regulatory authority to encourage and motivate licensees so that they work on security issues on their own with a positive attitude.

3.2. National registration system for radioactive sources

In Japan about 90% of radioactive sources of Categories 1 and 2 are circulated through the Japan Radioisotope Association (JRIA), an association of users of radioisotopes and a not-for-profit organization. Ownership of the sources can be tracked to a large degree by current and past transaction records kept by JRIA and other dealers.

As the next step, MEXT is now planning to establish, within the next few years, a national registration system for Category 1 and 2 sources that can trace the quantity of sources entering and leaving the premises of each licensee, and that will show how the sources are kept at the premises of each licensee.

3.3. Export control for radioactive sources

Most of the radioactive sources in Japan have been imported from abroad. The scheme for import control has been established. Only licensees under the radiation regulation law can import sources, within the amount permitted by the licence, but no export control is exercised in accordance with the Guidance on the Import and Export of Radioactive Sources.

The introduction of export control is necessary for implementation of the Code of Conduct, which requires permission for the export of Category 1 and 2 sources, although, as mentioned above, there have been few instances of export of radioactive sources from Japan except for the return of sources to their manufacturers. MEXT is consulting competent authorities on this issue, with a view to the implementation of the Guidance by the end of 2005.

4. INTERNATIONAL COOPERATION

The effect of the Code of Conduct will be enhanced as more countries implement it. In this connection, international and intraregional cooperation on the activity of each country or region to implement the Code of Conduct is quite important.

In this respect Asia is one of the most important regions in the world, because uses of radioactive sources are expected to rise in Asia in the near future. Harmonization of regulation in the neighbouring area is also important to establish a rational trade control system compatible with the promotion of the use of radioactive sources. Japan has contributed to the safe and secure control of radioactive sources in Asia under the auspices of the Forum for Nuclear Cooperation in Asia (FNCA) for more than ten years. In this cooperation, control of radioactive sources in the region has been surveyed and discussion has been continuing.

On the basis of this cooperation, we are now in the process of establishing an advanced and comprehensive safety management structure to promote the use of radioactive sources with the neighbouring countries rather than simply strengthening regulation.

We would like to lead the discussion among Asian countries to share information and to contribute to the improvement of the safety and security of radioactive sources, as well as to promotion of their use in the region.

5. CONCLUSION

In the implementation of the Code of Conduct, security measures have to be devised giving due consideration to the diversity in the uses of radioactive sources. To realize this, great importance is attached to the international exchange of views and experience, as well as deliberation towards more specific guidance material in the IAEA, to which Japan is going to contribute.

DISCUSSION

A. JOUVE (France): You referred to the terrorist attacks in the Tokyo metro. Japan is a member of the International Nuclear Event Scale (INES). Do you think that the use of communication tools such as INES could be useful to neutralize or minimize the impact on people’s fear reaction, which is the aim of a terrorist attack?

S. KATAYAMA (Japan): Of course, the subway attack did not involve nuclear or radioactive material, but poison gas. For a case where radioactive material could be involved, it could be useful for people to use communication tools like INES. We would like to contribute to these activities.

OBJECTIVE AND SUBJECTIVE IMPEDIMENTS TO THE BROAD AND SUCCESSFUL APPLICATION OF IONIZING RADIATION SOURCES

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According to IAEA data, millions of ionizing radiation sources (IRSs) have been produced worldwide in the last 50 years. Of these, hundreds of thousands are being used in medicine, metallurgy, agriculture, mining, mechanical engineering, etc. The advantages and prospects of IRS application are obvious. However, in addition to the successful use of IRSs, events in recent years have revealed the problem of IRS security and protection from unauthorized use in connection with the threat of terrorism.

The risks connected with IRSs are related to their security and possible radiological accidents, and IRSs have become a subject of close attention from the world community in recent years. There is a necessity to solve the problem of IRS safety and security. On 8 September 2003, the IAEA Board of Governors approved a revised version of the Code of Conduct on the Safety and Security of Radioactive Sources. The goals of the Code of Conduct are as follows:

— To reach and sustain a high level of safety and security of radioactive sources;
— To prevent unauthorized access to radioactive sources or their damage, loss, theft or unauthorized transfer, in order to decrease the probability of accidental harmful exposure by such sources or intended malicious application of such sources aimed at causing harm to individuals, society or the environment;
— To mitigate or minimize the radiological consequences of any accident or malicious actions related to radioactive sources.

The topicality of the Code of Conduct was confirmed by the participants of the Evian summit of the Group of Eight States in June 2003. At this summit, a statement regarding a necessity "to ensure the unavailability of radioactive sources" was made. The statement appealed to all countries of the world to reinforce accounting and control of IRS management and to implement the requirements of the Code of Conduct.

Significant attention is being paid to the general problem of terrorism, and in particular nuclear terrorism, all over the world. The term ‘dirty bomb’ is being widely used. It includes both nuclear weapons and devices made of standard explosives and radioactive substances. The non-proliferation regime and the system of special accounting and control of nuclear materials define conditions where the probability of using radioactive sources for terrorist purposes is much higher than the probability of using nuclear weapons or nuclear materials.

Radiological terrorism should be understood as the intended dispersion of radioactive substances or the placing of IRSs in populated places or in infrastructure objects, as well as sabotage at facilities where a radiation hazard is present, aimed at creating radiation effects on the population and the environment, and destabilization of social life and the economy. Considering the problem as a whole, it might be stated that an act of radiological terrorism involving radioactive substances of any origin can lead to the following direct and indirect negative consequences:

— Radiation exposure of individuals and the environment;
— Interference in the lives of different population groups, connected with radiation protection measures;
— Effect of information on the social and cultural environment, which is known to acutely perceive the radiation hazard.

The effect of radiation is connected with contamination of environmental objects and, if the exposure is high, with pathological changes in living organisms, including radiogenic diseases. All radiological consequences are well studied and can be expressed by monetary factors, which include loss of material objects, medical expenses and the cost of work to remediate radioactive contamination.

Non-radiological consequences, including those of a psychological, social, economic and political nature, are called secondary effects or side effects. The damage to the society caused by these consequences is called indirect harm. The secondary consequences are much less well studied, and even today it is quite difficult to assess this harm by monetary factors. It is well known how to evaluate the lost benefit due to loss of material objects and the economic base. However, there are no methods to assess, for example, the decrease of the economic potential of a region affected by radioactive contamination. In trying to do this, one needs to take into account public health limitations; the rise of prices for imported foodstuffs; the decrease of the competitive capabilities of local manufacturers; the decrease of sales, salaries, purchasing power of the population, real estate prices and business; and the resettlement of the active population to other regions, etc.

Estimates based on the analysis of the experience accumulated during mitigation of past radiation accidents have shown that the indirect consequences of an act of radiological terrorism can lead to economic and social losses in the society that greatly exceed the losses from the direct effects of radiation exposure. For instance, the direct losses from the Chernobyl accident for the Russian Federation, Belarus and Ukraine are assessed as tens of billions of US dollars. At the same time, only one component of indirect harm — lost benefit (not the major one) — increases the total losses of the three countries for the 15 years following the accident by an order of magnitude, at a minimum.

In this connection, special attention should be paid to potential threats of radiological terrorism involving the application of an IRS and any radioactive substance, including radioactive waste. Owing to the wide application of IRSs in different branches of the economy (industry, agriculture, medicine, etc. — see Table 1) and the imperfection of the system for accounting, control, licensing and regulation, it is difficult to close all pathways of unauthorized movement of IRSs, especially in non-nuclear branches.

Specialists from the Nuclear Safety Institute of the Russian Academy of Sciences (IBRAE RAN), together with experts from various Russian ministries and agencies, have for the past several years systematically studied the threats

TABLE 1. RADIOACTIVE SOURCES IN THE WORLD (IAEA DATA)

Application	Radionuclide	Half-life	Activity
Radiotherapy	^{60}Co	5.3 a	50–1000 TBq
	^{137}Cs	30 a	500 TBq
Industrial radiography	^{192}Ir	74 d	0.1–5 TBq
	^{60}Co	5.3 a	0.1–5 TBq
Sterilization	^{60}Co	5.3 a	0.1–400 PBq
	^{137}Cs	30 a	0.1–400 PBq
	^{90}Sr	29 a	50–1500 MBq
Well monitoring	^{137}Cs	30 a	1–100 GBq
	^{241}Am	432.2 a	1–800 GBq
Level and thickness gauges	^{137}Cs	30 a	10 GBq–1 TBq
	^{60}Co	5.3 a	1–10 GBq
Density detector	^{241}Am	432.2 a	0.1–2 GBq
	^{137}Cs	30 a	Up to 400 MBq
	^{226}Ra	1600 a	~1500 MBq

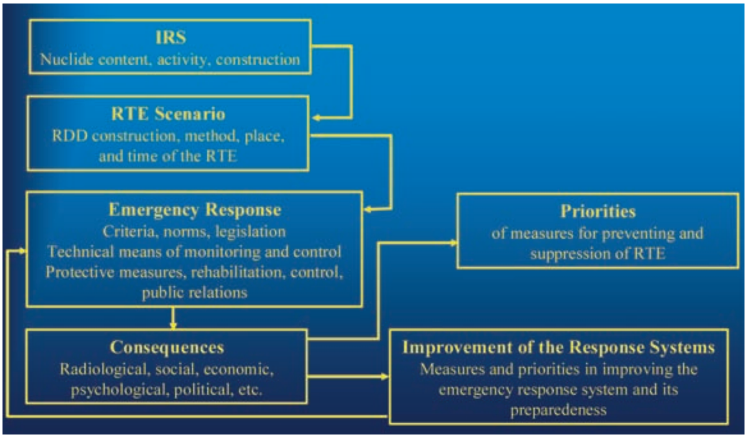

FIG. 1. Factors determining the consequences of an act of radiological terrorism and their interconnection. RTE: radiological terrorism event.

and possible consequences of acts of radiological terrorism involving IRSs or radioactive substances. An important task of such systems analysis is to develop approaches to the organization and implementation of measures to prevent and minimize the consequences of radiological terrorism. It is necessary to stress that the existing approaches to the development of measures and priorities are as a rule based upon independent analysis of single facts determined by a given design of radiological dispersal device (RDD) and its 'radiation' component, a limited set of scenarios of secret transport of an RDD or its parts to the location of the proposed act, and the degree of possible involvement of people and infrastructure in the potential consequences of such events. Unfortunately there is no thorough analysis of the connection of the health, social and economic consequences with the technical RDD design, the special methods of transformation of physical and chemical properties of the radioactive substances, and the scenario of the radiological terrorism event.

Figure 1 presents an outline of a simplified mechanism for the development of measures and priorities to prevent and minimize the consequences of radiological terrorism.

The development of measures and priorities to prevent and minimize the consequences of radiological terrorism requires a systems approach based on multifactor analysis, namely:

(a) Various scenarios of unauthorized movement, ways and means of radioactive substance transport, taking into account measures of concealment from technical means for detecting radioactive substances, especially for α and β emitters.

(b) Possible designs of RDD, the means and objects for carrying out the terrorist act.

(c) All possible consequences (radiological, environmental, public health, economic, social, etc.). The parameters of the radiological situation for different acts of radiological terrorism in urban conditions should be taken into account (the short timescale of development of the radiological situation, spatial non-uniformity of radioactive contamination, multicomponent infrastructure).

(d) Requirements for methods and technical means of radiation survey and monitoring, based on the parameters of the radiological situation for a radiological terrorism event in a large city, and the levels of detection of α, β and γ radiation for the case of an unauthorized movement of a radioactive substance, taking into account possible concealment and the ways and means of delivery.

(e) Current legislative and normative base in the area of radiation safety and its effect on decision making in a situation where there are huge differences in permissible and control levels of radiation and contamination of people, everyday objects and the environment in normal and emergency conditions.

(f) Practical applicability of radiation protection criteria, taking into account high non-uniformity of radioactive contamination, complex distribution of individual exposure doses and many interconnected components of municipal infrastructure.

(g) Reasons for the inadequate public perception of radiation risks.

A brief analysis of the results of studies carried out at IBRAE RAN for several scenarios of possible radiological terrorism acts can give an idea of the scale of possible problems in the case of such an act in a large city.

The first of the scenarios studied is the planting of a ^{60}Co based γ radioactive source in a Moscow subway car. Sources of this type are in widespread use, typically in different calibration devices. Real data on subway car characteristics, number of passengers and length of Moscow subway lines were used in the calculations. The results showed that the majority of the passengers (about 98%) could be exposed to an external dose of below 100 mSv. However, about 100–200 passengers could show external signs of radiation injuries (where the whole body dose exceeds 0.1 Sv and is followed by a prompt body response, including, for example, dry mouth, headache, nausea and emesis). For about ten persons who during their ride in the car were close to the seat where the source had been planted and who were exposed to the maximum doses, there is a low probability of death from radiation sickness. Assessments also show that for a large group of passengers who were close to the seat during the ride, high exposure doses are possible to the skin of the parts of their bodies that were closest to the radioactive source. Such exposure could possibly result in skin radiation injuries ranging from slight reddening to massive destruction of the skin and even to internal radiation injuries.

The next case was studied in order to analyse possible consequences of the detonation of a ^{90}Sr based dirty bomb at a subway station. It was assumed that a low yield (in TNT equivalent) dirty bomb with a ^{90}Sr source (a widely used type of source) is detonated at the centre of a platform of a subway station during rush hour. The total number of passengers on the platform at the moment of detonation could be about 1300, of whom 300 could be in the close vicinity of the detonation point. Rather conservative assumptions were used for the calculations, which show that the maximum internal exposure dose to the lungs for some individuals could reach 5 mSv. It should be noted that the lung internal exposure doses of 5 Sv would lead, with a sufficient degree of confidence, to detectable effects of radiation injury to the lungs. For people with lung exposure doses of 1–1.5 Sv, the probability of deterministic effects is low. However, people with weak health, especially with lung problems, could face unfavourable health effects. It is worth noting that a group of passengers could in future become a higher risk group in terms of possible additional diseases and fatalities caused by lung cancer.

The indirect consequences of such a terrorist act would be the following:

(1) Radioactive contamination of the subway station and neighbouring areas due to the spread of radioactive materials.
(2) Exclusion of this station, and possibly even of a section of the subway line, from the transportation system for a long period. The simultaneous closure of several stations and an interchange station would lead to large scale transportation problems and could paralyse the functioning of the subway.
(3) Problems with compensation for the contaminated belongings of people who were in the zone of radioactive contamination, and the expense of organizing long term medical service for a large group of people, both those directly involved and those who participated in consequence minimization.

The third scenario studied involves the dispersion of some amount of ^{137}Cs above a region of a large city. Two options were considered: ^{137}Cs sources with low and with intermediate activity. Such sources are widely used.

Dispersion of the contaminant at a height of 100–200 m is effected either by detonation of a small yield explosive device or by any other kind of RDD.

The calculations show that even in the case of a low activity ^{137}Cs source above a city, there is a probability of contaminating 0.2–2.6 km^2 of urban territory to a level exceeding 1 Ci/km^2 (1 Ci = 3.7×10^{10} Bq). Larger areas would be contaminated in the case of dispersion of an intermediate activity source. It is known that, in the assessment of the consequences of contamination of a large territory by ^{137}Cs after the Chernobyl accident, a level of contamination of 1 Ci/km^2 was a criterion for regarding a territory as a zone of privileged socio-economic status, which was perceived as acknowledgement by the State that living on such a territory was harmful for people's health. The direct comparison of this norm with the situation in a large city contaminated as a result of an act of radiological terrorism could lead to deactivation of a living area with tens of thousands of residents, and to a loss of dwelling and other buildings in an area of some hundreds of thousands of square metres.

The analysis of possible consequences of a dirty bomb explosion with an ^{241}Am radioactive source on the territory of a large city showed that sets of existing methodologies and computer codes which are sufficient to describe the behaviour of contaminants in the area of the radioactive release source in field conditions and in conditions of increased surface roughness cannot work effectively when applied for patterns of actual dense city building conditions, large industrial enterprises and traffic centres. Therefore, to realistically assess the consequences of such a scenario, an IBRAE RAN 3-D aerodynamic model was used to model adverse admixture propagation in conditions of dense city building, to identify typical locations of stagnant areas and areas with abnormally high contamination levels. The results of the calculations showed that the area of significant radioactive contamination of the city environment resulting from such an incident could stretch up to 1 km and feature very high gradients of changes in the concentration of radioactive substances in the air, depending on the actual structure of the city building and weather conditions at the moment of the dirty bomb detonation (Fig. 2).

The strong temporal and spatial non-uniformity of radiological situation parameters, as clearly seen in the figures, represents technical and methodological difficulties in the organization of monitoring and fast analysis of the radiological situation in the early stage after the terrorist act. In this connection, it is required to develop specialized technical means of measurement and software packages for monitoring data processing in order to adequately assess the situation and make decisions on urgent population protection measures.

Our calculations also demonstrated that about 100 of the 5000 individuals present in the street within the calculated area at the moment of the terrorist act could be affected by radiation exposure to the lungs with doses (over 5 Sv) that could lead to adverse effects on their health.

The last, fifth scenario of a terrorist act with application of a radioactive source deals with a deliberate contamination of a section of an asphalt roadway at a junction with a highway. It was assumed that some amount of water containing dissolved ^{137}Cs at a high concentration was poured on to the road. Contamination of such a section of the road is potentially dangerous because

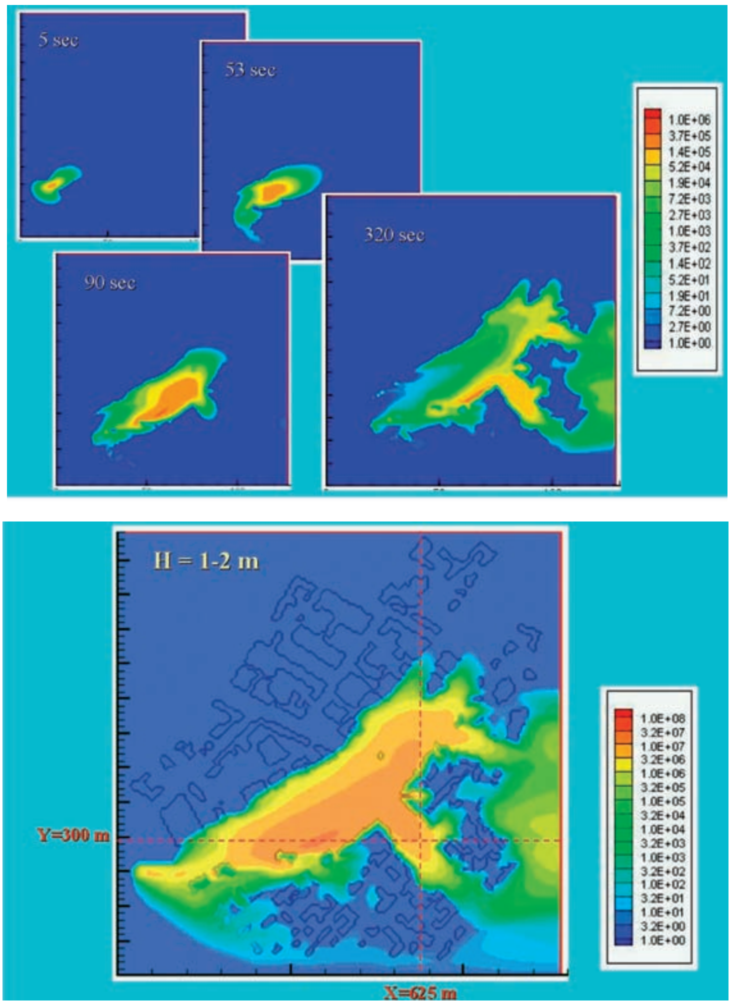

FIG. 2. Dynamics of changes in ^{241}Am air concentration (top) and the integral ^{241}Am air concentration (bottom) in the event of the detonation of an explosive device containing a radioactive source for one of the scenarios for city conditions; relative units.

this is the place where vehicles stop before entering the highway. The external exposure doses to vehicle passengers are increased, and owing to a prolonged contact of vehicle tyres with contaminated roadway the significance of processes of contamination migration along the highway also increases.

The results of calculations show that already 15 minutes after the contamination, the zone with a contamination density of over 100 Ci/km^2 would reach over 100 m. Naturally, as the road runs on, some of the cars would leave it. This would lead, on the one hand, to a reduction of the radioactive contamination density of the road, but, on the other hand, it would involve additional roads in the contamination process. The estimates show that several days after the initial contamination, the total length of the city roads contaminated above 10 Ci/km^2 could already be several dozens of kilometres.

In this case, there is no direct radiological impact, since only road workers and police could be exposed to significant extra doses, as they could be in the contamination zone for several hours owing to their duties. However, the indirect harm could be much more significant, as this incident would require deactivation of large areas of roads and pavements and the arrangement of a traffic diversion route. All these measures would need to be realized in accordance with safety norms, which, in urban conditions, would lead to a significant amount of work and financial losses.

The estimates presented show that even using an IRS of low or intermediate activity in a terrorist act could lead to serious problems for the population and city infrastructure.

In order to enhance the safety of IRS management, reduce the risk of unauthorized use of sealed radioactive sources (SRSs) and perfect the IRS security system, the Russian Academy of Sciences and the Federal Atomic Energy Agency have commenced work on analysis of the availability of SRSs and the status of the SRS physical protection system, and on development of priority measures to improve the State system of control and accountability of sources being used in different branches of the economy. This work is also being performed within the framework of United States–Russian cooperation. Table 2 and Fig. 3 present some data from such studies. The data characterize the situation in several regions of the Russian Federation in 2004.

As seen from the data of Table 2, the total number of SRSs in regions varies from hundreds to thousands, though in some regions, e.g. the cities of Moscow and St. Petersburg, this value can be much higher. It should also be mentioned that the activity of most of the sources is of the order of a few curies (Fig. 3). On the one hand, this reduces the potential radiological threat of their application as the active element of a terrorist device; on the other hand, the security regime of such sources might not be so strict. At the same time, the social and economic harm resulting from the application of such sources for

TABLE 2. QUANTITY AND ACTIVITY OF SRSs BEING USED IN SEVERAL REGIONS OF THE RUSSIAN FEDERATION

	Quantity	Activity (Bq)
Arkhangelsk Region	3 556	6.15E+16
City of St. Petersburg	18 973	3.93E+16
Kemerovo Region	697	3.57E+15
Samara Region	483	1.24E+15
Saratov Region	1 118	8.04E+14
Khabarovskii Krai	722	9.84E+14
Chelyabinsk Region	5 118	9.13E+15

terrorist purposes could be quite high, since low activity sources are more vulnerable from the point of view of their unauthorized removal, secret relocation and accumulation.

The great number of orphan sources continually being found, as well as the significant number of instances of IRS theft, loss and destruction outside of Rosatom control (some tens of such cases occur annually), may serve as proof of the actual difficulties of organizing efficient control and accounting. Analysis of these data reveals that sources are often lost during geological surveys, i.e. in conditions where control over IRS security is extremely difficult. A similar situation arises in other industrially developed countries. For instance, in the United States of America up to 375 radioactive sources are lost annually. The

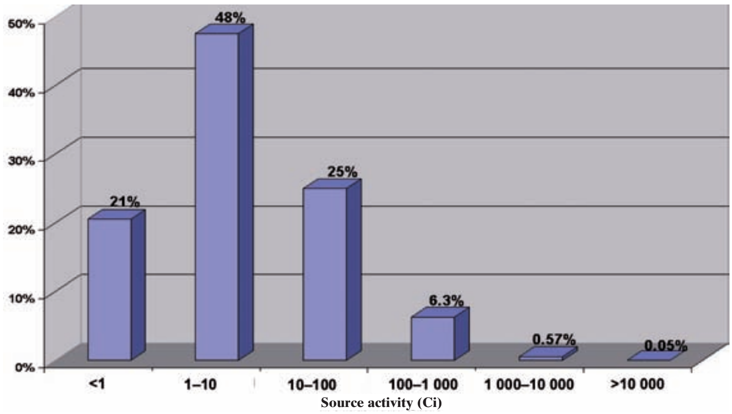

FIG. 3. Distribution of SRS use according to source activity. 1 Ci = 3.7 × 10^{10} Bq.

fact that some such sources, once withdrawn from service, are left without any protection or are simply thrown away gives rise to a certain anxiety.

As a result of system analysis, three priority work areas associated with the reduction of threats of unauthorized IRS use were identified:

— Disposal of unused IRSs, aimed at reduction of the number of organizations possessing IRSs with elevated activity;
— Improvement of IRS physical protection systems at organizations that use IRSs;
— Perfection of IRS physical protection during IRS transport.

The ‘radiation populism’ prevailing in the post-Chernobyl period led to the adoption of unjustifiably rigid legislative public health norms in the Russian Federation. The application of such radiation criteria leads to situations where even a slight exceeding of norms, which is quite harmless for health, becomes a source of serious public concern. For instance, the Chernobyl related legislation guarantees compensation for health damage to the Chernobyl area residents, for whom the additional exposure level is lower than variations in the natural radiation background.

The data given in Table 3 demonstrate how the levels of current public health norms affect the sizes of areas where selected population protective measures are implemented. Table 3 contains calculated values of areas with radioactive contamination exceeding recommended levels for one of the scenarios described above, dispersion of an intermediate activity ^{137}Cs source at 100 m height above a large urban area. It is seen from Table 3 that when recommendations of the International Commission on Radiological Protection (ICRP) regarding radiological terrorism are used to make decisions concerning population protection measures, the maximum sizes of sheltering zones or zones for temporary relocation of the population vary in the limits of 0 to 3 km^2. When the OSPORB Sanitary Rules are applied to such a situation, the sizes of those zones can approach 100 km^2 and cover a significant part of the city, considering the interfaces of the municipal infrastructures.

Inadequate perception of radiation risks exists not only at the level of perception of the general public. Prejudice against radiation exists in practically all professional and social groups, including representatives of legislative and executive power, who are involved in population protection and environmental regulation. Practice shows that persons responsible for decision making share all the stereotypes of public perception regarding radiation hazards. In response to real or expected pressure from the public, decision makers choose the maximally rigid criteria for territory zoning and compensation for damage. In such decision making, momentary political interests prevail. The remote

TABLE 3. AREAS OF A LARGE CITY WITH RADIATION PARAMETER VALUES EXCEEDING RECOMMENDED CRITERIA FOR THE POPULATION IN THE EVENT OF DISPERSION OF AN INTERMEDIATE ACTIVITY Cs-137 SOURCE AT 100 m HEIGHT ABOVE THE URBAN AREA

Information source	Recommended guideline	Area of the contaminated territory, depending on weather (km^2)
Draft ICRP recommendations on radiological terrorism	Sheltering, 10 mSv over 2 days	0.0–2.0
	Temporary evacuation, 50 mSv over 7 days	0
	Relocation, 0.1 Sv over the first year	0.1–3.3
ICRP Publication 82	10 mSv over a year	3.1–11
EPA recommendations, USA	20 mSv over a year	1.3–8.5
Radiation Safety Standards, NRB-99, Russian Federation	5 mGy over 10 days — Level A for sheltering	0.0–2.0
	50 mGy over 10 days — Level B for sheltering or Level A for evacuation	0
	500 mGy over 10 days — Level B for evacuation	0
Sanitary Rules (OSPORB), Russian Federation	10 μSv/a — population exposure dose monitoring zone	37–99
	100 μSv/a — protective measures optimization zone	27–58
	1 mSv/a — population exposure dose reduction area	18–24
Chernobyl related legislation	1 Ci/km^2	
Current levels of soil contamination due to Cs-137 global fallout	50% addition to fallout density	37–103
	Factor of 2 increase in global fallout magnitude	55–235

TABLE 3. AREAS OF A LARGE CITY WITH RADIATION PARAMETER VALUES EXCEEDING RECOMMENDED CRITERIA FOR THE POPULATION IN THE EVENT OF DISPERSION OF AN INTERMEDIATE ACTIVITY Cs-137 SOURCE AT 100 m HEIGHT ABOVE THE URBAN AREA (cont.)

Information source	Recommended guideline	Area of the contaminated territory, depending on weather (km^2)
Guidelines for permissible contamination of surfaces for the population residing within the Chernobyl zone	200 β particles · min^{-1} · cm^{-2} — vehicle contamination	22–41
	100 β particles · min^{-1} · cm^{-2} — contamination of clothes and building internal surfaces	25–51
	10 β particles · min^{-1} · cm^{-2} — contamination of skin, underwear and bedclothes	35–91

Note: ICRP: International Commission on Radiological Protection; EPA: US Environmental Protection Agency. 1 Ci = 3.7×10^{10} Bq.

consequences of the decisions made for the entire society are as a rule not considered, though they contribute most to the indirect harm. Thus work towards developing an adequate public perception of threats and the possible consequences of radiological terrorism events requires an individual approach to each target group. For instance, information for decision makers should contain not only data on levels of radiation risks and population protection measures, but also data on the economic efficiency of those measures, their social acceptability and their sufficiency.

Data of actual measurements demonstrated that a high discontinuity of contamination densities and external γ radiation dose rates was typical for the Chernobyl zone. There are also significant variations of individual doses among different professional and age groups of the population (Fig. 4). This creates difficulties in work on territory zoning, causes a negative attitude among the population regarding the implemented protection measures and leads to social stress in the society. The results of the analysis conducted show that all the problems mentioned would be much more complicated in the conditions of a large city.

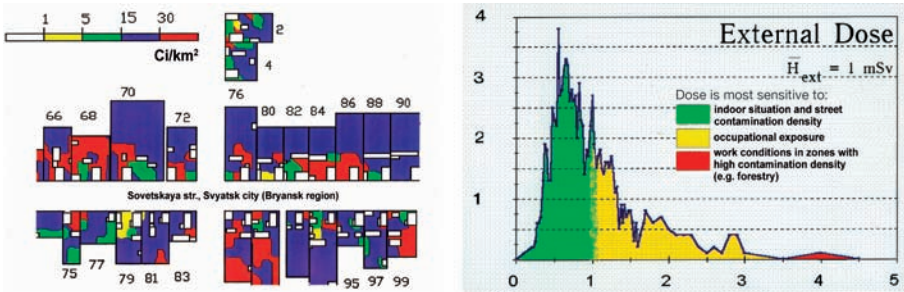

FIG. 4. Data on contamination density of territories by ^{137}Cs (left) and exposure doses of the population (right) in a settlement in the Chernobyl zone. 1 Ci = 3.7×10^{10} Bq.

The fear of radiation, and the severity and confusion of the existing norms and criteria in the field of radiation safety and radiation protection, make the society extremely vulnerable to the radiological terrorism threat. This fear, in combination with the ease of acquiring instruments capable of detecting the slightest increase of radiation background, makes the entire system quite unstable. The mechanisms for social disturbance are triggered by the slightest threat of a terrorist act involving radiation sources. In this case the magnitude of the indirect damage caused by the inadequate behavioural response would inevitably exceed any consequences of radiation exposure itself. An 'epidemic' of fear could spread especially rapidly in densely populated regions with modern communications, putting in jeopardy the entire system of public life.

One may judge the scale of social disturbance and the speed of rumour-spreading by the public, even in the absence of a radioactive release, from the operational event at the Balakovo nuclear power plant that occurred at night on 4 November 2004 (a scram of the plant's unit two). This event, rated on the International Nuclear Event Scale (INES) at Level 0 (i.e. an accident without release of radioactivity), produced rumours about a radiation accident in the plant's satellite city of Balakovo, owing to the lack of adequate official information. People were telephoning each other and recommending immediate administering of iodine and wine, and, if possible, leaving the place for somewhere else. Thirty hours later anxiety seized several millions of residents of the European region of the Russian Federation. Several people suffered from iodine poisoning.

Since the most probable places for acts of radiological terrorism are large cities, the existing methods of radiation survey and interpretation of the results of measurements might be inadequate. Additionally, existing methodologies and systems of emergency response to radiation accidents could also be inappropriate in the event of radiological terrorism, first of all because of the necessity to promptly respond and make decisions. This means that new methods of calculation, simulation, measurement and analysis of radioactive contamination in the conditions of a large city should be developed. Apart from this, development of fast and highly efficient systems of decision making support based on modern means of communication and monitoring is an urgent task for densely populated regions.

On the basis of the analysis conducted, the following priority tasks can be proposed:

(i) Development of requirements for equipment and systems for the detection of illegal relocation of a radioactive source based on the analysis of potential consequences of use of a radioactive source and the means of its delivery to the scene of an act of radiological terrorism;
(ii) Development and manufacturing of the corresponding detection equipment;
(iii) Creation of the corresponding methodological basis, software and hardware, and organization of a system for integrated prompt expert support to decision making regarding population protection and the drawing up of measures to minimize social and economic consequences;
(iv) Development of recommendations to form a regulatory basis in the field of radiation safety, which will ensure effective protection of human health and prevention of unjustified social and economic consequences based on the objective analysis of radiation risks and adequate protection and intervention level criteria;
(v) Development of methodologies and hardware for radiation survey and monitoring under conditions of radiological terrorism in large cities;
(vi) Establishment of national specialized centres of expert support to decision making regarding protection of populations and territories in the case of a radiological terrorism event, and a system for their international coordination;
(vii) Development of a strategy and creation of a corresponding system for emergency response and protection of populations and territories in the event of radiological terrorism, taking into account different, essentially new technical, legislative and organizational challenges;
(viii) Setting up of national and international systems for objectively informing the public about radiation risks, radiation safety approaches and norms in the provision of radiation safety, and objective representation of lessons learned from radiation accidents and incidents of the past, especially their real radiological consequences.

Considering the topicality of the radiological terrorism issue, the work in the areas mentioned is to be supported by the positive experience gathered in the bilateral US–Russian cooperation, as well as international cooperation under the IAEA aegis, in the field of radiation safety and radiation protection. This would allow effective ways to be found to reduce the probability of acts of radiological terrorism and to minimize their direct and indirect consequences.

DISCUSSION

R.F. GUTTERRES (Brazil): Could you comment on the risk of using unsealed sources in the presented scenarios?

L.A. BOLSHOV (Russian Federation): Unsealed sources could be even more dangerous than processed sealed sources. It is not difficult to convert them to liquid or aerosol form.

A.J. GONZÁLEZ (Argentina): Your institute has made a unique model. However, I did not see any modelling for cases involving the ^{90}Sr thermogenerators, which produce sources of 40 000 Ci. About 1000 units were produced, which means a viable activity of 40 million curies, a very serious matter. The modelling of any dispersion scenario for that is not clear to me at all. Is there any real danger of dispersion? Did your institute work on this?

L.A. BOLSHOV (Russian Federation): A big source produces a big impact. I am not prepared to discuss details in front of this audience. My message is that other sources can also result in a big impact. It is necessary to view the problem systematically and in a broad perspective.

UNITED KINGDOM STRATEGIES AND EXPERIENCE FOR REGAINING AND MAINTAINING CONTROL OF RADIOACTIVE SOURCES

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Abstract

The United Kingdom has been producing, using, importing and regulating radioactive substances for more than 50 years. Over that time, arrangements have been developed that have generally provided effective control of radioactive sources. Some arrangements are statutory; others are provided on a voluntary basis by industry. These include regulatory authorities, legislation, plans to deal with certain types of incident and 'long stop' arrangements when no other arrangements are available. The paper outlines the United Kingdom legislation and regulatory authorities, and describes the current arrangements. It goes on to describe new and planned developments that have been driven by the emergence of the European Union's High Activity Sealed Source Directive, recognition of terrorist threats and modernization initiatives from the regulators.

1. BACKGROUND

The United Kingdom has three territorial environmental regulators of radioactive substances: The Environment Agency for England and Wales, the Scottish Environment Protection Agency in Scotland, and the Environment and Heritage Service (Chief Industrial Pollution and Radiochemical Inspector) for Northern Ireland. In addition, regulation of radiation safety is provided by the Health and Safety Executive. Together, these bodies regulate over 5000 premises that use radioactive substances.

The main legislation relevant to this paper is the Radioactive Substances Act 1993. This implemented the Revised Basic Safety Standards Directive Euratom 96/29. The first Act was made in 1948. The Act is intended to minimize the generation of radioactive waste, as well as to minimize the impact of disposal of such waste on humans and the wider environment. The Act currently applies to relevant premises rather than individual sources.

Radiation safety is regulated under the provisions of the Ionising Radiations Regulations 1999. The Transport Regulations are enforced by the Department for Transport.

2. CURRENT ARRANGEMENTS

The legislation provides a pre-authorization regime of permitting and compliance checking (inspection). Enforcement measures available to the regulators range from the use of the less formal stern letter, through statutory notices, to criminal prosecutions with penalties that include imprisonment for up to five years for a conviction on indictment.

The requirements of the Transport Regulations have led to the development by the nuclear industry of a consortium of organizations that offer mutual assistance in the event of a transport accident. This consortium is called RADSAFE and its purpose is to provide expert assistance to the emergency services following an incident involving the transport of radioactive material by any signatory company of the RADSAFE contract. Further details are available at the RADSAFE web page: www.radsafe.org.uk/.

Like many other countries, the United Kingdom has had incidents involving the introduction of orphaned radioactive sources into the supply chain of metals recycling sites (MRS). The regulators are pleased to have a very constructive relationship with the metals recycling industry and welcomed their introduction of portal monitors to screen consignments of scrap metal on arrival at larger MRS, at the top of the supply chain. This has been funded entirely by the industry and has proved to be generally effective at detecting β–γ emitters, whether these are naturally occurring radioactive substances, contaminated or activated items, or discrete sealed sources.

However, not all β–γ sources are detected, and α emitters are effectively invisible to such systems. Not surprisingly, therefore, melting incidents have occurred including ^{238}Pu and ^{241}Am. Although the environmental and safety consequences of these incidents have not been very significant, the commercial impacts have been great.

The regulators provide some support to the industry by taking pragmatic approaches to permitting, in recognition that operators of MRS inadvertently and unexpectedly acquire radioactive sources in these incidents, but the regulators require the MRS operator to take steps to secure the prompt disposal of any items acquired in such circumstances. To be less pragmatic carries the risk that such discoveries might not be reported and that the very few less reputable operators would make irresponsible disposals. In general though, operators of MRS take a very responsible attitude in these circumstances and take any such material into management control, usually at their own financial cost. The regulators strongly wish to keep this constructive relationship with the industry, for obvious reasons. One way this is being done is to provide advice on the use of competent contractors to assist with cleanup and disposal of waste arisings.

In addition, the Environment Agency chairs a United Kingdom Orphan Sources Liaison Group that provides a forum for all stakeholders to share views and exchange business intelligence. The group was originally established in 1999 following the IAEA conference co-sponsored by the World Customs Organization, the International Criminal Police Organization, the European Commission and the French Atomic Energy Commission. This has enabled effective communication on a number of relevant issues, for example by assisting both the industry and HM Customs in the early stages of planning interdiction of illicitly trafficked radioactive sources at United Kingdom ports. In addition, through the group other industries have established radiation portal detectors in some key commercial facilities.

On some occasions, incidents involving radioactivity occur outside the control of any legal person, and outside the scope of established contingency plans. The United Kingdom is fortunate in having the NAIR scheme (National Arrangements for Incidents Involving Radioactivity, www.hpa.org.uk/radiation/understand/radiation_topics/radiation_incidents/nair.htm).

In Northern Ireland there is a similar scheme, RIPP (Radiation Incident in a Public Place).

These arrangements have been in place since 1964, and since 1971 they have been coordinated by the National Radiological Protection Board (now part of the Health Protection Agency). They are invoked by the police when no other arrangements are available so that they can call on technical support and advice provided by the voluntary participation of medical and university radiation physics departments, as well as the nuclear industry. These arrangements work very well in making the scene safe, and sometimes the respondent may be able to remove the item from the scene. The Environment Agency values this aspect of the service provided by NAIR respondents, and it provides flexible permits to allow this work and some financial support to assist with disposal costs. The arrangements have been invoked between six and twenty times per year, and most often it is found that the incident does not involve an orphan source, simply something mistakenly taken to be radioactive.

The paper has so far described the main components of the United Kingdom's strategy for regaining and maintaining control of radioactive sources. These have been built upon more than 50 years of experience and lessons learned by all involved. However, the situation continues to develop. Recent changes in European legislation and the nature of world terrorist threats have resulted in further improvements. These will be described in the next section.

3. RECENT AND IMMINENT DEVELOPMENTS

The United Kingdom Government and regulators are currently working hard to implement the High Activity Sealed Sources 2003/122/Euratom Directive (HASS Directive). At the time of writing, the United Kingdom's Department for Environment, Food and Rural Affairs (Defra), the Scottish Executive, the Welsh Assembly Government and the Department of the Environment, Northern Ireland, are jointly consulting publicly on proposed regulations to implement the HASS Directive. As the details will be decided only when this consultation is complete, the descriptions relating to HASS that follow are not fixed.

Only a brief summary of some of the HASS provisions will be provided here. The intention is to provide an impression of some likely enhancements to the United Kingdom strategy for regaining and maintaining control of radioactive sources.

The HASS Directive requires financial provision for end-of-life disposal of all relevant sources, and financial provision for the disposal of orphan sources. This will in some cases introduce a new commercial discipline to users of HASS, and especially to their finance officers, who have to make this provision.

The requirements of the HASS Directive will be built into permits granted under the Radioactive Substances Act 1993 (as amended). In particular, the notification of transfers between 'holders' will require the development and use by the regulators of a register of all HASS. This will enable 'cradle to grave' regulation of each individual HASS. The regulators will use information technology systems to periodically reconcile statutory notifications made by both the consignor and the consignee of HASS. Any failures of reconciliation will enable ad hoc compliance checks (inspections) to be implemented to assess the situation and the continuing competence of the holders. The existing enforcement regime will continue.

Article 9 of the HASS Directive requires competent authorities to make provision to recover orphan sources and to deal with radiological emergencies due to orphan sources. The Environment Agency strongly supports the proposition from the United Kingdom Government that it will lead a national committee to coordinate the various arrangements to manage incidents involving orphan sources, including those described below.

At the same time that the HASS Directive is implemented, further legislative changes are being prepared to develop a new Protective Security

Regime. This is part of a range of measures for the risk based management of deliberate releases of radiological material.

The new regime will require that users of HASS and sources of a similar level of potential danger (so as to include overlapping IAEA categories) meet the requirements of a statutory Security Standard. Under development at present, it will be based on a voluntary code of practice that was established soon after September 2001. The Standard will prescribe levels of protective security for each category of source, based on IAEA-TECDOCs-1344 and 1355. The ability of any operator applying for a permit under the Radioactive Substances Act to comply with the Standard will be assessed by a specialist police officer. Only if the police are content will the environmental regulators issue a permit for the keeping and use of the relevant sources. Transitional arrangements will be put in place for existing premises. Enforcement action will be undertaken by the regulator.

The United Kingdom Government has funded a Surplus Source Disposal Programme for the past year and which has a further two years to run. The programme follows on from two programmes previously run in Scotland by the Scottish Executive and one in Northern Ireland. Managed by the Environment Agency on behalf of the other regulators, it has identified several thousand sources which are potential candidates for disposal under the programme. Recycling options are also being considered. Some 200 sources have been collected so far and removals are being prioritized for the higher hazard category sources. The programme will provide cost subsidies in the range 100% to 20%, depending on the industry sector of the owner. Some industry sectors will not be subsidized at all.

At United Kingdom borders, HM Customs has established Operation CYCLAMEN, a programme to screen imports for illicit radioactive materials. This work surveys freight, passengers and vehicles at sea, air and land ports within the United Kingdom. HM Customs has agreed to notify the relevant regulators in the event of discoveries that have safety or environmental implications even if there are no national security aspects.

Finally, in order to provide resources where they are most needed, where the risks of environmental harm are greatest, the Environment Agency is modernizing its approach to the regulation of radioactive sources. This may mean that lower risk sources will be regulated less than at present, to free resources for higher risk sources. The Environment Agency is also looking to become more efficient by using fewer staff but in a more focused way, and it may reduce its permitting workload, where appropriate, by automated processing of selected applications and by automated issue of selected permits, using the Internet.

4. CONCLUSIONS

The United Kingdom is moving forward from arrangements that have been developed over 50 years to enhanced arrangements consistent with the needs of today. This has been driven by European Union legislation, but also by national security considerations. We are not trying to stop the justified use of radioactive substances; we are improving further our risk based arrangements to provide for the effective regaining and maintaining of control of radioactive sources.

ACKNOWLEDGEMENTS

I am grateful for the advice of my colleagues in the Environment Agency and the other regulatory bodies on the preparation of this paper, as well as that of colleagues in Defra, HM Customs, the police and the Health Protection Agency.

DISCUSSION

S.B. ELEGBA (Nigeria): Does the Radioactive Substances Act provide the Environment Agency with powers to impose fines and imprisonment or is this carried out by the court?

C.J. ENGLEFIELD (United Kingdom): In England and Wales (in Scotland it is different), the Environment Agency is the prosecuting authority. Imposition of fines and execution of prison sentences is a role of the courts as it would be for any other criminal offence.

S.M. AU (China): You mentioned that in the United Kingdom, the NAIR scheme (National Arrangements for Incidents Involving Radioactivity) was activated some six to twenty times a year. What are the typical incidents that call for activation?

C.J. ENGLEFIELD (United Kingdom): The arrangements are coordinated by the Health Protection Agency, whose experience is that the typical incident is probably a false alarm, for example an item labelled with a radiation trefoil that is not actually radioactive. Incidents involving sources occur infrequently, and it is difficult to specify what is typical. However, arrangements can be escalated to meet large scale incidents involving radioactivity and — in the few cases where they were needed — have always worked very effectively.

UNITED STATES NUCLEAR REGULATORY COMMISSION INITIATIVES ON NATIONAL SOURCE TRACKING

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Abstract

The terrorist events of 11 September 2001 caused the United States of America to review the nuclear security requirements for the use of radioactive material for industrial and medical purposes. The Nuclear Regulatory Commission (NRC) has pursued several domestic initiatives in the area of safety and security. One of the initiatives involved working with the US Department of Energy in a joint study on radiological dispersal devices. This study identified radionuclides and quantities of concern, with recommendations for improvements in the tracking and inventory of high risk sealed sources. To meet the recommendations from the joint study and the US commitments in the Code of Conduct on the Safety and Security of Radioactive sources, the NRC is developing a National Source Tracking System. The NRC has also developed an interim database as precursor to a National Source Tracking System. The interim database is being updated periodically until the National Source Tracking System is in place. The National Source Tracking System will ultimately provide a ‘cradle to grave’ account for all high risk sealed sources.

1. INTRODUCTION

As a result of the terrorist attacks in the United States of America on 11 September 2001, the Nuclear Regulatory Commission (NRC) has undertaken a comprehensive review of nuclear security requirements for the use of radioactive materials for industrial and medical purposes. The NRC’s review takes into consideration the changing domestic and international initiatives in the nuclear security area.

In June 2002, the US Secretary of Energy and the NRC Chairman met to discuss the nation’s ability to adequately protect inventories of nuclear materials that could be used in a radiological dispersal device (RDD). At that meeting, the Secretary of Energy and the NRC Chairman agreed to convene an Interagency Working Group on Radiological Dispersal Devices to address security concerns. In May 2003, the joint United States Department of Energy

(USDOE)/NRC report was issued. The report, entitled Radiological Dispersal Devices: An Initial Study to Identify Radioactive Materials of Greatest Concern and Approaches to Their Tracking, Tagging, and Disposition [1], contained a recommendation that a National Source Tracking System be developed to better understand and monitor the location and movement of sources of interest.

The NRC also participated in the development of the IAEA Code of Conduct on the Safety and Security of Radioactive Sources [2] and IAEA-TECDOC-1344, Categorization of Radioactive Sources [3]. Annex I to the Code of Conduct, List of Sources Covered by the Code, identified the top three categories from IAEA-TECDOC-1344 as high risk sources. The recommendation for a national source registry applies only to those Category 1 and Category 2 radionuclides identified above the dashed line in Table I of Annex I to the Code. The work on the USDOE/NRC joint report was done in parallel with the Code of Conduct and the work on IAEA-TECDOC-1344. As it turned out, the quantities of concern identified in the USDOE/NRC joint report were similar to the IAEA-TECDOC-1344 Category 2 values, so the NRC adopted the IAEA values to allow alignment between the domestic and international efforts to increase the safety and security of radioactive sources.

While the NRC and the Agreement States previously concentrated on ensuring the safe and effective use of sealed sources, we now increasingly consider how to prevent terrorists from obtaining and using the material. Efforts to improve controls over sealed sources involve significant challenges, especially balancing the need to secure the materials without discouraging their beneficial use in academic, medical and industrial applications. The NRC has begun efforts to meet the commitments made by the US Government's endorsement of the Code of Conduct and to implement recommendations from the USDOE/NRC joint report. These efforts have resulted in an interim database and work towards the development of the National Source Tracking System.

2. INTERIM DATABASE

Currently there is no single US source of information to verify the authorized users, locations, quantities and movement of high risk sealed sources. Separate NRC and Agreement State systems track licensees and the maximum amounts of materials they are authorized to possess, but do not record actual sources or their movements.

To address this lack of information on actual material possessed, the NRC, with the cooperation of the Agreement States, began working on an interim database of high risk sealed sources. In November 2003, both NRC and Agreement State licensees were contacted and requested to voluntarily provide some basic information on the IAEA Category 1 and Category 2 sources located at their facilities. This database was intended to be a 'snapshot' of material actually possessed at the time compared with licensed authorizations. Of the approximately 2600 licensees contacted, 1313 licensees reported possessing over 5000 high risk sealed sources at the IAEA Category 1 or Category 2 level. The interim database will be updated in 2005 and again in 2006, and will ultimately be replaced by the National Source Tracking System. The database is currently being used to inform NRC efforts to improve security and to better track high risk sealed sources. The interim database will serve to meet the US commitment for a national source registry until the National Source Tracking System is operable, beginning in late 2006.

3. NATIONAL SOURCE TRACKING SYSTEM

While the interim database provides a snapshot in time, the National Source Tracking System will provide information on an ongoing basis. Development of the National Source Tracking System is a two part activity that includes both a rulemaking and information technology development. The rulemaking will establish the regulatory foundation for the National Source Tracking System. The information technology development aspect will develop the actual system. When completely operational, the National Source Tracking System will be a Web based system that would allow licensees to meet the reporting requirements on-line with ease. The system will contain information on NRC licensees, Agreement State licensees and USDOE facilities.

The rule would require licensees to report information on the manufacture, transfer, receipt and disposal of high risk sealed sources. The thresholds for reporting will be the list of radionuclides that the US Government endorsed in the Code of Conduct for Categories 1 and 2, with seven other radionuclides added at the direction of the NRC. The information to be captured by the system includes the origins of each high risk sealed source (manufacture, recycling or import), all transfers to other licensees, all receipts of high risk sealed sources and end points of each high risk sealed source (decay, disposal or export). Information on the companies involved in the transactions will also be collected. Ultimately the National Source Tracking System will provide a 'cradle to grave' account for all high risk sealed sources.

A system of this type will need continuous updating to be useful and accurate. In order to capture information as soon as possible, licensees will be required to report information on high risk sealed source transactions by the close of the next business day. To ease the burden on licensees, the NRC is planning to establish a secure Internet based interface to the National Source

Tracking System. This interface would permit licensees access to the system using an Internet browser. Licensees would log on to the system and enter the required information by filling out a form on-line. Licensees will be able to view only their own information. While on-line access should be fast, accurate and convenient for licensees, the NRC would also allow licensees the option of completing and mailing or faxing paper forms.

The proposed schedule for implementing the National Source Tracking System reflects the need for a rulemaking and the development of the system itself. The proposed rulemaking should be provided to the NRC by spring of 2005, and the final rule should be in place by July 2006. After issuance of the final rule, there will be a phased implementation of the tracking system beginning in late 2006.

4. CONCLUSION

National source tracking is part of a comprehensive radioactive source control programme for the radioactive materials of greatest concern. Although neither a source tracking system nor a source registry can ensure the physical protection of sources, it will provide greater source accountability. A National Source Tracking System in conjunction with other controls will result in improved security and accountability for high risk sealed sources. This paper has presented the NRC's efforts on developing a National Source Tracking System. Significant progress has been and continues to be made domestically. The efforts include development of an interim database, a rulemaking and the development of the National Source Tracking System. The tracking system is expected to be implemented in late 2006 or early 2007.

REFERENCES

[1] UNITED STATES DEPARTMENT OF ENERGY/UNITED STATES NUCLEAR REGULATORY COMMISSION, INTERAGENCY WORKING GROUP ON RADIOLOGICAL DISPERSAL DEVICES, Radiological Dispersal Devices: An Initial Study to Identify Radioactive Materials of Greatest Concern and Approaches to Their Tracking, Tagging, and Disposition, Washington, DC (2003), http://www.doe.gov/engine/doe/files/dynamic/9620039919_RDDRPTF14MAY.pdf

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA-TECDOC-1344, IAEA, Vienna (2003).

ACCOMPLISHMENTS AND LESSONS LEARNED FROM THE UNITED STATES DEPARTMENT OF ENERGY'S DOMESTIC RADIOLOGICAL THREAT REDUCTION PROGRAMME

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Abstract

The United States Department of Energy (USDOE) recovers excess and unwanted sealed radiation sources in the USA through its Offsite Source Recovery Project (OSRP). The OSRP is now included in the USDOE's Global Threat Reduction Initiative announced in March 2004. The excess and unwanted sources being addressed by this effort consist of ten isotopes that either lack a permanent disposition path or are considered to present high radiological security risks. This project recently exceeded the 10 000 mark for excess sealed sources recovered for safe and secure storage. These sources consisted mainly of ^{241}Am and ^{238}Pu. The programme has expanded its efforts into additional radionuclides. Since 2004, the first substantial amounts of ^{60}Co, ^{137}Cs and ^{90}Sr have been recovered. Commercial contractors safely removed nearly 500 of these sources from a bankrupt and abandoned Pennsylvania facility. In another action, ^{137}Cs irradiators were removed from public schools in the New York City area. Most of these sources have been disposed of or recycled. The paper describes the USDOE's radiological threat reduction programme.

1. INTRODUCTION

The United States Government has recovered excess and unwanted sealed radiation sources from the US commercial and academic sectors for 25 years. This activity started as a limited effort addressing only ^{239}Pu provided through a government special nuclear material loan/lease programme. These sources were returned to the government defence programmes. During the 1990s, additional work began addressing other long lived sealed radiation sources containing ^{241}Am and ^{238}Pu. These sources presented a growing problem because they comprise low level radioactive waste (LLW) but are not suitable for disposal in shallow land burial facilities. Other appropriate disposal options are not yet available.

With no disposal options, these sources represent potential health and safety issues and present an economic burden to the owners. With no disposition path, increasing numbers of excess radiation sources became orphaned and abandoned. Through the 1990s, the US Department of Energy (USDOE) recovery effort was limited to small numbers of radiation sources handled on a case-by-case basis. Typically action was taken only in response to a specific request from a federal or state regulatory agency.

More recently, further concerns have arisen over theft and illicit trade in sealed sources and the possibility that terrorists could deliberately misuse sealed sources. Since the mid-1990s, a number of international conferences have been convened to establish general standards for the safety and security of sealed radiation sources. The issues involved include establishing national databases of materials and material tracking systems, identifying and securing abandoned and orphaned radioactive sources, and developing ‘cradle to grave’ management and regulatory strategies.

The US Radiological Threat Reduction (USRTR) programme is a US Government activity that addresses the immediate need to identify and secure domestic excess and unwanted sealed radiation sources. The USDOE’s National Nuclear Security Administration oversees the programme. Managed by the Los Alamos National Laboratory (LANL), it is the only proactive domestic effort under way to address this problem. In one form or another, this activity has been under way for more than 20 years.

2. DISCUSSION

The USRTR programme underwent substantial changes in the past few years. In the aftermath of terrorist attacks, the USDOE determined that the Offsite Source Recovery Project (OSRP) should no longer be administered as a waste management activity, but rather as a national security activity. This decision resulted in the OSRP’s transition from the environmental management programme to programmes addressing nuclear non-proliferation and threat reduction. Equally important, the US Congress determined in 2002 that the activity required supplemental funding. An additional $10 million was allocated to the programme, with a specific goal to recover 5000 excess and unwanted sources. The USRTR programme exceeded this aggressive goal by recovering over 5500 sources. During 2004, the programme exceeded the 10 000 mark for excess and unwanted sealed sources recovered from domestic licensees.

This government programme addresses the safety and security risks posed by unwanted long lived sealed sources. One of the most common isotopes used is ^{241}Am (Table 1). Many of these sources are used in oil and gas well-logging activities. Small firms lacking the physical capability and financial

TABLE 1. SUMMARY OF SEALED RADIATION SOURCES SECURED BY THE USRTR PROGRAMME

Nuclide	Number of sources	Activity	
		TBq	Ci
Americium-241	7 721	468	12 659
Plutonium-238	2 099	353	9 553
Plutonium-239	354	20	549
Caesium-137	3	44	1 200
Cobalt-60	100	1 576	42 586
Strontium-90	10	3 069	82 959

resources to provide safe storage commonly own these neutron sources. The most prolific domestic use of long lived sealed sources is in portable and fixed industrial gauges. Recovering these sources is particularly important because many are excess and unwanted, and commonly are lost, stolen or inadvertently discarded.

Considerable numbers of heat sources containing ^{238}Pu once were used in cardiac pacemakers. These pacemakers and ^{238}Pu batteries became obsolete in the 1970s with the onset of long life chemical battery technology. The OSRP has recovered more than 2000 excess and unwanted pacemakers to date.

Late in 2003, the OSRP resumed recovering excess government owned ^{239}Pu neutron sources. These sources are found at numerous colleges and universities, and are derived from the former Atomic Energy Commission's special nuclear material loan/lease programme. The USDOE has established that these sources meet the criteria for transuranic (TRU) waste disposal at the Waste Isolation Pilot Plant (WIPP). However, while they are consolidated at USDOE sites, they require storage in secure facilities owing to the attractiveness and considerable quantities of special nuclear material involved.

Most recently, the USRTR programme added ^{90}Sr sources to its list of recovery capabilities. Large ^{90}Sr sources are typically found in the radioisotope thermoelectric generators (RTGs) once used in remote terrestrial applications requiring low wattage electrical power supplies. These excess sources are now chiefly found in storage at government sites and military bases. All known commercially owned RTGs were recovered from firms in Texas and California during 2004 and 2005. These six RTGs accounted for nearly 3100 TBq (83 000 Ci) of material.

As medium and large ^{137}Cs irradiators become unwanted, or are replaced with newer technologies, increasing numbers of excess ^{137}Cs sources might require government action. The initial approach being taken for ^{137}Cs recovery takes advantage of the current commercial recycle and reuse capabilities. Since 2004, the USRTR programme has recovered five irradiators from public schools. Each irradiator contained approximately 7400 GBq (200 Ci). Many sources do not exceed the class C LLW criteria, and yet are not acceptable for commercial disposal. Planning is under way to recover 14 more of these devices in 2005.

Finally, the USRTR programme began recovering ^{60}Co in 2005. Approximately 41 TBq (1100 Ci) of ^{60}Co was recovered from a research irradiator. The sources had been on government loan since the 1960s and had decayed significantly. The recovery was the first removal of sources from a pool irradiator for the programme, and the first major ^{60}Co recovery. The sources were the property of the USDOE and were sent to USDOE LLW disposal. Another university irradiator is scheduled for decommissioning in 2005, amounting to 2440 TBq (66 000 Ci) of ^{60}Co.

On the basis of radiological threat criteria, the list of isotopes has expanded beyond the traditional scope of greater than class C waste (GTCC). Relying upon long term exposure modelling derived from radiological dispersal device (RDD) scenarios, the USDOE has identified ten isotopes to target for radiological threat reduction recovery:

^{241}Am, ^{252}Cf, ^{137}Cs, ^{60}Co, ^{244}Cm, ^{192}Ir, ^{238}Pu, ^{239}Pu, ^{226}Ra, ^{90}Sr.

3. RECOVERY AND STORAGE OPERATIONS

Beginning in the late 1990s, the USDOE greatly expanded its sealed source handling capacity at LANL to accommodate thousands of excess sealed sources from the licensed sector. Excess and unwanted sources are simply stored as radioactive waste at government facilities. This strategy requires developing nuclear material containers specifically for long lived neutron sources. The first of these is a special-form overpack capsule for individual sources. The second is a multifunction container capable of providing safe storage, transport and ultimately disposal.

3.1. Recovery, transport and storage efficiency

Composed of thick walled stainless steel, the special-form capsule safely contains damaged sealed sources or sources that for other reasons cannot be certified. Once closed, a special-form capsule cannot be reopened. The USDOE and LANL continue to modify and fabricate these capsules to accommodate unique sources as they appear, especially from government nuclear research and development laboratories. These capsules are available for both government and commercial activities.

The multifunction container evolved from containers used by the USDOE for transport and disposal of TRU waste. The container incorporates neutron shielding and accommodates considerable quantities of neutron sources without special handling requirements. The pipe overpack concept was modified to provide a narrow diameter (15 cm) inner payload container, within a standard 208 L (55 gal) drum. The annular space is filled with neutron shielding material. This multifunction container has been evaluated and approved by the government's TRU waste certification staff at WIPP, and is now acceptable for field recovery, transport, storage and disposal in the government's waste repository.

3.2. Cost, capacity and schedule

LANL expects to store more than 20 000 long lived radioactive sources by 2010. More than 10 800 radioactive sources are already in storage. More than 2000 additional sources are known to be excess, and recovery continues. Subsequent radioactive source recovery will occur at a pace depending upon numbers of sources declared excess and upon funding levels. The USRTR programme encourages licensees to register excess and unwanted sources from the list of eligible nuclides above.

Current operating costs for sealed source recovery and management average less than $3000 per source. This cost includes project management activities, recovery operations, storage facilities and container procurements. This figure excludes the costs to site, design and build a suitable disposal facility in the future. Radiation exposure to OSRP personnel is averaging substantially below 1 mrem/Ci (1 Ci = 3.7×10^{10} Bq) of activity collected and 1 mrem per source.

3.3. Ultimate disposition

The USA has not established a permanent disposition path for most long lived sealed sources. Currently the only suitable disposal site is WIPP, located in southeastern New Mexico. WIPP, however, is restricted to TRU waste generated from the US Government's nuclear defence programmes. Most recovered radiation sources are derived from the commercial and academic sector. These waste streams cannot be disposed of with US Government waste at WIPP. Therefore interim storage is required until a disposal pathway is developed. Projections indicate that less than 500 m^3 of waste in shielded containers will require interim storage. The next step for the US Government is to examine disposal options.

4. GLOBAL THREAT REDUCTION

The USRTR programme is also working closely with a partner international threat reduction programme and the IAEA. The programme has recently completed a demonstration of packaging and shipment of US origin ^{241}Am sources from South Africa to the USA. These sources will be shipped and received in the USA in the coming weeks. Additionally, the USRTR programme demonstrated its process with the IAEA by packaging a US origin ^{239}Pu source in Uruguay that will be shipped to the USRTR in the USA in the coming weeks.

New work will involve sealed sources containing the same isotopes already addressed, but in concentrations qualifying as class B or C LLW. The OSRP will also expand its activities to isotopes that never exceed class C LLW criteria but that are seen to present radiological threats. These isotopes include ^{252}Cf, ^{60}Co, ^{226}Ra and ^{192}Ir.

5. LESSONS LEARNED

So, what have we learned after six years of government sponsored sealed radiation source recovery? The principal reason a radiation source recovery programme was required is the lack of adequate disposal capacity. In the USA, most long lived alpha radiation sources and many large beta/gamma sources are now allowed in shallow land burial facilities. An alternative disposal method has yet to be developed. Excess and unwanted sources will continue to present safety and security risks if they are not disposed of or recycled.

Since 1999, the USRTR programme has solicited US institutions to register excess and unwanted sealed radiation sources. Since that time, the programme has recovered nearly 11 000 sources. Annual recovery rates have exceeded 3100 sources. Despite these statistics, the USRTR database has rarely dipped below 2000 additional sources requiring recovery. States should be assured that proactive national policies and programmes to consolidate, store and dispose of excess sources are necessary and will be used.

USDOE facilities have large capacities for providing safe and secure storage for radiation sources. In the long run, using the commercial sector to assist in packaging, consolidating and transporting radiation sources brings a great deal of expertise and efficiency to the programme.

The variety of radiation sources manufactured, and the conditions in which they are used, lead to many unexpected situations. Radiation source recovery, conditioning and interim secure storage require experienced persons, robust equipment and flexible operating procedures so that unexpected conditions can become routine work.

6. CONCLUSION

The USRTR programme manages large numbers of excess and unwanted long lived sealed sources and addresses substantial safety and security risks, recovers sealed sources from the commercial and academic sectors at an increased rate, and provides safe storage pending the availability of a suitable repository. With the expansion of the programme to include other nuclides, including non-actinides, source owners are encouraged to register sources for management.

DISCUSSION

J. CROFT (United Kingdom): You described the capability for removing sources from bankrupt companies. Are there mechanisms to identify companies going bankrupt in order to address the source security issue before people walk away and leave the sources?

J.P. GRIMM (USA): This occurs in a number of ways. In the USA, we have always relied on licensees and the state and federal regulators to inform us of situations of higher priority than we might be aware of. We typically prioritize recovery activities by amount of material with known or perceived lack of security at a facility. The USDOE's Memorandum of Understanding with the NRC addresses cooperation between the agencies wherein either one can inform the other of emerging problems and we rely upon that good working relationship to resolve the difficulties.

P.K. HOLAHAN (USA): At the NRC, if we get notification of the possibility of a licensee going bankrupt, we can put in a claim for any money available from the bankruptcy courts. If there is no money, we contact the Offsite Source Recovery Project (OSRP). If the USDOE gets information about a potential bankruptcy, it will inform the regulator.

A.-C. LACOSTE, Chairperson (France): That means a case by case process.

P.K. HOLAHAN (USA): Yes.

L.A. BOLSHOV (Russian Federation): You mentioned protecting information while companies order sources and plan shipping. Do you restrict manufacturers' advertising their products or do you protect only the shipping part of the deal?

P.K. HOLAHAN (USA): There are no restrictions on advertising by a manufacturer but the information in the orders to licensees and in the National Source Tracking System is considered not publicly available because it contains data on specific sources. That includes shipping information.

J.P. GRIMM (USA): The database that creates the map that I have presented is managed for us by our contractors at Los Alamos National Laboratory. Not even I have access to it. Obviously, it contains much more information than has been shown here. We use it as a management tool to schedule and track sources from when they are registered with us until we put them in containers and move them to our facilities, and then on to the point of disposal. We never provide such detailed information to the public.

C. MacKENZIE (IAEA): Does the OSRP use the IAEA categorization system for prioritizing which sources get disposed of?

J.P. GRIMM (USA): First, there is nearly no known disposal path for most sources included in the USDOE's programme. Rather, the sources are consolidated for secure interim storage. Secondly, IAEA categorization is only one tool we use to prioritize sealed source recovery. The USDOE attempts to address the highest activity sources and lowest security sites first. Also, there are other parameters and concerns that can affect prioritization. Finally, many sources are included in the OSRP because they have no disposal path and they could be as low as Category 4 or 5.

P.K. HOLAHAN (USA): For example, the facility that the USDOE went into in Pennsylvania had sources of all different types and categories, so they picked up the whole lot rather than just Categories 1 and 2.

J.P. GRIMM (USA): The number of sources and the amount of radioactivity at the Pennsylvania facility were not perceived as a security threat except for the fact that the sources were completely abandoned.

TECHNICAL SESSION 2: CHAIRPERSON'S SUMMARY

A.-C. LACOSTE
France

I have drawn the following main conclusions from this session on national strategies for and experience in gaining and maintaining control of radioactive sources:

Most presentations were quite modest; they were not at all arrogant. Some speakers noted recent changes in their organizations. There was much work in progress on national strategies and scenarios in order to maintain and regain control. We are all aware of the difficulty of controlling radioactive sources.

We are all trying to implement a cradle to grave strategy. Mr. Féron mentioned the three pillar idea: a licensing system, an on-site inspection system and a national inventory with source transfer monitoring. We discussed the problems associated with orphan sources, the implications of returning used sources to the supplier, and the issue of import and export.

In the discussion on international cooperation, two items emerged: (i) international instruments, such as the Code of Conduct (not legally binding) and the European Union Directive on High Activity Sealed Sources (legally binding); and (ii) bilateral, multilateral, regional and worldwide cooperation. An important point: The best way to find out what a regulatory body in another country does is to send somebody from your organization to work there for several years. That way, you not only understand the work and procedures but you also create a pattern of cooperation.

On security and safety, some presentations dealt exclusively with one of the topics (the French presentation, for example, was only on safety issues), others with both.

Commenting on Mr. Bolshov's presentation, I have nothing against its quality but I regard it as a mistake to present the content to such an audience.

REGIONAL AND INTERNATIONAL EFFORTS TO REGAIN CONTROL

(Technical Session 3)

Chairperson

Z.Q. PAN
China

IAEA–USA–RUSSIAN FEDERATION COOPERATION IN THE FIELD OF ENHANCING THE SECURITY AND PROTECTABILITY OF IONIZING RADIATION SOURCES

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1. FEDERAL ATOMIC ENERGY AGENCY ORGANIZATION

In the Russian Federation, issues relating to the safe operation of nuclear power facilities are coordinated by the Federal Atomic Energy Agency (FAEA). Rosatom is responsible for the provision of nuclear, radiological, technical, industrial, fire and environmental safety; labour protection; protection of personnel, the population and the environment in the vicinity of the facilities; prevention and mitigation of emergency situations; accounting and control of radioactive materials and radioactive waste; and the safe handling of nuclear and radioactive materials, radioactive waste and spent nuclear fuel, taking into account the international scientific and technical cooperation in this field. All these issues are also related to the management of ionizing radiation sources (IRSs). The legal basis of regulation of IRS use in Russia consists of the following:

(a) Federal Law of the Russian Federation "On the Use of Atomic Energy", No. 170-FZ, dated 1995-11-21;
(b) Federal Law of the Russian Federation "On Sanitary and Epidemiologic Well-being of the Population", No. 52-FZ, dated 1999-03-30;
(c) Order of the Government of the Russian Federation No. 1298, dated 1997-10-11, "On Approval of the Rules of Organization of the State System for Control and Accounting of Radioactive Substances and Radioactive Waste";
(d) "The Provisions on the State Accounting and Control of Radioactive Substances and Radioactive Waste in the Russian Federation", registered with the Ministry of Justice of the Russian Federation on 1999-11-11, Reg. No. 1976;
(e) Normative technical documents setting the requirements and procedures for various types of activity connected with IRS management: design

requirements, manufacture, storage, security, transport, lifetime prolongation and other requirements.

The following functions of IRS management are implemented by the FAEA:

— Methodical supervision, organization and conduct of work on licensing, certification and preparation of decisions on recognition of the organizations reported to Rosatom as being capable of operating nuclear power facilities, including handling of IRSs and prolongation of their lifetime;
— Issue of certificates for transport of nuclear and radiological materials;
— Organization of the State system of accounting and control of radioactive materials (RM) and radioactive waste (RW);
— Prevention and mitigation of emergency situations at the organizations reported to Rosatom.

Management of the State system of accounting and control of nuclear and radioactive materials and radioactive waste, including keeping of the corresponding logs and records, is implemented by Rosatom according to the legal and normative acts listed above. At present, the main executive agencies implementing regulation and control of radionuclide sources in the Russian Federation are the following:

(1) Federal Service for Environmental, Technological and Nuclear Supervision, which implements the functions of approval of normative legal acts, control and supervision in the field of safety of the use of nuclear energy and, in particular, licensing of the activities connected with the use of sources and monitoring of the observance of licensing requirements;
(2) Federal Service for Supervision in the Field of Protection of Consumer Rights and Well-being of the People, which performs the State registration of potentially hazardous products and facilities and, in particular, issues permissions for use of radionuclide sources to facilities, on completion of inspection of the conditions in which the sources would be operated.

The organizational structure of the State system of accounting and control of radioactive materials and radioactive waste is given in Fig. 1 and includes:

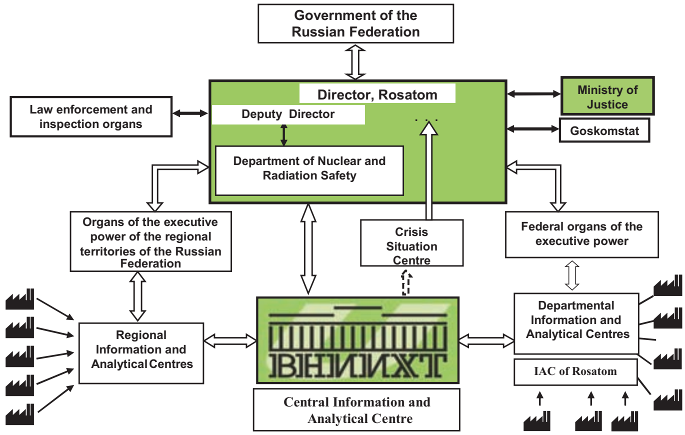

FIG. 1. Organizational structure of the State system of accounting and control of RM and RW in the Russian Federation.

(i) The FAEA and its Central Information and Analytical Centre (CIAC), which implements control and accounting of RM and RW at the federal level. The CIAC has been set up by the FAEA directives at the All-Russian Research Institute of Chemical Technology (FSUE VNIIKhT), with an office at the Emergency Technical Centre of Minatom of Russia (FSUE ETC).

(ii) Federal executive agencies and their Departmental Information and Analytical Centres (DIAC) set up by the relevant directives. These organizations implement control and accounting of RM and RW of the organizations which report to the said bodies. The organizations include federal State unitary enterprises and State organizations.

(iii) Executive agencies of the ‘subjects’ (regional territories) of the Russian Federation and their Regional Information and Analytical Centres (RIAC) set up by the relevant directives. These organizations implement control and accounting of RM and RW of organizations that are located in the territory of a corresponding regional territory of the Russian Federation and are not subordinate to the federal executive agencies.

(iv) Supervision and law enforcement agencies, which provide supervision over the functioning of the system at all levels, the investigation of incidents and the carrying out of actions directed at prevention of theft of sources, etc.

(v) Organizations which carry out activities involving RM and RW. The organizations carry out the initial control and accounting of RM and RW.

They are responsible for meeting requirements set by the legal acts and other regulations on conditions of safe operation, integrity and security.

2. SYSTEM DYNAMICS

The dynamics of the development of the system with respect to the number of Information and Analytical Centres and of organizations within the system are given in Figs 2 and 3, respectively.

Information and Analytical Centres are responsible for carrying out the organization and implementation of measures on RM and RW accounting and control, including:

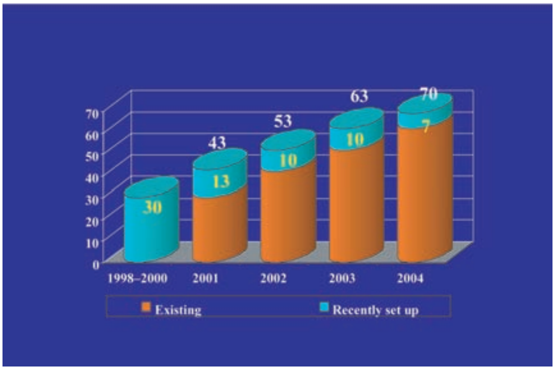

FIG. 2. Development of Information and Analytical Centres in the years 1998–2004.

FIG. 3. Development of organizations within the State system of RM and RW accounting and control.

(a) Collection of information on RM and RW incoming from subordinate organizations, including data received from supervision agencies, the results of RM and RW inventory at the organizations, and inspections;
(b) Processing, generalization and credibility analysis of incoming information on RM and RW accounting and control;
(c) Compiling and maintaining databases on RM and RW accounting and control;
(d) Preparation of data on RM and RW accounting and control data and their transmission to the CIAC in accordance with the established procedure;
(e) Participation in inspections of individual organizations related to issues of RM and RW accounting and control in accordance with the procedure established by the federal executive agency;
(f) Arrangements for training of specialists from interested subordinate organizations in RM and RW accounting and control.

The functioning of the State system of accounting and control of RM and RW is supported by normative and methodological documents which are constantly being improved. IRSs are accounted for in the system from the moment of their manufacture until the moment of their utilization or disposal. All intermediate relocations of the sources are registered. Both the supplier of the sources (upon dispatch) and the purchaser (upon receiving) must present the relevant information.

The system allows:

— Determining, within a short period of time, the party responsible for loss of control over sources;
— Supervising the timely decommissioning of sources and transfer of sources with expired lifetime to a utilization facility.

Further improvement of the system will take place upon completion of the all-Russian inventory of radioactive sources, which is scheduled for 2006, and improvement of the legislation in the field of establishing a procedure for conclusion of contracts connected with sources of Categories 1 and 2 according to the IAEA classification.

At the FAEA, great attention is being given to other activities connected with increasing the safety of management of radionuclide sources, in addition to supporting the functioning and modernization of the State system of accounting and control of RM and RW. Issues of enhancing safety and security are regularly discussed at both Russian and international conferences organized by the FAEA, and at the scientific and technical discussions held at the FAEA and the Russian Academy of Sciences. In particular, several issues are to be discussed at the Seventh International Conference on Safety in Nuclear Technology: Economy of Management of Ionizing Radiation Sources, which will be held in St. Petersburg on 26–29 September 2005.

Special attention is also being paid to advanced training of personnel in such aspects as safety culture in the nuclear branch, basic training in accounting and control of RM, and certain other specialities.

3. SECURITY

Increasing the security of IRS management is becoming more and more important in the wake of the threat of unauthorized use of IRSs in terrorist acts. Several activities directed at increasing the safety and security of IRS management are being carried out in the framework of international cooperation. This work is being most actively performed in the framework of the cooperation between Rosatom and the United States Department of Energy (USDOE), and covers the following areas:

(a) Analysis of the available information resources on IRS management in Russia and development of recommendations on top priority measures directed at increasing IRS safety and security;
(b) Removal of the radionuclide sources from unused gamma irradiation installations, reuse of the sources and improvement of IRS security system equipment;
(c) Removal of the radionuclide sources from radionuclide thermoelectric generators (RTGs) and reuse of the sources.

In the wake of the threat of possible use of IRSs in radiological terrorist acts, there is an urgent need to identify the storage places and operating conditions of IRSs, which are potentially attractive from the point of view of their use in radiological terrorist events. This was the motivation to start work in Russia in the first area mentioned above.

Work in this area is performed by the Nuclear Safety Institute of the Russian Academy of Sciences (IBRAE RAN), VNIIKhT and the Emergency Technical Centre in St. Petersburg. In the first stage of the work, the conditions of IRS handling in 20 regions of Russia (678 organizations) and 11 departments (676 organizations) were investigated. Gamma and beta sources with an activity above 100 Ci[1] and alpha sources with an activity above 10 Ci were

[1] 1 Ci = 3.7×10^{10} Bq.

considered, in accordance with the suggestion of the US side. The analysis shows that such IRSs are operated at 141 organizations under regional jurisdiction and 150 organizations under departmental jurisdiction. The total number of high activity IRSs exceeds 6000. System analysis allowed the identification of three priority directions for work associated with the reduction of threats of unauthorized use of high activity IRSs:

(1) Utilization of unused IRSs in order to decrease the number of organizations possessing high activity IRSs;
(2) Enhancement of IRS security at the IRS operating organizations;
(3) Enhancement of IRS transport security.

The analysis conducted is sufficiently representative to draw a conclusion about the similar situation with management of high activity IRSs in another 68 regional territories of the Russian Federation and federal executive agencies (ministries, agencies and services). The second stage of the work for ten other regions of Russia is in progress at this time.

FSUE Izotop, as an authorized representative of the FAEA, has been developing gamma irradiation installations since 2003. It performs the following work on the basis of the analysis of IRS management conditions at organizations:

(i) It identifies unused, non-maintained or orphan radiation sources (stationary irradiation installations and devices) containing IRSs.
(ii) It inspects facilities possessing unused or orphan IRSs intended for return and utilization in order to determine the level of their vulnerability (including vulnerability from the point of view of IRS theft), collects specific information concerning IRSs possessed by these organizations, develops a general plan for removal and subsequent disposal of the IRSs, estimates the cost of the work and gathers the data for drawing up a plan of work for each facility.
(iii) Identifies, decommissions, conditions, prepares for transport, transports and stores IRSs in a secure place.
(iv) Upon the request of the US working group, identifies, designs, plans and implements initial and comprehensive measures for modernization of systems of security, accounting and control of materials at selected inspected facilities where IRSs remain unreturned and security enhancement is required.

4. PROGRESS

The work at ten facilities was completed in 2004. In total, 21 gamma installations were received. Work at two facilities is now at the completion stage, and at five more facilities work has been started.

Work on removal of the sources from RTGs is under way. The work is being performed by the FSUE All-Russian Research and Development Institute of Technical Physics and Automation (VNIITFA). VNIITFA, in cooperation with Rosatom, identifies, removes, inspects, defines priority measures for, coordinates activities related to, transports, decommissions and puts into storage or disposes of these generators.

As of this time, 54 RTGs of various types have been inspected, decommissioned and removed from the North Shipping Route, and nine RTGs have been inspected, decommissioned and removed from Novaya Zemlya Island, Yugorskiy Shar Peninsula and Yamal Peninsula, including one emergency generator.

The total activity of 63 RTGs (77 sources) was 3.6 MCi. Forty of the 63 RTGs delivered to VNIITFA have been dismantled, and dismantling of other generators is under way. IRS processing is being performed at the Mayak Production Association.

A joint project, Securing and Managing Radioactive Sources (the Tripartite Initiative) is now being carried out on the basis of the agreement of the Presidents of the Russian Federation and the USA, and the Minister of Atomic Energy of the Russian Federation (the head of Rosatom) and the leadership of the USDOE and the IAEA.

The project is directed at assisting the independent States that were formed after the disintegration of the Soviet Union in order to raise the security of radioactive source management and prevent the possibility of their use in terrorist acts. According to the decision of the parties, the project is organized and managed by the IAEA.

Archived data of Rosatom facilities that were responsible for designing and supplying powerful IRSs, radiation installations and various kinds of equipment were analysed in the initial stage of the project. Lists of facilities and installations in the countries of the former Soviet Union were drawn up on the basis of analysis of documents. Information on the owners of the most powerful sources was updated. Russian experts, in collaboration with IAEA representatives and, in some cases, with USDOE representatives, carried out missions in seven republics — Armenia, Azerbaijan, Belarus, Kazakhstan, Moldova, Tajikistan and Uzbekistan. The specific objectives of the missions were:

(a) Assessment of the completeness of the source inventory, including information on the actual or possible location of the sources.
(b) Visits to the known locations of the sources and assessment of the safety level (including radiation safety, security and control) of operation and storage of these sources.
(c) Determining what was needed to increase the safety of sources, including utilization of sources, raising the safety of storage, organization of the return of sources to the countries of manufacture, and other measures.
(d) Assessment of the current situation and preparation of recommendations on further measures. Special attention has been given to the radioactive sources, radioisotope irradiation installations and RW repositories that are potentially hazardous from the point of view of their use by terrorist groups.

The missions allow information to be gained about the technical condition of installations and the level of security and radiation safety. Proposals on taking control over such facilities and ensuring their safety and security have been developed. Special attention is given to the sources that correspond to the category of ‘hazardous’ according to IAEA-TECDOC-1344, Categorization of Radioactive Sources.

Seventy-nine facilities have been visited and inspected in the course of the work, including radioisotope irradiation installations with various purposes and seven RW repositories that store about 450 kCi of various long lived sources based on $^{90}Sr + ^{90}Y$, ^{137}Cs, ^{60}Co and $^{239}Pu + Be$.

As a rule, similar situations have been observed in all the countries listed above. In general, the measures undertaken provide a minimum level of safety of radiation installations and facilities. At the same time, most of the countries do not have the resources to ensure the required level of safety in the management of radionuclide installations and radioactive sources without external help.

During the visits, special attention has been given to medical institutions. Oncological hospitals have the necessary infrastructure and qualified personnel. However, the equipment requires modernization. Many sources require replacement and utilization (disposal).

RW repositories have been inspected in all of the countries in the framework of the visits. The repositories were constructed about 40 years ago in the former Soviet Union. In general, such facilities provide the necessary conditions for temporary storage of powerful IRSs; however, modernization of the equipment is required, including equipment for the conditioning of RW and modern technologies for the management of powerful sources.

Visits to a number of facilities allow the conclusion to be drawn that financial support from the USDOE has helped to equip over half of the most vulnerable facilities with modern security equipment. However, this work has not been completed, and further work is required in order to enhance security in accordance with the recommendations of the US team and the specialists from Rosatom and the IAEA on increasing the safety of installations and facilities in the framework of the Trilateral Initiative, including those in the republics of Tajikistan and Uzbekistan.

For the republics of Azerbaijan, Belarus, Kazakhstan and Moldova, specific proposals have been prepared concerning the measures directed at taking control over powerful sources at the most vulnerable facilities and the long term storage of these sources. These actions are financed by the IAEA in the framework of the Trilateral Initiative.

Also, Russian specialists, supported by the IAEA, organized the transport from the vicinity of the Chernobyl nuclear power plant of four RTGs with a total ^{90}Sr + ^{90}Y activity of 128 kCi.

It was also clarified that some development and modernization of the national legislation and normative basis, and of the structure of regulatory agencies and their equipment, were required in order to meet the international requirements.

The programme of work coordinated with the host parties and implemented by the missions covered nearly the full scope of concerns related to the safety and security of radioactive sources. As a result of the work of the missions, scientific, technical and informational contacts were established with the State regulatory agencies in the field of nuclear energy use in the seven countries. Basic IAEA standards and technical documents were presented to these countries by the missions along with documents on the legislative and normative basis for management of radioactive sources in Russia. This will facilitate development of national legislative and normative databases. Recommendations were given to the supervisory agencies. The process of taking control over powerful sources, including carrying out a complete inventory of the sources, was stimulated. Specific proposals for dismantling and disposal of powerful sources have been developed for all the countries. These proposals were used to start the work in four of the countries. The accumulated experience was used to develop recommendations to the IAEA, Rosatom and its facilities. The implementation of these recommendations would greatly increase the safety level of IRS management and control over the most vulnerable facilities.

The missions carried out in the framework of the Trilateral Initiative are of great importance, as they draw the attention of governments and State management agencies in the field of nuclear energy use in the countries of the

Commonwealth of Independent States to the problems of increasing the safety of IRS management.

5. CONCLUSIONS

(a) A great amount of work has been realized in the framework of international cooperation. The work was directed at increasing the safety of IRS management and decreasing the possibility of the unauthorized use of IRSs by terrorist groups.
(b) The organizational structure created for the planning, management and implementation of the work greatly facilitates the effective realization of projects.
(c) The high level of professionalism of the participants has been demonstrated in the framework of international cooperation. This has allowed the safety of IRS management to be raised to the level of the normative requirements.

DISCUSSION

G. PRETZSCH (Germany): (1) What role does the Kurchatov Institute play in the removal and disposal of RTGs? (2) At what RADON facility besides Mayak will the RTGs be stored?

A.M. AGAPOV (Russian Federation): (1) RTGs are not — and will not be — stored at the Kurchatov Institute. (2) During operation and dismantling, RTGs are stored temporarily at premises, mostly military, with good physical protection. They are then transferred to the All-Russian Research and Development Institute of Technical Physics and Automation (VNIITFA), where they are dismantled, discharged and then sent for reprocessing to the Mayak Production Association. This is standard technology. Currently another possibility of temporary storage, retaining the basic technology, is being discussed.

BEYOND TRIPARTITE

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Abstract

Since the beginning of the nuclear age, radioactive materials have been directed towards peaceful uses in research, education, medicine and industrial activities. Any concerns raised were generally directed towards the inadvertent use of or accidental exposure to radioactive materials, which would cause a concern for the environment, safety and public health. Only recently have governments and experts begun to recognize the possible malevolent use of radioactive materials — that is, as weapons of mass disruption and of mass terror — by fashioning the materials into a radiological dispersal device. The attacks on the United States of America by terrorists on 11 September 2001 serve as an exclamation point to this concern because they demonstrate in the most graphic terms the ways in which many of the most common tools and materials that societies throughout the world use to enhance the quality of life can be used as weapons.

Today, radioactive materials are used in many areas of the economy, such as health care, food irradiation, oil exploration and education, and as remote power sources. The theft and use of these radioactive materials in a radiological dispersal device (RDD) pose a danger that few could have imagined only a few years ago. The radioactive materials that could be used in an RDD exist in a variety of forms in virtually every country in the world. They are often only loosely monitored and secured, if at all. Therefore it is critically important for each country to effectively address security in order to prevent terrorists from gaining access to the radioactive sources they need to construct such weapons. The threat requires a determined and comprehensive international response. Our governments must act, individually and collectively, to identify all the high risk radioactive sources that are being used or are no longer under any effective control. We must educate officials and the general populace, raising awareness of the existence of these dangerous radioactive sources and the consequences of their misuse, and we must account for and secure these sources wherever they may be.

Because radioactive sources are so widespread and so commonly used throughout the world, difficult choices remain for preventing their use for purposes of terrorism. First, how does one identify which radioactive sources pose the greatest security concern for use in an RDD? Second, how does one balance the need for appropriate security over sources that pose a significant risk, such as teletherapy units in hospitals, with the need to provide access to such sources for the public good?

The challenges posed by the need for increased security over radioactive materials led to the development of a partnership of the Governments of the United States of America and the Russian Federation and the IAEA, where each party could leverage its resources to implement the first multilateral radiological security partnership, known as the Tripartite Initiative. Within this new initiative, the three participants identified an immediate need for security upgrades and worked together to identify, secure and recover vulnerable, highest risk radioactive materials located in the former Soviet Union. Furthermore, under the Tripartite Initiative, efforts are also under way to establish the foundation for a long term, sustainable radiological security infrastructure and culture in the region.

To date, the Tripartite Initiative has successfully completed, or is in the process of completing, physical protection upgrades and/or new security activities in 12 of the 13 participating countries of the former Soviet Union. The broad spectrum of activities conducted under the Tripartite Initiative has included searching for, securing and recovering hundreds of high risk radioactive sources; constructing a number of secure radiological storage facilities; training hundreds of radiological experts, including first responders, in the area of radiological security; and transferring needed radiological detection equipment.

All three members have played vital roles in realizing the successes of the Tripartite Initiative. The Government of the Russian Federation provided expertise and key data; the IAEA provided coordination and management oversight for such key activities as the safe and secure transport of sources involved in these projects; and the Government of the USA provided technical assistance and other resources. Without the contributions of any one of these partners, this radiological security partnership in the former Soviet Union would not have been realized. The key word that reflects the success of the Tripartite Initiative is partnership. Without a partnership, the initiative would not be achieving its successes, especially in such a short period of time.

On the basis of the successes of the Tripartite Initiative and the findings and objectives of the Global Threat Reduction Initiative International Partners' Conference that was held in September 2004 in Vienna, we are now moving to implement similar regional radiological security partnerships throughout the world. The US Department of Energy's National Nuclear Security Administration is currently working with more than forty countries to enhance the security of radioactive sources that could be used in malevolent acts targeted at the international community. The findings of the conference reflected the concern of more than 590 participants from over one hundred countries that unsecured, high risk nuclear and other radioactive materials pose a threat to the international community. The conference participants also acknowledged that all States share the objective of helping to reduce that threat through common but differentiated efforts. They also recognized that the purpose of the Global Threat Reduction Initiative was to build international support for national programmes to identify, secure, recover and/or facilitate the disposition of high risk nuclear and other radioactive materials that pose a potential threat to the international community.

We can now point to the establishment of several regional radiological security partnerships, ranging from a very successful regional partnership with Australia in which radiological security support, including training and joint security missions, has been provided to numerous countries in the Pacific Rim and South Asia regions, to radiological regional security partnerships that are being established with India, Argentina, Brazil and Morocco. In addition, we are working with the Governments of the United Kingdom, France and several countries on the African continent to establish additional regional radiological security partnerships. It is also gratifying to note that the Government of the Russian Federation has also agreed to direct its very capable expertise to establishing partnerships, wherever appropriate, in other regions of the world to help improve the security and control of high risk radioactive sources.

The primary motive of this new regional radiological security partnership approach that was born of the Tripartite Initiative is to help achieve a lasting and effective radiological security infrastructure and culture in all the regions of the world, one that addresses the call for a long term, sustainable approach to radiological security. The approach of the regional radiological security partnership is that, fundamentally, the countries in a region are the most familiar with the security challenges and needs of that region and are best positioned to realize a long term solution. The approach also assigns responsibility to the governments of those countries to ensure that the radioactive materials used in research, commerce and industry are effectively controlled and secured within and while transiting their national boundaries.

Finally, the regional radiological security partnership approach also recognizes that countries that have available resources and technical means should assist those that have limited resources to address these new security concerns. A region can be secure from attacks that use RDDs only when all the countries in that region are secure. In turn, the world will be more secure only when all the regions of the world have effectively addressed security concerns. It is a constant reminder of the old adage, “A chain is only as strong as its weakest link." In the case of nuclear and radiological security, a malevolent act against any one country will have a lasting effect on all countries.

With the horrific events of 11 September 2001, it has become clear that radioactive material can be safe only if it is also secure. Safety and security are the two pillars on which the world must establish and implement all nuclear programmes as it moves forward. The good news is that, if the world addresses nuclear safety and security, then nuclear research, education, medicine and commerce will flourish as a direct result. The aim of this conference should be to commit to the construction of a safe, secure foundation on which future cooperative efforts can grow. Only cooperation on this scale will allow the world to continue to thwart those intent on causing violence to citizens and harm to our countries.

EFFORTS TO SAFELY MANAGE AND SECURE DISUSED RADIOACTIVE SOURCES IN AFRICA — AN AFRA INITIATIVE

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Abstract

The paper aims to evaluate the efforts on the part of the African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology (AFRA), as supported by the IAEA, to ensure that sealed radioactive sources on the African continent are safely and securely managed. Significant progress has been made in three areas: (1) the completion of successful radium conditioning missions to some countries in Africa, (2) the development of the Borehole Disposal Concept, and (3) the development of mobile units for the conditioning of spent high activity sealed sources and neutron sources in Africa. The work done so far by the First Africa Workshop on the Establishment of a Legal Framework Governing Radiation Protection, the Safety of Radiation Sources and the Safe Management of Radioactive Waste, held in Addis Ababa, Ethiopia, in April 2001, to advance the application of the Code of Conduct on the Safety and Security of Radioactive Sources, as well as proposals for follow-up, are discussed.

1. INTRODUCTION

The efforts aimed at managing the safety and security of disused sealed radioactive sources in Africa are evaluated against the background of international developments and standards. The African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology (AFRA) is eminently suited to act as the vehicle for facilitating the safety and security of sealed radioactive sources on the African continent. The achievements of AFRA in the management of disused radioactive sources as supported by the IAEA are: (1) the completion of successful radium conditioning missions to some countries in Africa, (2) the development of the Borehole Disposal Concept, and (3) the development of mobile units for the conditioning of spent high activity sealed sources and neutron sources.

The development of the Code of Conduct on the Safety and Security of Radioactive Sources, approved by the IAEA in September 2003, constitutes a major achievement in reaching international consensus on the safety and security of radioactive sources. An important milestone was the formulation of a ‘Common Position’ by the First Africa Workshop on the Establishment of a Legal Framework Governing Radiation Protection, the Safety of Radiation Sources and the Safe Management of Radioactive Waste, held in Addis Ababa, Ethiopia, in April 2001, calling for the creation of a forum for African countries to consider the effective application of the Code of Conduct. It is, however, important that this initiative be further pursued in order to ensure full implementation of the Code of Conduct in African countries.

2. AFRA AGREEMENT

2.1. Establishment of AFRA [1]

AFRA is an arrangement geared to facilitate regional cooperation between its Member States with the aim to address development problems through the effective application of appropriate nuclear science and technology and to facilitate the sharing of resources and facilities available in the region. The Board of Governors of the IAEA endorsed the AFRA Agreement at its meeting in February 1990.

Participation in AFRA is open to any African country which is a member of the IAEA and continues until such time as it is terminated in a written communication to the IAEA Director General. AFRA Member States reaffirm their wish to participate every five years and all either have done so or are in the process.

2.2. Participation in AFRA [1]

Each participating government shall decide upon the internal organization that will best enable it to execute AFRA projects, to which end it shall designate a National Representative and a National Coordinator, as well as a Project Coordinator for each project in which it participates.

Moreover, it has been an accepted principle from the inception of AFRA that this programme would exclusively promote and develop nuclear science and technology in Africa by optimizing the utilization of available laboratory facilities and expertise for the benefit of all countries concerned. In particular, the AFRA Agreement involves the majority of African governments and covers perhaps two thirds of the land area of the continent.

2.3. Role and involvement of the IAEA [1]

The role and involvement of the IAEA are clearly defined in the AFRA Agreement, which indicates that the IAEA is not a party to it. It provides that on the entry into force of the Agreement the IAEA will perform various administrative and financial functions aimed at facilitating the effective implementation of the Agreement. Also, Article VII.2 of the Agreement foresees that, subject to available resources, the IAEA will endeavour to support cooperative projects under the Agreement by means of its technical assistance and other programmes. AFRA is committed to assist not only its Member States but also any African country that needs assistance in this regard.

3. IMPORTANT ACHIEVEMENTS OF AFRA IN THE MANAGEMENT OF DISUSED SEALED RADIOACTIVE SOURCES

During the 1980s the IAEA Waste Management Advisory Programme (WAMAP) identified the need for proper management of sealed radioactive sources after experience gained from their missions had shown that such sources were generally stored under poor conditions.

3.1. Conditioning missions to Africa [2]

In 1991 the IAEA established its spent sealed radioactive sources programme, which included, among others, recommendations on issues associated with the safe management of spent radiation sources. This programme led to the appointment of expert teams for each regional global grouping to carry out radium conditioning in Member States.

A South African team was appointed to carry out the task on the African continent, with Egypt as an alternate. The conditioning programme in Africa formed part of the AFRA initiative, commencing with the conditioning of sealed radium sources. From 1999 to date the South African team has executed these conditioning missions in the following countries: Ghana, Tanzania, Madagascar, Sudan, Tunisia, Mauritius, Zambia, Zimbabwe, Morocco, Ethiopia and the Democratic Republic of the Congo. The missions were originally designed to condition radium sources, but ended up including the conditioning of other sources such as ^{60}Co and ^{137}Cs. AFRA called on all Member States to request assistance for the conditioning of these disused sources.

The objectives of these missions included the collection of sources at a central venue, their preparation prior to transportation, transportation, storage, conditioning, transfer to storage, interim storage and further management where necessary.

3.2. Borehole project

The IAEA, under the auspices of AFRA, has since 1995 investigated the concept of disposing of disused sealed radioactive sources (DSRSs) in boreholes. The primary purpose of this investigation was to develop the Borehole Disposal Concept (BDC) for the countries of the African region. The AFRA/BDC project investigation specifically focused on the technical and economic feasibility of the concept, employing systems and infrastructure that would be suitable for African conditions. The project was designed to be executed in three phases: Phase 1: Concept Definition; Phase 2: Concept Evaluation; Phase 3: Practical Demonstration, covering the second iteration of the safety evaluation and the licensing process associated with the implementation of the concept. As part of Phase 3 of the project, the development of a public participation model was required. In September 2001 the IAEA awarded to the Nuclear Energy Corporation of South Africa (Necsa) the Phase 3 part of the BDC project.

It was agreed with the IAEA that the practical demonstration of Phase 3 would not involve “a real disposal operation”, owing to difficulties foreseen in selecting a suitable site in South Africa for disposal of live sources. Necsa indicated to the IAEA that the selection of a site for real borehole disposal would be an unpredictable and lengthy process expected to extend beyond the BDC project time limits. Hence it was agreed that the current project would include all activities as originally agreed with the IAEA, except for the fact that a simulated disposal operation would be performed at Necsa’s Pelindaba site.

Necsa considered it necessary at this stage to determine the level of interest for the BDC among African countries. Hence a public participation survey was done involving 13 African countries, from which it appeared that they generally supported the concept. The countries that responded to the survey were Algeria, the Democratic Republic of the Congo, Egypt, Ethiopia, Gabon, Ghana, Kenya, Madagascar, Morocco, Namibia, Nigeria, Sudan and Zambia.

In April 2005 the IAEA convened an International Review Team consisting of five senior experts in radioactive waste management to assess the BDC. The Review Team, in its draft recommendations, affirmed that the BDC had been demonstrated to be a safe, economic, practical and permanent means of disposing of DSRSs. Further, the BDC was considered likely to be applicable to a wide range of DSRSs across a wide spectrum of hydrogeological and climatic environments. Accordingly, the BDC was considered to be a viable waste management option for present day management of these sources.

3.3. Sealed high activity radioactive sources

The IAEA also awarded to Necsa the contract to develop mobile conditioning units for sealed high activity radioactive sources (SHARS) to be employed in countries without the necessary infrastructure to handle SHARS. Necsa has already completed the conceptual and feasibility study phases of the project and is presently in the process of designing and constructing the unit required by the IAEA for delivery towards the end of 2005. The IAEA Borehole Review Team, mindful of the need to include all types of DSRS for borehole disposal, insisted on linking the BDC and SHARS projects. In particular, it recommended that adjustments be made to the SHARS system design in order to facilitate utilization of this system in conjunction with the borehole disposal system [3]. It further considered that the BDC was sufficiently developed that, after some improvements to the documentation and the incorporation of SHARS, it could soon be implemented, i.e. within a few years.

4. INTERNATIONAL DEVELOPMENTS REGARDING THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES [4]

The International Conference on the Safety of Radiation Sources and the Security of Radioactive Materials held in Dijon in September 1998 produced findings in the light of which the IAEA prepared an Action Plan, leading in September 1999 to the development of a Code of Conduct on the Safety and Security of Radioactive Sources [5].

International support for the Code of Conduct was soon expressed at the International Conference of National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Materials held in Buenos Aires in December 2000. The Buenos Aires conference called upon States to provide for the effective application and implementation of the Code.

In 2001 the IAEA, taking into account the major findings of the Buenos Aires conference and the Common Position (see Section 5), produced a Revised Action Plan for the Safety and Security of Radiation Sources. According to the Revised Action Plan the IAEA was required to consult Member States on their experience in implementing the Code of Conduct. The effectiveness of the Code was subsequently reviewed at a meeting of technical and legal experts in August 2002, resulting in the Code's provisions being strengthened in the light of the events of 11 September 2001.

The IAEA approved the Code of Conduct on 8 September 2003. The Code in its final form reflected the important findings produced by the International Conference on Security of Radioactive Sources held in Vienna in March 2003.

5. POTENTIAL IMPACT ON AFRA OF INTERNATIONAL DEVELOPMENTS IN THE SAFETY AND SECURITY OF DISUSED RADIOACTIVE SOURCES [4]

In response to the needs of smaller and less developed countries, notably those in Africa, the IAEA launched a technical cooperation project — as an IAEA Model Project — aimed at strengthening national regulatory structures in developing Member States, and thus enhancing the security of their radioactive sources. The Model Project was launched in 1995, and 52 developing countries participated from the outset. By the end of September 2001, the IAEA had received a request from another 29 countries to join the Model Project.

The need for tackling this problem in the developing world was abundantly clear. As a result, the issue was debated in April 2001, during the First Africa Workshop on the Establishment of a Legal Framework Governing Radiation Protection, the Safety of Radiation Sources and the Safe Management of Radioactive Waste, held in Addis Ababa, Ethiopia. It was attended by 35 participants from 14 Member States (Angola, Egypt, Ethiopia, Ghana, Kenya, Libya, Mauritius, Namibia, Nigeria, Sudan, Tanzania, Uganda, Zambia and Zimbabwe).

The workshop adopted a Common Position, namely that exporting States should be responsible for ensuring that manufacturers of radioactive sources duly carry out their duties of reshipment and disposal of sources that have outlived their useful life. The participants also called upon the IAEA to create a forum for African countries to consider the Code of Conduct and give it a legally binding effect so that the safe and peaceful use of nuclear technology is not compromised.

6. CONCLUSIONS

The following recommendations are made:

(a) That the Common Position reached in April 2001 by the First Africa Workshop (above) should be pursued further, and specifically with regard to the creation of a forum for African countries to consider the Code of Conduct, and give it a legally binding effect so that the safe and peaceful use of nuclear technology is not compromised.
(b) That the SHARS project awarded to Necsa for the conditioning of sealed high activity and neutron sources be expeditiously pursued. Furthermore, that the SHARS system design, as recommended by the IAEA International Review Team, be adjusted to incorporate features allowing it to function in tandem with the borehole disposal system.
(c) That the BDC, as recently demonstrated in South Africa, be implemented as soon as practically possible in a willing country. The IAEA is therefore encouraged to pursue the implementation of the BDC as expeditiously as possible within the African continent.

ACKNOWLEDGEMENT

The authors wish to acknowledge the invaluable contribution of G.R. Liebenberg, who was responsible for organizing the radium conditioning missions to African countries.

REFERENCES

[1] AFRA/INTERNATIONAL ATOMIC ENERGY AGENCY, African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology — AFRA Procedures and Operational Guidelines, AFRA 0001, 2000.
[2] LIEBENBERG, G.R., Collection and Conditioning of Sealed Sources (Radium) in Africa, internal report, Necsa, Pretoria, 2002.
[3] INTERNATIONAL ATOMIC ENERGY AGENCY, (Draft) WATRP Review Report on the Borehole Concept for the Disposal of Disused Sealed Sources Developed by the Nuclear Energy Corporation of South Africa (Necsa) in the Frame of the IAEA TC Project RAF/4/015, Necsa, Pelindaba, 2005.
[4] GONZÁLEZ, A.J., Security of radioactive sources: The evolving new international dimensions, Int. At. Energy Agency Bull. **43** 4 (2001) 39.
[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).

DISCUSSION

I. USLU (Turkey): There are many African countries that benefit from AFRA projects but have not sent their political commitment to the Code of Conduct or to the Guidance on the Import and Export of Radioactive Sources. South Africa has not done so, either. What action do you foresee to elicit commitment from those countries?

P.J. BREDELL (South Africa): This question should be addressed on two levels: national and international. On the national level, I can speak only for South Africa. We are currently developing our policy of radioactive waste management and have been focusing on completion of that rather than on the Code of Conduct itself. On the international level, I believe that many African countries may not be fully aware of the importance of officially recognizing the Code initiative. Therefore, a forum — through AFRA — aimed at facilitating discussion of the Code among them would be useful.

K. MRABIT (IAEA): Last month the IAEA held a meeting in Vienna for all AFRA Member States on strengthening regulatory infrastructure, including the implementation of the Code of Conduct and compliance with the Guidance. As a result of the meeting, specific national action plans were established. In addition, a regulatory network is being created by the IAEA for regulators from Africa and other regions also to implement the Code. So which forum are you referring to?

P.J. BREDELL (South Africa): It would appear that my proposal with regard to a follow-up of the first Africa workshop held in Addis Ababa in 2001 has been realized through the events you described.

V. FRIEDRICH (IAEA): You mentioned that the development phase of the BDC is close to completion. Do you know of any other African countries that would be interested and willing to implement it?

P.J. BREDELL (South Africa): I do not know of any specifically. An opinion survey of African countries conducted during Phase 3 of the BDC indicated that at least 13 countries would be interested in principle. We assume that the IAEA would play an active role in advising countries on implementation issues.

COOPERATION IN SOUTHEAST ASIA

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In its budget of May 2004, the Australian Government made provision for two initiatives related to strengthening infrastructure related to radioactive sources. Both initiatives flow from Australia's history of active involvement in international efforts to develop the Code of Conduct on the Safety and Security of Radioactive Sources and the Guidance on the Import and Export of Radioactive Sources.

The first initiative — a programme to enhance Australia's national radiation emergency preparedness and response capability — is being led by the Australian Radiation Protection and Nuclear Agency. The second programme is a three year, US $3 million project to strengthen the security of radioactive sources in the Southeast Asia and Pacific regions. It is based on the recognition of security threats in the region and on the Australian Government's desire to strengthen regional partnerships in the field of security and radiation protection. That project, known as the Securing Sources project, is being led by my organization, the Australian Nuclear Science and Technology Organisation (ANSTO).

The project has a wide scope that includes technical, administrative and regulatory aspects of source security. It is being delivered in two programmes, one of which covers 11 Southeast Asian countries closest to Australia. These include the seven IAEA Member States Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam, as well as four States that are not members of the IAEA: Laos, Cambodia, Brunei and East Timor.

A companion programme focuses on 14 Pacific Island countries, including Papua New Guinea, Fiji and the Solomon Islands, which are not members of the IAEA.

The decision to separate the programmes for Southeast Asian countries and the Pacific Island countries was made on the basis that most of the participating Southeast Asian countries have significant involvement with radioactive material and many are IAEA Member States. In contrast, there has been little history of use of radioactive sources in the Pacific Islands. It is also recognized that the security situation in the Southeast Asia region poses more immediate concern than the situation in the Pacific Islands.

The Regional Security project aims are to assist countries in a region to manage poorly controlled sources and to generally improve source security.

Activities planned for the project include:

- Strategies for remediation of legacies of orphan sources and poorly controlled sources;
- Sharing of historic information on source transfers within the region and on past activities that may have used radioactive sources, for example knowledge of past mining activities or oil and gas exploration;
- Evaluation of national strategies for regaining control of sources and sharing practical experience in searching for and securing sources;
- Strengthening national capabilities and capacities in source security through training, professional development and technology transfer.

From the start, our vision for the project has been to work not only with other countries in the region but also with the IAEA staff involved in activities supporting the International Action Plan for the Safety and Security of Radioactive Sources and with the United States Department of Energy's (USDOE) International Radiological Threat Reduction (IRTR) programme.

This desire for cooperation is hardly surprising. The benefits of regional cooperation and partnership are keystones of the IAEA Action Plan and the USDOE's work, and ANSTO has been an active player in various regional initiatives such as the Regional Cooperative Agreement (RCA) and the Forum for Nuclear Cooperation in Asia.

ANSTO has good relations and contacts with radiation protection authorities, national laboratories and medical centres in the region and has particular links with non-IAEA States such as the Pacific Island Forum countries and Papua New Guinea.

At the initial planning workshop in June 2004, staff from the IAEA, IRTR and the Securing Sources project, along with representatives from Indonesia, Thailand and Vietnam, met to discuss the objectives of the three projects and to shape plans for activities under the projects that would meet regional needs.

A few months later, we met with all ten Southeast Asian countries and brainstormed on regional needs and priorities. Not surprisingly, the overwhelming demand from the workshop was practical assistance to increase national capacities to deal with radioactive sources.

Bearing in mind this demand, the 2003 International Action Plan for the Safety and Security of Radioactive Sources, the IAEA Director General's 2004 report on promoting effective infrastructure for the control of radioactive sources, and the USDOE initiative, we have shaped a programme that has five types of activity.

The first of these is training programmes for various stakeholders. For example, staff have given lectures on radiation protection and source awareness to law enforcement trainees in Indonesia. We are building on ANSTO's training expertise and practical experience to give hands-on training in areas such as search and secure techniques.

Project members have started a series of visits to various countries in the region to increase awareness of the programme and to progress self-assessments of source security needs. A recent visit to Papua New Guinea led to the identification of a disused teletherapy source that was being stored in suboptimal conditions. Since the source had been supplied in the 1970s by ANSTO, we are making arrangements to transport the source back to our Sydney site for safe, secure storage.

We are producing various communications products, including a brochure for a range of stakeholders taken from IAEA-TECDOC-1344, Categorization of Radioactive Sources.

As a specific example of the practical and collaborative nature of the Securing Sources project, in February 2005 ANSTO organized a workshop with the catchy title Search, Location, Identification, Securing and Disposition of Orphan Radioactive Sources. The workshop was held at ANSTO in conjunction with the USDOE and the support of the IAEA. Twenty-one participants from ten Southeast Asian countries received theoretical and practical training in various aspects of dealing with sources. The group also worked together to identify future regional and national needs and defined specific activities for in-country expert missions.

Since the workshop, the programme of in-country expert missions has started. These missions will be interspersed with training and technical workshops such as the IAEA Workshop on Physical Protection to be held in August 2005.

There are several factors and challenges that are shaping the Securing Sources project:

(a) We must recognize that despite the desire and need for regional cooperation to establish regional control of radioactive sources, national action plans and programmes for radioactive source security contain sensitive information and are rightfully the responsibility of national authorities.
(b) We must bear in mind that all of us have limited resources and it is essential that we seek to avoid unnecessary overlap or duplication of the various programmes. This is being achieved by proactive communication and coordination of the plans and activities of all stakeholders with complementary programmes and objectives.
(c) All involved parties are expected to help shape the programme. While ANSTO, IAEA and USDOE staff have clear responsibilities to deliver

results based on their own programme objectives, the actual activities are being driven by regional participants and are delivered on the basis of participants' needs, managing the limited expertise available and recognizing that there are other important activities involving similar personnel from the region.

(d) Other factors that are shaping the programme are the cultural and language differences and the varying level of experience with source security of the participants.

In addition to the fairly standard and predictable benefits of the project that are listed above, I believe there is a more intangible benefit. I have already alluded to the fact that many of our regional partners have limited capability and capacity to respond to the challenges of maintaining adequate security of sources in their country. We are confident that having regular opportunities to participate in joint activities will result in informal support networks, or 'self-help groups', within the region. We are encouraging these links in several ways:

— In workshops, participants are expected to work in teams and to solve problems in groups.
— During in-country missions, we make opportunities to share examples of good practices in the region and recommend that participants contact each other to seek advice.
— We also emphasize the cooperative nature of this project, building on the strengths and resources of all parties.

From the start of this project a year ago, Australian agencies have worked with regional partners and with USDOE and IAEA staff to ensure that activities meet the goals of the various contributing agencies and participants' needs. We are helping to strengthen regional security in the short term and, more importantly, for the future.

DISCUSSION

A.J. GONZÁLEZ (Argentina): What is the size of the problem in countries in the region that are not IAEA Member States?

C.M. MALONEY (Australia): The project has not yet completed its evaluation of the problems faced by States that are not members of the IAEA. However, we are aware that there are problems. I saw, for example, a teletherapy unit that required enhanced security measures in one such State.

ACTIONS UNDERTAKEN IN THE EUROPEAN UNION TO STRENGTHEN THE MANAGEMENT OF HIGH ACTIVITY SEALED RADIOACTIVE SOURCES

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Abstract

On 22 December 2003 the Council of the European Union (EU) adopted a Directive on the control of high activity sealed radioactive sources and orphan sources (HASS Directive). The paper provides the background to the European Commission initiative leading to this Directive, and gives an overview of its scope and requirements, in particular the authorization regime, financial securities, transfers, record keeping and identification, and the management of orphan sources. The Directive should be transposed into national legislation by 31 December 2005, and the current status of transposition is presented. Further actions are discussed, in particular studies, institution building and investment projects in new EU Member States and Candidate Countries, as well as the EU Council Joint Action in support of related IAEA activities.

1. INTRODUCTION

High activity sealed radioactive sources are widely used in industry, medicine and research. Mismanagement of these sources may lead to acute exposure of workers and members of the public, and in some cases to significant contamination of the environment. The need for European Community action was prompted by a series of incidents in steel production plants, in particular the melting on 20 July 1998 of a caesium source at the Acerinox stainless steel production plant at Los Barrios, Cádiz province, Spain. In this context, in the late 1990s the European Commission supported several exploratory studies on the analysis of regulatory frameworks and management practices for disused/spent sealed radioactive sources on the European continent, namely:

- Management of spent radiation sources in the European Union: quantities, storage, recycling and disposal (EUR report 16960, 1996);
- Management and disposal of disused sealed radioactive sources in the European Union (EUR report 18186, 2000);
- Management of sealed radioactive sources produced and sold in the Russian Federation (EUR report 18191, 1999).

The main achievements of the studies dealing with management of disused/spent sealed radioactive sources in the European Union were presented and discussed with experts from EU Member States and Candidate Countries during a workshop that took place in Brussels on 9 and 10 June 1999.

The series of studies was completed as follows:

- Management of spent sealed radioactive sources in the Czech Republic, Estonia, Hungary, Poland and Slovenia (EUR report 19842, 2001);
- Management of spent sealed radioactive sources in Bulgaria, Latvia, Lithuania, Romania and Slovakia (EUR report 20654, 2003).

The outcome of the workshop contributed to the drafting of a proposal for a Directive on the management of disused sealed radioactive sources (HASS Directive). The Group of Experts established under Article 31 of the Euratom Treaty drafted a proposal over the years 1999–2001. In March 2002 the Commission adopted the proposal, and having received in July 2002 the opinion of the Economic and Social Committee, forwarded the proposal to the Council and the European Parliament (European Parliament opinion in November 2003). The Council finally adopted Council Directive 2003/122/Euratom on the control of high activity sealed radioactive sources and orphan sources on 22 December 2003.

In parallel to this initiative of the Commission, the Council discussed the need to take action also in steelworks and other locations where lost sources may appear, and adopted in 2002 a Council Resolution on the establishment of national systems for surveillance and control of the presence of radioactive materials in the recycling of metallic materials in the Member States (2002/C119/05).

Section 2 of this paper gives an overview of the content of the HASS Directive. Sections 3 and 4 describe further actions undertaken in the EU to strengthen the management of high activity sealed radioactive sources, in particular the PHARE and Transition Facility projects and the EU Council Joint Action in support of related IAEA activities.

2. COUNCIL DIRECTIVE ON THE CONTROL OF HIGH ACTIVITY SEALED RADIOACTIVE SOURCES AND ORPHAN SOURCES (HASS DIRECTIVE)

2.1. Scope

The HASS Directive supplements the requirements in the Basic Safety Standards Directive (BSS, 96/29/Euratom) specifically to prevent exposure of workers and members of the public arising from inadequate control of high activity sealed radioactive sources. The HASS Directive pursues the harmonization of requirements in place in Member States to ensure that each such source is kept under control. It also addresses the need to recover orphan sources and to deal with radiological emergencies due to such sources.

High activity sealed radioactive sources are defined on the basis of the activity at the time of manufacture with reference to nuclide specific levels specified in an Annex (e.g. 4×10^9 Bq for ^{60}Co). These levels broadly correspond to Categories 1, 2 and, in part, 3 in the IAEA classification. Sources remain within the scope of the HASS Directive until radioactive decay reduces their activity to levels lower than the exemption values in the BSS.

2.2. Authorization regime

The BSS already require practices using radioactive sources for industrial purposes (radiography, processing) or medical treatment to be subject to prior authorization (Art. 4.1.3). In the HASS Directive any holder of sources will need to obtain prior authorization. Before an authorization is issued, it shall be ensured that arrangements are made for the safe management of the sources, including when they become disused. The authorization will cover:

- The allocation of responsibilities;
- Staff competences (education and training);
- Performance criteria (source, container, equipment);
- Emergency procedures;
- Work procedures;
- Maintenance;
- Management of disused sources.

Training, in addition to radiation protection training under Article 22 of the BSS, shall include the safe management of sources and put emphasis on the possible consequences of the loss of control of a source.

2.3. Financial securities

Disused sources may be transferred either to the supplier or to a recognized installation. The manufacturer or supplier may be obliged to receive returned disused sources. The arrangements to ensure safe management of disused sources shall include adequate financial security (or any other equivalent means) to cover the cost of return or disposal (for example should the holder become insolvent or go out of business).

A system of financial security shall also be established to cover intervention costs relating to the recovery of orphan sources. Member States may participate in the cost of recovering, managing and disposing of the sources.

2.4. Transfers, record keeping and identification

A key factor in keeping continuous control of sources is the establishment of an inventory. The holder shall keep records of all sources under his/her responsibility, their location and their transfer. A standard record sheet is established for this purpose. The holder shall provide the competent authority with a copy of relevant parts of the record, without delay, at the time of their establishment and modification and at 12-month intervals. The holder's records shall be available for inspection by the competent authority, and the holder shall regularly verify that each source or piece of equipment is still present and in good condition.

The competent authority shall keep records of authorized holders and of the sources they hold: type of source, radionuclide and initial activity (at the time of manufacture, placing on the market or acquisition, as appropriate).

The HASS Directive thus requires a double accountancy system: one kept by the holder including the location of the source, and one centralized system for all authorized holders. Member States shall set up a system to be kept informed of individual transfers of sources and regularly update their records, taking such transfers and other factors into account. Before a source is transferred, the holder shall ascertain that the recipient holds the appropriate authorization.

The manufacturer, or the supplier in the case of imported sources from outside the Community, shall ensure that each source is identified by a unique number. This will be engraved or stamped where practicable on the source and on the source container. Each source shall be accompanied by written information. The holder shall ensure that the information remains available and check that markings and labels remain legible. This identification will allow unambiguous association of sources and record sheets. The information includes photographs of the source, container, transport packaging, device and equipment (photographs of design types of sources and containers to be provided by the manufacturers).

The unique identification of the sources and the photographs will facilitate the recovery of sources for which control has been lost.

2.5. Orphan sources

An orphan source is a source that is currently not under regulatory control because it has been abandoned, lost, misplaced or stolen. A source that has been transferred to a new holder without informing the recipient or without notification of the competent authority is also regarded as an orphan source. Sources may, in addition, never have been under regulatory control. The HASS Directive applies to any orphan source whose activity level, at the time of its discovery, is above the (activity) exemption level referred to in the BSS.

Member States shall ensure that:

— Competent authorities are prepared to recover orphan sources and to deal with radiological emergencies due to such sources;
— Assistance and specialized technical advice are given to persons who suspect the presence of an orphan source (allowing for the fact that such persons are not normally involved in operations subject to radiation protection requirements).

Member States shall encourage the establishment of systems aimed at detecting orphan sources in large metal scrapyards and major metal scrap recycling installations or at nodal transit points such as customs posts. The management and workers in such installations and customs officers shall be:

— Informed of the possibility that they may be confronted with a source;
— Advised and trained in the visual detection of sources;
— Informed of basic radiation protection facts and trained in actions to be taken in the event of (suspected) detection of a source.

Member States shall ensure that campaigns are organized to recover orphan sources left behind from past activities, including surveys of historical records (e.g. at customs posts, research institutes, industries and hospitals).

The HASS Directive further requires that Member States shall promptly exchange information and cooperate with other Member States and relevant international organizations as regards loss, removal, theft or discovery of sources. (It should be noted that the requirements for early exchange of information under Council Decision 87/600/Euratom may also apply.)

2.6. Transposition

Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with the HASS Directive before 31 December 2005. As regards sources placed on the market before this date, the requirements on authorization and record keeping as well as other requirements for holders may be postponed until 31 December 2007. The identification and marking of existing sources are not yet required, but each source and container shall be accompanied by written information and, if practicable, be labelled with an appropriate warning sign.

According to Article 33 of the Euratom Treaty, Member States shall submit draft legislation to the Commission, which may issue recommendations (within three months) to ensure conformity of the final measures with the Directive. In the case of non-notification of draft legislation — or late adoption of the final measures — the Commission launches infringement procedures against Member States.

So far, four Member States have submitted draft legislation. A workshop was organized within the framework of a seminar organized for new Member States and Candidate Countries (see Section 3.1) to exchange views between Member States on problems encountered with the transposition of the HASS Directive. Questions related to matters such as:

— Financial security requirements (for example in cases where different Member States are involved);
— Identification and marking (unique numbering within the EU);
— Aggregation of sources in relation to exemption values;
— Technical standards (e.g. for leak tests).

3. PHARE AND TRANSITION FACILITY PROJECTS

3.1. General

In parallel to the preparation/adoption and transposition of the HASS Directive, the PHARE nuclear safety programme and the Transition Facility programme, which are, respectively, pre- and post-accession financial instruments led by the Directorate General for Enlargement (DG ELARG), have supported a number of projects aiming to improve the management of sealed radioactive sources in Candidate Countries and new EU Member States.

Since 2001, the horizontal PHARE nuclear safety programme led by DG ELARG has included in its annual programme projects dealing with the management of institutional radioactive waste, including sealed radioactive sources. Two main areas for support are considered:

— Institution building, i.e. regulatory and technical assistance mainly given to the national nuclear safety authorities;
— Investment projects that consist of supplying software and hardware, equipment and construction work.

In addition, in order to update the reports on existing regulations and management practices regarding sealed radioactive sources in the Central and Eastern Europe Countries (CEECs) and to take stock of the situation regarding the transposition of the Council Directive into national legislation and regulations, the PHARE programme, in collaboration with the European Commission Technical Assistance Information Exchange Office (TAIEX), organized a technical seminar that took place in Brussels on 17 and 18 March 2005. Some 80 experts from regulatory authorities, radioactive waste management agencies and technical safety organizations from EU Member States (EU 25), Candidate Countries (Bulgaria, Croatia, Romania and Turkey) and Western Balkans attended the seminar. The proceedings will be published in late 2005 on the web site of the European Commission.

3.2. Institution building

The institution building projects consist of regulatory and technical assistance provided to national safety authorities that are facing the implementation of the HASS Directive. Two countries (Bulgaria and Romania) benefit from the PHARE regulatory assistance activities for this specific purpose. Amongst the main issues of concern, the following tasks are being investigated:

— Operational safety of sealed radioactive sources;
— Reduction in the number of sealed radioactive sources at risk;
— Retrieval of orphan sources (e.g. import of scrap metal, financing mechanism to cover management cost of orphan sources);
— Storage of high activity sealed radioactive sources, including long term storage of long lived sources.

3.3. Investment projects

At present the most important PHARE support is allocated to Bulgaria for the modernization of the Novi Han long term central storage facility. By this means it is expected that the facility can be licensed by the end of this decade so that it can proceed with the repackaging and long term storage of high activity disused sealed radioactive sources that are at present stored at users' premises or at the INRNE Institute. The PHARE projects are supporting the design of the new processing and storage facility, the construction work and the fitting out of the facility, including the delivery of a hot cell.

In line with the repackaging of high activity sealed radioactive sources, PHARE support has been allocated to the reconstruction of hot cells located at Brinje (Slovenia) and at Litomerice (Czech Republic).

Improvement of storage conditions and/or design of new storage facilities for institutional radioactive waste have been the object of PHARE support at Brinje (Slovenia) and at Baldone (Latvia).

The PHARE and Transition Facility programmes also contributed to the design and manufacture of transport and storage containers for sealed radioactive sources in Slovakia and Lithuania, thereby increasing the safety of these operations. Measuring equipment for detecting the possible presence of neutron sources in drums containing radioactive waste is being supplied to the Czech Republic as part of the refurbishment of the Richard facility near Litomerice.

Of particular importance is the support given to the Czech Republic, Slovakia and Romania (subject to Romania's approval of the 2005 PHARE nuclear safety programme) to develop specific computerized systems for record keeping and tracking of sealed radioactive sources on their territories. The beneficiary organizations are either national agencies for radioactive waste management or regulatory authorities.

Summing up the PHARE and Transition Facility support to improve management of sealed radioactive sources in the CEECs, it can be said that this is in full compliance with three main components of the HASS Directive, since the related projects are directly contributing to:

- 'Transfer of disused sources to a recognized installation' through design, construction, fitting out and refurbishing of central storage facilities;
- 'Transfers and record keeping' through the development of computerized databases and a waste tracking system;
- 'Management of orphan sources' by assisting national nuclear safety authorities to lay down new and specific regulations for that purpose.

In terms of funding over the period 2001–2005, the PHARE and Transition Facility contribution to improving management of sealed radioactive sources in CEECs amounted to about €10 million, roughly broken down as follows:

— Institution building: €2 million;
— Delivery of software and hardware for databases: €0.7 million;
— Supply of equipment and construction work: €7.3 million.

Seven CEECs benefited from this support, namely the Czech Republic, Slovakia, Lithuania, Latvia, Slovenia, Bulgaria and Romania.

4. EU COUNCIL JOINT ACTION

On 17 May 2004 the EU Council approved a Joint Action (2004/495/CFSP) on support for IAEA activities under its Nuclear Security Programme and within the framework of the implementation of the EU Strategy against Proliferation of Weapons of Mass Destruction. This action has been launched within the framework of the European Common Foreign and Security Policy (CFSP).

Of the three projects considered within this Joint Action, one is specifically devoted to strengthening the security of radioactive materials in 'non-nuclear applications', in other words of high activity sealed radioactive sources.

This action has an estimated duration of 15 months covering 2005 and 2006. Approximately €1.1 million has been allocated to projects dealing with security of high activity sealed radioactive sources. This action should be pursued beyond 2006.

DISCUSSION

B. DODD (International Radiation Protection Association): The HASS Directive was being developed at the same time that the IAEA was revising the Categorization of Radioactive Sources and the Code of Conduct on the Safety and Security of Radioactive Sources. Despite being repeatedly invited to participate in IAEA activities, the EU did not send anyone, and as a result we ended up with different criteria, thereby creating a problem for European Member States of the IAEA. Can you explain why the EU did not engage with the IAEA, and is there any chance of future harmonization?

A. JANSSENS (European Commission): I find it hard to believe that at the time the classification of sources was discussed at the IAEA, the Commission would have been absent. Certainly we were all very much aware of this development through individual Article 31 experts or Member State representatives. Unfortunately the decision making process in the EU left little room for endorsing the IAEA's classification of sources. The drafting of the HASS Directive was completed before the classification was available. In practice, however, this will not cause any difficulties with the implementation of either the Directive or the Code of Conduct. While the lack of harmonization is regrettable, there is little prospect of amending the HASS Directive, which would mean going through the whole decision making process once again.

B. VIGLASKY (Canada): The HASS Directive does not make any reference to security requirements. Can you provide information on how the security issue is being addressed by the EU?

A. JANSSENS (European Commission): Indeed, as I said at the opening ceremony, security does not appear in the HASS Directive — nor are the events of 11 September 2001 mentioned in the preamble even though they were foremost in everybody's mind — because security is outside the scope of the legislation. That does not mean it is of less importance. While the Commission and the Community have a very clear mandate in terms of radiation protection and safety, security is essentially a matter for national authorities, and the individual EU Member States are very aware of the need for security against the malevolent use of radioactive sources. Nevertheless, the HASS Directive is certainly instrumental in facilitating actions undertaken for source recovery, which will support national security objectives.

A.J. GONZÁLEZ (Argentina): Referring to Mr. Dodd's remarks about the lack of EU harmonization, I remind you that this is not the first time — the same thing happened with the IAEA BSS. One gets the feeling that the people in Brussels want to be different from the international community, which causes considerable harm.

My question concerns the Algeciras accident. You make a direct link between the HASS Directive and this accident, which I am not sure is correct. In fact the source in Algeciras was imported; it was not a European one. Therefore I believe that the Directive would not have improved the situation, while at the time there were accidents in Germany, Italy and France, all with European sources. The report on the Algeciras accident at the Dijon conference triggered a recommendation for an international undertaking. I find that Algeciras best illustrates the fact that we need an international undertaking to solve such problems, not an EU Directive, which will not solve them.

A. JANSSENS (European Commission): It is true that the incident in Algeciras was not caused by a source originating in the EU. Nevertheless, after a series of similar incidents elsewhere, for example in Italy, the one in Algeciras got wide publicity and prompted the EU — at the level of the Commission and the Council — to take action. It is no coincidence that this Directive was adopted under Spanish presidency. While to our knowledge no high activity sealed radioactive source has been lost within the EU, it was clear to all that the EU had to be at the forefront in strengthening controls. At the same time, at the Dijon conference, the need for similar international action was underlined.

G.R. MALKOSKE (International Source Suppliers and Producers Association): Source suppliers and producers support the principles of the Code of Conduct and the HASS Directive. Do you think that the differences between the Directive and the Code of Conduct will make it more difficult for radioactive sources to be available for their intended beneficial use?

A. JANSSENS (European Commission): The HASS Directive and the Code of Conduct are very similar, and the differences that do exist — in particular the additional requirement in the HASS Directive for a unique identification engraved on the source and the container — should not hinder hospitals or industrial users in purchasing the sources they need. We believe the engraving to be very important to allow unambiguous record keeping and traceability of the sources, and if a source should get lost, to enable its origin to be traced. We hope that manufacturers will — on a voluntary basis —apply what is required for importing sources into the EU to sources for customers elsewhere in the world.

K. ULBAK (Denmark): This comment should clarify the differences between the classification of radioactive sources in the HASS Directive and the Code of Conduct. The classification in the 2001 version of the Code of Conduct was based on the type of application and not on the source activity, which was necessary for the legally binding Directive. We needed measurable units, i.e. activity measured in becquerels, in order to implement it. After the Directive's adoption in 2003, the IAEA developed the Categorization of Radioactive Sources now used in the 2004 version of the Code of Conduct.

DECOMMISSIONING OF RTGs IN NORTH-WEST RUSSIA: THE NORWEGIAN APPROACH FOCUSING ON RISK AND ENVIRONMENTAL IMPACT ASSESSMENTS

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Abstract

The nuclear legacy in north-west Russia continues to be a large concern for Russia's neighbouring countries, the international community and indeed Russia itself. Potential radiation hazards to humans and the environment from accidents at nuclear installations and waste storages should be a focus area. The process of removing a potential radiation hazard may lead to an increase in risk in the short term. However, this risk is usually of minor importance when decommissioning radioisotope thermoelectric generators (RTGs), compared with future potential risks if the 'do nothing' option is chosen. Removing and securing RTGs has been a priority task for Norway in recent years. Fifty-five RTGs were removed and secured by the end of 2004. A further 31 RTGs are planned to be decommissioned in 2005. It is important to minimize risks when decommissioning. Risk assessments and environmental impact assessments that address different options are key tools used to provide a minimum risk to humans and the environment from a specific measure. Such an assessment was performed in 2004, and additional assessments are planned during 2005 activities. International consensus on requirements for these assessments is needed to reduce potential risks from radioactive contamination, especially when Western donor countries fund specific projects in Russia.

1. INTRODUCTION

The Norwegian Government annually allocates funding to help improve the safety and security of spent nuclear fuel and radioactive waste in north-west

Russia. An important goal is to prevent potential radioactive contamination of the environment from waste storages and nuclear facilities. Such activities are funded by the Norwegian Nuclear Action Plan (NNAP), which is administered by the Norwegian Ministry of Foreign Affairs. An important aspect of the Norwegian Radiation Protection Authority (NRPA) involvement is to provide independent assessments of health and environmental consequences of specific projects. According to a statement from the Norwegian parliament, health and environmental assessments should be carried out prior to projects receiving funding.

Along the Arctic coast of Russia, in remote areas where electricity is not available, there are lighthouses powered by radioisotope thermoelectric generators (RTGs) in which a radioactive ^{90}Sr source produces heat that powers a generator. The generator produces electricity to power the lamp in the lighthouse. RTGs are also used as power sources in radio beacons and weather stations, and are found throughout Russia and other former Soviet republics. At present, about 750 RTGs are located in remote areas of Russia. The large majority of them belong to the Northern Fleet or the Ministry of Transport.

Decommissioning RTGs in north-west Russia is a priority area under the NNAP. This project is headed by the Office of the County Governor of Finnmark and is carried out in close cooperation with the Regional Administration in Murmansk and VNIITFA (the All-Russian Scientific Research Institute of Technical Physics and Automation).

There are important security, environmental and radiological protection incentives for the RTG decommissioning project. The RTGs contain highly radioactive ^{90}Sr sources, which represent a local environmental and public hazard. Because of insufficient regulations for control and physical protection of the sources, many RTGs are accessible to intruders and the general public. A number of thefts from RTGs have been discovered in recent years. In 1999, 2001 and 2003, RTGs were vandalized, mainly through the attempted theft of the valuable cladding metals in the RTG structure. These thefts demonstrate that intruders may easily gain access to these radioactive sources and highlight the potential security concerns related to RTGs in remote areas.

An independent health and environmental assessment has been undertaken as part of the joint Norwegian–Russian project to decommission RTGs in north-west Russia. It is based on information received from VNIITFA (the Russian project leader for the decommissioning work), as well as on independent reviews and assessment.

2. DECOMMISSIONING OF RTGs

Inside the RTG are from one to six radioactive sources (radioactive heat sources, RHSs) that decay, thereby generating heat which is transformed into electrical energy by a semiconductor thermoelectric converter. The RTGs used in Russian lighthouses utilize radioactive strontium, ^{90}Sr, a beta emitter with a half-life of 29.1 years. The activity level in one RTG may range from 0.7 to 13 PBq. The ^{90}Sr is most often in the form of strontium titanate ($SrTiO_3$), which is chosen specifically as it is a high temperature resistant, relatively insoluble ceramic. X rays are emitted as bremsstrahlung when the beta radiation from the ^{90}Sr is absorbed in nearby materials. RTG cores are shielded in a special capsule to reduce the external radiation emissions. The radiation dose rate to a person can reach 10 Sv/h on the surface of an unshielded core, which could provide a lethal dose within half an hour of exposure.

The removal and securing of RTGs started in 1997. Since that time a total of 55 RTGs, containing 65 RHSs, have been removed from Murmansk and Arkhangelsk Oblast with funding from Norway. Thirty-seven of the RTGs have been replaced with solar cell panels. All of the replaced RTGs belonged to the Northern Fleet.

A general procedure for RTG decommissioning has been as follows. The RTGs are inspected to assess their current condition and are removed from their location by helicopter to a temporary storage site. The RTGs are then transported further to RTP Atomflot by a boat belonging to the hydrographical service of the Northern Fleet. Then the RTGs are transported by train to VNIITFA near Moscow, where they are dismantled. The RHSs are then taken out and placed in a special shielding device before being transported by train (in specially built railway wagons) for final storage at Mayak Production Association in South Ural. At Mayak the RHSs await vitrification, together with other high level radioactive waste, and final storage. More information on decommissioning activities can be found in publications from the Office of the County Governor of Finnmark [1] and from the NRPA [2].

During the period 2006–2009 Norway is planning to fund removal of all remaining RTGs in Murmansk, Arkhangelsk and Nenets (about 110), and to replace them with solar cell panels. International effort is needed to enhance the speed of RTG removal and waste handling. The rate of waste treatment and storage at Mayak is 100 RHSs each year. Other bottlenecks result from the need for more transport containers and the lack of proper interim storage facilities.

3. RISK AND ENVIRONMENTAL IMPACT ASSESSMENT

Prior to decommissioning activities in 2004, it was decided to perform an independent risk and environmental impact assessment of the work funded by Norway. The scope of the assessment was the removal of 23 RTGs located in the Barents Sea and White Sea regions. The main aims of impact assessments are to minimize or avoid adverse health and environmental effects before they occur and to incorporate environmental factors into the decision making process. Here, adverse effects are understood to be detrimental effects on local and distant human populations and the environment.

The purpose of the independent assessment was to:

- Review the scope and content of the existing Russian assessment, the proposed working procedures and quality assurance measures;
- Provide an independent analysis of the potential worker, public and environmental risks associated with the 2004 RTG decommissioning project;
- Make recommendations for improvements to the work specifications and their implementation.

As part of this work, three different key scenarios were considered: an accidental drop of an RTG into the sea; a drop on to the shoreline or in very shallow sea water; and a drop on to or other accident on land.

An initial step in the process was to obtain first-hand information regarding health, safety and environmental aspects associated with RTG decommissioning. Such information was obtained by the Russian operator and project leader (VNIITFA). The process of obtaining information from the Russian project leader was very similar to the internal process in Norway between a regulatory authority and the operator. A chronological overview of the process is given below.

Some of the main outcomes of the assessment were as follows [3]:

(a) As the ^{90}Sr heat source is well protected in an RTG in good condition, it is deemed highly unlikely that any conceivable accident connected to the planned decommissioning of RTGs will cause radiation exposures to the surroundings. If, in the unlikely event of a breach being caused to the RTG's multiple protective layers during an accident, the ^{90}Sr source is exposed to air or water, the resultant spreading of radioactivity will be very limited owing to the low solubility of the ^{90}Sr titanate matrix. The ^{90}Sr titanate also has a high melting point, indicating that the risk of radioactive contamination due to fires is also negligible.

(b) The very robust nature of the RTG system and its low potential for significant releases of activity to the environment, and hence low migration rates of the radioactive source material into the food chain, have been demonstrated. This indicates a low probability of significant environmental impacts under both normal and accident conditions, provided that control of the project, its work plans, safety regulations and a consistent approach to compliance and communication by all involved parties are achieved.

(c) The 'do nothing' option (i.e. leaving the RTGs where they are) is not realistic. However, the establishment of a high security regime designed to protect the radioactive sources is a possible option that might be cost effective. The environmental impact assessment should cover any courses of action that are discounted and give the reasons why these options should not be considered.

On the basis of results from the independent assessment, it is concluded that the decommissioning project should continue, as leaving the RTGs unmonitored could potentially lead to a risk of undesired access to radioactive materials. However, it is important to ensure that the relevant Russian regulatory authorities and organizations have clear separate responsibilities throughout the entire process of inspecting, collecting and dismantling the RTGs, as well as the storage and disposal of radioactive waste generated from decommissioning. Radiation protection guidelines should be reviewed and amended where necessary with correct procedures and checklists to ensure compliance.

The following recommendations were made:

— Guidelines for radiation protection and procedures to ensure implementation should be documented.
— Transport by helicopter should be used only where the lack of other transport options makes it necessary, and should be over as short distances as possible.
— When using helicopter transport, an emergency beacon should be used to help recover the RTG in the event of an accident.
— Experience from previous work on the removal and handling of RTGs should be documented, and a report summarizing the work in 2004 should be submitted to the NRPA.

4. CONCLUSIONS

The removal and securing of RTGs is considered to be an important task to reduce the radiation risks to humans and the environment from exposure to these sources.

The independent assessment in 2004 provided specific information regarding present and potential health, safety and environmental consequences of the removal of RTGs. Even though some information was lacking compared with the requirements for a complete environmental impact assessment, the outcome increased our knowledge, which will be useful for future decommissioning of RTGs in north-west Russia. This work will be followed up prior to funding further decommissioning work in 2005.

The Norwegian Government has stated that it will provide funding for the removal of all RTGs in the Murmansk, Akhangelsk and Nenets areas in the years to come. It is important to obtain an international focus on removing and securing these radioactive sources. At the IAEA Contact Expert Group workshop in Oslo, held on 16–18 February 2005, decommissioning of RTGs was a focus area, and it was agreed to establish an international coordination group to address the topic.

ACKNOWLEDGEMENTS

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REFERENCES

[1] MURMANSK REGIONAL GOVERNMENT, OFFICE OF THE FINNMARK COUNTY GOVERNOR, RITEG Dismantling on the Kola Peninsula (2003).

[2] Dismantling of RTGs on the Kola Peninsula, NRPA Bull. **7** (2004), www.nrpa.no

[3] NORWEGIAN RADIATION PROTECTION AUTHORITY, Assessment of Environmental, Health and Safety Consequences of Decommissioning Radioisotope Thermal Generators (RTGs) in Northwest Russia, Rep. 2005:4, NRPA, Østerås (2005).

DISCUSSION

P. CARBONERAS (Spain): Are RTGs still being manufactured on the territory of the former Soviet Union?

I. AMUNDSEN (Norway): Not as far as we know, but you should ask the Russians. An impact assessment has just been published.

JAPANESE ACTIVITIES FOR THE SAFETY AND SECURITY OF RADIATION SOURCES WITHIN THE FRAMEWORK OF THE FORUM FOR NUCLEAR COOPERATION IN ASIA

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Abstract

The Forum for Nuclear Cooperation in Asia was organized subsequent to the International Conference for Nuclear Cooperation in Asia in 1999. Nine countries — Australia, China, Indonesia, Japan, Republic of Korea, Malaysia, Philippines, Thailand and Viet Nam — are participating, with the aim of exchanging views and information on the fields of: (1) utilization of research reactors, (2) utilization of radioisotopes and radiation in agriculture, (3) application of radioisotopes and radiation in medicine, (4) public information on nuclear energy, (5) radioactive waste management (RWM), (6) safety culture of nuclear energy, and (7) human resources development and new projects. A task group on management of spent radiation sources was established in the RWM project in 2001. Four discussion/survey meetings were held, with fruitful results. One of the most important points was that this kind of 'horizontal' cooperation would not only foster mutual understanding but could also guide the preparation of a regulatory system and management system.

1. INTRODUCTION

1.1. History of the Forum for Nuclear Cooperation in Asia

The First International Conference for Nuclear Cooperation in Asia (ICNCA) was held by the Atomic Energy Commission of Japan in March 1990 to promote more efficient cooperation in the field of nuclear energy with neighbouring Asian countries. Since then, the Atomic Energy Commission has held many ICNCAs, where the ministers in charge of development and utilization of nuclear energy exchanged frank views on how to proceed with regional cooperation, and has carried out practical cooperation on specific subjects as well. At the Tenth International Conference for Nuclear Cooperation in Asia, held in March 1999, it was agreed to move to a new framework, the Forum for Nuclear Cooperation in Asia (FNCA) (including a Coordinator and Project Leader system), with a view to achieving more effective and organized cooperation activities. Within this framework, views and information are exchanged on the following fields: (1) utilization of research reactors, (2) utilization of radioisotopes and radiation in agriculture, (3) application of radioisotopes and radiation in medicine, (4) public information on nuclear energy, (5) radioactive waste management (RWM), (6) safety culture of nuclear energy, and (7) human resources development and new projects.

The participating countries are Australia, China, Indonesia, Japan, Republic of Korea, Malaysia, Philippines, Thailand and Viet Nam (the IAEA participates as an observer).

The basic framework of cooperation consists of the following:

— Forum meeting: Discussion on cooperation measures and nuclear energy policies. A forum meeting is comprised of a ministerial level meeting and a senior official level meeting.
— Coordinators meeting: Discussion on the introduction, revision and termination, adjustment and evaluation of cooperation projects by an appointed coordinator from each country.
— Cooperation activities for each project.

1.2. Outline of the RWM project group

Safe handling of radioactive waste is an important issue in nuclear applications development in FNCA countries, as waste issues generally are a subject of enhanced public interest. Accordingly, it was necessary to promote an international consensus on the safe management of radioactive waste, to promote regional cooperation in this field and to further strengthen existing technologies among participating FNCA countries.

A project was initiated in 1995 to exchange information and to share experiences among the FNCA countries. At the Fifth ICNCA, held in Tokyo in March 1994, Indonesia proposed taking up a new theme, that of nuclear safety and radioactive waste management. At the Sixth ICNCA, it was agreed that an RWM project would be implemented to promote the safe utilization of nuclear energy in Asia and to develop a common understanding of RWM issues and concerns. Within the framework of the FNCA Radioactive Waste Management Project, information has been exchanged and shared on RWM in general. Specific topics have included: the current state of RWM in each country, and problems encountered; general concepts in RWM; RWM education/training; and how to carry out cooperative activities in RWM in Asia.

In order to have an in-depth discussion of priority issues specific to the host country of the particular workshop, sub-meetings were held with the participation of specialists from a broad range of related fields. A detailed reporting of RWM status in the FNCA countries was carried out by means of a questionnaire type of survey. RWM newsletters were published, a web site was created, and a list and database of participants was developed.

2. ESTABLISHMENT OF THE SPENT RADIATION SOURCE MANAGEMENT TASK GROUP WITHIN THE RWM PROJECT OF THE FNCA

Following the proposal and agreement of the First Forum for Nuclear Cooperation in Asia (First FNCA Meeting), held on 13 November 2000 in Bangkok, and the confirmation of the FNCA countries' support at the Second FNCA Coordinators Meeting, held on 14–16 March 2001 in Tokyo, the Project for Establishment of Spent Radiation Source (SRS) Management Task Group was authorized as a new project under the RWM project of the FNCA.

The first activity of the Project for Establishment of SRS Management Task Group was implemented as the Philippines–Japan Discussion/Survey Meeting on 30 July–3 August 2001 in Manila at the Philippine Nuclear Research Institute (PNRI). The second activity was implemented as the Thailand–Japan Discussion/Survey Meeting on 20–24 August 2001 in Bangkok at the Office of Atomic Energy for Peace (OAEP). The third activity was implemented as the Indonesia–Japan Discussion/Survey Meeting on 12–16 August 2002 at BATAN and BAPETEN in Jakarta and Serpon. The FNCA 2002 SRS Management Task Group meeting was held on 26–30 August at the Nuclear Environment Technology Institute (NETEC) in Taejon as the fourth activity.

3. SOME OUTCOMES OF DISCUSSION/SURVEY MEETINGS OF THE SRS MANAGEMENT TASK GROUP

3.1. State of SRS management in each country

The approach to SRS management has its own features in each country.

In Indonesia, the Act of Nuclear Energy was issued in 1997 and the regulatory function was separated from BATAN and assigned to BAPETEN (Nuclear Energy Control Board). An accident involving the loss of radiation sources, which were used in a thickness gauge, is accelerating the promotion of safe management of radiation sources. As a result of recent movement and efforts of the Indonesian Government, a new system is expected.

In the Republic of Korea, the Government recently carried out a reform of nuclear and radiation related governmental systems. Now the regulatory aspect (safety management and licensing procedure) of radiation source management is covered by the Ministry of Science and Technology (MOST). The Korea Institute of Nuclear Safety (KINS) functions as the regulatory body. Radiation source management is performed by the Korea Radioisotope Association (KRIA) together with NETEC. KRIA covers the collection of radiation sources and NETEC covers radioactive waste management and disposal. The Republic of Korea has also experienced several SRS management events, but now a radiation source management system based on information technology has been established as a complete database and traceability system for radiation sources.

In the Philippines, since 1958 PNRI has covered both the promotion of nuclear applications and the safety aspect of the nuclear and radiation field. PNRI takes a position of direct introduction of the IAEA standards and guidelines on radiation safety. From an early stage, PNRI joined the IAEA's Radium Source Conditioning Project and obtained a very positive outcome. The Philippines has also had several cases of scrap containing radiation sources, but a strong effort has been made to develop countermeasures, with the introduction of an education system and the preparation of a customs monitoring system. With the introduction of the International Action Plan for the Safety and Security of Radioactive Sources in combination with these activities, the situation in this country has been advancing.

In Thailand, the loss of a radiation source and a radiological accident occurred in 2000. Medical use ^{60}Co was sent to a scrapyard without being detected. This caused the death of three people. This severe event had a strong impact of reform at the OAEP, which was split into two activities: the research activity, carried out by the Thailand Institute of Nuclear Technology (TINT); and the regulatory and inspection body activity, performed by the Office of

Atoms for Peace (OAP). Now new regulations are in preparation in connection with the establishment of this new organization.

In Japan, the implementation of spent radiation source management was not so mature. We also had experienced the mismanagement of spent radiation sources. A ^{60}Co source and a neutron source were found in iron scrap imported from an East Asian country at Wakayama port in 2000. The other cases involved radiation sources (^{137}Cs and ^{226}Ra) contained in scrap imported from an East Asian country. Orphan sources have been found not only in imported scrap but also in domestic scrap, for example in the Okayama prefecture event. After these accidents, several domestic meetings were held with the aim of developing measures to avoid such events. Some results, such as a manual on radiation monitoring of scrap iron, have been effective. Details of the sharing of expenses for countermeasures in an emergency situation have not yet been fixed with respect to the question of responsibility for the emergency.

3.2. Considerations on problems to be solved

The issues requiring solution for SRS management can be summarized in two categories: domestic problems and international problems.

3.2.1. Domestic issues

Among the domestic issues, legal, regulatory and management requirements are important. These include: preparation of a legal framework; establishment of a source management system, an RWM system, an inspection system and an emergency preparedness system; a mechanism for collection of spent radiation sources; and education.

Technical requirements include the preparation of radiation equipment and monitors, e.g. gate radiation monitors for detection of orphan sources in steelworks, equipment for conditioning and stabilization of radium sources used in medicine and equipment for emergency remediation.

3.2.2. International issues

Legal requirements at the international level include the clarification of the responsibilities of suppliers of radiation sources, the joining of relevant conventions, an agreement on a quality assurance system, full use of the customs system, an international agreement for troubleshooting in SRS management and international cooperation for emergency medical preparedness.

Technical requirements include having standardized radiation inspection monitors in customs, and preparation of a standardized radiation marking for clear identification of radiation sources.

3.3. Role of the FNCA

The RWM project of the FNCA established a Spent Radiation Source Management Task Group for the promotion of safety culture in the RWM field. This kind of 'horizontal' cooperation will not only foster mutual understanding but also guide the preparation of a regulatory system and a management system. Through face to face discussion and on-site observation, peer review has taken place and mutual understanding has been increased. This kind of horizontal activity would be complemented by the 'vertical' activity of the IAEA, bringing about a synergy effect.

4. FUTURE PLANS

At the Ministerial Meeting of the Fifth FNCA, which was held in December 2004 in Viet Nam, Y. Tanahashi, Japan's Minister of State for Science and Technology Policy, stated that each country was requested to comply with the Code of Conduct on the Safety and Security of Radioactive Sources, and that Japan has been strongly endorsing the Code and expects every member country of the FNCA to support and fully observe it.

At the workshop of the FNCA RWM project, chaired by T. Kosako, in September 2005, there will be a discussion of how the Code of Conduct is being observed in Japan, and there will be a discussion and survey of the technical needs of FNCA countries for observing the Code.

It is expected that some new projects will be established in the RWM project of the FNCA according to these technical needs, in order to achieve good results for the safe management of radiation sources.

BIBLIOGRAPHY

Forum for Nuclear Cooperation in Asia, http://www.fnca.jp/english/index.html

KOSAKO, T., et al., Safe management of spent radiation source, Jpn. J. Health Phys. **38** 2 (2003) 154–193.

SRSM TASK GROUP, Activity Report: Safe Management of Spent Radiation Sources (2003).

STRENGTHENING CONTROLS OVER IMPORTS AND EXPORTS

(Technical Session 4)

Chairperson

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EUROPEAN UNION PERSPECTIVE REGARDING IMPORT AND EXPORT

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Abstract

When talking about controls on exports/imports of radioactive sources — in particular against the background of the IAEA guidance in this field — the special status of countries that are Member States of the European Union (EU) needs to be taken into account, in particular their belonging to a single economic area within which goods are free to move under conditions similar to those of a domestic market. Within the EU, uniform procedures apply as a result of a common legal framework based on trade, customs and source security/safety considerations (in particular the provisions supplementing the European Basic Safety Standards, based on Title II, Chapter 3, of the Treaty Establishing the European Atomic Energy Community). Several pieces of legislation apply to intra-Community and extra-Community movements of radioactive sources. The need for specific Community legislation applying to exports of radioactive sources should therefore be analysed in view of the existing binding regime (the newest Directive on the Control of High Activity Sealed Sources and Orphan Sources), while deciding on the right level of action (in view of the principle of subsidiarity) and following the appropriate procedures.

1. INTRODUCTION

The latest enlargement of the European Union (EU) as of 1 May 2004 brought the number of its Member States up to 25: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden and United Kingdom. Belonging to the EU means the acceptance and implementation of the

[1] This paper reflects the authors' personal viewpoint and should not be regarded as an official document of the European Commission.

European legislative framework in those fields where uniform or harmonized rules exist.

2. ONE SINGLE MARKET

The European Single Market is the world's largest domestic market. The free movement of goods is one of its cornerstones. Since 1 January 1993, goods crossing the Union's internal frontiers are not subject to controls. The free movement of goods within the Union presupposes in particular: the prohibition between Member States of customs duties and charges having equivalent effects; the adoption of a common customs tariff for trade between Member States and third countries; and the prohibition of any quantitative restrictions or measures having equivalent effect. Some examples of measures having equivalent effect to quantitative restrictions are: requirements for import licences and permits, obligations to produce certificates, and inspections and controls on the imports of certain goods.

Standardization. At the European level, standardization is a key element in the proper functioning of the internal market. Through European harmonization and along with the principle of mutual recognition, standardization ensures the free movement of goods within the internal market. Legislative harmonization is limited to essential requirements that products placed on the Community market must meet if they are to benefit from free movement within the Community. (These requirements deal in particular with the protection of the health and safety of users, usually consumers and workers, and sometimes cover other fundamental requirements, for example the protection of property or the environment.)

Harmonized standards. The technical specifications of products meeting the essential requirements set out in the directives are laid down in harmonized standards. Harmonized standards are European standards that are adopted by European standards organizations (CEN, CENELEC, ETSI), prepared in accordance with the General Guidelines agreed with the Commission, after consultation with the Member States. Products manufactured in compliance with harmonized standards benefit from a presumption of conformity with the corresponding essential requirements. The national bodies authorized to issue marks or certificates of conformity must comply with the International Organization for Standardization (ISO) principles and practices. The uniform application of international standards (ISO, IEC, ITU) in Europe is further supported.

CE marking. Affixed to a product, CE marking implies that the product conforms to all applicable provisions and that it has been subject to the appropriate conformity assessment procedures. Hence Member States are not allowed to restrict the placing on the market and putting into service of CE marked products, unless such measures can be justified on the basis of evidence of the non-compliance of the product. The obligation to affix the CE marking extends to all products within the scope of directives providing for its affixing and which are intended for the Community market. Some examples of legislation requiring the CE marking are: Council Directive 90/385/EEC of 20 June 1990 on the approximation of the laws of the Member States relating to active implantable medical devices (OJ L 189, 20.7.1990, p. 17); Directive 93/42/EEC of 14 June 1993 concerning medical devices (OJ L 169, 12.7.1993, p. 1); and Directive 98/79/EC of the European Parliament and of the Council of 27 October 1998 on in vitro diagnostic medical devices (OJ L 331, 7.12.1998, p. 1).

External trade. While recognizing the freedom to import and export, the abolition of controls at internal frontiers presupposes that external frontiers are reinforced and administered consistently.

Imports. The scope of the common commercial policy covers a broad range of instruments, and in particular the common external tariff, which is one of the essential features of the European customs union. It involves applying uniform customs duties to products imported from third countries, irrespective of the Member State of destination. The creation of the common external tariff has resulted in Member States' protection vis-à-vis third countries being standardized. Imports can be subject to specific surveillance or safeguards procedures.

Exports. Specific schemes for export are foreseen relating to items that require that certain controls be in place. This is the case of the dual use goods and technologies, which are subject to effective control when exported outside the Community, in order to ensure compliance with the international commitments of the EU and the Member States on non-proliferation. Controls on the export of these goods are carried out on the basis of Regulation (EC) No. 1334/2000 of 22 June 2000 setting up a Community regime for the control of exports of dual use items and technology (OJ L 159, 30.6.2000), as updated by Regulation (EC) No. 1504/2004 of 19 July 2004 (OJ L 281, 31.8.2004, p. 1). 'Dual use items' are goods and technology that can be used for both civil and military purposes, and include all goods that can be used for both non-explosive purposes and for assisting in any way in the manufacture of nuclear weapons or other nuclear explosive devices.

All EU Member States are committed to controlling exports of such items, in conformity with their national commitments taken as parties to the relevant international treaties of disarmament and non-proliferation, and also, for most EU Member States, in conformity with their commitments taken as members of the international export control regimes (e.g. the Nuclear Suppliers Group or the Wassenaar Arrangement — export control of arms and dual use technologies).

The principle of the Regulation is that the items listed in Annex I of the Regulation cannot leave the EU customs territory without an export authorization granted by the competent authorities of the Member States. Annex I includes a Category 0, listing a number of nuclear materials, facilities and equipment. Furthermore, an authorization shall be required for the export of dual use items not listed in Annex I if the exporter has been informed by the competent authorities of the Member State where the exporter is established that the items are or may be intended, in their entirety or in part, for use in connection with the development, production, handling, operation, maintenance, storage, detection, identification or dissemination of nuclear weapons or other nuclear explosive devices.

The freedom of circulation of dual use items in the single market is recognized except for the limited items listed in Annex IV of the Regulation (covering items of the Nuclear Suppliers Group), for which an authorization is also needed in the case of intra-Community transfers.

3. THE EUROPEAN BASIC SAFETY STANDARDS; CONTROLS ON RADIOACTIVE SOURCES

At a Community level, on the basis of the Treaty Establishing the European Atomic Energy Community (Euratom Treaty), Title II, Chapter 3, "Health and safety", a Community legislative framework was put in place in 1959 that today comprises more than twenty legal instruments of different nature, including six directives. Different requirements apply to the movement of radioactive sources within the EU and to exports and imports of sources.

3.1. Council Directive 96/29/Euratom laying down basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation

Council Directive 96/29/Euratom sets up a system of notification or authorization of practices with radioactive sources, according to the degree of concern. As a matter of principle, the production, processing, handling, use, holding, storage, transport, import to and export from the Community, and disposal of radioactive substances are subject to notification or authorization.

These practices are exempted from authorization/notification or are no longer submitted to it where concentration values/quantities are under the exemption values given in Annex I of the Directive.

The Basic Safety Standards Directive constitutes the key instrument in this field and has been supplemented by different pieces of legislation, in particular Regulation No. 1493/93 and Directive 2003/122/Euratom.

3.2. Council Regulation (Euratom) No. 1493/93 on shipments of radioactive substances between Member States

Council Regulation No. 1493/93 provides for a double declaration system (by holder and consignee) for intra-Community shipments of radioactive sources:

— Prior to the shipment: The holder has to obtain from the consignee (recipient) of radioactive substances a declaration (stamped by the authorities of the Member State of destination) that all relevant requirements are met.
— After the shipment: The holder has to provide the authorities of the Member State of destination all relevant information on the shipments carried out during the period of a quarter.

This applies to all radioactive sources and substances above the exemption values laid down in the European Basic Safety Standards.

3.3. Council Directive 2003/122/Euratom on the control of high activity sealed radioactive sources (HASS) and orphan sources

Council Directive 2003/122/Euratom is the subject of a separate paper, given in Technical Session 3[2]. Further to the provisions in Directive 96/29, the HASS Directive sets up a satisfactory system allowing source traceability.

The Directive imposes a technical and administrative burden on both holders and national authorities, which is nevertheless justified by the objective risk that high activity sealed sources represent. The requirements it imposes are therefore applicable to a smaller number of sources than those covered by Directive 96/29 or Regulation 1493/93, as delimited by its scope, defined in the Annex.

[2] JANSSENS, A., et al., “Actions undertaken in the European Union to strengthen the management of high activity sealed radioactive sources”, these Proceedings.

The HASS Directive aims at harmonizing the control of sources and the type of available information, having in mind the free movement of sources within the Community. While establishing primarily obligations in connection with the national authorities, a number of its provisions give an international dimension to this system of control:

- Authorization is requested for any practice involving a source within the scope of the Directive, which includes imports and exports of sources.
- Obligations on record keeping imply that information is recorded both on the circumstances of receipt of the HASS (including name of manufacturer, supplier or another user) and on the circumstances of transfer (to a manufacturer, supplier, another user or a recognized installation). This information is not limited to holders and manufacturers based within the EU territory or to sources manufactured within it. Records are communicated to the national authorities.
- Holders are obliged to ascertain that, before a transfer is made, the recipient holds appropriate authorization. This is also applicable to sources being exported outside the Community.
- Concerning identification and marking, for sources imported from outside the Community, the supplier is responsible for respecting the relevant obligations.
- Concerning international cooperation, Member States shall promptly exchange information and cooperate with other relevant Member States or third countries and with international organizations as regards the loss, removal, theft or discovery of sources and as regards related follow-up or investigations.

4. PERSPECTIVES

The deadline for setting up the legislation and infrastructures necessary to comply with the HASS Directive expires on 31 December 2005. Failure to meet this deadline can have serious consequences for the Member States of the Union, including the possible referral of the case to the European Court of Justice.

The European Basic Safety Standards constitute dynamic legislation, which has been updated and supplemented in the past on the basis of the evolution of scientific knowledge, while taking into account the Union principles — for example the principle of subsidiarity —and procedures. Article 31 of the Euratom Treaty provides in particular for the drawing up of draft new legislation by the European Commission after having consulted a specific Group of Scientific Experts and the European Economic and Social Committee. The proposed legislation needs to be adopted by the Council after having consulted the European Parliament.

The existing legislation based on the Euratom Treaty provides a legal framework on the basis of which Member States can adequately keep track of sources within the territory of the Union. The Guidance on the Import and Export of Radioactive Sources — as approved by the IAEA Board of Governors and endorsed by the General Conference in September 2004 — calls for a reflection on whether the Euratom framework should be supplemented by a Community instrument establishing common procedures in those fields that are not covered by the present legislation, and in particular on the need for special common procedures for authorizing exports of sources outside the Union.

The features of a future Community regime, and its consequences, need to be determined in detail, while bearing in mind that Community binding legislation cannot impose obligations on third countries, and that the cooperation from third countries necessary for implementing export procedures such as those recommended by the IAEA Guidance would therefore only be obtained on a voluntary basis.

All the above considerations will be taken into account and will necessarily have an influence on the choice of the appropriate Community legal instrument, whether binding or not.

DISCUSSION

R. JAMMAL (Canada): Are you saying that you do not require consent from an importing State, for example for a Category 1 radioactive source, because you cannot force the State to give it?

B. ANDRÉS-ORDAX (European Commission): I was talking from a European perspective about exports to countries outside the EU, not between EU Member States. The special provisions for implementing the Guidance to the Code of Conduct need reflection on how to proceed in cases where no reaction is obtained from third (importing) countries, as EU legislation cannot impose obligations, e.g. a deadline for replying, on them. We need to find an alternative solution.

S. McINTOSH (Australia): The EU Member States have committed themselves to implementing the import/export Guidance from 31 December 2005. Given no EU regulation for transfers outside the EU, this will have to be done at the national level, since the political commitment exists.

B. ANDRÉS-ORDAX (European Commission): The lack of Euratom legislation dealing specifically with the export and import of radioactive sources does not prevent its Member States from implementing the Guidance within the time limit to which they committed themselves politically, so long as they comply with all the relevant EU legislation (comprising market related and radiation protection rules).

Here I can tell you an anecdote. While I was attending a meeting of the group drafting the import/export Guidance two weeks after the summit where this political statement had been made, I received — by chance — a document from colleagues from another service that mentioned the political commitment made by the EU Member States. I showed it to representatives of some of those Member States present in the drafting group and they were not aware of this political commitment made by their own authorities. This illustrates what we have already discussed at this conference: Sometimes there is not very good communication between the political and the technical level.

IMPACT OF THE CODE OF CONDUCT ON THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES ON THE BRAZILIAN CONTROL SYSTEM FOR IMPORT AND EXPORT OF RADIOACTIVE SOURCES

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Abstract

The paper presents an evaluation of the impact of the requirements of the Code of Conduct on the Safety and Security of Radioactive Sources and of its associated document, the Guidance on the Import and Export of Radioactive Sources, on the Brazilian control system for the import and export of radioactive sources. An overview of the current control procedures adopted in Brazil for the import and export of material or equipment capable of producing ionizing radiation is also presented. The compatibility of the Brazilian control system with the new requirements is discussed. New procedures are considered in order to implement an improved control system for the import and export of radioactive sources, which would be completely harmonized with the requirements of the Code of Conduct.

1. INTRODUCTION

The safety and security of radioactive sources has been the theme of several studies, and the necessity of an increasing control over these sources is commonly pointed out (see, for example, Refs [1–3]). The development of new legislation, standards, regulations and procedures in this field has been one of the major actions of the regulatory bodies of many States and has been strongly supported by the IAEA. These control actions embrace several domains, including the control of the import and export of radioactive sources.

The Code of Conduct on the Safety and Security of Radioactive Sources [4] (the Code) and its associated publication, the Guidance on the Import and Export of Radioactive Sources [5] (the Guidance), can be considered a milestone of the control actions. In the domain of the control on the import and export of radioactive sources, they introduce important requirements for the authorization of import or export of a radioactive source or an aggregation of sources. The present work does not have the intention of describing in detail the Code and the Guidance; nevertheless, we will treat some main points of these publications. In a few words, all export or import of the sources of Categories 1 and 2, within the scope of the Code, should be authorized by both the exporting and the importing State. For the export of Category 1 sources, the exporting State should present a request for consent to the importing State. In order to take the final decision on authorizing the export, the exporting State should:

- Satisfy itself that the recipient is authorized by the importing State to receive and possess the source;
- Satisfy itself that the importing State has established a regulatory framework robust enough to cover at least sources of Category 1;
- Consider available information on a possible breach of security of the exported source or the risk of a malicious act involving the source.

The request for consent should be made as established in the Guidance. Also, the evaluation of the regulatory framework should be made in accordance with the Code and the Guidance. The IAEA will play an important role at this point by informing the Contact Point of the importing State and providing the importing State with the answers of the State Self-Assessment Questionnaire, present in the Guidance, which will contribute to the evaluation of the regulatory framework established by the importing State. Following the Guidance, the shipment of sources of Categories 1 and 2 should be notified at least seven calendar days prior to the export.

In the case of the export of Category 2 sources, the request for consent is not necessary a priori, but the exporting State should verify if the recipient is authorized by the importing State to receive and possess the requested source and if the importing State has established a regulatory framework covering Category 2 sources, and should consider available information on a possible breach of security of the exported source or the risk of a malicious act involving the source.

The authorization of import should be given only if the recipient has satisfied the requirements established in the Code and in the Guidance. These requirements include evaluating if the recipient is licensed or authorized to possess and operate the source, if there is a risk of a breach of security conditions or a malicious act involving the source, and if the transport will be conducted in a manner consistent with the relevant international standards in the field of transport of radioactive material. The importing State should also provide a copy of the issued authorization if it is requested by the exporting State.

2. OVERVIEW OF THE BRAZILIAN CONTROL SYSTEM FOR THE IMPORT AND EXPORT OF RADIOACTIVE SOURCES

The Brazilian control system for the import and export of radioactive sources (and equipment capable of producing ionizing radiation) is based on a joint action between the Brazilian regulatory body and Brazilian Customs. Any imported or exported product is registered, and in some cases taxed, by Brazilian Customs, which uses an on-line system for control of foreign trade — the integrated foreign trade system SISCOMEX (Sistema Integrado de Comércio Exterior) [6]. The materials or equipment registered in SISCOMEX are classified following the Mercosul Common Nomenclature for Tariff Item Descriptions, NCM (Nomenclatura Comum do Mercosul) [7], consistent with the Harmonized System (HS) for tariff classification [8, 9]. Several governmental organizations require the blockage by default of the import or export of a number of products described by specific NCM items. The import or export operation of these products is authorized by Brazilian Customs only after the end of a parallel authorization process in the governmental organization which has requested the blockage of the specific NCM item and is able to unblock, on-line, the import or export operation in SISCOMEX.

The Brazilian Nuclear Energy Commission (Comissão Nacional de Energia Nuclear, CNEN) is the Brazilian nuclear and radiological regulatory body, and it requests the blockage of a number of NCM items, which cover all radioactive (and nuclear) sources and equipment capable of producing ionizing radiation. CNEN implements an import or export authorization process parallel to that of Customs. The process ends in authorization or denial of the import or export operation, or is left open until the user fulfils the specific conditions required by CNEN.

In the case of import, CNEN's authorization process starts with the presentation of a request for a specific import of material or equipment capable of producing ionizing radiation; the request includes the following information:

— Firm, company or business name and legal address of the user and the importer;
— Registration number in CNEN of the user and the importer;
— Radionuclide(s), radioactivity, aggregate activity level and uses;
— Registration number of the import in SISCOMEX.

All requests are evaluated taking into account the user's situation in the licensing process, as well as the relevance of the request itself. In other words, an import is authorized only if the user is authorized to transport, operate and store the source or sources presented in the request for import. The licensing process for radiation facilities is conducted by CNEN considering the Brazilian Norm of licensing of radiation facilities [10], which is consistent with the IAEA standard [11] in the field. Also, the transport conditions are evaluated according to the established Brazilian Norm of transport of radioactive material [12], which is consistent with the IAEA standard [13] in the field.

In the case of export, the process is slightly different. Currently there are no requirements presented by CNEN concerning the evaluation of the importing State's regulatory framework or requiring authorization of the facility receiving the exported radioactive material; only the transport conditions in Brazil are evaluated. The request, which is now in use for a specific export of a radioactive source or sources, includes the following main information:

— Firm, company or business name and legal address of the user and the exporter;
— Registration number in CNEN of the user and the exporter;
— Firm, company or business name and legal address of the foreign facility which will receive the exported radioactive material;
— Radionuclide(s), radioactivity, aggregate activity level and uses.

3. NEW PROCEDURES

The present system of control of foreign trade of radioactive materials, operated by CNEN and described above, ensures that most of the recommendations of the Code and the Guidance have already been applied in Brazil. The system already includes specific import and export authorizations established in the Code, and the requests of CNEN already provide the information allowing the accomplishment by CNEN of almost all the requirements of the Code and the Guidance. Nevertheless, in order to completely satisfy the requirements of the Code and the Guidance, some modifications should be considered and incorporated into the procedures adopted in Brazil.

In the case of the import of radioactive material, the adopted procedure, which already includes the specific authorization for the import of radioactive sources, should be maintained. CNEN should be able to inform, as fast as possible, the regulatory bodies of the exporting States about the issued authorizations for Category 2 sources, or answer the request for consent for Category 1 sources. In the event that there is not yet any import request but there is already an export request in the exporting State, CNEN must give notification that the licensed radiation facility will be able to import the specific source. It should be noted that the information about the authorization to operate, including the expiration date, of all radiation facilities licensed by CNEN is public and available on the homepage of CNEN.

In the case of export of radioactive sources, certain information must be incorporated in the request adopted by CNEN for a specific export of a radioactive source or sources. This information includes the classification of the sources within the scope of the Code and, in the case of sources of Categories 1 and 2, the estimated date of export. With this information it will be possible to present a request for consent to the importing State for Category 1 sources, or to verify the issued import authorization for Category 2 sources, and give prior notification of the shipment.

New internal procedures are also being adopted in order to ensure that the exports are authorized only after it has been verified that the recipient is authorized to receive the requested source and that the importing State satisfies the requirements of the Code and the Guidance. In this case the State Self-Assessment Questionnaire answers should be considered as well as any information which indicates a possible breach of security of the source to be exported or a risk of a malicious act involving the source. In order to take the decision whether to authorize the export or not, the new procedures should include not only the agreement of CNEN's Transport Licensing Department but also the agreement of CNEN's department responsible for combating the illicit trafficking of radioactive and nuclear material.

4. CONCLUSION

Brazil fully supports and has endorsed the IAEA's efforts to enhance the safety and security of radioactive sources. CNEN believes that the implementation of the Code and the Guidance recommendations is an important step towards better control of these sources. The recommendations shall be implemented in a way that is consistent with the Code objective of not impeding international cooperation and commerce in radioactive sources.

CNEN has systematically answered demands for information on the issued import authorizations and is introducing upgrades and improvements in the Brazilian inventory of radioactive sources and radiation facilities in order to provide this information within a reasonable time frame. We also believe that future work should be done in order to implement common channels of communication and multilateral agreements, which should include a unique request for consent and prior notification pattern, allowing better and more flexible control of the import and export of radioactive material.

REFERENCES

[1] GONZÁLES, A.J., Strengthening the safety of radiation sources and the security of radioactive material: Timely action, Int. At. Energy Agency Bull. **41** (1999) 2–19.

[2] GONZÁLES, A.J., Securing radioactive sources against terrorism: An international perspective, Health Physics Soc., Newsl. **30** (2002) 3–5.

[3] LUBENAU, O.J., et al., Safety and security of radiation sources in the aftermath of 11 September 2001, Health Phys. **83** 2 (2002).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources: Guidance on the Import and Export of Radioactive Sources, IAEA Vienna (2005).

[6] SECRETARIA DA RECEITA FEDERAL, Sistema Integrado de Comércio Exterior (SISCOMEX), Lei nº 9.716, de 26 de novembro de 1998, Dá nova redação aos artigos 1º, 2º, 3º e 4º do Decreto-Lei nº 1.578, de 11 de outubro de 1977, que dispõe sobre o imposto de exportação, e dá outras providências, Brasilia (1998).

[7] SECRETARIA DA RECEITA FEDERAL, Instrução Normativa SRF nº 281, de 10 de janeiro de 2003, Aprova o texto consolidado da Coletânea de Pareceres de Classificação da OMA — Organização Mundial das Alfândegas, Brasilia (2003).

[8] UNITED NATIONS STATISTICS DIVISION, Standard International Trade Classification (SITC), Rev. 3, Series M, No. 34/Rev. 3, UN, New York (1986).

[9] SECRETARIA DA RECEITA FEDERAL, Instrução Normativa SRF nº 99, de 19 de Dezembro de 2001, Aprova a nova versão, em português, do Sistema Harmonizado de Designação e de Codificação de Mercadorias, Brasilia (2001).

[10] COMISSÃO NACIONAL DE ENERGIA NUCLEAR, Licenciamento de Instalações Radiativas, NE-6.02, Brasilia (1998).

[11] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

[12] COMISSÃO NACIONAL DE ENERGIA NUCLEAR, Transporte de Materiais Radioativos, NE-5.01, Brasilia (1988).

[13] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standards Series No. TS-R-1, IAEA, Vienna (2005).

DISCUSSION

A. NADER (Uruguay): We must, within the framework of Mercosur (a small common market between four Latin American countries), formalize this import/export question, especially in the light of the fact that there are industrial enterprises (e.g. gamma radiography) working in our countries.

R.F. GUTTERRES (Brazil): We will discuss this at the next meeting in Uruguay. However, I would like to mention that in Brazil, the possession of radioactive material without authorization by the Brazilian Nuclear Energy Commission is a very serious crime.

IMPORT/EXPORT CONTROL OF RADIOACTIVE SOURCES IN NIGERIA

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Abstract

Radioactive sources are used in many sectors of the Nigerian economy. All radioactive sources used in the country are imported. Nigeria does not produce radioactive sources and does not have any radioactive waste depository. There is a draft national policy on radioactive waste management which is yet to be approved by the Nigerian Government. The only operational part of this policy today is the return of the sources to the original manufacturers, i.e. export. This establishes the nexus between the Nigerian Nuclear Regulatory Authority (NNRA) and the Nigerian Customs Service. The safety and security of radioactive sources are two of the major statutory functions of the NNRA, which was established in 2001 by the Nuclear Safety and Radiation Protection Act 1995. These functions are carried out through the process of regulations and guidance; authorization; oversight functions; emergency planning and response; and ancillary functions. A very effective import/export control has been established through the process of application, inspection and authorization. A comprehensive inventory of sources and users is in progress and has proved to be a necessary condition for an effective regulatory control of radioactive sources in the country, which in turn will enhance safety and security. Some positive achievements have been recorded. However, the NNRA still faces some challenges, which can be removed through enhanced national capabilities in the area of detection at the ports of entry and through international cooperation between importing and exporting countries of radioactive sources in particular and of radiation sources in general.

1. INTRODUCTION

Radioactive sources are used mostly in seven sectors of the Nigerian economy. These are the petroleum industry, mining industry, manufacturing industry, construction industry, agriculture and water resources, the health sector, and education and research. All the radioactive sources are imported, mainly from the Group of Eight States and China. Tables 1 and 2 give data on the import and export of radioactive sources in Nigeria. The petroleum industry is the largest importer and user of radioactive sources in the country.

TABLE 1. IMPORT AND EXPORT OF RADIOACTIVE SOURCES IN 2004

	Number imported	Number exported	Maximum activity (Ci)[a]	
			Import	Export
Ir-192	63	44	5239.56	875.18
Cs-137	4	2	0.59	1.97
Se-75	7	14	747.20	369.50
Total	74	60	5987.35	1246.65

[a] 1 Ci = 3.7×10^{10} Bq.

TABLE 2. AUTHORIZATIONS GRANTED FOR IMPORT AND EXPORT OF RADIOACTIVE SOURCES IN 2004 AND FIRST QUARTER 2005

	Import	Export
2004	46	19
First quarter 2005	11	1
Total	57	20

There are today in the country a nuclear research reactor and several neutron generators. There are six radiotherapy centres. There are several hundred radioactive sources for various applications in these practices. These include nuclear well logging, industrial radiography, nuclear gauging, radiotracing, etc.

Before May 2001, radioactive sources were imported without any form of authorization, although the Nuclear Safety and Radiation Protection Decree [1] was promulgated in 1995. The Decree (now Act) provides for the establishment of the Nigerian Nuclear Regulatory Authority (NNRA). This was, however, established only in May 2001. The NNRA has the overall responsibility for nuclear safety and radiological protection regulation in the country. Consequently radiation protection, the safety and the security of radioactive sources, the safeguarding of nuclear materials and the physical protection of nuclear installations constitute the five major regulatory functions of the NNRA.

The safety and security of sources are guaranteed through an effective regulatory control programme. This regulatory control must necessarily include the ports of entry, hence the close working relationship between the NNRA, the Nigerian Customs Service and other law enforcement agencies such as the Nigerian Police, the Nigerian Immigration Service and the State Security Service. This coordinated approach to the safety and security of radioactive sources from the port of entry, through use, to the port of exit has led to the establishment of the Interministerial Committee on Nuclear Security.

The effectiveness of the regulatory programme for the import of radioactive sources has been attested to in the London Times of 6 October 2002 [2]. This network has also been tested, and failed once, in May 2003, when sources were exported as scrap metal. The second incident was in December 2004, when a duly authorized export of a spent radioactive source was repackaged and misdeclared as 'mould'. These lapses are traceable to inadequate radiation detection capability at the ports and inadequate training of the officials at the ports and airports. These challenges are currently being addressed through a collaborative effort with the Nuclear Security Office of the IAEA. The import/export regulatory mechanism for radiation sources is nevertheless very effective.

2. LEGISLATIVE AND REGULATORY INFRASTRUCTURE

The Nuclear Safety and Radiation Protection Act of 1995 provides for the establishment of the NNRA, which was established in May 2001 with the responsibilities and powers described below.

2.1. Responsibilities

According to Sections 4(1) and (2) of the Act, the NNRA has the responsibility for nuclear safety and radiological protection regulation in the country. This includes:

(a) Regulating the possession and application of radioactive substances and devices emitting ionizing radiation;
(b) Ensuring the protection of life, health, property and the environment from the harmful effects of ionizing radiation, while allowing beneficial practices involving exposure to ionizing radiation;
(c) Advising the federal government on nuclear security, safety and radiation protection matters;

(d) Liaising with and fostering cooperation with international and other relevant organizations or bodies having similar objectives;
(e) Regulating the introduction of radioactive sources, equipment and practices, as well as existing sources, equipment and practices involving the exposure of workers and the general public to ionizing radiation.

2.2. Powers

To carry out these responsibilities, the NNRA is empowered by Section 6 of the Act to, amongst others:

(a) Categorize and license activities involving exposure to ionizing radiation, in particular the possession, production, processing, manufacture, purchase, sale, import, export, handling, use, transformation, transfer, trading, assignment, transport, storage and disposal of any radioactive material, nuclear material, radioactive waste or prescribed substance, and of any apparatus emitting ionizing radiation;
(b) Establish an appropriate register for each category of sources or practices involving ionizing radiation;
(c) Issue codes of practice which shall be binding on all users of radioactive and prescribed substances, and of sources of ionizing radiation;
(d) Review and approve safety standards and documentation;
(e) Protect the health of all users, handlers and the public from the harmful effects of ionizing radiation;
(f) Provide training, information and guidance on nuclear safety and radiation protection;
(g) Establish, in cooperation with other competent national authorities, plans and procedures which shall be periodically tested and assessed for coping with any radiation emergency and abnormal occurrence involving nuclear materials and radiation sources;
(h) Undertake investigations and research into ionizing radiation sources and practices;
(i) Do everything necessary to ensure that all concerned persons and bodies comply with the regulations laid down under the Act.

Furthermore, the control of radiation sources and of premises where they can be used or stored is strengthened by Section 15 of the Act. In fact no person can carry out any activity under the Act and at the end of the activity abandon, decommission or rehabilitate installations thereof without a licence issued by the NNRA. This essentially is a codified demonstration of the ‘cradle to grave’ principle of the IAEA. In this regard, the NNRA has at its inception taken steps to put in place the proper regulatory framework, within the context of its enabling Act, to effectively register, license and inspect practices involving ionizing radiation and to enforce nuclear safety and radiological protection nationwide. It has also taken the necessary measures to have in place the basic administrative and technical capability to support its activities. These have been achieved through a very rigorous regulatory control programme.

3. REGULATORY CONTROL PROGRAMME

The regulatory control of radioactive sources in Nigeria is derived from Section 4(1) of the Nuclear Safety and Radiation Protection Act. The main elements of the regulatory control programme are:

— Regulations and guidance;
— Authorization;
— Oversight functions;
— Emergency planning and response;
— Ancillary functions.

3.1. Regulations and guidance

In accordance with Sections 47(1) and (2) and Sections 6(d) and (e) of the Act, the NNRA developed and promulgated in 2003 the Nigeria Basic Ionizing Radiation Regulations (NiBIRR) [3], which cover all uses of radiation sources in the country, including import and export. According to Regulation 79 of the NiBIRR, any employer who intends to import a sealed source containing any radioactive material for any practice shall:

(a) Require the supplier, as a condition of any contract for the purchase or transfer, to receive the source back;
(b) Submit to the authority a copy of relevant parts of the purchase or transfer document and obtain its authorization prior to having the contract enter into force or accepting the source;
(c) Return the source to the supplier within six months after the end of its useful lifetime.

Furthermore, the NNRA has adopted the IAEA Code of Conduct on the Safety and Security of Radioactive Sources [4]. A draft national regulation on the safety and security of radioactive sources is awaiting final approval for promulgation. The new regulation fully implements the Guidance on the

Import and Export of Radioactive Sources [5]. This provides an appropriate elaboration of the enforcement of the Act, which can be in the form of suspension or revocation of authorization (Section 32) or in the form of a fine or imprisonment (Section 45).

3.2. Authorization

Section 6(1) of the Act empowers the NNRA to issue authorization for all activities involving exposure to ionizing radiation. Thus the import and export of radioactive sources require authorization in the form of a licence. Furthermore, Section 19 of the Act requires that no source or practice shall be authorized except through a system of application, notification, registration or licensing as established by the NNRA. The authorization presently can be in the form of a notification, permit, certificate or licence. This is very important for the safety and security of radioactive sources. The authorization procedure involves the following stages.

3.2.1. Documentation

(a) Notification/registration by a prospective user or importer;
(b) Completion and submission of the Authorization Application Form, which demands specific answers with respect to names of responsible officers, competencies, equipment, sites of operation/storage, radiation protection programme, calibration records, waste disposal agreement and local rules;
(c) Certificate of incorporation from the Corporation Affairs Commission;
(d) Certificate of registration with the appropriate trade regulatory body, for example the Department of Petroleum Resources [6] or the Nigerian Medical and Dental Council [7];
(e) Source certificates and decay charts, for identification;
(f) Recent leak test certificate, for integrity (safety);
(g) Documentary evidence by the manufacturer that it will accept return of the source after the end of its useful life;
(h) Name of freight forwarder/local transporter;
(i) Shipper's declaration of dangerous goods;
(j) Programme for the security of radioactive sources during use, transport and storage to prevent sabotage, theft, fire, flooding and unauthorized use;
(k) Evaluation of the completed Authorization Application Form by the NNRA and the State Security Service;
(l) Pre-authorization inspection of the premises and facilities of the registrant, and of the transport vehicle, where applicable.

3.2.2. Inspection

Upon satisfactory documentation, a pre-authorization inspection is conducted in the case of an import licence application. The objective here is to verify claims made on the application form with regard to the storage facility, intended use, staff competencies and radiation protection programme. The observations are documented in writing and in photographs. In the case of an export licence application, a pre-shipment inspection is conducted to verify the adequacy of the packaging, the labelling and the radiation protection programme. The inspections are usually carried out by two inspectors.

Upon submission of the inspection report, the application is reviewed along with a report by a different officer of the NNRA. A recommendation is thereafter submitted to deny or grant authorization. If the recommendation is positive, the authorization is granted for a specific period with specific terms and conditions. Licensees are obliged to inform the NNRA of the date of arrival of the consignment or date of shipment for export.

It is pertinent to state here that the inspections have had a positive impact on the inventory of radioactive sources, which was started in 2002. Today radioactive sources in the health sector, in the petroleum industry, and in educational and research institutions have all been inventoried. The only major sector yet to be fully surveyed is the manufacturing industry, where radioactive sources are used, for example, in fixed nuclear gauges. Some of them have also been issued import/export licences in 2005. The total number of sources will be known at the end of 2005, and is expected to be in the thousands. Through the authorization process, the inventory has become very dynamic, largely owing to the activities in the petroleum industry.

The inventory of radiation sources is a veritable tool for radiation protection and the security of radioactive sources. This is a major goal of Milestone 1 of the Model Project on Upgrading Radiation Protection Infrastructure. It is a necessary condition for an effective security system for radioactive sources. The updated software distributed by the IAEA, the Regulatory Authority Information System (RAIS), has been very useful.

To complement the survey exercise, the NNRA, in January 2003, also contacted for assistance the embassies of some ten countries from which radioactive sources have been imported to Nigeria. The assistance sought was to use the good offices of the embassies to contact their respective national customs services for data on radioactive sources exported from their country to Nigeria between 1995 and 2002. Fortunately most of the embassies responded. Other legacy sources were discovered when survey exercises were carried out and during pre-authorization inspections either for export or for import of fresh sources.

4. FEATURES OF THE LICENCE

(a) Purpose: The purpose of the licence is clearly indicated, i.e. import or export of radioactive sources.
(b) Licensee: The name of the organization to which the licence is issued is clearly stated. Additionally, the name of the legal representative of the organization is also stated for an import licence.
(c) Address: The address of the licensee is clearly stated in full.
(d) Authorization number: The format of the NNRA authorization number is NNRA/AUT/type/number/year — indicating the NNRA, type of licence, serial number and year of issue.
(e) Expiry date: All licences have a common expiry date, which is 31 December of the year in which an authorization was issued. This is required by law.
(f) Copies to relevant authorities: A list of authorities that are issued with copies of authorizations is also given on the authorizations. These include: the Nigerian Customs Service, the Nigerian Police Force and the State Security Services.

4.1. Terms and conditions of the licence

(a) The licence is subject to compliance by the licensee with the provisions of the NiBIRR 2003 in matters relating to: safety assessments, operational radiation protection programme (for both personnel and the public), physical security, transport, radiological emergencies, quality management, compliance schedule and radioactive waste management (e.g. return of spent sources to the manufacturer).
(b) The NNRA must be notified upon the arrival of the sources.
(c) Copies of this authorization must be conspicuously displayed at all registered sites.
(d) The licensee is authorized to import/export the specified radioactive sources through a designated airport or seaport.
(e) Packaging of the sources must conform to the IAEA Regulations for the Safe Transport of Radioactive Material, as contained in TS-R-1 (ST-1, Rev.) and TS-G-1.1 (ST-2).
(f) The security of the sources at all stages of the transport is the responsibility of the licensee and is not transferable.
(g) The licensee shall notify the NNRA upon completion of packaging prior to transport from the authorized storage facility for pre-shipment inspection, in the case of export.

(h) Copies of this authorization must be conspicuously displayed on all the packages.

5. INCIDENTS

In December 2002, a nuclear well-logging company lost two high risk Am–Be sources with activities of 19.5 and 0.5 Ci[1] in the Niger Delta. The organization was not under regulatory control and therefore had no import licence in the first place. The sources were subsequently exported out of the country as scrap metal, but were intercepted before they could be recycled. The sources are now safely back in the country and under full regulatory control.

In December 2004, an industrial radiography company was duly authorized to export two spent radioactive sources (^{192}Ir and ^{75}Se) from a designated airport but chose to use a different airport without authorization. In the process the licensee transferred the already inspected and properly labelled consignment to an unauthorized freight forwarder, who in turn illegally transported the radioactive package by road over a distance of about 500 km to a different airport. The freight forwarder or the forwarder's agent shipped the consignment of radioactive material without declaring it to be such, a gross violation of the Act. Its external surface was not marked or labelled as dangerous goods, and no shipper's declaration of dangerous goods accompanied the consignment, which upon inspection at the destination in Europe was discovered to be a correctly marked and labelled wooden crate that had been overwrapped with a fibreboard box that was unmarked. The consignment escaped the attention of Nigerian Customs because of the wrong labelling and because there was no portal radiation monitor at the airport. The freight forwarder was arrested and the case is in court.

6. CHALLENGES

(a) Promulgation of national regulation restricting the import/export of radioactive sources to three designated airports and two seaports;

(b) Conclusion of a Memorandum of Understanding between the NNRA and the other organizations at the ports of entry, particularly the Nigerian Customs Service;

[1] 1 Ci = 3.7×10^{10} Bq.

(c) Training of first-line officers of the Nigerian Customs Service, the Nigerian Police and the security organizations in the areas of radiation protection and the identification and detection of radioactive sources;
(d) Installation of radiation portal detectors at the designated airports and seaports;
(e) Promulgation of the Nigerian Regulations for the Safety and Security of Radioactive Sources.

REFERENCES

[1] Nuclear Safety and Radiation Protection Decree 19 of 1995, Official Gazette of the Federal Republic of Nigeria **82** (1995) A547–A569.
[2] SPARKS, J., CONRADI, P., Revealed: radioactive material for dirty bomb is just a phone call away, Sunday Times, London (6 Oct. 2002) 14.
[3] Nigeria Basic Ionizing Radiation Regulations, Official Gazette of the Federal Republic of Nigeria **90** (2003) B165–B247.
[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA, Vienna (2004).
[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources: Guidance on the Import and Export of Radioactive Sources, IAEA, Vienna (2005).
[6] Mineral Oils (Safety) Regulations (1997), Petroleum Act Cap. 350, Laws of the Federation of Nigeria.
[7] Medical and Dental Practitioners Act Cap. 221 of 1990, amended by Decree 78 of 1992, Laws of the Federation of Nigeria.

DISCUSSION

A. JOUVE (France): How do you verify that a source reported stuck in an oil well has not been lost outside the well or stolen? Do you perform an inspection?

S.B. ELEGBA (Nigeria): When a source is reported stuck in a well by a licensee, usually a service contractor to the oil exploration company that is the legal owner of the well, the report must be corroborated by the oil exploration company. The company must then submit in writing steps to be taken to determine the location. Only then does the regulatory authority send inspectors there, accompanied by the owner.

TECHNICAL SESSION 4: CHAIRPERSON'S SUMMARY

K.B. CUTLER
United States of America

In conclusion, let me say that I am impressed and encouraged by the fact that countries are clearly taking the Guidance on the Import and Export of Radioactive Sources very seriously, and by the progress made thus far. I find that the Guidance represents a major breakthrough in enhancing control over radioactive sources. Its ultimate success is linked to harmonized implementation. I therefore urge countries to implement it as soon as possible and to work with others to harmonize our actions and create a level playing field for all concerned.

INADVERTENT MOVEMENT AND ILLICIT TRAFFICKING OF RADIOACTIVE SOURCES

(Panel Session 2)

Chairperson

A. TSELA
South Africa

Members

A.S. STREZOV (Bulgaria)
P. BASTIDE (France)
R. HOSKINS (IAEA)
P. CARBONERAS (Spain)

EVALUATION OF BULGARIAN NEEDS FOR SECURITY OF RADIOACTIVE SOURCES AND TRAINING OF LAW ENFORCEMENT PERSONNEL THROUGH BORDER EXERCISES

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Abstract

The creation and implementation of an adequate legal framework is important for eastern European countries in the field of combating organized crime, especially the illicit trafficking of radioactive materials, in these countries' efforts towards joining the European Union by adopting many legislative, economic and political frameworks for the combating of terrorism. The Republic of Bulgaria, as a PECO country in the phase of pre-adhesion to the European Union, is preparing its legislation and law enforcement institutions to meet the new challenges and tasks of the process of joining the European Union. One of the best ways to combat illicit trafficking is collaboration between neighbouring countries through connections between similar law enforcement bodies. The Institute for Nuclear Research and Nuclear Energy in Bulgaria and the Çekmece Nuclear Research and Training Centre in Turkey participated in a joint border exercise at the Kapi Kule checkpoint which provided a unique opportunity for law enforcement institutions and scientific experts to respond jointly in a simulated border incident with real nuclear materials.

1. INTRODUCTION

The last ten years of great political and economic changes in the whole of eastern Europe have led to an increased traffic of people and goods all over Europe, including the Balkan region. Bulgaria's geographical situation at the crossroad between Europe, the former Soviet Union and the Middle East leads to a stream of illegal traffic — people, arms, drugs, gold, jewellery, etc. In recent years a new phenomenon has come into being — the criminal transport of stolen radioactive sources. In most of these cases, the criminal diversion of radioactive substances has been performed by uninformed people with a low level of education, in an attempt to make money on something that is difficult to sell. Illicit trafficking is the possession, use, transfer, disposal or unauthorized trade of radioactive materials (including nuclear materials) with criminal intent. This is a serious violation of international laws and also poses a risk to public health. Criminal diversion of fissile materials could potentially lead to the construction of a nuclear weapon or, if the radioactive material is applied with conventional explosives, could pose a threat to dwelling places, water supplies, etc. For these reasons, measures should be taken to promote collaborative efforts among the law enforcement institutions (police, counter-intelligence, customs, etc.) of the European countries that have to deal with such trafficking.

The criminal activities in this field include:

— Activities that breach non-proliferation controls;
— Other criminal acts intended to cause harm to people or the environment;
— Realizing profits from the sale of radioactive materials;
— Avoiding taxes or costs for disposal;
— Violation of transport regulations.

Radioactive materials are used throughout the world for a wide variety of purposes in industry, medicine, research, defence, etc. The radiological risks associated with such uses need to be restricted and protected against by the application of appropriate radiation safety standards.

2. REGULATORY ACTIVITIES

The Bulgarian regulatory system is expected to ensure the effective control of radioactive materials, but nevertheless, control can be lost for a variety of reasons. A user of radioactive materials may not follow the procedures required by regulations, or loss of control may result from inadequate physical security. There may also be deliberate diversion of radioactive materials, which may be done to avoid the costs of waste disposal or as an attempt at illicit trade.

Terrorists may also attempt to acquire radioactive materials. Because of the issues associated with the proliferation of nuclear weapons and terrorism, there is a particular concern in this regard with materials that are used in nuclear power and nuclear weapons programmes. Because of the possibility of transfer across borders, regaining control of radioactive materials at the point of entry into a country or at other checkpoints prevents escalation of the problem later, when the consequences may be much greater. The trafficking of nuclear and radioactive materials in Bulgaria can be divided into two main parts — internal and external.

2.1. Internal trafficking

Up to now, internal trafficking has consisted of radioactive sources stolen from companies or plants that were privatized or stopped functioning owing to the economic changes in the country. In the last nine or ten years, there were attempts to divert and transport materials from the uranium mining industry, including different amounts of yellow cake that had been produced and stored. These cases included radioactive sources or isotopes that were used in industry and had mainly been imported with equipment from the former Soviet Union. They included highly radioactive sources based on the isotopes ^{137}Cs, ^{60}Co, ^{192}Ir, ^{226}Ra, etc.

The devices involved level meters, densitometers, devices for removing static electricity, weighing devices, parts of irradiation devices, smoke detectors, etc.

There were a few cases of criminal diversion of materials or devices containing natural or depleted uranium, containers or shielding applied in gamma defectoscopy. Although the handling and transport of such substances require special equipment and licensing according to Bulgarian legislation, the trafficking was carried out by incompetent people who endangered their own health and subjected innocent people to harmful doses.

2.2. External trafficking

The external trafficking of illicit nuclear materials is connected with the transfer of raw materials and expensive metals from the former Soviet Union towards western Europe and the Middle East. This trafficking includes aluminium, osmium, rare earth elements, red mercury, plutonium and enriched uranium. The trafficking of the last three items is of greatest concern and should be addressed with highest priority.

The creation and proposal of a model procedure for developing countries is important for starting the initial process of preventing and combating the illicit trafficking of radioactive materials, and particular efforts should be directed at protection of fissile materials. The reported incidents of diversion of nuclear materials have raised the problem of potential nuclear terrorism. The proposal of a model procedure will allow better and quicker upgrading of developing countries' capabilities for combating illicit nuclear trafficking.

One of the most crucial problems that arise in these countries relates to the number of institutions involved and their coordination. The main efforts should be directed towards the proper division of responsibilities and the creation of a qualified team capable of quick response in the event of illicit trafficking. The proposed scheme for reaction to such an event in Bulgaria is described below.

3. BULGARIAN MODEL ACTION PLAN FOR SEIZED OR FOUND RADIOACTIVE (NUCLEAR) MATERIAL

First step

- Preservation of evidence;
- Health physics analysis;
- Adoption of proper protocols by the law enforcement forces — police, customs, etc.

Second step

- Non-destructive analysis to categorize the radioactive material as radioactive, non-fissile material or nuclear fuel (^{235}U content less than 20%), or as plutonium or enriched uranium (^{235}U content higher than 20%);
- High resolution gamma spectroscopy;
- Passive neutron interrogation for plutonium (if hidden in a strong gamma source);
- Active neutron interrogation for ^{235}U (if hidden in a strong gamma source).

Third step — in-depth analysis by a specialized laboratory

- Traces (dust, pollen, etc.) on packaging material;
- Packing material;
- Element composition of nuclear material, including traces.

4. SETTING UP A LEGAL AND ADMINISTRATIVE FRAMEWORK

First + second step — coordination of the services involved

- Establishing what law enforcement service is in charge;
- Establishing whose function it will be to call for the services of nuclear experts, health physics experts and non-destructive analysis experts;
- Designating trained expert team for non-destructive analysis (on alert);

— Packing the seized material for transport to intermediate storage or to a specialized laboratory;
— Reporting to the prosecution, giving evidence to the court.

Third step

— In the case of a specialized laboratory outside the country, shipment of samples;
— In the event that seized plutonium material cannot be sampled, shipment of the material out of the country;
— Carrying out joint analysis (in collaboration with a laboratory outside the country);
— Preparation of expertise report for the court;
— Carrying out the proper procedure for storage, disposal, etc., of the seized material.

5. ACTIONS THAT TAKE PLACE ON-SITE

(a) Health physics examination for occupational and public radiation hazard

— Gamma–neutron radiation dose;
— Alpha–beta surface contamination.

(b) Law enforcement actions

— First check for booby traps;
— Preservation of evidence, chain of custody.

(c) On-site categorization of seized material by mobile non-destructive analysis equipment

— Natural sources (e.g. fertilizer and plants), scrap;
— Contaminated material from nuclear activities, waste (e.g. spent fuel and resins);
— Radioactive sources;
— Nuclear material — fuel, weapons utilizable or weapons grade.

6. RESPONSE TO THE ILLICIT TRAFFICKING OF RADIOACTIVE MATERIALS

The detection of internal and external trafficking raises serious problems for the controlling organs in Bulgaria with respect to the need for equipment and qualified personnel at the borders and inside the country. The creation and proposal of a model action scheme for Bulgaria is important for starting the process of preventing and combating the illicit trafficking of radioactive materials, which is a new threat that requires rapid implementation of comprehensive, joint measures and efforts, new approaches, coordination of services and institutions, and even new legislation.

The assurance of the security of radioactive sources requires that measures be applied to prevent unauthorized access to sources at all stages of their life cycle, as well as prevention of loss, theft and unauthorized transfer of sources. However, consideration needs to be given to the expansion of these measures to take into account the threat of people acquiring control of a radioactive source for criminal purposes. The recommended security measures are aimed at the prevention and countering of malicious acts by a combination of deterrence, early detection and delay of attempts at unauthorized acquisition, and appropriate measures to respond to a loss of authorized control, including recovery. The necessary security measures at nuclear facilities or radioactive waste disposal facilities should provide a high standard of security based on the existing requirements for physical protection against unauthorized removal of nuclear material and acts of sabotage.

7. ADMINISTRATIVE MEASURES

Administrative measures are the use of policies, procedures and practices that direct personnel to securely and safely manage sources. Administrative measures include:

— Access control;
— Alarmed access points (for example equipped with radiation detectors);
— Video cameras and personal surveillance;
— Inventories;
— Regulations and guidance;
— Reliability and trustworthiness of personnel;
— Information security.

8. TECHNICAL MEASURES

Technical measures pose a physical barrier to the radioactive source, device or facility in order to separate it from unauthorized persons to deter or prevent unauthorized access to or removal of a radioactive source. Technical measures are generally hardware or security devices and include fences, walls, cages, transport packaging, locks and interlocks for doors, and resistant source-holding devices. The reporting of unusual events to the regulatory authority will enable the regulatory authority to keep track of sources. The events to be reported include:

— Loss of control over a radioactive source;
— Unauthorized access to or unauthorized use of a source;
— Malicious acts threatening authorized activities;
— Discovery of any unaccounted source.

9. FIRST BORDER EXERCISE ON COMBATING ILLICIT TRAFFICKING OF NUCLEAR MATERIALS, WITH PARTICIPATING COUNTRIES TURKEY AND BULGARIA

Place: Kapi Kule border crossing point;
Dates: 14–15 October 2002.

Acting partners:

— Çekmece Nuclear Research and Training Centre, Istanbul, Turkey;
— Institute for Nuclear Research and Nuclear Energy, Sofia, Bulgaria.

Observers of the joint exercise at Kapi Kule:

— European Union representatives — experts from the Institute for Transuranium Elements, Karlsruhe, Germany;
— Experts from the IAEA;
— International Criminal Police Organization;
— European Police Office;
— United States embassy in Sofia.

Turkish authorities:

— Turkish Atomic Energy Authority;
— Turkish Border Police;
— Turkish Customs.

Bulgarian authorities:

— Nuclear Regulatory Agency;
— National Service of Border Police;
— National Service for Combating Organized Crime;
— National Police — Regional Department;
— Ministry of Finance — Customs Agency;
— State Agency of Civil Defence.

10. CONCLUSION

The illicit trafficking of nuclear materials is a new threat that requires rapid implementation of comprehensive measures and efforts, new approaches, coordination of services and institutions, and even new legislation. One of the best ways to combat illicit trafficking is to conduct a border exercise between neighbouring countries to demonstrate the interrelation between similar law enforcement bodies and other institutions involved in combating the illicit trafficking of radioactive materials. The Institute for Nuclear Research and Nuclear Energy in Bulgaria and the Çekmece Nuclear Research and Training Centre in Turkey participated in a joint border exercise at the Kapi Kule checkpoint which provided a unique opportunity for law enforcement institutions and scientific experts to respond jointly in a simulated border incident with real nuclear materials. The experience acquired and lessons learned through this first international exercise will serve as a model for future collaboration between neighbouring countries, especially in combating nuclear terrorism at ‘hot spots’, such as Bulgaria and Turkey, which are geographically situated in a stream of major illicit trafficking.

PRESENTATION OF THE CENTRAL OFFICE FOR THE SUPPRESSION OF TRAFFICKING IN ARMS, EXPLOSIVES AND SENSITIVE MATERIALS, OCRTAEMS

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The Central Office for the Suppression of Trafficking in Arms, Explosives and Sensitive Materials (OCRTAEMS) was created on 13 December 1982. For around twenty years it was no more than a simple group within the Anti-Terrorist Division of the Central Directorate of the Criminal Police (DCPJ). At that time, it was almost exclusively terrorists who had recourse to explosives and weapons of war, hence the name.

In April 2002, following the Nanterre massacre (March 2002), where a mad marksman decimated the Municipal Council of the town during a meeting, it was decided to reactivate this office. Its mandate was also redefined to cover general suppression of arms trafficking, whatever the area of crime: organized crime, common law crime, terrorism, crime in sensitive areas, etc.

The main reason for this choice is the development of arms trafficking which, for several years, has involved a much more diversified criminal population than in the past. This phenomenon has been helped along by the geopolitical changes in recent decades which have given criminals of all kinds access to an enormous clandestine arms market. Over 12 000 weapons are seized in France every year. Moreover, the weapons used are more lethal, new and highly dangerous explosives are being discovered, and home-made plans for the manufacture of explosive devices can be disseminated through the Internet. Trafficking in nuclear, radiological, biological or chemical substances is a possibility which can no longer be underestimated.

For that reason, the arms office was removed from the National Anti-Terrorist Division (DNAT) and became a separate office directly under the Subdirectorate for Criminal Affairs. The number of its staff was set at 30.

Its function is to promote and coordinate the fight against crime relating to the manufacture and possession of, trading in and illicit use of weapons, ammunition, explosives and sensitive materials (nuclear, radiological, biological and chemical). Therefore the office has privileged contacts in France with all police and gendarmerie services and with various ministries related to its field of competence.

Its structure is traditional and comprises two inquiry groups, one technical and legal analysis unit and an operational documentation section. It has a ballistics and weapons expert, an explosives specialist and a nuclear, radiological, biological and chemical threat consultant.

Thus the service is able to fulfil its mandate, which, as for any central office, comprises two complementary aspects:

(a) Centralization and analysis of information: This involves the collection and processing of all information passed on by all police, gendarmerie and customs services. It covers all weapons which have been stolen, found, seized or mentioned in legal cases or messages sent by the bodies we are in contact with. Information is also collected on explosives and sensitive materials. These operations have a dual purpose:
   - A statistical aspect and knowledge of the field, which allows us to put together a picture of clandestine arms circulation in France and perform a series of analyses of the types of weapon or material found, the types of crime in which they are involved and their origin. These studies are performed to help the political, administrative or legal authority define penal, legislative or regulatory policies giving rise to specific actions.
   - An operational documentation aspect with a view to determining supply routes via confirmation and investigation of the data. This documentation also allows us to answer questions from other services.

(b) An operational intervention wing: The office deals with two types of case, either as the main actor, or in collaboration with the territorial police or gendarmerie services, or as coordinator:
   - Major trafficking cases.
   - Cases which shed light on the state of the weapons, explosives and sensitive materials situation in France, whatever area of crime it may be related to. The office studies the modalities of clandestine arms circulation in sports shooting circles, among collectors and in certain specialized military surplus stores, for example. Within this specific framework, it explores the sensitive materials supply routes of criminal or terrorist circles.

To fulfil the mandate entrusted to it, the office formed ties with its partners: the justice system, the army, the customs authorities, laboratories, technical and scientific police experts, all police or gendarmerie services and equivalent services abroad. It rapidly became apparent that the reactivation of a central service for weapons, explosives and also sensitive materials met a need and an expectation among its partners.

To fulfil all its functions, the office recruited staff from different police backgrounds, and its staff includes a liaison officer from the national gendarmerie who maintains contacts with that body, a weapons expert also from the national gendarmerie and an explosives expert. The last maintains permanent contacts between the office, the demining services and the internal security services.

Despite its recent establishment, since its 'reactivation' in April 2002 the arms office has been giving new impetus to its activities in the areas mentioned (operations relating to a very wide range of cases, contacts in France and abroad, participation in various bodies dealing with weapons, or control of trade or trafficking in weapons, and regulation of weapons) and is finalizing the major project of creating a file on weapons which have featured in legal cases.

It is also developing its activities in its more specific fields of competence relating to trafficking in sensitive materials: nuclear, biological and chemical.

In this very specific sector, the staff of OCRTAEMS go on regular training internships both in the field of intervention and in the field of technical studies, in which areas the service works regularly with privileged partners such as the Atomic Energy Commission (CEA) or the Bouchet Research Centre (CEB) in the biological and chemical field.

FRENCH INVESTIGATION PROCEDURES AND TECHNICAL RESOURCES

Generally the French police services have free access to all open information sources (files accessible to the public such as the telephone directory, the trade and companies register, etc.).

Within the framework of their investigations they also have access to specific files managed by the Ministry of the Interior or the Ministry of Defence (national gendarmerie).

These include principally:

- Operations files of the national police or the gendarmerie, and in particular the recorded offences processing system (STIC) and its counterpart JUDEX;
- Schengen area files;
- Administrative files managed by the Ministry of the Interior (national file of aliens, driving licences, vehicle registrations, etc.).

On this basis, the police services are in a position to provide their foreign partners with some information when requested to do so through the International Criminal Police Organization (ICPO-Interpol) or the European Police Office (Europol).

However, for more specific requests, legal authority is needed to obtain information held by other administrative bodies or by private bodies.

Such investigations can thus only be conducted on the basis of legal requisitions. These are only issued within the framework of a specific inquiry. This may involve:

- Compliance with international letters rogatory issued by foreign authorities to the French judicial authorities;
- Inquiries conducted in France under the authority and control of magistrates (public prosecutors or judges).

Apart from these circumstances, the information held cannot be obtained by the French police services.

THE SPECIFIC AREA OF NUCLEAR, RADIOLOGICAL, BIOLOGICAL AND CHEMICAL THREATS

International tensions and the current terrorist situation have prompted the security services to include all kinds of attack hypotheses in their prevention or response plans.

The information services (Directorate for National Surveillance or General Information) are responsible at the Ministry of the Interior for collecting information which may be subject to judicial use by such specialized services as the National Anti-Terrorist Division (when the threat is terrorist in nature) or the Central Office for the Suppression of Trafficking in Arms, Explosives and Sensitive Materials in the case of illicit trafficking in nuclear, radiological, chemical or biological substances.

In the latter area, OCRTAEMS receives information through international channels such as ICPO-Interpol and Europol, and national information relayed through territorial criminal police or gendarmerie bodies.

The use made of it at central level shows that much nuclear or radiological material is not kept under optimal security conditions and that the dismantling of some military or industrial equipment is giving rise to a profitable trade managed by criminal organizations.

The French police services have thus been able to bring to light two instances of trafficking in radiological or nuclear material over the last ten years: in 1995, when two individuals were involved in the trafficking of two ^{60}Co sources; and in 2001, when several individuals were questioned after attempting to sell 2.5 g of highly enriched uranium.

Apart from the above mentioned cases, the information brought to the attention of OCRTAEMS relates mainly to attempted swindles involving material claimed to be radioactive (red mercury, for example) and offered at very high prices.

Where the presence of sensitive materials is confirmed, the office can have recourse to the operational skills of the central interministerial task force which answers directly to the head of the RAID (Investigation, Assistance, Intervention, Dissuasion) force, and the specialized services of the CEA for nuclear or radiological threats.

Thanks to the central position of the office, its representatives participate very regularly in national or international bodies to discuss security as it relates to sensitive materials.

The service was also recently designated by the Minister of the Interior as the French contact point for the implementation of an early warning network at European level for weapons, explosives and sensitive materials.

ILLICIT TRAFFICKING INVOLVING RADIOACTIVE SOURCES

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Abstract

The IAEA's Illicit Trafficking Database (ITDB) is a unique mechanism for collecting, analysing and disseminating authoritative information on incidents of illicit trafficking in nuclear and other radioactive materials. In the period 1993–2004 the ITDB recorded information on 662 incidents, of which 411 involved radioactive sources. The data show that for a variety of reasons the number of cases involving radioactive sources has been rising since 1996, and it reached a high point in 2004. Only 11% of sources encountered were classed as 'dangerous', but most of these cases occurred in the period 1999–2004. Over half of all incidents involved the recovery of sources the theft or loss of which had not been previously reported. About one third of all recoveries were aided by radiation detection equipment. About one third of all incidents were losses or thefts, the vast majority being either from the owners' premises or while in transport. About 43% of incidents involved some form of criminal activity, mostly theft. About a fifth of all incidents involved crossing a border, and three quarters were detected at the border rather than later.

1. INTRODUCTION

Millions of radioactive sources are used worldwide in a large number of legitimate peaceful applications. They often become targets for criminals or fall out of legitimate control. There is a credible risk that radioactive materials used in such sources could be used for malicious purposes. The collection and analysis of authoritative information on cases of illicit trafficking involving radioactive sources, and the timely exchange of such information and analysis, are essential ingredients in improving the security of radioactive sources worldwide.

The IAEA's Illicit Trafficking Database (ITDB) is a unique international mechanism for the collection, analysis and exchange of authoritative information on incidents of illicit trafficking involving nuclear and other radioactive materials, including radioactive sources. It was established in 1995 in response to the request by the IAEA Board of Governors to the Director

General to develop “a reliable database of information on incidents of illicit trafficking to assist Member States and to better inform the public.” In March 2002, the ITDB was identified in GOV/2002/10 as an integral part of the IAEA’s Plan of Activities to Protect against Nuclear Terrorism. As of 31 December 2004, 81 IAEA Member States were participating in the ITDB programme.

Information is collected on incidents which involve the unauthorized acquisition, provision, possession, use, transfer or disposal of nuclear materials and other radioactive materials, whether intentional or unintentional, and with or without the crossing of international borders. Also included are unsuccessful or thwarted events and incidents involving the inadvertent loss and discovery of uncontrolled radioactive materials, e.g. orphan sources.

The ITDB office collects and disseminates information on incidents through a network of national points of contact. It also cooperates with international organizations, such as the International Criminal Police Organization (ICPO-Interpol), the European Police Office (Europol) and the World Customs Organization (WCO). The ITDB staff assesses individual cases and analyses threats, trends and patterns. The results are disseminated regularly in the form of quarterly and annual reports. The ITDB has, however, certain limitations. Reporting is voluntary and is therefore often incomplete. Membership is not universal, so information coverage is not comprehensive.

2. GLOBAL STATISTICS, 1993–2004

As of 31 December 2004, States had reported 662 incidents of illicit trafficking and other related unauthorized activities involving nuclear and other radioactive materials to the ITDB. Of these incidents, about 30% involved nuclear materials, roughly 60% involved other radioactive materials, about 4% involved both nuclear and other radioactive materials, and the remaining incidents involved radioactively contaminated materials and other materials.

3. INCIDENTS INVOLVING RADIOACTIVE SOURCES

3.1. Aggregate statistics

Since 1993, there have been a total of 411 confirmed incidents involving radioactive sources. The number of such cases has been rising since 1996 (Fig. 1). This may reflect a real increase in the number of illicit trafficking cases

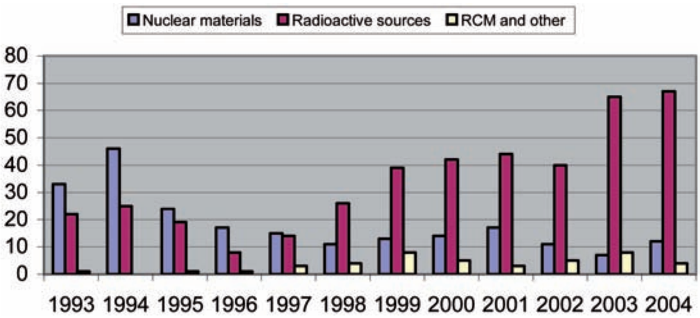

FIG. 1. Incidents confirmed to the ITDB, 1993–2004. RCM: radioactively contaminated materials.

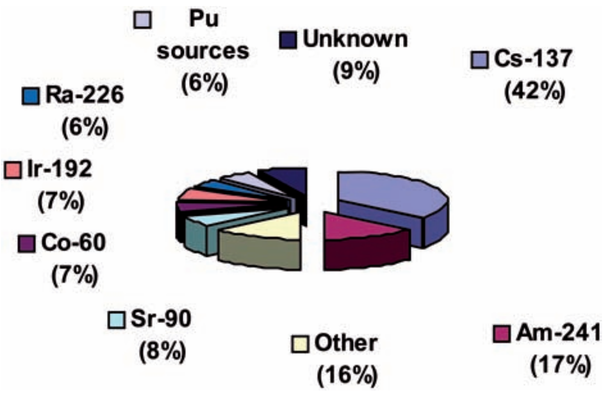

FIG. 2. Incidents by radioisotope, 1993–2004.

but it may also reflect improved reporting due to heightened awareness of the security and safety risks, improvements in national detection capabilities, enhanced accounting procedures which allow timely detection of the lost or stolen sources, increased reporting of incidents with no evidence of criminal activity or incidents involving small quantities of materials (previously regarded as 'insignificant'), and growth in the ITDB membership.

3.2. Radionuclides

The radioisotopes most frequently involved in incidents reported to the ITDB during 1993–2004 (Fig. 2) were ^{137}Cs, ^{241}Am, ^{192}Ir, ^{90}Sr, ^{226}Ra, ^{238}Pu and

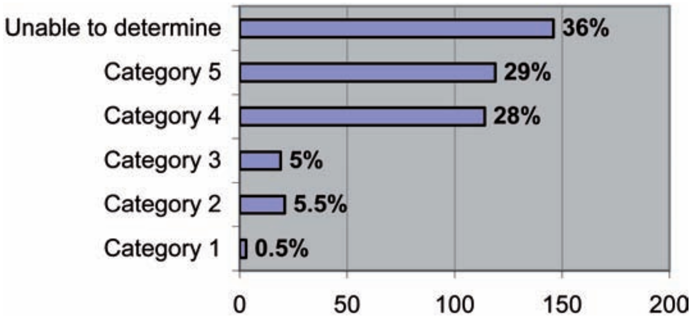

FIG. 3. Incidents by source category, 1993–2004.

^{60}Co[1]. Among these, ^{137}Cs is the most frequently encountered radioisotope. During 1993–2004, it was involved in about 42% of all incidents. This may reflect the fact that ^{137}Cs is in widespread use.

3.3. Source categorization

The ITDB assesses the radiological risk posed by sources using the IAEA Categorization of Radioactive Sources (IAEA-TECDOC-1344). About 11% of incidents involved 'dangerous' sources[2] (Fig. 3). Such sources fall under Categories 1–3 of the IAEA categorization. The number of incidents involving dangerous sources is rising. About 80% of the incidents involving such sources were recorded during 1999–2004. Notably, the majority of such incidents involved criminal activity.

3.4. Recovered and missing radioactive sources

About 53% of incidents involved the recovery of uncontrolled or illegitimately controlled radioactive sources. In all cases the theft or loss of these sources had not been detected or had not been reported. About 4% of incidents involved detections of radioactive sources amidst metal scrap in international transport. In these cases, the loads of scrap, together with the

[1] The plutonium sources involved in incidents reported during 1993–2004 contained a mixture of ^{238}Pu and ^{239}Pu. The exact atomic weight of ^{238}Pu in these sources is not known to the ITDB. Plutonium-238 presents a greater internal hazard than ^{239}Pu.

[2] The IAEA Categorization of Radioactive Sources, IAEA-TECDOC-1344, defines a 'dangerous' source as a source that could, if not under control, give rise to exposure sufficient to cause severe deterministic effects.

unrecovered sources, were returned to the country of origin. It is not known whether or not the returned sources were subsequently recovered.

In about one third of all cases, radioactive sources were detected/ recovered with the help of radiation detection equipment, either fixed positioned or handheld. About 90% of the cases involving such detections occurred during the period 1999–2004. This appears to indicate improved detection capabilities both at national borders and within States, e.g. at entries to scrap collection or processing facilities. About 17% of detections/recoveries were the result of police work.

About 37% of incidents involved lost or stolen sources. About 90% of such cases occurred in 1999–2004 (Fig. 4). This appears to be an indicator that accounting measures in many States have improved to allow the timely detection of sources' theft or loss. About 38% of the stolen or lost radioactive sources were recovered.

The types of source whose loss or theft was most frequently detected were moisture–density gauges, some other types of portable gauge and radiography devices. These data show that the loss of control of sources or devices with which the operators require frequent physical contact is more susceptible to timely detection. In about 43% of incidents, the sources were lost or stolen from the users' premises, such as factories, hospitals, offices or storage facilities. In about 40% of cases, the sources were lost or stolen during transport or from parked transport vehicles outside users' premises, and in 4% of cases, sources were stolen from remote sites or construction sites.

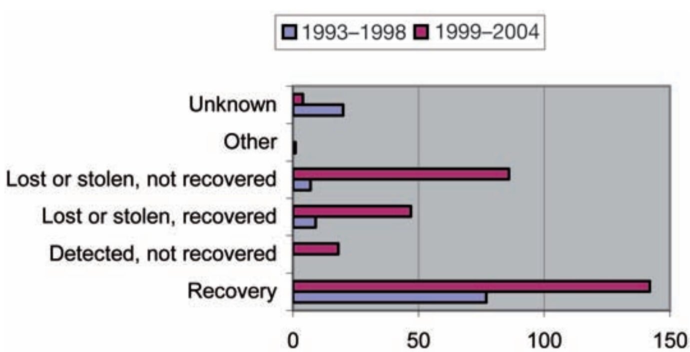

FIG. 4. Confirmed incidents involving radioactive sources. Recovered versus missing sources, 1993–2004.

3.5. Criminal activity

About 43% of incidents involved some form of criminal activity, such as theft, unauthorized possession or an unauthorized transaction. About 57% of incidents did not show any evidence of criminal activity. There was a substantial increase in the number of incidents with no evidence of criminal activity in 2003–2004 (Fig. 5). Incidents involving criminal activity declined slightly in the same period. In the period 1999–2004, the number of incidents involving criminal activity remained generally stable.

Eighty per cent of cases involving criminal activity were reported in the period 1999–2004. This may be due to improved reporting or improved detection of thefts, or both. During 1993–2004, roughly 35% of incidents with criminal activity involved illegal possession of sources; in about one third of these cases the perpetrators tried or had the intention to sell the sources.

Theft has been a predominant form of criminal activity recorded by the ITDB. Roughly 65% of cases with criminal activity involved theft. In the majority of cases, the thieves' intentions or motives were not known or possible to discern. Radioactive sources and devices in which they are used can be attractive for thieves because of their perceived high resale value or the value of their shielding and encapsulation metals. Several cases, however, have been recorded involving the intention to offer the stolen sources for sale on the 'nuclear black market'.

Discovery of uncontrolled, or 'orphan', sources constituted the bulk of the incidents where there was no evidence of criminal activity. Of these, about 60% involved detection/discovery of sources amidst metal scrap. These incidents, while with no apparent criminal content, may have had a criminal

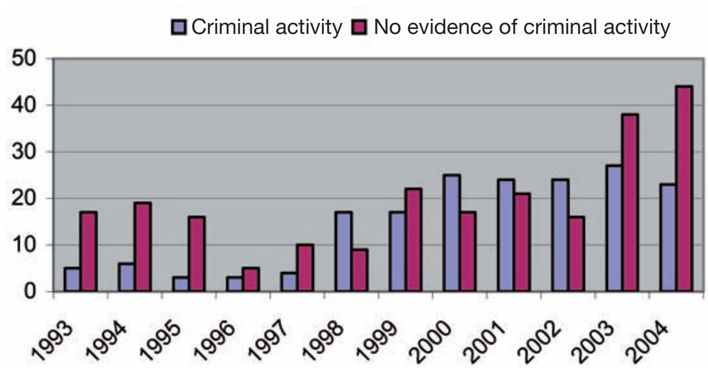

FIG. 5. Incidents involving criminal activity, 1993–2004.

origin. They may indicate attempted environmental crime in the form of disposal of radioactive sources in violation of disposal requirements.

3.6. Cross-border movement

During 1993–2004, 21% of cases involved evidence of unauthorized cross-border movement of radioactive sources. Of these, 75% of incidents were detected at borders, and in 24% of cases, sources were detected after having crossed one or more national borders undetected. Figure 6 shows the distribution of confirmed incidents involving unauthorized cross-border movement by detection location during 1993–2004.

The majority of these cases involved unauthorized transport of radioactive sources amidst metal scrap. In 2004 an especially high number of such cases were recorded. Unauthorized movement of radioactive materials amidst metal scrap appears predominantly to be incidental to the transport of scrap itself, although it can be assumed that some of these sources have been intentionally and illegally removed from their authorized use. It cannot be ruled out, however, that in some cases metal scrap can be deliberately used as a means to facilitate the smuggling of sources.

4. CONCLUSIONS

The data on incidents involving radioactive sources recorded by the ITDB during 1993–2004 provide evidence of the continuing challenges which the international community faces in ensuring the security of radioactive sources and preventing the sources from falling into the wrong hands.

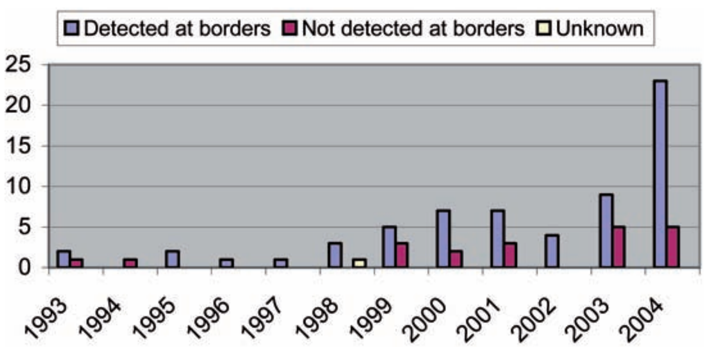

FIG. 6. Cross-border movement, by detection location, 1993–2004.

The data for the last 12 years show that the number of incidents involving radioactive sources has increased substantially since 1996, but the trend may have a number of causes.

Less than half of incidents show evidence of criminality, and many of these were amateurish, supply driven and opportunistic. Well organized criminals are less likely to be detected.

The radioisotopes ^{137}Cs, ^{241}Am, ^{192}Ir, ^{90}Sr, ^{226}Ra, ^{238}Pu and ^{60}Co were the most frequently involved in incidents reported to the ITDB during 1993–2004. The most dangerous sources, those in Categories 1–3, make up about a tenth of incidents but the number is rising.

Too many sources are lost or stolen without being detected or recovered.

There is evidence that the investment in developing and deploying radiation detection equipment at borders and elsewhere is showing some benefit.

EXPERIENCE OF THE APPLICATION OF THE 'SPANISH PROTOCOL' FOR THE RADIOLOGICAL SURVEILLANCE AND CONTROL OF SCRAP AND THE METALLIC PRODUCTS RESULTING FROM ITS PROCESSING

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Despite the fact that the use of radiation technologies has been subject to strict controls in most countries since the very beginning, the presence of radioactive material in scrap has been detected relatively often in recent years. This has led to the implementation of a series of national and international initiatives aimed at detecting and preventing such events, regardless of whether they are intentional or unintentional.

The Spanish iron and steel industry is one of the most important industrial sectors in the country, and depends to a large extent on the importing of a significant proportion of the scrap used as raw material. Experience has shown that countries that import large quantities of scrap should complement the aforementioned international initiatives with others of a national scope, in order to reduce the risks arising from the presence of radioactive material in scrap.

In this context, in 1999 the Spanish authorities, along with the business associations involved in the metal recovery and smelting industry and the radioactive waste management agency, voluntarily signed a 'Protocol' defining and implementing a national system for the radiological surveillance and control of scrap and products resulting from its processing. Since then the most relevant trade unions and others in the industrial sector have also signed the Protocol.

The system defines the rights and obligations of the Parties and describes the surveillance and control system to be established, which consists of a set of legal bases, the operation of specific radiological surveillance equipment — either new and specific or general purpose equipment already in existence prior to these initiatives, the development of radiological training and information plans for the professionals involved in the metal recovery and smelting sectors, the definition of a fully operational system to safely manage the materials detected, and general improvement of the national radiological emergency system.

Since its signature more than 90 industrial companies have joined the Protocol, and new industrial sectors are actively considering joining as well. The accumulated experience has proven to be very positive and the Spanish example is increasingly being seen as a ‘good reference’. The number of actual detections so far stands at around 400, with more than 100 sources and 900 miscellaneous materials with radioactive content (mainly of natural origin) having been detected and controlled.

The Protocol contains a main text with the basic agreements and a Technical Annex describing the operational actions undertaken by the Parties. It establishes a Technical Commission to follow up its operation and to learn from experience. On this basis a new revision of the Technical Annex has been prepared and will be formally in operation in January 2005.

1. INTRODUCTION

Recycled scrap metal is increasingly used in modern steel production. In 2001, the worldwide consumption of scrap metal was of the order of 370 million tonnes. Scrapyards and steel mills are increasingly detecting radioactive material in incoming scrap metal as the result of accidents or inadvertent disposal. In North America alone, nearly 4000 incidents involving various types of radioactive material in scrap metal were recorded in 2001. Some of these sources have gone undetected, have been inadvertently melted down or shredded and have thus entered the metal stream.

The origin of the radioactive sources entering the recycled scrap metal stream is very often unknown. In the past few years there has been a significant increase in the number of such uncontrolled (orphan) radioactive sources. While the potential environmental and health risks of most of these incidents are usually not very high, owing to the relatively low radiation levels involved, they are still often above acceptable levels, but more significantly the economic and financial consequences of such incidents for the steel processing industry are always very serious (for example, the cost for the cleanup of individual incidents can range from 1 million to more than 100 million euros). The detection of radioactive material, even with radiation levels below those requiring regulatory control, almost always results in the closure and cleanup of the facilities involved. In addition, such incidents might lead to a loss of trust in recycled materials, as businesses and consumers simply do not want to have any radiation emanating from their purchases.

With the use of increasingly sophisticated systems, the number of detections of radioactive sources in scrap metal will continue to rise. Current efforts to control high activity sealed radioactive sources will not change this trend in the near future, since recovered and recycled scrap metal is often 40 years old or more.

Therefore the effective monitoring and control of radioactive material, particularly in scrap metal, which is to a large extent transported and traded internationally, are of considerable importance and should be tackled at both national and international levels.

Considerable work has already been undertaken by many countries and international organizations, such as the IAEA, the United Nations Economic Commission for Europe (UNECE) and the European Union (EU), to address environmental and health aspects of radioactive material and its transport, even though the implementation and enforcement of these regulatory standards and procedures still need to be enhanced.

However, little concerted action has been taken by countries and the international community to consider harmonized standards and procedures that would facilitate the international transport and trade of scrap metal that is virtually free of detectable radioactive contamination and is thus acceptable to metal processing industries and consumers worldwide.

2. BACKGROUND OF THE SITUATION IN SPAIN

As a result of an incident that occurred at a steelyard in the province of Cadiz in May 1998, the Spanish authorities set up a working group to promote, define and coordinate national actions aimed at preventing radiological risk in the industrial activities involved in the recycling of metals. The Spanish radioactive waste management agency, Empresa Nacional de Residuos Radiactivos, S.A. (ENRESA), was invited to participate in this group.

On 2 November 1999, and as a result of the work of the aforementioned group, the Spanish authorities, including the Nuclear Safety Council (Consejo de Seguridad Nuclear, CSN), ENRESA, the Iron and Steel Companies Union, and the Spanish Recovery Federation signed the Protocol on Collaboration in the Radiological Surveillance of Metallic Products (hereafter the Protocol). Subsequently, and in view of the importance of the correct radiological surveillance of metallic materials for iron and steel company workers and for society in general, the Protocol was signed also by the most relevant trade unions in the field. Likewise, and more recently, the Protocol has been signed by other non-ferrous-metal recycling associations (the Spanish Society of Aluminium Refiners, the National Copper Industries Union, the National Lead Industries Union and the Spanish Federation of Smelting Associations).

Each individual company joins the Protocol voluntarily, and a register is kept of all the members, which currently number more than 90.

The Protocol contains a main text and a Technical Annex, in which are established the commitments undertaken by each of the signatories. The system defined in the Protocol is structured around five elements:

— Legal bases of the radiological surveillance and control of scrap;
— Installation and/or improvement of radiological detection and surveillance systems;
— Implementation of fully operational systems to safely manage the radioactive material detected;
— Implementation of radiological training and information programmes;
— Enhancement of radiological emergency response plans.

Among other aspects, the main text includes the agreement between the signatories to set up a Technical Commission for Tracking of the Protocol on Collaboration in the Radiological Surveillance of Metallic Materials. The Commission was given the task of analysing the results of implementation of the Protocol, interpreting the contents of its Technical Annex and, where appropriate, agreeing on and incorporating whatever possible modifications such implementation might make advisable.

In the wake of the aforementioned agreement, the Technical Commission has, among other actions, revised the content of the Technical Annex, which entered into force in January 2005.

The overall evaluation of the Spanish experience is highly satisfactory for all the signatories of the Protocol and for the different companies attached to it. Other Spanish industrial sectors are formally considering joining the Protocol.

The actions performed since the incident in 1998 that led to the initiative of establishing the Protocol have allowed more than 100 radioactive sources to be recovered without processing, in addition to more than 900 miscellaneous materials with radioactive content, mainly of natural origin. During this period there have also been a further five incidents in which a radioactive source was processed. In all cases, the Protocol has undoubtedly proven to be efficient, and it has also been possible to improve its operability on the basis of the experience gained.

3. THE SPANISH EXPERIENCE

The number of detections to date amounts to some 400. A more detailed description of ENRESA's activities is provided in Annex I, which includes details of the types and characteristics of the radioactive sources and materials removed. Annex II includes a selection of photographs and gives the characteristics of certain of the radioactive sources and materials detected.

As has been pointed out above, since the initial event in 1998 there have been five other incidents resulting from the accidental processing of radioactive sources: one in 2001, two in 2003 and two others in 2004. In four of these cases, the incident involved steelyards that had smelted a radioactive source of some magnitude, and in the last a metal recycling company that inadvertently processed a radioactive source in a disused automobile fragmentation system.

The radioactive sources involved in all these cases were of ^{137}Cs and had moderate levels of activity (units or tens of gigabecquerels). None of these cases implied any radiological impact for people or the environment, although the operations of the companies in question were affected and the costs of cleanup and management of the radioactive waste were significant in some cases. (Annex III includes a summary of the main data on these incidents, while the data on the radioactive waste generated are included in Annex I.)

4. RECENT RELEVANT INTERNATIONAL DEVELOPMENTS

It may be said that in 1998 there were no systematic practices in place regulating the radiological surveillance of scrap at international or national level (Italy might be the only exception).

4.1. EU

The most noteworthy recent development emerges most clearly in the issuing of the EU Council's Directive 2003/122/Euratom of 2003-12-22 on the control of high activity sealed radioactive sources and orphan sources, in relation to the need to establish systems for the detection of orphan sources in large stores and recycling facilities for metallic scrap.

Additionally it is good to recall the European Council Resolution on the establishment of national systems for surveillance and control of the presence of radioactive material in the recycling of metallic materials in the EU Member States (2002).

4.2. IAEA

The most noteworthy recent development has been the approval by the IAEA Board of Governors of the Code of Conduct on the Safety and Security of Radioactive Sources, which has now been signed by 28 countries and for which application guidelines are currently being prepared. Likewise, the development and implementation of a specific Action Plan in this area are under way.

For several years the IAEA has been promoting international conferences in this area. The present conference in Bordeaux follows those held in Dijon and Buenos Aires.

Specifically interesting has been the recent publication of Safety Guide RS-G-1.7 (Application of the Concepts of Exclusion, Exemption and Clearance) on the scope of radiation protection standards, which defines, at world level, the levels of concentration of activity of the various radionuclides below which materials may be used without being subject to the said standards. The IAEA is preparing similar guidelines on the release of land.

4.3. UNECE

In 2001, the UNECE published a report on Management of Radiation Protection in the Recycling of Metal Scrap. As a follow-up, a Group of Experts on Monitoring of Radioactively Contaminated Scrap Metal was convened by the UNECE in Geneva (5–7 April 2004). The first session, which was attended by experts from more than 20 countries and international organizations, reviewed the results of a questionnaire that had been circulated to countries, and discussed policies and experiences in the monitoring and interception of radioactively contaminated scrap metal worldwide. The primary focus was on ways and means to facilitate and secure international trade and transport of scrap metal. In addition, safety and health issues that generally are already addressed and regulated in legal instruments, standards and guidelines prepared by the UNECE and the IAEA were reviewed.

With a view to addressing these issues, the session considered the need for: (a) examining the possible preparation of an international voluntary protocol facilitating a consistent, comprehensive and harmonized approach to monitoring, interception and response measures in the event of radiation contamination incidents; (b) preparation of training and capacity-building materials on best practices to assist affected personnel dealing with the control of scrap metal; and (c) establishment of an Internet based information exchange system open to all concerned parties.

More detailed information on the activities of the UNECE, including those of the expert group meeting, is available at the following web site: http://www.unece.org/trans/radiation/radiation.html

4.4. World Customs Organization

The illicit trafficking of radioactive and other hazardous materials has been a concern of the World Customs Organization (WCO) for a number of years, and the focus is on stopping such activities at borders.

In 1998, the IAEA and the WCO established a Memorandum of Understanding, and training efforts for customs officers are being developed. A small number of detection incidents have been reported so far.

In June 2003, the Johannesburg Convention, which enhances border controls, was approved, including provisions for hazardous goods. Efforts should continue and should be reinforced.

5. CONCLUSIONS AND LESSONS LEARNED IN SPAIN

5.1. View of ENRESA

5.1.1. Conclusions

ENRESA's activities are always undertaken on the basis of notifications received, as established in the Protocol. These are of two types:

(a) Removal of radioactive waste (prior to or following the eventual processing of radioactive material);
(b) Technical advice on various issues (including training).

To date the following conclusions may be drawn from the information provided:

(1) The surveillance and control systems established are certainly efficient for the detection of the presence of radioactive materials, which indeed appear with significant frequency.
(2) Most of the radioactive materials detected contain exclusively radioactivity of natural origin. To date no homogeneous international approach has been adopted regarding how to proceed in such cases. For some countries it is considered that such materials should not be treated as radioactive, while for others they should.

(3) Of the rest of the materials detected, the vast majority are radioactive sources with very low (or in certain cases moderate) levels of activity. The eventual processing of such materials might have caused operational disturbances and material damage to the industry involved, and would certainly have led to the undesirable generation of radioactive waste to be managed, but it is not credible that it would have caused significant radiological effects for people or the environment.

(4) If detection occurs before the radioactive material is processed, the operational impact on the industry is minimal and the total volume of radioactive waste produced is normally small. Indeed, when the radioactivity content is exclusively of natural origin, it is frequently possible to process the materials in the normal manner, following the appropriate evaluations, without this implying any effect at the factory, in its products or by-products, or for the environment.

(5) When, on the other hand, the radioactive material is detected after processing, the operational impact on the industry is high (or very high), and the total volume of radioactive waste produced is normally large (or even very large).

(6) When detection occurs before processing, the operation of segregating, removing and managing the waste is carried out in an absolutely normal manner. In the event of detection occurring after processing, the efficiency of the internal management of the waste by the industry and of its removal by ENRESA has improved as a result of the experience acquired from the incidents that have occurred since May 1998, although the results depend substantially on the specific problems involved in each case.

(7) The origins of the different radioactive materials detected, both national and international, vary, although both the industry and the authorities are now taking specific actions when there are signs that a given supplier might be causing problems. Nevertheless, the current scrap market at world level is affected by deficiencies in supply.

(8) The re-exporting of the radioactive materials detected to their places of origin is proving to be very complex for a variety of reasons. Re-export has been achieved in very few cases and has always been possible because the specific origin of the material (previous country and owner) has been identified.

5.1.2. Lessons learned

(a) The experience accumulated through application of the Protocol may be described as being clearly positive. Its existence and content have served especially to minimize the effects and consequences of incidents due to the presence of radioactive material in metallic scrap. Indeed, the capacity, flexibility and efficiency of the actions required, essentially as a result of the incidents due to the processing of certain radioactive sources, have improved significantly.

(b) Notwithstanding the above, the following aspects may be identified from the experience acquired by ENRESA as being open to improvement:

(i) It is necessary to continue strengthening the essentially preventive spirit of the Protocol, the objective of which is to attempt to prevent the presence of radioactive materials in scrap, and in any case to detect such materials and remove them from the stream as early as possible, preventing them from being processed, since this is where the consequences of all types are greatest.

(ii) In all the incidents in which radioactive sources have been inadvertently processed, there has been a ‘human factor’ in their development. Emphasis should be placed on the training of the relevant workers and the information provided to them.

(iii) There continues to be a need for efforts to clearly discriminate between the waste materials generated (especially when radioactive sources have been processed) and those that are to be managed as ‘radioactive waste’. This is especially important when the radioactive content is of natural origin. Also to be underlined is the need for specific installations for the optimum management of great volumes of very low level radioactive waste, which constitute the vast majority of the waste to be expected in this type of event.

(iv) The essentially international dimension of this issue cannot be forgotten. The Spanish experience is highly valued in all the forums known to ENRESA, but the implementation of specific measures varies from one country to the next, and the ‘globalization’ of sensitivity to the subject is still clearly insufficient, including that of the international organizations and of the market itself. Only if sensitivity to the international dimension of this issue is attained will it really be possible to achieve the ultimate objective sought, which is to bring about a world metallic scrap and materials market free from the presence of radioactive sources.

(v) Although the experience acquired to date is clearly positive, it should not be forgotten that public opinion is of decisive importance for the type of action required in application of the Protocol to be performed in the best way possible.

5.2. View of CSN

5.2.1. Conclusions

The Protocol is now fully operative and the experience has underlined its usefulness, not only for the detection of radioactive material that might be present in recycled scrap, thus preventing the risks that this implies, but also for ensuring that, even in the event of a radioactive source being smelted, contamination is prevented from spreading outside the facility. Likewise, the presence of previously established rules for action makes it possible for interventions to be initiated automatically and allows for better coordination between the entities involved as well as for a reduction of the radioactive waste to be managed and of plant recovery time.

5.2.2. Lessons learned

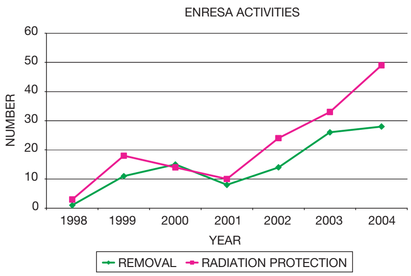
In this situation, and following approval of the modification to the Technical Annex, the most significant action to be addressed in the future will be the resolution of technical aspects pending in the practical application of the Protocol. In this respect the Technical Commission is currently working on an analysis of the existing radioactivity detection systems and on the preparation of procedures and practical guidelines for the actions to be taken in the event of detection of radioactivity in scrap, products or by-products.

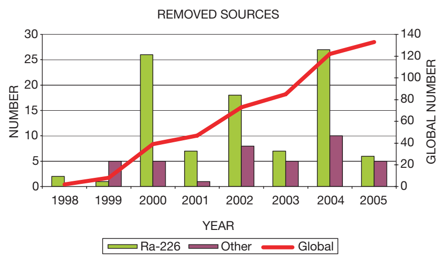
In addition, the training and public information activities foreseen in the Protocol are to be strengthened, for which a photographic database of detections that will be available to the public is being developed.

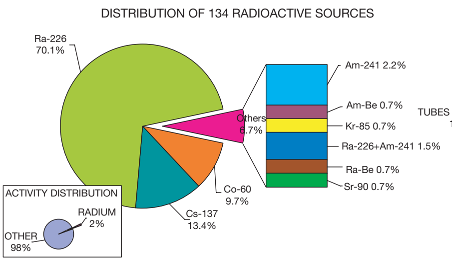
Finally, the Protocol is expected to be extended to include other industrial sectors, such as steelyard dust management companies.

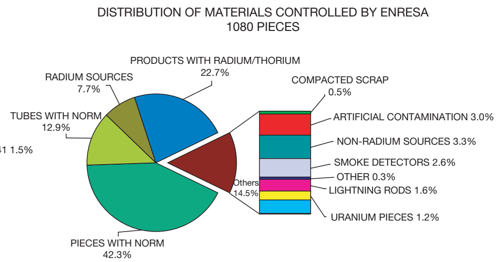
Annex I

SUMMARY OF ENRESA'S ACTIONS IN APPLICATION OF THE SPANISH PROTOCOL FOR THE RADIOLOGICAL SURVEILLANCE AND CONTROL OF METALLIC SCRAP, INCLUDING THE RADIOACTIVE WASTE DISPOSED OF, AS OF 31 DECEMBER 2004





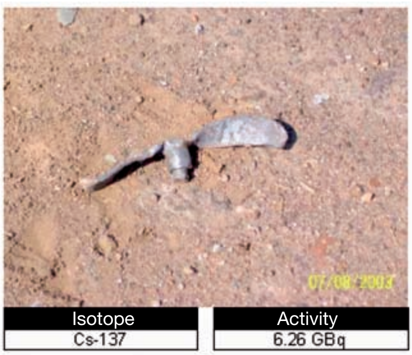


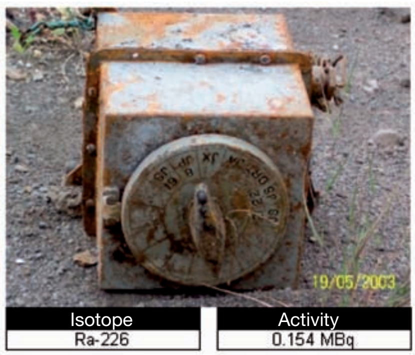


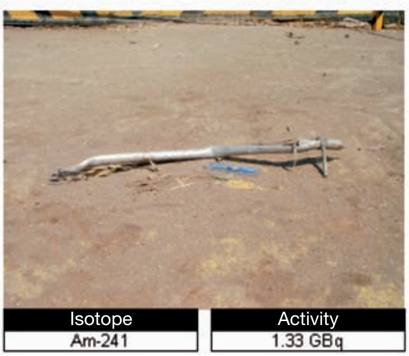
NORM: naturally occurring radioactive material.

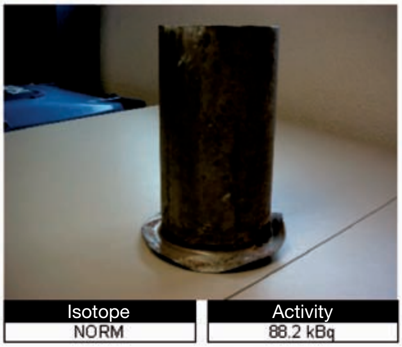
Annex II

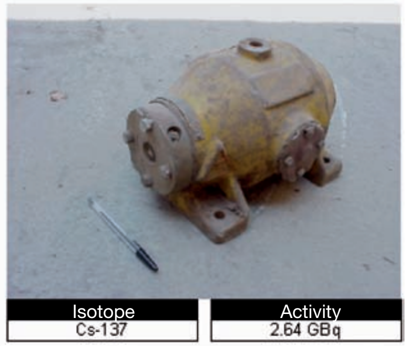
SELECTION OF RADIOACTIVE SOURCES AND OTHER RADIOACTIVE MATERIALS DETECTED IN APPLICATION OF THE SPANISH PROTOCOL FOR THE RADIOLOGICAL SURVEILLANCE AND CONTROL OF METALLIC SCRAP



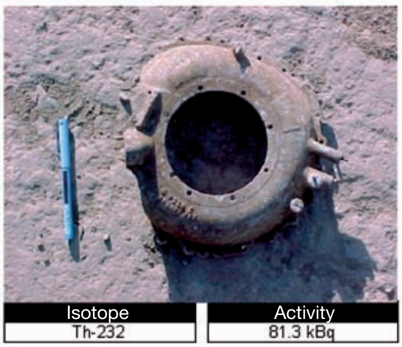


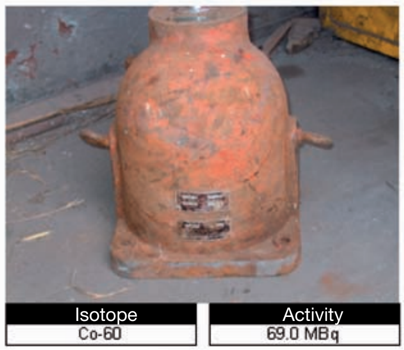






NORM: naturally occurring radioactive material.





Annex III

SUMMARY OF THE MOST RELEVANT INFORMATION RELATED TO THE INCIDENTS THAT OCCURRED IN SPAIN FROM 2001 TO 2004 OWING TO THE PROCESSING OF RADIOACTIVE SOURCES

1. IRON AND STEEL INDUSTRY, DECEMBER 2001

- The incident involved the smelting of a radioactive source of ^{137}Cs of some 100 GBq.
- Operational activities were interrupted for one month in the affected part of the facility.
- An outside steelyard dust management facility was affected and had to be cleaned.
- There was no radiological impact at all, to either people or the environment, other than the need to clean the aforementioned steelyard dust tip.
- A total of 325 m^3 of radioactive waste was generated and sent to El Cabril radioactive waste storage installation.
- The surveillance and control system installed at the facility worked correctly and efficiently and proved to be sufficient. There was a human error in interpretation of the indications provided.
- Analysis of the incident led to various improvements for incorporation into the Technical Annex of the Protocol, and personnel training was reinforced.
- Neither the steel produced nor the slag was affected. Only the steelyard smoke dust and facility systems associated with it were affected.

2. METAL RECYCLING INDUSTRY, AUGUST 2003

- The incident involved the destruction of a radioactive source of ^{137}Cs of some 10 GBq in a disused automobile fragmentation machine.
- Although the rest of the facility continued to operate, the shredder machine was shut down for 1.5 months.
- There was no radiological impact for either people or the environment.
- A total of 40 m^3 of radioactive waste was generated and sent to El Cabril radioactive waste storage installation.

— Although the facility was fitted with surveillance and control systems, their operational application was insufficient and the personnel in charge of their operation were insufficiently trained.
— Analysis of the incident underlined the importance of reinforcing the awareness of this type of problem in the metals recycling industry, which includes a high degree of fragmentation technology capacity.

3. IRON AND STEEL INDUSTRY, SEPTEMBER 2003

— The incident involved the smelting of a radioactive source of ^{137}Cs of some 2 GBq.
— The operational activity of the affected part of the facility was interrupted for eight days.
— There was no radiological impact for either people or the environment.
— A total of 75 m^3 of radioactive waste was generated and sent to El Cabril radioactive waste storage installation.
— Although the facility was fitted with surveillance and control systems, it was demonstrated that the materials entry system failed as a result of human error and that the detection system installed in the smoke line was inefficient in the case of the smelting of moderate activity sources.
— The incident underlined the fact that, instead of sophisticated radiological detection systems in the smoke dust processing systems, it was simpler and more efficient to ensure that the exit of by-products was controlled in addition to the entry controls implemented. Training was also reinforced.
— Neither the steel produced nor the slag was affected. Only the steelyard smoke dust and facility systems associated with it were affected.

4. IRON AND STEEL INDUSTRY, MARCH 2004

— The incident involved the smelting of a radioactive source of ^{137}Cs of some 36 Bq.
— The operational activity of the affected part of the facility was interrupted for 12 days.
— There was no radiological impact for either people or the environment.
— A total of 70 m^3 of radioactive waste was generated and sent to El Cabril radioactive waste storage installation.
— Although the facility was fitted with surveillance and control systems, there was a failure due to human error in the materials entry system. The

by-product exit control agreed on in the wake of the third incident mentioned above operated correctly.
- As a result of this incident, the measure agreed on following the previous incident was seen to work correctly, the mechanisms for communication and coordination between the affected companies and the authorities involved were improved, and training was reinforced.
- Neither the steel produced nor the slag was affected. Only the steelyard smoke dust and facility systems associated with it were affected.

5. IRON AND STEEL INDUSTRY, MAY 2004

- The incident involved the smelting of a low activity radioactive source of ^{137}Cs (not valued).
- The operational activity of the affected part of the facility was interrupted for three days.
- There was no radiological impact for either people or the environment.
- No radioactive waste to be managed by ENRESA was generated.
- Although the facility was fitted with surveillance and control systems, there was a failure due to human error in the materials entry system. Furthermore, the exit by-product control system had not been implemented, although the redundancy of the overall system worked correctly, since detection occurred at the company receiving the steelyard dust for recycling.
- As a result of this incident, the need to comply strictly with the agreements reached on the basis of the Protocol was underlined, in the interests of the companies themselves. Agreements were reached regarding reinforced training and information, these having been implemented during 2004.
- Neither the steel produced nor the slag was affected. Only the steelyard smoke dust and facility systems associated with it were affected.

PANEL SESSION 2: DISCUSSION

W. STERN (United States of America): Is the European steel industry working to ensure that the European Commission (EC) directives are harmonized with the IAEA Code of Conduct on the Safety and Security of Radioactive Sources and the Guidance on the Import and Export of Radioactive Sources?

P. CARBONERAS (Spain): It is difficult for me to speak for the Spanish authority because I am not part of it. I am aware that the aim of the various Spanish participants in the European working, advisory and decision groups or commissions has been to achieve as much harmonization as possible. Yesterday we heard about the differences between the approaches of the IAEA and the EC. Although such differences should not exist, I do not think they are so important in practice. It is much more important for us to work hard and fast to establish harmonized protocols and procedures, recognizing that the problem is growing and cannot be solved at the national level.

A.J. GONZÁLEZ (Argentina): I fully share Mr. Stern's concerns. The small diversity in European numbers is not helpful. The European Union (EU) must make an effort to be on board with international harmonization.

Mr. Hoskins, you made a very important qualification about the increase in numbers on the Illicit Trafficking Database (ITDB). I share your suspicion that there is not a real increase but rather an increase in awareness and therefore in the ability to detect. This is similar to the post-Chernobyl syndrome where more cancer was detected because people were looking for it.

The use of the word 'criminal' for some of the incidents recorded on the ITDB is tricky. Do you mean malicious intent or just violation of the law? For instance, in Goiânia, the law was violated but there was no malicious intent.

R. HOSKINS (IAEA): I agree that the assessment of trends must be done with care. Here a combination of factors is driving up the numbers. One factor could be a real increase in the number of incidents. However, in a large percentage of cases, there was no evidence of criminal activity. This does not mean it was absent, but we do not know enough about the circumstances to make a judgement. We err on the side of caution: We are not looking for criminals; we are looking for clear evidence of criminality.

A.J. GONZÁLEZ (Argentina): Regarding the data that you presented on Spain, which perhaps could be extrapolated to the IAEA database, you mentioned that there was a lot of naturally occurring radioactive material (NORM). If you were to apply the numbers approved at the last IAEA General Conference for radiological criteria for material in general, i.e.

between a few becquerels per gram up to — depending on the radionuclide — 1000 Bq/g, how many cases will remain if you exclude that range?

P. CARBONERAS (Spain): If you want my own opinion on the EU Directive, I am not in favour of its content. Otherwise, it depends. In most cases, just the metal pieces are internally contaminated with NORM coming from exploration or construction in the oil and gas industry. We generally manage to extract the internal content and leave the metal part totally free for reuse. I do not have the data in mind, but considering the very low values in the document you mentioned, perhaps a significant part of the scrap metal so contaminated with NORM would have had 'specific concentration' values (Bq/g) of natural radiation above such values.

J.R. WARDEN (United States of America): What is the greatest strength of the IAEA's ITDB and where do its greatest potential future benefits lie? In what ways do IAEA Member States believe that it could better serve them?

R. HOSKINS (IAEA): The greatest strength is that all data have been confirmed by the States involved. No other database in the field has this quality. Potential improvement lies in increasing its comprehensiveness, i.e. the number of participating States, raising reporting standards and gathering greater detail on the circumstances surrounding incidents both from the States involved and through enhanced cooperation with other organizations with analogous information, in particular the International Criminal Police Organization (ICPO-Interpol). In this way great analytical benefit and a better understanding of the illicit trafficking phenomenon can be derived from the database.

P. CARBONERAS (Spain): Member States can be best served by having free access to the ITDB, sharing information and being open with each other. I agree with Mr. Hoskins that it is desirable to go into more detail about the reported incidents, which will increase efficiency and provide valuable examples to learn from. Also, the ITDB should be linked to databases of other relevant international organizations, not only those within the nuclear field.

F. FÉRON (France): The ITDB covers a very wide range of events. Not only criminal activities but also thefts and losses of control are registered. The last two categories are also International Nuclear Event Scale (INES) reporting events. What is the relationship between the two databases?

R. HOSKINS (IAEA): There is good cooperation between INES and the ITDB. We supplement each other's data where relevant. An important concept underlying the ITDB is that we have a very wide definition of illicit trafficking. Our analytical approach is to compartmentalize the information ourselves rather than have it prefiltered by reporting States, possibly to differing standards. We ask our points of contact to trust us, to tell us everything and let us decide where the analytical cuts take place. It is tempting to argue that the illicit trafficking registry should focus only on clear cases of criminality and the technical characteristics of the material involved. But that would narrow the value that we could extract from the database. The intrinsic value — material and intent — is obvious, but there are other indicators that you can infer from illicit trafficking patterns, e.g. weaknesses in detection, monitoring and accounting systems, and evidence regarding markets, general intent and methodologies. These go beyond the strict definition of an illicit trafficking incident but help us to extract as much value as possible.

I. OTHMAN (Syrian Arab Republic): I understand from the database, and from what the panellists said, that the radioactivity involved in illicit trafficking seems to be very low. Have any buyers been identified, or is it just the idea of Mafia gangs looking for a terrorist market or stupid customers?

R. HOSKINS (IAEA): There is very limited evidence of involvement of organized crime or of a demand driven market. Most incidents are supply driven cases with amateurish and opportunistic sellers. These are more easily detected and caught than organized criminals.

M. BASTIDE (France): Actually, the trafficking cases discovered in France have been opportunistic ones, but one cannot exclude the possibility of terrorist organizations trying to acquire radioactive sources in order to commit criminal acts.

P. CARBONERAS (Spain): Your question may be answered by means of the further analysis advocated for the ITDB. This is really needed because in the end you can only learn from experience when you go into the details of selected, specific cases. Not all situations are equally urgent or important, so you have to establish priorities. Thought and effort in this direction are needed in any database.

A.S. STRESOV (Bulgaria): Every case is specific, so we should look for common ground. In Bulgaria, opportunistic source thieves have been arrested. Because of lack of proper control, they had accumulated great numbers of different sources over the years. Also, ‘new businesspeople’ — not knowing or caring about regulatory control — try to become dealers in radioactive sources. They forge certificates, presenting radiological as nuclear material, especially as uranium or ‘red mercury’. It is essential that databases find common patterns, particularly for transborder movement of sources.

C.M. MALONEY (Australia): Here, of course, we are focusing on nuclear and radiological material. Are there any databases covering chemical and biological material?

R. HOSKINS (IAEA): Not as far as I know.

A.J. GONZÁLEZ (Argentina): I understand that ICPO-Interpol has its own database, which is confidential and which certainly includes data on radioactive sources. I am sure that it would also include data on chemical and biological material.

A. TSELA, Chairperson (South Africa): Maybe a representative from ICPO-Interpol or the European Police Office (Europol) could shed some light on this.

C. ENGLEFIELD (United Kingdom): I represent the regulator for non-nuclear radioactive material, for which we in the UK use a customs definition of illicit trafficking, which requires the crossing of an international border. In addition, from the regulator's standpoint, there are legal 'sub judice' and— increasingly — national security issues regarding some of the incidents and reports. Is there value in sitting down together to talk about these things with a view to improving 'buy-in' into the ITDB, and also to updating the buy-in to the definition of illicit trafficking used for the database?

R. HOSKINS (IAEA): Sub judice issues do restrict the ability of some States to report incidents to the ITDB in a timely manner. Reporting has to await the outcome of a criminal trial. A good case in point — though not a subject of this conference — was the seizure of high enriched uranium in Paris that resulted in a court case. Full details were not available to us from the French authorities until after judgement had been passed in court. Then we had the whole court transcript to work from, which was a mine of information. This is one of the cases we have been following more closely. The problem of such legal hurdles can be partly addressed by restricting the distribution of information of the database, an option that we have. However, in one or two cases, the very title of the database, 'illicit trafficking', places a restriction on the provision of information, because legal advisors in these — fortunately very few — States argue that until a court determines that it is illicit trafficking, they cannot give us even basic details because that would be prejudging the case.

A. TSELA, Chairperson (South Africa): Your answer, with the idea of redefining illicit trafficking, provides material for further discussion.

K. SASTRI (India): Joint exercises at borders between countries are required to improve the control of illicit trafficking of radioactive material and should be encouraged by the IAEA.

N.E. ABU TALIB (Jordan): From the experience and records of those controlling the movement of radioactive sources at borders: (1) Is there any case known of scrap metal being used to transfer the sources with criminal intent? (2) Is this a good way (from the offender's viewpoint) to do so?

R. HOSKINS (IAEA): (1) Sources are regularly detected among shipments of scrap metal, but there has been no incident of which I am aware that indicated that the scrap shipment was being used to deliberately conceal a radioactive source.

P. CARBONERAS (Spain): (1) I am not aware of any such situation in Spain since the 'Spanish Protocol' has been in operation. (2) As I am not a criminal, I cannot give you an answer from that point of view. However, I see at least two reasons why scrap metal would not be a 'good' vehicle: (i) It is well controlled nowadays in most countries. (ii) It would be difficult for the 'criminal' to regain access to the source in the process.

A. TSELA, Chairperson (South Africa): To conclude this session, it is clear that illicit trafficking is a problem for all of us. One of the critical tools in combating it is cooperation between the various agencies concerned. We are taking forward this and a number of other points raised in this session to our closing discussion tomorrow.

PANEL SESSION 2: CHAIRPERSON'S SUMMARY

A. TSELA
South Africa

There is no hesitation about the continued significant contribution of the peaceful use of radioactive sources. While this is so, categories of events and activities that may lead to inadvertent movement and illicit trafficking must be understood and effectual actions be put in place to address those events.

It is clear that broad measures for addressing inadvertent movement and illicit trafficking have been identified and defined by the international community as prevention, detection and response. What remains is the experience of dealing with the details within these areas.

SOME OBSERVATIONS

(a) The main points on which Member States have focused their work in this area relate to:
- — Scrap metal recyclers, and movement of radioactive sources within Member States in general;
- — Movement of radioactive material across borders.

(b) The nature of the work that Member States have engaged in includes:
- — Improvements in detection systems, i.e finding easier and cheaper techniques and methodologies;
- — Improvements in the legislative framework to provide for systems and protocols nationally for addressing this area;
- — Putting in place collaborative national systems and protocols amongst relevant stakeholders for detection and monitoring of radioactive sources, and for effective response to incidents.

SOME CONCLUSIONS

(a) The area of movement and illicit trafficking of radioactive sources is one where the need for cooperation between relevant stakeholders (safety regulators, customs officials, enforcement agencies, intelligence, etc.) is an essential foundation; otherwise the effort is a non-starter.

(b) Though the broad measures for addressing this issue have been defined (prevention, detection, interdiction, response) and individual States have taken actions within their borders, there is a need for the international community to consider harmonized protocols and procedures for a truly global system for continuous control. Illicit trafficking does not affect only one Member State.

(c) It is understood that the health risk of most of the incidents in this area is not very high, but the other consequences can be as damaging. These consequences are often of a social, financial and economic nature, owing to public panic, the cost of the associated cleanup, and the degrading of public trust in the peaceful uses of the atom. Consequently, public awareness and education must still be one critical tool in addressing this problem.

(d) Another, but small, category of incident that may also cause panic is the inadvertent movement of radioactive sources where criminals hijack a vehicle not for the source but for financial gain from the vehicle.

STRATEGIES FOR THE MANAGEMENT OF DISUSED SOURCES

(Technical Session 5)

Chairperson

J.-M. POTIER
IAEA

DISPOSAL OPTIONS FOR DISUSED SEALED RADIOACTIVE SOURCES

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Abstract

The widespread use of sealed radioactive sources raises the question of how they are to be managed once their useful life is ended, because, whereas many countries possess sealed radioactive sources, few countries possess suitable radioactive waste disposal facilities. The issue is especially acute for long lived and high activity sources, both of which can remain potentially hazardous for hundreds or even thousands of years. If these sources are not to endanger present and future generations, sustainable long term management is required. The paper suggests that this may be best achieved through the disposal of disused sealed radioactive sources in specially constructed borehole facilities.

1. INTRODUCTION

The use of sealed radioactive sources (SRSs) in medicine, research, industry, agriculture and consumer products has brought significant benefits to humankind in the form of improved health and prosperity. Their use has also created waste radioactive materials with a range of chemical, physical and radiological properties. Some of these wastes (for example radioactive sources used in industry and medicine) can be intensely radioactive; some will remain potentially hazardous for many thousands of years. The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [1] places an obligation on Contracting Parties to control and manage these wastes safely.

When the radionuclides in the waste have half-lives of less than a few years (e.g. ^{192}Ir, half-life 74 days), decay storage will usually be an appropriate management strategy for all but the most powerful sources. In decay storage, wastes are placed in a facility where they can safely decay for the ten to twenty half-lives needed to allow the radioactivity to reach very low levels. When the half-life is greater than five years, storage is unlikely to be a sustainable option for two main reasons: It places the burden of waste management on future generations who may lack the resources and the expertise for the task; and it relies upon the continuity of societal institutions when there is ample evidence that this cannot be guaranteed. Consequently there has long been a consensus (within the technical community at least) that permanent disposal is the only sustainable long term option for this type of radioactive waste.

In countries with a well developed nuclear infrastructure (for example those that use, or have used, nuclear reactors for research or the generation of electricity), it is likely that facilities will already exist for decay storage and disposal; and where disposal facilities do not exist, often these will be planned. But countries with a well developed nuclear infrastructure are relatively few in number. More often, countries have radioactive waste in the form of disused SRSs but lack a safe disposal route or even the prospect of one. For example, the SRSs used in industry and medicine can be high energy gamma emitters that require heavily shielded containers for their safe use, transport and storage. At the end of their useful life, it is sometimes possible to return these sources to their manufacturer, who, it is assumed, will be able to provide appropriate management. In many instances, though, this is not possible, and even though they may be ‘spent’, i.e. no longer radioactive enough for their intended use, SRSs may still present a significant hazard. This is evident from a number of incidents and fatalities that have arisen from their misuse [2]. To promote the safer storage of radium sources (for which the sealing device may be thin metal foil), the IAEA has funded a programme of radium source conditioning in African countries.

Given that disposal is the only sustainable option for many disused SRSs, the purpose of this paper is therefore to outline possible options for the long term management of disused SRSs. Particular emphasis is placed on the evolving concept of disposal of radioactive waste in specially constructed borehole facilities (loosely, ‘borehole disposal’).

2. NATURE OF SEALED RADIOACTIVE SOURCES

The use of SRSs for an ever expanding range of purposes has resulted in the manufacture of many different kinds of SRS. Table 1 ([3], adapted from Ref. [4]) suggests that in 1988 there were more than 600 000 industrial and medical sources, most of which were located in industrialized countries. Table 1 shows the main radionuclides and Fig. 1 shows the types of SRS likely to be a source of problems. While the uses of SRSs are diverse and the number of sources is large, only a few types of radiation have found widespread practical use and the number of different radionuclides used to produce these radiations is fairly small: Table 1 lists ten. Other radionuclides could be added to the list but the total number of radionuclides would still remain less than 40, and those not shown in Table 1 would be of low significance.

TABLE 1. ESTIMATES OF THE WORLDWIDE INVENTORY OF THE MAIN TYPES OF SEALED RADIOACTIVE SOURCE IN 1988

Application	Number of sources	Main radionuclides	Usual range or average activity of sources
Medicine			
Brachytherapy	100 000	Cs-137, Ir-192, Ra-226, Cf-252, etc.	Tens to hundreds of megabecquerels
Teletherapy	2 600	Co-60 Cs-137	220 TBq 40 TBq
Bone densitometry	Not available	Am-241, Gd-153, I-125	
Commercial irradiators	142	Co-60 Cs-137	40 PBq 400 PBq
Industrial radiography	25 000	Co-60, Cs-137, Ir-192, etc.	0.1 to some terabecquerels
Industrial gauges	500 000	Co-60, Sr-90, Cs-137, Ir-192, Pu-238, Am-241, etc.	0.1 to some tens of gigabecquerels
Oil well logging	Not available	Am-241/Be Cs-137	1 to 500 GBq 1 to 100 GBq

A more recent survey of disused SRSs in applicant European Union countries [5] concluded that it was industrial sources that, because of their size, constituted the most significant radiological risk. A list of types of source of medium to high risk was compiled and broadly confirms the information shown in Table 1 and Fig. 1. The report also provides information on the useful working lives of the various source types, noting that short lived[1] sources typically have working lives of less than a year so that, needing fairly frequent replacement, it is normal for them to be returned to the equipment manufacturer. Long lived sources, on the other hand (e.g. ^{226}Ra and ^{241}Am), may remain in use for 20 years or more, which makes it less likely that they will be returnable — either because records have been lost or because the original manufacturer no longer exists. From this it seems that, not only do long lived sources constitute the most persistent hazard, but they are also the sources that are most likely to have no prospect of being returned to the original manufacturer.

[1] For the purposes of this paper, 'short lived' denotes a half-life of less than 5 years; 'intermediate lived' denotes a half-life of more than 5 years and less than about 30 years; and 'long lived' denotes a half-life of more than 30 years.

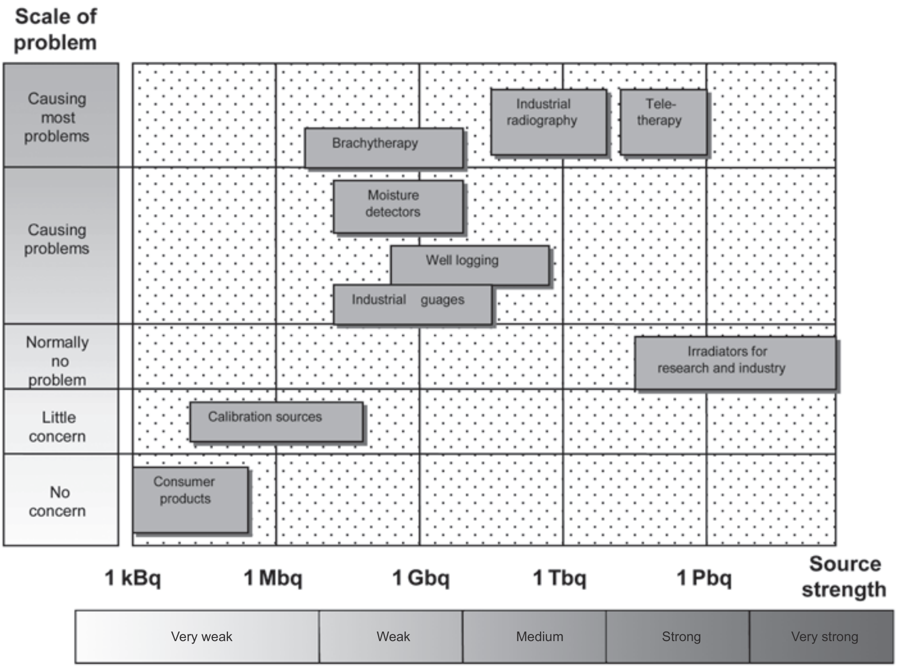

FIG. 1. Activity ranges for some important radiation sources and the magnitude of the problems caused when they become disused.

3. OPTIONS FOR DISPOSAL

3.1. General considerations

The question of whether radioactive waste is disposable has two equally important dimensions: a technical dimension related to engineering feasibility, safety and regulatory compliance; and a social dimension connected to public acceptability. Difficulties in siting disposal facilities have led to an increasing realization that, if radioactive waste disposal is to be implemented, both dimensions need to be developed and progressed, but public acceptability is too large a subject to be included within the scope of this paper. Consequently the discussion of disposal options is here confined to technical matters. In this sense then, the main determinants of waste disposability come from the assessment of safety. Safety assessment aims to demonstrate that, throughout all its phases, a repository will achieve adequate levels of radiological and conventional safety, and it is usual for safety assessments to be performed for:

— Transport of the waste to the site;
— Operations at the repository site;
— The post-closure period when operations have ceased and the repository has been closed.

Different regulatory limits and constraints apply to workers and the general public, and safety assessments aim to demonstrate that these limits and constraints are met in normal operation and in off-normal (e.g. emergency) situations. An important purpose of safety assessments is the derivation of waste acceptance criteria, which prescribe the type of waste that can be disposed at a specific facility. The issue of waste acceptance is often accompanied by a categorization scheme (usually decided nationally) that separates the waste into a few categories that may also serve to denote the disposal route, e.g. very low level waste destined for landfill, low level waste for a designated near surface disposal facility and high level waste for deep disposal. Because transport and repository operations can be designed to accommodate practically any waste that can be envisaged, it is post-closure safety assessment that mostly determines what waste can be safely accepted for disposal at each type of facility. Of course, safety assessments still need to demonstrate that the waste can be transported and handled safely, but this does not change the fact that it is post-closure safety that mostly determines the disposal route.

Post-closure safety assessment generally indicates that, with respect to the disposability of a radioactive waste, the most important considerations are the identities of the various radionuclides and their total amount (Bq) and concentration (Bq/kg) in the waste. A disposal site then needs to be chosen and engineered to accommodate the amount and concentration of radioactivity, and the physical, chemical and radiological properties of the radionuclides in question (including any radioactive progeny produced by ingrowth). In broad terms the most important properties are:

— Physical: the existence of gaseous radionuclides (^{85}Kr and ^{222}Rn produced from ^{226}Ra);
— Chemical: the mobility of a radionuclide ion in the environment (i.e. solubility in water and sorption onto environmental media such as rocks and soil);
— Radiological: the type of radiation emitted, radiotoxicity and half-life in comparison with the time that it would take for these radionuclides to migrate out of the repository into the environment accessible to humans.

3.2. Near surface disposal

Near surface disposal can be broadly separated into two types: minimum engineered and fully engineered. The first of these consists of excavation of a trench, emplacement of the containerized waste, backfilling with the previously excavated soil and covering with a low permeability cover. A fully engineered facility may include the lining of an excavation (vault or trench) with reinforced concrete, the use of a movable weatherproof cover during operations, backfilling with a cement grout rather than soil, and control of groundwater. In general the final cover over a closed near surface facility is likely to be a few metres thick.

Post-closure safety assessments for near surface disposal are obliged to analyse a complete range of potential radiation exposure scenarios. Of these, human intrusion scenarios are important because they tend to limit the allowable concentration of radionuclides in the waste [6]. For minimum engineered repositories, a key scenario is often one in which someone is imagined as building a house on top of the repository, inhabiting it and perhaps growing garden produce on the surrounding contaminated ground. Where the waste is disposed at more than 3 m below the surface, however, it may be considered that this scenario would be unlikely to produce contact with the waste itself, and instead another scenario, such as road construction, may be assumed to be more important. Generally one-off intrusions involving various types of construction are less constraining than residence scenarios, which produce persistent radiation exposures. The chief defences against human intrusion are disposal at greater depth, a more highly engineered repository (because this limits the range of intrusion activities that can be carried out) and (for short and intermediate lived radionuclides) the use of an institutional control period. A 300 year institutional control period is generally considered to be a maximum value [7] that is credible for societies that have shown stability and institutional continuity over similar or longer periods of time.

Most near surface repositories are constructed above the water table. Here, an important natural pathway for radionuclides is one in which rainwater leaches radionuclides from the waste and transports them into a surface or underground water body used as a source of drinking water. This pathway usually places a limit on the total inventory of the repository. However, because the transport processes occur slowly, this pathway mostly concerns long lived radionuclides such as radium and other alpha emitters. As a consequence, the total alpha content of a repository may be significantly more constrained than the total content of beta/gamma emitters.

Near surface facilities are primarily designed for disposal of low level waste (LLW). The radioactivity limits for LLW are determined nationally and depend upon the type of facility that is available or envisaged. For a near surface repository with waste at less than 3 m depth and a 300 year institutional control period, LLW might typically be defined as having a radioactivity concentration of beta/gamma emitters of less than 20 MBq/kg [6]. If we imagine, therefore, that an intermediate lived source of 100 MBq beta/gamma activity or less were to be encapsulated into 5 L of cement grout (weighing about 12 kg), in most cases this would be classified as LLW suitable for near surface disposal.

Allowable activity concentrations for alpha emitters (which are mostly long lived) in LLW are typically a factor of 3–4 less than for intermediate lived radionuclides. Sometimes, though, the most important constraint on the alpha content of a package is not its concentration but its absolute level. This is because a repository's total capacity for alpha emitting radionuclides can be set ten or more times lower than is allowed for beta/gamma emitters. Consequently, even though the alpha radiation may be a minor part of the total radioactivity, the repository operator will need to manage the disposal of alpha bearing waste to avoid coming up against the alpha limit before the repository is full. This may mean that waste with alpha activity at the upper end of the allowable LLW range will need to be diverted to deep disposal.

3.3. Deep geological disposal

Deep disposal is usually interpreted as meaning disposal at a depth of at least 100 m in a mined facility. The purpose of going to these depths is: (i) to provide long term isolation of the waste in order to reduce the likelihood of intrusion due to human action or natural events; and (ii) to promote containment of the radionuclides in the waste by positioning the repository so as to diminish the effect of any natural processes that might cause the radionuclides to return to the surface.

Isolation greatly limits the range of natural events or human activities that could affect the waste. For instance, waste at depths of greater than 20–30 m is very unlikely to be disturbed by excavation from the surface [6], so that human intrusion is limited to mining or drilling (see, for example, Ref. [8]). Isolation therefore aids security.

Containment is designed to confine the radionuclides in the waste so that they have time to decay in situ to harmless decay products. A typical example of a process that could cause radionuclides to return to the surface is groundwater movement, which could leach radionuclides from the waste and then transport them through the geosphere. The advantage of placing the waste at depth is that this creates a longer transport path and, more importantly, accesses lower permeability rock. As a result, groundwater moves slowly, allowing time for radioactive decay to occur. The geochemistry of a site is also critical because of its impact on the longevity of the engineered barriers. An example would be the possibility that high levels of sulphate in deep groundwater could bring about deterioration of concrete used in backfill, seals, etc.

In constructing a post-closure safety assessment, a wide array of site specific information is needed. Much of this will be gathered from a site characterization programme that will aim to collect geological, geochemical, hydrogeological and meteorological information. Often this will require the drilling of several boreholes that will allow detailed examination of rock core and, for saturated sites, hydrogeological testing of the various formations. This, together with investigations of the conditioned waste and the engineered barriers, commonly takes more than 20 years.

In principle, there is no limit to the size of radioactive source that could be safely emplaced in a deep repository. Such facilities are proposed for the disposal of hundreds of tonnes of spent nuclear fuel, which, 40 years after discharge from the reactor, still contains radioactivity in the TBq/kg range. Nor is there any need, with these facilities, for a period of post-closure institutional control. The aim is that the waste should be passively safe so that there is no need for monitoring or other form of control. Deep facilities are therefore eminently suitable for the disposal of all disused SRSs. The difficulty is that the development of a deep repository is complex, expensive and likely to extend over several decades. Such facilities are mostly limited to countries with a significant nuclear power programme, where sales of nuclear generated electricity help to raise the necessary funds for disposal, and the accompanying nuclear infrastructure, i.e. relevant legislation, regulation and licensing.

So, while deep disposal is suitable in principle for disposal of disused SRSs, in practice it is unavailable for most countries that might wish to use it for this purpose. This would change, of course, if countries that own (or intend to own) such facilities would allow them to be used for small volume foreign waste, which could be accommodated at marginal cost. Unfortunately, few such facilities exist, and public resistance to the importation of foreign waste is likely to rule this out as unacceptable. An alternative strategy is the creation of international or regional deep repositories. At present this is no more than a distant prospect.

3.4. Disposal in specially constructed borehole facilities

The lack of suitable and available facilities for disused SRSs indicates a need for small scale disposal facilities capable of providing the requisite standard of safety at an economic cost. An obvious contender is a borehole facility. A number of these exist and we begin by describing three of them.

3.4.1. Existing borehole facilities

All existing borehole facilities are situated on established radioactive waste disposal sites. They include: the RADON type, of various designs, mostly built in States of the former USSR during the Soviet era [9]; the Mount Walton East facility in Western Australia [10]; and the Greater Confinement Disposal facility on the Nevada Test Site, United States of America [11].

RADON facilities are between 5 and 40 m deep, with the top of the waste located 3 to 4 m below ground level [9]. Designs intended for management of SRSs employ a steel disposal compartment at the bottom of the borehole that can contain up to petabecquerel quantities of disused SRSs; such quantities generate significant heat. To help with heat dissipation, molten lead is poured into the compartment to provide a high heat conductivity encapsulant. Other designs use larger diameter boreholes (1.9 m) with bentonite cement for backfilling. In the Russian Federation all these designs are now designated as storage (implying that the waste will eventually be retrieved), but there is an expectation that, subject to a satisfactory evaluation of post-closure safety, some could be redesignated as disposals.

The Mount Walton East facility [10] is designed for the disposal of both radioactive and chemical waste. There are two boreholes at the site which are 28 m deep and 2 m in diameter. Waste is cemented into 60 L drums which are then concreted into 200 L drums. Within the boreholes the drums are arranged in layers of three, each surrounded by a concrete backfill that is added after each layer has been put in position. The topmost layer is 8.5 m below the surface. Above this is 0.5 m of concrete, 8 m of previously excavated soil and (above ground level) a concrete cover. SRSs are an important component of the inventory of this repository. The total inventory of ^{137}Cs (78 items) is 320 GBq and the total inventory of ^{241}Am (1362 items) is 4.4 GBq. Dividing these inventories by the total mass of conditioned waste (derived from the borehole volume and the density of concrete) gives a ^{137}Cs concentration of about 1 MBq/kg and a mean ^{241}Am concentration of 14 kBq/kg. So, although the activity of an individual source could be fairly high (4 GBq average for ^{137}Cs), the average disposed concentration throughout the facility is consistent with current practice for near surface disposal.

The Greater Confinement Disposal facility [11] was intended to dispose of mixed transuranic waste, mostly consisting of debris from nuclear weapons accidents. The facility consists of a number of boreholes with a diameter of about 3 m and a depth of 37 m; the waste occupies the bottom 15 m, and the upper 21 m is backfilled with native soil. At the outset of the project, a trial borehole was drilled to test the concept. This entailed the placing of 18 PBq of short lived, heat generating SRSs and 26 PBq of tritium into the test borehole. Monitoring of the test focused on the movement of tritium. On successful completion of this test, 12 further boreholes were drilled, of which four have actually been used for disposal. The average activity of the transuranic waste is greater than 200 MBq per kilogram of waste. This is significantly greater than the levels usually encountered in near surface disposal, but then the 21 m minimum depth of disposal is considerably greater than the depths usually encountered in near surface disposal. Furthermore, the safety of the disposed wastes benefits greatly from the arid nature of the site and the more than 200 m between the base of the borehole and the water table.

The minimum depths of disposal for these three examples of existing borehole facilities are:

RADON	3–4 m
Mount Walton East	8 m
Greater Confinement Disposal	21 m

Where wastes are disposed close to the surface, institutional control is needed to avert the possibility of human intrusion; this institutional control needs to be maintained for as long as the wastes remain a hazard. For long lived wastes, therefore, disposal at accessible depths could result in a need for perpetual control. Work by an expert group brought together by the OECD Nuclear Energy Agency [6] has clarified what is meant by ‘accessible depths’, suggesting 3 m as the maximum depth of a ‘normal residential intrusion zone’. With a minimum engineered near surface repository, such a depth could be excavated for the foundations of a house with a basement. Construction of a house that penetrates into the waste allows the possibility of a residential scenario with a wide range of exposure pathways, such as indoor inhalation of radon gas and ingestion of contaminated foodstuffs grown on adjacent contaminated ground. The depth of intrusion can increase to about 10 m for major road construction and to 20 m for the construction of tall buildings. Both these activities would probably occur with lower frequency than the residential scenario.

3.4.2. AFRA Borehole Disposal Concept

The AFRA Borehole Disposal Concept designed for the IAEA by the Nuclear Energy Corporation of South Africa (Necsa) [12] draws on examples such as those just described, but it proposes a greater depth than used in the examples and takes advantage of the small physical size of disused SRSs by proposing a smaller diameter borehole (260 mm). Boreholes of this size are routinely drilled in remote sites in the course of exploration for water and mineral resources.

In general, the small footprint of borehole facilities greatly diminishes the importance of human intrusion to post-closure safety but, by taking the disposal zone below 30 m depth, the AFRA concept effectively limits the human intrusion scenarios to drilling. With this design, post-closure institutional control of the site becomes unnecessary. Because of the difficulty of waste retrieval from this depth, security is also aided.

In the AFRA concept, SRSs are placed inside a 304 stainless steel capsule. This in turn is placed inside a 316 stainless steel disposal container with a preformed cement annulus inside it to locate the capsule. The disposal container is then sealed with a lid. The containers would probably be manufactured centrally to permit quality management and to benefit from the economies of scale. Within the borehole, the disposal container would be surrounded by a free flowing cement grout.

With a well designed and implemented near field (i.e. capsule, containers and the surrounding backfill cement), it should be possible for the near field alone to be capable of providing sufficient protection to meet the regulatory requirements. This does not mean that the geosphere can be neglected. The IAEA requirements for geological disposal [13], for example, call for all the barriers, engineered and natural, to contribute to safety. But the main roles of the geosphere in this case are to provide isolation and to create and maintain the environmental conditions that allow the near field containment to function as anticipated. A third potential safety function, that of providing containment of radionuclides in the geosphere, can be seen more as a backup to near field containment.

This view clarifies the main objectives of site characterization as being: (a) to demonstrate that isolation will be maintained over the required period, i.e. to show that surface processes will not significantly reduce the amount of rock cover; and (b) to demonstrate that the geochemical conditions are conducive to the expected near field performance. Understanding of the hydrogeological conditions of the site is mostly important in so far as it relates to (a) and (b). Because the function of containing radionuclides in the geosphere is secondary, a higher level of uncertainty concerning hydrogeology should be acceptable. This should make the design very portable, i.e. widen the range of potentially acceptable sites, allowing facilities to be sited more conveniently. It should also simplify site characterization.

Another interesting development springing from the AFRA concept is the use of a generic post-closure safety assessment (GSA) to simplify the creation of inventory specific and site specific post-closure safety assessments. The word 'generic' is used here to mean 'not site specific' or 'applicable to many sites'. The GSA is used to calculate the dose to a critical group for each becquerel of a range of radionuclides of interest. This calculation is repeated several times to cover a wide range of environmental conditions. The idea is that the GSA can be used many times to construct site specific safety assessments by:

(a) Identifying, from the GSA, the set of environmental conditions that most closely, but conservatively, represents the conditions at an actual (e.g. a candidate) site;
(b) Using the GSA to estimate the radiation exposure and the exposure time that would result from disposal of the complete inventory of each radionuclide at this site;
(c) Showing that, when the doses for the individual radionuclides are added together (if necessary, making allowance for the different times at which they occur), the total dose falls below the (nationally prescribed) regulatory constraint.

Together, the use of a high integrity near field and the use of a post-closure safety assessment that has received extensive international peer review should greatly simplify the safe regulation of SRS disposal, and provide confidence to regulators and the general public that such disposals are safe and in accordance with best international practice.

4. CONCLUSIONS

Many countries own disused SRSs but do not have the means of providing secure long term management. For sources with half-lives of greater than a few years, disposal is the only sustainable option.

For countries that do not have suitable radioactive waste disposal facilities, disposal in specially designed borehole facilities offers the prospect of safe, economic disposal of disused SRSs that will not require institutional control. The use of a standardized, high integrity near field design, and a site specific safety assessment that is based on an internationally peer reviewed GSA should allow more flexible siting and a simplification of the regulatory approval process, while at the same time providing the necessary assurance of safety and best international practice.

An alternative, if less immediately available, strategy would be to use regional or international repositories for the disposal of disused SRSs.

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REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, INFCIRC/546, IAEA, Vienna (1997).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Management for the Prevention of Accidents from Disused Sealed Radioactive Sources, IAEA-TECDOC-1205, IAEA, Vienna (2001).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Considerations in the Disposal of Disused Sealed Radioactive Sources in Borehole Facilities, IAEA-TECDOC-1368, IAEA, Vienna (2003).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Conditioning and Interim Storage of Spent Radium Sources, IAEA-TECDOC-886, IAEA, Vienna (1996).

[5] ANGUS, M., COWLEY, M., MORETON, T., WELLS, D., Management of Spent Sealed Radioactive Sources in Bulgaria, Latvia, Lithuania, Romania and Slovakia, EUR 20654 EN, European Commission, Luxembourg (2003).

[6] OECD NUCLEAR ENERGY AGENCY, Shallow Land Disposal of Radioactive Waste: Reference Levels for the Acceptance of Long-lived Radionuclides, A Report by an NEA Expert Group, OECD/NEA, Paris (1987).

[7] OECD NUCLEAR ENERGY AGENCY, Long-term Management of Radioactive Waste: Legal, Administrative and Financial Aspects, OECD/NEA, Paris (1984).

[8] OECD NUCLEAR ENERGY AGENCY, Safety Assessment of Radioactive Waste Repositories: Future Human Actions at Disposal Sites, OECD/NEA, Paris (1995).

[9] OJOVAN, M.I., DMITRIEV, S.A., SOBOLEV, I.A., “Long-term safe storage and disposal of spent sealed radioactive sources in borehole type repositories”, Waste Management ’03 (Proc. Symp. Tucson, 2003), Waste Management Symposia, Tucson, AZ (2003).

[10] HARTLEY, B.M., et al., “Establishment of a radioactive waste disposal facility in Western Australia for low level waste”, Proc. 9th Pacific Basin Nuclear Conf. Sydney, 1994, Australian Nuclear Assoc., Sydney (1994).

[11] COCHRAN, J.R., CROWE, B.M., COLARUSSO, A., “Results of the performance assessment for the classified transuranic wastes disposed at the Nevada Test Site”, Waste Management ’01 (Proc. Symp. Tucson, 2001), Waste Management Symposia, Tucson, AZ (2001).

[12] NEL, B.V.D.L., POTIER, J.-M., "Development of the Borehole Disposal Concept", these proceedings.
[13] INTERNATIONAL ATOMIC ENERGY AGENCY, Geological Disposal of Radioactive Waste, IAEA Safety Standards Series No. WS-R-4, IAEA, Vienna (2006).

DISCUSSION

V. FRIEDRICH (IAEA): Why do existing near surface repositories not accept sealed sources for disposal?

I. CROSSLAND (United Kingdom): Near surface facilities place limits on the specific activity of waste packages (i.e. Bq/kg) for two main reasons: operational safety relating to permissible doses to workers, and post-closure safety relating to the doses that result from human intrusion scenarios. The latter could be mitigated by disposing at greater depth.

J.-M. POTIER (IAEA): To complement the answer, I point out that among the dozens of disposal facilities in operation worldwide — near surface repositories for low level waste — very few accept these sources. The specific activities of the high activity sources do not comply with the waste acceptance criteria for most existing near surface repositories. Some intrusion scenarios considered in post-closure safety assessments of disposal facilities lead to radiological impacts exceeding acceptable dose limits for intruders. I think that instead of having many thousands of sources stored all over the world, we should consider using existing facilities to accommodate more sources, at least medium activity ones.

I. CROSSLAND (United Kingdom): I agree with you, but there is also an operational difficulty. Many facilities are not designed to take high activity sources, and their radiation field constitutes a problem in terms of operational procedures.

I. USLU (Turkey): In the categorization of sources, you used IAEA-TECDOC-886 (very old) to illustrate problematic sources in your slides. IAEA-TECDOC-886 focuses on mobile sources. The IAEA changed the concept of categorization in the recently published IAEA-TECDOC-1344 (especially for waste disposal activities). You should use this in your slides where you show the less problematic irradiation sources, which — according to the new concept — are Category 1.

I. CROSSLAND (United Kingdom): Recent work for the European Commission (see paper) has shown that the most powerful sources, e.g. industrial irradiators, often do not cause societal security difficulties, and broadly confirms the diagram extracted from IAEA-TECDOC-886. This is a good diagram (not repeated in IAEA-TECDOC-1344) and I used it for that reason. This is not to deny the importance of IAEA-TECDOC-1344 in providing a useful categorization. Rather IAEA-TECDOC-886 complements IAEA-TECDOC-1344 by providing information about the likelihood of the various source types being subject to loss of control.

DEVELOPMENT OF THE BOREHOLE DISPOSAL CONCEPT

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Abstract

The Nuclear Energy Corporation of South Africa (Necsa) initiated the Borehole Disposal Concept (BDC) with a view to improving radioactive waste management practices in Africa. An IAEA Technical Cooperation project was launched to investigate the technical feasibility and economic viability of a borehole for the disposal of disused sealed radioactive sources. Phase III of the project was completed by the end of 2004, and the main objective of this phase was to demonstrate the technical feasibility of the concept by means of a practical demonstration. The disposal concept consists of a 260 mm diameter borehole drilled to a depth of up to 100 m in which stainless steel disposal containers are emplaced and backfilled with cement. Each disposal container contains a source within a stainless steel capsule within a containment barrier. Included in the terms of reference of Phase III were the design and the evaluation of the disposal concept. The evaluation included container materials, backfill materials and a generic post-closure safety assessment. The post-closure safety assessment and the associated derivation of activity limits showed that, through the use of multiple physical and chemical barriers, the BDC provides an appropriate degree of long term safety. Furthermore, the safety of the disposal concept is not reliant on an extended period of institutional control, and owing to its small 'footprint', the likelihood of direct human intrusion into the borehole is small. An international peer review team positively assessed the technical feasibility, economic viability and overall safety of the concept, and thus concluded the development phase of the project. The Member States of the African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology (AFRA) have decided to proceed to Phase IV of the project with the main aim to implement the borehole disposal technology.

1. INTRODUCTION

During the IAEA Regional Training Course on the Management of Low Level Radioactive Waste from Hospitals and Other Nuclear Applications, hosted by the Atomic Energy Corporation of South Africa Ltd. (AEC), now the Nuclear Energy Corporation of South Africa (Necsa), during July–August 1995, the African delegates reviewed their national radioactive waste programmes. Among the issues raised, which are common to most African countries, were the lack of adequate storage facilities, lack of disposal solutions and lack of equipment to implement widely used disposal concepts to dispose of their disused radioactive sources. As a result of this meeting, an IAEA Technical Cooperation project was launched to investigate the technical feasibility and economic viability of a borehole for the disposal of disused sealed radioactive sources. Phase I of the project was limited to a conceptual description of the concept, while Phase II can be considered as the first iteration to improve individual elements of the concept and to perform a preliminary long term (post-closure) safety assessment. The Phase II results were widely communicated, nationally and internationally, through conferences, presentations and a workshop, which provided useful comments and suggestions to improve the concept.

During an AFRA (African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology) Training Workshop on Safety and Technology Considerations for the Borehole Disposal Concept (BDC) (C7-RAF-4.015-007) held in Pretoria during September 1999, a decision was made to proceed with a Phase III of the project, aiming at demonstrating the technical feasibility and economic viability of the concept. Phase III of the project was completed at the end of December 2004 and was reviewed by international experts during April 2005.

Phase III follows a pragmatic approach to concept design and implementation, aiming at addressing all technical and safety aspects associated with the operational and post-closure phases of a radioactive waste disposal facility. The aim of Phase III was to design a standard concept suitable for the disposal of disused sources that is robust and requires little site specific adaptation. This paper describes the BDC and presents the post-closure safety assessment of the concept.

2. BOREHOLE DISPOSAL

Borehole disposal facilities have a number of favourable characteristics that should benefit waste safety, economy and physical security. These characteristics are that they:

- Provide long term isolation from humans and the environment for small volumes of high specific activity radioactive waste in high integrity waste packages;
- Provide direct and cost effective access to suitable geology, using readily available technology;
- Require limited land area and limited infrastructure;
- Require short periods of construction, operation and closure;
- Can be constructed as and when required to dispose of waste;
- Have a low probability of human intrusion owing to their small 'footprint';
- Require minimal post-closure control over the disposal site.

The design of the disposal concept contributes to the general requirement of safety for disposal of radioactive waste, which, amongst others, is to ensure the safety of the public and the environment now and in the future without putting a burden on future generations. Fundamental requirements in the design of the borehole are:

- The dimensions of the borehole should allow for the disposal of disused sources in suitable waste packages.
- The design of the borehole should take into consideration the operational requirements; for example, waste emplacements should be able to take place as a matter of routine over the period during which it operates.
- The design should minimize the need for active maintenance after site closure and complement the natural characteristics of the site to reduce environmental impact.
- Human intrusion (intentional and inadvertent) should be difficult.

3. AFRA BOREHOLE DISPOSAL CONCEPT

During the development of the disposal concept, different design options for different components of the disposal system were evaluated and qualified. These components were the capsule, a disposal container (material and manufacturing), a physical barrier (copper or lead) or a chemical barrier (bentonite or cement), and the borehole backfill material (bentonite or cement). Other aspects that were evaluated were the construction of the repository, the conditioning and the disposal process.

The above evaluations resulted in the proposed concept that comprises a borehole drilled down to a depth of between 30 and 100 m. The 30 m depth is the minimum requirement for a cover to prevent any intrusion. The borehole

(260 mm in diameter) and the 100 m depth are guidelines. If required, wider boreholes can be drilled, while depths of less or more than 100 m could be acceptable on a site specific basis. The borehole is fitted with a 160 mm outside diameter casing, fitted with centralizers to ensure that the casing stays in the middle of the borehole. The casing is used to define the disposal volume. Pressure grouting of cement is used to fill the space between the borehole wall and the casing. To ensure that the disposal volume is dry during the operational period, a bottom plug is provided. Once the grout and bottom plug are set, the repository is ready to accept waste. The disposal area can be fenced off to limit access, and a temporary site office can be erected. The design includes a container of 316L stainless steel, a cement based waste form and encapsulated sources. Casing will be sunk into wet cement at the bottom of the borehole to seal the hole. Any water will be pumped out of the casing to ensure dry emplacement of disposal containers. The waste package would then be placed into specially formulated wet cement in the borehole, after which cement would be poured on to the container. The next package would then be lowered into the hole and the process repeated (Fig. 1). Packages would continue to be placed into the borehole until the waste acceptance criteria for that hole were met or until the cut-off depth was reached. The section of the casing above the disposal zone will be removed to prevent the possibility of a preferential water intrusion pathway. The rest of the hole will be sealed off with natural soil. The decision to mark the disposal site rests with the relevant countries since the footprint of the facility is very small. There is merit in putting some sort of intrusion resistant deflection plate in the borehole and then camouflaging the hole, making it difficult to find. A schematic design is provided in Ref. [1].

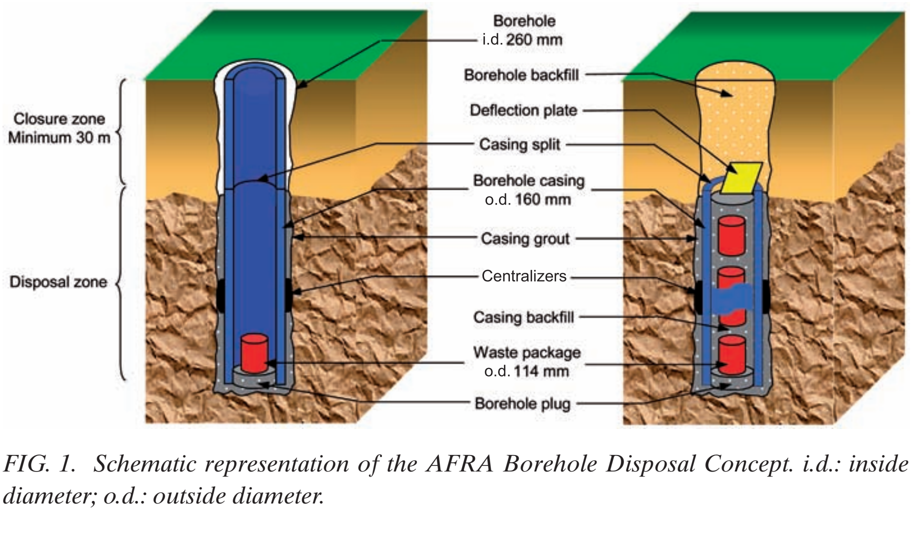

FIG. 1. Schematic representation of the AFRA Borehole Disposal Concept. i.d.: inside diameter; o.d.: outside diameter.

4. GENERIC POST-CLOSURE SAFETY ASSESSMENT OF THE CONCEPT

Included in the terms of reference for Phase III was a generic post-closure safety assessment [2, 3] of the BDC. This was not meant to replace a site specific post-closure safety assessment; however, it was designed to provide information to help guide and facilitate a site specific implementation of the concept in future. In addition, there was a requirement under Phase III to derive generic activity limits for the disposal of sealed sources to a borehole for a range of radionuclides.

The approach developed by the IAEA's Coordinated Research Project on Improving Long Term Safety Assessment Methodologies (ISAM) for Near Surface Radioactive Waste Disposal Facilities has been used, with the aim of ensuring that the assessment is undertaken and documented in a consistent, logical and transparent manner.

The purpose of the assessment was to identify the key safety features of the disposal concept under varying conditions in order to support facility design and the licensing process in different African countries. This would provide useful strategic information for the future development of the concept (e.g. waste emplacement configuration, engineered barrier configuration, influence of different environmental conditions on the performance of the concept), waste activity limits, guidelines for site selection and characterization, and the establishment of regulatory standards for the licensing of such disposal facilities.

A range of near field conditions (cement, bentonite), geosphere conditions (argillaceous, arenaceous, crystalline) and biosphere conditions (arid/semi-arid, seasonally humid, humid) were included as being representative of African conditions. An inventory of ten radionuclides was specified that was considered to be representative of sealed source inventories found in African countries.

In total, 27 disposal systems, six scenarios (with ten variants) and ten radionuclides were considered in this generic safety assessment. The assessment and associated derivation of activity limits showed that the BDC for disused sealed radioactive sources provides an appropriate degree of long term safety for the vast majority of these disposal systems, scenarios and radionuclides. Furthermore, the disposal concept's safety is not reliant on an extended period of institutional control, and owing to its small footprint, the likelihood of direct human intrusion into the borehole is small. The various components of the engineered near field, together with the unsaturated zone (if present) and the saturated zone, successfully act as physical and chemical barriers to the migration of contaminants from the borehole, thus ensuring that the disposal concept is based on a multibarrier system for isolating the waste from humans. Should one of the components not perform as anticipated, the safety of the concept is not compromised for all disposal systems, except for those with the combination of high permeability geosphere and humid biosphere. For such systems, the travel times through the geosphere of both unsorbed and sorbed radionuclides are relatively rapid compared with those for the other systems. However, sensitivity analysis showed that increasing the thickness of the engineered barriers and adopting a less cautious corrosion rate for stainless steel provided sufficient near field containment.

5. IAEA–AFRA FUTURE PROGRAMME OF WORK

The international peer review of the BDC successfully concluded the development phase of the project initiated in 1996. Following the positive assessment of the technical feasibility, economic viability and overall safety of the BDC by the expert team, the AFRA Member States have decided to proceed with a new AFRA regional project for the period 2005–2009, identifying the implementation of the borehole disposal technology as one of their main priorities. This decision implies that additional efforts will be needed by Member States themselves and by donors, as well as by the IAEA, to make available all the necessary requirements and conditions for the implementation of the BDC in African countries. The ambitious objective assigned to the new regional project, Technical Cooperation Project RAF/3/005, is to have at least one borehole disposal facility operational and licensed by 2009 in one of the AFRA Member States.

The generic disposal concept designed by Necsa has been demonstrated to be suitable for a reference inventory representative of sealed sources found in African countries and for a wide range of geospheres and biospheres typical of African conditions. Future site specific adaptation and optimization of the generic BDC is expected, in order to take account of the safety sensitive features of the site and thus conform with the internationally accepted ALARA (as low as reasonably achievable) principle. Once AFRA candidate countries volunteer for the implementation of a borehole disposal facility and provide accurate country specific information on their source inventory and site characteristics, it will be required to verify that these data fall within the design requirements of the generic concept and to reassess the safety and feasibility of the BDC on the basis of those country specific conditions.

The work programme developed by the IAEA in cooperation with AFRA Member States for the next five years of the BDC implementation phase, under Technical Cooperation project RAF/3/005, addresses the need to strengthen Member States' infrastructures for the safe and efficient management of radioactive waste, including disused sealed sources. African countries will continue to be assisted in their efforts to identify, characterize, condition and store their radioactive sources safely and securely. Assistance will also be provided to AFRA Member States to help them update their waste inventory. The establishment of a detailed and comprehensive radioactive waste inventory constitutes a prerequisite to assessing the suitability of the BDC in any country candidate for the implementation of a disposal facility.

Different activities are planned by the IAEA under the new five year programme to assist its Member States to plan, site, license, implement and operate a borehole disposal facility. These activities include training courses, workshops, preparation of technical guidelines, expert advisory missions, review services, equipment supply, etc.

Apart from the AFRA countries, a number of IAEA Member States worldwide have expressed their interest in the implementation of the BDC to solve the long term problem of their disused sealed radioactive sources. Regional workshops have been convened by the IAEA in Latin America and Southeast Asia to inform interested countries on the status, results and future development of the borehole disposal project in Africa. Candidate countries from those regions will be provided with technical assistance to help them to license and implement a borehole disposal facility under the IAEA Technical Cooperation programme.

6. CONCLUSIONS

The BDC for the disposal of disused sealed radioactive sources was developed with the specific aim of solving an existing problem in a number of countries. It is foreseen that the technology developed for the BDC could be used and safely implemented by any country possessing small volumes of high specific activity radioactive waste [4].

The design includes a multibarrier system that provides chemical and physical isolation and containment. It also provides defence in depth, so that should one or two barriers not perform as anticipated, the other barriers will provide the necessary containment.

The BDC provides direct and cost effective access to suitable geology, using readily available construction materials and technologies.

The repository requires limited land area and has a low probability of human intrusion owing to the small footprint of the borehole.

Using conservative assumptions, the calculations from the operational safety assessment showed that, for both normal operation and accident situations, the doses to the workers can be controlled, and comply with safety criteria. It is highlighted that the action that can cause the highest exposure to workers is the dismantling of a source without appropriate shielding during preconditioning.

The generic post-closure safety assessment study demonstrated that, for most of the disposal system combinations, the peak dose for the design scenario is orders of magnitude below the dose constraint. The combination of humid conditions and a high permeability geosphere results in the dose constraint being exceeded. This could be considered as a geosphere that would not be acceptable for the implementation of the BDC.

The assessment demonstrated that, with a suitable combination of inventory and geological environment, the BDC is capable of providing a safe solution for the disposal of both long lived and short lived radionuclides. For some short lived radionuclides, post-closure safety places no limit on the radionuclide inventory that could be disposed of.

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REFERENCES

[1] NEL, B.V.D.L., Design for the Borehole Disposal Concept, Rep. GEA-1623, Nuclear Waste Systems, Necsa, Pretoria (2004).

[2] LITTLE, R.H., VAN BLERK, J., WALKER, C., BOWDEN, R.A., Generic Post-Closure Safety Assessment and Derivation of Activity Limits for the Borehole Disposal Concept, Rep. QRS-1128A-6 v2.0, Quintessa, Henley-on-Thames, United Kingdom (2004).

[3] LITTLE, R.H., WATSON, C., Generic Post-Closure Safety Assessment and Derivation of Activity Limits for the Borehole Disposal Concept: A Further Study, Rep. QRS-1128C-1 v2.0, Quintessa, Henley-on-Thames, United Kingdom (2004).

[4] STEYN, I.E., NNR Review Report on the Borehole Disposal Investigation, Rep. BDC-006-NTW, National Nuclear Regulator, Centurion, South Africa (2005).

DISCUSSION

Y. BOUABDELLAOUI (Morocco): Referring to the environmental assessment, how did you assess the geospheric and biospheric characteristics? I am not sure that corrosion would not occur at 30–50 m below the surface and jeopardize the groundwater.

B.V.D.L. NEL (South Africa): You can dispose in both saturated and unsaturated zones. The stainless steel capsule on its own will last for 30 000 years, which will be vastly increased by all the other barriers: the cement, the disposal container and the geology.

H. KAWAGOSHI (Japan): I find borehole disposal a good solution. My questions: (1) I think lead containers are not suitable for disposal because of lead's toxicity. Can you confirm this? (2) With so many parameters, how do you evaluate economic feasibility?

B.V.D.L. NEL: (1) I agree. Lead was an option investigated but we did not make use of it. (2) In comparison with a deep geological disposal facility, it is possible to calculate the costs for the container and the borehole, which are standard. The cost of establishing a suitable site, with the public communication activities involved, can vary from country to country.

AN INDUSTRY PERSPECTIVE ON STRATEGIES FOR THE LONG TERM CONTROL AND MANAGEMENT OF SOURCES

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1. INTRODUCTION

There is a clear understanding of the many and significant benefits that radioactive sources provide to humankind in the myriad applications for which they are used today — applications in healthcare, industry, research and development. Radioactive sources are used in the healthcare field for the medical treatment of cancer by teletherapy and brachytherapy. Industrial applications of radioactive sources include applications such as sterilization of single-use medical products, oil well logging, gauging and radiography. Agricultural applications include food irradiation for shelf life extension, preservation and disinfestation. Additionally, to further scientific exploration, radioactive sources are used in research and development applications.

However, with today's increased concern about terrorism and malicious acts, the rather ubiquitous nature of this technology gives rise to some concerns related to security risks. A societal concern has grown about safety and security should this valuable technology be misused. Particularly, in the post-9/11 world, there is a growing concern about misuse of this technology as a radiation exposure device (RED) or radiological dispersal device (RDD). At the highest level of government and international agencies there is a ground swell of initiatives to ensure that all reasonable measures are being taken to ensure the safety of the public and the environment. One broad initiative is to have effective management oversight and control of radioactive sources throughout their life cycle to address those societal concerns. It is imperative for all stakeholders in the source life cycle to address perceptions and to take all reasonable measures to enhance security and ensure the continued availability of radioactive sources.

2. DEFINING THE ISSUE

When one considers a strategic solution to enhance the safety and security of radioactive sources, a clear definition and understanding of the issues and concerns must be obtained in order to address them.

A key issue is the loss of effective control of radioactive sources. This could occur in a number of ways. Some examples are abandonment of sources, mismanagement of disused sources, loss or theft of sources, or an intentional malicious act. All of these situations can cause concerns about safety and security owing to real or perceived radiological consequences. Unless the issues are identified, reaction to the concerns can lead to the imposition of regulations and administrative controls that might cause restrictions on the availability of sources for their intended beneficial applications.

3. A STRATEGIC APPROACH TO LONG TERM CONTROL AND MANAGEMENT OF SOURCES

A strategic approach to a long term control and management programme for radioactive sources requires a life cycle source management philosophy. This is a cornerstone to an effective, comprehensive and robust programme. A life cycle source management strategy has several aspects. Foremost, a key objective is to enhance the management and control of sources, and to avoid or to mitigate the consequences of any event that might create fear or cause injury.

Regulators, manufacturers, suppliers and users of radioactive sources all have specific but complementary and even overlapping roles and responsibilities.

Figure 1 illustrates a number of important aspects in a comprehensive source life cycle management structure. The overarching objective is the safe and secure use of radioactive sources. Collaboration between all stakeholders is necessary to promulgate effective strategies to achieve this objective. This is something that all responsible and trustworthy stakeholders strive for. The IAEA plays a pivotal role, providing a robust foundation for all the initiatives that are being taken to achieve the objective of safety and security. When establishing policies, regulations and practices, a risk-informed approach is fundamental to the security of sources and devices. This will help to ensure that the strategies are cost effective and that they can be implemented in a practicable manner. This approach will strengthen commitment to implementation and help to achieve the overarching objective of safety.

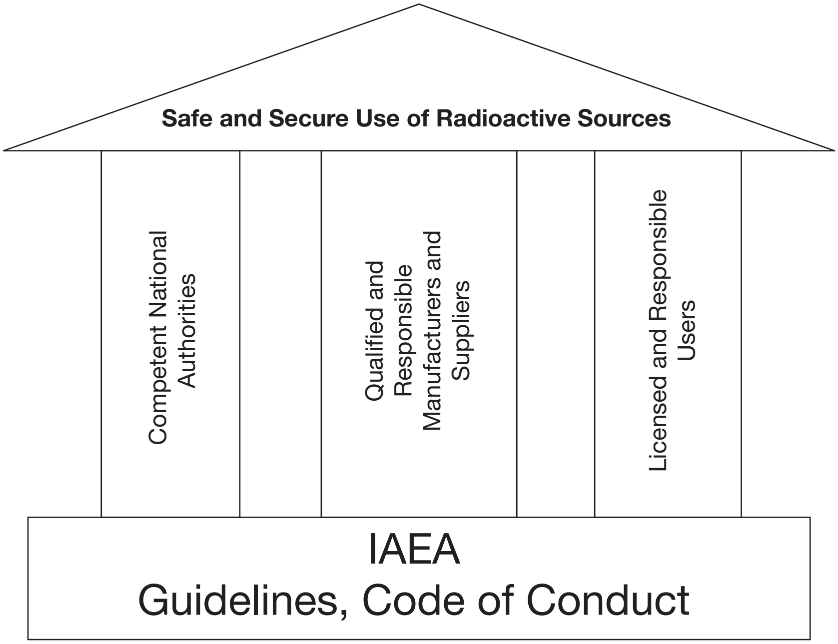

FIG. 1. A source life cycle management structure.

The IAEA also brings together the key stakeholders to establish voluntary codes, standards and guidelines. These stakeholders include national regulators, non-governmental organizations (NGOs) and industry, who accompany their national competent authorities to key meetings hosted by the IAEA. This provides an opportunity for collaboration on issues of mutual interest. Collaboration amongst these stakeholders also establishes the protocol, the enabling mechanism, for a level playing field for all suppliers and manufacturers engaged in international trade. This level playing field is essential to allow manufacturers and suppliers to provide society with the benefits that radioactive source applications bring, without disadvantaging one supplier in favour of another.

Building on the foundation established by the IAEA, national competent authorities, manufacturers, suppliers and users establish the system of policies, rules, regulations and practices to achieve the objective of safety and security. This system must be integrated to ensure that all relevant aspects and interrelationships are harmonious and complementary.

4. A NEW INDUSTRY INITIATIVE

There has been a long standing understanding by the IAEA of the important role that manufacturers and suppliers play in addressing concerns regarding life cycle control and management of radioactive sources. In fact, the engagement of industry is a key success factor for achieving the objective of safety and security during the source life cycle.

Manufacturers and suppliers worldwide also think it is important that industry participate in actively developing strategies for the long term control and management of sources. There is a desire of industry as a whole to collaborate with the IAEA in developing international policy, to forge a strong relationship with national legislators and regulators, and to facilitate communication, education and awareness amongst key stakeholders. As a whole, manufacturers and suppliers take seriously the responsibility to ensure effective stewardship and self-management of our industry.

It was the convergence of purpose amongst industry, the IAEA and the national competent authorities that led manufacturers and suppliers to take the initiative to establish an international industry association to address our common interests and opportunities.

In April 2003, at Technical Meeting 26266, held by the IAEA in Vienna, source manufacturers and suppliers determined that collectively they should develop and establish a Code of Practice that defines the roles and responsibilities of suppliers in the life cycle of high risk sources. This was the first time that manufacturers and suppliers had taken such a step forward. The Code of Practice was perceived as the guide, the de facto ‘stamp of approval’, for manufacturers and suppliers to demonstrate that industry has a strong interest in self-management and adherence to principles related to safety and security, throughout the source life cycle.

The next year, at Technical Meeting 26601, manufacturers and suppliers took another step when the concept was established of an international Source Manufacturers and Suppliers Association. All industry members in attendance at that technical meeting in February 2004 worked together to develop a mission statement and objectives for an international association. Furthermore, the idea of the Code of Practice was taken a step further. The framework for a Preliminary Code of Good Practice was developed and it was endorsed by all in attendance.

Later that year, in September 2004, industry participants attending Technical Meeting 26670 further endorsed and confirmed the concept of an international association. Key milestones to be reached in establishing the association and a detailed action plan were prepared. An implementation steering committee was established, and tasked with taking the concept to the point where the association was registered as a non-profit organization. The steering committee was comprised of representatives from AEA Technology, MDS Nordion and Reviss Services.

In early 2005, Articles of Association were finalized. Legal registration for the International Source Suppliers and Producers Association (ISSPA) as a non-profit organization was obtained in Vienna in April 2005. The three members of the steering committee became the founding members of ISSPA. The inaugural meeting of ISSPA was held in Vienna on 27–28 April 2005. Twenty prospective members from eight countries attended the inaugural meeting. An Action Plan for ISSPA was developed by all founding and prospective members in attendance.

Since the inaugural meeting, the ISSPA membership has grown to 11 members from seven countries. One of our main objectives is to be associated with the IAEA as an NGO. Our initial application for NGO status was filed in May 2005. Today, although not formally accepted, ISSPA is pleased to be essentially regarded as an NGO by the IAEA, with the opportunity to participate in key meetings and conferences.

We certainly look forward to continued association and collaboration with the IAEA and national competent authorities in the future as we strive to fulfil our mission.

The mission of ISSPA is to ensure that the beneficial use of radioactive sources continues to be regarded by the public, media, legislators and regulators as a safe, secure, viable technology for medical, industrial and research applications.

DISCUSSION

A. JOUVE: (1) What proportion of source manufacturers worldwide belong to your association? (2) How do you enforce the Code of Good Practice internally?

G. MALKOSKE (ISSPA): (1) Currently more than 80%. Our members are from Argentina, Australia, Canada, Germany, the United Kingdom and the United States of America. We would like even broader participation. (2) The ISSPA Articles of Association require members to adhere to and implement the Code of Good Practice if they wish to join and remain in the association. All members can participate in developing the Code of Good Practice, which is currently only a framework and needs to be built out.

H. MANSOUX (France): You mentioned the return of disused sources to the supplier several times. (1) Is it a basic requirement to be part of the association? (2) Is it a common view of all manufacturers?

G. MALKOSKE (ISSPA): (1) Yes, we have this as a requirement in the Code of Good Practice. We think that a responsible supplier must accept returned disused sources. (2) Yes, but some manufacturers have difficulty in implementing this owing to national laws and regulations regarding radioactive waste. They are encouraged to address that. It is important to have measures like reuse and recycling to extend the source life cycle.

TECHNICAL SESSION 5: CHAIRPERSON'S SUMMARY

J.-M. POTIER
IAEA

In conclusion, I would like to summarize the findings of this session. On the basis of long experience, the storage of disused sources seems to be a straightforward technical operation in Canada. The options available are wet storage in reactor pools, or dry storage in shielded casks either with the vendor or at a site of Atomic Energy of Canada Limited.

Mr. Crossland reviewed all options for the disposal of disused sealed sources. Near surface disposal repositories, though an acceptable option, generally do not accept them. Deep underground disposal would be the safe solution for all source types, but the costs are prohibitive for most countries with small inventories.

The borehole technique seems quite promising, as demonstrated by Necsa's work in South Africa over the last ten years and by the successful outcome of a peer review in April 2005, which confirmed the safety, technical feasibility and cost effectiveness of the Necsa concept. Several IAEA developing Member States with small source inventories have already expressed great interest. Assuming that high activity sources can be returned to the supplier, I think that the borehole concept may solve the disposal problem in many developing countries.

Mr. Malkoske's main points were: (1) Life cycle management is the cornerstone of a strategic approach to long term control of sources. All stakeholders have complementary and supportive roles. (2) Beneficial, safe, secure and cost effective use of radioactive sources requires harmonized regulations in order to define requirements and thus minimize confusion. (3) Responsible suppliers must continue to establish enabling mechanisms to facilitate return, reuse and recycling of sources as part of the long term management strategy.

STRENGTHENING THE INHERENT SAFETY AND SECURITY OF RADIOACTIVE SOURCES AND OTHER OPTIONS

(Panel Session 3)

Chairperson

A. JAMMAL
Canada

Panel Members

G. MALKOSKE (International Source Suppliers and Producers Association)
M.S. KRZANIAK (International Organization for Standardization)
D.D. DIETRICH (United States of America)
P. DUBÉ (Canada)

PANEL SESSION 3: CHAIRPERSON'S INTRODUCTORY COMMENTS

R. JAMMAL
Canada

We are as strong as our weakest link. All entities involved in the life cycle of radioactive sources have roles and responsibilities. A radioactive source within a device is an integrated system. If the source is separated from the device, it becomes a radiological hazard. In this session, we shall hear from the International Source Suppliers and Producers Association and the International Organization for Standardization about their roles in increasing the inherent safety of such systems. Inherent safety implies looking at the form, activity, encapsulation and dispersability of the source. We shall also hear about methodologies for providing safety and security, and finally about the impact of security requirements on users and facilities.

STANDARDIZATION OF SAFETY AND SECURITY FEATURES FOR SEALED SOURCES AND DEVICES

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Abstract

Standardized requirements are critical to the effective implementation of safety and security requirements for sealed sources and devices. Many relevant standards exist in this area, some dealing with the performance requirements for the sources, and others with the devices that contain the sources. Recent work within Technical Committee 85, Subcommittee 2, of the International Organization for Standardization is presented, with a focus on activities of the working group revising performance standards for sealed sources and developing the standard for an ionizing radiation warning symbol. Review considerations for these standards and more general concerns around harmonization are presented. It is concluded that the International Organization for Standardization provides a convenient mechanism for the generation of new standards and a means to resolve conflicts between standards.

1. INTRODUCTION

Sealed sources are used worldwide in many applications, from industrial applications such as gauging, oil well logging and radiography, to medical applications such as sterilization and cancer therapy.

Effective standards are critical to the implementation of safety and security requirements for sealed sources and devices. Many relevant standards exist in this area, some dealing with the performance requirements for the sources, and others with the devices that contain the sources. The International Organization for Standardization (ISO) publishes many of these standards.

This paper discusses some of the relevant standardization activities currently under way within ISO Technical Committee 85, Subcommittee 2 (ISO TC85/SC2). It focuses on activities related to revision of ISO 2919, the

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standard describing performance requirements for sealed sources, and on the development of ISO 21482, the ionizing radiation warning symbol. Review considerations for these standards and more general concerns around harmonization are presented.

2. RELEVANT ISO STANDARDS

ISO is a non-governmental organization representing 151 member bodies. It has published and maintains over 15 000 standards. Work is divided among technical committees (TCs), with TC 85 responsible for aspects of nuclear energy. Within each TC, subcommittees are formed along broad lines of interest. In turn, each subcommittee delegates work on standards to working groups.

Membership on working groups is open to all member bodies. Nominations are normally issued through the national standards bodies. Once a working group completes its deliberations, a final draft international standard is submitted to the member organizations for vote.

ISO TC85/SC2 has the responsibility for standards relevant to the safety and security of sealed sources and devices. Examples of these are provided in Table 1.

TABLE 1. EXAMPLES OF STANDARDS WITHIN ISO TC85/SC2

Working Group 1	ISO 361:1975, Basic Ionizing Radiation Symbol
Working Group 4	ISO 7205:1986, Radionuclide Gauges – Gauges Designed for Permanent Installation ISO 3999:2004, Apparatus for Industrial Gamma Radiography — Specifications for Performance, Design and Tests
Working Group 11	ISO 9978:1992, Sealed Radioactive Sources — Leakage Test Methods ISO 2919:1999, Sealed Radioactive Sources — General Requirements and Classification ISO 21482, Ionizing Radiation Warning Symbol (Original Issue)
Working Group 20	ISO 22188:2004, Monitoring for Inadvertent Movement and Illicit Trafficking of Radioactive Material

2.1. Activities of ISO TC 85/SC 2 Working Group 11

Working Group 11 has responsibility for standards relevant to sealed sources. Current activities involve the revision of ISO 2919 [1] and the creation of ISO 21482.

2.1.1. ISO 2919 review considerations

ISO 2919 has been implemented by many source manufacturers. Originally issued as ISO 1677 in 1977, it has been revised twice, most recently in 1999. ISO 2919 provides guidance on test methods that can be used to demonstrate that sources maintain their integrity under their conditions of use. Simulated sources are required to be subjected to a series of tests that establish their resistance to temperature, mechanical damage, vibration and pressure. The tests vary in severity, depending on the application, and the applications range from radiography, to teletherapy, to oil well logging. The more severe the environment, the more challenging the test.

A key consideration of the working group is weighing the benefit of the change against its cost. As ISO 2919 has been implemented around the world, considerable infrastructure exists. This includes the efforts of the designers in qualifying their sources, the investment of source manufacturers in their processes, and the regulatory infrastructure associated with source and device approvals around the world. It is important to consider how changes affect each of these.

Another key consideration is harmonizing ISO 2919 with other national standards implemented in the United States of America, Europe and around the world. Currently, conflicting requirements exist between some of these national standards and ISO 2919. Resolving the conflicts is important to the effective implementation of this safety standard. Alignment between national and international standards is necessary for the effective implementation of safety requirements.

The working group is also considering the need to expand the scope of the standard to other applications, including brachytherapy seeds and some neutron generators. Key questions include the specification of test requirements to demonstrate fitness for use for these applications. ISO 2919 should be considered as a living standard. As new applications evolve, it is expected that additional sealed source designs will enter into its scope.

ISO 2919 also provides guidance on the marking of sealed sources and their certification. It requires manufacturers to uniquely identify manufactured sources, and advises how to certify that they are leak tight and free from contamination. During this review cycle, the working group is also considering how to implement potential requirements for the ISO 21482 ionizing radiation warning symbol.

2.1.2. Ionizing radiation warning symbol (ISO 21482)

The IAEA has recently completed worldwide testing of a new ionizing radiation warning symbol to supplement the trefoil warning symbol. IAEA experience has shown that the trefoil alone does not clearly identify the hazardous nature of radiation sources [2]. The purpose of this is to convey the message "Danger – Run Away – Do Not Touch."

ISO was selected as the mechanism for standardization of this symbol and the task has been assigned to Working Group 11. A draft was prepared in February 2005 in parallel with country testing to finalize the geometry of the symbol. The current status of the symbol and its development are described in Ref. [3]. This work will be used to finalize the draft standard.

The working group considered the application of the warning symbol to the surfaces of sealed sources and concluded that it will likely be impractical for many sealed source designs. The small surface area of most sealed sources does not allow a clear symbol to be engraved. Instead, it was suggested that this label be added to the shield or at a point of access that will indicate that disassembly of the parent device is dangerous. The working group also concluded that the symbol should be placed discreetly and should be visible upon the dismantling of the device.

As the sign is meant to prevent the inadvertent disassembly of devices containing radiation sources, it was recommended that the new warning sign not be added to transport packages, freight containers and building access doors.

2.1.3. Challenges to the implementation of ISO 2919 and ISO 21482

Compliance with ISO standards is voluntary. In some cases, changes to regulation may be necessary to effect change.

Implementation of ISO 21482 should be considered during the review of applicable device standards. However, many of these standards will lag behind ISO 21482 and are not currently under review. Other means of communicating the specific requirements of this standard will have to be considered. Therefore cooperation between designers, manufacturers, users and regulators is necessary to effectively implement the requirements of these standards.

3. RELEVANT STANDARDS OUTSIDE OF ISO

ISO does not have standards for all applications containing sealed sources. In some cases national standards exist. Important applications not currently considered by ISO include standards for wet and for dry irradiators [4, 5]. In an international environment, it is important to recognize that national standards may drive design and performance. The adoption of such standards by ISO would facilitate the international acceptance of conforming designs. Mechanisms exist to create common standards between national bodies and ISO. A unified approach is necessary to ensure effective implementation.

Additional examples of relevant standards outside of ISO can be found in a report by the European Committee for Standardization [6].

4. CONCLUSION

A key challenge is to ensure that applicable standards are in agreement. Harmonized requirements are critical to the effective implementation of safety and security requirements for sealed sources and devices. This is particularly important when one considers that sealed sources and devices are designed, manufactured and used all around the world. Consistent requirements enable equivalent safety and security measures to be uniformly applied.

ISO provides a convenient mechanism for the generation of new standards and for their effective review. It provides a means for all stakeholders to provide input and achieve consensus in an international forum.

REFERENCES

[1] ISO 2919:1999, Radiation Protection — Sealed Radioactive Sources – General Requirements and Classification.

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Revised Action Plan for the Safety and Security of Radiation Sources (Attachment to GOV/2001/29-GC(45)/12).

[3] MacKENZIE, C., "New radiation warning sign", poster presented at Int. Conf. on the Safety and Security of Radioactive Sources, Bordeaux, 2005.

[4] ANSI N43.7, Self-Contained, Dry Source Storage Gamma Irradiators (Category I).

[5] ANSI N43.10, Safe Design and Use of Panoramic, Wet Source Storage Gamma Irradiators (Category IV) and Dry Source Storage Gamma Irradiators (Category II).

[6] EUROPEAN COMMITTEE FOR STANDARDIZATION/TR 14715, Safety of Machinery. Ionizing Radiation Emitted by Machinery. Guidance for the Application of Technical Standards in the Design of Machinery in Order to Comply with Legislative Requirements.

STRENGTHENING THE INHERENT SAFETY AND SECURITY OF RADIOACTIVE SOURCES: ACCELERATOR BASED OPTIONS

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Let me be perfectly clear at the outset about two issues. First and foremost, radioactive sources are both useful and cost effective. I am a strong supporter of the need for tools that are effective, both technically and financially. If a technology can't be utilized in an effective manner, it won't be useful, no matter how clever and elegant it is. Secondly, as we all know at this conference, there are safety and proliferation concerns that must be addressed. Accidents, contamination, dirty bombs, etc., all represent real concerns. A single incident can impact the cost of all uses. We can already see how these issues and regulations devised to reduce these risks are driving up the costs and lowering efficiency. Having said that, I believe that the substance of my remarks will be controversial at this forum.

The accelerator based option is nothing new, it has been around for decades. What is new is embedded intelligence and the impact of the global marketplace in the production of high technology instrumentation. Imagine what the world will be like in 5–10 years, because this is where my remarks are targeted. There are several trends at work that are simultaneously lowering the costs of accelerator based solutions while increasing the cost of radioactive source based solutions. Modern technology is bringing down the cost of traditional instruments dramatically. Embedded computer systems simplify the operational complexity, meaning lowered costs for operator training. Self- and/or remote diagnostics reduce the necessity and cost of service calls. Modern communications allow anyone in the world to take advantage of these factors. The global economy is helping industry produce high technology products more efficiently. Thus the obvious answer to me is to simultaneously strengthen the inherent safety and security of radioactive sources, while re-evaluating the attractiveness of accelerator based sources of the required radiation. I believe that the topic of this conference emphasizes the need to utilize these alternatives to radioactive sources as they become more effective both technically and financially.

We routinely use small portable neutron generators and radiography tools in field applications. This is cost effective, since a major concern of the United States Government is exposure of workers and the general public to radiation. The ability to control when the radiation is on and off limits the physical control required during times when the source is not in use. Costs associated with storage and legacy issues are also greatly reduced when accelerator based solutions replace radioactive sources. The technical effectiveness of accelerator produced radiation is not at question. Having a computer control the energy and intensity of the radiation produced is of considerable advantage, especially when using modern computer assisted treatment plans. The real issue is the financial effectiveness.

Using accelerator technologies to produce radiation will address the issues I raise by limiting the production of radiation to only those times when a switch has been flipped. Producing radiation that way has one main advantage over the use of radioactive sources. When the switch is off, there is no radiation. Making instruments that are doubly fail-safe is straightforward. Issues associated with radiation safety during transport and storage disappear. There are also minimal issues of disposal and tracking of materials. There is very little potential for diverting a transportable radiography machine or portable neutron generator for nefarious uses.

I know that the use of radioactive sources has been the easiest in the past and may still be the least expensive, but the costs associated with using accelerators to generate radiation are certain to come down relative to the costs of using radioactive sources. Beyond medical treatments, radioactive sources are used for far more than just radiation oncology. They are used in radiography, food sterilization, thickness gauges and moisture/density gauges, to name a few. Some applications require portability with both gamma and neutron sources, while some utilize fixed installations as part of larger, complex instrumentation. Almost all are in a form, during at least part of their life cycle, which is extremely portable, in order to facilitate easy shielding for transport and storage when not in use. Even the largest radiation oncology machines use tiny pellets of radioactive material to minimize self-attenuation and to make source replacement easy. The use of accelerators will benefit us by removing these potential sources of materials that may contaminate the environment if not properly controlled, or be diverted to make a dirty bomb, or even merely present extra costs associated with future regulations regarding storage, recovery and disposal.

In my opinion we need not replace all radioactive sources with generators. What we do need to do is carefully monitor the balance between the increasing number of sources in use, increasing concern for their location and condition, and the cost of employing radiation generators. I believe that in many cases there will be a natural progression away from using sources towards the use of radiation generators. Another key factor that would influence this balance is if an accident and or misuse of radioactive sources were to occur. The costs of dealing with sources would rapidly escalate, and would likely tip the balance sooner.

PANEL SESSION 3: DISCUSSION

W. STERN (United States of America): The IAEA should start a process, such as a working group, to study long term issues associated with radioactive sources, including replacing the most dispersable sources with other instruments.

R. JAMMAL, Chairperson (Canada): I agree about the working group to discuss long term issues associated with radioactive sources. We should also look at new technologies, keeping in mind requirements, assessment of the case of use and the long term life and associated costs. We should not live in a bubble, but should recognize what is really happening around us.

V. FRIEDRICH (IAEA): My answer is certainly not an IAEA position. New developments and changes in technology and costs should be followed. However, our developing Member States do not have the necessary resources and infrastructure to maintain and operate accelerators. The trend of the increasing cost of radioactive source application and the decreasing cost of electronic devices does not mean that they are close to each other. Accelerators are still far more expensive.

D.D. DIETRICH (USA): One must remember that the crossing points are application dependent. For low energy radiography, the crossing point is in the near future, whereas higher energy applications may be several years off.

W. STERN (USA): My proposal was for a process to begin looking at longer term issues, not to simply replace some sources with accelerators. There are a small number of sources posing the greatest risk. I'm suggesting that we start looking at how we deal with them and that we think it through before a radiological emergency happens.

R. JAMMAL, Chairperson (Canada): I have taken note that such a working group has been proposed.

S. McINTOSH (Australia): The crucial issue is the dispersability of sources. There may be a role for regulators in imposing a standard and requiring industry to meet it within a specified period.

G. MALKOSKE (International Source Suppliers and Producers Association (ISSPA)): It would be beneficial if regulators could establish an R&D programme to examine ways to ensure source security while continuing to ensure that the best technology is developed for the intended application. When addressing issues like dispersability, the overall performance characteristics must be maintained. Many small suppliers do not have adequate resources to establish R&D programmes on their own.

J.A. BARRETT (United Kingdom): It is all very well to say that new technologies provide an alternative to the use of sources. Very careful thought needs to be given to the use of software controls in safety-critical systems. Power fluctuations or loss may have adverse effects on operator safety. Quality assurance must be introduced at the very start of the design process. Integrated safety is just as important as the prevention of diversion or of malicious use. Before any novel technologies are released to the market, they must be subjected to a full, integrated risk assessment.

A. DELA ROSA (Philippines): My question refers to second-hand radiotherapy machines and the accompanying radiation sources. These bring inherent safety and security problems with them to the recipient country. I would like to know if such second-hand equipment and sources are within the scope of the ISSPA.

G. MALKOSKE (ISSPA): Any second-generation suppliers that join ISSPA must also abide by the Articles of Association and the Code of Good Practice. This will cover requirements for source and equipment quality. However, first-generation suppliers would generally prefer equipment and sources to be returned to them for refurbishment, revalidation and certification before they are resold.

F. FÉRON (France): There are not many standards setting provisions for the safety and security of equipment with radioactive sources or of facilities. Will the International Organization for Standardization (ISO) or ISSPA establish such standards?

M.S. KRZANIAK (ISO): Some standards for facility design, for example for containment enclosures, are covered within the scope of ISO. Where needed, ISO can form working groups to develop new standards or revise existing ones. Also, outside of ISO there are standards relevant for the industry within national and international jurisdictions.

G. MALKOSKE (ISSPA): ISSPA would encourage the establishment of standards and guidelines for sources, equipment and facilities, where appropriate. Although ISSPA itself will not develop the standards, we would be pleased to participate.

M. AL-MUGHRABI (IAEA): (1) For sources, while the risk substantially increases when they become spent, so do the options to render them secure. Hence we should pay more attention to post-use, for example conditioning for management as waste. (2) Accelerators are not the best solution for developing countries mainly because of difficulties associated with vacuum engineering rather than with power supply.

R. JAMMAL, Chairperson (Canada): To comment on Mr. McIntosh's and Mr. Stern's suggestions, I think we need to be open minded and not get complacent or resigned.

This session can be summarized as follows. ISSPA: We need to develop source security using a systematic approach, and to have cooperation between all stakeholders. ISO: Standardized requirements are critical, especially for sealed sources. Mr. Dubé: The challenge is to balance operational and security needs. Collaboration with users is vital. Mr. Dietrich: New technology should be considered, weighing the advantages and disadvantages.

PROVIDING PUBLIC INFORMATION

(Panel Session 4)

Chairperson

P. Rickwood
IAEA

PANEL DISCUSSION

PROVIDING PUBLIC INFORMATION

Chairperson: **P. Rickwood** (IAEA)

Members: **R. Broomby** (BBC World)
L. Charbonneau (Reuters News)
J. Diaz (Universitat de Vic, Spain)
P. Worms (Ogilvy Public Relations Worldwide)

P. RICKWOOD (IAEA): Thank you for joining us this afternoon. My name is Peter Rickwood. I work in the Division of Public Information at the International Atomic Energy Agency. For those of you whose roots are in the scientific community, I have some good news. In a poll conducted recently in the United Kingdom it was determined that 45% of the public declared their trust lies with the scientists, compared with only 14% with journalists. For journalists, like my friends beside me, that's bad news. Frank Burnet, an iconoclastic academic at the University of the West of England in the United Kingdom, uses the statistic to ask the question: If you were a scientist — and I think perhaps I would say, if you were a regulator — from your community, why would you bother communicating with journalists?

The purpose of this session is not to shine a blinding light on why the public may or may not trust journalists and better trust scientists. What we in the Division of Public Information in the IAEA try to do is to help experts such as yourselves to communicate better with the public and, of course, with journalists. The mass media provide you with the means to reach a large audience, under certain circumstances, almost immediately. The task of reporters such as Rob Broomby, who is sitting on my extreme right, and Lou Charbonneau, who is the first on my right, is to satisfy that demand for immediacy. Lou is a senior reporter for Reuters and Rob Broomby is a senior feature reporter for the BBC. Journalists like them receive very complex and novel information, and they have to translate it into a form that the public will understand. So it means they have to take it out of its sealed source, if you like, of scientific terms and put it into something more accessible. It's not an easy task.

But what is required is that — if you think you have to communicate with the public, which I think we all accept is a given —you provide the information in a manner that journalists will be able to understand, and that's an endless task but one you must never give up on. You can't afford to. You need the public, and journalists are one of the links to the public.

There are other ways of reaching the public, of course, and Joanna Diaz, to my left, who teaches at the University of Vic Sagrada in Barcelona, is an environmental communications expert whose search focuses on how to more effectively provide information that engages the public, that informs the public and that changes attitudes, rather than just provide information for consumption. The analogy of 'water off a duck's back' comes to mind. It is critical in the area of the challenges that you all face that you do get to the core of public sensibility and that people are made aware that there is a need to improve the security of radioactive material, although obviously there's a desire not to raise unnecessary anxiety and hysteria. So you work towards good government relations, which probably won't be achieved without that degree of public support.

There's a difficult task ahead. That's why the public information process is important. And going back to formulate a message, experts such as Patrick Worms from Ogilvy Public Relations Worldwide, second on my left, have developed techniques that assist you to more effectively communicate. I'm not a scientist, so you wouldn't ask me to solve a complex scientific problem. Unfortunately, sometimes scientists are asked to manage complex communications problems without the necessary knowledge.

In the last four years, the IAEA — in journalist parlance — has been transformed into the world's 'nuclear watchdog'. Clearly, events over which the IAEA has no control at all have elevated our profile. Yet hand in hand there has been much greater emphasis placed on improving the output of public information. We work diligently and closely with journalists, with people such as Patrick helping us with attempting to improve how we communicate. It's something we have to keep learning all the time. We also try to support journalists by recognizing that they can't be expected to understand everything all the time. It takes a lot of effort, it takes a lot of time and it requires enthusiasm, but I think the one thing that is important is the process. If you don't like the public communications process, you're probably better off not participating in it. Find someone else who does.

J. DIAZ (Universitat de Vic, Spain): I have to say that I'm neither a journalist like my colleagues here nor am I a scientist, so what I've chosen to do is to talk about something a little more abstract, which makes it very easy for me. Nevertheless, I hope that I can contribute properly to the discussions later. By 'abstract' I mean the scenarios. What type of scenario do we need to make communication effective? Because when we talk about communication it seems that only journalists and the media are the main characters, the ones that play the most important role. They do, of course, play a very important role, but the scenarios in which communication takes place are also very important, and for that I want to talk about cultures, specifically about the 'no culture', as I call it.

What's this? What's the 'no culture'? Well, I think about the 'minimum effect', which most of you might have heard of. It started in the 1950s, and was this idea of 'not in my backyard', and it started with the legislative movement of bio-activists, who protected national areas of special interest from hazardous influence through the construction of an environmentally friendly plant, etc. That became something slightly different in the 1970s. 'Minimum effect' swept all through society and somehow it became the citizen's response to dangerous or hazardous operations by industries.

This was solved, and is mostly solved today, by legislation and regulation. Of course most plants and industrial facilities today are subject to very strict environmental requirements set by governments, by international organizations and even by society. So this minimum effect today is no longer the culture that I was referring to earlier. It means we say 'no' to everything today. So when a new plant is proposed to be constructed close to our homes, when a power line crosses a mountain close to our city, when a pharmaceutical company is going to create a lot of jobs but at the same time is going to build equipment that might use radioactive sources, we say 'no'; we don't want that close to us.

However, at the same time we want to benefit from the comforts that so many Western countries, especially, are enjoying today — the advantages of the welfare State, but we reject all of its disadvantages even though technology and science have reduced these disadvantages to a minimum. So now, we have this divide between the welfare State and the risks of society where we reject as citizens everything connected with the facilities, plants and constructions that we might perceive as dangerous or simply ugly. Even prisons are not something that we want to have close to our home. We don't want crime in our cities, we defend the right of those who are imprisoned for crime to have a humane place to pay their dues to society but we don't want that prison to be close to our place.

So in keywords we have been spoiled by the welfare State, we're misinformed and our ecological footprint makes our territories too small to live in. So conflict arises. And the scenario I suggest we have in mind for the discussion that will run later is this scenario of conflict. Information is not flowing everywhere and we're not dealing with people who know exactly all the little scientific and technological details of things that we use in our homes and so on. This scenario is the scenario of conflict, of environmental problems and of misinformation.

And who are the actors in question in this scenario? There are two big blocks of actors. On the one hand we have governments, scientists, regulators and corporations, who try with difficulty to manage these risks, to manage complexity and communication and information released to society. Mostly — unfortunately for these governments, scientists and corporations who anticipate the problem — the conflict makes things very difficult in terms of communication. So the communication they practise is reactive. They intend to protect their interests when there is a problem that has to be solved, and what usually happens is that they end up lobbying for their interests, so they use the media sometimes in an ad hoc way. They send out press releases. They even — if we're talking about powerful corporations, for example — try to influence the media through their power advantage. In the case of scientists, what usually happens is that they cause confusion, probably not intended, and they build some sort of barricade of uncertainty. So this is one of the blocks.

The other block is society, neighbourhood platforms, associations and organized citizens. They are smart, they are well informed, they have access to the information but they don't understand. They demand responsibility, they demand accountability, but at the same time they don't intend to stop using their newly acquired commodities that make life more comfortable for them.

So with these two blocks of actors trying to deal with conflict, we can imagine that the role of the media is usually characterized not by their routine way of working, but by stress, and by lack of time, space and accessible sources. My colleagues will talk about that later. In this scenario of conflict, what we should probably think about is: How can we change it? How can we make it more convenient for communication to be easier, to flow in a more effective way. I want to leave here four points for the discussion and with that I will finish.

The first point is that maybe we should stop thinking about a changing role in the media — the role of setting the agenda, raising issues, deciding what's news, etc. Maybe, apart from that, we should stop thinking that the media can be used as ad hoc actors. We cannot use them only in a crisis to see if we can influence the public, or if we have new technology that we know is very good and that we need to publicize through the media. We need this, too, of course, but we could also use the media to act as moderators in a dialogue between interest groups, not as people, professionals who are in the middle of these two blocks in conflict, but as moderators of several interest groups, groups of stakeholders that have an interest in finding a solution that's beneficial for all parties.

The second point is the type of dialogue. I said we needed to build some sort of dialogue between the stakeholders in a conflict. First, we have to stop talking about strategic or tactical dialogue to solve local, sporadic problems and conflicts. So think long term, not short term.

The third point is that we have to relocate power. Instead of having two blocks that hold all the power — corporations, government and scientists on the one side, and organized society on the other side — we should stop regarding them as different groups that can be represented and that have legitimate power and influence to take the decisions. This is something that is being introduced at the decision making level, government talking about government, but government means mutual, joint decision making processes, so let the public participate in the process of decision making. That means a lot of transparency. Corporations talk about corporate social responsibility. That's not dream marketing but means a lot more. It means current, systematic relations with stakeholders — the investors, customers, etc. And in the case of science, of course, there are also ways in which stakeholders can be together, close to scientists so they know their interests and concerns.

Finally, we should start moving from reactive change, i.e. management of conflict resolution, to anticipated change and proactive research for mutual benefit. I think this idea of mutual benefit is the key to this stakeholder dialogue. These are the abstract ideas, and I leave the concrete ideas to the journalists.

L. CHARBONNEAU (Reuters News): I work for Reuters news agency in Vienna, where I have been covering the IAEA for over four years. I want to give you a sense of how we journalists work, not just at Reuters but around the world.

First of all our job is to tell a story. We are storytellers and that's why we come to work everyday — we write stories. And we have a diverse audience. First of all, we have the traditional media clients. We're selling our stories to newspapers and to television broadcasters. While that's one part of it, we also sell to traders, analysts, currency traders, energy and oil traders, some financial markets. They use our news, they trade on it. So there are many times that a news bulletin goes out on Reuters wire. It is read on hundreds of thousands of screens around the world and in training rooms, in newspapers. They see those news bulletins and they can figure out what they want to do with them. We want a news bulletin to be a good story, because otherwise the readers aren't going to be interested.

But not only do we want it to be a good story, even more importantly we want it to be right. We want it to be correct, we want it to be accurate, and we don't want to make mistakes. We hate making mistakes and if we do make a mistake we want to correct it as soon as possible. We want it to be correct. We also want to be first. This is part of the game. It's a competitive world in the media out there and we want to break the news and want to bring it to our clients first so that they know that we are the ones they are going to turn to if they've got to make a choice about who's going to bring them the news today. So, you won't be able to help us necessarily break the news first and you won't even necessarily be able to help us tell a good story but you can help us get it right. We are dealing with difficult scientific issues. We are not nuclear scientists. We are normal people who cover many different issues on a daily basis and so we turn to the experts. So we need you to talk to us. Talk to us; don't *not* pick up the phone, that's the worst thing. Return phone calls. If something happens, it's very important to talk to the journalists. Get to know them. Develop relationships with journalists. Get to know whom you can trust — who's a good writer, who's intelligent, who seems to understand the issues, who maybe messes it up now and then. Then work with those who don't quite get it right but — as Joanna was saying — don't just treat them as enemies. We're there to work with you and can make both sides happy.

So help us understand what you're doing. Be prepared to talk to us in language that we understand. Help us to understand difficult concepts so we can put them into stories. If it happens that a radioactive source goes missing, I hear about it from someone, let's say it's a police officer. Police like to talk. They don't always understand the scientist any better than the journalists, maybe even worse, so that they're going to tell me things as they understand them. I'll call up the nuclear regulatory authority then, and you've got to deal with it, you've got to be ready to talk to me, because if you say that you're unavailable for comment, I have to write in my story that you're unavailable for comment because I called two or three times and I didn't get a response and I've got a deadline. My editor is saying, "Where's that story? We need that story on that missing nuclear bomb material." I say, "Well, I don't know if it's missing nuclear bomb material. The regulatory agency won't talk to me." He says, "Well, we've got to put the story in, it's important. Our competitor at the BBC has it so we've got to run." So if we write in our story 'unavailable for comment', that will be treated as possible confirmation. Or if I write something like, "after they refuse to return repeated phone calls", it looks bad. It can make the situation worse down the line rather than your picking up the phone and saying, "Something's missing, but it's not so dangerous."

There are other situations where you don't have to react. You may have a story that you want to get out. One of the complaints — and I think often it's a fair complaint made against journalists in general — is that we only write the negative stuff. We aren't interested in positive news. We aren't interested in positive things about the nuclear industry. Well, that's where you can come to us but you need to sell it to us in a way that we can take to our editors, who will then say, "OK, that's worth a story." Because when we come to work, when I come with a story, I have to call my editor, who says, “OK, sell it to me, make a pitch.” So I make a pitch and he wants to know, “Where’s the angle?” And I say, “Oh, they’re building this new nuclear power plant, maybe it’s a story.” What’s the news in that, you know? Maybe it’s interesting because there’s a listed company involved. But we need the ‘hook’ and you can help us with that.

Also, it’s good to avoid technical jargon in talking with journalists. Figure out a way to talk to us in language that we understand and we can put into quotes that are going to work as *the* quotes in a story or sound bites if you’re going to go on the radio or TV. A couple of examples I wanted to give. Here’s how not to present a quote to journalists. I wouldn’t say this: “Under Policy Directive 2356, all installations licensed by a licensing authority are required to submit questionnaire C24 and IXY documentation annually.” I can’t use that. But if you turn it around and turn it into normal plain language that I can understand and you say, “All nuclear facilities are now required to submit detailed documentation on their preparedness for a terrorist or other malicious attack and as outlined under security measures taken, etc., etc., to prevent the loss of any dangerous nuclear material.” I’m exaggerating slightly, but it’s language that speaks to me. I think I’ll leave it at that. We’re going to continue with these issues when we do our exercise.

P. RICKWOOD (IAEA): Well, Joanna has been stressing transparency. Luis saying be proactive and speak plainly. Rob, would you challenge the audience please?

R. BROOMBY (BBC World): I work for BBC Radio 4 and I have done a lot of nuclear investigations over the recent years. I picked up this from your table. It isn’t the only thing I picked up outside. I don’t want you to think we’re terribly one dimensional, but it’s very colourful, and it is in fact the IAEA’s International Nuclear Event Scale. I can understand it, so I thought that was worth commenting on as some kind of classical, nicely laid out piece of information.

I’d like to start with a story. At an Anglo-German conference I attended last year, a British official stood up and he was talking about science reporting in the media. He said, “Reporting science is fine when it’s in the hands of expert correspondents and the trade press; they understand the issues. They speak our language.” “But”, he said, beginning to wring his hands, “it’s the rest.”

The ‘rest’, ladies and gentlemen, are people like me. What I’m not is a science or nuclear specialist. The bad news for you is that most media organizations don’t have one. There are no, or at least very few, nuclear correspondents that I know of. That said, in my own work I’ve done probably more investigations into nuclear topics than anyone else at the BBC in recent years. The fact is that it's the rest that you need to worry about actually in the media field. Turn it upside down and you will see that actually it's the rest that count. Most news, most reporting, is done by generalists, who are experienced journalists and little else. So if a reporter hasn't grasped the facts when you put the phone down, it will soon become your problem. If you can't explain your story or your issue to me or someone like me, in terms that I can understand, what hope would you have when that sound bite comes out of the radio speaker into a busy family kitchen or is digested with someone's TV dinner?

I work in current affairs. When I contact people like you, on the whole, it will be in an ongoing investigation where I'm seeking in-depth analysis, spin or even opinion, the driving elements behind a big piece. So it's not all about news. Sadly, I'm going to be a little unkind to my British colleagues here, but I hope you take it in the spirit in which it's intended. Secrecy and defensiveness are still all too common in the broader nuclear field. The assumption seems to be made that safety and security are best guaranteed under a cloak of secrecy. But while I acknowledge that, as journalists, we cannot — perhaps should not — know everything, I do firmly believe journalists' scrutiny, public awareness and public pressure are a positive influence — keeping the powers that be on their toes as it were. Government in the sunshine is usually better than promises of security in the shadows.

So you can imagine my frustration when, at an IAEA conference in London a few months back, I was asking a British official, somewhat rhetorically, I admit, about the work of our own Office of Civil Nuclear Security (OCNS), which oversees and guarantees security. I complained that journalists who try to pose questions about nuclear security and terrorism got no further than the Department of Trade and Industry press office. I was perhaps aiming a little high, but then these days it's not so difficult to get a briefing in Downing Street. I don't see why it shouldn't be possible to have contact with officials from the OCNS. I asked whether greater transparency might not be desirable. Why couldn't we meet the staff? Well, in true British style, the official sitting next to Dr. ElBaradei leaned out in the press conference, fixed me with an empathetic gaze, and said that he was terribly sorry that I'd had that experience and I should see him after the conference to arrange a background briefing in the near future. Well, I sat down feeling that at last I was getting somewhere, it looked for a second as if the doors of secrecy were opening. As the months went by I concluded that simply the draft excluder had slipped and nothing really had changed at all.

You can imagine where the story went: exchange of emails, exchange of phone calls. Months and months on, I got nowhere, didn't get to meet anyone from the OCNS, and I'm glad that there are some OCNS people here today so

I'm presuming we will talk later. But that kind of thing is not helpful in any way. We are now told by the press that they simply don't do that sort of thing. My question was simply whether they should.

The message then is clear: If you want us to understand your work, you have to trust us. Above all, talk to us. We are your interface with the public. Without us — and this is really important — you have no voice. There is no way to get your message out. If you want to build confidence and trust that security is being taken seriously, that nuclear material is secure and that your facilities are safe, then why are your key actors and officials trying to hide behind anonymity, press officers and Cold War style secrecy? Just talk to us. Transparency and openness usually deliver better results in the end, I would suggest.

All too often, getting information is like pulling teeth. During one ongoing investigation — I stress ongoing — into the activities of a high profile British nuclear organization, I was told that the company concerned wouldn't be putting up anyone for interview on the subject and wouldn't provide any of the key facts on record. There's still a worry, I would say a shameful tendency, to hide behind business confidentiality and commercial secrecy in some sectors. But — and this is bizarre — if I acquired the facts elsewhere, I was told that they would then probably be forced to confirm them and might want to be interviewed after all. What a waste of time, what a complete and total waste of time. I offer them the chance to talk to me, to be involved in a partnership, to be involved in dialogue, and what they say is you pull the teeth and then we'll talk afterwards when there's blood running down our cheeks. It makes no sense at all.

Anyway, let's not be naïve about this. Our interests as journalists are not always the same as yours. Naturally, I'm not in the business of advising you how to kill or bury difficult stories and I'm certainly not going to get involved in anything like media training. But surely you can see that the laws of supply and demand still govern journalism. The value of information simply rises when it's in short supply. If we have to drag the facts out of you, then their value as exclusive information simply rockets. You simply boost our prestige and the story climbs up the bulletin or in newspaper terms finds its way onto the front page. An investigation, we can report that.

At worst it all leaves a very bad taste in the mouth. You are all involved in legal activities. So why behave like you have something to hide? It's often straightforward. Tell us what's happened and tell us what you're doing about it. That's often as far as it goes. Post-9/11, the public wants more reassurance, more reassurance than ever before about the safety and security of nuclear material and facilities, and rightly so. But let's not get paranoid. It's actually very hard to get nuclear stories on the air at all. You see, the perception of editors — and I get this all the time — is that they are boring stories and also, sadly, with great respect, that you're boring too, and that you can't communicate. It's a battle to keep it on the airways. Yes, there have been some moves towards greater openness and transparency in some agencies but not all. There's still a long way to go. In the past, the record has been very poor.

To conclude, let's have a dose of truth and reconciliation so that society can make the right choices with the right information. I can't promise it will always be easy. It's our job to ask you or people like you the difficult questions and to probe in some uncomfortable areas. To ask the simple question, is it safe and what are the consequences? But without us you will never be heard. That's it for me.

I would like to offer one lighter point. My colleague here talked about the bad quotation, the bad sound bite. I'd offer a funny one. Don't be afraid to lighten up — not in a crisis, not when the nuclear source has gone missing, not when there's a tragedy — but when you're dealing with people, try and use us; there's nothing wrong with using people. I interviewed recently a defence academic who fought his way into one of my pieces because he'd just written an article entitled, "Does my bomb look big in this?" There's no way I was going to ignore one like that. Thank you.

P. RICKWOOD (IAEA): Thank you very much for that. It was very interesting. One reason for having this session, as I said earlier, is to try to encourage you to think about communicating better. Well, how you do it is another issue, and this is why Patrick Worms is with us, because his job is to help people improve the way they deliver information. And we're going to ask you to participate in an exercise that Patrick will introduce to you. We will all assist you. We're not out to embarrass anyone. I'm quite sure my journalistic friends Lou and Rob are not trying to score some points off you. So what we're going to do after Patrick has made his short presentation is that we're going to divide the room up and we're going to give you a very simple exercise. It's an exercise that may well raise your eyebrows but the intent of it is to try and get you to focus quickly and to respond in a real life situation, because you don't have the luxury of taking your time under those circumstances.

P. WORMS (Ogilvy Public Relations Worldwide): I am absolutely mystified by the fact that the most natural couple in the world — you, who have a story to tell, and journalists, who are dying to get information — do not get along better. But it is because you do not get along better that people like me can make a living, because I work for a company called Ogilvy Public Relations and at first I thought I'd put a picture of my kids up there, but I think it's probably more appropriate to have our building in Brussels. You can tell it's a nice building with a big window. So obviously we have a big market because —

let me reassure you — your industry is not the only one which has this problem. Yet it still mystifies me. Journalists are your window to the world. They explain what you do to the world. They are dying to translate what you do in terms that the world can understand. You want journalists to understand what you do better. They want you to understand what they do better. If you become friends, if you talk to them regularly, you will become better communicators. They will become, dare I say it, better at understanding what you do as nuclear physicists. So the day that an investigation reaches a conclusion or the day when a crisis happens, you already know each other. You're talking with a certain degree of trust. You don't suddenly have to sit in the glare of publicity not knowing what to do. That's why my presentation is going to be about dealing with journalists. Figuring out how you can use the relationship that journalists have with the public to your advantage. You need to do that because he may enjoy his radioactive terrorism game but, as we very well know, everyone else, of course, is scared of the material with which you work. So let's deal with it. Let's figure out how to communicate under pressure.

Why do I say communicating under pressure when I've just given you this big spiel about becoming friends with the journalists? Because I know human nature. I know you may walk out of this room full of good intentions to ring the nearest journalists when you get home to go out for a beer with them. But the pressures of everyday life mean this will get to the bottom of your to-do pile and it probably won't happen, which is why one day when something bad or worrying or unusual happens in your business, you're suddenly going to be faced with communicating under pressure.

This is a huge challenge, because you're dealing with facts that no one understands. I am a trained physicist. I did genetics before turning to communications. So I am better equipped than most of the public to understand what you do, yet I do not understand either. Ninety-nine per cent of the world does not understand what you do. So there are these complicated facts sloshing around. They are connected to popular culture. Everybody's afraid of the bomb. There are news stories regularly about what Kim Il Sung might be up to in North Korea. There is a complicated science and there is a gut feeling, an emotional reaction, of, "Oh my god, this stuff is so dangerous that it's going to kill me and my children." You have a complex issue to deal with. You have many players that you have to worry about. Not just within the industry but within the wider world. Each of those players has an agenda and will understand that facts are not enough, that facts and emotions are the items that will turn the argument around.

So, let's just go through this communicating under pressure bit. Let's assume that you have some really bad news to deal with. What is your role with regard to this bad news? It could be really bad news or it could merely be worrying news, but still it's something you'd rather not have. Well, when that happens, your first job is not to be intimidated. I know it's hard. I know when your phone rings, it's much easier to say, "I'm sorry, I can't deal with you right now", put the phone down and hope the problem goes away. And it may, even in career terms, be a matter of choice. I don't think anyone ever got fired for not talking to a journalist, but people do get fired for telling the wrong things to journalists. But it will only make a problem worse. You cannot wish a problem away. You have to be present and available. So don't be intimidated and, of course, do correct inaccuracies. Do so immediately. Be totally open with the information you have. If you do not have information, say so. If the information is available from some other authoritative body, refer to journalists of that authoritative body, but if you do have the information, do communicate it. Clear up confusion. These days, whenever the word 'radioactive' is used in public, in people's minds it means Al Qaeda. So when you are talking to people about a little bit of technetium that went missing from a hospital, that's too complicated. All they know is that radioactive stuff went missing from a hospital and, my god, what if an evil terrorist gets his hands on that. So there's a lot of confusion. You have to clear up that confusion. You have to reassure people. You have to explain the enormous difference between material that most of you work with most of the time and the material that is truly dangerous in the wrong hands.

You have to tell your industry's story. I have known the industry now through my relationship with the IAEA for only a short time — about a year or so — and I'm amazed and fascinated at the extraordinary depth of commitment that I find within the industry. I believe, now that I have got to know you, that you probably are one of the very safest industries around. The fact that you are all gathered here for these two days to worry about setting up a database and inventory for nuclear material is proof of your commitment. Tell that story. It's a story that will stand you in good stead. Tell it every day. Tell it when you're having a beer with a journalist. It raises your prestige, it makes you trustworthy and it means your relationship with the media is going to be better.

Still, sometimes bad things happen and you have to prepare for an interview with media or for a meeting with stakeholders. And how do you prepare for such a meeting? Well the most important thing to remember is what message you want us to acquire. Only then do you worry about the other things. Who else is going to be there? Can you get some supporters to be there for what you have to say? Have you figured out a way of closing the gap between emotion and science? All those things matter but do not matter as much as your message.

Here are some examples of key messages. And I'm not going to go through them, but these are the kinds of key messages that you may want to put down on a piece of paper before you start seeing somebody. When you start talking, remind people why you are qualified to comment. If you say, "I am Dr. Professor Patrick Worms and I've got 72 degrees in X and I work for Y," people are not interested in that. Tell us a story of your life. Tell us a story about your children. Tell a story about why what you do is important to you and why it's important to the people around you. Become a real human being to the people to whom you're going to talk. And then explain the story. Get your message across. We all prefer listening to stories. When we are trying to relax, when we read a newspaper for relaxation, we much prefer one that tells us a story to one that gives us long, dense miles of facts. Make sure that the story carries messages. Make sure that it's supported by facts, by third party endorsements wherever you can. Think, then speak, if you are asked a difficult question. Think, "I'm going to read that."

Now if you remember one thing from this presentation, I want you to remember what I'm going to tell you now. There's a wonderful trick called bridging, and bridging is a way to deal with a difficult question by going back to your zone of comfort, to the key messages that are your islands of safety. Yes, there's a lot of confusion out there, yes, there's controversy, yes, science is difficult, but if you bother to sit down and write clear messages before you talk, then you have a place where you can go back to. You can bridge back to it. You have islands of safety, areas of conversation where you have a message, where you are in control, where you are happy. Things you want to talk about because you're prepared for them. For example, you are committed to safety. You work with governments to ensure that everything's as safe as possible. What you do brings great benefits to communities around the world. As an energy source, your industry makes no contribution to global warming. These are islands of safety that you can come back to, because they are true, because they address the issue that your industry is facing. So how do you do that? You have a question. You have to answer the question. You cannot *not* answer the question. If the journalist asked you a question, you need to answer. But you have the right to add more information to your answer. You can give the answer, then bridge to the message you want the journalist to pick up.

You may think that I am advising you treat the journalist like a child, like a moron, because you are repeating the same message again and again and again. That's not what you are doing at all. What you're doing is sending a message to the journalist that this one thing that you're talking about is very important to you, and the journalist is happy to give you something in exchange for what you've given him, so he is going to give you the chance to put it back in your piece. He knows it's important to you. And because the interview is going to be wide ranging, because you are going to be talking about all sorts of things, repetition is important to anchor that. So how do you bridge? You answer the question. You remember what message you want to spread and you use a bridging phrase.

Here is an example. This is something to do with Dell computers. The question was, “How concerned are you about that?” The answer to the journalist, “We are not very concerned about it.” And this guy, who happened to be the CEO, could have said just that, “We’re not very concerned”, but he didn’t. He went back to his message. His bridge phrase was, “We’re concerned about two main things that our shareholders and our customers care about.” So he knew what his messages were. They were messages about his customers and about his shareholders, and he got them out. He got them out at any opportunity. He even got them out when the journalist clearly had no idea what the answer was and the CEO clearly had no idea what the question was.

Listen to this: “And I’m interested in terms of the pattern of spending, are they buying the bells and whistles equipment, are they bundling in as much as they can get with the deal or are they holding back by buying the basic box and going it alone?” Well, if you’re faced with a question like that, the only answer you can give is, “Oh my god, what on earth is that all about?” Then you think of the prepared bridging phrase. You just give an answer. Maybe a bad answer, but it’s an answer.

You can use exactly the same techniques in your industry. In your case you have to worry about the audience you have to impress when you’re dealing with something. You have to put yourself in the shoes of the audience and you have to get out the message that is tailored for them. So your responses should always be empathetic. If there is a crisis, don’t hide behind procedures of bureaucracy. Display sympathy for victims. Be factual, don’t speculate. Be confident — you’re the expert — but don’t be cocky. Be concise. A journalist is usually looking for a quote to the story. He’s got a short deadline. He’s maybe only learned about the story a couple of hours previously and he probably has another half a dozen stories — none of them connected with nuclear energy — on his boiler at the moment. Don’t make his life difficult, make it clear.

Stay safety-focused, of course, because that’s what you do. Be consistent and be strategic. What I mean by that is, get at least one message into every one of your responses. Time is your friend. Listen to questions. Science is perfectly acceptable. You can just sit there and think if that’s what you need to do. Don’t do what I’m doing now. Don’t rush. Speak slowly, speak deliberately. Don’t over-answer. One answer is enough. Ten answers are too many. Don’t speculate, don’t argue, don’t be emotional, don’t repeat negative language, don’t use jargon. The last is particularly difficult for an industry which is such a scientific one as yours, but believe me it’s not limited to your industry — everyone has a problem with that. And don’t ever assume that you’re off the record, because if what you say is juicy enough, depending on the culture and on the media with which you are dealing, you may find that your off the record does not stay off the record.

So now we're going to practice what I've just told you. We are going to give you, as Peter explained, a little exercise. We are going to give you a scary scenario and your job is to work in little groups to prepare a one paragraph press release. You have ten minutes to prepare it. And you then present your press releases back in groups to one of the five of us. We will comment, we will listen, we will pick up pointers and we will then come back in this plenary in order to share what we've learned.

MANAGEMENT OF RADIOLOGICAL EMERGENCIES INVOLVING RADIOACTIVE SOURCES

(Technical Session 6)

Chairperson

W. WEISS
Germany

RADIOLOGICAL EMERGENCIES
Lessons identified and response requirements

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Abstract

Radiological accidents occur more frequently than nuclear accidents and can lead to more serious health effects. As a result of the disaster of 11 September 2001 and of the increased awareness of possible terrorist acts involving radioactive material, more efforts have been invested in the preparation of radiological emergency plans and in training. Lessons identified from past events and from work recently carried out in support of international guidance in this area provide a good basis to ensure that the plans, procedures and training for a radiological emergency are effective. The paper looks at some of the more important lessons and discusses some of the preparedness and response concepts contained in the latest international guidance on this subject.

1. INTRODUCTION

Radiological accidents, as opposed to nuclear accidents, involve radioactive material outside the nuclear fuel cycle. Their probability of occurrence is higher than that of nuclear accidents and, although the geographical extent of their potential impacts is less, the severity of the potential health consequences for specific individuals can be much greater. Yet until recently, much less effort has been invested in the development of coordinated radiological emergency response plans. In the aftermath of the attacks on the World Trade Center and the Pentagon in the United States of America on 11 September 2001, it is now recognized that the threat of radiological events of a malevolent nature is real. This has fostered a heightened awareness of the need for radiological response plans throughout most countries.

The aim of this paper is to present key lessons identified in radiological emergencies and to introduce the resulting requirements for preparedness and response.

2. NATURE OF RADIOLOGICAL EMERGENCIES

Radioactive material is used by practically every country in industrial, research and medical applications. Therefore radiological accidents can happen anywhere. They include situations where the hazard is well defined and localized as well as events where the discovery may be delayed, the extent unknown and the impact on a much wider scale. IAEA-TECDOC-1162 [1], which provides generic procedures for responding to radiological emergencies, classifies potential radiological emergencies in seven categories: found source or contamination; missing source; unshielded source; laboratory accident; transport accident; dispersion of alpha emitters; and X ray machines and accelerators. Their consequences can be severe. Acute radiation health effects have a high probability of occurrence. The number of people affected depends very much on the ability of the authorities and emergency response organizations to recognize the hazard. The recent event involving multiple found sources in Georgia led to 11 injuries [2]. The Goiânia incident [3] led to four deaths, 20 injuries and 112 800 people being monitored. In Morocco, following the 1984 lost source incident, eight people died.

Malevolent acts are illicit actions with the intention to cause harm to persons, damage to property or an adverse impact on the environment by exposure to ionizing radiation. Malevolent acts include deliberate actions to irradiate persons, contaminate food or water supplies, and/or spread contamination (including through the use of an explosive radiological dispersal device). The potential impacts of malevolent acts are similar to those of random radiological accidents but can be amplified by the intentional nature of the event.

3. LESSONS IDENTIFIED

Dealing with radiological events can be both easier and more challenging than managing nuclear emergencies: easier because, provided that the event is discovered early, the number of people affected is smaller and the impact is more localized; more complex because radiological events can occur anywhere, the impacts can be severe, and the organizations that initially respond do not necessarily have detailed plans and training to manage such situations. Many of the lessons identified in the past are obvious to emergency management practitioners. The following discussion attempts to address some of the more interesting lessons, which are not always obvious at first, and which specifically focus on radiological emergencies.

3.1. Detection and notification

In many previous situations involving lost radioactive sources (often without anyone knowing that they were lost), physicians were the first officials who could have recognized the event. The prompt detection could have helped minimize the number of casualties. However, in many cases, the medical personnel involved were unable to provide an early diagnosis of a radiation injury because they were not familiar with the symptoms of radiation exposure.

When responding to the scene of an accident of a potentially malevolent nature, first responders must assume that hazardous agents (radiological, chemical or biological) are involved. This can have two opposite effects. If the presence of hazardous material is unknown, response efforts can worsen the impacts by spreading contamination. If it is known, responders may delay their response.

Initial calls from people reporting potential radiological emergencies are often received by different organizations or response centres (i.e. response initiators). In many cases, the response initiators do not know whom to contact to initiate the full radiological response. They often call the organization with which they are most familiar for radiation matters, which may not be the one identified in the plans to initiate and coordinate the radiological emergency response. Such situations have caused confusion and delays.

3.2. Technical assistance

In most types of radiological emergency, first responders are conventional emergency services. In most cases, their radiological assessment capabilities are limited. Often national plans do exist for the prompt dispatch of qualified technical teams to support the first responders. However, in practice, this support is slow compared with the timescale on which first responders must act.

3.3. Emergency management and coordination

Radiological emergencies often involve organizations and jurisdictions that are not used to working together, with respective roles that are not clear. This often results in confusion on how the organizations should interface and who should lead the response. For example, in several countries, first responders (in particular firefighting services) have a traditional role as on-scene controllers, or incident commanders, while specialized radiological organizations, e.g. teams from the national regulatory agency, consider themselves responsible for managing radiological events, including actions at the scene. This conflict between technical know-how and operational expertise leads to confusion and potential delays in the response.

Some countries have adopted a standard emergency management system, such as the Incident Command System or the National Incident Management System, to improve the ability of different organizations to work together in a multidisciplinary emergency. While this has definite merits, in some cases the rigidity of the system adversely affects the quality of the response. In some situations, Incident Commanders, who are often senior firefighters, have been reluctant to share their role with or to take advice from more technically qualified senior specialists.

The roles and responsibilities of organizations involved at the national, provincial, state and/or municipal levels are often ill defined in the case of radiological emergencies. In some cases, they do not reflect the reality of the generic national emergency management system. Many countries treat nuclear and radiological events as a special threat, requiring a special organizational structure which is different from the one usually adopted for other types of emergency. This leads to confusion, gaps in the information sharing system, decision making conflicts and a general reduction of the emergency response effectiveness. The national system may also be too rigid to adapt itself to the wide spectrum of possible radiological events. For example, some events present impacts that are predominantly medical and that are best managed by the organizations in charge of the medical infrastructure. Other events, such as malevolent acts, require the leading involvement of law enforcement or national security organizations.

3.4. Decision making and protective actions

In a radiological emergency, international guidance consisting of generic intervention levels (GILs) cannot be applied since GILs are not directly measurable quantities. Consequently, operational intervention levels (OILs), which are measurable quantities, have been developed to assess environmental measurements to immediately determine where protective actions are warranted. This is particularly important for first responders, who generally do not have the tools and equipment to properly characterize and evaluate the nature of the hazard. However, OILs can vary enormously according to the assumptions and methods used for their calculation, and depending on the nature of the radioactive material involved.

Excessively cautious assumptions are often used because decision makers are not prepared to deal with uncertainties. The repeated use during the Goiânia response of excessively cautious assumptions in developing the OILs resulted in unjustified actions that were inconsistently applied, criteria that were difficult to explain, and an unrealistically inflated risk in the eyes of the decision makers and the public, thus exacerbating the economic and social impacts.

Once more specialized personnel become involved, computer projections are often used to guide decision makers. The availability of computer codes and their ease of use by untrained or minimally trained individuals have enhanced the use of such projections as a core element of the decision making process. Tests and experience (see, for example, Ref. [4]) have clearly demonstrated that computer dose projections are of limited value because they are not sufficiently timely or accurate. Furthermore, their use by untrained personnel without a proper understanding of the assumptions and conservatism in the models can lead to misleading results that are, unfortunately, trusted by decision makers, often at the expense of concrete evidence such as field measurements. Studies show that different experts and codes can produce projected doses for the same accident conditions that vary by six orders of magnitude. Experience at hundreds of emergency exercises has shown that analysts often waste time attempting to understand these differences.

Decision makers are often reluctant to order an evacuation, because it is believed that it could cause panic and numerous traffic fatalities. However, nearly fifty years of research on major evacuations (including those in response to serious radiological emergencies) [5, 6] shows that evacuations are common and orderly, and that the risk of traffic fatalities in evacuations is no greater than it is during normal traffic.

It is also often thought that, in the name of 'safer is better', it is better to impose protective actions on a larger scale as part of a conservative approach. However, during the Tokaimura incident, sheltering was implemented, by default, over a 10 km area, even though a careful analysis of the situation and the existence of a pre-established protective action strategy would have precluded such a large scale sheltering. Not only did this measure provide little effective protection, but it led to the perception that the radiological impacts of the accident did indeed extend to 10 km, which resulted in economic impacts over that entire area.

3.5. Protection of emergency workers

The use of standard hazmat (hazardous materials) equipment and universal precautions usually provides adequate basic protection for emergency responders who are not used to dealing with radiological hazards. National programmes for the distribution of dosimeters to first responders and promotion of the understanding of time, distance and shielding, and of the need for keeping one's hands, food and cigarettes away from the mouth, enhance the ability of first responders to protect themselves. These concepts have now been incorporated as part of the standard training in many countries (with mixed success — see Section 3.10). However, one aspect that is often left out is the need for providing counselling and medical follow-up for emergency workers, especially if they have potentially been exposed to internal contamination. The response to the Goiânia accident lasted several months and the emergency workers were involved in many very stressful activities. For years after the event, the responders still felt the psychological effects.

Electronic dosimeters are also widely used for emergency responders. Such dosimeters can warn personnel when the dose or dose rate limits are reached. However, experience with training and exercises has demonstrated that emergency responders with only basic training do not adequately understand the use and limitations of electronic dosimeters. For example, limits are sometimes set on the basis of effective dose without properly taking into account that the dose measured is only the external component and that respiratory protection may not have been worn. In other cases, personnel do not understand that the dosimeter is of limited use in the case of exposure to alpha or beta radiation.

3.6. Medical response

Despite the fact that basic guidance exists on the reception, screening and emergency treatment of casualties involved in a radiological event, many hospitals still do not have plans for this. Similarly, despite the fact that the first aid treatment of casualties at the scene and transport of contaminated casualties by ambulance are not different from those in the case of victims of a conventional accident involving hazardous chemicals, many ambulance services still refuse to deal with such casualties until they have been decontaminated.

3.7. Mass casualties and screening

In a situation involving a large number of potentially contaminated people, or in cases where a large number of people may need to be screened for potentially significant external exposure, the medical infrastructure becomes quickly overwhelmed. Unless alternative facilities and supplies are promptly established, the effectiveness of the medical system in the affected area may become greatly reduced.

Following the Goiânia accident, authorities established a three tiered system of medical treatment facilities: decontamination, patients with slight impairment to their haematopoietic system, and patients with severe impairment of their haematopoietic system or with local radiation injuries requiring isolation and replacement therapy. However, this strategy entailed separating families, experienced staff were sometimes in very limited supply, facilities had problems controlling contamination and contaminated waste, and some medical staff were fearful of radiation exposure and contamination.

3.8. Media

The media become aware of radiological emergencies as soon as local authorities are notified and rapidly converge on the site of the event. Because such emergencies often involve an open or public site, journalists are often the first ones to communicate the information to the public and, as a side effect, to the strategic emergency managers, who are often far remote from the scene. In some instances, this has caused authorities to respond to events on the basis of media information rather than of information provided through the emergency response network. During the response to a lost source in Turkey [7], there was severe pressure, mainly from the media, to mitigate the hazard by pouring concrete over the source location. Yielding to this pressure would have caused further problems since it would have precluded locating other sources. As a matter of fact, recovery personnel discovered that the missing sources were not at that location.

All serious nuclear and radiological accidents have resulted in significant adverse psychological effects. People's fear of radiation, together with conflicting and confusing information about the event, creates mistrust of authorities and official experts. Some of those in the vicinity of the event can be subject to stigmatization and social segregation. Often the reasons for monitoring and protective action recommendations are not explained adequately. Consequently, some people often take inappropriate and, occasionally, harmful actions. This is more prevalent in the case of a radiological emergency, which can happen where people least expect it, where a public education system has not been implemented, and where knowledge about radiation and radiological emergency response is low or non-existent.

3.9. Assurance monitoring

Assurance monitoring involves verifying that potentially affected areas are not hazardous. The directly affected area is of course the first one to be monitored. However, assurance monitoring normally extends far beyond the immediately impacted area. The belief has been that assurance monitoring on a large scale provides benefit in terms of public perception and confidence. However, this is not always the case. After the Goiânia accident, long term monitoring of insignificantly contaminated areas carried out to alleviate public concern or for scientific purposes raised doubts about earlier declarations that these areas were clean and safe.

3.10. Training

Most countries have placed an increased emphasis on providing basic training to all emergency response personnel. This training is often provided as a one-time deal, subject to often non-renewable financial resources. It has sometimes, but not always, been incorporated as part of the standard hazmat training that response services periodically receive. However, there is some evidence that this training is not effective. Quite often it is provided too infrequently to be remembered at the time of an emergency. There are also indications that emergency response personnel, even when trained, may not respond immediately to radiological events until radiation specialists are present at the scene.

Senior officials often cause confusion by developing ad hoc plans because they are unaware of the plans and procedures that their organizations have established and because they lack the appropriate training. This happens when there are no national standards for response to radiological emergencies and/or when senior managers are not required to meet the same training standards as other responders.

3.11. Exercises

Field drills and exercises for radiation emergencies often lack the realism associated with the complexity of field measurements that may vary in time and space depending on the release profile and on wind direction changes. Therefore field personnel may get a misleading perception of the sometimes dynamic nature of such events, and as a result often learn to apply procedures in a mechanical fashion and fail to adapt their strategy to take into account changes in the situation. Management exercises (sometimes known as command post exercises) at the operational and strategic levels are often based on a static situation where the radiological status is presented as a fait accompli. Here again, emergency managers can fail to learn to respond to a situation where the information sometimes comes drop by drop and where decisions must often be made on the basis of very limited information. Most exercises have also demonstrated that individual teams perform very well in isolation, but that the system often fails, or its effectiveness is greatly diminished, when they must coordinate their actions. Yet there are few inter-agency exercises.

4. RESPONSE REQUIREMENTS

This section presents some of the basic concepts contained in the most recent international guidance published (or in draft) by the IAEA [8–10]. It also introduces concepts being considered in some countries to improve the response to radiological emergencies.

4.1. Detection

First responders should be trained to recognize the possible presence of hazardous material, including radioactive sources, and take basic precautions whenever the presence of hazardous substances is suspected. Depending on the risk of radiological events in a particular area, they could also be equipped with electronic dosimeters or instruments with a dose rate alarm set sufficiently low to indicate the presence of radioactive material. This will not cover situations involving low energy beta emitters or alpha contamination. Furthermore, all health personnel should be informed about the basic characteristics of radiation injuries and of how to obtain further confirmatory assistance. This information should be readily available at all health and medical facilities. It is particularly important that this information be emphasized and repeated in a period of heightened threat of malevolent use of radioactive material.

4.2. Notification

There should be a single contact number within each jurisdiction having a key responsibility in managing a radiological event. This contact number should be responsive 24/7. The notification chain should be clear to all potential response initiators. Which agency or organization is responsible for initiating the radiological response and leading the initial response coordination should be clear to all response organizations. Depending on the situation, and in particular on the focus of the response requirements (e.g. medical, security or conventional), the lead agency may vary. However, it is useful and less confusing if the initial agency in charge is unique.

4.3. Technical assistance

Where possible, mutual agreements should be established with local teams and organizations that can provide radiological assistance. As a minimum, a 24/7 contact number for obtaining on-line advice and getting technical assistance should be provided and known to all first response organizations. In some countries, a system of decentralized coordination of technical support has been or is being established. In the Netherlands, for example, specialists in chemical accidents from various national institutes throughout the country are alerted and coordinated through a Web based virtual emergency coordination system. Activation time has been reduced to a few minutes and the provision of technical advice based on an integrated risk assessment is available to the local responders within 45 minutes.

4.4. Emergency management and coordination

The most recent IAEA guidance is based on the adoption of a system consistent with the Incident Command System. However, the key objective of any system at the national level is to ensure that interfaces and coordinating arrangements are well defined, regardless of the concept adopted. There are many types of radiological emergency, and the roles played by various organizations, institutes and ministries may vary greatly depending on the situation. Emergency plans should be reviewed to ensure that the division of responsibilities, and in particular the lead management and support coordination roles, are clearly defined for the different types of radiological event.

4.5. Decision making and protective actions

The IAEA has published generic OILs [1] for radiological emergencies that involve unknown radioactive material (e.g. 100 μSv/h for unknown gamma emitters). There are OILs for several cases, including public monitoring, public screening and others. These OILs will assist first responders in making the initial protective action decisions. It is also important to recognize the fact that OILs and GILs are already based on very conservative assumptions, and that adding conservatism based on the perception of the radiological hazard can in most cases only lead to less than optimal response and overall protection. This does not preclude the need to take operational factors into account as part of the decision making process.

4.6. Protection of emergency workers

Guidance and training for potential emergency workers should emphasize the need for and the adequacy of an all-hazard approach to personal protection. It should also reiterate the fact that lifesaving actions take priority over decontamination. The provision of electronic dosimeters to first responders, or of one dosimeter per team, is a potentially costly proposition, and this decision should be based on the probability of radiological events in a particular region. Emergency plans should also make provisions for counselling of emergency workers who have been involved in an event where radioactivity was, or was perceived to be, present. This should be done in concert with radiation health physicists who understand and can communicate the real risk associated with radioactivity, and it must be based on an accurate knowledge of the radiological hazard at the time of the response.

4.7. Medical response

Programmes should be in place to encourage medical facilities to incorporate into their plans guidance on the reception and emergency treatment of potentially contaminated casualties. However, in spite of this guidance, the likelihood is that many institutions will be reluctant to treat such casualties without the advice and support of radiological specialists. Therefore arrangements should be made for the prompt mobilization and dispatch of qualified radiological personnel to medical facilities. Where medical first response and ambulance teams are still reluctant to handle potentially contaminated casualties, national and provincial/state authorities should increase their efforts to establish requirements for these teams to provide adequate support at the scene of a radiological accident. It is important to convey the fact that handling radioactively contaminated persons is similar to handling victims of a hazardous chemical incident, that lifesaving takes priority over decontamination and that there should be no health hazards to medical staff provided that they take basic precautions to protect themselves against the inadvertent ingestion or inhalation of radioactive material. Such efforts will need to be supported by an appropriate training and communications programme.

4.8. Mass casualties and screening

Regional, provincial/state and national arrangements should be established to provide alternative facilities for handling a large number of potentially contaminated or overexposed persons and casualties. The purpose is to alleviate the potential burden on critical medical services in cases involving mass casualties or a large number of potentially affected people. These arrangements should be coordinated with existing mass casualty plans. Possible options may include the need for individual medical facilities to set up separate triage and first aid centres, or the use of reception centres already established to deal with accidents at nuclear facilities.

4.9. Assurance monitoring

Assurance monitoring plans and procedures should be in place and should be coordinated between all agencies involved. Where possible, local teams can be trained and used as part of the assurance monitoring units. Such plans should incorporate considerations for communicating the purpose of the monitoring, including the actual risk in the areas being monitored. Interfacing effectively with local populations will be a key factor in ensuring that their perception is not biased by the assurance monitoring activities. Furthermore, care must be exercised to ensure that the monitoring procedures do not in themselves create a disproportionate perception of the risk. For example, sending assurance monitoring teams with full personal protection into an area where the risk of contamination is considered low would send the wrong message.

4.10. Training and exercises

Training of emergency workers for radiological emergencies, especially training of first responders, should be part of a frequent all-hazard refresher programme that is not limited to radiological matters. National training programmes should focus on train-the-trainer courses provided to key personnel in each region, who can independently provide the training at a later date. Distance or computer based training programmes can provide a sustainable and cost effective solution to the low retention period of conventional training sessions. Several tools are now available to enhance the value of training by providing real time, realistic simulated field measurements on handheld instruments or with replicas of the actual survey instruments. More realistic management drills and exercises, or command post exercises, should be conducted to provide a more accurate perception of the time factor in responding to radiological emergencies. Finally, more inter-agency drills and exercises, including management tabletops, should be conducted to test the ability of the various teams and agencies to cooperate during a radiological emergency.

5. CONCLUSION

Radiological emergencies have a higher probability of occurrence than nuclear emergencies, can lead to more severe health impacts and, in some cases, can involve a very large number of people. Emergency plans of the past have focused on nuclear emergencies. Recently, as a result of the disaster of

11 September 2001, significant efforts have been invested in achieving a rapid improvement of radiological response capabilities on the national level. These efforts have involved significant startup budgets and a large number of emergency services. However, these improvements will not be sustainable unless continued investment as part of a coordinated national programme, including the development of standards, effective coordination mechanisms and practical training programmes, is maintained. The lessons identified provide a good basis for the sustainable enhancement of emergency plans. The major challenge faced by most countries is now to ensure that those lessons that are identified become lessons learned.

REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Assessment and Response during a Radiological Emergency, IAEA-TECDOC-1162, IAEA, Vienna (2000).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Lilo, IAEA, Vienna (2000).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Goiânia, IAEA, Vienna (1988).

[4] UNITED NATIONS, Peaceful Uses of Atomic Energy (Proc. 2nd Int. Conf. Geneva, 1958), Vol. 18, Waste Treatment and Environmental Aspects of Atomic Energy, UN, New York (1958).

[5] DRABEK, T.E., Human System Responses to Disaster, Springer-Verlag, New York (1986).

[6] LINDELL, M.K., PERRY, R.C., Behavioral Foundations of Community Emergency Planning, Hemisphere, Washington, DC (1992).

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Istanbul, IAEA, Vienna (2000).

[8] INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, IAEA, Vienna (2003).

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, Draft Manual for First Responders and Local Response to Radiological Emergencies, IAEA, Vienna, 2005.

[10] INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Medical Response During a Nuclear or Radiological Emergency, IAEA, Vienna (2005).

DISCUSSION

W. STERN (United States of America): Are actual first responders involved in drafting IAEA-TECDOCs on emergency response? Is there an international community of first responders helping to develop this guidance?

J.F. LAFORTUNE (Canada): Yes. Working groups on the development of IAEA technical guidance have included a wide spectrum of specialists and some first responders. It would be a good idea to continue drawing on first responders' expertise and even to increase their participation in developing practical guidelines.

R. JAMMAL (Canada): Can you tell us about public education in emergency response?

J.F. LAFORTUNE (Canada): For a known risk at nuclear facilities, the public can easily be identified, which makes it easy to target. Nuclear power plant public education programmes are well developed and generally fairly effective. However, for radiological emergencies, public education is a challenge because the hazard, the location and therefore the target audience are not well defined. Public education programmes should focus on all-hazard concepts. At the moment I am not aware of any public education that has been very effective in mobilizing the public to help in an emergency response.

W. WEISS, Chairperson (Germany): I am sorry to say that this is true for all the countries that I know. It is very important to progress in this to improve emergency preparedness. If we cannot communicate with the public, we have lost part of the game.

PREPARING FOR THE RESPONSE TO A RADIOLOGICAL EVENT

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In recent years the first responder community has been thrust to the frontlines of every nation's homeland security force. This community has been tasked with the responsibility of developing effective strategies for lifesaving, recognition, identification, mitigation and decontamination operations which result from not only accidental but also intentional events involving hazardous materials. The threat posed by terrorism involving radioactive materials, ranked high on the list of intentional events involving hazardous materials by the first responder community, has been addressed by the rapid enhancement of the community's preparedness and capabilities. However, to keep this rapid enhancement moving forward, additional guidance (technical), training and public information programmes will be needed in the future.

The international scientific community has a major role and obligation in the issuance of technical guidance to the first responder community to enable them to advance their preparedness and capabilities. Emergency dose limitations and information on acute and chronic health effects of ionizing radiation are examples of the guidance that should be continually re-evaluated by the scientific community. This re-evaluation will provide the best information available for the first responder community to use in their development of effective strategies for tactical operations (response plans).

Training of the first responder community in the proper use of radiological equipment and the concepts of radiological protection is an additional issue that should be embraced by the international scientific and political communities. First responders in recent years have been given equipment originally designed for the radiological scientific community. The equipment has been modified for the first responder and the instructions on its proper use in radiological detection and force protection can be confusing to the first responder. Training programmes on the proper use of radiological detection equipment are extremely important, along with a tiered progression of training courses in the concepts of radiological protection. These programmes and courses need to be funded with the assistance of the political community. The political community needs to continue the development of funding programmes that are designed for short as well as long term objectives. Finally, training should be an ongoing process so that first responders will be able to remain competent. If you fail to train, you train to fail.

For the first responder community to be able to protect the public they serve, there needs to be an effort to enable the public to help themselves. The first responder community cannot do it alone. An informed public will be the first responder's greatest asset when dealing with a radiological event. Panic comes from the unknown. If the public is informed about what to expect and the reasons behind the first responder's tactical operations, the potential for panic is substantially decreased. The international scientific and political communities should be the leaders in the effort to inform the public about radiation and what to expect in the event of a radiological event. This will help reduce public anxiety due to the lack of reliable, credible, accessible information and to the misunderstandings that may arise.

How in the future these three communities (first responder, scientific and political) interact with each other and the public will determine the safety and security of them all. By assisting the first responder community in the areas of technical guidance, training and public information, the scientific and political communities will determine the success or failure of this three-community team in protecting the public it serves.

DISCUSSION

W. WEISS, Chairperson (Germany): Your message was clear: We — as scientists/regulators — cannot leave you alone because you are at the front doing the 'dirty work', but if you do not do a good job, nobody will. The success of remedial action is decided during the early hours; after that, the damage is done. You have to cope with the brunt of the emergency, so we — as much as we can — must give you all the information and the assets you need.

W. STERN (USA): The IAEA needs to do more to reach out to the first responder community. For example, links could be established to the International Fire Protection Association that Mr. Schlueck mentioned.

W. WEISS, Chairperson (Germany): I agree with you. When we — as international organizations — make recommendations of a general nature, we have to ensure that they are not only understood at the front but also transferred to it.

C.M. MALONEY (Australia): You are trained to respond to chemical, biological, radiological and nuclear (CBRN) incidents. Have you learned lessons from your preparation for chemical and biological incidents that would apply to preparedness for radiological and nuclear incidents?

R.K. SCHLUECK (USA): Yes, training for radiological incidents is part of our CBRN training, and we monitor for everything, not just radiation. There can be multiple threats. An example would be different types of decontamination procedures that need to be used for different types of event.

G. MALKOSKE (International Source Suppliers and Producers Association): Do you have a network of 'informed civilians' and, if so, whom does it include?

R.K. SCHLUECK (USA): In New York City, the agency in charge of developing such a network is the NYC Department of Health and Mental Hygiene. It provides citizens with information on health and safety through pamphlets and web sites. I would like to see a more aggressive programme, for example using prime time on TV and radio to make it more accessible to the public.

A.F. SHALABI (Canada): In your training programme for first responders, how do you handle management of stress associated with a radiological event?

R.K. SCHLUECK (USA): First responders constantly have to face danger, and stress goes with the job. I try to put the risk of radiation exposure into perspective for them. Rescuing someone from a burning skyscraper is likely to be a lot more dangerous and stressful than taking a 1 mSv dose. The NYC Fire Department provides first responders with psychological assistance for stress — including that associated with radiological events — through its Bureau of Health Services.

TECHNICAL SESSION 6: CHAIRPERSON'S SUMMARY

W. WEISS
Germany

To conclude, the message is that, should prevention of a radiological incident fail, there are people out there who try to manage and mitigate the consequences. This community can be made more effective and efficient through cooperation with regulators and manufacturers. The more people involved in making specific tasks operational, the better the tasks will be done.

Sustainability of investment is important. Whenever there is a threat, policy makers are willing to invest money in preparedness, but five years later when technical upgrades are necessary, they are no longer interested. However, preparedness must be maintained at a certain level because an emergency could happen tomorrow. Society will not forgive us if we are not prepared.

The IAEA should further develop international standards and guidelines, which should be easily understood by the operational community. This is partly our job and partly that of local and regional authorities.

Finally, interacting with the public early in a radiological event is crucial. For this, guidelines — called for in a recent publication of the International Commission on Radiological Protection — are necessary, as we win or lose within the first hours of an emergency. By providing the public with understandable information, we not only regain their trust but we also help them to help us.

THE WAY FORWARD

(Panel Session 5)

Chairperson

F. MARIOTTE
France

Members

S. McINTOSH (Australia)
J.S. WHEATLEY (IAEA)
A. TSELA (South Africa)
J.R. CROFT (United Kingdom)

PANEL SESSION 5: CHAIRPERSON'S INTRODUCTION

F. MARIOTTE
France

I have the pleasure and the honour to chair this final session on looking towards the future. The objective of this session is to outline several ways forward for the control and monitoring of radioactive sources throughout their life cycle.

Before starting this discussion group, let me introduce myself.

I am Frédéric Mariotte. I have worked for the Military Applications Division of the French Atomic Energy Commission (CEA) for about 20 years.

Currently I am Head of the nuclear intervention project and, among other things, I am in charge of intervention in the event of a known threat of nuclear or radiological terrorism.

In this context, I am also the Deputy Head of the Central Interministerial Task Force for Technical Intervention (DCI), which intervenes in the event of a known threat of nuclear or radiological terrorism. Mr. Bastide, the Commissioner, introduced the DCI to you briefly yesterday.

It is in this capacity that I take a keen interest in the safety and security of radioactive sources, in order to prevent their possible malevolent use, for example to make a dirty bomb.

Having analysed the various presentations and discussions of this week's conference, I believe that the main paths for the future are as follows:

— First of all, we must remember that there are two excellent reference texts, which are very good tools for the control of radioactive sources: the Code of Conduct on the Safety and Security of Radioactive Sources and the Guidance on the Import and Export of Radioactive Sources. These two texts were approved by the IAEA Board of Governors in September 2003. These two texts must be applied. As Mr. González mentioned, we should consider establishing a solid mechanism for applying this Code of Conduct.
— The second point, as underlined by Mr. Taniguchi, is to raise awareness of the safety and security of sources among all those involved, from the producer to the users.
— Thirdly, we should agree in the future to exert strict control over the entire cycle of radioactive sources, in order to ensure the best possible protection against any attempt to use them for malevolent or terrorist purposes, and also to protect the environment. In particular, such control

could make it compulsory for users to return radioactive sources to suppliers at the end of their lifetime.

— Detection of illicit trafficking in radioactive sources is another area to be developed in the future. It should deter acts of malevolence or terrorism. Such detection should be coupled with close international cooperation among specialized national services, namely customs and the police, as well as competent international organizations such as the European Police Office, the International Criminal Police Organization and the World Customs Organization.

— The situation of orphan sources and lost sources is of great concern. We should encourage the authorities of States using these sources and States that supplied them to cooperate, in partnership with the IAEA. The sharing of information among States is absolutely essential to remedy this problem. It would also be of interest to make a concerted effort to search systematically for these lost sources.

SUMMARY OF THE CONFERENCE WITH RESPECT TO THE CODE OF CONDUCT ON THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

S. McINTOSH
Australian Nuclear Science and Technology Organisation,
Menai, New South Wales, Australia

The conference showed wide support for the Code of Conduct on the Safety and Security of Radioactive Sources and its associated Guidance on the Import and Export of Radioactive Sources. There were divergent views as to the need for the Code to be converted into a legally binding instrument (convention) in the short term.

THE IAEA'S ROLE

Technical cooperation projects on upgrading radiation protection infrastructure have played a vital role in strengthening the safety and security of sources, even before the conclusion of the Code of Conduct and its associated Export/Import Guidance. The recent realignment of the projects to fit more closely with the Code was welcomed.

EXCHANGE OF INFORMATION ON IMPLEMENTATION OF THE CODE OF CONDUCT

The informal nature of Tuesday's working group discussions allowed an exchange of views and national experiences in the implementation of the Code of Conduct. Generally it was a very frank discussion of successes, as well as of areas where States had more work to do to align their national legislation and practices with the full range of the Code's provisions. Such an exchange is promising in terms of international cooperation. There was a widespread feeling that such exchanges should be institutionalized or formalized in some way, although any such process should not place undue burdens on countries, or divert scarce resources away from regulatory needs.

GUIDANCE ON THE IMPORT AND EXPORT OF RADIOACTIVE SOURCES

All States – even those which do not produce sources – are both importers and exporters. Strengthened controls over import and export are essential to strengthen safety and security. A smooth and harmonized process for approval of imports and exports is needed. There has been widespread political support for the implementation of the Guidance, but only three countries have so far written to the IAEA Director General. Despite this, national presentations showed that many States are currently taking steps to implement the Guidance in national legislation, particularly in relation to export. The key to smooth and trade-friendly implementation of the Guidance will be in liaison between national regulatory authorities. The conference encouraged all States to provide details of their national contact points for import and export to the IAEA Secretariat as soon as reasonably possible.

EUROPEAN UNION HIGH ACTIVITY SEALED SOURCE (HASS) DIRECTIVE

The process of cross-fertilization between negotiation of the 2000 Code of Conduct and of the HASS Directive ensured that the provisions are broadly similar. The most significant differences are:

— The scope of the Code is somewhat wider than that of the HASS Directive. Nevertheless, the HASS Directive is a minimum standard, and European Union Member States may choose to apply it to all Category 1–3 sources.
— The HASS Directive does not cover security of sources, or their import or export. In the absence of EU rules in these areas, EU Member States can apply the relevant provisions of the Code and the Guidance directly.

SUMMARY OF THE CONFERENCE WITH RESPECT TO NATIONAL, BILATERAL, REGIONAL AND INTERNATIONAL EXPERIENCE AND EFFORTS FOR STRENGTHENING CONTROL OVER RADIOACTIVE SOURCES

J.S. WHEATLEY
Department of Nuclear Safety and Security,
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GENERAL ISSUES

The safety and security of sources is a global concern, but the responsibility (especially for security) is with national governments. The Code of Conduct on the Safety and Security of Radioactive Sources provides an internationally endorsed benchmark for States to work towards, and the IAEA Categorization of Radioactive Sources provides an internationally approved basis for risk informed decision making.

Radioactive sources need to be safely and securely managed throughout their life cycle, and while many countries have had controls in place for some time, more can be done. States are giving priority to the safe management of high activity sources, and there is much work ‘in progress’ to supplement and further strengthen existing regulatory controls.

REGAINING CONTROL OVER ORPHAN AND VULNERABLE SOURCES

A number of countries have implemented successful national source recovery campaigns, and thousands of vulnerable, orphan and disused sources have been recovered. Monitoring at national nodal points, such as scrap dealers and ports, has proved to be useful. In some cases the lack of national disposal or storage facilities means that many disused sources are stored on users’ premises. Manufacturers are trying to help by taking back disused sources for recycling, but a safe and secure long term solution, supported by governments, is needed.

MULTILATERAL INITIATIVES

Many countries have benefited from external support through multilateral, regional or international initiatives, such as: the Tripartite Agreement between the United States of America, the Russian Federation and the IAEA; the Trilateral Agreement between the USA, Mexico and Canada; the European Union programme; the Global Threat Reduction Initiative; the Global Radiological Security Partnership; the Southeast Asia Regional Cooperative Agreement; and the African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology (AFRA project).

LOOKING TO THE FUTURE

A strategic approach is needed to ensure sustainable control over sources 'from cradle to grave'. This should be based on an effective licensing system with on-site inspections (including the physical verification of the location of sources), supported by a national source tracking system and a system of financial guarantees to ensure the safe and secure end-of-life management of sources.

Many countries have benefited from IAEA Model Projects on Upgrading Radiation Protection Infrastructure, and multilateral and regional partnerships can facilitate the provision of targeted assistance.

SUMMARY OF THE CONFERENCE WITH RESPECT TO LESSONS LEARNED AND THE WAY FORWARD

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National Nuclear Regulator,
Centurion, South Africa

The world has to continue with the use of radioactive sources for beneficial, peaceful purposes, and it has to be done in a safe and secure manner. This is a challenge, and we all are entrusted with the responsibility to provide assurance that the control, i.e. safety and security, of sources is ensured. Safety and security must be viewed as two integral facets of the same thing: sustainable, continuous control of radioactive sources.

Four main aspects of source control have been addressed during the conference: scientific and technical aspects, national synergies and cooperation, training and public awareness, and the role of the international community. Improvements were reported in all four areas. In the scientific and technical area, significant achievements were made in detecting, locating, recovering and securing disused radioactive sources. Various countries have demonstrated that the cooperation of safety and security authorities and organizations is possible and beneficial. Training of government officials, exercises and media participation in raising public awareness were also reported. The role of the international community has been demonstrated by multiple activities of the IAEA, such as its involvement and leading role in multilateral projects or the development and management of the Illicit Trafficking Database (ITDB).

Regarding future efforts, several ideas were repeatedly mentioned throughout the conference. The appropriate use of terminology and synergies in requirements will benefit the continued use of radioactive sources, and the international community should learn from national successes. There is a need to further strengthen the usefulness of the IAEA ITDB. Member States have been encouraged to report, also in standardized format, and the IAEA Secretariat has been encouraged to improve the features of the database to provide more information and possibly links to other databases, and to allow for analysis of the data. Since illicit trafficking is a global issue, there is a need for continued harmonization of protocols and procedures at the international level, based on national successes. It is also necessary to further improve the inherent safety and security of radioactive sources. In order to achieve this goal, more dialogue is needed with all stakeholders in the chain.

Manufacturers, in particular, need more information about various possible safety and security related scenarios in order to develop improved source and equipment designs.

SUMMARY OF THE CONFERENCE WITH RESPECT TO CONTINUOUS CONTROL 'FROM CRADLE TO GRAVE'

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A number of issues were identified that had arisen that were pertinent to the topic of the panel session, The Way Forward.

(a) The terms 'safety' and 'security' were used in the conference (and in other fora) with a variety of meanings, often with an overlap between the terms and with subtle changes depending on whether the terms were applied to nuclear material or to radioactive sources. In many ways this was a semantic distraction, but outside the circles of the cognoscenti this lack of clarity did cause confusion for radioactive source users. There was merit in the view of L.-E. Holm, Chairman of the International Commission on Radiological Protection, that "radiation safety is a prerequisite for security".

(b) P. Holahan, of the United States Nuclear Regulatory Commission, addressed balancing risks and benefits, in particular "balancing the needs to secure the materials without discouraging their beneficial use". G. Webb, of the International Radiation Protection Association, also addressed this but from a different perspective, namely that it would be appropriate to revisit 'justification', adding in the security dimension, but in a structured way, optimized to reduce the security threat. Both approaches are pertinent and warrant development.

(c) Many presentations addressed different aspects of the 'cradle to grave' lifespan of radioactive sources and the threats that may result in loss of control. It was encouraging to note that many of these were being addressed within IAEA programmes of work or national analogues, often drawing on IAEA guidance.

(d) Effective and comprehensive national registries of radioactive sources were seen as a key element in control. The IAEA Regulatory Authority Information System (RAIS) computerized system was increasingly used and was reported as useful especially where the source inventory was not large. Some Member States have developed custom designed registries to deal with large inventories and/or complex situations, for example federal systems. There were interesting initiatives such as 'source passports', unique identification systems and Web based tracking systems. Overall, there were some good examples of progress to learn from.

(e) IAEA-TECDOC-1388 provides guidance on developing national strategies to strengthen control over radioactive sources in authorized use and for regaining control over orphan sources. There were encouraging reports on the use of this document and initiatives to scope the potential for orphan sources, search strategies, bringing sources within the regulatory system and source recovery programmes. More widespread use of IAEA-TECDOC-1388 together with corresponding international and bilateral initiatives is to be encouraged.

(f) Arrangements to deal with disused sources are a key element of source control. A range of issues were reported at the conference: clarity on when a source becomes disused, how to alert relevant authorities to bankrupt companies holding sources and, most importantly, how to deal with the backlog of disused sources. There were some good examples, but it is clear that there is much more to be done.

(g) The potential for orphan sources has emphasized the need for national authorities to have the capability to manage radiological emergencies. Presentations focused on the importance of working with first responders (fire, police and ambulance), having integrated command and control, handling contaminated persons, working with the media, providing information to the public and exercises.

(h) A range of IAEA initiatives were referenced in the various presentations, e.g. regulatory infrastructures based on the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, the Model Project and its successor, the Radiation Safety and Security of Radioactive Sources Infrastructure Appraisal, RAIS and regional networks. It is clear that these initiatives from the IAEA are important to supporting sustainable control.

CLOSING SESSION

FINDINGS OF THE PRESIDENT OF THE CONFERENCE

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1. INTRODUCTION

The need for safety and security measures to support the peaceful uses of radioactive sources in social and economic development has been recognized for many years. These issues were addressed at several previous international conferences organized by the IAEA — the International Conference on the Safety of Radiation Sources and the Security of Radioactive Materials held in Dijon in 1998, the International Conference of National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Materials held in Buenos Aires in 2000, and the International Conference on Security of Radioactive Sources held in Vienna in 2003. They were also addressed at the International Conference on National Infrastructures for Radiation Safety held in Rabat in 2003 and the International Conference on Nuclear Security held in London in 2005.

These conferences took place, firstly, as a result of the growing realization that inadequately controlled radioactive sources have led to radiological accidents, some causing serious injuries, deaths and severe economic disruption, in a number of countries throughout the world, and secondly, as a result of recent terrorist attacks and the growing realization that such sources might be used for malicious purposes.

The Vienna conference concluded that the IAEA should organize a further conference in two years' time. Subsequently, a follow-up conference on the safety and security of radioactive sources was announced at the Group of Eight (G8) Evian Summit held under the French presidency in 2003.

The present Bordeaux conference was hosted by the Government of France and organized by the IAEA in cooperation with the European Commission, the European Police Office, the International Commission on Radiological Protection, the International Criminal Police Organization, the International Labour Organization, the International Radiation Protection Association, the World Customs Organization and the World Health Organization, under the auspices of the G8. It was attended by 286 participants from 65 IAEA Member States.

2. CODE OF CONDUCT ON THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

The conference acknowledged that the completion and subsequent endorsement of the Code of Conduct on the Safety and Security of Radioactive Sources represented a major achievement since the Vienna conference and recognized the IAEA Categorization of Radioactive Sources as the foundation of the Code and the central role of the Categorization in the Code's harmonized implementation.

The conference recognized the global support for the Code. To date, 72 States have expressed their political commitment to working towards implementing the guidance contained in the Code.

The conference encouraged all Member States to continue to work towards implementing the guidance contained in the Code, and to make a political commitment to the Code if they have not already done so.

The conference focused on Member States' progress towards implementation of the Code and recognized that the degree of Member State implementation of the Code necessarily varied widely. For countries in the earliest stages of establishing a national regulatory system, bilateral, regional and multilateral support, including the creation of networks, is recommended, in addition to the assistance provided by the IAEA. However, even countries with well established regulatory infrastructures indicated that work remains to be done to fully implement the Code.

The conference recognized that safety and security are an integral part of effective and comprehensive regulatory infrastructures for ensuring the continuous control of radioactive sources throughout their life cycle. All organizations, both national and international, with competence and responsibilities related to the continuous control of radioactive source were encouraged to cooperate effectively in enhancing the control of sources.

The conference recognized that an adequate balance between confidentiality and information exchange must be struck to ensure the safety and security of radioactive sources.

The conference asked the IAEA to continue its work of promoting the Code and supporting global efforts to implement the Code.

The conference recognized the value of the presentation and discussion of 24 national working papers from Member States representing all regions of the world, and encouraged the IAEA to undertake consultations with Member States with a view to establishing a formalized process for a periodic exchange of information and lessons learned and for evaluation of progress made by Member States towards implementing the provisions of the Code.

The conference discussed the issues associated with moving the Code towards a legally binding undertaking. A number of participants were in favour of making such a move in the near future. Other participants preferred that priority be given to implementation of the Code before considering such a step.

3. IMPORT AND EXPORT CONTROLS

The conference welcomed the Guidance on the Import and Export of Radioactive Sources as another important step towards a global system for the continuous control of radioactive sources throughout their life cycle.

The conference acknowledged the challenges inherent in implementing the Guidance as a necessarily multilateral endeavour and stressed the importance of its implementation in a cooperative and harmonized fashion.

The conference recalled that the IAEA General Conference had in 2004 noted that more than 30 countries had made clear their intention to work towards effective import and export controls by 31 December 2005, and that the General Conference had encouraged States to act in accordance with the Guidance on a harmonized basis and to notify the IAEA Director General of their intention to do so. The conference noted that so far only three Member States had notified the Director General, and it urged all Member States to write to the Director General as requested by the General Conference and re-emphasized the importance of implementing the Guidance on a global, harmonized basis.

The conference noted the value of exchanging information on national implementation of the Guidance, which further highlighted the desirability of a formalized review process.

4. DEALING WITH THE LEGACY OF PAST ACTIVITIES

The conference noted the substantial national efforts undertaken in many countries to establish national strategies for regaining and maintaining control of vulnerable and orphan sources.

The conference also noted the success of a number of multilateral efforts to strengthen controls for radioactive sources and the legacy of past activities. Such initiatives include the Tripartite Agreement between the United States of America, the Russian Federation and the IAEA, which focuses on the strengthening of controls for sources in countries of the former Soviet Union, and programmes initiated with the support of the European Union. New initiatives such as the Global Threat Reduction Initiative, the G8 Global

Partnership, and the cooperative arrangements in Southeast Asia are expected to strengthen controls in many more countries throughout the world. The conference stressed the need for harmonization and for the avoidance of duplication of effort in these activities.

The conference encouraged Member States with limited resources and experience to take advantage of existing and future assistance programmes for regaining and maintaining control of vulnerable and orphan sources.

The conference recognized the financial burden associated with the regaining of control of radioactive sources and encouraged the IAEA to collect and disseminate information on national approaches to this issue.

The conference encouraged the IAEA to continue providing assistance to Member States in regaining and strengthening control over vulnerable and orphan sources by implementing regional projects in cooperation with regional partner States.

5. SUSTAINABILITY AND CONTINUITY OF CONTROL

The conference encouraged Member States to strengthen, as necessary, their regulatory infrastructures so as to ensure the sustainability of the control of radioactive sources. It urged the IAEA to continue to provide support for the efforts of Member States to strengthen their regulatory infrastructures.

The conference encouraged the IAEA to keep under review its safety standards and to develop security guidance documents relevant to radioactive sources in order to support Member States in strengthening their national regulatory infrastructures and, where necessary, to develop further guidance of this nature.

Recognizing that the IAEA Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS) were published prior to the Code of Conduct, the conference encouraged the IAEA to take account of the Code and of feedback from its implementation in the planned revision of the BSS.

The conference recognized the effectiveness of the IAEA's Model Project on the Upgrading of National Radiation Protection Infrastructures, which had helped to establish and strengthen radiation control infrastructures in more than 90 countries. The conference looks forward to implementation of the recently established IAEA policy on promoting effective and sustainable national regulatory infrastructures for the control of radiation sources, which explicitly includes implementation of the guidance in the Code of Conduct and the promotion of networking.

The conference recognized the role of Radiation Safety and Security of Radioactive Sources Infrastructure Appraisal (RaSSIA) missions and related self-assessments, and of the Regulatory Authority Information System (RAIS) for establishing national registries of sources and for promoting sustainable systems for the control of radioactive sources. It also recognized the role of the International Catalogue of Sealed Radioactive Sources and Devices.

The conference recognized the role of source manufacturers in designing inherently safer sources and in providing lifetime support to users, especially at the end of the source life cycle. Manufacturers will also have an important role to play in the systems required by the Code of Conduct for ensuring that radioactive sources are identifiable and traceable. In this regard, the conference noted that the latest binding European Union legislation on high activity sources provides for such identifiability and traceability.

The conference welcomed the establishment of the International Source Suppliers and Producers Association and its intention to contribute to the safety and security of radioactive sources as expressed in its mission statement and draft Code of Good Practice.

The conference recognized the importance of recycling radioactive sources to the extent possible, but acknowledged that appropriate disposal options must be available as an integral part of a complete radioactive source management system.

The conference noted that, while waste management is primarily a national issue, regional cooperation in dealing with disused radioactive sources should be considered.

The conference recognized the need for strengthening the inherent safety and security of radioactive sources and the potential value of alternative technologies using ionizing radiation and of less dispersable materials. In this regard, the conference proposed that the IAEA explore appropriate options.

6. ILLICIT TRAFFICKING AND INADVERTENT MOVEMENTS

The conference recognized the continuing need for international efforts to prevent illicit trafficking in and inadvertent movements of radioactive sources, and recognized the need to further upgrade detection capabilities and to take appropriate enforcement actions.

The conference encouraged the further development and strengthening of capacity building measures to help States detect, interdict and respond to illicit trafficking.

The conference encouraged the development and deployment of effective and sustainable technologies for detecting radioactive sources at borders and elsewhere.

The conference called for enhanced cooperation in preventing, detecting and responding to illicit trafficking and inadvertent movements and for interaction between States and international organizations.

The conference encouraged continued support for the IAEA Illicit Trafficking Database and urged that the quality of the data be improved and the level of analysis be upgraded.

7. EMERGENCY MANAGEMENT

The conference noted that the effective management of radiological emergencies involving radioactive sources needs to be an integral part of national strategies for the safety and security of radioactive sources. In particular, it is fundamental that first responders to an emergency have appropriate training in dealing with ionizing radiation. In this regard, the conference suggested that the IAEA facilitate exchanges of information between first responder organizations in different countries.

8. OUTLOOK

The conference recommended that the IAEA, taking account of these findings, revisit the Action Plan for the Safety and Security of Radioactive Sources. Governments and other relevant international organizations were encouraged to review these findings and to take them into account in defining their own particular actions.

In view of the importance of the topic, the conference recommended that the IAEA organize a further conference in about three years' time to assess the progress in moving towards a global system for the continuous control of radioactive sources throughout their life cycle, taking into account the proposal for a formalized process of information exchange made by the conference.

CLOSING REMARKS

T. Taniguchi
Deputy Director General, Department of Nuclear Safety and Security,
International Atomic Energy Agency, Vienna

We are now very close to the end of this conference. I would like to make a few closing remarks on behalf of the IAEA. I am very pleased that 286 participants from 65 IAEA Member States and 13 international organizations attended the conference.

The idea of establishing an international undertaking on the safety and security of radioactive sources was first raised at the Dijon conference in 1998 and was promoted by further conferences held in Buenos Aires and Vienna. The Code of Conduct on the Safety and Security of Radioactive Sources was approved by the IAEA Board of Governors and the General Conference of the IAEA in 2003, with strong political support from Member States and in particular from the Group of Eight, as expressed at its summit held in Evian in that year. Subsequently, in 2004, the Guidance on the Import and Export of Radioactive Sources was approved by the IAEA Board of Governors and General Conference. The Vienna conference concluded that the IAEA should organize a further conference to assess progress in the implementation of the Code of Conduct, in the further development of measures to protect high risk radioactive sources, and in the development and implementation of national strategies for regaining control over orphan sources. It was this conclusion that led to the present conference, which the French Government kindly agreed to host.

The programme of this conference was very full and successful. Besides the review of national experiences in the implementation of the Code of Conduct, to which a whole day was devoted, we have surveyed many aspects of the ‘cradle to grave’ control of radioactive sources. National and international efforts to regain control over vulnerable and orphan sources were presented and discussed. The conference also provided an excellent opportunity for the Member States’ government authorities responsible for nuclear and radiation safety and security — including regulatory bodies, customs authorities, police, and bodies responsible for preparedness and response for radiological emergencies or terrorist threats — to exchange information and experience. It also identified important roles of relevant international organizations, source manufacturers and distributors, and users of sources in medicine, industry and research in further improving the safety and security of radioactive sources worldwide. Valuable new information was provided by excellent keynote speakers and panellists in areas such as inadvertent movement and illicit trafficking of radioactive sources, strategies for the management of disused sources, strengthening of the inherent safety and security of sources, the role of manufacturers and the management of radiological emergencies.

The President of the Conference has just summarized the main achievements of the work done this week. His findings will be made available to all participants after this closing session and will be published on the IAEA web site. The findings of the President of the Conference will be presented to the IAEA Board of Governors at its next meeting in September. We will eagerly work with our Member States to follow up these findings and convert them into concrete actions. In line with the findings of the President of the Conference, the IAEA Secretariat will review the action plans related to the safety and security of radioactive sources and continue to commit its resources and efforts in a strategic manner.

Among many actions identified, I believe, it is particularly important to promote the global efforts to fully implement the Code of Conduct and the Guidance on Import and Export, and to undertake consultations with Member States with a view to establishing a formalized process for exchange of experiences and good practices and for a periodic evaluation of progress made by Member States towards implementing the provisions of the Code of Conduct and the Guidance on Import and Export.

Other important actions include areas such as:

— Regaining and strengthening control over vulnerable and orphan sources;
— Revision of the IAEA Basic Safety Standards to reflect the provisions of the Code of Conduct;
— Sustainable national regulatory infrastructures;
— Radiation Safety and Security of Radioactive Sources Infrastructure Appraisal (RaSSIA) missions and related self-assessment and feedback;
— Cooperation with the International Source Suppliers and Producers Association;
— Safe and secure disposal of disused radioactive sources;
— Improvement of the quality of the data and their analysis in the Illicit Trafficking Database;
— Incident and emergency response capability and preparedness.

With regard to the cradle to grave control of sources, I should like to emphasize that the application of control measures without hindering the beneficial use of the sources requires harmonized cooperation between all stakeholders with different competencies, for example radiation safety regulators, security authorities, source manufacturers and users of sources.

Finally, I should like to mention that many people have cooperated to make this conference successful. We appreciate the excellent leadership of the President, Mr. Lacronique, and the session chairs; the careful preparation on the part of the speakers; and the overall guidance of the Programme Committee and its chairperson, Mr. Loy, which planned the programme, selected the speakers and reviewed the contributed papers.

I should also like to acknowledge with particular gratitude the highly professional and dedicated work of the local conference assistants, the interpreters, the efficient technicians and the IAEA Conference Services staff. I hesitate to mention specific names for fear that I will omit someone who contributed significantly. Nevertheless I would like to express my deep gratitude to Mr. Thierry Thevenin and the staff of the Commissariat à l'énergie atomique in particular for their extreme dedication and hard work many months before, as well as during, the conference. In closing, I would wish to express my sincere appreciation for the warm hospitality of the Government of France and the Mayor of Bordeaux, and for the cooperation of the eight international organizations.

This conference can only be considered very successful if its findings are translated into effective actions. This we intend to do. But we cannot do it on our own; we need your support. We are looking forward to working closely with you, the representatives of Member State authorities, regulatory bodies, technical support organizations and industry, in establishing and enhancing a global system for the continuous control of radioactive sources throughout their life cycle.

ANNEX

UNCERTAINTIES IN THE ASSESSMENT OF THE RADIOLOGICAL IMPACT OF RADIOLOGICAL DISPERSAL DEVICES

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Abstract

Effective planning for events of radiological terrorism requires the use of atmospheric dispersion models and knowledge of input parameters. Dispersion of radioactive material has been calculated to obtain an estimate of population exposure and ground contamination following the detonation of a radiological dispersal device. Using typical high activity sources of ^{60}Co, ^{137}Cs and ^{192}Ir as source terms and different meteorological conditions, the results from two dispersion models were compared. The Hotspot model (Lawrence Livermore National Laboratory, United States of America) and the Plume5 model (Atomic Energy Research Institute, Hungary) provided similar ground deposition values, but exposure (effective dose) values were significantly different. The paper discusses the extent of uncertainties due to variation of some parameters.

1. INTRODUCTION

The threat that terrorists may explode a radiological dispersal device (RDD) has recently been considered by relevant authorities, scientists and the media. Most of the published evaluations emphasize that an RDD is not a 'nuclear explosion device'; its impact would be much less serious. While this statement is obviously true in terms of health effects, the social and economic consequences of an RDD could still be disruptive. Nevertheless, the public is more anxious about its health risk, however small it might be, than about any other consequences. This is one reason why the authorities are interested in the possible radiation exposure of the population due to such an event. Another reason is that the authorities should be prepared to take appropriate preparatory actions in advance. Most media and scientific publications speak about exposure in the millisievert range, which is certainly not an alarming level. These expectations are usually based on a 'likely' design of a bomb and 'likely' scenarios. How much can we rely on such predictions? Are our assumptions all valid? Do our calculation models and codes reflect reality? In the following we try to answer some of these questions. It is noted that our approach is not the usual way to assess the uncertainty of a given dispersion model compared with measurable quantities, but rather an analysis of our overall knowledge of expectations.

Types of uncertainty maybe classified as follows:

(a) The accuracy of a given dispersion model depending on the correctness of parameters;
(b) The validity of the model (does the underlying physics represent reality?);
(c) The uncertainty of basic assumptions (source term, environmental and meteorological conditions).

The present paper deals with case (c) exclusively, providing a few examples to illustrate the issue. In other words, in addition to parameter sensitivity, the sensitivity to the lack of knowledge is outlined. We know almost nothing about the 'what and where and when'; therefore it is rather difficult to satisfy decision makers' curiosity.

2. PREDICTION OF RADIOLOGICAL IMPACT

In this study we attempted to obtain estimates of the ranges of potential public exposure and ground contamination following the detonation of a 'typical' RDD. Calculations were carried out using two atmospheric dispersion models:

— Hotspot 2.01 and 2.05 (Lawrence Livermore National Laboratory (LLNL), United States of America), downloaded from the Internet;
— Plume5 (KFKI Atomic Energy Research Institute (AEKI), Hungary), developed for our task.

The two codes were both based on the Gaussian plume dispersion model. Both were designed for quick and simple use, understanding that the most sophisticated (complex) models may not be practical, for example, in the case of a terrorist attack.

Input parameters were varied to assess sensitivity. For the source term, ^{60}Co, $^{125/131}$I, ^{137}Cs and ^{192}Ir sources and various explosive strengths were selected. The release height was 10 m in all cases. The meteorological conditions were varied, grouping them in two sets: 'average' or 'normal', and 'extreme' conditions. Urban terrain (city) was selected. In this paper, calculations for ^{137}Cs of 3.7E13 Bq (1 kCi) only are presented.

Because of differences in the modelling details and the parameter sets used, the codes provided different numerical predictions for the major outputs, namely the exposure (effective dose), the time integrated radioactive concentration in air and the radioactivity deposited on the ground.

How large are these differences? First, the comparison was made using source term, meteorological and other environmental parameters characteristic of a ‘likely’ bomb design, a ‘normal’ meteorological situation and urban terrain (city). The expressions in quotation marks obviously deserve some further clarification and will be discussed elsewhere. Tables 1 and 2 show parameters used in various conditions.

The results of calculations (three main outputs: total effective dose, time integrated activity concentration and ground deposition; ratios of results from the two codes) are shown in Table 3.

It is noted that the numerical results depend to some extent on the distance along the plume axis (and also on the lateral positions), but the overall picture would not be very much affected. If significant changes in the meteorological conditions are allowed, the numerical results would vary significantly as well, especially at very close and longer distances.

Some of the results for various meteorological conditions obtained by the two codes are displayed in Table 4 and are also shown in Figs 1–3.

3. DISCUSSION

It is noted that the ground deposition values for the two codes are rather close, although they are not identical. The differences in the exposure values are quite high. The Plume5/Hotspot ratio is approximately 14. Such a discrepancy would undermine decision makers’ and public confidence in predictions. A thorough error analysis should reveal the causes. It seems, however, that the reasons for the discrepancies in the exposures lie mainly in the following:

(a) The calculations resulted in different $Bq \cdot s \cdot m^{-3}$ values, with a ratio (P/H) of close to 5.
(b) The codes used different dose conversion factors (DCFs). In the Plume5 code, 7E–8 (lung absorption type S, age group 5 a) was selected (variable); in the Hotspot code, it was fixed at 8.63E–9.
(c) The codes used different breathing rates. The Plume5 value is 1.0E–3 m^3/s (child); the Hotspot value is 3.3E–3 m^3/s (adult) set as default.
(d) Differences in the physics of the models have not yet been identified.

TABLE 1. PLUME5 INPUT DATA

	Normal cases					Extreme cases				
	1[a]	2	3	4	5	2ex	3ex	4ex	5ex	6ex
Wind speed (m/s)	5	5	**10**	5	5	5	**25**	5	5	5
Pasquill category 1–6 (A–F)	4	**3**	**4**	4	4	**1**	4	4	4	4
Precipitation (mm/h)	0	0	0	**3**	0	0	0	**40**	0	0
Explosive (kg TNT)	2.27	2.27	2.27	2.27	**10**	2.27	2.27	2.27	**1814**	2.27
Sigma *y* (m)	11	11	11	11	**16.5**	11	11	11	**60**	11
Sigma *z* (m)	23	23	23	23	**33**	23	23	23	**121**	23
Integration time (d)	4	4	4	4	4	4	4	4	4	**365**

Note: Half-life (Cs-137) 30 a; respirable deposition velocity 0.10 cm/s; inhalation dose conversion factor **7E–8** Sv/Bq; breathing rate 1E–3 m^3/s.

[a] Case 1 is the ‘reference’ case. Figures in bold type indicate changes compared with the reference case.

TABLE 2. HOTSPOT INPUT DATA

Parameter set	1[a]	2	3	4	5	2ex	3ex	4ex	5ex
Explosive (lb TNT)[b]	5	5	5	5	**22**	5	5	5	**3990**
Debris cloud top (m)	114	114	114	114	**165**	114	114	114	**604**
Wind speed (m/s)	5	5	**10**	5	5	5	**25**	5	5
Stability class (city)	D	**C**	D	D	D	**A**	D	D	D
Washout coefficient (1/s)	None	None	None	**4E–4**	None	None	None	**3E–3**	None

Note: Half-life 30.0 a; respirable deposition velocity 0.30 cm/s; airborne fraction 1.000; non-respirable deposition velocity 8.00 cm/s; respirable fraction 0.900; breathing rate 3.33E–4 m^3/s; respirable release fraction 0.900; inhalation dose conversion factor **8.63E–9** Sv/Bq; dose data include 4 d of groundshine (100% stay time).

[a] Case 1 is the ‘reference’ case. Figures in bold type indicate changes compared with the reference case.

[b] 1 lb = 0.45 kg.

TABLE 3. COMPARISON OF CALCULATION OUTPUTS USING THE PLUME5 AND HOTSPOT CODES, ASSUMING THE USE OF A Cs-137 SOURCE OF 3.7E13 Bq (1 kCi) ACTIVITY IN REFERENCE CONDITIONS (SEE TABLE 1)

Distance (km)	Plume5 (Sv)	Hotspot (Sv)	Plume5/ Hotspot	Plume5 ($Bq\cdot s\cdot m^{-3}$)	Hotspot ($Bq\cdot s\cdot m^{-3}$)	Plume5/ Hotspot	Plume5 (Bq/m^2)	Hotspot (Bq/m^2)	Plume5/ Hotspot
0.03/0.05	6.6E–2	5.20E–3	**12.81**	5.49E+9	9.90E+8	**5.55**	5.49E+6	1.20E+7	**0.46**
1	4.72E–3	3.30E–4	**14.30**	3.90E+8	6.60E+7	**5.91**	3.90E+5	6.90E+5	**0.57**
10	1.62E–4	1.20E–5	**13.50**	1.33E+7	2.80E+6	**4.75**	1.33E+4	2.20E+4	**0.60**

TABLE 4. COMPARISON OF CALCULATION OUTPUTS (mSv) USING THE PLUME5 AND HOTSPOT CODES, ASSUMING THE USE OF A Cs-137 SOURCE OF 3.7E13 Bq (1 kCi) ACTIVITY IN VARIOUS METEOROLOGICAL CONDITIONS (SEE TABLE 1)

Distance (km)	P1	H1	P2	H2	P3	H3	P4	H4	P5	H5
0.03/0.05	66.6	5.2	48.8	4.8	33.3	2.6	73.4	58	37.4	2.5
1	4.72	0.33	1.36	0.17	2.37	0.17	5.77	5.7	4.14	0.26
10	0.162	0.012	0.0516	0.0037	0.0813	0.0067	0.227	0.56	0.159	0.011

Distance (km)	P1	H1	P2ex	H2ex	P3ex	H3ex	P4ex	H4ex	P5ex	H5ex
0.03/0.05	66.6	5.2	29.4	3.2	13.3	1	121	400	3.66	0.18
1	4.72	0.33	0.115	0.073	0.947	0.068	10.9	25	1.51	0.063
10	0.162	0.012	0.000505	0.00063	0.0327	0.0029	0.0717	0.11	0.135	0.0077

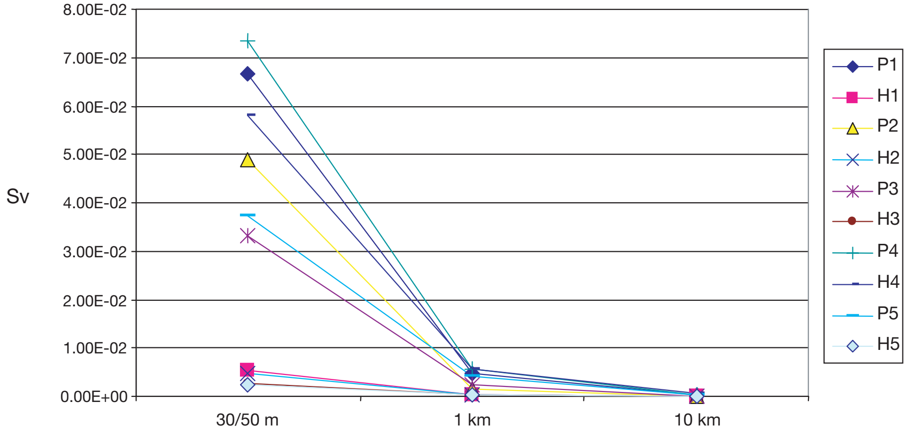

FIG. 1. Plume5 and Hotspot predictions for public exposure (Sv) under 'normal' meteorological conditions for a ^{137}Cs source of 3.7E13 Bq (1 kCi).

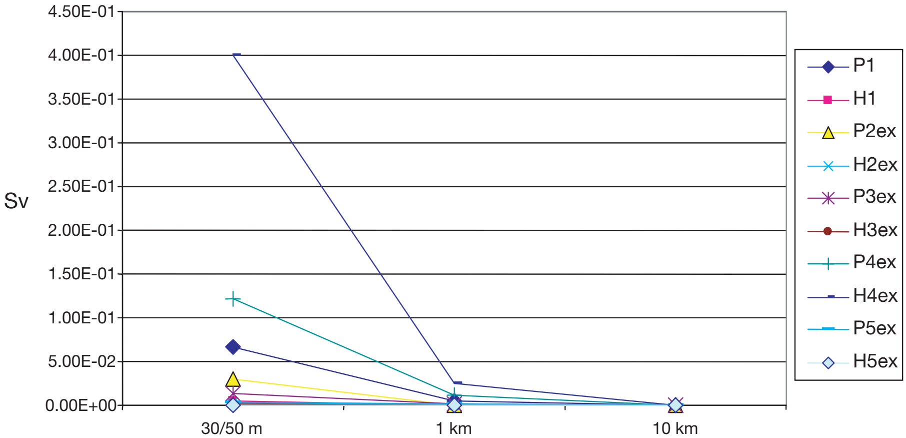

FIG. 2. Plume5 and Hotspot predictions for public exposure (Sv) under 'extreme' meteorological conditions for a ^{137}Cs source of 3.7E13 Bq (1 kCi).

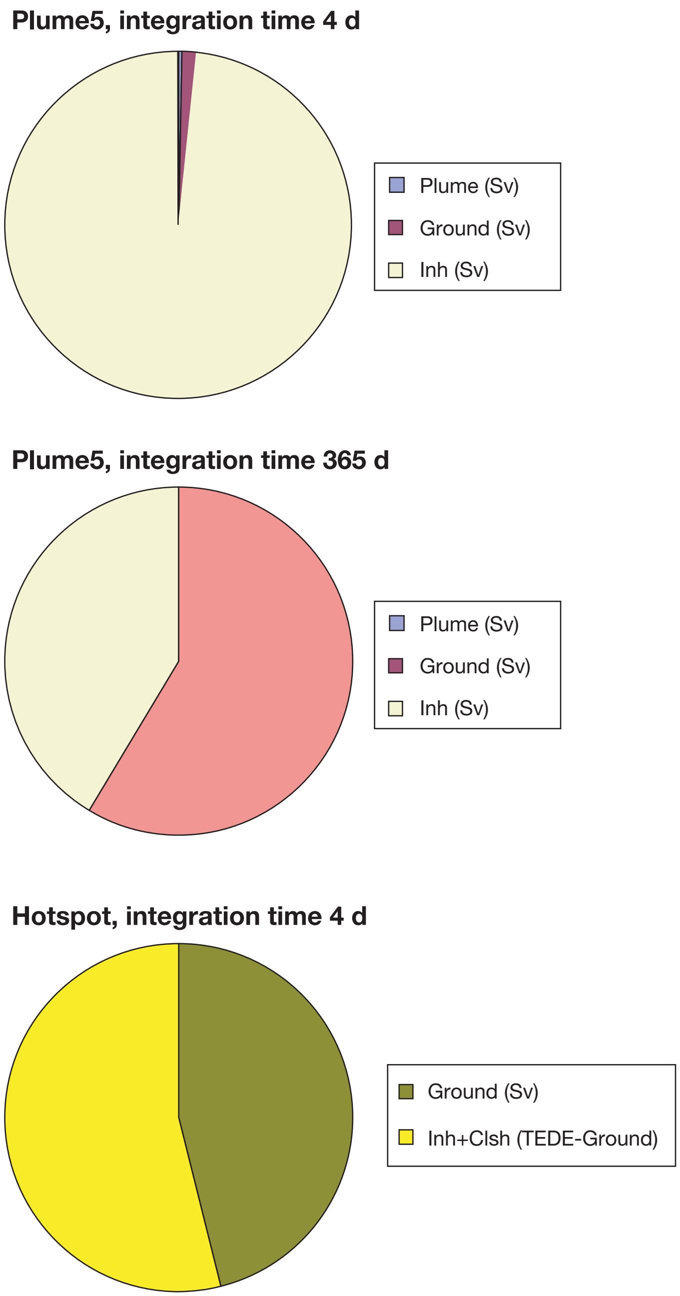

FIG. 3. Total dose (Sv) components at 0.05 km for a ^{137}Cs source of 3.7E13 Bq (1 kCi). Inh: inhalation; Clsh: cloudshine = plume; TEDE: total effective dose equivalent; Ground: groundshine.

Concerning (a) above, no concrete explanation is available for the difference between the Bq·s·m^{-3} values. The reason may be in the details of the underlying physics in the dispersion models.

Concerning (b), in this discussion we consider inhalation as the dominant component of the total dose (Fig. 3). Hotspot uses a fixed DCF value; for ^{137}Cs it is 8.63E–9 (close to the S type value of the International Commission on Radiological Protection (ICRP)). Which is the proper DCF to be used? DCFs depend on the radionuclide, the population age group and the lung absorption characteristics of the inhaled material, broken down into three classes — F, M and S — pertaining to the chemical and physical forms. Let us consider a ^{137}Cs source, which usually contains highly soluble and dispersable CsCl or a hardly soluble and dispersable ceramic. Table A.2 of ICRP Publication 72 displays the DCF values for inhalation, which is the major contributor to public exposure in the case of the detonation of an RDD. It can be seen that the dependence on the age group is relatively small, but the DCFs depend largely on the lung absorption type. The ratio of F/S values ranges from about 10 to 20, depending on the age group. It is an acceptable prudent practice to take the highest value to obtain a conservative prediction.

The difference in the inhalation DCFs used (a factor of 8) contributes substantially to the difference in the calculated exposures.

Concerning (c) above, in the Hotspot code the breathing rate is variable, while in Plume5 it is fixed (can be changed in the code). This difference has an opposite effect, reducing the observed difference in exposure (dose).

It is also noted that the numerical results for 30 or 50 m away from the place of detonation only indicate tendencies, because these points are at about the perimeter of the primary cloud.

4. CONCLUSIONS

Assuming a ‘likely’ RDD event, the public exposure would probably be relatively low, but because of the large number of additional unknown factors, the overall uncertainty of predictions (made in advance) could be much larger than the factor of 5–10 claimed for atmospheric dispersion models developed to deal with emergencies at nuclear facilities. It is noted that generic action levels are close to the range of predictions.

Uncertainties due to the variability of environmental and meteorological conditions are high within a few hundred metres of the detonation site. At longer distances the predicted impacts are less sensitive to parameter variations.

There are also other important factors and details which were not considered in the current study. It is recommended that uncertainties associated with impact predictions should be further investigated to understand better the causes and limitations, and to develop tools specific to needs arising from an RDD event.

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BIBLIOGRAPHY

HOTSPOT PROGRAM, www.llnl.gov/nai/technologies/hotspot

JANOSY, J.S., DEME, S., LANG, E., Modelling of potential air dispersants from normal and incidental nuclear power plant operations, Proc. Conf. on Advanced Simulation Technologies, Orlando, FL, 2003, pp. 51–56.

SURVEY OF LOST AND POORLY CONTROLLED RADIOACTIVE SOURCES IN NON-MEDICAL APPLICATIONS IN IRAN

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Abstract

Despite the existence of well developed regulatory authority systems for radiation protection, there are some concerns about lost and poorly controlled radioactive sources owing to the large number and the wide distribution of the users of radioactive sources. The survey presented covers the current situation of radioactive sources of Categories 3–5 (based on the IAEA categorization) in non-medical applications in the Islamic Republic of Iran. The investigation was performed on a selected group of non-medical users of radioactive sources in different provinces of Iran. The findings show that unauthorized supply and the existence of legacy sources, in addition to the abandonment of sources under regulatory control, are the main reasons for lost sources. Considering the possibility of increasing numbers of poorly controlled sources, which can lead to an increasing number of lost sources, further development is needed of national regulatory control as well as of international cooperation and discipline in this regard.

1. INTRODUCTION

Radioactive sources are widely used in different fields of industry, medicine, research and teaching, agriculture and some other applications in the Islamic Republic of Iran. On the basis of the applications, different types and amounts of radioactive material, from very high activity sources to very low activity sources, are used. According to the Radiation Protection Act of Iran (RPAI), the National Radiation Protection Department (NRPD) of Iran, as the regulatory authority, is responsible for regulating and controlling all applications of radiation sources in the country [1]. Basic national requirements of radiation protection are specified in the Basic Radiation Safety Standards (BRSS) [2]. To achieve efficient regulatory control over radiation sources, the regulatory authority, in accordance with the suggestions of the IAEA, has developed the necessary infrastructure [3]. One of the main goals of such regulatory control is to develop an efficient mechanism to prevent sources under regulatory control from becoming poorly controlled (vulnerable), or in the worst case lost (orphan), sources.

An orphan source is a radioactive source which is not under regulatory control, either because it has never been under regulatory control, or because it has been abandoned, lost, misplaced, stolen or transferred without proper authorization [4].

A vulnerable source is one which is currently under regulatory control, but for which the control is insufficient to provide assurance of long term safety and security. A vulnerable source is one that could relatively easily become orphaned [4].

Practices can be assigned to the five categories given in Table 1, in which D is a normalized value for activity of a source in a practice which has the potential to cause severe deterministic effects and A is the activity of the source. D values are defined in IAEA-TECDOC-1344 [4].

In Iran there is strong control on sources of Categories 1 and 2, owing to their high risk, through licensing and frequent inspections. On the other hand, there are a considerable number of medium and low risk sources (thousands) within Categories 3–5 which are not under such strong regulatory control.

To evaluate the current situation of the sources in non-medical applications in Iran, a study with the aim of improving and strengthening the regulatory authority's control over radioactive sources was carried out. The study included inspection of some selected factories, universities and well logging companies in different provinces from 11 Jan. 2003 to 11 Jan. 2004. The results of 48 inspected centres compared with the last information on them (mostly three to five years earlier) revealed that there were some vulnerable and orphan sources.

TABLE 1. EXAMPLES OF SOME COMMON PRACTICES AND CATEGORIES OF THE SOURCES USED

Category	Practices	Activity ratio (A/D)
1	Radioisotope thermoelectric generators (RTGs), irradiators, teletherapy, gamma knives	$A/D \geq 1000$
2	Industrial gamma radiography, high/medium dose rate brachytherapy	$1000 > A/D \geq 10$
3	Fixed industrial gauges, well logging gauges	$10 > A/D \geq 1$
4	Portable gauges, thickness/fill level gauges, bone densitometers, static eliminators	$1 > A/D \geq 0.01$
5	X ray fluorescence devices, electron capture devices, Mossbauer spectrometers	$0.01 > A/D$ and $A \geq$ exempt

2. MATERIALS AND METHODS

Evaluation of the effectiveness of the current regulatory authority strategy for sources of Categories 3–5 was carried out following an assessment plan in which 48 non-medical centres, of about 500 centres, from different parts of the country were selected. These centres consisted of factories using fixed industrial gauges and X ray analysing systems, well logging companies, users of portable gauges for measurement of density and moisture, and universities using neutron sources for research and teaching in the range of hundreds of gigabecquerels and using other sources of different radionuclides in the range 0.5–500 MBq (check sources). Check sources are often of such a low hazard that there is no need to consider them in a national strategy for control over radioactive sources, but from the regulatory and administrative point of view, loss of control over them is not acceptable [5].

Selection of the centres was based on factors such as the inspection intervals and latest inspection report. The survey covered 19 factories, three well logging companies and 26 research and teaching centres, including 443 sources.

3. RESULTS AND DISCUSSION

Tables 2 and 3 show the orphan and the vulnerable sources according to their type and number. In Table 2 we also see the current situation of the orphan sources, whether they are under the responsibility of a radiation protection officer (RPO) and whether they are legacy sources and/or had been supplied without proper authorization.

In Table 3 the sources that are vulnerable but which are not yet orphaned are listed. They have the potential to become orphaned relatively easily, owing to their poor control or to their having no RPO.

The case of four melted sources of a well logging company, including three ^{137}Cs sources and one Am–Be source, shows one of the threatening aspects of orphan sources. There is no evidence of how many people may have been exposed by them. The only thing we concluded was that the sources had been left and stored by a foreign well logging company in an inappropriate place and may have been subjected to fire for unknown reasons (some people may have burned them with the hope of finding something valuable inside). A university RPO reported the discovery of the melted sources.

TABLE 2. ORPHAN SOURCES FOUND IN THE STUDY

Centre	Type of orphan source found	Situation	RPO	Origin
Well logging company A (has left Iran)	1 neutron and 3 Cs-137	Have never been under regulatory control	No	Legacy sources
University A	1 neutron, 185 GBq Am–Be	Transferred without proper authorization	No	Supplied by local supplier A
University B	1 portable gauge	Abandoned	No	Previously under control
	1 check source	Abandoned	No	Previously under control
University C	1 portable gauge	Lost	No	Previously under control
University D	1 neutron, 185 GBq Am–Be	Transferred without proper authorization	Yes	Supplied by local supplier A
	21 check sources	Transferred without proper authorization	Yes	Supplied by local supplier A
Research A	9 check sources	Lost	No	Previously under control

TABLE 3. VULNERABLE SOURCES FOUND IN THE STUDY

Centre	Type of source found	Situation	Responsible person?	Possible danger
Factory A	4 Co-60 fixed industrial gauges	Improperly stored	Yes	Theft
Factory B	1 portable gauge	Improperly stored	Yes	Theft
Factory C	1 portable gauge	In service	No	Damage or theft
University A	1 portable gauge	Improperly stored	Yes	Theft
University B	1 neutron source	Improperly stored	No	Damage or theft
In three universities	44 check sources	Improperly stored	No	Damage or theft

4. CONCLUSION

The discovery of four orphan sources belonging to Category 3 (well logging sources), four orphan sources belonging to Category 4 (portable gauges and research neutron sources) and 31 orphan sources belonging to Category 5 (check sources) shows the fact of there being some unknown and lost sources in non-medical centres in Iran. This study also shows that legacy sources, abandoned sources and locally supplied sources are the main subjects of concern. None of the orphan sources were found in a factory, but mostly in research and teaching centres. The list of vulnerable sources shows that the common weak points of control on the sources are the lack of an RPO and improper storage.

Considering the increasing number of applications of radioactive sources in Iran, the regulatory authority needs to effectively strengthen its strategy and control over the sources. Considering the above findings and appreciating the international efforts, a new strategy has been planned to extend the survey and to establish a proper programme, including the following:

(a) New efforts will be made for public information through governmental channels, advertising through the media, and inviting key persons to attend relevant press conferences and seminars to identify unknown users of sources.
(b) Stronger control and more strict enforcement are to be implemented with respect to the suppliers of radioactive sources, owing to their mismanagement in delivering sources to unauthorized users.
(c) A more rigid authorization procedure seems to be needed for research and teaching centres, especially for medium and high risk sources. Most of the orphan sources were found in research and teaching centres and not in factories, owing to the stronger security plans in factories and the lack of proper discipline in research and teaching centres.
(d) Direct contact with the authorized users and RPOs is needed, even by telephone or email. One of the main factors which can lead a poorly controlled source to become an orphan source is a lack of administrative measures [6, 7]. The very important role of users and RPOs will be highlighted and taught properly.
(e) Foreign companies should bear more responsibility in observing and fulfilling national regulations. Lack of regulations or supervision in a country must not be a reason to leave sources for any purpose in the country without proper control.
(f) Information has a key role in control. The national regulatory authority is developing a new database, based on the Regulatory Authority

Information System (RAIS). Transferring multiple inventory data sets into the single new database would facilitate management of the data. Sources of Categories 1 and 2 have been entered into the database and entry of sources of Categories 3–5 is in progress.

REFERENCES

[1] ATOMIC ENERGY ORGANIZATION OF IRAN, NATIONAL RADIATION PROTECTION DEPARTMENT, Radiation Protection Act of Iran and its Regulations, AEOI, Tehran (1989).

[2] IRANIAN NUCLEAR REGULATORY AUTHORITY, NATIONAL RADIATION PROTECTION DEPARTMENT, Basic Radiation Safety Standards, NRPD, Tehran (1999).

[3] GHIASSI-NEJAD, M., BEITOLLAHI, M.M., FALLAHIAN, N., "Radiation protection infrastructure and role of the competent authority in Iran", National Infrastructures for Radiation Safety: Towards Effective and Sustainable Systems (Proc. Int. Conf. Rabat, 2003), IAEA, Vienna (2004).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA-TECDOC-1344, IAEA, Vienna (2003).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Strengthening Control over Radioactive Sources in Authorized Use and Regaining Control over Orphan Sources, IAEA-TECDOC-1388, IAEA, Vienna (2004).

[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Organization and Implementation of a National Regulatory Infrastructure Governing Protection against Ionizing Radiation and the Safety of Radiation Sources, IAEA-TECDOC-1067, IAEA, Vienna (1999).

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources, IAEA-TECDOC-1355, IAEA, Vienna (2003).

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Radioactive sources are extensively used for beneficial purposes around the world in medical, industrial, agricultural and research applications. However, their safety and security remain a matter of concern. Loss of control, sometimes as a result of inadequate regulatory oversight, has resulted in 'orphan' sources. Such sources have led, in some cases, to serious injuries, even death. In recent years, additional concerns have emerged related to the possibility that sources might be used for malicious purposes. These concerns reinforce the importance of ensuring that proper control of radioactive sources is established and maintained throughout the world. This conference was held with the aim of generating an exchange of information on these issues. These proceedings contain the addresses and the invited papers presented at the conference, as well as records of the discussions and the findings of the conference. The contributed papers are available on a CD-ROM that is included with this volume.

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