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International Conference held in Buenos Aires, Argentina, 11–15 December 2000

National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Materials

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FOREWORD

As a follow-up to the International Conference on Safety of Radiation Sources and Security of Radioactive Materials, which was hosted by the Government of France in Dijon, in September 1998, and as envisaged in the *Action Plan for the Safety of Radiation Sources and the Security of Radioactive Materials (the Action Plan),* approved and endorsed during 1999 by the IAEA Board of Governors and General Conference respectively, the IAEA organized an ***International Conference of National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Materials***, which took place in Buenos Aires from 11 to 15 December 2000 (the ***Buenos Aires Conference***).

The ***Buenos Aires Conference***, hosted by the Government of Argentina, was attended by 89 regulatory officials from 57 Member States, 31 of those Member States being participants in the IAEA's Model Projects for the strengthening of radiation protection infrastructure, which cover 52 Member States. The conference provided a forum for fostering the exchange of information and experience on the development of adequate regulatory systems for effective control of the safety of radiation sources and the security of radioactive materials. It brought together a broad spectrum of high level officials and senior experts, from national authorities concerned with the regulatory control of radiation sources and radioactive materials, and was also of interest to senior policy and decision makers of other governmental bodies and institutions. The conference benefited considerably from the participation of the European Commission (EC).

In general, participants in the ***Buenos Aires Conference*** agreed that, although the safety and security during the use of radiation sources and radioactive materials in industry, medicine, research and teaching is adequate in most of the Member States; a number of accidents had occurred because a lack or breakdown of control, which have led in some cases to serious consequences, including deaths. Particular concern has been expressed over those radiation sources that have become 'orphans', i.e. sources that were never subject to regulatory control, or were subject to regulatory control but then abandoned, lost or misplaced, stolen, or removed without authorization. These sources are likely to be found in the public domain; examples include sources used in radiation therapy units, which have been unintentionally sold as scrap metal and melted thereafter, or which have been found by unsuspecting individuals or stolen, causing serious public exposure to ionizing radiation and radioactive contamination of the human habitat.

Therefore, the participants at the ***Buenos Aires Conference*** discussed mainly topics of current concern to regulators and the radiation protection community, such as estimated national inventories of significant radiation sources and radioactive materials; national regulatory infrastructures responsible for the safety of radiation sources and the security of radioactive materials, including descriptions of legislative infrastructure and the regulatory authority; national systems of notification, registration, licensing, and inspection of radiation sources and radioactive materials; and the enforcement of regulatory provisions. Discussions also included the national arrangements for the management of disused sources; the planning, preparedness and response to abnormal events and emergencies; the recovery of control over orphan sources; informing users and others who might be affected by lost sources; and education and training in the safety of radiation sources and the security of radioactive materials.

Particular attention was focused on the *Action Plan* and its implementation, and on the further development of activities to assist Member States in maintaining and, where necessary, improving the safety of radiation sources and the security of radioactive materials over their life cycle. Then, the ***Buenos Aires Conference*** facilitated a broad exchange of information and experience among the participants on the administrative, technical and managerial aspects required to ensure the regulatory control of radiation sources and radioactive materials by the national authorities. In this respect, emphasis was placed on the problems and difficulties confronted in establishing an effective regulatory authority operating within a suitable national infrastructure that must be supported by the government of each Member State and be able to act independently, and on the scope of the appropriate regulatory system for the effective control of radiation sources and radioactive materials.

Bearing these aspects above in mind, the ***Buenos Aires Conference*** came to a number of major findings which were essentially adopted as a resolution of the IAEA Board of Governors in March 2001.

These proceedings contain the invited and contributed papers, summaries of discussions, session and round table summaries, and the remarks presented at the opening of the ***Buenos Aires Conference***.

The ***Buenos Aires Conference*** Secretariat gratefully acknowledges the support and generous hospitality extended to the participants by the Argentinean authorities, in particular the Autoridad Regulatoria Nuclear of Argentina.

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WELCOMING REMARKS

A.A. Oliveira
Autoridad Regulatoria Nuclear (ARN),
Argentina

On behalf of the Nuclear Regulatory Authority of Argentina (ARN), I am both pleased and honoured to welcome you to this International Conference of National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Materials.

It would be negligent of me if I did not first express my thanks to the International Atomic Energy Agency (IAEA) for organizing this event and to the Universidad Autónoma de la Empresa (UADE) for providing us their home and support.

As you know, Argentina has been very active in stressing the need for all governments to ensure the existence within their territories of effective national systems of control for the safety of radiation sources and the security of radioactive materials.

Furthermore, at the time of the approval, by the Board of Governors, of the Action Plan devised to address the very important issue of “orphan sources”, in September 1999, and of its endorsement by the 43rd IAEA General Conference, Argentina offered to host this international conference. Such an offer is consistent with the great importance my Government attaches to this issue, and also with the nuclear regulatory authority´s tradition of active participation in the international efforts aimed at improving the safety of the array of applications which involve the use of radiation sources throughout the world.

I can see that this interest is widely shared by many governments since more than seventy countries are represented in this conference hall.

In September 1998, in his welcoming remarks to the conference on the safety of radiation sources and security of radioactive materials, held in Dijon, France, Abel González expressed the hope that the IAEA would like to see that conference as a turning point for our focus on radiation protection. In other words, the need for more effort into safety and security than in the past was emphasized. This conference is, therefore, an opportunity for demonstrating how well such a message has been taken into account.

I have stressed the role that regulatory authorities have in dealing with the delicate subject that has brought us together here today. Nevertheless, this is a game to be played by several players. Among them are organizations like those managing many radioactive sources and large quantities of nuclear materials, and users of sources in activities like gammagraphy, radiotherapy and industrial irradiators.

On the other hand, customs and security forces also play a principal role in the control of radioactive sources and nuclear materials. Representatives from all these local institutions are also attending this conference.

The national contributed reports to be presented and the discussions to be held during the week ahead and the outcome of this conference will certainly contribute to a review of present activities in this area. Only international exchange of expert knowledge can help us in ensuring the adequate regulatory control of radiation sources and radioactive materials.

Finally, I imagine that all of you are well aware of the fact that, for a major event like this to be a success, a lot of hard work by many people takes place behind the scenes. They know well who I am making reference to and how extremely grateful to all of them I am.

OPENING ADDRESS

A.J. González
Department of Nuclear Safety,
International Atomic Energy Agency,
Vienna

It is a special honour for me to open this International Conference on behalf of the Director General of the International Atomic Energy Agency, Dr. Mohamed ElBaradei.

I confess that I feel great emotion at being in such a privileged position in the city where I grew up, played football, was educated and entered into the wondrous world of radiation safety. I also confess that I feel rather uneasy about not addressing you in my mother tongue, the form of Castilian that distinguishes this city and is responsible for much of the poetry of the tango. But, given the rules of the United Nations and budget restrictions which do not allow for interpretation, you will have to suffer my somewhat broken English.

Let me first express the Agency's thanks to the Government of Argentina for hosting this event. Also, I wish to thank the Argentine Nuclear Regulatory Authority (ARN), represented here by its Chairman, Mr. Antonio Oliveira, and the Universidad Argentina de la Empresa, represented here by Mr. German Guido Lavalle, Dean of its Faculty of Engineering. But in particular I would like to thank all those who worked so hard at all levels to make this Conference feasible. I know from experience how much detailed work is necessary in order to organize such a large gathering of senior people and at the same time to provide a pleasant and relaxed atmosphere. To those who helped to resolve the many problems involved, allow me to express my sincere gratitude.

This Conference is a unique assembly of important regulators from all over the world. Most of you have travelled long distances to Buenos Aires, in pursuit of a common objective: to ensure that radiation sources are managed safely and kept secure and under control. The Agency is extremely thankful to all of you for giving up so much of your precious time.

Out of curiosity, it may be worth exploring briefly why the quest bringing us together here was in the past perhaps not given the attention it deserved. I would submit that radiation safety experts used to take it for granted that radiation sources would be safe and secure. They therefore concentrated on creating a framework for constraining and reducing the radiation exposures that inevitably arise during the operation of an already safe and secure source; and they did a superb job. The radiation doses resulting from the normal operation of radiation sources are extremely low and have been reduced more and more over the years through application of the principle of optimization of protection.

This general approach to radiation safety was reflected in national standards and, consequently, in the international radiation safety standards that the Agency established in discharging one of its most important statutory functions.

Until the latest international standards were adopted, relatively recently, the global guidelines were completely silent on the crucial issue of the security of radiation sources and basically silent as far as their safety was concerned. They included just a single obvious requirement, which went more or less as follows: "accidents with radiation sources should be prevented". I trust that you will agree with me that this was not very helpful.

During the preparation of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (the BSS), which — as you know — have been published by the Agency as Safety Series No. 115, there was a major effort by experts and consultants to remedy this situation. Member States of the Agency, however, did not want to go too far. Their argument was that the recommendations of the International Commission on Radiological Protection (ICRP) were basically silent on matters of safety and security and also that no serious breaches of safety and security were being reported, and the Agency had to take into account the ICRP's recommendations in the development of its standards. ICRP Publication 60 addressed the issue of safety for the first time under the somewhat cryptic title of "potential exposures" — namely, exposures that were not certain to occur but for which a finite probability of occurrence could be estimated. The issue was not explored in depth, however, and ICRP spent a number of years producing the recommendations which now represent its policy on this issue — namely, the recommendations in ICRP Publications 64 and 76, which were issued after the BSS had been approved.

Meanwhile, another decisive event had taken place: the Goiânia accident. I consider this accident to be what shaped the perception of experts regarding the seriousness of the problems of radiation source safety and security. They realized how a relatively simple breach in the security of a very common radiation source could have disastrous consequences. A few years before, an accident whereby a melted source crossed undetected from Mexico into US territory had created regulatory anxiety in the United States and had disseminated the crucial message that a breach in safety or security somewhere could make itself felt anywhere.

Perhaps it was the awareness created by the Goiânia accident and the Mexican accident, together with the many discussions on safety and security during the drafting of the BSS at the end of the 1980s, which led to the detection of accidents which would otherwise have gone unnoticed. The fact is that the 90s saw an increase in the number of investigations of radiation accidents involving breaches in safety or security or both. Many of these accidents were reported on by the Agency thanks to Member States' willingness to share lessons learned. The important Agency publications containing the reports created still greater awareness. They also made it clear that the problem was universal and not restricted to particular areas of the world or to particular levels of development. This was an important message that I wish to underline.

More or less at the time when these events were occurring, there came the somewhat protracted, traumatic dissolution of the former Soviet Union, where radiation sources had been in wide use for both civilian and military purposes. The dissolution was accompanied by the emergence of new States. The authorities of these States suddenly discovered that they had, distributed over their territories, many radiation sources to control and that they had no regulatory infrastructures on which they could rely. During the Soviet era there had been centralized control from Moscow, but that did not help the new authorities much as they started to build up regulatory systems from scratch. The magnitude of the problem became evident in an early forum of these authorities that took place in Vienna 4–7 May 1993.

These developments and many others that escape my memory were the ingredients for a cake that was ready for baking. The ingredients needed only to be but together for the world to become aware that action was long overdue. The initial step in this process was the successful conference organized by the Agency and hosted by the French Government two years ago in Dijon. There, hundreds of high-level experts emphasized the seriousness of the problem and concluded that prompt action was necessary. I remember that the conference ended on a Friday and that on the following Monday the 1998 session of the Agency's General Conference was due to start. At the end of the week, the General Conference, in which top-level representatives of Agency Member States discuss issues high on the political agenda, noted with interest the major findings of the Dijon Conference and requested the Agency's Secretariat to follow them up. After expert meetings in Buenos Aires and Washington D.C., hosted by the Argentine National Atomic Energy Commission and the US Nuclear Regulatory Commission respectively, a technical committee of high-level experts chaired by a representative of the US Environmental Protection Agency endorsed an Action Plan which was soon afterwards approved by the Agency's Board of Governors.

The Action Plan lays down many steps which are being successfully and expeditiously taken. One of these steps, which relates to the fostering of information exchange among regulatory authorities, involved the organization of the event that you are attending today.

The objective of this conference is clear: it is to enable you to share your experiences, your problems and the solutions that you have found to those problems. That would be more than enough for ensuring a successful outcome. We are ambitious, however, and looking at the conference programme you will realize that we wish to extract a little more from you. You will notice that this morning there will be a typical setting of the scene, with keynote presentations by the President of the conference, by the Chairman of the US Nuclear Regulatory Commission, Dr. Meserve, who has found time to be with us here despite his many commitments as head of the world's largest regulatory organization, and Dr. Croft of the United Kingdom's National Radiological Protection Board, who has been involved in the assessment of most of the radiation accidents assessed by the Agency. These presentations will be followed by national presentations that will facilitate the exchange of information. In addition, there will be three Round Tables on crucial problems with no easy solution.

The first Round Table will be on the essential issue of how to achieve effective control of radiation sources. The second one will try to bring clarity to a very complicated issue — namely, how to face the past, because we know that, even when superb national systems of control are in force, there will remain a large legacy of orphan sources from the past. What should we do about them? Should we try to localize and regain control over them? If so, how? And, if not, shall we be waiting for the next accident to happen? These questions do not have easy answers, but they should be explored. The third Round Table will concentrate on a difficult problem from which everyone shies away. This I call — in my own terminology — the problem of the regulatory authority which exists on paper but not in practice. What do I mean by that? I mean a regulatory authority that has been set up by proper legal procedures but cannot operate in practice, either for lack of funds or of expertise or simply because the government is not really committed to it. This may seem an esoteric topic, but in my judgement it is the one that most negatively affects the safety and security of sources. I would guess, and I do not do so disrespectfully, that a large number of States are suffering from this problem. Also, I would say that many have unwittingly exacerbated the problem by pushing for the establishment of legal radiation safety infrastructures as a kind of necessary and sufficient goal. As a result, many governments which have adopted national legislation believe that that was a necessary and sufficient measure for ensuring the safety and security of sources. In fact, it is clearly insufficient and, in my view, at the starting point of the establishment of a regulatory infrastructure it may not even be absolutely necessary. That belief — an illusion on the part of governments that by passing a law they solve a problem — is extremely dangerous. I do not wish to preempt the discussions of this Round Table, but let me state my view that the absolutely necessary condition for having an infrastructure that guarantees the safety and security of radiation sources is a critical mass of technically well educated and competent professionals with sufficient resources and the political commitment of the government.

At this conference there will also be an special session on “the international response”, with presentations not only from the Agency but also from the European Commission, which, by virtue of Article 31 of the Euratom Treaty, has an important regulatory role. The Euratom Treaty Article 31 Group of Experts discussed this important issue just a few days ago during a meeting that I had the honour to attend, and you will hear a report on the outcome. On the Agency side we will share with you information about some of our relevant activities, and in this connection I would particularly mention the presentation that will be made tomorrow by Ms. Anita Nilsson, who will address the complicated issue of preventing criminal activities involving nuclear and other radioactive materials.

In closing, let me introduce your President for this week, Dr. Dan Beninson. Dan is probably the radiation protection expert who least needs an introduction. His curriculum vitae speaks for itself: Scientific Secretary of UNSCEAR, Chairman of ICRP, and leader of influential participants in most of the international endeavours relating to radiation safety. He brings to the international arena the unique experience of building radiation safety in Argentina from scratch to what it is today. He could not be absent from this new phase in radiation safety. He travelled all round the world speaking about the need for international action to deal with the problems of radiation safety and security. When, in the last decade, everyone was ignoring the problem, Dan was emphasizing it at every meeting in which he participated. When ICRP ignored the problem, he was the one to introduce the concept of “potential exposure”, to ensure its inclusion in ICRP’s main recommendations and then to develop the follow-up guidance. It is not surprising therefore that it was Dan, the guiding spirit of the Dijon conference, who from Argentina’s seat in the Agency’s General Conference convinced the delegates of the need for political action. He was also the main drafter of the Action Plan which followed, and he convened — in Buenos Aires — the first meeting of experts in that connection. Finally, it was he who, from Argentina’s seat in the Agency’s Board of Governors offered Buenos Aires as the venue for this conference and invited Agency Member States to be represented. In my many years in the Agency’s Secretariat, I can remember very few occasions on which a conference presidency was more richly deserved than this one.

SETTING THE SCENE
(Session 1)

Chairperson

D.J. BENINSON
Argentina

EFFECTIVE REGULATORY CONTROL OF RADIOACTIVE SOURCES

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INTRODUCTION

The theme of this meeting — the effective control of radioactive sources — is one that has been the subject of considerable discussion over the past several years. I believe that I can best contribute to that discussion by providing a US perspective on the challenges we face and the potential paths to their resolution. I also hope to learn from your experiences.

Before getting into details, let me frame the issue.

THE ISSUE

The use of radioactive sources is now commonplace throughout the world. Such sources are in widespread use in medical practice, in academic research, and in numerous industrial applications, such as gamma irradiation, radiography, gauging, gas chromatrography, and well logging. Domestic and international commerce in these sources is extensive. As all of you know, although these sources are particularly useful, they are also potentially harmful if misused or if misplaced or stolen.

Despite strong efforts by the International Atomic Energy Agency (IAEA) and others, much work remains to establish effective national and international control over radioactive sources. And the controls that do exist — in my country and probably in each of yours — are often hampered by less than effective communication between the users and the regulatory agency and by the failure to focus on the most important problems.

Public attention is often more closely focused on the radiation and environmental hazards associated with the nuclear fuel cycle, and particularly with the dangers arising from power reactors, than on those associated with radioactive sources. The number of operating nuclear power reactors around the world is relatively small — approximately 440 reactors, of which 103 are in the United States — but they attract close attention. Reactors contain substantial amounts of radioactive material under conditions of pressure and temperature that could cause very serious adverse consequences for a substantial number of people in an accident. Thus, governments are certainly justified in focusing resources on ensuring reactor safety because a reactor accident could entail significant consequences, however unlikely such an accident might be. Fortunately, in the USA no member of the public has received exposures in excess of regulatory limits from activities at a nuclear power plant. Even the worst reactor accident in the USA the accident at Three Mile Island Unit 2 — did not result in the exposure of any member of the public to radiation in excess of the applicable dose limits.

Notwithstanding this focus of public attention on reactors, we should be mindful that the public health issues associated with radioactive sources also are important and should command attention commensurate with the hazard they pose. US operational experience with radiation sources includes many incidents, some of which have resulted in serious radiation exposures in excess of applicable limits. For example, in one incident in 1996, two cobalt-60 cameras and an iridium-192 camera were stolen from a location in Texas and eventually made their way to a scrap yard. When a cobalt-60 sources was dislodged from one of the devices, workers and customers of the facility and law enforcement officers received whole body doses of up to 0.1 Sv (10 rem).[1]

It is clear from this example that, if control of radioactive sources is lost, these devices can constitute a significant hazard to the public. Although the cumulative impact from an event involving a source may be less than that arising from a reactor accident, the likelihood of an event is larger. In contrast to the 103 licensed nuclear power plants in the US there are about 150 000 licensees for radioactive materials in the US and about 2.0 million devices containing radioactive sources in use by licensees.[2] On the basis of experience and in view of the large number of sources, I conclude that the likelihood of serious radiation exposure of a member of the general public is larger from radioactive sources than from civilian reactors.

THE CHALLENGES

The control of radioactive sources poses challenges on both national and international scales. The public is generally unaware of the widespread use of radioactive sources and the hazard that their misuse can pose. As a result, the public and political pressure in support of legislative or regulatory action in this area, in contrast to that brought to bear in the power reactor arena, has not been strong. Under these circumstances regulatory authorities have not always been able to devote the resources to the control of radiation sources that the hazards deserve. The challenge is to find ways to use the limited resources that are available to achieve the greatest public benefit.

Although all countries have a vested interest in protecting their citizens from exposure due to misused, misplaced, or stolen radioactive sources, controls are not as effective as they should be. There is a lack of an awareness of the hazards posed by these devices, limited experience in regulating such sources, and limited resources to do the job. The IAEA has noted that more than 100 countries are thought to lack effective control over radiation sources because most do not have the required infrastructure[3]

Each of us also has an interest in the adequacy of controls in other countries because commerce in sources and devices is conducted on a global scale, and no country can effectively prevent contaminated products from crossing its borders. For example, we have discovered that on ten occasions radioactively contaminated metal products were imported in the USA and, of course, we do not know how many times such materials were imported without being detected. The sources of contamination in most of these cases are probably radioactive sources that became mixed with the raw materials used to make the products. Although none of the discovered cases resulted in significant exposures to the public, their unexpected appearance in the marketplace raises concerns. The lesson to be learned from

[1] *See* NRC, "Final Report of the NRC-Agreement State Working Group to Evaluate Control and Accountability of Licensed Devices," App. H, October 1996; Dicus, G.J., "USA Perspectives Safety and Security of Radioactive Sources," 41 IAEA Bulletin no. 3 23 (1999).
[2] These figures do not include sources used by the Department of Energy or sources licensed exclusively by the states (such as radium sources).
[3] Gonzalez, A.J., "Strengthening the Safety of Radiation Sources & the Security of Radioactive Materials: Timely Action," 41 IAEA Bulletin no. 3 9 (1999).

these cases is that the loss of control of radioactive sources in one country has the potential to affect the health and safety of the citizens of another country.

There is thus an international challenge to heighten the global awareness of the hazards posed by radioactive sources, to attempt to bring some consensus on how these hazards are to be addressed, and to initiate improvements in the regulatory systems throughout the world. As I will note in more detail later in my presentation, the IAEA is in the forefront of efforts to define the problem on a global scale and is helping Member States to work towards effective solutions.

Let me now turn to some of the initiatives that the US Nuclear Regulatory Commission (NRC) is taking to improve control over radioactive sources in the USA. So that those initiatives can be understood in context, I would first like to provide background on the NRC's programme.

THE NRC'S ROLE

You may be surprised to learn that the NRC's authority is not sufficiently extensive to cover all the hazards presented by sources. Under US law, the NRC has the authority to regulate the civilian use of sources and devices that incorporate radioactive materials that are produced by reactors. The NRC does not regulate sources or devices that incorporate radioactive materials obtained in other ways, such as accelerator-produced materials, or sources containing certain naturally occurring radioactive material, such as radium. Moreover, the NRC may allow an individual state to enter into an agreement to assume the NRC's responsibility over nuclear materials. Thirty-two of the 50 states have accepted this role and thus have assumed regulatory authority for radioactive sources. States with agreements currently have jurisdiction over roughly three-fourths of the radioactive sources in the US In these states, the NRC maintains oversight to ensure that the sate programme are compatible with the NRC's programme, but otherwise the NRC relies on the states to ensure the protection of public health and safety.

Nonetheless, the NRC does play a central role. The NRC is the single federal agency with the greatest responsibility in this area and the NRC establishes the general framework within which each of the states exercises its authority. The NRC also promulgates regulations, issues guidance, and disseminates information. The NRC licenses manufacturers and distributors, and NRC staff routinely inspect their activities for compliance with the conditions and requirements of their licenses. The NRC also certifies the designs and production of sealed sources and devices, leading to the listing of products in a Sealed Source and Device Registry.

As I mentioned before, there are roughly 2.0 million devices (licensed under either general or specific licences) containing radioactive material in use in the USA today. Approximately, 20,000 persons or companies are specifically licensed to manufacture and/or use either sealed or unsealed sources. In addition, approximately 135,000 companies possess generally licensed sealed sources and devices for specified uses. Medical use is widespread; radioactive materials, as both sealed and unsealed sources, are used in 10 to 12 million diagnostic and therapeutic clinical procedures each year.

In regulating these devices, the NRC and Agreement States issue *specific* licences to users to allow the use of certain sources and devices for certain designated applications, such as medical brachytherapy and teletherapy, industrial radiography, product irradiation, well logging, and laboratory research. Specific licences are generally issued because the types and quantities of isotopes present in these devices present a greater hazard than the material found in generally licensed devices. There are approximately 260 000 devices with specific licenses. These devices are inspected on an annual basis and are subject to careful regulatory scrutiny. In my view, our regulatory system for specifically-licensed devices is adequate.

The NRC and Agreement States also issue *general* licenses to users for certain other sources and devices with applications in measuring, gauging, process control, light production, and ionized atmosphere production. There are about 1.8 million such devices in the USA. As noted previously, sources licensed under a general license are usually smaller than those that are specifically licensed and represent much less risk to health and safety. Persons who receive sources subject to a general license are required to meet certain regulatory requirements, such as maintenance, transfer, and testing of these sources and devices, but are not subject to the details scrutiny that is typical of our specific licensees. We have seen the need to tighten our controls on these devices, as I will discuss in a moment.

In order to complete the survey of our regulatory programme, I should also mention accountability. The agency conducts an enforcement programme that can include civil penalties and, in egregious cases, even criminal prosecution. For example, in 1989, the NRC imposed a $20 000 civil penalty on one licensee for multiple failures that resulted in the thefts or losses of moisture density gauges. On average since 1996, we have taken escalated enforcement action against six licensees per year for lost sources. Escalated enforcement action is generally reserved for those violations that have significant health and safety implications.

The US suggests that there are several key elements of an effective regulatory programme for sources[4]. Such a programme should entail several interdependent activities: developing an appropriate regulatory system, devoting resources to implementing that regulatory system and ensuring accountability, and establishing measures to address the potential for loss of control of radioactive sources.

In developing an appropriate regulatory system, consideration should be given to the diversity of radioactive sources and the relative hazards the sources pose to the public if loss of control occurs. In this way, the level of regulatory rigor applied to various devices can be commensurate with the hazard they pose. Priority must be given to sources that represent a threat to human life from acute exposure if they are misused, lost, or subject to improper disposal.

Resources must be devoted not only to the development of the regulatory system, but also to undertaking inspections and ensuring accountability. An important and often overlooked component is the need to educate the users of sources about the dangers that the sources pose so as to encourage both safe use and proper disposal.

Finally, no regulatory system can be 100 per cent effective. As a result, programmes should address the need for proper emergency response measures to address those cases when loss of control occurs. Key to the success of all these activities is the dissemination of information through established lines of communication between and among licensees and regulators.

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[4] *See* "Final Report of the NRC-Agreement State Working Group to Evaluate Control and Accountability of Licensed Devices", October 1996, (NUREG-1551)

THE UNITED STATES' EXPERIENCE WITH ORPHAN SOURCES

I know that you are interested in the US experience with orphan sources — the subject of this conference. On the basis of information available to the NRC, an average of approximately 375 sources or devices of all kinds are reported lost or stolen each year in the USA — that is, roughly one per day.[5] Fortunately, significant radiation exposures are relatively rare. It is likely, however, that we were just lucky in avoiding overexposures.

In addition to the potential for overexposure to occur as a result of a stolen or misplaced source, property damage can also result, particularly when the lost source appears in scrap destined for recycling at a metal mill. Since 1983, steel mills have accidentally melted radioactive sources on 20 occasions, while other metal mills have accidentally melted sources on 10 other occasions. The origins of the radioactive sources in the scrap are unknown because the sources were melted before they were detected. Although radiation exposures of mill workers and the public were estimated to be low, the financial consequences of the events have been large. The remediation costs for the affected mill shave ranged up to $23 million. As a result. most mills now have metal detectors to scan incoming scrap in order to avoid the inadvertent acceptance of a discarded radioactive source. In fact, some facilities have multiple monitors: at the entry gates, at the scrap bucket, and at the entry to the furnace itself.

One consequence of this experience with orphan sources is heightened concern by the metal recycling industry about the release of any materials for recycling from licensed sites, no matter how slightly radioactive. The NRC has been exploring whether to establish a rule for the release of slightly contaminated material — a clearance rule. The metal recycling industry has been vigorous in its opposition. Part of this opposition does not arise from health or environmental concerns, but from the perceived loss of attractiveness of recycled metals that contain trace levels of radioactivity, however small. Part of this opposition, however, also arises from concern that materials released pursuant to a clearance rule might trigger the sensitive alarms at the portals of mills, thereby compromising the capacity of mills to discriminate incoming scrap that includes a lost radioactive source. Thus, the concern about lost sources is having its effects on seemingly distant subjects.

SOME RECENT INITIATIVES IN THE UNITED STATES

Although the US has the benefit of a mature regulatory programme, we have concluded in recent years that more should be done to provide a greater margin of protection to the public. Let me again note that these initiatives apply to generally licensed devices because the existing programme is adequate for the higher activity sources covered by specific licenses.

We believe that we have adequately addressed the need to ensure that such devices are designed and manufactured to minimize the potential hazard that the source can present from normal or abnormal use. However, our experience has shown the need to improve accountability for generally licensed sources and to develop programmes to respond when orphan sources are discovered.

In order to enhance accountability, the Commission has developed a registration programme for improved tracking for generally licensed sources that pose a significant hazard to public

[5] Recent data indicate some improvement: the number of reported loses has decreased steadily from 399 in 1997b to an estimated 288 in 2000 (accordingly to 240 reports through October of 2000).

health and safety. The registration requirement will apply to about 4300 general licensees possessing about 17 000 devices and about 12 000 general licensees in Agreement States possessing about 49 000 devices. We are in the final stages of promulgating a rule that would require that general licensees appoint a responsible individual to ensure day-to-day compliance with the regulations[6]. The specifically-licensed distributor of a generally licensed product would be required to obtain the name, title, and telephone number of this person from its customer, and to provide this information to the NRC or the Agreement State in quarterly transfer reports. For those registering devices, information on the responsible individual will be updated through the registration process.

Devices containing more than specific threshold amounts of cesium, strontium, cobalt, or americium or any other transuranic must be registered annually. Information required for registration includes the address or location at which the devices(s) are used and/or stored. Registration provides the NRC with reasonable assurance of licensees continuing accountability.

Additional labelling also would be required to ensure that devices can be identified as containing radioactive material and can be traced back to the responsible party in the event of loss of control. As an additional incentive for licensees to comply with these requirements, the NRC's enforcement policy would be changed to incorporate separate (and significant) base civil penalties for loss, abandonment, or improper transfer or disposal of sources and devices.

"Orphan" sources obviously require a different approach. Although orphan sources comprise only a small portion of the total number of sources in commerce, they obviously are likely to present a greater hazard to the public than sources that are subject to appropriate control. Therefore, the NRC has been working with other federal an state agencies to establish a special programme for such sources. The central focus of this effort is the development of mechanisms to ensure that someone takes responsibility for orphan sources when they are found. The Environmental Protection Agency (EPA) now provides this service on a limited basis when public health is at risk. We are considering a more comprehensive contract programme that would enable the US Department of Energy or other qualified parties to take possession of and arrange for proper transfer or disposal of orphan sources. A pilot project of this kind is currently being conducted in Colorado where a state organization is gathering and disposing of unwanted and orphaned cobalt-60 and caesium-137 sources. If successful, this pilot project could form the basis of an expanded orphan source programme, pending the outcome of ongoing consultations with other federal agencies and the states to define jurisdictions and regulatory responsibilities and pending the outcome of evaluations of costs.

Our efforts to improve communications should also be mentioned because gathering and disseminating information are central to effective control of radioactive sources. As many of you know, the NRC maintains a Nuclear Materials Events Database. The database contains over 10 000 records of materials events submitted to the NRC from approximately January 1990 to date. The NRC is expanding this database to include data on orphan sources which, thereby, enables users to search source or device information on found orphan sources.

The NRC also generates quarterly reports on trends, on radiation events, and the causes of corrective actions for significant events. The information provided in these reports allows the NRC to make informed judgements about the effectiveness of and potential need for change in

[6] The proposed rule is found at 64 Fed. Reg. 40,295.

its regulatory programme. Because we have found this information useful, we believe that its dissemination may also be helpful to others involved in regulating radioactive sources. The quarterly reports are available on the Web at http://nmed.inel.gov/nmed

We also need to raise awareness about the responsibilities that attend possession of radioactive materials. As a result we now require vendors of sources to provide specific information about pertinent regulatory requirements to users. Included in these communications are the licensees' obligations regarding disposal; this reflects the reality that improper disposal is often the origin of incidents that result in risks to the public. The states also are undertaking programmes in both information dissemination and training to strengthen accountability by informing people about identifying and properly disposing of unwanted or uncontrolled radioactive material. The Conference of Radiation Control Program Directors, an organization drawn largely from the state regulators, has produced a brochure and maintains a web site on the internet on this subject[7].

Because significant risks can result from accidental incorporation of sources in processing recycled metals, we have made a concerted effort to raise the awareness of personnel in the metals industry so that they can more readily identify sources and devices and respond appropriately when they find them. Also, working the US EPA in a joint effort to enhance the ability of environmental response teams to identify uncontrolled radioactive materials and to increase awareness of the importance of proper handling and disposal.

Although the United States has a relatively mature regulatory programme for radioactive sources, we have found it necessary to undertake significant enhancements in recent years. Each of these initiatives is a small but important step in what must be a steady effort to enhance controls, to improve responsible behaviour by licensees, and to strengthen governmental capacity to respond to incidents involving radioactive sources.

THE INTERNATIONAL EXPERIENCE

Now let me return to the international scene.

As I indicated earlier, the IAEA has demonstrated strong leadership through the elaboration of education and training needs and support of the development of national regulatory structures by Member States. The Model Project on "Upgrading Radiation Protection Infrastructures", which is scheduled to be completed later this month, is a clear demonstration of IAEA's leadership. The associated plan for action to develop, prepare, and implement activities to assist Member States in maintaining and, where necessary, improving the safety of radiation sources and the security of radioactive materials is paying real dividends, particularly in the nations of the western hemisphere. The development of the database of unusual radiation events (RADEV) to capture international data on radiation incidents and accidents is another important tool an assessing and addressing the problem before us. In addition, the IAEA General Conference in September passed several nearly unanimous resolutions that helped to define the problems that the international community and Member States must solve in order the achieve a system of effective accountability and communication. I am pleased that the United States has been fully supportive of these activities, providing funding and expertise to further co-operative work in this field.

[7] This site is found at http://www.crcpd.org/Orphans.htm

The Latin America experience illustrates what can be done with the IAEA's help to identify and secure radioactive sources. By the end of this year, all Member States in that region will have had radium sources collected and conditions for long term storage. The elimination of the radium source hazard in Latin America is clearly in sight and is a tribute to the countries involved. The record of achievement being written in Latin America is an encouraging sign indeed.

This conference also is an indication of progress. The opportunity to share views and experience is vitally important for ensuring that the international community continues to make progress in the control of sources.

We all recognize, however, that the achievements to date, both nationally and internationally, are just a beginning. And, although the IAEA plays an essential role, progress in the field depends on the hard work of each of us and the national and local regulatory agencies that we represent. I do not underestimate the challenges, but as experience is gained and confidence built — and as resources become available — we can build comprehensive and robust programmes to minimize the risk that radioactive sources present.

CONCLUSION

In summary, radiation sources and devices containing radioactive materials can provide important benefits to individuals and societies when they are properly designed, safely used, and carefully managed. Effective national and international programmes are needed to ensure these characteristics, however, because these sources and devices can represent a significant hazard to public health and safety.

In the light of the large number of radiation sources in use worldwide, the safety record on balance is remarkably good. But, as we all appreciate, there is still considerable room for improvement. The IAEA has an important role to play, and it is playing it effectively. International programmes to facilitate the exchange of information and experience among local, national, and international bodies are central to ensuring effective co-operation on the control and security of radioactive materials. This conference is another key step in achieving the common objective of the safe use of these sources and devices worldwide.

ORPHAN SOURCES: CONSEQUENCES, REGAINING CONTROL AND LEARNING THE LESSONS

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INTRODUCTION

Technologies that make use of radiation sources and radioactive material continue to spread around the world. They are to be found in industry, medicine, research and teaching and provide many benefits. The safety and security record of the technologies and their application is adequate in most cases, but on occasions there has been a lack of appropriate controls or circumvention of those that exist, leading to radiological accidents. These can have serious consequences, including the death of some exposed persons and environmental impacts with serious economic consequences. Experience from such accidents over the last decade or so prompted the IAEA, in collaboration with the European Commission (EC), Interpol and the World Customs Organization (WCO), to jointly sponsor an international conference on the topic in Dijon, France, in September 1988 [1]. Particular concern expressed at that conference, and since, has been over those radiation sources that have become “orphans”, i.e. sources that were never subject to regulatory control, or were subject to regulatory control but then abandoned, lost or misplaced, stolen or removed without authorization. These sources are likely to be found in the public domain; examples include sources used in radiotherapy units which have been unintentionally sold as scrap metal and melted thereafter, or which have been found by unsuspecting individuals or stolen, causing serious radiation exposure of people (in some cases involving deaths) and contamination of the human habitat.

Previous presentations from Beninson [2] and Meserve [3] have respectively covered the overall potential risks from orphan sources and the need for preventive measures through effective regulatory control. Nevertheless, experience indicates that control of some radiation sources will be lost or, more pressingly, has already been lost and that radiation sources are in the public domain: in essence, accidents waiting to happen. Competent authorities and international organizations need to address these issues and this involves two main strategy decisions on:

i) an appropriate programme to detect and locate orphan sources; and

ii) emergency preparedness plans to regain control of radiation sources, once located, and to deal with the consequences arising from their having been out of control.

The first of these is covered in the paper by Gayral [4] and it is the other that is the focus of this paper. The intention is not to go through every possible element of emergency preparedness plans (that is adequately addressed in a number of IAEA publications [5, 6, 7]; but to focus on some of the key issues involved and to illustrate them by reference to previous accidents. In addition, the paper addresses the need to complete the loop and provide feedback that helps regulators, suppliers and users to learn the lesson from accidents and hence improve the control of radiation sources.

INITIAL RESPONSE ARRANGEMENTS

Emergency preparedness needs to take into account several phases, principally the initial response, the planned source recovery and restoration/clean up phases. Throughout these phases there will be different streams of action, for example those targeted at health effects and environmental impacts, investigating causes and dealing with media interest.

One of the key objectives in the initial response phase is to minimize the degree of uncontrolled exposure following the first indication that there may be an uncontrolled radiation source (or sources), such as an orphan source. This requires those identifying a potential problem to be able to have quick access to expert assistance. It is therefore sensible to first look at the possible trigger points.

POTENTIAL TRIGGERS TO RESPONSE ACTIONS

Health Effects

In the more serious cases the first indication of an orphan source can be persons presenting themselves to doctors with health effects such as radiation burns or acute radiation syndrome. The initial symptoms presented may not be unique to radiation effects. In a number of accidents these have not been immediately diagnosed as such.

- **San Salvador, 1989** [8]. Three workers who had been involved in an irradiator accident (but not aware of the significance) presented themselves at the local hospital on the same day. All were vomiting but were misdiagnosed as suffering from food poisoning. When they returned three days later, still with the same symptoms, but now with strong general erythema, a correct diagnosis was made. The irradiation plant was contacted but communications failed and the significance was not appreciated. During the original accident the source array holding the source pencils had been damaged and over the next six days, some source pencils spilled out. Although there was some exposure of other staff, fortunately none of the source pencils (each about 20 TBq Co-60) fell into one of the product boxes that would have taken them outside the irradiation chamber and possibly the plant. Thus, during this six day period there was a real potential for further significant exposure at the plant and for a source to get into the public domain.

There are many other examples, including accidents in Goiania [9], Tammiku [10], Lilo [11] and Istanbul [12]. To help address this, the IAEA and WHO have produced guidance on the diagnosis and treatment of radiation injuries [13, 14]. However, national initiatives are necessary to disseminate this information — and, importantly, information about who to contact following diagnosis.

Intelligence Information

The primary focus of intelligence agencies and police forces in this area is on the illicit trafficking of nuclear material. However, the information gathering networks can also generate information on orphan sources, alerting authorities on possible illegal movements of sources. Alternatively, the network can be used in the investigation element to track down the origins of sources. Details of a system operated by Interpol are given in the paper from the United Kingdom [15]. The very nature of intelligence work requires an excellent network, but by the same token the availability of information can be to a restricted group. National arrangements need to ensure that for potential radiological incidents the information is disseminated to those who need to know.

Planned Monitoring Programme

Planned monitoring programmes for orphan sources can have both static and mobile elements. Examples of the former may be border monitoring equipment or portal monitors for truck/train access to metal recycling plants. These are dealt with in more detail by Gayral, but there are some points relevant to the initial response.

- Installed monitoring systems will routinely detect potential radioactive sources. In some instances these will be false readings due to the characteristics of the installations. Some will be due to naturally occurring radioactive material, some due to radium luminized items, but some will be orphan sources. Clearly there is a need to ensure that the operators of these facilities have suitable training and that relevant guidance is available The objective is to enable them to deal with day-to-day insignificant finds, but also to know when to ask for expert assistance and who and how to ask.

- Are there arrangements to deal with initial storage and subsequent disposal of orphan sources that are found? Border monitors, by their nature, will be run by the competent authorities and the cost of the disposal of sources will be absorbed by overall costs. However, the vast majority of portal monitors for the metal recycling industry are installed by plant operators to protect their facilities, and they or their suppliers will have to pay the storage and disposal costs. These can be significant. The question is raised as to whether they are incurring the costs of poor regulation of sources and whether this is fair. Of practical significance is that as one goes down the metal recycling chain to the smaller operator, disposal costs can become a positive disincentive to detect and/or report orphan sources.

Suspicious Items or Events

One of the common routes by which orphan sources come to notice is through a member of the public finding either a package or a device that is in some way suspicious or has indications that the contents may be radioactive. If there are no warning signs, or the people do not understand them, and they are inquisitive, then significant exposure might ensue and discovery would be by the health effects. However, in many cases the “authorities” are notified of a suspicious package. Who these “authorities” are will differ from country to country, but often they will be the police. Whoever they are, they are unlikely to have the expertise, readily available, within their own organization. Therefore, arrangements need to be in place to enable the “authorities” to summon expert assistance quickly. The general requirements are addressed in an IAEA TECDOC [5] and an example from the UK is given below.

UK ARRANGEMENTS: NAIR

In the UK these arrangements are known as the National Arrangements for Incidents involving Radioactivity (NAIR) [16] and are administered by the UK National Radiological Protection Board (NRPB). NAIR has been devised around the provision of assistance to the civil police, since that body will normally be among the first to be informed of an incident in a public place, and it is in any case the police, who in the UK, have the prime responsibility for ensuring the safety of the general public. Other bodies such as fire and rescue services may on occasions be faced with incidents involving radioactivity. Where the general public is involved, they go through the police to summon assistance.

The country is divided into areas of assistance based on the different police forces and assistance can be provided in two stages. Stage 1 assistance is provided by a radiation expert, usually a local hospital physicist, who — with the aid of relatively simple monitoring equipment — can advise the police on the appropriate action to take. The expert will have limited resources and will normally only be able to carry out small recovery operations. He will not be equipped to cope with an incident involving the spread of contamination, unless it is of a minor nature. Where the incident is beyond his capability to restore, he will advise the police to obtain Stage 2 assistance. Advice will also be given on the steps that should be taken to prevent undue exposure of the public, such as the erection of barriers or covering and containing contaminated material to prevent its spread.

Stage 2 assistance is provided by the nearest nuclear establishment. It will comprise a team of up to four people (as required by the situation) including an operational health physicist with suitable monitoring equipment, special clothing, decontamination facilities and communication links enabling them to call up further resources if needed. A single telephone number is now provided and manned 24 hours. The person answering will have up-to-date contact details for Stages 1 and 2 NAIR respondents, and will also alert the Environment Agency, as appropriate.

The NRPB periodically publishes a NAIR Handbook [16] that provides:

- guidance on dealing with incidents
- guidance on monitoring instruments and equipment
- radionuclide data and guide to suitable detectors
- package and source identification information
- information on the disposal of radioactive materials.

In addition, the NRPB runs a series of training courses for those involved. These include syndicate exercises on how to deal with a range of scenarios. NAIR has been operating for nearly 40 years and has proved itself to be robust and effective in dealing with a wide range of situations. It is emphasized that NAIR applies only to where the public may be involved. Users of radioactive materials are required by law to have their own emergency arrangements. In most cases this would necessarily include access to a “qualified expert” on radiation protection, known in the UK as a radiation protection adviser (RPA). The NRPB is RPA to over 900 organizations and therefore has a depth of experience in dealing with emergencies.

LEGAL PROCEEDINGS

Whilst regaining control of sources and protecting people are the primary objectives, those dealing with incidents need to keep in mind that regulatory or criminal enforcement action may be necessary following the investigation of an incident. Therefore, there is need for guidance by competent authorities, on the custody or care of potential evidence.

SCALE OF PROBLEM AND RESPONSE

Whatever the emergency preparedness arrangements are in each country, one of the above potential trigger routes is likely to result in a telephone call to a contact point with a radiation protection expert. That person will need to have contact details of regulatory bodies and other relevant organizations and to know how to mobilize resources. However, the extent to which these are pursued will depend on judgements made by the expert. Those judgements will depend upon:

- the experience of the expert; from training, first hand experience of incidents and feedback from other incidents;
- the information available and acquired by the expert.

It is a fact of life that in these situations, you rarely, if ever, have all the information that you would like in order to make judgements. However, the level of knowledge gained from experience and training is crucial to ensuring that the expert maximize the pertinent information available. Here, it is highly desirable that, in the first instance, the expert speaks directly by telephone, radio etc to a person at the scene and other key persons. Information passed through a third party can be unintentionally distorted.

There will inevitably be a delay between when the expert is first contacted and when he or she can reach the scene. It is therefore important that the expert provides advice to those at the scene to help prevent further uncontrolled exposure and minimize any possible spread of contamination. This advice will undoubtedly have to be given on the basis of imperfect information, but the judgements must be made. Similarly, the expert will need to have a feel for whether the incident is at a level that he/she can deal with or whether it would be prudent to get backup resources on standby or, in extreme cases, mobilized.

CATEGORIZATION OF SOURCES

To help in these judgements, the IAEA has adopted a categorization of sources [17]; shown in Table 1. This categorization recognizes that activity alone is not the only relevant criterion. Another key criterion is the use to which the source is put, as this can reflect the probability of a source entering the public domain and causing serious harm. For example, industrial radiography sources generally have orders of magnitude less activity than radiotherapy and irradiation sources, but the circumstances in which they are used provide a significant potential for control of the source to be lost. Similarly, the greater mobility of low dose-rate brachytherapy sources than that of high dose rate brachytherapy sources makes the threat from both types about the same.

Table 1. IAEA Categorization of Sources: adopted by General Conference September 2000

Category	Types of Source
1	Industrial radiography
	Teletherapy
	Irradiators
2	High dose-rate brachytherapy
	Fixed industrial gauges involving high activity sources
	Well logging
	Low dose rate brachytherapy
3	Fixed industrial gauges involving low activity sources

- **Morocco (1984)** [18]. In this serious accident, eight members of the public died from overexposure to radiation from a radiography source. A 1.1 TBq (30 Ci) iridium-192 source became disconnected from its drive cable and was not properly returned to its shielded container. Later, the guide tube was disconnected from the exposure device and the source eventually dropped to the ground, where a passer-by picked up the tiny metal cylinder and took it home. The source was lost from March to June, and a total of 8 persons (the passer-by, members of his family and some relatives) died; the clinical diagnosis was 'lung haemorrhages'. It was initially assumed that the deaths were the result of poisoning. Only after the last family member had died was it suspected that the deaths might have been caused by radiation. The source was recovered in June 1984 [16].

  This is a classic example of a radiography accident and of the consequences that can ensue when no radiation surveys are performed to ensure that a source has returned to the fully shielded position.

- **Yanango, Peru (1999)** [19]. In this accident, gamma radiography using a 1.37 TBq iridium-192 source in a remote exposure container was being carried out at the Yanango hydroelectric power plant. At some stage the "source pigtail" became detached from its drive cable. A welder picked up the source, placed it in his pocket and took it home. The loss of the source was noticed the same day and it was recovered within 24 hours. However, the dose received in this period was such that, despite heroic medical treatment, the welder lost one leg and had other major radiation burns. His wife and children were also exposed, but to a lesser extent.

In May 2000 near Cairo, Egypt, another fatal radiography accident occurred [20]. It is understood to have involved a 1.85 TBq iridium-192 source found by a farmer. He and his son died. As yet, there has been no formal publication covering the accident.

Gamma radiography provides the potential for sources to become disconnected from their drive cables and become orphan sources. An essential element of source security is routine monitoring to demonstrate that a source has returned to the fully shielded position. Gamma radiography on sites is often carried out under difficult circumstances with limited supervision. The combination of potential equipment failures and human failures can be a lethal combination. The examples above clearly demonstrate why gamma radiography sources have been categorized as providing one of the highest risk potentials.

THE INITIAL VISIT

Almost irrespective of the information available, the expert will need to visit the site where the suspected source is located and make radiation measurements. In many cases, the measurements will confirm that no radioactive material is present and that it was a false alarm. Quite often, this is due to packaging marked with the trefoil system being inappropriately disposed of. Nevertheless, the origins of the packing may need to be followed up for legal reasons. Also, such events do have a value:

- They test the contact arrangements for the initial response; and
- they provide reassurance to the public and the authorities that in the event of a real problem the arrangements would work.

Next up the scale of incidents are those involving category 3 sources. These will tend to be relatively small events, involving a simple recovery of a source and/or taking a found shielded source into custody. Events involving category 2 and 1 sources are likely to be more challenging, requiring more careful planning of the source recovery. However, in all cases there is more to dealing with the event than just making the source safe and putting it in safe storage.

TIP OF ICEBERG?

Is the origin of the source known? When was it last under regulatory control and what has happened to it since? These questions are partly related to the investigation of the causes of the incident, but also to trying to identify the potential exposure of people who may have been in the vicinity of the source and to discover whether there are other orphan sources out there.

- **Lilo, Georgia (1997)** [11]. The initial trigger to the detection of this incident was several soldiers from the Lilo Training Centre developing skin lesions. This prompted radiation measurements being made at the Centre and a radiation source (164 GBq casesium-137) was recovered from a soldier's coat pocket. Crucially, the search did not stop at this point; a further source (126 GBq caesium-137) was found buried 30 cm below the surface of the football field. Searches located another eight unshielded caesium-137 sources ranging from 0.02 to 0.88 GBq. In addition, several other sources in shielded containers and radium luminized devices were found. The sources had been used by the previous military owners of the facility for training purposes. When they left, they abandoned the sources and the inventory of sources was not transferred to the new owners. Taken together with other "finds"/incidents elsewhere in Georgia, this prompted co-operation between the Georgian authorities and IAEA to carry out an aerial survey using French capabilities [4].

- **Tammiku, Estonia (1994)** [10]. In this accident, a radioactive cylinder in a metal frame was first found in a consignment of scrap metal imported to Tallin, Estonia. The source was estimated to be between 150 GBq and 7.4 TBq caesium-137. It was thought to be part of an irradiation unit. It was successfully recovered and taken to the national waste disposal facility. Unfortunately, the security of the facility was poor and it was stolen for resale as scrap metal by three brothers. As a result, one brother died from radiation exposure and the other two brothers and two other members of the family suffered deterministic effects. The original find of the source in scrap metal imports had raised queries about other possible orphan sources being out of control in Estonia and a governmental commission to assess the situation was set up. During its work, the commission found a 1.6 TBq caesium-137 source in a container that had been abandoned close to a main road in the countryside.

  In all situations where a source had been out of control there is the need to check the source integrity and that there has been no dispersal of activity. Extreme examples of the consequences from damaged sources can be found in the Juarez (Mexico) [21] and Goiania (Brazil) [9] accidents (see below).

RESPONDING TO MAJOR RADIOLOGICAL INCIDENTS

Major radiological incidents are likely to involve category 1 sources, but could also stem from category 2 sources, for example where the source has been ruptured and dispersed via a variety of routes. In preparing plans to deal with such situations, a distinction needs to be made between the phases of:

(i) bringing sources under control and ensuring that there is no further uncontrolled exposure, e.g. the source put in a safe shielded situation, barriered areas established to prevent access to the hazard, measures put in place to prevent the dispersion of activity or control of activity in the food chain; and

(ii) the recovery phase, e.g. the planned recovery of a sealed source to safe long term storage or the decontamination of the environment.

The latter can often take place on a more relaxed timescale than the initial phase, but crucially needs to be undertaken as part of a coherent plan tailored to the specific situation. An old adage "presence of mind is better than presence of body" is relevant here. Rushing in without a plan can cause unnecessary exposure and, in some cases, actually make the situation worse.

Whilst plans need to be tailored to the specifics of an incident, emergency preparedness allows one to prepare generic plans that can be used to ensure appropriate deployment of resources. This subject is dealt with more fully in reference [13], but some of the more important points are given below.

DEALING WITH POTENTIALLY EXPOSED PERSONS

A response plan needs to address how to deal with persons who have potentially received significant exposures or who may be significantly contaminated. In most cases, only a few people may have been exposed and these can be transported to one of the hospitals in the country designated to deal with potential radiation casualties. Assessing and treating radiation casualties is not a common occurrence and guidance on this [14] has been published by the IAEA and WHO. Also, many of the IAEA reports on specific accidents provide detailed feedback on the treatment of patients [8-12, 19, 22, 23]. Even so, many countries will not have the expertise to deal with radiation casualties. A later section of the paper covers broader aspects of getting help in emergencies, but to specifically address the medical aspects, WHO has established the Radiation Emergency Preparedness and Assistance Network (REMPAN). Under these arrangements patients can be treated at specialized hospitals that are WHO collaborating centres.

In very large scale incidents there may be a need to deploy dose assessment and medical triage capabilities at the site of the accident.

- **Goiania, Brazil (1987)** [9]. Following the break-up in 1985 of a medical partnership in a clinic in Goiania, Brazil, a teletherapy unit containing a 50.9 TBq Caesium-137 source was abandoned in the clinic's former premises, which were partly demolished. In September 1987, the source was removed from its protective housing in the teletherapy machine by local people who had no knowledge of what it was and were simply after its scrap metal value. The source was in the form of a highly soluble and readily dispersible caesium chloride salt, compacted to form a coherent mass within a doubly sealed stainless steel encapsulation. The source was later ruptured, and over the next few weeks the activity was widely dispersed in the city. Many people incurred large doses from both external and internal exposure. Four of these people died, and 28 suffered radiation burns. The extent and degree of contamination were such that seven residences and various associated buildings had to be demolished, and topsoil had to be removed from a significant area. The decontamination of the environment took about six months to complete and generated some 3500 m^3 of radioactive waste.

The health consequences were:

- 249 people were contaminated externally;
- 129 people had significant internal contamination (all were constantly producing external contamination from their bodies due to the presence of caesium-137 in their sweat, thus producing contamination control problems;
- 21 people received doses in excess of 1 Gy and were hospitalized;
- ten needed specialist medical treatment; and
- four died.

The lead medical team at the accident had to triage a large number of people and set up care and treatment facilities. Their ability to deal with this was greatly aided by their recent training for such emergencies. One of the lessons from the Goiania incident is that in dealing with such situations there is a need for readily transportable equipment for bioassay and whole body monitoring capabilities.

MEDIA LIAISON ARRANGEMENTS

Any radiation accident is likely to prompt media interest, especially for the large scale accidents.

- **Goiania, Brazil (1987)** [9]. The circumstances of the discovery of the incident required a number of emergency measures, such as the evacuation of buildings and the gathering together of potentially contaminated persons. From this it was clear that there was a serious incident, but with few health physics resources available a clear picture did not emerge during the first 24 hours. Rumours abounded and by the time the leading health physics and medical teams arrived from Rio de Janeiro (some 1300 km away), crowds of people and media almost besieged them. Over the first few days of the incident this was a serious drain on the resources of those trying to deal with the consequences of the incident and increased the time taken to regain control of the situation. The IAEA report on the accident [9] recommended that "response teams in radiological emergencies should have administrative and public information support appropriate to the scale of the accident".

- **Istanbul, Turkey (1998/9)** [12]. In 1993 in Ankara, Turkey, three radiotherapy sources were taken out of use by a specialist company and put into specially designed shielded packages for return to their original supplier in the USA. However, the company did not despatch the packages but stored them. In 1998, two were moved to Istanbul and stored in their general purpose warehouse on an industrial estate. After some time, there was no room left in the warehouse and the packages were moved to adjoining premises that were empty. After nine months or so, these premises were transferred to new ownership and the new owners, not realizing what was in the packages, sold them as scrap metal. The source containers were broken open and at least one unshielded source, 3.3 TBq cobalt-60, was left exposed in one location for about two weeks and then moved to another location for two further weeks before the accident was recognized and dealt with. Eighteen persons were admitted to hospital with 10 showing clinical signs and symptoms of acute radiation syndrome.

The source from the second container, 23.5 TBq cobalt-60, has so far not been found, though there is doubt about the validity of some of the records.

As might be expected, the incident elicited significant public interest and news media coverage. Initially there was considerable confusion with the public and the media comparing the event with the Chernobyl accident. However, the competent authorities deployed significant resources to deal with these concerns and the open public information policy helped to allay public concern.

RESPONSE COMMAND STRUCTURE

Response plans must include the necessary technical, logistic and media support, but an absolutely key element is a clear command structure. This must take into account the fact that a variety of organizations, each with their own hierarchy, may be involved, e.g. police, regulatory bodies, government departments, military forces, medical authorities, local authorities. The response plans must identify a lead organization and determine responsibilities and interactions of the organizations.

Examples from the UK can be found in the NAIR publication [16] and in a government publication on "Dealing with Disasters" [24]. The IAEA is in the process of revising its advice in this area and a TECDOC "Response to Events Involving Illicit Trafficking in and Inadvertent Movement of Radioactive Material" will shortly be available.

CAPABILITIES AND RESOURCES AVAILABLE

Response plans must be realistic about the resources available. For example:

- the number of appropriately trained staff in the various disciplines;
- stocks of monitoring equipment and personal protective equipment;
- medical facilities and personnel to deal with irradiated and contaminated persons;
- source storage, transport and waste capabilities (see later);
- dosimetry and analytical facilities available;
- logistics support; and
- geographic distribution of resources and time needed to deploy.

- **Goiania, Brazil (1987)** [9]. This accident provides an extreme example of the consequences but it does provide a benchmark for what might be involved. In addition to the medical consequences covered earlier, there was the need for the following:

  Localizing the Activity:

  - 67 km^2 of land area was monitored in the first few days (using monitors carried on foot or fitted in cars and helicopters);
  - Seven major sites (each of about 100 m radius) were isolated and required full protective clothing and respirators to enter;
  - 42 other significantly contaminated sites were identified; and
  - activity was transported to many other cities.

Monitoring Regimes:

- 112,000 people were monitored;
- all banknotes in circulation were monitored;
- the city's bus fleet was monitored;
- the water supply and local produce needed monitoring;
- an instrument workshop to repair and maintain monitoring instruments needs to be set up;
- training facilities for the many staff members who had not used a monitor for years or had no operational experience were required;
- a dedicated laundry was required; and
- a factory unit to produce the specialized waste containers was needed.

Countermeasures and Actions:

- 200 people were evacuated from 41 houses;
- 85 houses required significant decontamination;
- Seven houses were demolished; and
- 3,500 tonnes of active waste was produced.

PROVISIONS FOR RADIOACTIVE WASTE

As identified above, the recovery of the Goiania accident generated a large volume of radioactive waste, some 3,500 m^3. The rate at which the waste is produced in such accidents is prodigious (see also the example below from Juarez, Mexico). If there is no clear plan about what to do with the waste, either for a temporary or permanent location, then the sheer volume and logistics of dealing with it can bring the recovery operations almost to a halt. This was the case both with the Juarez and Goiania operations and the lessons from these accidents need to be fed into emergency preparedness planning.

- **Juarez, Mexico (1983)** [21]. In 1977, a medical centre in the city of Juarez, Mexico, purchased a second-hand radiotherapy unit from the USA which incorporated 37 TBq of cobalt-60 in the form of 6000 cylindrical cobalt metal pellets, each 1 mm x 1 mm, inside a doubly encapsulated source capsule. The importation of this unit was not reported to the competent Mexican authority. Because of lack of resources, the unit was never used, and it was stored in a warehouse without any safety precautions. In December 1983, a technician who worked at the medical centre dismantled the unit, without authorization, in order to sell it for its scrap value. It was taken on a pick-up truck to a scrap yard, and during the journey the technician, out of curiosity, deliberately ruptured the unrecognized source capsule. Source pellets were scattered throughout the scrap yard and surrounding areas, and along the transport route. However, most of the activity went into scrap metal consignments to various foundries, where it was incorporated into steel 'rebars' (reinforcing bars for concrete) and cast iron table pieces.

  The discovery of the accident occurred on 16 January 1984, when a lorry carrying rebars passed close to the Los Alamos National Laboratory, USA, and set off radiation alarms designed to warn of radioactive material leaving the site. In the intervening period, significant volumes of potentially contaminated metal had been produced and distributed by several foundries. A major survey programme to trace these materials had to be instituted. In Mexico, surveys were made of 17,600 houses which could have incorporated contaminated rebars and as a result 814 houses were demolished. In the USA, a search for the table pieces, which covered 1,400 customers, revealed 2,500 contaminated items, which were returned to Mexico for disposal. In addition, a major decontamination programme of the various sites in Juarez had to be undertaken. In total, active waste amounting to 16,000 m^3 of soil and 4,500 tonnes of metal was collected. Reaching a decision on a repository for the waste was protracted and it complicated the recovery programme.

GETTING HELP

The vast majority of radiation accidents can be dealt with by countries' own response plans. However, the more significant accidents can provide challenges to the resources available in any one country. To address this point there is an International Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. This Convention requires that party States co-operate between themselves and with the IAEA to facilitate prompt assistance; such as experts, equipment and materials, methodologies and techniques. To this end, the IAEA has established an Emergency Response Centre (ERC) to provide 24 hour cover.

Assistance under the Convention has been provided in many of the accidents described in this paper.

- **Istanbul, Turkey (1998/9)** [12]. Following requests from the Turkish authorities the IAEA provided

  - a team of three doctors specialized in the diagnosis and treatment of patients exposed to radiation;
  - assistance with cytogenetic dosimetry of blood samples;
  - a monitoring team to help in the search for the 2nd source presumed to be missing;
  - an expert to bring together the information about the circumstances of the accident, source recovery search actions, medical treatment of victims, etc. This, together with the efforts of the Turkish authorities, provided the basis for the IAEA publication on the accident [12].

LEARNING THE LESSONS

Over the past 13 years, the IAEA's report of accident investigations have contributed significantly to the process of learning lessons from accidents. However, it is not only the big accidents from which we can learn, we can also learn; from the smaller accidents and near misses. This feedback is relevant to suppliers in improving the safety aspects of design, to management in developing radiation protection measures and training their staff, and to national and international authorities in helping them prioritise issues and the resources to deal with them; e.g. raising the profile of the orphan source issue.

Conferences such as this and the IAEA's publications play a significant role, but there is also a need to use other means of capturing relevant lessons and providing feedback mechanisms. As an example of a national approach, in the UK, NRPB in partnership with two regulatory bodies, the Health and Safety Executive (HSE) and the Environment Agency (EA), has established the Ionizing Radiation Incident Database (IRID) [25]. The database contains anonymized descriptions of accidents and the lessons learned from them, categorized to allow easy analysis and navigation through the database. So far, 100 cases are entered and have been published. The format of the case studies has been designed so that they can easily be incorporated into training material.

At the international level, the IAEA has drawn on this experience and on that of the NRC and REAC/TS in the USA in developing RADEV (RADiation EVent database). This is currently in the later stages of development and trialling. RADEV uses Microsoft Access and the intention is to make compiled software versions available to Member States so that they can enter their own data, prepare material statistics and develop their own databases. This will be useful to the Member States and also facilitate easy transfer of the more interesting cases to the international RADEV operated by the IAEA.

CONCLUSIONS

A 20th century Spanish-American philosopher, George Santayana, stated "Those who do not remember the past are condemned to repeat it". My version is "If we do not learn from history, we are condemned to repeat it".

There is ample evidence from the various accidents and publications quoted in this paper that we are indeed repeating history; not learning the lessons from previous accidents. In particular, the problem of orphan sources, outside regulatory control, is a recurring theme.

This paper has identified some of the serious consequences stemming from orphan sources and the problems of recovery. This conference provides an opportunity to learn from each other how to address this problem.

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SEARCH AND LOCALIZATION OF ORPHAN SOURCES

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SETTING THE PROBLEM

Radioactive sources are widely used in industry, medicine and research, and each State should apply rules for their proper and safe management. Otherwise, the local authorities may have to face one or more of the following situations:

- sources are misplaced or lost (with any malevolent intention);
- they are voluntarily dissimulated;
- they are the subject of illicit trafficking.

Usually, the sources in these situations are called "orphan sources".

If a State knows that orphan sources do exist on its territory, it must make the efforts necessary to try to put them again under control. That means that actions must be taken to try to search, locate, identify, transport and store them under conditions conforming to the IAEA safety recommendations.

This paper will address only the detection and localization phases, which seem to be the most difficult phases to organize; the remaining phases should be organized through the application of technical standards.

Each State should organize its response to one or more of the situations just mentioned according to the level of the problem it has to cope with, for safety reasons and also for economic reasons.

This paper will offer advice in support of States wishing to define objectives and to establish strategies on what to do, where to act and with what kinds of tools. Some comments will be added about tools existing at the international level, and finally — by way of an example — a brief description will be given of the operation carried out recently by a French team in the Republic of Georgia under the auspices of the IAEA.

THE DEFINITION OF OBJECTIVES

Regaining control over orphan sources is the first major task of a State in the protection of the population by preventing severe accidents leading to overexposure of unsuspecting individuals; the second task protection of the environment.

Not all States have the same situation regarding orphan sources, and not all orphan sources present the same hazards. There is no ideal response and each State must therefore decide what its priorities will be. This political decision will require the following:

- a knowledge, even incomplete, of the situation of the State as regards the scale of the level of the problem;
- a clear idea of the State's objectives, which can be expressed by defining what has to be detected.

For both, criteria and parameters must be established. Proposals are given as follows.

SITUATION OF A STATE

The situation of a State can be characterized from several parameters, among which should be considered, at a minimum:

1. the potential number of orphan sources to be searched for in the country, assessed partly on the following information:
   - the number of potential users and potential facilities where sources could be used;
   - the different radionuclides and the associated activities;
   - the estimated number of imported radioactive sources;
   - the sources declared as lost or stolen;
2. the number of persons (workers or inhabitants) who could be involved and potentially overexposed;
3. the situation of neighbouring countries. If they do not have an efficient regulatory infrastructure, they will not be able to prevent the entry of orphan sources and might even induce incoming traffic.

Although these parameters will allow the situation to be assessed, not measured, they will give a general idea of the size of the problem, from which a State should decide whether or not to develop a strategy for coping with the problem.

This strategy requires that the objectives of the State be previously defined. These objectives can be defined by different factors, among them:

- the nature and type of the sources to be detected;
- the amount of radioactive material entering from neighboring countries without the knowledge of the regulatory authority and which must be intercepted, etc.

These objectives have to be balanced against the means which the State can deploy in order to achieve them.

Depending on the chosen objectives, when the State establishes a strategy, it will have to consider the budget to be made available for that purpose. It will have to take into account factors such as the cost of the organization to be put in place, the cost of equipment, the sensitivity of this equipment, its maintenance and the number of operators to be trained. Since ideal situations, in which the necessary budget is available, are very rare, compromises will be necessary.

It is from the consideration of all these factors that strategies for the detection of orphan sources will be developed and assessed.

The first step is to determine the types of sources to be covered by the strategy, i.e. to state the minimum activity of the orphan sources to be included in a search or to define what has to be detected.

WHAT TO DETECT

The analysis of the situation of the State, such as just described, should give an estimate of the number, nature and types of orphan sources to be detected and of the radionuclides and activities involved.

This information has to be processed in order to determine the risk that not searching for and regaining control over orphan sources could mean for the health of the population and for the environment. This risk has to be balanced against the acceptable costs of deletion and therefore against the available budget.

The cost of a search operation is roughly an inverse function of the activity of the orphan sources to be detected: the lower the activity to be detected, the higher the cost since the more sensitive a detector is, the more it costs.

If a State wishes to respect the BSS recommendations, it will have to detect all the potential orphan sources on its territory, i.e. it will need a large number of very sensitive detectors together with operators etc. and therefore a large budget, which is rarely available, even in countries with a well developed infrastructure. So each State should decide on an acceptable level of risk which will correspond to radionuclide activity values above which it should provide the capabilities for guaranteeing detection.

Obviously, the sources of particular concern are those containing high levels of radioactivity which have a potential for causing significant harm to persons in the short term. For other sources, a State needs to base its decision on technical parameters for assessing the risk posed by the various sources to be detected. Given such a problem, States may wish to establish national systems of source categorization.

The need for such systems has also been recognized by the IAEA. A technical document (TECDOC) "Categorization of radiation sources" has been issued and it classifies existing sources according to five attributes:

- radiological properties;
- form of material;
- practice or conditions of use;
- exposure scenarios;
- end of life.

It gives, for identified practices or applications, the typical activities of radionuclides and recommends control measures for sources in each category.

This TECDOC should be of a great use to the States wishing to cope with the danger posed by orphan sources, offering information relevant, not only to the regaining of control over orphan sources but also more widely, to the safe management of radioactive sources.

THE STRATEGY OF DETECTION

An important factor to consider when developing a strategy for the detection of orphan sources is the way the detection will actually be carried out.

They are two ways to search for orphan sources:

- the first is to try to detect and intercept them as they leave the location of the daily use or to detect and intercept them as they arrive at the location of unapproved storage, disposal or use (i.e. a scrap metal yard);
- the second is to try to intercept them between those two locations

Before starting the relevant tasks, it is necessary to determine the current situation, by trying at least to identify and locate the existing sources.

There is not a known method to identify places where sources are likely to be, but the potential uses of radioactive sources are well known, and are listed in various TECDOCs of the IAEA. On the basis of these lists, a State should be able to develop a national inventory of the potential locations of radioactive sources and to contact their operators or owners in order to make them declare which sources they are operating or storing. Of particular interest are hospitals, plants with industrial radiography equipment, melting plants, oil companies, food processing plants, agricultural establishment, recycling plants and nuclear fuel cycle facilities.

The inventory should give the locations of sources, their number, their activities and the radionuclides involved. It may reveal which sources are missing. Once the inventory as been drawn up, the only way to organize the search is to use appropriate technical capabilities in order to detect the orphan sources:

1. during unapproved removal from an area of use;
2. as they arrive at locations where their presence or transit could be a threat to the population or the environment;
3. between the two kinds of locations referred in 1 and 2.

The detection capabilities appropriate to 1 and 2 could be described as "static detection" capabilities as they are associated to fixed locations, while those appropriate to 3 " could be qualified as "dynamic detection" capabilities as they are deployed at the various locations where there might be a problem.

DETECTIONS CAPABILITIES

STATIC DETECTION
Where to detect

The problem of static detection is, on one hand, one of trying to organize a system which will make it possible regain control over radioactive sources moving inside the country and, on the other hand, one of trying to detect sources which could enter or leave the country by crossing the border.

The IAEA has made recommendations concerning regulatory infrastructures, methods and tools to control radioactive sources. But a State could decide to take various othersactions before establishing a complete regulatory infrastructure. The following considerations should be born in mind by the authorities responsible for identifying where to try to detect orphan sources.

A. Before establishing its own infrastructure for the control of sources, a State should develop a national inventory of known existing radioactive sources in order to assess the problem.

At the end of inventory development, the national authorities should know where sources are or should be, and therefore the places where they have to take the appropriate action to:

(i) prevent the sources in the inventory from leaving their location of use without being detected; and
(ii) locate the sources not included in the inventory.

B. When a radioactive source is no longer needed, the user may abandon it or dispose of it as waste at a facility whose operator does not know that the waste is radioactive. In such a case, depending on its size and appearance, the radioactive source may enter a recycling circuit with the risks of being incinerated or melted and then dispersed. Some well known accidents have been caused in this way.

Thus, as well as developing a national inventory to identify the potential locations of radioactive sources is developed, the State should develop an inventory of all places where used sources could be disposed of (scrapyards, garbage tips, melting plants etc).

C. When radioactive sources are removed from their normal route they may stay within the territory of the State or leave it without any criminal intention. However, traffickers may try to import or export radioactive sources or move them within the territory of the State. If the level of probability of illicit trafficking is significant and if the locations of the potential border crossing points can be identified, it should be useful to consider the detection possibilities. Not only road and rail border crossings should be considered, but also railway stations, seaports and airports.

How to detect

When a complete regulatory infrastructure exists, administrative tools such as inventories should be used to detect anomalies. However, technical detection through the use of equipment is the only way to find lost or hidden radioactive sources before they can cause serious accidents affecting the population or the environment.

The use of equipment is costly, so it is the responsibility of the State to analyse the situation and balance the risk against investment in the light of the objectives.

When it has been decided to prevent radioactive sources from leaving a facility where they are being used, the exit gate(s) should be equipped and/or strict procedures established for the maintenance of permanent control. When a programme for detecting orphan sources has been decided on, it is essential to try to detect them at places where they could be inadvertently disposed of — scrapyards, melting plants, garbage tips etc. — and the entrance gates of such places should be equipped with appropriate detectors. The best method of static detection is the use of fixed monitoring portals, with automatic detection when the alarm threshold is exceeded, installed in appropriate locations, generally at check points of the traffic to be monitored. The use of portable equipment is also acceptable, but it needs a full time operator. The mixed use of fixed and portable equipment may be an efficient answer.

To support decision makers, the IAEA has organized a programme aimed at the detection of orphan sources. Several TECDOCs are about to be issued, as well as a Safety Guide on Preventing, Detecting and Responding to Illicit Trafficking in Radioactive Materials. Moreover, an assessment programme for commercially available equipment (ITRAP) is under way and the results are soon to be published.

DYNAMIC DETECTION

The problem

Static detection is for regaining control over orphan sources through the detection of radionuclides as they pass fixed position detection. There are also cases, however, where sources are disposed of unknown and may never be detected unless search actions are taken with the help of mobile equipment. Such dynamic detection should be carried out in the following situations:

- when the locations of unidentified radioactive sources are unknown;
- when identified radioactive sources have been misplaced or lost.

It is first necessary to determine the most likely locations.

Where to search

Search operations should be undertaken first at locations where radioactive material is believed to be used or stored. The use of static detection equipment allows the detection of radionuclides leaving such facilities but not the detection of radionuclides abandoned nearby and/or inside the facility limits. To identify more precisely the places inside these facilities which should be searched it may be useful -for example - to find out what parts of the facility have been demolished and where the waste was sent, to consult older or retired staff members who recall specific events, etc. To identify all other locations where a search operation might be worthwhile, use should be made of information in documents such as:

- customs records relating to imported radioactive sources;
- suppliers' sales records;
- international co-operation agreements between hospitals, laboratories, universities, etc.

Information from national agencies in charge of issuing licences for the use of or for dealing in radioactive materials may also be useful.

To summarize, before a search operation starts there is a need to obtain, directly or indirectly, information indicating where to carry it out. Some examples have been given, but each State must consider its own situation when analysing the available information. The State should then prioritize the list of locations and decide on the capabilities necessary for achieving its objectives.

Capabilities

The basic capability is a search team, which should be organized in the lights of the results of previous analyses.

The number of team members should result from the number of locations to be investigated, the programme established on the basis of priorities, and the period of time allowed for the search. The training of the team members and the nature of the equipment (detectors and dosimeters) should be *adapted* to the kinds of sources to be searched for and the associated risks. It is useful to have search teams composed of, or at least headed by radiation specialists. Administrative steps, e.g. the obtaining of clearances, should be taken to obtain legal authority for the search. The mains factors to consider when establishing a search team are described in TECDOCs issued by the IAEA.

MEDICAL DETECTION

In some cases, orphan sources have been found because doctors have identified specific pathologies due to overexposure. That has happened only where the doctors have been specially trained to recognize such conditions. State authorities should ensure that doctors have received or will receive the necessary training.

INTERNATIONAL ASSISTANCE

An operation aimed at regaining control over radioactive sources needs a structure, equipment, trained staff and finances. When a State cannot cope with an event, the IAEA can act as a link between it and a State able to provide assistance. The Assistance Convention was established for this purpose.

To organize provision of assistance to a requesting State the IAEA is setting up an emergency response network (ERNET). This network will be composed of teams of experts from Member States, approved by the IAEA, who could be proposed for responding to requests for assistance made under the terms of the Assistance Convention.

SURVEY IN THE REPUBLIC OF GEORGIA

The IAEA has been monitoring the radiological situation in the Republic of Georgia for several years, especially since the LILO accident, in which border guards were overexposed to radiation from abandoned sources.

The Georgian Ministry of the Environment has begun cleaning up the territory with the help of the IAEA, which has organized training courses and provided equipment through its technical co-operation programme.

During a search carried out by the Georgian authorities, four strontium sources (among many others) were found The activity of each was around 1 500 TBq (40 000 Ci). The IAEA supported this recovery. Then, in addition, the IAEA provided advice on how to deal with four other similar sources. The whereabouts of these sources were known, but they were not accessible before the spring because of bad weather conditions. Eventually, the four source containers were found empty. According to the high potential for causing serious harm and the uncertainty about the whereabouts of the missing sources, the Republic of Georgia requested the IAEA to support a search. The IAEA itself requested the assistance of Member States.

Meetings in preparation for the search were held in the Republic of Georgia and in Vienna, to explore the situation and to develop a strategy planning. The Georgian authorities demarcated an area where they wished the search to be performed. However, the budget was not sufficient to enable this large area to be searched with the necessary detection system (equipment and personnel).

As a compromise, the French participants proposed a strategy based on searching in the more heavily populated zones within the envisaged search area. In the light of the sensitivity of the detection system offered for this operation and the period of time where the detection system was to be available, the populated zones to be surveyed, and the exposure level accepted by the Georgian authorities, a compromise was reached about the level of activity above which the population was not to be overexposed. The strategy was accepted by the IAEA and the Republic of Georgia.

The French search team used an airborne gamma mapping system called HELINUC installed on a helicopter provided by the Georgian authorities. The helicopter flight parameters were fixed in accordance with the terms of the compromise. The data (spectrum and position) were recorded in flight and processed after landing. The results of the flights of a given day were provided the same day, in the form of a map, to the IAEA representative heading the mission. The maps on which the results could be easily seen allowed decisions to be taken about the next day's activities.

During the operation, the helicopter flew 81 hours with the detection system, *1200* km^2 were investigated, and a caesium source of around 100 MBq (2.5 Ci) was detected in a populated area near the city of Poti. The Georgian team in charge of the recovery of the source took care of it with the limited capabilities existing locally.

The situation in the Republic of Georgia is typical: a number of orphan sources are known to exist, but their whereabouts are unknown and the existence of others is suspected. Action was taken to try to locate sources on the basis of information about their potential uses and many have found. The limited capabilities of this country led to a request for IAEA advice and assistance. The results of the operation have proved its usefulness: following a strategy appropriate to the problem, enabled the detection of a source which could have caused serious harm and the verification that the population had not been overexposed.

CONCLUSION

The control of all radioactive materials should be a major and permanent concern of every State. In the past, several accidents resulting in death occurred because of orphan sources. The necessary actions are to be undertaken by each State which would have to face to such a problem and would like to regain the control of such sources.

This paper has outlined some of the steps which should be taken in order to detect and localize orphan sources. Two of them are of great importance for any State wishing to resolve the orphan source problem. The first one is to analyse the situation and the second is to establish a strategy before taking action. It is the responsibility of the State itself to work on the first step; but for the second it can draw on the advice of IAEA specialists with experience gained from a variety of situations. The specialists also advise the State on the objectives it may wish to achieve and the necessary compromises between those objectives and the budget available for that purpose.

The survey carried out in the Republic of Georgia is a good example of what can be done.

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NATIONAL REPORTS
(Session 2)

Chairperson

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THE UTILIZATION OF RADIATION SOURCES IN ANGOLA

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Abstract. The report describes the situation that Angola, which joined the IAEA in September 1999, is facing with the lack of an appropriate infrastructure for the control of radiation sources. It emphasizes the country's needs in technical assistance from the IAEA and other Member States for improving its regulatory infrastructure for radiation safety.

Angola, which joined the IAEA in September 1999, has embarked on activities in the field of nuclear science and technology. The Ministry of Science and Technology was designated in July 2000 as the national authority responsible for co-operation with the IAEA. An inter-sectoral nuclear science and technology unit was established within the Ministry in November 1999 as the nucleus for the future national regulatory authority for radiation safety.

An Angolan request for technical assistance in the area of nuclear physics teaching under the IAEA's technical co-operation programme for 2001–2002 has been approved, and it is hoped that in addition the IAEA will help Angola to upgrade its national radiation protection infrastructure.

In Angola, radiation sources are being used in medicine, the petroleum industry, diamond mining, beer brewing, geology and a number of other areas. However, the national infrastructure for radiation protection and radioactive waste management is very inadequate, with no legislative, regulatory or technical infrastructure provisions in place. The top priority for the near future is to bring the country into compliance with the BSS through an IAEA technical co-operation Reserve Fund project.

In August 2000, an IAEA mission to Angola helped to draft radiation protection legislation and to draw up a preliminary inventory of radiation sources, which is summarized below:

- medical diagnostic X-ray facilities: 21
- industrial X-ray facilities: 6
- industrial X-ray crystallography facility: 1
- radioactive sources utilized in the petroleum industry, diamond mining and beer brewing: 61 (Cs-137, Am-241, Am-Be, Ir-192, Co-60, including three neutron generators for petroleum prospecting)
- radioactive sources for teaching and research: 4
- radioactive sources for therapy: 2 (Co-60 and Cs-137)
- radioactive sources for calibration: 7

Angola hopes that, in developing applications of nuclear science and technology and establishing an adequate national radiation protection infrastructure, it will receive assistance not only from the IAEA but also from other countries - both developed and developing.

CONTROL OF THE SAFETY AND SECURITY OF RADIATION SOURCES IN ARGENTINA

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Abstract. The report refers to the main elements of the regulatory infrastrucutre in Argntina, noting as relevant the promulgation in 1997 of the Act 24.804, which established the Nuclear Regulatory Authority (ARN) as an independent agency empowered to establish standards and enforce their application with regard to the possession and use of radiation sources. Important elements of such regulatory infrastructure are described in the report, and in particular those explaining the existing licensing system, the basic radiological safety and security requirements, the enforcement programme, and the key actions considered for the appropriate control of radioactive sources. In this respect, the report emphasizes the importance of the management of disused and orphan sources, and the role of education and training.

THE REGULATORY INFRASTRUCTURE

Following its creation in 1950, the Argentine Atomic Energy Commission (CNEA) was the competent authority for the control of nuclear applications with regard to protection against the harmful effects of ionizing radiation and to the safety of installations. In 1958, the Executive issued Decree 842 approving regulations for the use of radioisotopes and ionizing radiation. A regulatory branch was then formed within the CNEA and very rapidly established itself as the national authority in the areas of radiation and nuclear safety, safeguards and non-proliferation assurances, and physical protection.

When the separation of regulatory functions from research and technological development became an issue, Decree 1540 (1994) created the Nuclear Regulatory Board (ENREN), an independent governmental body performing all the regulatory control activities formerly within the competence of the CNEA's regulatory branch. In 1997, Act 24.804, passed by Congress, created the Nuclear Regulatory Authority (ARN), an independent agency reporting to the Executive, as the successor to ENREN, with their same staff and technical resources.

The ARN is empowered to establish standards and enforce their application to the possession and use of radiation sources. The regulatory goals are:

- to ensure that radioactive materials are imported, exported, produced, transferred, stored, used, or disposed of only by registrants or licensed persons at authorized or licensed installations, as required by Argentina's regulations;
- to ensure that registrants or licensees do everything reasonable and within their capabilities regarding the safety and security of radiation sources;
- to ensure that radioactive materials are transferred to another user or disposed of as radioactive waste only when the transfer or disposal has been specifically authorized by the ARN.
- to keep an updated database on all the sealed radioactive sources in Argentina;
- to prevent illicit trafficking in radiation sources;
- to ensure the safety and security of disused sealed radioactive sources, doing whatever is necessary in order to maintain the required controls;

- to ensure that the technical characteristics of imported and locally produced radioactive sources comply with Argentina's safety requirements.

THE LICENSING SYSTEM

Act 24.804 stipulates that any person or organization using radioactive sources in medicine, industry, research or teaching must have an authorization or license issued by the ARN. It also stipulates that the ARN's licensing system may grant licences and authorizations only to applicants (responsible organizations) that fulfil the safety and security requirements established in the regulations.

The Argentine licensing system requires that potentially high-risk installations (e.g. industrial irradiation facilities, radiation therapy units, gamma radiography facilities) be constructed, commissioned, operated or decommissioned only after the relevant licence or authorization has been granted by the ARN. Licensees must comply with the conditions, standards and requirements established by the ARN. Under the sanctions regime in force, non-compliance may be enough for the ARN to suspend or cancel the licence. Workers must be qualified and adequately trained for the job. Safety-related tasks require a specific licence.

Lower-risk installations (e.g. oil well logging units, gauges) may be operated only after the ARN has granted the corresponding authorization.

The applicant (the responsible organization) must, as the person responsible for the safety and security of radiation sources, an individual who has a permit for the practice in question. The responsible organization must supervise that individual's performance and provide the support necessary for the performance of his/her duties.

The purpose of the inspections performed and enforcement actions taken by the ARN is to verify whether the responsible organization is complying with the regulations and requirements and doing all it can to avoid situations that could lead to radiological accidents. Deterrence through the possibility of sanctions imposed on persons or organizations for non-compliance with regulations helps to prevent accidents. Inspections are performed periodically depending on the risk associated with the practice in question — for example, gamma radiography facilities and radiation therapy units are inspected (more or less at random) once a year, while oil well logging units and nuclear medicine centres are inspected every two years.

The inspectors look into safety issues such as users' individual permits, radioactive contamination, the shielding integrity of portable gauges and level gauges, the pigtail connectors in gamma radiography projectors, safety interlocks, approved sign displays, radiation monitors, occupational dose records and abnormal event log books. They also look into security issues such as sealed source inventories, oil well logging or gamma radiography source log books, and security measures to prevent burglaries at radioactive source storage sites.

BASIC RADIOLOGICAL SAFETY AND SECURITY REQUIREMENTS

In order to reduce the likelihood of radiological accidents, licensees and registrants must comply with the following basic safety requirements of the ARN:

- no radiation source may be owned or used unless its owner has been granted a licence or authorization by the ARN for a specific purpose,

- radiation sources may be used only by or under the supervision of persons with the appropriate knowledge of and training in radiological protection,
- licensees and registrants must maintain a sealed source inventory on their premises and check the effectiveness of measures to prevent intrusion into storage bunkers.

THE ENFORCEMENT PROGRAMME

Enforcement actions fall into four broad categories:

1. The licensee or registrant is requested, usually during an inspection, to correct minor deviations from the regulations.
2. The licensee or registrant is required, immediately after a safety review, to correct safety problems or to stop committing minor safety violations and to take the necessary corrective action promptly.
3. The licensee's or registrant's authorization is withdrawn temporarily in order to avoid health risks to workers or the general public (inspectors can withdraw an authorization, but they should act cautiously in the case of medical practices owing to the possible detriment to the health of patients).
4. The licensee or registrant is required to dispose of or store any disused radioactive source at the CNEA's disposal site.

If inspectors conclude that a radioactive source might be a risk to people's health, the regulatory authority — as a precautionary measure — impounds it and stores it safely. In the event of deliberate obstruction of such actions, the ARN's officials can request a federal judge to grant access to the registrant's premises and sources.

KEY ACTIONS FOR THE APPROPRIATE CONTROL OF RADIOACTIVE SOURCES

- The ARN liaises closely with the Border Military Police and the Coast Guard, for the purpose of preventing illicit trafficking in radioactive sources.
- The ARN promotes the installation of radiation monitors at points of entry (by sea or by road) in order to prevent illicit trafficking in radioactive sources, to detect orphan sources in imported scrap and to impede the importation of radioactively contaminated materials.
- The ARN encourages the installation of portal monitors at steel mills in order to detect orphan sources in the scrap used in steel-making.
- The ARN interacts closely with the Federal Police, which is responsible for locating stolen radioactive sources.
- The ARN has an agreement with the Customs whereby:
  - an authorization granted by the ARN is necessary for importing or exporting radioactive materials;
  - importers of industrial plant, gauges or laboratory equipment that may include sealed radioactive sources have to declare whether the goods to be imported contain such sources (if so, the importer must present the corresponding authorization from the ARN);
  - the Customs report any radioactive material left at customs storage premises for more than 30 days, enabling the ARN to store it or dispose of it at the CNEA's disposal site.

- ARN personnel verify that the design of both imported and locally produced radioactive sources is properly certified in accordance with ISO or similar standards. They also make sure that the corresponding competent authority has licensed the manufacturer and that each source has been calibrated, and leak-tested if necessary.
- An authorization from the ARN is necessary before any transfer of sealed radioactive sources among importers, producers, users and exporters and for disposal at the CNEA's disposal site.
- In the event of bankruptcy or of a lack of corporate memory regarding disused radioactive sources, the ARN requires the responsible organization to promptly deposit the sources at a safe site (the ARN's personnel pay particular attention to such situations as they can dramatically increase the probability of sources ending up in the public domain).
- In the event of bankruptcy, the ARN goes to court in order to prevent the auctioning of radioactive sources (meanwhile, the bankruptcy liquidator is advised on measures to secure the sources until the court authorizes the ARN to impound them).
- The regulatory staff verify whether the responsible organization complies with requirements in due time (procedures established by the ARN call for immediate corrective actions in order to avoid situations of chronic non-compliance, and such actions increase the credibility of the enforcement policy).
- Audits looking for early warnings of deviations from safe conditions are performed regularly at installations authorized for practices such as gamma radiography and cobalt therapy (checks during such audits may cover safety interlocks in radiotherapy bunkers, radioactive source inventories, gamma radiography equipment care, etc.).

LICENSED ORGANIZATIONS USING SEALED RADIOACTIVE SOURCES

Type of installation	Number
Radioisotope fractionating and sealed radioactive source production	5
Industrial irradiators	4
Therapy units	74
Manual HDR and LDR brachytherapy	116
Gamma radiography (mobile and fixed)	62
Gauges and chromatography	341
Research and teaching	194
Importers	11
Total number	**807**

INVENTORY OF SEALED RADIOACTIVE SOURCES

The numbers of sealed radioactive sources in use in medicine, industry, research and teaching, classified according to the damage that they could cause, are given in the following table.

Category	Number
1	765
2	1104
3	1412
Total number of sources	**3281**

- Category 1: Sources used in gamma radiography, cobalt therapy units, and irradiators. The number takes account separately of each radioactive source of the array in an irradiator.
- Category 2: Brachytherapy sources; high-activity sources (higher than 37 GBq) used in industrial gauges and oil well logging.
- Category 3: Low-activity sources used in industrial gauges and chromatography.

MANAGEMENT OF DISUSED SOURCES

Act 25.018, which entered into force in August 1998, establishes that the CNEA is responsible for the management of radioactive waste (defined as “any radioactive material for which no later uses are foreseen”). The Act also establishes that the producer is responsible for the conditioning and safe storage of radioactive waste, in accordance with Argentina’s radiological safety criteria, until the waste is handed over to the CNEA, which operates a disposal site.

The ARN requires registrants and licensees to dispose of or to deposit all disused radioactive sources in a safe location so as to reduce the probability of such sources being found in the public domain. Found orphan sources are impounded for their safe management.

The CNEA may reuse some disused sources (such as those from therapy units and gamma irradiators) for R&D work as long as the new uses are justified according to Argentina’s safety regulatory criteria.

ABNORMAL EVENTS AND EMERGENCIES

Argentina’s regulations stipulate that persons or organizations using radiation sources must have emergency plans or procedures and be able to implement them. The ARN establishes emergency criteria and evaluates procedures for scenarios like the theft or loss of a source, a breach of shielding integrity, and on-site fires or explosions. Also, the ARN verifies that all parties involved in the safety and security of radioactive sources are ready to assume their responsibilities in connection with accidents or other abnormal events.

For installations using Category 1 radiation sources, the applicant must implement an emergency plan before commissioning, while at installations that use other categories of radiation sources the emergency procedures must provide against typical accidents and be designed to lessen their consequences.

The ARN's Radiological Emergency Intervention System (SIER) is prepared to give assistance in coping with emergencies with radioactive sources. The intervention group, on call night and day all year round, has the infrastructure and equipment necessary for prompt and efficient intervention at installations and in public areas.

In addition, the ARN has concluded co-operation agreements with the Federal Police, the Border Military Police, the Coast Guard and other organizations for co-ordinated actions during a radiological emergency.

ORPHAN SOURCES

The ARN has taken several actions to prevent orphan sources ending up in the public domain. Some are of an institutional character, such as the agreement with the Customs, which has established mechanisms to prevent the unauthorized import of radioactive sources. Other actions are based on the licensing, inspection and control programme, which ensures that radioactive sources are permanently under control while in use, are properly stored when no longer in use and disposed of when declared to be radioactive waste.

The ARN promotes the use of automatic radioactive material detection systems at places where orphan sources are likely to be found, such as steel mills and the border crossing points. Also, it provides training and technical support to those who are involved in the detection of orphan sources and co-ordinates the management of orphan radioactive sources with the CNEA.

EDUCATION AND TRAINING

The ARN requires that individuals undergo appropriate theoretical and practical training in the safety and security aspects of a practice before applying for a permit to engage in that practice. The training is based on courses given by different organizations recognized by the ARN.

The ARN arranges for the continuous training of specialists in radiological and nuclear safety, safeguards and physical protection through participation in courses, congresses and expert meetings.

The ARN carries out those activities through a Training Division responsible for the design, organization and co-ordination of courses, workshops and seminars; the Postgraduate course in Radiological Protection and Nuclear Safety is a joint effort with the University of Buenos Aires and the Ministry of Health. The IAEA endorses the courses and supports them by granting scholarships to Spanish-speaking university graduates — mainly from Latin American countries but also from European and Asian countries. In the past 20 years, more than 540 participants — half of them from outside Argentina — have attended the Postgraduate course.

THE REGULATORY CONTROL OF RADIATION SOURCES IN AUSTRALIA — THE CHALLENGES OF A FEDERAL SYSTEM

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Abstract. The report refers to the challenges that Australia is facing, as a federal nation having a Commonwealth Government and six States and two territories, in establishing appropriate regulatory control of radiation sources. Information on the national inventory of radiation sources and existing regulatory infrastructure, including the system of notification, registration, licensing, inspection and enforcement, is explained in the report. The national provisions for the management of disused sources; the planning, preparedness and response to abnormal events and emergencies; the recovery of control over orphan sources; and education and training; are specifically emphasized.

INTRODUCTION

Australia is a federal nation having a national (Commonwealth) Government and six States and two Territories. Health matters (where radiation safety legislation typically rests) fall within the jurisdiction of the relevant State or Territory across Australia.

The Commonwealth Government, and each State and Territory Government, has passed legislation protecting health and safety from the harmful effects of radiation. While this multi-layered system of radiation protection regulation differs in the detail within Australia, it is basically in line with the philosophy of the International Basic Safety Standards (BSS).

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) undertakes the radiation regulatory activity on behalf of the Commonwealth Government. It also provides the country's largest and most sophisticated radiation measurement and assessment capacity and takes the lead in preparing the range of standards, codes and guidance used by the regulatory authorities and by industry in ensuring radiation protection.

THE ESTIMATED NATIONAL INVENTORY

Australia is an advanced industrialized country and uses the full range of radiation sources for medical and industrial purposes. Australia does not have any nuclear power reactors, but does operate a large research reactor (planned to be replaced) for research and for the production of radioisotopes (especially medical radioisotopes).

In preparing this paper, information on sources was sought from each jurisdiction using the definition under discussion in the draft *IAEA 'Categorization of Radiation Sources'* document. The resultant response for the significant, or category 1, sources held in Australia is presented in Table 1. The responses for category 2 and category 3, i.e. the 'less significant' sources, have been amalgamated in Table 2 to provide meaningful comparisons.

Table 1: Significant Sources in Australia — Category 1

Jurisdiction	Source Use	Teletherapy	Whole blood irradiation	Industrial radiography	Sterilisation and food preservation (Irradiators)	Other irradiators
	Isotope and Activity range	Co-60; 50-1000 TBq Cs-137; 500 TBq	Co-60; 1-1000 TBq Cs-137; 2-100 TBq	Ir-192; 0.1-5 TBq Co-60; 0.1-5 TBq Cs-137;	Co-60; 0.1-400 PBq Cs-137; 0.1-400 PBq	Co-60; 1-1000 TBq
Commonwealth (National)		2 1	0 1	Details not available Details not available 1	1 0	4
New South Wales		Details not available	Details not available	Details not available	Details not available	Details not available
Victoria		Nil	2 6	36 0 7	1 0	Included in whole blood numbers
South Australia		4 0	1 0	28 2 0	Nil	Nil
Tasmania		Nil	1 0	2 0 0	Nil	Nil
Western Australia		Nil	0 2	43 3 3	Nil	Nil
Queensland		Nil	12 1	58 0 1	Nil	2
Northern Territory		Nil	Nil	4 to 6	Nil	Nil
Australian Capital Territory		Nil	Nil	Nil	Nil	Nil
TOTAL = 201		**7**	**26**	**160**	**2**	**6**

Table 2. Significant Sources in Australia — Category 2 and 3

Jurisdiction	Source use	Remote afterloading brachytherapy	Manual brachytherapy	Well logging	All radiation gauges	Moisture/density detectors
	Isotope and activity range * values differ from IAEA draft	Co-60; 10Gbq Cs-137; 2-10.5Gbq* Ir-192; 400Mbq	Cs137; 1.5-2GBq* Co-60; 50-500MBq Sr-90;50-4000MBq*	Cs-137; 1-100GBq Am241/Be; 800 GBq	Cs-137; 20GBq Co-60; 10GBq Am241; 4GBq Others	Am-241/Be; 2GBq Cs137; 400MBq Ra-226/Be;
Commonwealth (National) * includes sources stored		0 0 0	0 0 0	Data not available	Total = 260	Total =101*
New South Wales		Data not available	Data not available	Data not available	Total = 800	Data not available
Victoria		0 3 5	1 0 9	13 12	104 19 163 131	150 107 0
South Australia		0 1 1	17 1 11	30 55	227 110 28 7	110 2 9
Tasmania		Data not available	Data not available	Data not available	Data not available	Data not available
Western Australia		0 12 0	8 3 10	Total = 101	Total = 1351	167 0 0
Queensland * includes sources stored		Data not available	Data not available	11 31	53* 0 14 3	26* 2 0
Northern Territory		Data not available	Data not available	Data not available	Data not available	Data not available
Australian Capital Territory		0 0 1	Nil	Nil	Nil	8 0 0

THE NATIONAL REGULATORY INFRASTRUCTURE

Australia has both national legislation for radiation protection and separate legislation for each of the eight States and Territories. Each jurisdiction operates a 'radiation control branch'. In most cases, this is a part of the Department of Health; for the largest State, New South Wales, it is a part of that State's Environmental Protection Agency. The majority of the jurisdictions have some form of associated 'radiation advisory council' of independent people. In two of the jurisdictions, these councils are, in fact, the formal decision-maker for licensing, registration etc. For others, the formal decision-makers may be the statutory officer (e.g. the CEO of ARPANSA), the CEO or head of the health department, or the minister.

THE NATIONAL SYSTEM OF NOTIFICATION, REGISTRATION, LICENSING, INSPECTION AND ENFORCEMENT

Each jurisdiction in Australia has requirements for the notification, registration, licensing, inspection and enforcement for users of radioactive sources and radioactive materials. Although the requirements of the BSS are met in each jurisdiction, these requirements vary somewhat, and this makes the system non-uniform around Australia.

The radiation protection standards and system flowing from ICRP 60 and developed at the same time as the BSS were adopted in Australia in 1995. The standards and system were endorsed by the nation's peak health body — the National Health and Medical Research Council. They are incorporated into licence conditions and referred to through regulations made under each of the relevant Acts.

There are national codes of practice and guidelines established for the proper handling of a range of sources (e.g. 'Code of Practice for the Safe Use of Sealed Radioactive Sources in Borehole Logging (1989)'). These codes are now being reviewed and revised through ARPANSA and a 'Radiation Health Committee' on which all jurisdictions are represented.

Agreement on the minimum qualifications for a licensee is not uniform in Australia, and this is complicated by the various 'turf' battles within the professions.

Once all the policy positions have been reached, and there is an updated series of 'Codes of Practice', there still remains the need to amend the various Acts and Regulations of each jurisdiction within Australia. This involves both some form of regulatory impact assessment and further public consultation, which can led to further non-uniform requirements in the final legislation.

The national provisions for:

a) the management of disused sources;
   Currently each jurisdiction has either its own above ground waste store, or requires the producers of radioactive waste to store the waste themselves under some form of authorization from the regulatory authority. One jurisdiction has its own shallow ground burial site. Australia has, however, embarked on a search for a national low level and short lived intermediate level waste repository. A general location has been selected for this shallow ground repository and drilling of a number of specific sites for assessment is under way.

b) the planning, preparedness and response to abnormal events and emergencies;
   On the individual State and Territory level there is a link between radiation regulators, and the relevant hazardous materials response system. The emergency response system is typically triggered by the 24-hour State emergency response centre, which calls the fire brigade as the relevant 'combat agency' for hazardous materials incidents. The police and the radiation regulators in each jurisdiction normally provide backup assistance to the combat agency. On the national level, ARPANSA is the WHO Collaboration Centre for Radiation Protection and Radiation Emergency Medical Assistance (CRPREMA) and maintains a 24-hour on-call duty roster for that purpose.
c) the recovery of control over orphan sources;
   Orphan sources are typically included in the response arrangements as detailed above. The State or Territory radiation regulator normally takes custody of the orphan source for storage and ultimate disposal.
d) informing users and others who might be affected by lost sources;
   Public information on lost sources is typically handled by the emergency services, such as the police, with technical advice provided by the radiation regulator.
e) education and training in the safety of radiation sources and the security of radioactive materials;
   Appropriate training and education on the use of radiation sources is normally undertaken by specialist organizations such as universities or technical colleges. Some jurisdictions also run 'in-house' courses where commercial courses are not available or demand is low but this can present problems as the course providers are also the course assessors because attendance at the course is often a prerequisite to the issue of a licence.
   Some of the major users of radiation, e.g. ANSTO, provide both in-house training for their employees, and commercial courses for other users. These courses are normally accredited by the various jurisdictions, but again this process is not uniform across Australia, and needs formalizing.

CONCLUSION

In summary, the challenge for Australia is not so much the lack of administrative infrastructure, but the lack of a uniform administrative infrastructure. This lack of uniformity could lead, in a worst case scenario, to administrative control of sources being lost as the sources move across jurisdictions. It is this challenge of uniformity that Australia seeks to address in the foreseeable future.

THE REGULATORY AND WASTE SAFETY INFRASTRUCTURE OF BANGLADESH: PRESENT STATUS AND FUTURE DIRECTION

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Abstract. Although nuclear energy and ionizing radiation exist as this planet earth exists, the history of human use of these energies is only a little over hundred years old. Nuclear and radiological practices are of immense benefit to society. But, like all other practices, nuclear and radiological practices also involve risks of a special type and nature. People and media are particularly sensitive to the use as well as to any accident or emergency involving the practices. Necessary laws and regulatory bodies have existed in many countries for a long time to control and keep the risks within acceptable limits. Nonetheless, accidents do occur and emergencies arise, which leads to the questioning of such regulatory systems' effectiveness. International interaction and co-operation are essential to addressing societal concerns appropriately. Bangladesh, though late, has also enacted laws and established a regulatory system to control the practices. This paper focuses on the country's regulatory status, hurdles being faced in implementing the legal requirements, and future thinking to increase effectiveness and efficiency.

INTRODUCTION

Bangladesh is an economically challenged country with a population of about 130 million living in an area of 147 570 square kilometers.

The discovery of X ray by W.C. Roentgen (1895) and the successful accomplishment of nuclear chain reaction by Enrico Fermi (1942) opened up a new vista of nuclear energy and radiological practices. Today nuclear energy and radioactive materials are being extensively used all over the world for the generation of electricity and in many other economic and beneficial applications in medicine, industry, agriculture, research, etc. Nevertheless, the misuse or uncontrolled use of nuclear and radiological practices can expose people and the environment to unacceptable risks. Appropriate regulatory control, therefore, is essential.

Bangladesh uses nuclear and ionizing radiation sources to a small extent in various economic activities. Necessary laws and rules have been promulgated and are being enforced, the success of which largely depends on human resources and infrastructure. The country's regulatory infrastructure is still at a formative stage and is in the process of strengthening with IAEA collaboration.

Nuclear technology is evolving with knew scientific knowledge and technological inventions and innovations. Regulation of nuclear and radiological practices needs special knowledge and equipment to be applied systematically. International interaction and co-operation are essential to ensure safety and protection commensurate with the requirements of the IAEA International Basic Safety Standards (BSS).

RADIOLOGICAL PRACTICES

The first X-ray machine in the country was installed in Dhaka in 1921. Since then the use of ionizing radiation sources has increased considerably and is being diversified. The country now has a 3 MW research reactor, three irradiators, and considerable use of ionizing radiation sources in health services, industry, construction, mineral exploration, agriculture, research and education and in other economic activities. The use of radiological practices is increasing at a faster rate than before. The trend is likely to continue. The country is also considering building a nuclear power plant.

LEGISLATION AND REGULATORY INFRASTRUCTURE

The Bangladesh Atomic Commission (BAEC), a statutory body, was formed by the Presidential Order No. 15 of 1973. This Order provides only promotional power to the BAEC. The Nuclear Safety and Radiation Control (NSRC) Act (No. 21 of 1993) was promulgated on July 22, 1993, "to provide for ensuring nuclear safety and radiation control". The Act confers all necessary powers on the BAEC to regulate use of nuclear energy, radiological practices and management of radioactive waste.

The NSRC Rules were promulgated and brought into force on September 18, 1997. The Rules incorporate the principal requirements of the BSS. Both the Act and the Rules have been written in Bangla, the national language. Authenticated English texts of the Act and Rules were published and copies were made available to the IAEA and other concerned agencies and establishments.

The Nuclear Safety and Radiation Control Division (NSRCD) of the BAEC is responsible for facilitating the implementation of the provisions of the Rules. The NSRCD is still at a formative stage, staffed mainly by newly recruited young scientists and engineers. The infrastructure and logistics need upgrading.

NATIONWIDE SURVEY

Accounting and safety assessment of all sources is the primary task and essential for an effective regulatory programme. As late as April 1999, the BAEC had information on important or critical practices, such as radiotherapy, nuclear medicine and industrial radiographym, covering only 10% of the estimated sources. Information, in particular, on the diagnostic X-ray machines was scanty and speculative.

In order to carry out comprehensive data based assessments of all radiological practices in the country, a nationwide survey programme was initiated in May 1999. The work, as planned, will be completed by December 2000. To date (September 30, 2000), surveys in 52 districts out of total 64 districts have been completed, yielding data of 2163 X-ray machines from 1820 X-ray installations. Information on other radiological practices was also collected. This accounts about 85% of all sources.

SURVEY FINDINGS

Survey findings are quite revealing. There was hardly any facility which could be considered fully satisfactory in strict sense of the Rules. Most X-ray installations had no dosimetry. Weaknesses in shielding, lack of radiation protection procedures and absence of qualified staff were observed. Things are now improving. Quality assurance (QA) is a new concept to the facilities. It will take time to develop the necessary capability and motivation of the operators to introduce appropriate QA programmes and put them into practice. Findings were fed back to the inspected facilities. The survey results are being published to use as a reference as well as to aid the decision-makers.

IMPLEMENTATION OF THE RULES

It took some time to start enforcing licensing requirements. Since mid-1999, the licensing activities have been gradually gaining momentum, as may be seen in Figure 1.

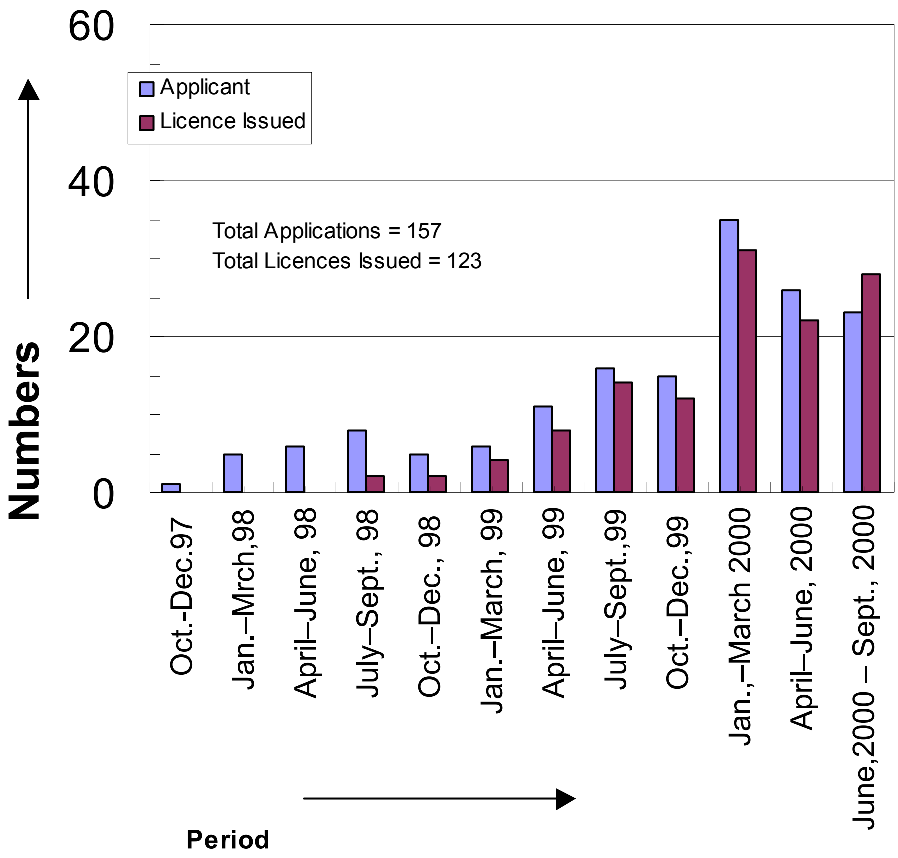

Fig.1 : Status of Licence Applications Received and No. of Licences Issued for the Period of Sept., 97 to September, 2000.

OCCUPATIONAL EXPOSURE CONTROL AND MONITORING

Currently, the number of radiation workers is estimated to be about 10 000. The BAEC laboratories provide personnel dosimetry services, but there are weaknesses and limitations. Only the critical groups engaged in radiotherapy, nuclear medicine and industrial radiography are covered by a routine monitoring programme. The occupational workers engaged in diagnostic X-ray services are still without a side dosimetry programme. The BAEC, with the support of the IAEA, is trying to improve the situation as fast as possible.

The BAEC has a secondary standards dosimetry laboratory (SSDL) for providing nationwide calibration services to users, who are being made aware of the need and importance of routine calibration services.

ENVIRONMENTAL AND PUBLIC EXPOSURE

The BAEC has conducted a number of studies involving environmental monitoring since the mid-sixties. The activity levels found in locally produced crops such as vegetables and fruits are well below permissible levels. Environmental monitoring is primarily carried out around the 3 MW TRIGA reactor facility. The monitoring of sources of potential risk receives greater attention than the monitoring of those causing chronic exposures.

WASTE MANAGEMENT

The efforts to account for all radioactive waste have been increased recently with the aim of accomplishing the task in a year's time. Also, an action programme was chalked out in January 2000 to find and manage all radium waste by October 2000. The BAEC is constructing a central radioactive waste processing and storage facility at AERE, Saver. The facility will be operational by June 2001.

EMERGENCY PREPAREDNESS

Due importance is placed on the issue. Formal lectures on emergency preparedness and the INES have been included in all training courses conducted recently. Nevertheless, if a major radiological emergency should arise, IAEA assistance under the "Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency – 1986", may be required.

TRAINING AND REQUALIFICATION

The key to the success of any programme is the responsible human resources. The NSRC Act and Rules have stressed this repeatedly. NSRCD conducted nine training courses in safety and protection related disciplines during the past eighteen months. Five were conducted with the BAEC's own resources and the remaining four in collaboration with the IAEA. Also, the IAEA provided numerous opportunities to train people abroad.

PRINCIPAL HURDLES

The principal hurdles are: age long inertia, inadequate training facilities for occupational workers (diagnostic X ray, in particular), poor maintenance of equipment and instruments, severe penalty provision, lack of experienced and qualified regulatory staff, inadequate regulatory infrastructure and support, absence of public awareness, and cultural and attitudinal problems. It will take time, patience, a pragmatic approach, concerted efforts and the support of all concerned persons and agencies to overcome these problems.

FUTURE PROGRAMME

The present penalty provisions in the Act need amendment. Independence of regulation from promotional activities requires consideration. A national seminar has been planned for February 2001 to discuss the survey findings and other key legal issues to enable the development of a realistic and meaningful programme. Specific guides for specific practices have to be prepared in the national language for better understanding and compliance. The present database and documentation system will be reviewed and strengthened.

INTERNATIONAL COLLABORATION

The BSS are a good example of international co-operation and collaboration to harmonize radiological safety and protection issues on a realistic and pragmatic footing. Legal and regulatory systems have existed in most countries for a considerable period. Nonetheless, accidents have happened in the past and also this year. The consequences may easily cross State borders and affect other countries. Orphan sources and illicit trafficking of radioactive and nuclear materials are global concerns. Collective dose resulting from practices should be questioned in relation to justification and optimization. The perception of safety and protection requires reassessment as the world is real, and the resources are limited in a competing demand scenario. International interaction and collaboration will help to address these issues. Developing countries like Bangladesh need international support and co-operation to strengthen regulatory regimes. The IAEA's efforts are contributing positively to this end.

CONCLUSION

Bangladesh wants to achieve safety standards compatible with the BSS requirements. To accomplish this goal, adequate financial and administrative support to train and motivate the concerned persons and to create the necessary infrastructure and facilities will be required. An economically challenged country like Bangladesh has competing priorities and, as such, it will take long and concerted efforts to achieve the regulatory objectives. Performance has to be judged from the perspective of a developing country with due consideration to the politico-economic and cultural norms.

The regulatory regime is continuously evolving with changing perceptions and attitudes, new scientific knowledge and technological inventions and innovations. The system should respond to the evolving situation. Strong political will, support of the concerned authorities, provision of adequate funds, qualified personnel and logistics are necessary. The support and co-operation of organizations like the IAEA and WHO will help to accelerate the process.

At the threshold of the new millennium, we hope that we shall be able to eliminate the major weaknesses and ensure desired safety and protection relating to peaceful uses of nuclear energy and beneficial radiological practices. This is needed to make a better and safer world for us and for posterity.

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RADIATION PROTECTION IN BOLIVIA

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Abstract. Radiation protection in Bolivia has gone through a number of stages. Initially, in the 1970s, the focus was mainly on the analysis of environmental sources resulting from the nuclear tests carried out by France in the Pacific Ocean. Subsequently, the focus switched somewhat to radiation protection in connection with the mining of uranium and in the area of public health. During the third stage, radiation protection in other areas became important as the use of radiation sources was introduced. Finally, during the present — fourth — stage, radiation protection regulations are being introduced and mechanisms for the control of radiation sources are being established.

INTRODUCTION

The use of nuclear technology is increasing as a consequence of knowledge of the benefits that this technology can bring. At the same time, more and more information about the risks associated with its use is being acquired, and this has highlighted the need for structures that ensure the safe use of ionizing radiation.

In Bolivia the use of radiation sources is not very widespread, although the number of areas where nuclear techniques have been introduced is growing. Health is an area where radiation sources are important, for both diagnosis and therapy. In industry, radioactive materials and irradiation equipment are being used. Other areas include livestock rearing, agriculture, environmental studies, scientific research and oil prospecting, although the amounts of radioactive material used are small.

Hence the need for a national authority responsible for ensuring that ionizing radiation is used safely and possessing the necessary means.

BACKGROUND

In Bolivia, research in the nuclear area — with the emphasis on nuclear physics — began in the 1970s, when the Comisión Boliviana de Energía Nuclear (the Bolivian Nuclear Energy Commission – COBOEN) was established. The nuclear tests carried out by France in the Pacific Ocean caused attention to focus especially on the consequences which those tests might have, and the first environmental monitors, air samplers etc. were set up for the purpose of evaluating the impact of the French tests.

In the light of the experience acquired, a Radiation Protection Division was created within COBOEN, but with very limited facilities and staff, and it grew very little in subsequent years as COBOEN had other priorities; between 1975 and 1982 the focus was on radiation protection in the mining of uranium, without much attention paid to other areas.

Only since 1983, when the Instituto Boliviano de Ciencias y Tecnología Nuclear (the Bolivian Institute of Science and Nuclear Technology – IBTEN) was established, has real importance been attached to radiation protection, both within IBTEN and at other institutes, especially ones working in the health area.

A radiation protection law establishing a regulatory authority was passed in October 1982, and by 1997 the regulatory authority had drafted ten radiation protection regulations. However, these were not adopted until this year. They confirm IBTEN as the regulatory authority.

DEVELOPMENT AND ADOPTION OF THE RADIATION PROTECTION LAW AND REGULATIONS

The Bolivian Nuclear Energy Commission was empowered by the eleven chapters and thirty articles of the radiation protection law, adopted on 6 October 1983 by means of decree No. 19172, to implement the law and draft the necessary regulations.

For fifteen years, draft regulations were presented to the relevant authorities, but sadly they accumulated during this very long period without being examined. Finally, they were approved on 29 January 1997. They once more confirm that IBTEN is the regulatory authority — the only body that can issue licences and authorizations to institutions and persons wishing to use ionizing radiation. They establish a dynamic and flexible structure for the regulatory authority and a link with the authority responsible for environmental protection. They introduce basic standards for protection against ionizing radiation and the security of radiation sources. They place under one authority everything relating to radioactive materials and irradiation equipment, which means better control and — in Bolivia's case — the optimum use of human and economic resources. Lastly, they introduce a mechanism for appealing against penalties imposed by the regulatory authority.

The approved regulations are the following:

Regulation No. 1	Registry of radiation sources
Regulation No. 2	Basic radiation protection standards
Regulation No. 3	Licences and authorizations
Regulation No. 4	Inspections
Regulation No. 5	Radioactive materials transportation
Regulation No. 6	Safety standards at radiological installations
Regulation No. 7	Decontamination of surfaces
Regulation No. 8	Radioactive waste treatment
Regulation No. 9	Medical control of personnel exposed to ionizing radiation
Regulation No. 10	Personal dosimetry
Regulation No. 11	Penalties

The IAEA's support for the preparation and introduction of the law and regulations, especially through a Model Project for the strengthening of regulatory authorities, was crucial. It has led to the establishment of a basic structure that enables essential tasks to be carried out under appropriate conditions.

Since the approval of the regulations, two documents supporting the performance of those tasks have been drafted:

- Requirements for registering and licensing radiological installation — health area; and
- Requirements for registering and licensing radiological gammagraphy and industrial radiography installations.

These documents are under consideration by the relevant authorities, and it is expected that they will be approved soon. Other, complementary documents are to be prepared with a view to strengthening the capacity of the regulatory authority.

The regulatory authority's capacity is still very limited, but it has made possible an approximate estimation of the number of radiation sources existing in Bolivia.

INSTALLATIONS THAT USE RADIOACTIVE MATERIAL

Type	No. of installations
Telegammatherapy	7
Brachytherapy	6
Petroleum prospecting	3
Industrial gamma radiography	8
Mining	6
Industry	7
Nuclear medicine	4
TOTAL	**48**

IRRADIATION EQUIPMENT

Type	No. of installations
Radiodiagnostics	219
Dental	76
Mammography	8
Simulators	2
Tomography	9
Therapy	4
Industry	3
Accelerators	1
TOTAL	**322**

CONCLUSIONS

IBTEN has come a long way, but it still has a long way to go. Little by little the foundations have been laid of a dynamic and efficient regulatory authority, although with limitations.

CONTROL OF RADIATION SOURCES THROUGH REGULATORY INSPECTIONS OF RADIATION SAFETY IN BRAZILIAN INDUSTRIES

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Abstract. This work presents a brief description of the situation of Brazilian Regulatory Authority with regard to safety control of industrial radioactive installations. It shows the national regulatory infrastructure responsible for radiation safety inspections, the regulation infrastructure, the national inventory of industrial installations, the national system of inspection and enforcement and the national system for qualifying radiation protection officers. Some results of regulatory safety inspections are also shown.

GENERAL ASPECTS

The Brazilian Regulatory Authority is the National Commission of Nuclear Energy (Comissão Nacional de Energia Nuclear–CNEN), which is responsible for all activities related to nuclear or radioactive materials. CNEN's infrastructure for controlling industrial radioactive installations comprises a Director of Radiation Protection and Nuclear Safety with two general co-ordinators: the Co-ordinator of Licensing and Control–SLC, responsible for the national system of licensing, and the Institute of Radiation Protection and Dosimetry-IRD, responsible for the national system of radiation safety inspections.

The Brazilian regulation infrastructure related to industrial radioactive installations consists of general guidelines and six specific guidelines. CNEN has the following regulation infrastructure:

General guideline

The Basic Guidelines for Radiation Protection, NE3.01-CNEN, 1988, specify basic principles; occupational radiation limits and limits for the public; obligations for the director of an installation, radiation protection officer and workers; basic controls for human and environmental protection against the potential negative effects of ionizing radiation. It also contains the necessary minimum items for the elaboration of a radiation protection programme.

Specific guidelines

Radiation Protection Service, NE3.02-CNEN, 1988, establishes the requirements to operate such a service in nuclear and radioactive facilities and presents a structure for facilities to qualify personnel and operate equipment. It determines the activities to be carried out by the service concerning the control of radiation sources, workers, radioactive areas, the environment, the population, radioactive waste and radiation equipment. It also presents a training programme for workers and records to be kept.

Certification of Qualification for Radiation Protection Officer, NE3.03-CNEN, 1999, establishes the requirements to certify radiation protection officers' qualifications for duty in nuclear and radioactive facilities, and also in the transport of radioactive material. It specifies the areas of performance, and requirements for personnel and training documentation. It also presents the methodology for evaluation, issuance and validation of the certification. The main violations of requirements that cancel the certification issued by CNEN are also shown.

Licensing of Radioactive Installations, NE6.02-CNEN, 1998, establishes the process for licensing radioactive facilities concerning the activities related to their location, construction, operation and modification. It presents the classification of facilities and license methodology for issuing prior approval, construction license, authorization for acquisition of radioactive material and authorization for operation of radioactive facilities. It also determines the minimum requirements to be fulfilled concerning the authorization for modification and operation and defines the limits of exemption.

Operation of Industrial Radiography Service, NE6.04-CNEN, 1989, establishes the requirements for the operation of an industrial radiography service and the procedures for acquisition and transfer of radioactive sources or X-ray equipment used in fixed or movable installations. It specifies the requirements to be fulfilled for the issuance of a construction license, authorization for acquisition or transfer of radioactive sources and irradiator equipment, and for authorization of operation. It also presents the main topics of the General Plan of Radiation Protection including programmes of operation, staff training, emergency and physical protection. It presents specifications for radiation protection officers, for staff responsible for movable installations, and for facility operators.

Management of Radioactive Waste in Radioactive Facilities, NE-6.05, 1985, establishes general criteria and relative basic requirements for management of radioactive waste in radioactive facilities. It presents waste classification and the general requirements for waste management. It also specifies the criteria to be followed during transport, temporary storage and disposal of radioactive waste.

Transport of Radioactive Material, NE-5.01, 1988, establishes all requirements of radiation protection and safety for the transport of radioactive materials necessary to guarantee an appropriate level of control of potential exposure of people, goods and the environment to ionizing radiation.

Table 1. Number of industrial radioactive facilities in Brazil — 1999

Application area		Number of facilities	
Industrial radiography	Movable installations [1]	15	100
	Fixed installation: gamma ray	25	
	Fixed installation: X-ray	60	
Industrial irradiator plant		06	06
Well logging petroleum - bases		13	13
Nuclear gauges	Manufacturers	03	403
	Installation with less than 10 radioactive sources	240	
	Installation with up to 40 radioactive sources	120	
	Installation with more than 40 radioactive sources	40	
Total		522	

[1]That number is related only for installation officer. The radiation works number is explained above.

All industrial installations that use radiation sources must be licensed by the regulatory authority, CNEN, and subjected to regulatory inspection. CNEN's database programme with the national inventory shows that there are 522 facilities that use radioactive sources as a work tool (see Table 1). Facilities are classified for purposes of inspection management [1], as: industrial radiography, well logging petroleum, industrial irradiator plant and nuclear gauge.

Industrial radiography accounts for 100 facilities (19% of total), 15% of which are movable installations with their high concentration of workers and irradiation equipment. These movable installations that use industrial gamma radiography equipment account for almost 200 off-site radiation jobs per year around the country, as shown in Figure 1. Well logging petroleum, with its industrial bases, accounts for 13 facilities (2.5%). Although industrial irradiator plants comprise only six facilities nationwide (1%), they are responsible for 185PBq (3MCi) of cobalt-60. Brazil has five industrial irradiator plants built by a Canadian company and one plant designed and built by a Brazilian company. Nuclear gauges account for the greatest number of facilities, 403 installations (77%), with a variety of radioisotopes with activities of up to 0.37TBq (10Ci).

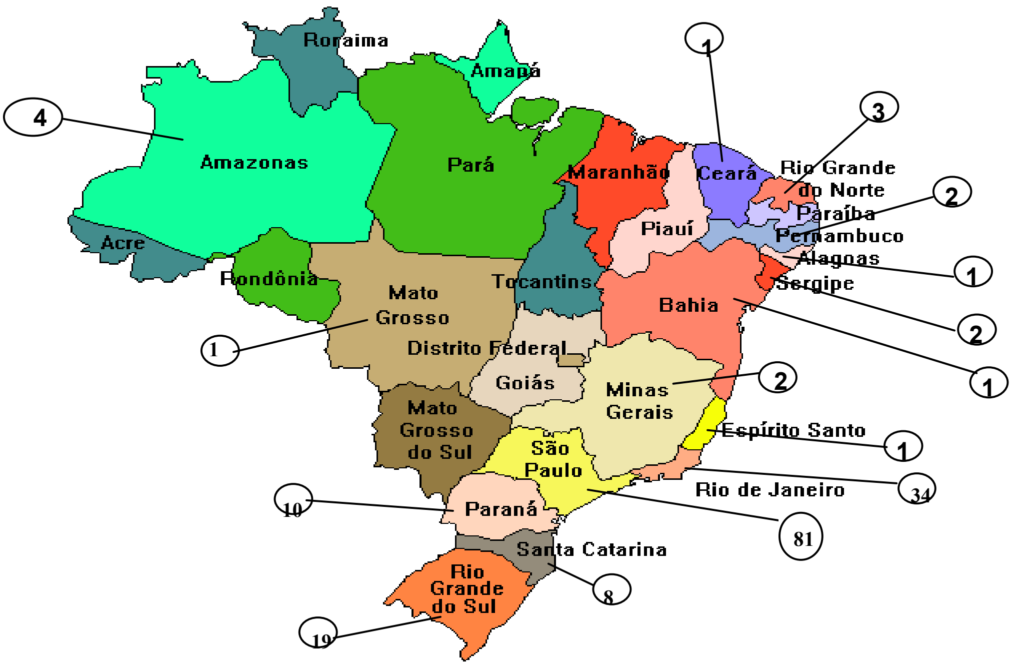

Fig.1. Distribution of movable installations using industrial gamma radiography equipment.

The national system of inspection to control the safe use of radioactive sources in industrial activities is provided by the Institute of Radiation Protection and Dosimetry (IRD), which has been inspecting a great number of radioactive facilities in recent years. The inspections are based on indicators and performed over specific periods for each installation type [2].

The main indicators used to guide the inspections are:

a) installation never inspected by CNEN – new installation;
b) installation with any dose registry above 4mSv/month;
c) installation with problems in the licensing process;
d) installation that shows problems with radiation protection and safety.

The minimum periods for routine regulatory safety inspections are:

(a) for industrial radiography:
  - movable installation: once a year;
  - fixed installation with gamma rays: once every two years;
  - fixed installation with X-rays: once every three years;

(b) for well logging petroleum: once every two years;

(c) for industrial irradiator plants: once every two years;

(d) for nuclear gauges:
  - manufacturers: once a year;

The frequency of inspection of installations is determined by the number of radioactive sources:

- up to 10 radioactive sources: once every five years; if the installation has neutron radioactive sources, the frequency is once every four years;
- between 11 and 40 radioactive sources: once every four years; if the installation has neutron radioactive sources, the frequency is once every three years;
- more than 41 radioactive sources: once every three years; if the installation has neutron radioactive sources, the frequency is once every two years.

According to regulations, all industrial installations that use radiation sources must have at least one radiation protection officer responsible for the radiation protection service. The national system for qualifying radiation protection officers requires the candidate to:

1. be a graduate professional; and
2. pass two types of examinations.
   - a general written examination about all basic aspects of radiation protection and safety, legislation, etc;
   - a specific examination on each area. This examination is divided in two parts: a written test and a practical, oral test.
3. The certification is valid for five years, and can be cancelled when violation of requirements or unsafe conditions are found during the radiation protection officer's performance of duties.

RESULTS

Using this methodology for selecting facilities to be inspected, 430 radiation protection and safety inspections were performed from 1996 to 1999, as shown in Figure 2. These were 89 inspections during 1996, 115 during 1997, 122 during 1998 and 104 during 1999. Figure 3 shows the number of inspections for each area during this period. There were 232 inspections in industrial radiography, 159 in nuclear gauges, 25 in well logging petroleum and 14 inspections in industrial irradiator plant.

Even though industrial installations have radiation protection officers, many regulatory violations were noticed during safety inspections. Table 2 shows the main violations committed by radiation protection services and detected by inspectors.

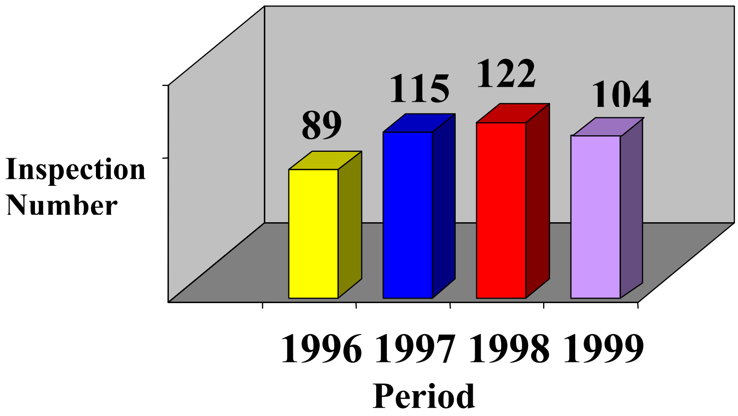

Fig. 2. Number of regulatory inspections of radiation safety in Brazilian industries from 1996 to 1999.

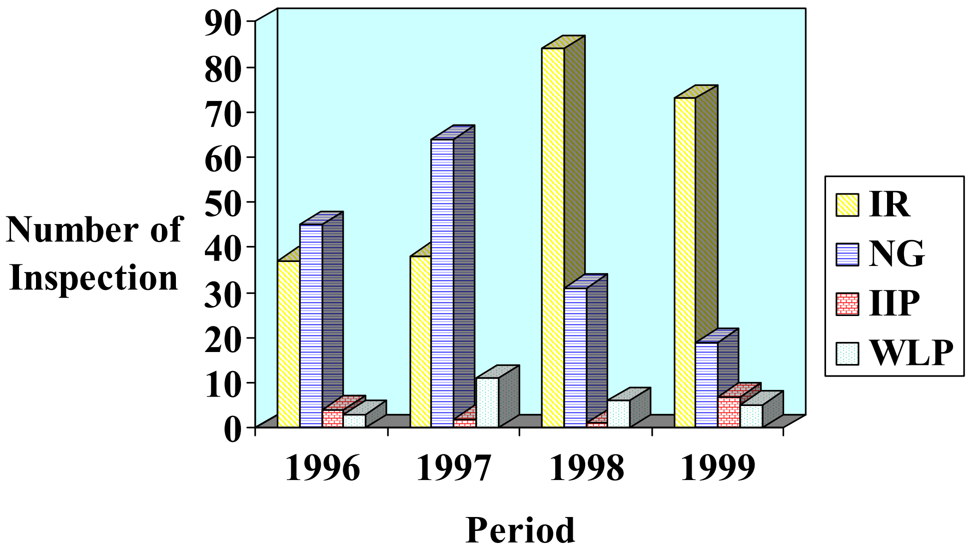

Fig .3. Number of regulatory inspections of radiation safety in Brazilian industries from 1996 to 1999 for each area of application.

Table 2. Main Violations detected during Radiation Safety Inspection

Violation	Industrial radiography	Nuclear gauges	Well logging petroleum	Industrial irradiation facilities
Operation authorization expired	x			
Lack of radiation protection officer		x	x	
Inappropriate radiation protection programme		x	x	
Lack of record of personnel dosimetry	x	x	x	x
Lack of record of worker's medical examination		x	x	
Lack of record of workers training	x	x	x	
Lack of record of workplace monitoring	x	x	x	
Lack of record of maintenance of equipment	x	x		
Lack of record of leaking source		x		
Inappropriate storage radiation source		x		
Inappropriate emergency programme				x
Lack of calibration or operational testing of survey equipment		x	x	
Lack of warning signals		x		

At the end of an inspection, a report is written recording all violations of requirements that were detected. On the basis of this report, CNEN can temporarily or definitively suspend authorization of the installation, and suspend or cancel the certification of the radiation protection officer or operator. From 1996 to 1999, the most important actions were taken in industrial radiography. Many installations had their authorizations temporarily suspended and three installations had their authorizations definitively suspended. Also, in industrial radiography, many radiation protection officers and operators had their certification suspended and one had it cancelled.

CONCLUSIONS

The number of inspections accomplished during these years shows that radioactive sources are being controlled by the regulatory authority.

Safety inspections are being performed throughout the country, taking a significant sampling of the radioactive facilities. This means that the inspection programme statistically embraces the whole country.

More attention should be paid to operational procedures in industrial radiography and well logging petroleum and to the administrative controls for nuclear gauges.

It is intended to increase the number of inspections year by year to adapt to the IAEA frequency of inspections recommended for industrial radioactive facilities.

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ACTIVITIES OF ARCAL XX FOR THE DEVELOPMENT OF GUIDELINES FOR THE SAFETY OF RADIATION SOURCES

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Abstract. This report presents the contribution of the ARCAL XX project “Guidelines for the Control of Radiation Sources” for the development and harmonization of the safety of radiation sources in Latin America. The project began in 1997 with the participation of nine countries. The methodology adopted has enabled all experts from the nine countries involved in the project to participate in discussions on the development of guidelines based on regional experience. Three common documents for all practices and six safety guides for the main practices have been revised for publication. For the next two years, the project co-ordinators are proposing regional and national workshops for the application of the safety guides approved by the ARCAL programme.

INTRODUCTION

The IAEA/RLA/9/028 ARCAL XX project "Guidelines for the Control of Radiation Sources" was proposed as a continuation of ARCAL XVII project “Estructura Normativa y Organización Regulatoria” (1994–1996) with the aim of harmonizing the safety radiological conditions of all radiation sources operated in Latin America. However, after the creation of the Model Project INT/9/143 “Mejoramiento de Infraestructura de Protección Radiológica y Seguridad de los Desechos Radiactivos”, with eight countries of the original group, the initial idea was reformulated and the project started in 1997 with nine countries(Argentina, Brazil, Chile, Colombia, Cuba, Mexico, Peru, Venezuela and Uruguay). At that time, all these countries had presented descriptions of their national regulatory infrastructures, including:

- a legislative structure and regulatory authority for applying a system of notification, registration, licensing and inspection of radiation sources and radioactive materials and forthe enforcement of regulatory provisions;
- a national radiation inventory of all facilities with significant radiation sources and radioactive materials, including disused sources and devices;
- a planning, preparedness and response programme to deal with abnormal events and emergencies;
- radiation protection services; and
- education, training and certification of personnel in radiation protection.

ARCAL XX OBJECTIVE AND PROPOSED RESULTS

The objective of the project is to promote an effective control of radiation sources in order to avoid unnecessary exposures and limit the probability of the occurrence of accidents; and to harmonize and update existing procedures within the region in order to adopt the IAEA BSS.

The main results required to achieve this goal are:

- definition of performance indicators for evaluation of the efficiency of the regulatory systems (regulatory authority and the users of radiation sources);

- harmonization and updating of the technical criteria for radiological protection in Latin America through the elaboration of safety guides for authorization and inspection of practices with radiation sources developed in medical, industrial and research facilities;
- diffusion of radiological security and safety in Latin America through the ARCAL XX Bulletin and maintenance of the www.Arcal XX Internet site.

DEVELOPMENT OF THE PROJECT

The project began in March 1997 in Caracas, Venezuela, and was consolidated at the Goiania Meeting, during the International Conference "Ten Years after the Goiania Accident", in October, 1997. During the La Habana Meeting, it was evaluated and reformulated, creating a revision committee formed by five countries (Argentina, Cuba, Mexico, Peru and Venezuela). The budgets for 1997, 1998 and 1999 were, respectively, US $68 189, US $78 851 and US $142 000. For the 2000 Activity Plan, the budget is US $ 155 900.

Each country is responsible for co-ordinating one activity, the others sending their contributions, such as regulations, procedures, inspection check lists and guides. The co-ordinating country elaborates the first draft and sends it to the countries before hosting the first experts meeting.The documents elaborated in the meeting are distributed to all countries and to the concerned IAEA technical officer for comments. Then a new draft is prepared and distributed for final revision.

The main difficulties in the process were:

- communication between countries and the IAEA;
- the number of documents to be displayed periodically, delaying comments and affecting the proposed schedule;
- changes in the IAEA technical officer, bringing about changes in the content and necessitating the rewriting of some documents approved by the experts.

In order to minimize these problems, in the second year of the project a revision committee was created with the objective of verifying accordance of the documents with the "Procedure to elaborate ARCAL XX documents". The committee can return a document to the co-ordinator country of the activity, which has to rewrite it according to the committee's recommendations. Each revision committee meeting may analyse three or four documents in two weeks.

Documents Common to all Practices

The *"Inspectors Manual"* presents the methodology to be followed during inspections performed by the regulatory authority, including planning and follow-up after enforcement. It contains recommendations about inspector's behaviour and a model report.

The *"Evaluation of the Radioactive Source Control System through Performance Indicators"* presents performance indicators for assessment of the effectiveness of the regulatory system, covering aspects related with the behaviour of the users of radiation sources. The indicators of influence of the regulatory authority, such as national and international agreements and the dissemination of information on radiation security and safety are presented, including aspects related to illicit trafficking.

The *"Guide for Practical Identification of Radiation Sources — and its Related Equipment — Used in Latin America and the Caribbean"* gives information to help identify radiation sources and equipment operated in Latin America. This guidance is very useful if abnormal events or emergencies occur, especially with orphan sources.The sources are categorized according to the associated potential exposure and radioactive contamination. Date are presented on characteristics of sources (radiotoxity, physical characteristics, semidesintegration periods, main emitters), external and internal exposure, dose calculation for skin contamination, shielding required at fixed distances, etc. The document includes pictures of devices containing radioactive materials covering the main manufacturers and models used in the region, activity dose levels and precautionary procedures to be taken. Additional data and procedures for transport containers are presented.

Regulatory Safety Guides

Safety guides have been elaborated for radiotherapy; nuclear medicine; diagnostic and interventional radiology; industrial radiography; industrial (gamma) irradiators; well logging and unsealed radioactive sources used in industrial applications (hydrology and radiotracers). Each safety guide contains three major documents:

Radiological Safety Requirements, with comprehensive technical criteria for facility design and safety operation; occupational, public and potential exposures; personal and institutional certification; classification of areas, local rules and supervision; quality assurance programme; transport of radioactive material; emergency programme and medical exposures (as applicable).

Guide for Application for Authorization, with the description of the technical documents to be included in an application for institutional and individual licenses. It includes an example of a "Procedure Manual of Radiological Protection" with administrative, operational and emergency procedures to be followed for performing the practice in question, considering the most common devices operated in the region.

Inspection Procedures, with a check list for each practice. In some cases, lists have been developed for each different category of devices or facilities, e.g. for categories I, II, III and IV for industrial gamma irradiators and for fixed and site industrial radiography. Several check lists have been developed for diagnostic radiology, including general evaluation of the facility, film processing, portable devices, tomography, mammography and fluoroscopy.

NEXT STEPS

In the last four years, ARCAL XX has promoted, with very few resources, an increase in knowledge and dissemination on national regulatory control among the Latin American regulatory authorities. Furthermore, it created other opportunities not initially planned such as interaction with the Asia and Africa programmes. The translation from Spanish to English of the documents by the IAEA and the ARCAL-RCA-AFRA meetings has contributed to increasing the exchange of experience among the specialists in the region and with the other two programmes.

The regulatory authorities in the region need to develop plans to improve competence of personnel (inspectors and security evaluators), to assess the performance of regulatory control and to promote a safety culture among the users of radiation sources. For 2001–2002 the

ARCAL programme recommends the implementation of ARCAL XX documents through regional and national workshops.

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CHILE 2000: RADIATION PROTECTION STATUS AND TRENDS

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Abstract. The current Chilean radiation protection infrastructure is quite complex because firstly, the laws, regulations and standards in force are based on former ICRP26 recommendations;and secondly, the designation of multiple competent authorities, i.e. the Chilean Nuclear Energy Commission, the Ministry of Mining, and some divisions of the Ministry of Health, complicates the harmonization of radiation protection criteria. Furthermore, some departments of these competent authorities are operators of nuclear or radioactive facilities and none of them has the competence to ratify either first or second order regulations. Consequently, the Chilean Nuclear Energy Commission is presently developing a programme to review all current national regulations to submit to the Government for consideration. The main objectives of the revision are to:

- update the legal framework
- include safety commitments taken on by subscription to international treaties, conventions and agreements
- improve the regulations with the BSS and ICRP based new recommendations on radiation protection
- work towards the establishment of a single, independent national regulatory authority.

This paper presents the current Chilean status of radiation protection status and suggests how to update it.

INTRODUCTION

Currently, the Chilean radiation protection infrastructure is quite a complex matter, for two important reasons. Firstly, the laws, regulations and standards in force are based on former ICRP26 recommendations. Secondly, the designation of multiple competent authorities, i.e. the Chilean Nuclear Energy Commission, the Ministry of Mining, and some divisions of the Ministry of Health, complicates the harmonization of radiation protection criteria. Furthermore, some departments of these competent authorities are operators of nuclear or radioactive facilities and none of them has the competence to ratify either first or second level regulations.

This paper is based on the regulatory authority's experience of the Chilean Nuclear Energy Commission (CNEC).

ESTIMATED INVENTORY OF SIGNIFICANT RADIATION SOURCES AND RADIOACTIVE MATERIALS

Information available from each regulatory authority is not always up to date, so it is not possible to make a reasonable estimation of the radioactive inventory in the country. Nevertheless, the approximate number of facilities utilizing radiation sources is known, as it is shown in the following tables.

CNEC own facilities	Number of facilities/units
Nuclear research reactors	2
Fuel fabrication plants	1
Radioisotope production plants	1
Multipurpose gamma irradiation plants	1
Radioactive waste processing plants	1
Associated research laboratories	30

CNEC own facilities	Number of facilities/units
External medical applications	Number of facilities/units
Electron accelerators	19
Remote loading brachytherapy units	2
Afterloading brachytherapy facilities/sources	12/260
Radiotherapy units	20
Nuclear medicine	35
X-ray general diagnostic units	(1200) *
X-ray dental units	(600) *
Mammography units	(80) *
Scanners/tomography units	(50) *

External research & industrial applications	Number of facilities/units
Particle accelerators	2
Gamma radiography projectors	190
Irradiators	2
X-ray radiography units	40
Level/density/flow/thickness gauges	(1500) *
Moisture gauges	(30) *
Well logging	(10) *
Luggage control X-ray units	(20) *
XRD & XRF	(40) *

* Unofficial figures, with an uncertainty of ±20%.

REGULATORY INFRASTRUCTURES RESPONSIBLE FOR THE SAFETY OF RADIATION SOURCES AND THE SECURITY OF RADIOACTIVE MATERIALS

LEGISLATIVE INFRASTRUCTURE

The Chilean legal framework is structured by the following levels of regulations:

International Regulations

The Chilean Government has subscribed to the international treaties, conventions and agreements listed below:

- Convention on Early Notification of a Nuclear Accident. Signed 26 September 1986
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Signed 26 September 1986
- Vienna Convention on Civil Liability for Nuclear Damage. Ratified 23 November1989
- Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention. Ratified 23 November 1989
- Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean (Tlatelolco Treaty). Signed 21 February 1994
- Convention on Physical Protection of Nuclear Material. Acceded 27 April 1994
- Treaty on the Non-Proliferation of Nuclear Weapons. Signed 25 May 1995
- Convention on Nuclear Safety. Ratified 20 December 1996.

As a general policy, the Chilean Government considers the international regulations at a supra-law level and applies then as rational regulations where applicable.

National Laws

The objectives of the laws — the first level regulations — are to establish general guidance and criteria. Currently, there are two fundamental laws:

- Nuclear Safety Law. Approved 16 April 1984
- Amendment to the Nuclear Safety Law. Approved 2 August 1988

These laws provide the legal framework to allow the development of the peaceful utilization of nuclear energy in Chile, and to set out the responsibilities of the exploitation entities and of the regulatory authorities.

Supreme Decrees

The objectives of supreme decrees — the second level regulations — are to give regulations related to law requirements; four of these regulations are in force:

- Licensing Regulation. Approved 22 May 1984
- Physical Protection of Nuclear Facilities and Materials. Approved 24 December1984
- Radiation Safety Regulation. Approved 3 January1985
- Regulations for the Safe Transport of Radioactive Material. Approved 3 March 1985.

Regulatory Guides

The objectives of regulatory guides — the third level regulations — are to provide safety details for specific practices. A variety of such guides are presently in force or are being developed.

REGULATORY AUTHORITIES

"The Chilean Nuclear Energy Commission is the competent authority for regulating, authorizing, controlling and supervising all activities related to the peaceful uses of nuclear energy for both nuclear and radioactive facilities of the 'first kind', while the Health Regional Services of the Ministry of Health are the competent authority for radioactive facilities of the 'second' and 'third kind'. In the special case of licensing relevant nuclear facilities (nuclear power plants, enrichment plants, reprocessing plants and waste repositories) a special authorization by supreme decree from the Ministry of Mines is required".

SYSTEM OF NOTIFICATION, REGISTRATION, LICENSING, INSPECTION OF RADIATION SOURCES AND RADIOACTIVE MATERIALS AND FOR THE ENFORCEMENT OF REGULATORY PROVISIONS

Current Chilean regulations are derived from the old ICRP26 Recommendations. For this reason neither notification nor registration is required. The sequence starts when a request for authorization is filed by the facility responsible, be it as required by the regulatory authority or through self-initiative. According to the implicit risk of the practice, the request must include documents and specifications relating to sources, processes, equipment, operations and operators. A license is issued after approval of such documentation.

Ensuring periodic inspections will be focused on verification that all applicable regulations have been complied with; also that facility operations and radiation protection manuals are in order, and that specific conditions and limits have been violated.

Regulatory authorities may apply sanctions such as fines or may even shut down facilities depending on how serious the faults are. Due to legal voids, CNEC cannot undertake such coercive actions by itself, but only in co-ordination with the Health Ministry.

NATIONAL PROVISIONS FOR DIFFERENT SITUATIONS

The management of disused sources

Current regulations require that users dispose of disused sources under safe conditions, using only authorized institutions. Presently, only CNEC is able to store and dispose of sources of low and medium level activity.

The planning and preparedness for and response to abnormal events and emergencies

Nuclear and radioactive facilities of the first kind must have their own emergency plans. Their personnel must be trained to face abnormal events and to recover control of their sources.

Minor facilities are not required to have such safety measures. In routine operation, CNEC participates and resolves almost all emergency situations throughout the country.

The recovery of control over orphan sources

Regulations require that any person who comes across an orphan source must inform the corresponding regulatory authority or the police. In such cases, the regulatory authority must relocate the source under safe conditions.

Informing users and others who might be affected by lost sources

In the case of a lost source, usually CNEC distributes information as to inherent risk and asks for public co-operation through newspapers, radio and TV.

Education and training in the safety of radiation sources and the security of radioactive materials

One of the essential requirements for granting an operator authorization is the accreditation of theoretical knowledge of radiation protection matters, by the applicant either showing evidence of formal courses taken or passing an examination given by the regulatory authority. Also, a certificate issued by the field supervisor is required indicating the applicant’s practical experience.

Courses of study given by CNEC cover 100% of the necessary subject matter to operate nuclear facilities and radioactive installations of the first kind. On the other hand, Health Services delegate training of operators to third parties.

RADIATION PROTECTION INFRASTRUCTURE TRENDS

As the complexity of the Chilean radiation protection is well known, CNEC is currently developing a programme to review all national regulations to submit to the Government for consideration. The main objectives of the revision are to:

- update the legal framework
- include safety commitments taken on by subscription to international treaties, conventions and agreements
- improve the regulations with the BSS and ICRP based new recommendations on radiation protection.

Looking to the future, the principal objectives of the changes to come are to:

- modernize the radiation safety regulatory framework
- apply latest developments
- promote regulatory authorities where necessary
- level criteria in the application of regulations
- improve supervising capacity and empowering of regulatory authorities
- create national databases to register radiation sources, facilities, exposed workers and radiation dose
- work for the establishment of a single and independent national regulatory authority.

SUMMARY OF DISCUSSION

Session 2

Chairperson: **J.W. Hickey** (USA)
Co-Chairperson: **M. Ridwan** (Indonesia)

K. Skornik (IAEA): Angola, which became a Member State of the IAEA — and thereby eligible for assistance under the IAEA's technical co-operation programme — only in October 1999, is a good example of a country with a solid commitment to establishing an effective national radiation protection infrastructure.

In November 1999, without waiting for finalization of the proposed IAEA technical co-operation programme for 2001–2002, Angola submitted a request for technical assistance in upgrading its radiation protection infrastructure, and the provision of assistance has already started.

The Government of Angola has committed funds in support of the country's Ministry of Science and Technology specifically for activities in the field of radiation protection, and a task force has been established within the Ministry as the core of the regulatory authority which is in the making.

In the IAEA's Secretariat we regard Angola as a model counterpart country.

D. Cancio (Spain): When an orphan source is found in Argentina, who pays for its safe disposal?

A.A. Oliveira (Argentina): We have decided that, when an orphan source is found, our first duty will be to get it under control — and, if necessary, we shall finance that operation initially from our own budget. We shall not start looking around for someone else who might pay; that can come later.

M. Ridwan (Indonesia): The issue raised by Mr. Cancio — "who pays?' — is an important one. If the regulatory body charges a lot for disposing of sources, users tend to prefer to keep their unwanted sources indefinitely (perhaps even requesting licence renewals), and with time those sources may be forgotten and become "orphaned". If the regulatory body charges very little, it may run short of money, so perhaps its disposal operations should be subsidized by the government.

J.R. Croft (UK): What happens in Australia, with its federal system, when a user of a source which is registered in a particular state wishes to use that source in another state?

J. Loy (Australia): The user has to register the source in that other state also.

This situation creates bureaucratic problems for users, although there is among Australia's six states broad "mutual recognition" of professional competences and fundamental agreement on radiation protection requirements.

D. Cancio (Spain): Who would manage the response in the event of a radiation accident (one like, say, the Goiânia accident) affecting two or more Australian states?

J. Loy (Australia): Each affected state would have the legal right and responsibility to manage the response within its own borders — and theoretically could manage it in isolation. However, there are national emergency arrangements, involving bodies like the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), to support the efforts of individual states, and I imagine that the affected states would draw on that support.

R. Czarwinski (Germany): Is there not, despite Australia's federal system, some institution responsible for the nationwide supervision of radiation source safety?

J. Loy (Australia): No, each state is fully sovereign in such matters and can adopt any radiation protection arrangements it wishes (or none). In practice, the states and the national Government work together, particularly through a national Radiation Health Committee, in preparing national guidance, codes of practice etc. These are generally applied throughout the country, although there are local differences in wording and legal approach which cause irritations for radiation source users.

A. Kisolo (Uganda): The three questions just put to Mr. Loy suggest that I am not the only person here who is surprised that Australia does not have a national regulatory authority for the entire country and feels that it should have one.

P. Ferruz-Cruz (IAEA): Who pays for regulatory inspections in Brazil?

F.C.A. da Silva (Brazil): Under a system introduced about two years ago, inspections are now paid for out of the proceeds of a kind of "tax" which is levied on all companies applying for licences to use radioactive material. The amount of the "tax" depends on the radiation practice in question, and the proceeds are used for financing — besides inspections — research and the purchase of equipment.

M. Ridwan (Indonesia): In Brazil, the regulatory authority is the National Commission of Nuclear Energy (CNEN), which is also a major user of sources. It would have been interesting to learn who licenses CNEN users.

In his presentation, Mr. da Silva talked of a CNEN infrastructure with two co-ordinators, one responsible for licensing and the other responsible for radiation safety inspections. It would have been interesting to learn whether information gained through inspections is factored into the licence renewal process.

D. Cancio (Spain): What is the relationship between the ARCAL XX project and the IAEA's regional Model Project for upgrading radiation protection infrastructure in Latin America and the Caribbean?

S.M. Velasques de Oliveira (Brazil): The ARCAL XX project is for Latin American countries which already have well-developed regulatory infrastructures and now wish to meet all the requirements of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (Argentina, Brazil, Chile, Cuba, Mexico, Peru, Venezuela and Uruguay). The Model Project is for Latin American and Caribbean countries which do not yet have well-developed regulatory infrastructures (Bolivia, Columbia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Jamaica, Nicaragua, Panama and Paraguay).

As they are finalized, the guidelines emanating from ARCAL XX are being made available to the countries participating in the Model Project.

A. Bilbao Alfonso (IAEA – *Scientific Secretary*): The IAEA's Secretariat is arranging for those guidelines to be made available (after any necessary translation) to all IAEA Member States in the form of technical documents (IAEA-TECDOCs).

M. Ridwan (Indonesia): Through ARCAL, the certification of non-destructive testing (NDT) personnel has been harmonized, so that people working in the NDT field can move from one country of Latin America and the Caribbean to the other without having to pass an examination in each country — and I understand that the intention is to do the same for radiation protection officers. I should like to see the IAEA supporting such initiatives in other regions.

GENERAL DISCUSSION

I. Othman (Syrian Arab Republic): In Session 1, Mr. Beninson spoke about "continuity of responsibility" for the safety of sources. As companies can go out of business and employees change jobs, and eventually retire, perhaps we should devise a mechanism for ensuring such continuity.

J.W. Hickey (USA – *Chairperson*): There is more likely to be continuity of responsibility in a system where user companies must take out insurance, post bonds or make financial deposits to cover costs arising out of incidents in which the sources being used by them may be involved. The user companies have a financial interest in there being continuity of knowledge regarding the sources, which is essential for meaningful continuity of responsibility.

M. Bahran (Yemen): Is enough being done at the international level to ensure the safety and security of radiation sources — if only of those belonging to Categories 1 and 2 of the *Categorization of Radiation Sources* recently issued within the IAEA framework?

A.J. González (IAEA): In my opinion, no. In fact, we have no idea how many sources there are in the world, partly because many of them (like the orphan sources found in Georgia) are military — not civilian — sources.

In September 1998, the International Conference on the Safety of Radiation Sources and the Security of Radioactive Materials (the Dijon Conference) called for further efforts to investigate "whether international undertakings concerned with the effective operation of national regulatory control systems and attracting broad adherence" can be formulated. In my opinion, most countries would be willing to enter into such undertakings, but unfortunately there are still some countries which would not.

We now have the *Code of Conduct on the Safety and Security of Radioactive Sources*, but the obligations arising out of it are only moral obligations — not legal obligations with penalties envisaged for cases of non-fulfilment. We need an international undertaking with tougher provisions than those of the *Code of Conduct*.

D.J. Beninson (Argentina): I think it will be an enormous step in the right direction if most countries start implementing the *Code of Conduct*.

A.M. Borras (Philippines): One way of supporting international efforts would be for each of us to try to determine, with a reasonable degree of accuracy, the number of sources — including orphan sources — within his/her own country.

J.F.M. Lacronique (France): A few weeks ago, a worker at a nuclear power plant in southern France triggered a radiation alarm as he was passing through a monitoring portal on his way into a control zone. It was soon established that the bracelet of his watch contained cobalt-60. At OPRI (the French office for protection against ionizing radiation), we subsequently established that the cobalt-60 was in the small connecting pins of the bracelet.

The watch had been purchased at a branch of the Carrefour supermarket chain during a one-day sale. We ascertained that some 1500 of the 5000 watches of the type in question which had been on offer that day had been sold — through about 80 different Carrefour branches.

Carrefour withdrew the unsold watches, which we took into our care.

We organized a meeting with representatives of Carrefour, of the company which had imported the watches and of the French agency for consumer protection in order to work out how to recover the watches which had not yet been returned. The Carrefour representatives, who wished to avoid a radioactivity scare so soon after a BSE scare which had affected Carrefour's business not long before, opposed the issuing of announcements containing the word "radioactivity" and referring to possible health problems. The announcements placed in newspapers were so "discreet" that they led to the return of only 5% of the sold watches. When we asked Carrefour sales staff why Carrefour was requesting customers to return the watches, we were told that it was because the watches were imitation Seikos. Despite the issuing of press releases by us, newspapers did not pick up the story; in my view, they exercised a form of "self-censorship" because Carrefour advertises very widely in newspapers. Finally, the cable-car disaster of early November 2000 in Kaprun, Austria, ensured that for the time being no media attention would be paid to the "radioactive watch" issue.

The importing company has traced the connecting pins to Hong Kong, where the watches were assembled, but further investigations are hampered by the fact that there are thousands of foundries in China.

We informed the IAEA and the European Commission about the incident, and we received requests for further information from Finland, Italy and Japan. In the case of Japan, we were told that a similar incident had occurred there some time previously.

How can we recover the watches which have still not been returned? Should we issue a dramatic public warning that the watches are dangerous? They are not dangerous: the dose rate to the wrist is about 40 μSv/hour, which means about 320 mSv/year if the watches are carried on the wrist continuously (for 8000 hours during the year). That is not a lethal dose, but there will be cancers among the people wearing the watches and some of those people may well attribute their cancers to the watches — so law suits are likely in the course of time.

I am sure that we have not heard the end of this story.

I. Othman (Syrian Arab Republic): We check everything being imported into our country for radioactivity, and in the course of checking a shipment of 4000 watches we discovered that about 600 of them were contaminated with cobalt-60. The contaminated watches were returned to Hong Kong.

That incident illustrates the importance of effective radiation monitoring at national borders.

D.J. Beninson (Argentina): I have heard a rumour that the radioactive connecting pins originated in Taiwan.

J.F.M. Lacronique (France): We knew that a radiation source had been melted in Taiwan 4–5 years previously, and in a press release issued by us we therefore referred to Taiwan. Very soon after that, the chargé d'affaires of the Taiwanese representation in France contacted us and requested us to issue a press release stating that Taiwan was not the "culprit".

A. Petö (Hungary): I am surprised that OPRI did not do more to publicize the incident.

J.F.M. Lacronique (France): I think that was more a matter for the agency for consumer protection, which — incidentally — is part of the Ministry of Finance. Moreover, OPRI — unlike Carrefour — does not have the money to pay for large advertisements.

We had hoped that Carrefour would publicize the incident enough, but our hopes were disappointed.

THE INTERNATIONAL RESPONSE
(Special session)

Chairperson

A.A. OLIVEIRA
Argentina

EUROPEAN UNION LEGISLATION ON CONTROL OF SEALED SOURCES

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Abstract. The background to the initiative of the European Commission to propose legislation for the control of radioactive sealed sources is presented. Under the terms of the treaty establishing the European Atomic Energy Community, the Community has the power to adopt legislation which is then disseminated to all Member States. The proposed legislation would be a part of this Community legislation. The current status of the initiative is explained together with the intended framework of the legislation as developed by a group of experts. The relevance to other programmes in this area is discussed.

LEGAL BASIS AND EXISTING PROVISIONS

The European Union (EU) refers to the political union of fifteen Member States, bound by treaties and derived legislation. This legislation may include directives, which are binding as to the result to be achieved but leave to the national authorities the choice of form and methods. The European Commission, as the executive of the EU, proposes directives and is currently developing such a proposal for the control of radioactive sealed sources.

The Euratom Treaty

Under the terms of the treaty establishing the European Atomic Energy Community, the Euratom Treaty, the Community shall "establish uniform safety standards to protect the health of workers and of the general public against the dangers arising from ionizing radiation and ensure that they are applied" (Article 2b of the Euratom Treaty). Article 31 of Chapter III ("Health and Safety") of the Euratom Treaty sets out the procedure by which these basic safety standards, their revisions or supplementary measures are established. The procedure requires in particular that the European Commission works out a proposal addressed to the Council of Ministers, after it has obtained the opinion of a group of persons appointed from among scientific experts in the Member States.

The first basic safety standards were adopted in the form of a Council Directive in 1959.

The Basic Safety Standards Directive

The version of the basic safety standards presently in force is the Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation.[1]

This directive, together with the requirements set out by the Euratom Treaty itself, is the cornerstone of the EU radiation protection legislation. It includes two important definitions. It defines a source as an apparatus, a radioactive substance, or an installation capable of emitting ionizing radiation or radioactive substances. Secondly, it defines a sealed source as a source

[1] O.J. No L 159, 29.6.1996.

whose structure is such as to prevent, under normal conditions of use, any dispersion of the radioactive substances into the environment.

The directive's scope is broad. It applies in particular to "all practices which involve a risk from ionizing radiation emanating from an artificial source or from a natural radiation source in cases where natural radionuclides are or have been processed in view of their radioactive, fissile or fertile properties, namely:

a) the production, processing, handling, use, holding, storage, transport, import to and export from the Community and disposal of radioactive substances;
b) the operation of any electrical equipment emitting ionizing radiation and containing components operating at a potential difference of more than 5kV;
c) any other practice specified by the Member State …".

One main requirement is a system of reporting or, in cases decided upon by each Member State, of prior authorization. Prior authorization is mandatory under the directive for "the use of X-ray sets or radioactive sources for industrial radiography or processing of products or research or the exposure of persons for medical treatment and the use of accelerators except electron microscopes."

The aim of the reporting/authorization system is to ensure that radiation sources are used under the control of competent national authorities, which in turn will ensure compliance with radiation protection requirements relevant to workers and to the public. The requirement for optimization of protection is mandatory.

Complements to the Basic Safety Standards Directive

The Basic Safety Standards directive is supplemented by other EU legislation, some of which is directly relevant to the management of sealed sources.

At the end of 1992, the establishment of the internal market within the EU was completed. This implies an area without internal frontiers in which the free movement of goods, persons, services and capital is ensured.

Within this area, national competent authorities could no longer rely on border controls to obtain information on radiation sources entering the territories under their jurisdiction. This necessitated the adoption of Council Regulation 93/1493/Euratom[2]. The regulation's key requirement, which applies only to shipments between Member States, is that the holder of a sealed source who intends to carry out its shipment has to obtain a prior written declaration from the consignee of the source that he/she complies with relevant national provisions applicable for the source's intended use. The declaration must have been approved by the competent authorities of the Member State of destination.

If the radioactive substances are not in the form of a sealed source, only post factum information from the holder to the competent authorities of the Member State of destination is required.

[2] O.J. No L 148, 19.06.1993.

Council Directive 92/3/Euratom[3] established an administrative system for transboundary shipments of radioactive waste covering information and consultation of the States involved, whether EU Member States or not. Outside the directive's scope are shipments where a sealed source is returned by its user to the supplier of the source in another country.

CONTROL OF SOURCES ON THE INTERNATIONAL AGENDA

Recently, the Commission's attention was drawn to the control of sealed sources through recurrent findings of sources in scrapyards and their occasional melting in metal production facilities. These events have caused deaths in various parts of the world, serious health effects, and associated economic losses as a result of the exposure of persons and contamination of industrial facilities or of the environment.

Within the framework of the Community Action Plan in the field of radioactive waste, the European Commission recently published a study on management and disposal of disused sealed radioactive sources in the European Union.[4]

The authors of the study, using their own techniques and assumptions, arrived at a rough estimate that approximately 500 000 sealed sources have been supplied during the past 50 years to operators in the EU's current fifteen Member States. Of these, approximately 110 000 sources are currently in use. Most of the remainder have been sent to central interim stores, returned to manufacturers or otherwise disposed of. The sources at greatest risk of being lost from regulatory control are disused sources held in local storage at the users' premises. The study estimates that there are about 30 000 such sources throughout the EU.

In June 1999, the Council of Ministers[5] stressed the need "to develop common views to address the problems related to radioactive scrap metals and proper management of spent radioactive sealed sources".

Sealed sources are used in practically all countries in the world and, if in some practices they are being replaced by electrical generators of radiation or by the use of other techniques, new applications regularly appear. Accidents involving sealed sources and loss of control of sources occur worldwide. The establishment of controls aimed at detecting such sources with a view to preventing accidents led to a number of detections. The international community reacted and in 1998 an international conference on the safety of radiation sources and the security of radioactive materials, jointly organized by the European Commission, the International Atomic Energy Agency (IAEA), the Interpol and the World Customs Organisation, was held in Dijon, France. In 1999, a workshop took place in Prague, organized by the Steel Federation of the Czech Republic and Slovakia under the auspices of the United Nations Economic Commission for Europe (UNECE) and of the IAEA, on radioactive contaminated metallurgical scrap.

The European Commission (EC) co-operates with the IAEA which, following the Dijon conference, started preparing an Action Plan for the safety of radiation sources and the security of radioactive material. The EC also co-operates with the UNECE, which convened a team of specialists on radioactive contaminated metallurgical scrap as a follow-up to the

[3] O.J. No L 35, 12.02.1992.
[4] EUR 18186.
[5] General Report on the Activities of the European Union – 1999, point 484.

Prague workshop. The European Commission particularly welcomes the adoption by the IAEA General Conference in September 2000 of the document on Categorization of radioactive sources and the Code of Conduct on the Safety and Security of Radioactive Sources.

RESPONSE BY THE EUROPEAN COMMISSION

The Group of Experts referred to in Article 31 of the Euratom Treaty

To discharge its institutional obligations and in response to requests from Member States, the European Commission set up a working group within the Group of Experts referred to in Article 31 of the Euratom Treaty at the end of 1999.

This working group is composed of legal and technical experts from several Member States. Its duty is to elaborate the elements of a legal text, i.e. a European Directive or regulation, supplemented by recommendations with the objective of strengthening the follow-up of sealed sources and making their management by the Member States more consistent. The provisions should complete or make more explicit those already in place under existing texts.

The need for and the objectives of additional measures

Specific provisions for potentially hazardous sealed sources are needed to improve the prevention — a key-word in this issue — of loss of their control. They include administrative, operational and financial means. The goal is to have a well-established traceability of the source from its manufacture until its final recovery by the operator responsible for its recycling or disposal. Appropriate technical and physical means should be developed to know clearly at all times the location of the source and to avoid its loss, theft or misuse. Precise relevant administrative means should help to avoid abandonment of the sources or any laxity in its management. Mobile sources, for instance devices for gammagraphy, are given particular attention. Intentionally fraudulent actions are not in the scope of the future text. Only normally authorized sources and any mistake or failure which could occur in such a context are considered.

The elements under consideration

In November 2000, the Group of Experts referred to in Article 31 of the Euratom Treaty considered the work so far carried out by its working group. The risk of serious accidents within the EU justifies additional measures aimed at reducing the risk of sources escaping control and at establishing control over orphan sources or those at risk of becoming orphan.

The Group noted that, within the EU, sources most likely to create accidents were those no longer in active use, which had been put in storage or simply left unattended for long periods. Members of the Group reported that in particular, hospitals and universities may keep disused sources in storage to avoid the cost of consigning the sources to an approved collection and storage facility for safe management. For the same reason, hospitals may export disused therapy equipment to non-Member States for a nominal price.

The Group agreed that the economic aspects of the management of disused sources are central in ensuring that such sources remain in control. Ideally, a system should ensure that users of sources receive a direct economic incentive from transferring the source to an approved collection and storage facility as soon as the source is no longer in active use. At least the system should ensure that the cost of the management of the disused source is paid, normally by the user, before the first use of the source. A financial guarantee should complete the system in case the foreseen operator in charge of recovering the disused source fails to do so.

The Group noted that other international legislation, including Community legislation, placed obligations on suppliers to make economic and administrative provision for recovery and treatment following use. The Group suggested that experts in liability should co-operate with the working group in addressing such economic aspects of the problem.

As regards the sources that should be subject to measures additional to those of the Basic Safety Standards, the Group welcomed the IAEA categorization and agreed that it needed to be taken into account, in consideration of the international dimension of the issue, with a view to ensuring consistency with future IAEA activities. The Group agreed that the guiding criterion in defining such sources must be health protection and concurred with the IAEA statement that "sources in Category 2 may present significant hazards". Several experts, therefore, supported a definition combining sources mentioned in Categories 1 and 2 of the IAEA, with other possible sources having an activity value above 1 GBq. This activity value should also apply to future applications or uses of sources not mentioned in the present IAEA categorization document.

The Group also discussed the administrative means that, in addition to strict implementation of the Basic Safety Standards would further reduce the likelihood of accidents involving sealed sources, particularly those resulting from loss of control. The measures should address not only new sealed sources put on the market following adoption of the text under preparation, but also, as appropriate, the two separate issues of pre-existing sources known to the authorities and of sources not under control at that time that first need to be detected and then put under control.

The measures currently being pursued are:

- keeping registers of sources by authorized persons and periodical reporting to the authorities
- establishment of a standard form for the registers of sources with a view to facilitating the exchange of information between all persons concerned
- periodic checks that the sources are present at their place of use or storage
- physical and technical means to avoid loss, theft or misuse of sources
- prompt reporting to the authorities of anomalies in the management of sources
- developing the concept of "source life-time", corresponding to a time period within which it is ensured that the characteristics of the source are not degraded to a level that may prevent the safe and efficient use of the source.

INTERNATIONAL DIMENSION

Whatever measures national authorities have in place, the possibility of accidents involving sealed sources cannot be completely ruled out, most probably as a consequence of a breach of the rules. In addition to this inevitable limitation, national provisions are not sufficient because — since sealed sources are in use worldwide — if the sources are not under adequate control in one country, they may enter the recycling loop of metal products and appear in any other country.

Several international organizations co-operate in a programme aimed at preventing, detecting and responding to illicit trafficking in nuclear and other radioactive materials. It is felt, however, that the most promising approach to preventing accidents involving sealed radioactive sources lies in prevention, i.e. a full and strict application worldwide of the Basic Safety Standards. This is certainly utopian at present. Therefore, countries that produce and export sources and equipment containing sources should act responsibly towards the countries where the sources are exported if the latter lack the necessary legal, technical and administrative structure for the safe management of the sources. One possibility that merits further exploration is that the exporting countries take back the exported sources when no longer in use. In return, importing countries may undertake not to import sources from countries that do not agree to take them back.

THE TECHNICAL APPROACH: THE IAEA ACTION PLAN ON THE SAFETY OF RADIATION SOURCES

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Abstract. As part of the measures to strengthen international co-operation in nuclear, radiation and waste safety, the report refers to the implementation of the *Action Plan for the Safety of Radiation Sources and the Security of Radioactive Materials*. Starting with background information, the report references the main results of the Dijon Conference and of General Conference resolution GC(42)/RES/12 in September 1998, describing the actions taken by the Secretariat pursuant such resolution and also by the Board of Governors, in its sessions of March and September 1999, as well as by the General Conference, in October 1999 when by resolution GC(43)/RES/10 the *Action Plan* was endorsed and the Secretariat was urged to implement it. Finally, the report provides information on the status of implementation of the seven areas covered by the *Action Plan* and on the suggested further actions to be carried out for its implementation taking into account the decisions of the Board in its meeting of 11 September 2000 and the resolutions GC(44)/RES/11, GC(44)/RES/13 and GC(44)/RES/16 of the forty-fourth regular session of the General Conference.

BACKGROUND

Radiation sources, utilizing either radioactive materials or radiation generators, are used throughout the world for a wide variety of beneficial purposes, in industry, medicine, research, defense and education. The risks posed by these sources and materials vary widely, depending on the activities, the radionuclides, the forms, etc. Unless damaged or leaking, sealed sources present a risk from external radiation exposure only. Damaged or leaking sealed sources as well as unsealed radioactive materials may however lead to contamination of the environment and intake of radioactive materials into the human body.

The risks associated with the planned use of radioactive sources or materials are generally well known and the relevant safety requirements generally well identified. Nevertheless, accidents can occur during use. In recent years there has been a growing awareness of the potential for such accidents, some accidents having had serious, even fatal, consequences. The attention of the radiation protection community has therefore become focused on the prevention of accidents involving the use of such sources.

More recently still, there has been a growing awareness of the problems associated with radiation sources that for one reason or another are not subject to regulatory control or over which regulatory control has been lost. As the sources may be transported across borders, such problems are not necessarily restricted to the State within which the sources were originally used. Such sources are commonly referred to as ‘orphan sources’, a term which is taken here to include sources that were never subject to regulatory control but should have been, or sources that were subject to regulatory control but have been abandoned, or sources that were subject to regulatory control but have been lost or misplaced, and or sources that were subject to regulatory control but have been stolen or removed without proper authorization. The number of such sources in the world is not known, but it is thought to be substantial.

Sealed sources can be attractive because of their shiny metallic appearance or their apparent value as scrap. Subsequent recovery of these sources by workers and members of the public, who are unaware of the possible hazards, can result in external irradiation or, if tampered with, the possibility of internal exposure. This has led to serious injury and in several cases death. There is also the possibility of the sources being incorporated into scrap metal for subsequent recycling, leading to contamination of the plant and environment possibly causing serious economic consequences. International trade in scrap metal means that such material can be transferred from one country to another.

Many of these radiation sources originate from medical or industrial uses. Some however originate from defense activities, knowledge of which may not have been available to the civil authorities.

DIJON CONFERENCE

In September 1998, an international conference took place in Dijon, France, on the Safety of Radiation Sources and the Security of Radioactive Materials. This conference was an important international attempt to address the growing concern about the safety of radiation sources and the security of radioactive materials, where the following conclusions were raised:

- radiation sources should not be allowed to drop out of the regulatory control system (meaning that the regulatory authority must keep up-to-date records of those responsible for each source, monitor transfers of sources and track the fate of each source to the end of its useful life);
- efforts should be made to find radiation sources that are not in the regulatory authority's inventory (because they were in the country before the inventory was established, or were never specifically registered/licensed or were lost, abandoned or stolen); and
- efforts to improve the detection of radioactive materials crossing national borders and moving within countries by carrying out radiation measurements and through intelligence-gathering should be intensified (optimum detection techniques need to be developed, and confusion would be avoided if international agreement could be achieved on quantitative levels that would trigger investigations, for example, at border crossings).

GENERAL CONFERENCE RESOLUTION GC(42)/RES/12

A report on the Dijon Conference was considered by the IAEA's General Conference at its meeting in September 1998 and the concern expressed about orphan sources led to the adoption of resolution GC(42)/RES/12, in which the General Conference — inter alia — encouraged all governments *"to take steps to ensure the existence within their territories of effective national systems of control for ensuring the safety of radiation sources and the security of radioactive materials".* This resolution was brought to the attention of Member States and the Secretariat later in December 1998 recalled that the Agency had established *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (the BSS) and that it was ready to provide for the application of the BSS at the request of a State to any activity in that State involving radiation sources.

In that resolution, the Secretariat of the IAEA was also requested *"to prepare for the consideration of the IAEA's Board of Governors, a report on*:

(i) *how national systems for ensuring the safety of radiation sources and the security of radioactive materials can be operated at a high level of effectiveness and*
(ii) *whether international undertakings concerned with the effective operation of such systems and attracting broad adherence could be formulated".*

ACTIONS TAKEN BY THE BOARD OF GOVERNORS AND THE GENERAL CONFERENCE

Responding to the General Conference resolution GC(42)/RES/12, the Agency called for a group of senior consultants to prepare a report which was considered at the March 1999 Meeting of the Board of Governors. During this session, the Board noted the conclusions and recommendations set forth in the experts' report and requested the Director General to bring the report to the attention of national authorities by distributing it to all States, encouraging them, in particular, to:

- establish or strengthen national systems of control for ensuring the safety and security of radiation sources, particularly legislation and regulations and regulatory authorities empowered to authorize and inspect regulated activities and to enforce the legislation and regulations;
- provide their regulatory authorities with sufficient resources, including trained personnel, for the enforcement of compliance with relevant requirements; and
- consider installing radiation monitoring systems at airports and seaports, at border crossings and at other locations where radiation sources may appear (such as metal scrap yards and recycling plants), develop adequate search and response strategies, arrange for the training of staff and the provision of equipment to be used in the event that radiation sources are detected, and take similar urgent actions.

In addition, the Secretariat was requested to prepare an *Action Plan* that took into account the conclusions and recommendations in and the Board's discussion of the report. The Director General was also requested to initiate exploratory discussions relating to an international undertaking in the area of the safety and security of radiation sources, which might take the form of a convention or some other type of instrument providing for a clear commitment by and attract the broad adherence of States, as well as authorized him to include the report in a document to be submitted to the General Conference for consideration at its next (1999) regular session.

Following it, the Director General in May 1999 distributed the report to all States requesting them to transmit it to the relevant national authorities in their countries and inviting them to submit their countries' views regarding the nature and scope of an international undertaking in the area of the safety and security of radiation sources. Later the Secretariat prepared the *Action Plan* and, on 20 September 1999, the Board approved it [Attachment 2 to document GOV/1999/46-GC(43)/10] and requested the Secretariat its implementation.

Consequently, on 1 October 1999, in resolution GC(43)/RES/10, the General Conference endorsed the Board's decision, urged the Secretariat to implement the *Action Plan* and requested the Director General to report at its forty-fourth (2000) regular session on the implementation of this resolution. Therefore, this year the General Conference in its resolution GC(44)/RES/11 endorsed the actions taken by the Board of Governors on 11 September 2000 in respect of document GC(44)/7 on the implementation of the Action Plan for the Safety of

Radiation Sources and the Security of Radioactive Materials; invited Member States to take note of the Code of Conduct on the Safety and Security of Radioactive Sources and to consider, as appropriate, means of ensuring its wide application; and urged Member States to take steps to help ensure that the *International Conference of National Regulatory Authorities with competence in the Safety of Radiation Sources and the Security of Radioactive Materials,* to be held in Buenos Aires, Argentina, from 11 to 15 December 2000, is well attended, particularly by participants from developing countries.

The General Conference in its resolution GC(44)/RES/13 also stressed the special importance of education and training in radiation protection and nuclear safety and waste management, and urges the Secretariat to implement all the actions mentioned in the document GOV/2000/34-GC(44)/7 (attachment 6) and to strengthen, within available financial resources, its current efforts in this area, in particular to assist Member States at regional and national training centres that would arrange for such education and training to be conducted in the relevant official languages of the Agency.

Additionally, in resolution GC(44)/RES/16 the General Conference encourages Member States to implement instruments for improving their response, in particular their contribution to international response, to nuclear and radiological emergencies, as well as to participate actively in the process of strengthening international, national and regional capabilities for responding to nuclear and radiological emergencies and to make those capabilities more consistent and coherent. This resolution also requests the Director General to continue to evaluate and, if necessary, improve the capability of the IAEA Emergency Response Centre to fulfil its role.

IMPLEMENTATION OF THE *ACTION PLAN*

The primary purpose of the *Action Plan* is to enable the Agency to develop and implement activities that will assist States in maintaining and, where necessary, improving the safety of radiation sources and the security of radioactive materials over their life cycle. Consideration is given to fostering a safety culture, including the development of effective regulatory infrastructures, and to the education and training and oversight of those responsible for radiation sources and radioactive materials. In particular, the training of the staff of organizations that use radiation sources or radioactive materials should lead to the development of an increased sense of responsibility and safety culture so as to ensure that operations are undertaken safely and the sources and materials are kept secure.

Even with an effective regulatory infrastructure, the possibility remains that sources may escape control , and States need to be able to respond appropriately. Consideration is therefore given in the *Action Plan* to the further strengthening of the Agency’s programme for the provision of support in such circumstances. This includes consideration of the need to train the staff of regulatory authorities in how to respond to orphan sources should such be discovered and in developing a plan for ensuring proper recovery and disposition of the sources.

While the *Action Plan* covers all such uses, it is recognized that the focus should be on those radiation sources and materials which pose the most significant risks. Primary consideration is therefore given to sealed radiation sources with relatively high levels of radioactivity which might necessitate interventional measures should control over them be lost. The *Action Plan* therefore calls for the categorization of sources as the basis for a graded approach to regulatory control.

A special aspect of the orphan source problem is the impact on persons or organizations that do not normally handle radioactive sources but may be at risk from them nonetheless. Examples include scrap metal recyclers and landfill operators. The *Action Plan* therefore also addresses the need to disseminate information to such persons and organizations regarding the types of sources that they may encounter and the actions to be taken if such sources are discovered.

The initiation by the Director General of exploratory discussions relating to an international undertaking is also included in the *Action Plan*.

Therefore, the regulatory components of the *Action Plan* comprise activities aimed at:

- strengthening national regulatory programmes covering notification and authorization (by either licensing or registration), the safety of radiation sources and security of radioactive materials, and the storage or disposal of disused sources;
- detection and emergency response; and
- recovery and remediation.

Training is an essential part of all these activities above.

The supporting components of the *Action Plan* are aimed at persons or organizations having an interest in seeing that the orphan source problem is addressed. These include metal recyclers, metallurgical plants and non-radioactive waste disposal facilities. Manufacturers, suppliers and distributors of radiation sources/devices and monitoring/detection systems are also part of this group.

The proposed new initiatives regarding the safety of radiation sources and the security of radioactive materials, including the problem of orphan sources, are grouped in seven areas which provide a logical division of tasks to be carried out by the Agency: *Regulatory Infrastructures, Management of Disused Sources, Categorization of Sources, Response to Abnormal Events, Information Exchange, Education and Training,* and *International Undertakings.* The *Action Plan* foresees one or more actions in each area (the actions and their status are described in attachments 1–7 to the document GOV/2000/34-GC(44)/7).

Regulatory Infrastructures

Action:

To establish a service for advising States on the establishment of appropriate regulatory programmes.

In order to assist States in ensuring compliance with the relevant requirements concerning regulatory infrastructures in the BSS, the Secretariat has established a Radiation Safety Regulatory Infrastructure (RSRI) service for:

- carrying out, at the request of States, assessments of the effectiveness of radiation safety regulatory infrastructures, identifying weaknesses and making recommendations for improvement; and
- assisting, at the request of States, with the organization of radiation safety regulatory infrastructures and the associated regulatory programmes and advising on how to operate those programmes and on matters such as the functions of regulatory authorities, the application of international standards, and the drafting of regulations consistent with international standards.

Therefore, on 11 September 2000, the Agency's Board of Governors — inter alia — encouraged Member States *"to avail themselves of the Secretariat's services relating to the development and review of regulatory infrastructures, and in particular to make use of the Radiation Safety Regulatory Infrastructure (RSRI) service recently established by the Secretariat"*. Further details about the RSRI service and information about the other Secretariat services relating to the development and review of regulatory infrastructures can be obtained from the Division of Radiation and Waste Safety in the Agency's Department of Nuclear Safety.

Management of Disused Sources

Action:

To prepare documents on particular aspects of the handling and disposal of disused radioactive sources.

The Secretariat is preparing technical documents (IAEA-TECDOCs) for:

- the management of high-activity disused sources (meaning a radioactive source no longer intended to be used for its original purpose) describing the proper handling, conditioning and disposal of sources which are no longer suitable for their initial purpose but still have high activities (e.g. teletherapy and industrial radiography sources, considering that such sources have been the main cause of serious accidents with disused sealed sources);
- establishing procedures for conditioning and storing long-lived disused sources (e.g. sources containing radium-226 or americium-241 and various neutron-emitting sources) describing procedures for managing (conditioning/storing) of long-lived disused sources and equipment containing such sources, which require proper management for as long as they are not disposed of (perhaps several decades); and
- disused sealed source management involving storage/disposal in boreholes summarizing current practices involving the use of boreholes for the storage/disposal of disused sealed sources.

Action:

To organize consultations and workshops on technical, commercial, legal and regulatory aspects of the return of disused sources to manufacturers and on the management of disused sources with long-lived radionuclides and of equipment containing such sources.

The Secretariat has initiated informal consultations with major source manufacturers about various aspects of the return of disused sources to manufacturers. All the manufacturers contacted so far have expressed a willingness to attend meetings organized by the Secretariat with a view to elaborating various return options and subsequently developing a strategy.

In this connection, the Secretariat intends to convene a Technical Committee meeting to consider possible strategies for the return of disused sources in order that the radioactive materials in them may be recycled (i.e. used in the manufacture of new sources) and also is planning workshops for the purpose of developing a strategy for the conditioning and storage of long-lived disused sources and equipment containing such sources.

Categorization of Sources

Action:

To prepare a document on the categorization of sources on the basis of the associated potential exposures and radioactive contamination.

A Technical Committee developed a *Categorization of Radiation Sources,* which is based on the following five attribute groupings: Radiological Properties, Form of Material, Practice or Activity, Exposure Scenarios and End of Life Considerations. This categorization was confined to sealed radioactive material sources.

Sources are ranked according to the harm they could cause, so that the controls to be applied will be commensurate with the radiological risks which the sources (and the materials contained in them) present. The resulting categories are:

- *Category 1 (higher risk):* industrial radiography sources, teletherapy sources, irradiators;
- *Category 2 (medium risk):* brachytherapy sources (with both high and low dose rates), fixed industrial gauges with high-activity sources, well logging sources; and
- *Category 3 (lower risk):* fixed industrial gauges with lower-activity sources.

The above general categorization provides an indication of the priority which a regulatory authority should assign when establishing a regulatory infrastructure and trying to bring sources under regulatory control. It would also be relevant to decisions regarding: notification and authorization of use (by registration or licensing); security requirements, during manufacture, transport, storage, use, transfer, repair, decommissioning or disposal; and emergency preparedness. It is designed to serve as guidance for all regulatory authorities, and will be used by the Secretariat in discharging the Agency's functions and responsibilities with regard to the safety of radiation sources and the security of the radioactive materials which are under its control or supervision.

On 11 September 2000, the Board of Governors authorized the Director General to issue the Categorization of Radiation Sources and invited Member States to draw on it as appropriate. The document is being issued as a TECDOC.

Response to Abnormal Events

Action:

To prepare guidance on national strategies and programmes for the detection and location of orphan sources and their subsequent management.

The Secretariat carried out a systematic review of the overall nature of the orphan source problem and identified areas in a model national strategy for the detection and location of orphan sources that need special attention and further development. From the review it was concluded that sources get out of control mainly through:

- loss during use or (in the case of mobile sources) in transit;
- being abandoned or their control being relinquished; and
- theft for scrap or illicit trafficking (particularly when sources are inadequately stored).

It was recognized that there may also be a "historical legacy" (meaning no control systems in place when the sources were used). Locations with a possible "historical legacy" include hospitals and industrial and military sites.

Whether control has been lost or did not exist in the first place, the consequences are that sources may cross borders, be mixed with scrap metal, or be sent to a landfill site or incinerator for disposal. National strategies therefore need to include the following elements:

- actions to bring sources that are in a vulnerable state (for example, in inadequate storage) under firm control;
- programmes for investigating sites where the presence of abandoned sources is suspected;
- detection systems at border crossings, scrap yards, and landfill sites or incinerators;
- intelligence gathering (for cases of illicit trafficking); and
- arrangements for responding to abnormal events which do not necessarily constitute emergencies (for example, the finding of a source).

Some of these elements will have substantial resource implications, and priorities will therefore have to be assigned. These elements are to be considered in a technical document which will define a model national strategy. This is expected to be finalized towards the end of 2001.

In the light of a number of very serious radiation accidents resulting from the inadequate storage of sources, the Secretariat prepared and distributed to States a leaflet containing guidance on the action which should be taken when sources are inadequately stored.

Various draft documents which touch on the question of national strategies for dealing with orphan sources (i.e. documents on regulatory infrastructure, emergency preparedness and response, and combating illicit trafficking in radioactive materials) will be reviewed also to ensure that the issues covered by them are dealt with in a harmonized manner.

Action:

To formulate criteria for the development, selection and use of detection and monitoring equipment at border crossings, ports of entry, ports of exit, and scrap yards and other facilities.

The Secretariat has begun formulating criteria for the development, selection and use of radiation detection and monitoring equipment intended for use at border crossings, ports of entry, ports of exit, scrap yards and other facilities. Priority is being given to the detection of sources belonging to *Category 1(higher risk)* as defined in the *Categorization of Radiation Sources*.

Action:

To develop further national response capabilities for dealing with radiological emergencies.

Technical documents and manuals

The Secretariat is preparing — for publication next year — a revised edition of the IAEA TECDOC-953: “Methods for the development of emergency response preparedness for nuclear or radiological accidents”, which will cover also the detection and location of orphan sources and their subsequent management.

The Secretariat published in August 2000 the IAEA-TECDOC-1162: “Generic procedures for assessment and response during a radiological emergency”. This technical document, which is in the form of a manual for emergency managers, first responders, on-scene controllers and radiological assessors, should be helpful to States in developing radiological emergency response systems and training personnel to respond effectively to radiological emergencies.

Since radiological emergencies are sometimes recognized as such only after the appearance of medical symptoms, and delays in responding can lead to unnecessary exposure and even death, it is essential that medical professionals presented with symptoms of radiation exposure be able to identify them as symptoms of radiation-related pathological conditions and recognize that they may result from a radiological emergency which requires an appropriate response. Consequently, the Secretariat has published a leaflet on “How to Recognize and Initially Respond to an Accidental Radiation Injury” for general practitioners and for medical school students and their instructors. The leaflet (in Arabic, Chinese, English, French, Russian and Spanish) will be made available via the public web-sites of the Agency and the World Health Organization. The Secretariat intends — after consultations with the World Health Organization — to start work on the development of a practical emergency response manual designed to help medical doctors and paramedics deal with radiation injuries.

Training materials

In support of its “train the trainers” approach to assisting with the development of national response capabilities, the Secretariat is continuing to develop standardized training materials matching the various technical documents on emergency planning, preparedness and response which have been or are to be published. The materials are to be produced in a number of languages in order to facilitate their wide use in Agency technical co-operation projects. The Secretariat’s ultimate goal is to publish all the training materials in hard-copy form; meanwhile, the already existing training materials are being made available to identified “trainers” in Member States on CD-ROM. The Secretariat has prepared a CD-ROM containing material for an “Awareness Training Course for Customs and Police Investigators on Combating Nuclear Smuggling”.

Development of national and regional response capabilities

To increase awareness of the need to strengthen capabilities for responding to radiological emergencies in Member States, the Secretariat has held regional workshops — in connection with ongoing and planned technical co-operation projects — in Europe, Latin America and the East Asia and Pacific region.

Towards the end of 1999, shortly before the Panama Canal was placed under the jurisdiction of Panama, the Secretariat held a national workshop, in Panama City, on how to respond to radiological emergencies, including such emergencies in the Panama Canal Zone. The workshop provided an opportunity to assess the value of various documents and training materials being developed within the Secretariat.

The Secretariat is designing a model of a two-week workshop on radiological emergency management, including assessment, response and preparedness. This workshop was tested in Slovenia, on 13–24 November 2000, and will be tested in other regions in 2001. Also, the Secretariat plans to conduct workshops on the medical response to radiological emergencies in Europe and Latin America in 2001.

Action:

To strengthen the Agency's existing capabilities for the provision of assistance in emergency situations.

The Secretariat has updated its Emergency Notification and Assistance Technical Operation Manual (ENATOM), which provides guidelines to Member States, parties to the Convention on Early Notification of a Nuclear Accident (the Early Notification Convention) and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (the Assistance Convention), relevant international organizations, and other States in order that they may adopt or develop suitable mechanisms for interfacing with the Agency within the framework of those conventions.

ENATOM was first issued in January 1989, and Member States, parties to the Early Notification Convention and the Assistance Convention, relevant international organizations, and other States have regularly received notices regarding amendments. However, factors such as technological developments, new operational concepts (for example, the concept of reporting emergency-related information even when there is no obligation under the Early Notification Convention to do so) and changes in States' expectations ultimately necessitated a complete revision, which resulted in the new edition.

The Secretariat intends to monitor the use made of the new edition of ENATOM, which is due to become operational in December of this year, with a view to issuing a further updated version in July 2002. Interim changes to the new edition will, if necessary, be made through the transmission of amendment notices to ENATOM holders. To consider how to strengthen the Agency's emergency response system and to improve the operational arrangements described in the new edition of ENATOM, the Secretariat will be convening on 18–22 June 2001 in Vienna a meeting of competent authorities designated by Member States pursuant to the Early Notification Convention and the Assistance Convention. The new edition of ENATOM will be made available to Member States, parties to the Early Notification Convention and the Assistance Convention, relevant international organizations, and other States before 1 December 2000 (a pre-publication version was already available to Member States).

The Secretariat has participated — through the Inter-Agency Committee on the Response to Nuclear Accidents, which it convenes — in the development of a "Joint Radiation Emergency

Management Plan of the International Organizations" describing and clarifying — inter alia — arrangements for the provision of medical assistance, through the World Health Organization, and humanitarian assistance, through the United Nations Office for the Co-ordination of Humanitarian Affairs (OCHA). This Plan is already in printing stage and copies of it are to be made available to all Member States of the Agency by the end/beginning 2000 (a pre-publication version was already available to Member States).

To facilitate the provision of prompt assistance by parties to the Assistance Convention, the Secretariat is establishing an Emergency Response Network (ERNET) consisting of suitably qualified emergency response teams based in various Member States and drawing on regional emergency response capabilities. These teams will be available to assist the Agency in providing rapid and effective response following a request for assistance during a radiological emergency.

The Agency's Emergency Response Centre recently received, from the United States of America, a donation of mobile radiospectrometry equipment which, when installed in land vehicles or helicopters, can be used in carrying out wide-area surveys for the purpose of locating radiation anomalies due to — for example — the presence of unshielded orphan sources. A number of staff members have already been trained to use the equipment, and there are plans to establish a standardized in-house training programme. The equipment will increase the ability of the Secretariat to assist Member States.

In addition, the Agency's Emergency Response Centre has been assisted by France's Commissariat à l'Energie Atomique, which has provided technology and expertise for the location of orphan sources through aerial surveys.

Regarding all the above, recently in resolution GC(44)/RES/16, the General Conference encourages Member States *"to implement instruments for improving their response, in particular their contribution to international response, to nuclear and radiological emergencies"* and *"to participate actively in the process of strengthening international, national and regional capabilities for responding to nuclear and radiological emergencies and to make those capabilities more consistent and coherent", and* requests the Director General *"to continue to evaluate and, if necessary, improve the capability of the IAEA Emergency Response Centre to fulfil its role".*

Information Exchange

Action:

> *To organize an International Conference on the Control by National Authorities of Radiation Sources and Radioactive Materials and regional workshops on specific topical issues.*

International Conference

The Secretariat is organizing an *International Conference of National Regulatory Authorities with competence in the Safety of Radiation Sources and the Security of Radioactive Materials*, hosted by the Government of Argentina in Buenos Aires from 11 to 15 December 2000. The main aim of the Conference is to provide a forum for an exchange of information and experience regarding the development of regulatory systems for ensuring the safety of radiation sources and the security of radioactive materials.

The Conference is directed at a broad spectrum of high-level officials and experts from national authorities concerned with the regulatory control of radiation sources and radioactive materials. It will also be of interest to senior policy- and decision-makers of other national bodies and to representatives of private sector institutions which use radiation sources and radioactive materials. The intention is to provide participants with an opportunity to present information on the situation in their respective countries regarding the regulatory control of radiation sources and radioactive materials and to discuss how, if necessary, the situation might be improved.

In this connection, in the resolution GC(44)/RES/11 the General Conference urged Member States to take steps to help ensure that the *International Conference* is well attended, particularly by participants from developing countries.

It should be noted as well that the same above resolution urges Member States to take steps to help ensure that the *International Conference on the Radiological Protection of Patients*, due to be held in Torremolinos, Spain, from 26 to 30 March 2001, is well attended and particularly by participants from developing countries.

Regional workshops

The Secretariat is organizing six regional workshops on the safety and security of radiation sources and radioactive materials to be held between November 2000 and the end of 2001. These workshops will be for users and manufacturers of radiation sources and for regulators. They will be open to participants from Member States of the Agency and from non-Member States.

The representatives will be encouraged to exchange information about problems encountered by them and about successes in dealing with such problems. A major topic will be the use to be made of the *Categorization of Radiation Sources*, although the items of the *Action Plan* will also be covered.

Action:

To develop an international database on missing and found orphan sources or to modify an existing database so as to include such sources.

A Technical Committee has concluded that the most efficient mechanism whereby the Secretariat might receive information on missing and found orphan sources and make it available to Member States is the 24-hour reporting system established pursuant to the Early Notification Convention and the Assistance Convention and described in ENATOM.

This Committee has worked out a configuration for an international database, procedures for the reporting of data and rules regarding access to and the security of data and has designed a reporting form. The Committee also considered that only sources belonging to the two most hazardous categories of the three-category *Categorization of Radiation Sources* are to be covered by the database. A reporting exercise, with a small number of participants, is to be carried out before the end of this year.

Action:

To fully develop and maintain the international database on unusual radiation events (RADEV) and make it available to Member States.

The Secretariat is at present carrying out in-house tests of RADEV. Later this year, the Secretariat will carry out an international trial in co-operation with a number of other organizations. If the results are satisfactory, RADEV will be made available for use by Member States in 2001.

RADEV will include summaries of reports giving the results of detailed reviews of the causes and consequences of serious radiological accidents and the lessons learned. Such reports are prepared by the Secretariat with the agreement of the States where the accidents occurred. The first such report covered the serious radiological accident that occurred in 1987 in Goiânia, Brazil. So far, the Agency has published eight such reports; five more are to be published in the near future. In addition, three reports on lessons learned from accidents which have occurred with industrial radiography sources, with industrial irradiators and in radiotherapy have been published. The publication of such reports can take a long time (up to several years), owing to the lengthy procedures involved in collecting and analyzing data and obtaining the permission of States to publish and, above all, to the need to wait and see how the medical condition of the accident victims develops. The Secretariat is therefore introducing a system for making available within a relatively short time the lessons learned from serious radiological accidents resulting, in particular, from the loss or the absence of control over radiation sources. The long-term medical follow-up of accident victims will be handled separately in collaboration with WHO.

The RADEV data based has been prepared and data are being entered. Initial statistical data from RADEV will be available by the time of the International Conference in Buenos Aires.

Action:

To develop a repository of information on the characteristics of sources and of devices containing sources, including transport containers, and to disseminate the information, with consideration of the advisability of dissemination through the Internet.

The Secretariat started work already in January 1999 on developing an information base to be used in support of the management of disused sealed sources. In February 2000, it presented the results of its preliminary work to a group of consultants, who suggested how the structure of the information base might be improved and how data might best be collected from Member States. In May 2000, the Secretariat sent to all Member States a questionnaire inviting them to provide relevant information.

The Secretariat's aim is to produce a catalogue which contains information on radiation sources and on devices containing such sources, including guides to facilitate the identification of sources and devices on the basis of radioactive characteristics and to facilitate visual identification on the basis of outward appearance (e.g. shape, size and labels). Completion of the software design phase and of the inputting of available data is tentatively scheduled for the end of March 2001.

Education and Training

Action:

To intensify post-graduate educational course activities in accordance with General Conference resolution GC(XXXVI)/RES/584 on "Education and training *syllabuses and training material for specific target groups and specific uses of radiation sources and radioactive materials.*

In the light of the BSS and of a number of other safety standards developed by the Agency, the Secretariat updated the "Standard Syllabus of Post-Graduate Educational Courses in Radiation Protection" (published by the Agency in 1995 in Arabic, Chinese, English, French, Russian and Spanish). The updated standard syllabus, with the title "Standard Syllabus of Post Graduate Educational Courses in Radiation Protection and the Safety of Radiation Sources", will be published (in the six aforementioned languages) early in 2001. The Secretariat — which has organized post-graduate educational courses in Arabic (in the Syrian Arab Republic), English (in Germany, India and South Africa), French (in France and Morocco), Russian (in the Russian Federation) and Spanish (in Argentina) — is planning to increase the frequency of the courses held in those languages and to organize courses also in Chinese.

The Secretariat is drawing upon the standard syllabus to design shorter training events (national and regional courses and workshops) on specialized topics such as the establishment of regulatory frameworks, occupational exposure control, medical exposure control, public exposure control, radioactive waste management, radioactive materials transport, and radiation emergency preparedness and response. Last year, over 40 such training events were organized, mainly within the framework of the Model Project on upgrading radiation protection infrastructure.

To assist Member States in running national and regional training courses, the Secretariat is developing a set of practice/task-specific modules (with — inter alia — syllabuses, lecture notes, guidance for lecturers, visual presentations, suggestions for practical exercises, and sample test questions). The modules are intended primarily for use on a "train-the-trainer" basis. The Secretariat intends to make the modules available to Member States for use by instructors who have attended an Agency post-graduate educational course. The training modules relating to "Basic Concepts of Radiation Protection and the Safety of Sources", "Industrial Radiography" and "Diagnostic X rays" are nearing completion. As a complement to educational courses and training events, the Secretariat is developing distance-learning material and a mechanism for computer-item-based training through the Internet.

The Secretariat is preparing standardized training material for all training in radiation protection and will make it available to relevant organizations in Member States, to lecturers and to participants in training events.

Also, it is standardizing the procedures for the organization of training events. A manual on "*Training in Radiation Protection and the Safe Use of Radiation Sources*" which provides guidance on how to organize training events and how to comply with the training requirements of the BSS was drafted, as well as also a Safety Guide entitled "*Building Competence in Radiation Protection and the Safe Use of Radiation Sources*" which deals with — inter alia — education and training requirements.

Action:

To strengthen, within existing resources, the role of regional training centres and to facilitate co-operation between such centres, on one hand, and national and regional authorities and professional bodies, on the other, with a view to encouraging the harmonization of training for protection against ionizing *radiation, the safety of radiation sources and the application of the Basic Safety Standards.*

The Secretariat is standardizing the organizational and administrative procedures for educational and training courses held with Agency assistance at regional and national training centres. Following a meeting early this year of representatives of regional training centres, the Secretariat has started:

- to prepare standardized training material (in Arabic, Chinese, English, French, Russian and Spanish);
- to prepare a long-term programme for training at regional training centres;
- to identify further institutions which might serve as regional training centres;
- to identify institutions in Member States with very extensive experience of providing education and training in radiation protection which might collaborate with regional training centres; and
- to establish a network of regional training centres and collaborating institutions which would assist the Secretariat in the preparation of standardized training material and/or the organization of post-graduate educational courses and specialized training events.

It should be noted, that the resolution GC(44)/RES/13 on *"Education and training in radiation protection and nuclear safety and waste management"*, which was adopted by the Agency's General Conference on 22 September 2000, at its forty-fourth regular session, emphasized *"the importance and role of education and training in establishing and maintaining an adequate radiation protection and nuclear safety infrastructure, including regulatory aspects as stipulated in the Preamble to the BSS"*.

On 11 September 2000 the Board of Governors also authorized the Secretariat *"to continue developing, in a systematic way, syllabuses and training material — and also educational material — for specific target groups and specific uses of radiation sources and radioactive materials and to continue with the activities which it has started in connection with the standardization of the organizational and administrative procedures for educational and training courses held with Agency assistance at national and regional training centres"*.

Therefore, and pursuant to resolution GC(44)/RES/13 (Paragraph 2), the Secretariat is intensifying, within the Agency's available resources, its current efforts to prepare a long-term programme of education and training to be provided at national and regional training centres. In this context it is:

- preparing standardized training material in Arabic, Chinese, English, French, Russian and Spanish;
- establishing a network of regional training centres and collaborating institutions which would assist the Secretariat in organizing post-graduate educational courses and specialized training events; and
- assisting national and regional training centres in conducting educational and training courses in Arabic, Chinese, English, French, Russian or Spanish.

In this connection, the Secretariat requests Member States to inform it of any national training centres and other national institutions (and of any national professional bodies) which might be able to support its efforts. Relevant communications should be addressed to the Division of Radiation and Waste Safety in the Agency's Department of Nuclear Safety.

International Undertakings

Action:

> *To initiate a meeting of technical and legal experts for exploratory discussions relating to an international undertaking in the area of the safety of radiation sources and the security of radioactive materials.*

The Secretariat convened in March 2000 an Open-ended Meeting of Technical and Legal Experts to undertake exploratory discussions on a possible Code of Conduct on the Safety of Radiation Sources and the Security of Radioactive Materials. A first draft Code of Conduct was produced at this meeting.

A second Open-ended Meeting of Technical and Legal Experts took place in July 2000 and the Chairman's report noted that:

- considerations of safety and security at the end of use of a radioactive source should be considered in regulations, how regulatory requirements should be implemented by the regulatory body and how to best disseminate the requirements of the Code (it was noted that, according to the definition of "regulatory body", such a body need not necessarily possess the legal authority to grant authorizations);
- regarding the scope, the Code should apply to (sealed) radioactive sources , excluding material within the nuclear fuel cycles of research and power reactors", but including "radioactive material released if the (sealed) source is leaking or broken";
- while recognizing that radiation generators have caused a certain number of accidents, it was also recognized that most of the accidents with serious consequences were caused by radioactive sources, and therefore the Code should focus on radioactive sources;
- while certain provisions in the Code did in fact apply to manufacturers, suppliers and users, regulatory activities fell within the domain of States, and that therefore the addressees of the Code should be States;
- States should create comprehensive national registries for radioactive sources under their jurisdiction, but for various reasons such a proposal was deemed not practicable at this time and, consequently, a further proposal that the Agency provide the platform for an international registry, at least initially for radioactive sources in *Category 1 (higher risk)* of the "Categorization of Radiation Sources" was also felt to be premature (noting that there were other fora, including the Agency's policy-making organs, in which this issue could be further pursued);
- concerning the import and export of radioactive sources, it was felt that the main responsibility for the safe management of radioactive sources rested with the *importing* State, which should consent to such an import only if it had the technical and administrative capability needed to manage the source in a safe manner (no agreement was reached regarding any obligations of *exporting* States in this regard); and
- regarding whether unilateral declarations where States would undertake to take the necessary steps to implement the provisions of the Code, it was felt that the Code as such should be an incentive document which may or may not be complemented by

binding legal undertakings and, therefore, it was felt that its mandate was to "undertake exploratory discussions relating to an international undertaking in the area of the safety and security of radiation sources" independent of its legal form.

On 11 September 2000, the Agency's Board of Governors — inter alia — took note of a *Code of Conduct on the Safety and the Security of Radioactive Sources* and requested the Director General of the Agency to circulate it to all States and all relevant international organizations, and pursuant to the resolution GC(44)/RES/11 (paragraph 4), States were invited to take note of the *Code of Conduct* and to consider, as appropriate, means of ensuring its wide application. The *Code of Conduct* references the *Categorization of Radiation Sources*, which was also endorsed separately, and includes the following provision for its dissemination: "Every State should inform public and private organizations and persons involved in the management of radioactive sources, as appropriate, of the measures it has taken to implement this Code and should take steps to disseminate that information widely."

Another action taken by the Board of Governors on 11 September 2000 was to request the Director General to organize consultations on decisions which the Agency's policy-making organs might wish to take, in the light of the report of the Chairman of the open-ended group of technical and legal experts which produced the *Code of Conduct on the Safety and Security of Radioactive Sources*, regarding — inter alia — the application and implementation of the *Code of Conduct* and to make recommendations to the Board.

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TRANSFER OF TECHNOLOGY: MANAGEMENT OF DISUSED RADIOACTIVE SOURCES

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Abstract. The number of sealed radioactive sources worldwide is estimated to be in the millions, although the existing registries indicate a much smaller number. If a source is no longer needed or has become unfit for the intended application, it is classified as spent or disused source. The activity of a disused source may still be in the order of GBq or TBq. Recognizing the risk associated with disused radioactive sources and the number of incidents and accidents with a wide range of consequences including widespread contamination and deterministic health effects, the IAEA has embarked on various activities dealing with the safe management of disused radioactive sources. These activities include publication of up-to-date technical information and guidance, development and distribution of management tools, transfer of technology and know-how through training and technical co-operation projects and direct assistance to solve specific safety and technical problems. This paper briefly describes these activities with reference to publications and projects carried out in various Member States.

INTRODUCTION

Sealed radioactive sources are extensively used in agriculture, industry, medicine and various research fields in both developed and developing countries. The number of sealed radioactive sources worldwide is estimated to be in the millions, although the existing registries indicate a much smaller number. A sealed source is a radioactive material that is (a) permanently sealed in a capsule, or (b) closely bound within a solid matrix. The capsule or the matrix material of a sealed source should be strong enough to maintain integrity and avoid leaking under normal conditions of use and wear and also under foreseeable accidental conditions. If a source is no longer needed (e.g. replaced by a different technique) or has become unfit for the intended application (e.g. activity too weak, malfunctioning or obsolete equipment, damaged or leaking source), it is classified as a spent or disused source. The activity of a disused source may still be in the order of GBq or TBq.

Moreover, old radioactive sources were manufactured to a lower quality standard than sources manufactured over the past decade. Earlier sources were, for example, manufactured from powder or soluble salts, making them susceptible to leakage and dissolution if exposed to water, especially since the encapsulation techniques used were also inferior to current practices.

A typical material used in old sources is radium; it was used for medical applications in needles and tubes. Today, radium sources constitute a significant problem, owing to the long half-life and high radiotoxicity of ^{226}Ra.

Recognizing the risk associated with disused radioactive sources and the number of incidents and accidents with a wide range of consequences including widespread contamination and deterministic health effects, the IAEA has embarked on various activities dealing with the safe management of disused radioactive sources. In one of the first publications on this subject [1], the nature and magnitude of the problem of spent radiation sources was surveyed with the conclusion that developed countries can be assumed to have the regulatory infrastructure and technical expertise needed to implement a programme for managing their spent sources, in marked contrast to many developing countries. It is, therefore, much more pressing for the Agency to assist the latter, and the highest priority has been given to improving the situation in these countries.

Following this policy, the Agency has implemented various activities to transfer technology and know-how to developing countries. The main types of activities are:

- collection, review and publication of up-to-date information and guidance, e.g. Technical Reports Series, technical documents (TECDOCs), conference and workshop proceedings;
- developing and distributing management tools (e.g. administrative procedures, computerized registries, databases);
- transfer of technology and know-how through training and other technical co-operation (TC) projects; and
- direct assistance to solve specific safety and technical problems (e.g. expert advice, action teams).

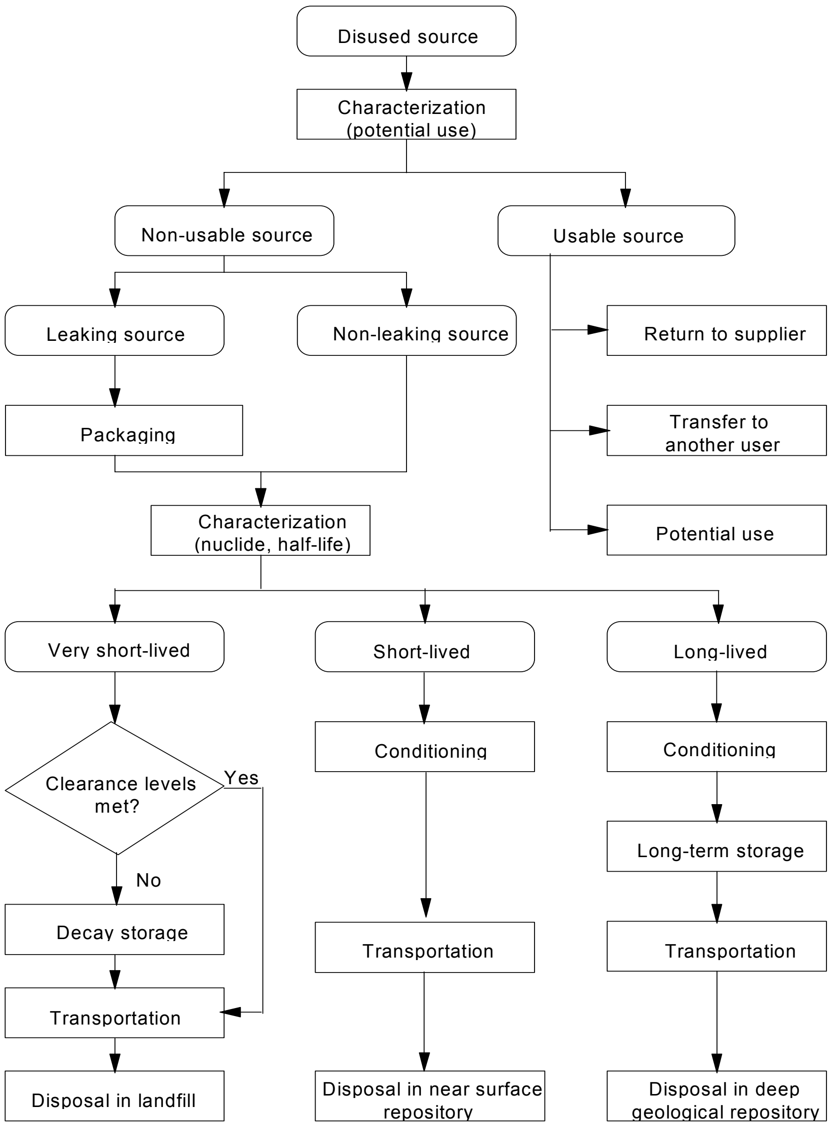
DISSEMINATION OF TECHNICAL INFORMATION

The publication of technical documents in a technical manual format provides a practical approach and guidance on the actual conduct of such work. In co-operation with some institutions in developed Member States, generic designs of facilities for processing and storage of disused sealed sources have been developed and are being used to provide advice on how to establish such facilities at the national level [2]. Another document provides detailed technical information about handling, conditioning and storing spent sealed sources [3]. Information on practical methods to identify and locate disused sealed sources and on the conditioning and storage of disused radium sources has also been published [4, 5]. Further documents on risk reduction in the management of disused radioactive sources and on their management involving storage/disposal in boreholes are in an advanced stage of preparation.

Regarding the disposal of disused radioactive sources in boreholes, a discussion paper is being finalized to assess the feasibility of using such a disposal method, particularly in countries that have no plans to develop other repositories for radioactive waste. Boreholes, which could be designed to meet the requirements of a greater confinement disposal system, appear to be a cost effective solution for the disposal of relatively small volumes of radioactive waste, including disused radioactive sources.

Other technical documents are planned to describe methods and procedures for conditioning and storing long lived disused radioactive sources and on the management of high activity disused sealed sources.

The typical steps for managing disused radioactive sources are shown in the diagram [6].



MANAGEMENT TOOLS

Experience has shown that lack of information about disused sources has been a prime cause of loss of control, causing accidents and incidents. The Agency has developed, as an important management tool, a simple database registry. The Sealed Radioactive Sources (SRS) Registry, has been specially designed to track and store relevant data about sealed radioactive sources. This computerized registry has been implemented in more than 30 Member States.

The Agency has developed a Waste Management Data Base (WMDB). The primary purpose of the WMDB is to provide an accessible source of information on waste management (including disused sources) in all IAEA Member States. The WMDB includes information on current waste inventories and projections, policy and regulatory developments, organizations responsible for waste management activities, national strategies, waste management research and development programmes, operational activities and significant milestones.

TRAINING

A special type of technology and know-how transfer, typically using international co-operation, is the "Demonstration of Predisposal Waste Management Methods and Procedures" which is hands-on practical training for small groups in real, operating waste processing facilities. This programme has been implemented since 1996 on a regional basis, particularly for the benefit of developing Member States. One of the main modules of this training deals with the conditioning and storage of disused sources. Demonstrations have been held so far in Chile (for Member States in Latin America), Turkey (Eastern Europe, Africa and West Asia), the Philippines (East Asia & Pacific) and the Russian Federation (for the Newly Independent States of the former USSR). Twelve demonstrations have been held in four regions so far, attended by about 100 experts from 50 Member States. Member States are supported to participate in the demonstrations through the interregional TC Model Project on Sustainable Technologies to Manage Radioactive Waste (INT/4/131).

DIRECT ASSISTANCE TO SOLVE SPECIFIC PROBLEMS

The Agency programme on conditioning radium sources ensures that, if requested, all identified disused radium sources in a country lacking appropriate infrastructure are conditioned in a single campaign by an expert team contracted by the Agency, thereby solving the immediate national problem of disused radium sources. The technical procedure has been internationally recognized as safe and viable, resulting in waste packages which appear to be compatible with a variety of future management options. Over the past three years, the programme has concentrated on Latin America with the help of cost-free experts from Brazil and an extrabudgetary contribution from the USA. National radium stocks have been conditioned and rendered safe in Chile, Costa Rica, Ecuador, Guatemala, Jamaica, Nicaragua, Paraguay, Peru and Uruguay. The programme has been extended to Eastern Europe, where similar operations have been carried out in Croatia in co-operation with the Austrian Research Centre Seibersdorf, and in Bosnia and Herzegovina in co-operation with the Ruder Boskovic Institute of Croatia. In 1998, the programme was further expanded to include Africa and Asia. In Africa, operations have been carried out in Ghana, Madagascar, Mauritius, Sudan, Tanzania and Tunisia by a South African team provided cost free to the Agency and in Egypt by a national team. In Asia, operations have been carried out in China and Pakistan by national teams under the guidance of the Agency, in Sri Lanka and Bangladesh by a team from Pakistan and in Myanmar by a team from Korea. The radium conditioning project is one component of the interregional IAEA TC Model Project on Sustainable Technologies to Manage Radioactive Waste (INT/4/131). Altogether, radium conditioning operations have been carried out in twenty-four developing Member States so far.

Some developing Member States do not have the infrastructure, resources or sufficient quantities of radioactive wastes to justify developing a full size repository. However, disused sources containing long lived radionuclides, even though properly conditioned, cannot be stored indefinitely. The Agency intends to promote co-operation among Member States, to encourage, for example, manufacturers and suppliers of sealed sources to take back disused sources for recycling and to accept the sources for disposal if they cannot be recycled.

In addition, the Agency has started activities aimed at assessing the feasibility of implementing disused source disposal in boreholes. The feasibility of the option depends on the outcome of the required safety assessment, which depends on the availability of specific information about the radionuclide inventory; the properties of the various barriers, both engineered and geological; and the environmental conditions of the proposed location. A TC project involving a number of African Member States has been initiated with the aim of helping them to develop the capability to perform the necessary safety assessments.

CONCLUSIONS

The number of disused radioactive sources worldwide is estimated to be in the millions, although the existing registries indicate a much smaller number. If a source is no longer needed or becomes unfit for the intended application, it is considered spent or disused. The activity of a disused source may still be in the order of GBq or TBq. Recognizing the risk associated with disused sealed radioactive sources and the number of incidents and accidents with a wide range of consequences including widespread contamination and deterministic health effects, the IAEA launched a programme on the management of disused radioactive sources at the beginning of the 1990s. This programme was designed mainly for developing countries where sealed radiation sources have been widely used in medical and industrial applications but infrastructure and experience in management of disused radioactive sources was limited.

The Agency is implementing its programme on the management of disused radioactive sources by assisting Member States to establish or improve technical infrastructure and management practices. The main types of these activities are collection, review and publication of up-to-date information and guidance (such as publication of technical documents, organizing conferences), development and distribution of management tools (such as computerized registries, databases), transfer of technology and know-how through training and other technical co-operation projects and direct assistance to solve actual safety and technical problems (such as the conditioning of radium sources using specialized expert teams and the safety assessment of disposal options, for example emplacement in boreholes).

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SECURITY OF MATERIAL: PREVENTING CRIMINAL ACTIVITIES INVOLVING NUCLEAR AND OTHER RADIOACTIVE MATERIALS

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Abstract. The report emphasizes the need for national regulatory authorities to include in the regulatory systems, measures to control and protect nuclear materials from being used in illegal activities, as well as aspects of relevance for detecting and responding to illegal activities involving nuclear and other radioactive materials. The report will give an overview of the international treaties and agreements that underpin the establishment of a regulatory structure necessary for States to meet their non-proliferation policy and undertakings. Ongoing work to strengthen the protection of nuclear material and to detect and respond to illegal activities involving nuclear and other radioactive material will be included. The focus of the paper is on the need for standards and national regulation in the nuclear security area.

INTRODUCTION

During the past ten years, nuclear material and other radioactive materials, including radioactive sources, have been reported to be seized in illicit trafficking. The IAEA's Illicit Trafficking Database Programme, started in 1996, now contains a total of some 330 officially confirmed cases of illicit trafficking of radioactive materials; half of which involved nuclear material and the other half other radioactive materials. The circumstances of these cases vary from theft, unauthorized possession, or just "seizure" (without other reason stated). The international community has recognized that measures are needed, on the international level as well as on the national level, to prevent, detect and respond to illegal activities involving nuclear and other radioactive materials.

DEVELOPMENT OF THE IAEA PROGRAMME: SECURITY OF MATERIAL

In a resolution, the IAEA General Conference of 1994 invited the Director General to intensify the activities through which the IAEA is currently supporting Member States to combat illicit trafficking. In 1995, the IAEA Board of Governors approved a programme of activities that should assist States in their efforts to combat illicit trafficking, including *prevention, detection and response* to such activities should they occur.

In 1997, the IAEA intensified its activities further and established the programme *Security of Material* within its major programme *Nuclear Verification and Material Security.*

From 1997–2001, the programme had three subprogrammes: 1) The Illicit Trafficking Database Programme, 2) Assistance to States in their Management of Nuclear Material, 3) Protection of Radioactive Sources. During the operation of the programme, it has been gradually recognized that all activities related to the safety of radiation sources should be handled within the IAEA's programme for Nuclear Safety, and that the programme Security of Material should be focused on *illegal or criminal activities involving nuclear or other radioactive materials*.

Consequently, for the budget period 2002–3, the IAEA's programme Security of Material includes the following two subprogrammes: 1) Technical, Administrative and Regulatory Arrangements in Members States to Protect and Control Nuclear Material, and 2) Illegal Activities Involving Nuclear and Other Radioactive Materials.

INTERNATIONAL INSTRUMENTS CONTRIBUTING TO THE PREVENTION OF ILLEGAL ACTIVITIES INVOLVING NUCLEAR MATERIAL

There is a global recognition that nuclear material, due to its fissile properties and potential use in nuclear weapons programmes, should be subject to strict regulatory arrangements for control and protection. The technical and administrative requirements in a State to maintain such control and protection of nuclear material and its use rest on:

a) nuclear material accountancy and control;and
b) physical protection of nuclear material and nuclear facilities

Several treaties, conventions and agreements reflect the legally binding undertakings by States in these areas, including the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the Convention on the Physical Protection of Nuclear Material (CPPNM).

For other radioactive material, including radiation sources, the IAEA together with Member State expert, has developed a "Code of Conduct on the Safety and Security of Radioactive Sources", which has been discussed by the Board of Governors as part of the Action Plan for the Safety of Radiation Sources and Security of Radioactive Materials.

THE NON-PROLIFERATION TREATY

The NPT opened for signature in 1968 and entered into force in 1970. It is the central component of the nuclear non-proliferation regime. Non-nuclear-weapon States undertook not to develop nuclear weapons and to accept international verification that their nuclear programmes were being used only for peaceful purposes. The IAEA was assigned the responsibility for verifying, through safeguards agreements, that this undertaking was being met. A non-nuclear-weapon State, party to the NPT, undertakes to declare *all* its nuclear material to the IAEA, and the IAEA undertakes to verify that the State *has* declared all its nuclear material. This is established in a *safeguards agreement* between the IAEA and the State. The purpose is to verify that nuclear material in the State has not been diverted to the manufacture of nuclear weapons or other nuclear explosive devices. A nuclear-weapon State, party to the NPT, undertakes not to contribute, with nuclear material or technology, to the development of nuclear weapons in a non-nuclear weapon State. The technical objective is to be able to detect, "in a timely manner", the diversion of "significant quantities" of nuclear material from a State's peaceful nuclear activities to the manufacture of nuclear weapons or other nuclear devices.

Technical, Administrative and Regulatory Arrangements in the State

A State has the sole responsibility for fulfilling its non-proliferation undertakings, including those in safeguards agreements. For this purpose, the State undertakes to maintain a system of accounting and control for all nuclear material to provide information on a) quantities, chemical and physical form of nuclear material, b) where and in what activities the material is used, and c) all transactions of nuclear material. This *State System for Accountancy and*

Control (SSAC) is a set of technical and administrative objectives and functions that are to be applied by the State and by an operator of a nuclear facility or anyone else that uses nuclear material to facilitate the State in fulfilling its obligations.

The SSAC provides the technical basis for *early detection* of theft or removal of nuclear material from a nuclear facility, storage or transport. The SSAC also provides the information required to design and implement effective physical protection of the nuclear material, and also the necessary information of relevance for exports and imports of the material. For the State, the SSAC thereby obtains a multifunctional purpose.

To become fully effective, known by and implemented in a State, the requirements of the SSAC should be reflected in the national nuclear regulatory system.

THE CONVENTION ON THE PHYSICAL PROTECTION OF NUCLEAR MATERIALS

While the NPT addresses nuclear non-proliferation at the State level, the CPPNM addresses the concern that nuclear material may be subject to *theft or other unauthorized removal* by subnational actors such as terrorist groups, criminal and politically motivated groups, and even individuals. The greatest challenge in building a nuclear explosive device remains in acquiring the weapon-usable nuclear material. While subnational groups or individuals are unlikely to have the means to manufacture nuclear material themselves, theft from established national sources may be a possible route for them for acquiring nuclear material. This could be by direct action or indirectly, by illicit trafficking. The physical protection of nuclear material, facilities and technology against theft or unauthorized diversion is, therefore, a non-proliferation issue.

The physical protection of nuclear materials, whether in use, in storage, or in nuclear transport, is a national responsibility.

The Convention, which came into force in 1987, is the central international instrument to protect nuclear material from theft or unauthorized removal. It requires States parties to make unlawful possession, use, etc., of nuclear material a criminal offence under national law and promotes international co-operation in the exchange of physical protection information. The States parties undertake to protect nuclear material during international transport at a certain agreed level depending on quantity and physical form of the material.

The requirements for protection of nuclear material in the CPPNM are limited to international nuclear transport.The Director General of the IAEA convened an open-ended expert meeting to discuss whether there was a need to revise the CPPNM in November 1999. The Expert Meeting will report to the Director General in May 2001.

Technical, Administrative and regulatory arrangements in the State

In order to promote uniform high standards for the protection of nuclear material, the IAEA provides the international community with recommendations on the requirements for physical protection of nuclear material against unauthorized removal whilst in use, transit, and storage in INFCIRC/225/Rev. 4; *The Physical Protection of Nuclear Material and Nuclear Facilities*. States implement these recommendations on a voluntary basis. The national system of physical protection defines the responsibilities at the State level and the (more technical) responsibilities that are to be fulfilled at the facility level. An important basis for a national physical protection system is the *threat assessment* which gives the basis for the measures to be implemented. INFCIRC/225/Rev. 4, underlines the need for a flexible approach in which the specific circumstances in a State may be taken into account.

The recommendations reflect a broad consensus among Member States on the requirements. The specific physical protection measures to be implemented at particular facilities are determined by the State taking into account factors specific to the State, including threat perception, economics, political infrastructure and culture. Most industrial and developing countries follow these recommendations in the establishment and operation of their physical protection systems.

In each State with nuclear activities, a national regulatory system for physical protection should be developed, which defines the appropriate physical, procedural and legislative measures for the protection of the material. The synergy between the physical protection system and the SSAC is recognized in that the SSAC provides the data on nuclear material that is needed for the design of the physical protection system. While the SSAC will enable early detection of theft or other unauthorized removal of nuclear material, the physical protection system will protect the material from such illicit activities.

DETECTING AND RESPONDING TO ILLEGAL ACTIVITIES INVOLVING NUCLEAR AND OTHER RADIOACTIVE MATERIALS

Detection of radioactive materials

The physical properties, the radiation, of radioactive materials make it possible to *detect* these materials when being used illegally, e.g. at borders. Most transports of radioactive materials emit some radiation at low levels. With radiation monitoring equipment, a customs officer may detect transports containing radioactive materials. The critical question for the officer on such an occasion is whether the transport is legitimate or not. Instructions on how to respond to the detection of radioactive materials should give clear guidance on measures to be performed when a signal has been received that a transport contains radioactive materials. In some cases, additional measurements will be needed, and the capability to perform such measurements should be available either at the border or on call.
In other cases, where radioactive material is seized in unauthorized possession, the characterization of the material is necessary in order to determine further actions. It is important that analytical capabilities are available, either domestically or regionally, for the characterization of the material seized.

Responding to the detection or seizure of radioactive materials

The seizure of nuclear or other radioactive materials e.g. in illicit trafficking, triggers a series of activities. Analysis of the material, arrangements for its safe and secure storage and investigative actions are to be undertaken. Different response activities are called for if nuclear material has been seized from those necessary if a radiation source has been seized or detected. Response manuals should give proper guidance for different cases.

Technical and administrative arrangements in the State

The national regulatory system should cover measures to detect and respond to illegal activities involving nuclear or other radioactive materials. The technical measures needed are related to detection capability, e.g. availability of instruments and laboratories to perform analysis of seized material. Possible arrangements for the shipment of samples of seized material should be part of the technical arrangements.

IAEA PROGRAMMES TO ASSIST STATES IN DETECTING AND RESPONDING TO ILLEGAL ACTIVITIES INVOLVING NUCLEAR AND OTHER RADIOACTIVE MATERIALS

In its programme for 2002–3, the Agency emphasizes activities that will generate standards, guides and norms in the area of preventing, detecting and responding to illegal activities involving nuclear and other radioactive materials. In addition, it will, within available resources, assist States in establishing the technical, administrative and regulatory functions that are needed to implement the standards, norms and guides.

The assistance programmes also include research and development efforts to develop radiation monitoring instruments with adequate capability.

The fostering of information exchange will continue by maintaining the Illicit Trafficking Database Programme, and by improving the use of the data, including analysis of the content of the database annually.

Closer interaction with the World Customs Organization (WCO), Interpol and Europol are promoted through the Memorandum of Understanding already signed with the WCO and one presently being drawn up with Interpol.

CONCLUSION

Any unauthorized possession, use or handling of radioactive material pose risks: for nuclear material the main risk is that the material may be used for nuclear weapons purposes; for other radioactive material and radioactive sources the radiation risk is to individuals, the public and also to the environment. The responsibilities to counter such abuses require measures at the national and the international level.

Addressing these issues successfully requires a spectrum of measures and arrangements, ranging from internationally binding undertakings to technical, administrative and regulatory arrangements in States and the availability of assistance programmes aimed at helping States to establish the necessary systems.

Effective measures to act against the *illegal — terrorist or criminal — activities* involving nuclear and other radioactive materials require additional measures by law enforcement authorities. The co-operation between the international organizations concerned, the IAEA and the World Customs Organization, Interpol and Europol is thereby essential. Effective programmes to ensure exchange of information are necessary.

THE PROVISION OF TECHNICAL CO-OPERATION: THE MODEL PROJECT FOR UPGRADING RADIATION PROTECTION INFRASTRUCTURE

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Abstract. The paper describes the IAEA's systematic effort to address the inadequate situation in many of its Member States with regard to radiation protection and safety. For this effort a special project was created and implemented in the past five years to create or strengthen existing radiation protection infrastructure in 52 countries where such infrastructure was non-existent or not appropriate for the type of practice involved. The implementation of this project focused on the development of qualified human resources, assistance for introduction of appropriate legislation and equipment for inspection and analysis. Workplans were tailored to the individual needs of each participating country and the elements of these workplans were grouped into five milestones – regulatory framework, occupational exposure control, medical exposure control, public exposure control, and emergency preparedness and response capabilities. By the end of 2000 more than 70% of the participating countries had radiation protection laws promulgated and a regulatory authority established; 46% had regulations adopted and 42% had a system of notification, authorization and control of radiation sources operational. During the five years of implementation, 555 fellows received individual training, another 2278 participated in training courses, over 1000 expert missions were fielded and equipment worth about US $6 million was provided. The total cost was over US $17 million.

INTRODUCTION

When the International Atomic Energy Agency (IAEA) was established more than 40 years ago, it was mandated to make provision for materials, services, equipment, and facilities to meet the needs for research and development in the use of nuclear energy and techniques for peaceful purposes with due consideration for the needs of the underdeveloped areas of the world. Also, the IAEA was assigned the responsibility to adopt, in consultation with other agencies, concerned standards of safety for the protection of health and minimization of danger to life. The IAEA should provide for the application of these standards to its own operations as well as to the operations making use of materials, services, equipment and facilities that it makes available.

Throughout the years, considerable financial and technical resources have been directed towards assistance in safety related activities in nuclear power projects and for the wide range of industrial, medical and agriculture uses of ionizing radiation. During the past 10 years alone, the Department of Technical Co-operation of the IAEA implemented some 350 assistance projects in almost 100 countries at a cost of more than 50 million US dollars.

In discharging these functions, the IAEA has issued a number of safety standards. One of the most important steps in this connection was the endorsement in 1996 by six international organizations, including the IAEA, of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS).

The first systematic attempt to improve the situation of the application of adequate health and safety standards in its projects was made between 1984 and 1995, with the organization of Radiation Protection Advisory Team (RAPAT) missions. During this period, RAPAT missions visited 64 countries[1] with the purpose of assessing their safety infrastructures and determining, together with the countries, the immediate and future actions to be implemented. Some fact finding missions were also carried out in countries of the former Soviet Union.

Although these missions contributed to an increased awareness of radiation protection and safety issues in the visited countries, their situation regarding the establishment of the minimum infrastructure necessary for ensuring the appropriate regulatory control of radiation sources as described in the Preamble to the BSS remained inadequate. The factors contributing to this included the absence of a regulatory framework and of the necessary trained staff and insufficient funding for inspections and operations. In 1993 and 1994, the IAEA evaluated the available information and identified, on priority basis, 52 countries as needing assistance in meeting regulatory infrastructure requirements. [1]

To remedy the situation, a large technical assistance project was conceived to implement the necessary activities in 52 countries simultaneously. For that, a fresh approach which would go beyond recommendations and isolated follow-up visits would be necessary to find a satisfactory solution for the problems identified. For this purpose, an interregional, large scale, multi-year project (Model Project) on "Upgrading Radiation Protection Infrastructure" was proposed, with a five year duration. The project, given the IAEA code INT/9/143, was included in the Technical Co-operation Programme for 1994 and beyond. Four experienced Project Managers were assigned to implement the project activities in selected countries of various regions: seventeen in Africa, eleven in Europe, ten in Latin America, five in East Asia and nine in West Asia (see *Table 1*). Regional field offices were established for the project — in Addis Ababa (Ethiopia), Bratislava (Slovakia), San José (Costa Rica) and Beirut (Lebanon). Detailed action plans for meeting the requirements of the BSS were agreed upon with each of the participating countries.

Soon it was realized that a much faster pace of implementation was required to achieve the objective within the proposed five years.Hence, in 1997 a revised management and work plan was approved by which the activities of this Model Project were grouped into five new (regional) projects: RAF/9/024 for Africa, RER/9/056 for Europe, RLA/9/030 for Latin America, RAS/9/021 for East Asia and RAW/9/006 for West Asia. In 1998, the regional field offices were moved to Vienna to ensure improved co-ordination and management of project activities.

[1] The countries visited by Radiation Protection Advisory Teams were: Albania, Bangladesh, Bolivia, Cameroon, Chile, People's Republic of China, Colombia, Democratic republic of Congo (formerly Zaire), Costa Rica, Cote d'Ívoire, Croatia, Cuba, Democratic People's Republic of Korea (1989 - DPRK was a Member State at that time), Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Ghana, Greece, Guatemala, Hong Kong, Iceland, Indonesia, Iraq, Islamic Republic of Iran, Jamaica, Kenya, Kuwait, Lebanon, Libya, Madagascar, Malaysia, Mauritius, Mexico, Mongolia, Morocco, Myanmar, Nicaragua, Niger, Nigeria, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Republic of Korea, Romania, Saudi Arabia, Senegal, Sierra Leone, Sri Lanka, Sudan, Thailand, Turkey, United Arab Emirates, United Republic of Tanzania, Uruguay, Venezuela, Viet Nam, Zambia, and Zimbabwe.

Table 1. Countries participating in the Model Project on Upgrading Radiation Safety Infrastructure (as of November 2000)

No.	Africa	Europe	Latin America*	East Asia	West Asia
1	Cameroon	Albania	Bolivia	Bangladesh	Jordan
2	Côte d'Ivoire	Armenia	Colombia	Mongolia	Kazakhstan
3	Dem. Rep. of the Congo	Belarus	Costa Rica	Myanmar	Lebanon
4	Ethiopia	Bosnia & Herzegovina	Dominican Rep.	Sri Lanka	Qatar
5	Gabon	Cyprus	El Salvador	Viet Nam	Saudi Arabia
6	Ghana	Estonia	Guatemala		Syrian Arab Republic
7	Madagascar	Georgia	Jamaica		United Arab Emirates
8	Mali	Latvia	Nicaragua		Uzbekistan
9	Mauritius	Lithuania	Panama		Yemen
10	Namibia	Rep. of Moldova	Paraguay		
11	Niger	T.F.Y.R. Macedonia			
12	Nigeria				
13	Senegal				
14	Sierra Leone				
15	Sudan				
16	Uganda				
17	Zimbabwe				

* Haiti was also invited to participate but did not reply.

WORKPLANS AND MILESTONES

Workplans tailored to the specific needs of each participating country were prepared, discussed and agreed upon. The main elements of each workplan include radiation protection law and regulations; a clearly defined and well established national regulatory authority; a system of notification, authorization and control; a national programme for monitoring radiation workers to control occupational internal and external exposures; individual monitoring; a quality assurance programme to ensure control of the exposure of patients; laboratories and methods to control public exposures from environmental radiation and other sources; a radioactive waste management programme; a system of emergency preparedness and response plans; and training and development.

Although development of a mature infrastructure requires years of effective national implementation with continuous financial support, the workplans were prepared to ensure that the minimum requirements of the BSS for establishing national radiation protection infrastructures could be met within the five year duration.

These elements were grouped in a set of five milestones. [2]

Milestone 1: The establishment of a regulatory framework, the most time consuming activity, involves the drafting and promulgation of radiation protection laws and regulations, the designation and empowerment of a national regulatory authority and the establishment of a system for the notification, authorization and control of radiation sources (including the preparation of an inventory of radiation sources and installations). Attainment of this milestone can be regarded as the main immediate indicator of progress by a country in meeting its project obligations.

Milestone 2: The establishment of occupational exposure control comprises individual and workplace monitoring programmes, including dose assessment. The effectiveness of the system is strongly dependent on the soundness of the regulatory framework.

Milestone 3: The establishment of medical exposure control relates to activities aimed at controlling exposure of patients in diagnostic radiology, radiotherapy and nuclear medicine. It includes the establishment and implementation of appropriate quality assurance programmes.

Milestone 4: The establishment of public exposure control aims at radiation protection of the public and the environment. It includes programmes for the registration, control and safe disposal of radioactive waste, the control of consumer products containing radioactive substances, and environmental monitoring.

Milestone 5: The establishment of emergency preparedness and response capabilities involves the development of plans and the allocation of means to ensure the effectiveness of the national regulatory authority and other relevant organizations in dealing with different radiological emergency scenarios.

Implementation

In the workplans, the obligations and responsibilities of both the recipient country and the IAEA were specified for effective implementation of the project within the planned time frame. With that, it was assumed that governments and national authorities would be better prepared to comply with their obligations. For this reason, firm commitments were obtained from all participating countries, and workplans were discussed, approved and signed by relevant counterparts and national authorities. The infrastructure to be established was the minimum considered appropriate to provide an adequate margin of protection and safety for the level of activities carried out in each country.

For many participating countries, implementation started with essential activities such as the drafting of laws, regulations and procedures, and the recruitment for the first time of personnel for training. These activities consumed most of the first two years and few countries have not yet overcome this initial step. Establishing a national inventory of radiation sources was a high priority issue from the beginning.

Also, from the beginning it was realized that training personnel should receive high priority. Hence, training needs were identified for each country in individual action plans, and planned to be met through national, regional and interregional courses and workshops, fellowships, scientific visits, and on-the-job training during expert missions. Starting in 1999, long term (one year) postgraduate courses, leading to a diploma in radiation protection, have been established at the Universiti Kebangsaan Malaysia, at the University of Witwatersrand in Johannesburg (South Africa), and at the High Institute for Applied Science and Technology in Damascus (Syria). A nine-week Basic Training Course on Radiation Protection was held in Germany in 1997 and in Russia in 1999. This is in addition to the traditional regional postgraduate course on radiation protection and nuclear safety offered by the University of Buenos Aires in conjunction with the Argentinean Nuclear Regulatory Authority and the Ministry of Health, which have been co-operating with the IAEA for many years. The training carried out under this project is summarized in *Table 2*.

Table 2. Human resource development

Project	Scientific visits	Fellows	Training course participants*
INT/9/143	38	114	–
RAF/9/024	14	75	149
RAS/9/021	25	130	660
RAW/9006	32	173	495
RER/9/056	37	29	850
RLA/9/030	4	34	224
TOTAL	**150**	**555**	**2278**

* Regional and national training courses.

Table 3.Number and origin of experts

Project	IAEA staff	International experts	National consultants	Participants in management meetings
INT/9/143	253	165	1	171
RAF/9/024	43	42	14	54
RAS/9/021	59	87	12	25
RAW/9006	39	64	3	32
RER/9/056	72	74	5	65
RLA/9/030	39	73	4	10
TOTAL	**505**	**505**	**39**	**357**

In addition to the extensive training of national staff, the projects provided continued support to the national authorities through the work of experts in the various tasks under the milestones. *Table 3* details the number and origin of the experts fielded through the project. The current status of project implementation is presented in *Table 4* for milestone 1 and in *Table 5* for milestones 2–5.

Table 4. Summary of the implementation of *milestone 1* by activities in action plans

REGION	Activity													
	1 Law				**2 Regulations**				**3 Regulatory Authority**		**4 System of Notification, Authorization, Inspection and Enforcement**			
	a	**b**	**c**	**d**	**a**	**b**	**c**	**d**	**a**	**b**	**a**	**b**	**c**	**d**
AFRICA (17)	**12**	**3**	**2**	**–**	**7**	**7**	**2**	**1**	**9**	**8**	**5**	**3**	**2**	**7**
EUROPE (11)	**9**	**2**	**–**	**–**	**6**	**1**	**2**	**2**	**9**	**2**	**6**	**1**	**1**	**3**
LATIN AMERICA (10)	**8**	**1**	**1**	**–**	**6**	**3**	**1**	**–**	**8**	**2**	**6**	**2**	**1**	**1**
EAST ASIA (5)	**4**	**1**	**–**	**–**	**3**	**2**	**–**	**–**	**5**	**0**	**2**	**1**	**2**	**–**
WEST ASIA (9)	**4**	**5**	**–**	**–**	**2**	**4**	**3**	**1**	**8**	**1**	**3**	**3**	**3**	**–**

1a: Promulgated
1b: In final stage of promulgation
1c: In drafting form
1d: No action taken

2a: Enacted
2b: In final stage of enactment
2c: In drafting form
2d: No action taken

3a: Established
3b: Not established

4a: In place
4b: Being implemented
4c: At initial stage of implementation
4d: Not established

Table 5. Summary of the implementation of *milestones 2–5* by activities in action plans (number of participating countries)[2]

REGION	*Milestone 2*						*Milestone 3*									*Milestone 4*						*Milestone 5*		
	Occupational Exposure Control						**Medical Exposure Control**									**Public Exposure Control**						**Emergency Response Plan**		
	Individual Monitoring			**Workplace Monitoring**			**DR***			**RT****			**NM*****			**Environmental Monitoring**			**Waste Management**					
	a	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**
AFRICA (17)	**9**	**4**	**4**	**5**	**2**	**10**	**1**	**6**	**10**	**4**	**1**	**12**	**1**	**1**	**15**	**3**	**6**	**8**	**2**	**5**	**10**	**–**	**1**	**16**
EUROPE (11)	**7**	**2**	**2**	**6**	**2**	**3**	**5**	**3**	**3**	**6**	**5**	**–**	**4**	**4**	**3**	**5**	**3**	**3**	**4**	**4**	**3**	**6**	**2**	**3**
LATIN AMERICA (10)	**8**	**2**	**0**	**4**	**4**	**2**	**3**	**4**	**3**	**4**	**4**	**2**	**2**	**2**	**6**	**5**	**2**	**3**	**1**	**2**	**7**	**1**	**4**	**5**
EAST ASIA (5)	**4**	**1**	**–**	**5**	**–**	**–**	**3**	**2**	**–**	**5**	**–**	**–**	**1**	**–**	**4**	**–**	**–**	**5**	**–**	**–**	**5**	**–**	**–**	**5**
WEST ASIA (9)	**8**	**–**	**–**	**8**	**–**	**–**	**9**	**–**	**–**	**6**	**–**	**1**	**9**	**–**	**–**	**–**	**–**	**9**	**–**	**–**	**9**	**–**	**–**	**9**

a: National programme in place & operational
b: National programme being established
c: National programme not established

* Diagnostic radiology
** Radiotherapy
*** Nuclear medicine

*

[2] Estimation based on the currently available information.

Activities related to milestone 1 (*Table 4*) were implemented with varying degrees of success. At present:

- more than 71% have promulgated laws;
- about 75% have a established a regulatory authority;
- nearly 46% have adopted regulations; and
- more than 42% have an operational system of notification, authorization and control of radiation sources.

On the basis of the above figures, it can be concluded that about 42% have achieved the level of compliance presumed in the Preamble to the BSS by completing all activities foreseen under milestone 1. This level of achievement is much lower than originally expected for five years of implementation. In fact, the time necessary to overcome some of the difficulties already identified at the time of project preparation was underestimated. The reasons for not meeting milestone 1 include time-consuming legislative procedures; unfocused regulatory structure (overlapping responsibilities); limited regulatory independence and empowerment; inadequate supplementary documentation (implementing regulations, authorization and inspection procedures and regulatory guides); insufficient financial and technical resources, trained staff and support services (e.g. individual monitoring); and incomplete and unclear registry of radiation practices and sources.

In order to further expedite the implementation of the Model Project, activities related to other milestones, particularly milestone 2, were initiated despite the fact that in many participating countries milestone 1 had not been attained.

Activities of milestones 2–5 (*Table 5*) can be summarized as follows:

- programmes for occupational exposure control (milestone 2) have been successfully implemented in many participating countries, with 70% having individual monitoring and about 54% having workplace monitoring established and operational; and
- substantial parts of activities relating to milestones 3–5 have yet to be implemented by most of the countries (it should be noted that the numbers given in *Table 5* for these milestones are indicative and can only be validated when the system for regulatory control of radiation sources is fully operational).

In addition to continuous monitoring of project activities, annual appraisal meetings and seminars have been organized in each of the five regions. These seminars have provided opportunities for direct contact with persons with political responsibilities (ministers, deputy ministers, members of parliament, permanent secretaries, etc.) and executive responsibilities (chairmen of atomic energy commissions, directors of regulatory bodies, project counterparts, etc.) in their countries.

Progress has also been evaluated through peer review teams sent to 29 of the participating countries. Each team, consisting of two IAEA staff members and one or two external consultants, provided an independent assessment of the project achievements. The main emphasis was on evaluating the adequacy of the regulatory infrastructures in the countries visited.

Lastly, the establishment of adequate infrastructure requires the provision of equipment and a total of about US $6 million worth of radiation detection and measuring instrumentation: dosimeters; complete dosimetry systems; counting equipment for alpha, beta and gamma analysis to more sophisticated spectrometry analysis; and accessory equipment was provided to the participating countries during these five years. This sum should be added to an equivalent amount provided earlier under individual national projects.

OVERALL ASSESSMENT

Progress has been made in upgrading the radiation protection infrastructure in participating countries, especially the regulatory framework, including systems for notification, authorization and control of radiation sources, and for occupational exposure control. In the light of the results achieved, participating countries can be divided into three groups:

(a) *Countries advanced in project implementation,* which have attained milestones 1 and 2 and are implementing activities relating to other milestones.

(b) *Countries where there have been some implementation delays* due to budgetary and/or organizational constraints. These countries need to revise existing legislation and restructure existing radiation protection systems. There are indications that the national authorities concerned have become more committed, and that steps have been taken to expedite project implementation. If present trends continue, and there are no serious unforeseen delays, these countries should be able to report substantial progress in meeting the requirements of the BSS in less than one year.

(c) *Countries where there have been major implementation delays* as a result of difficulties due to institutional instability, severe general infrastructural weaknesses, inadequate support at the decision making level, changes in national development programme priorities, inability to recognize the magnitude of certain problems, and failure to mobilize the necessary resources. These countries have not achieved even milestone 1.

With still several countries notably far away from milestones 1 and 2 requirements, preconditions for further assistance to national projects involving ionizing radiation were established in December 1999 by the Board of Governors of the IAEA. [2] Hence, requests for national projects involving radiation sources would not be submitted for Board approval until these two milestones were met. In addition, it was proposed that a) specific assistance packages that would meet particular needs, such as needs for training and equipment, be made available, and b) the implementation approach be adopted for future follow-up projects on radiation and waste safety carried out by the IAEA.

FUTURE ACTIVITIES

From the above assessment it is evident that the upgrading of the radiation protection capabilities achieved — although significant — is still not sufficient in many cases and needs to be further developed. Moreover, it has become clear that there are a number of other countries which have not participated in the project and where the existing radiation protection infrastructure is also inadequate. Hence, it was decided to continue this effort on a regional basis through two new projects with a four-year duration each.

The first, directed towards the establishment of an adequate and effective regulatory mechanism for the control of radiation sources, will focus on the achievement of milestones 1 and 2.The second will be directed at building sufficient capabilities for a sustainable radiation safety infrastructure, and will therefore focus on medical and public exposure control and the establishment of a national system for preparedness and response to radiological emergencies (milestones 3, 4 and 5).

The estimated budget for these additional four years is about US $29 million. Human resource development, and technical and operational capacities are the dominant elements. Adding the activities already implemented in the present project (1996–2000) to those planned for 2001–2004, they will amount to nine years of intensive work at a total cost of US $42 million. This is by far the largest and most complex technical co-operation project ever implemented by the IAEA. The challenges are manifold. The successful implementation of these projects in the five geographic regions (Africa, East Asia, Europe, Latin America and West Asia) should considerably improve the level of compliance to the BSS of Member States of the IAEA.

Radiation protection activities, however, cannot be seen in isolation. Hence, for the next four years the implementation of a sister project, dedicated to the management of low and intermediate level radioactive waste arising from the applications of nuclear techniques, will be brought closer, in a complementary way. The objective of this sister project (Sustainable Technologies for Managing Radioactive Wastes – INT/4/131) is to advise on and assist with the collection and conditioning of spent radiation sources, especially ^{226}Ra sources, and the transfer of know-how and technology to waste management operators on the preparations for disposal of low and intermediate level waste (LILW), with emphasis on waste from non-power sources. Further, the project aims at assisting in establishing facilities for the long term storage of radioactive waste, in particular spent radiation sources and brachytherapy sources; assisting in establishing centralized waste management facilities, where waste from multiple users can be collected, conditioned and stored for an interim period; and advising on the development and preparation of reference designs of LILW near-surface disposal facilities.

During 1997–2000 a total of 51 countries benefited from this waste management project (INT/4/131). It demonstrated that for countries with small quantities of spent sources or contaminated materials from past activities, transfer of technology results in a safe pre-disposal waste management solution. In countries that have a small but continual acumulation of radioactive waste, which is the case in most developing countries, the project should lead to a sustainable national capability. In countries that produce more significant amounts of waste on a regular basis (countries with nuclear research centres), the project will help with the planning of national strategy, the prioritization of resource use and the planning of centralized waste management and near surface disposal facilities.

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EUROPEAN DIMENSION OF THE IMPLEMENTATION OF THE IAEA TC MODEL PROJECT "UPGRADING RADIATION PROTECTION INFRASTRUCTURE"

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Abstract. A comprehensive evaluation carried out by the IAEA during the period 1984–1995 showed that eleven countries in Europe — Albania, Armenia, Belarus, Bosnia and Herzegovina, Cyprus, Estonia, Georgia, Latvia, Lithuania, the Republic of Moldova, The Former Yugoslav Republic (TFYR) of Macedonia — did not have a satisfactory system for radiation protection and the safety of radiation sources in accordance with the recommended international requirements. During the past four years, these countries have been participating in a Model Project aimed at upgrading radiation protection infrastructure in the Europe region with special emphasis on the establishment of an effective legal framework for adequate regulatory control of radiation sources and facilities. This paper analyses the results accomplished in the implementation of this project. It presents the main objectives, based on the present achievements for a follow-up programme to be carried out in participating and also in some other Member States with insufficient national infrastructures for assuring adequate safety in nuclear and radiation technologies.

INTRODUCTION

More than 15 years ago, the IAEA systematically began to collect and analyse available information on national systems for controlling radiation sources and associated exposure involving workers, patients and members of the general public. For more than a decade, extensive data were assembled. This data reflected major weaknesses and insufficient regulatory control in more than 50 countries worldwide. These included 11 countries in Central and Eastern Europe where, for different reasons, the situation was found to be inadequate as to compliance with recognized international standards governing protection against harmful effects of ionizing radiation and the safety of radiation sources. Therefore, a TC model project to upgrade radiation and waste safety infrastructure was initiated in 1994.
The main objective of the project was to assist the selected Member States to adopt and introduce relevant measures to comply with the International Basic Safety Standards (BSS) [INT96] and other relevant IAEA recommendations regarding radiation and nuclear safety [GON98]. The specifically oriented workplans addressing the countries' needs and priorities were prepared and approved by the IAEA and all participating countries.

These agreements between the representatives of the IAEA and the counterparts from individual participating Member States, both accepting clearly specified commitments, were signed during the period 1995–1997:

Albania (24 May 1995), Armenia (30 January 1996), Belarus (29 August 1996), Bosnia and Herzegovina (18 July 1996), Cyprus (5 September 1996), Estonia (4 April 1996), Georgia (17 April 1997), Latvia (7 March 1996), Lithuania (25 March 1996), Republic of Moldova (18 June 1996) and TFYR Macedonia (3 June 1996).

CHARACTERISTICS OF PARTICIPATING COUNTRIES

Although each of the considered countries has some specific features, there are some common characteristics, according to which these countries can be divided into four groups: 1. The countries of the former USSR (Armenia, Belarus, Estonia, Georgia, Latvia, Lithuania, and Republic of Moldova), 2. The countries of the former Yugoslavia (Bosnia and Herzegovina, and TFYR Macedonia), 3. Albania (isolated from outside world for many years), and 4. Cyprus (with a completely different system and structure). This is why in implementing some specific tasks, in various countries, different approaches have to be applied. In sending experts, facilitating fellowships and scientific visits, organizing seminars, on-the-job training and scientific visits, local conditions and also means of communication where knowledge of language plays an important role had to be considered.

In all of these countries, regulatory control was entirely within the ministries responsible for health care or welfare. Such supervisory arrangements could not be assumed to be independent of the users of radiation sources or those involved in the promotion and development of the practices being regulated.

The implementation of workplans addressing the needs and priorities of the countries was negatively affected by political instability, economic difficulties, problems encountered during the transition from a centrally controlled to a market oriented economy and also by wars, civil unrest and other real or fictitious divisions in the countries concerned. In many cases, this resulted in some delays in adopting legislation and weakened commitments in completing some other tasks.

OVERVIEW OF RADIATION SOURCES USED

Except for two countries, Armenia and Lithuania, the countries in question do not operate NPPs, but some of them used to utilise research reactors that are now closed and undergoing decommissioning procedures (Belarus, Georgia, Latvia). The infrastructure for complex nuclear fuel cycle, reactor and waste management operations has not been addressed under the Model Project RER/9/056. These issues have been covered by other TC regional and national projects. Attention was primarily focused on infrastructure concerned with protection and safety for radiation sources used in medicine, industry, agriculture, research and education. A vast majority of sources in these countries can be found in the medical field, which is responsible for more than 95% of the total population exposure due to practices involving man-made sources.

A brief summary of the most significant sources is given in Table 1, which demonstrates the size and scope of activities involving nuclear techniques in individual countries. Some of the numbers regarding the sources may be misleading, because they do not always differentiate between the sources according to their significance.

Although there are big differences in the amount and variety of radiation sources between individual countries, all countries need some minimum mechanisms to control them. On the other hand, to supervise more sources and practices requires more regulatory authority personnel for the evaluation of authorization applications of sources and for their inspections.

One of the first tasks of implementation was the establishment of an inventory or registry of radiation sources and facilities. Without a reliable record of the sources, it would be impossible to ensure their trustworthy control. In order to have an efficient tool to create as complete a registry as possible, a Regulatory Authority Information System (RAIS) has been developed by the IAEA.

Table 1. Overview of the most relevant radiation sources in participating countries.

Country	Sources and facilities
Albania	2 industrial irradiators, 4 non-medical electron accelerators, 2 neutron generators, 4 Am-Be neutron sources, 4 ind. radiography sources (3 X-ray units), 2 Co-60 therapy units (one not in use), 20 brachytherapy sources, 420 diagnostic X-ray units (including 100 dental), 1 nuclear medicine department, 2 RIA labs, more than 50 sources used in industry (problems with the sources in the abandoned enterprises and factories), 30 in research and education, some military sources
Armenia	1NPP (two WWER units, 1 in operation 376 MW_e , 1 cool shutdown), 7 linacs (Yerevan University), 42 ind. radiography X-ray units, 3 Co-60 therapy units, 36 brachytherapy sources, 590 diagnostic X-ray units (including 125 dental), 10 nuclear medicine laboratories, 380 industrial sources, 630 research and education, total number of sources estimated 1700
Belarus	19 different accelerators, 12 gamma irradiators, 5 neutron generators, 400 industrial radiography sources (incl. 200 gamma sources, 200 X-ray units), 3 medical linacs and 1 microtron, 26 Co-60 therapy units, more than 50 brachytherapy sources, 2900 diagnostic X-ray units (including 400 dental), 32 nuclear medicine facilities, more than 8600 industrial gages, 600 in research and education, 43 000 smoke detectors, total number of sources estimated 55 100
Bosnia and Herzegovina	9 industrial radiography sources (5 gamma sources, 4 X-ray units), 2 Co-60 therapy units and 1 linacs, more than 100 brachytherapy sources, 250 diagnostic X-ray units (including 70 dental), 4 nuclear medicine departments, 250 lightning rods, about 25000 smoke detectors, about 20 sources in research and education, about 95 industrial gauges
Cyprus	1 irradiator, 8 industrial radiography sources (3 gamma sources, 5 X-ray units), 3 Co-60 therapy units and 2 linacs, more than 100 brachytherapy sources, 290 diagnostic X-ray units (including 140 dental), 3 nuclear medicine departments, more than 40 industrial gauges, about 20 sources in research and education, about 50 lightning rods (most of them dismantled and stored)
Estonia	1 irradiators, 1 nuclear reactor (under decommissioning), 50 industrial radiography sources, 3 Co-60 therapy units and 2 linacs, 60 brachytherapy sources, 590 diagnostic X-ray units (including 300 dental), 3 nuclear medicine departments, more than 700 sources used in industry, 70 sources in research and education, 3500 smoke detectors, total number of sources 6600 (total activity 50 kCi)
Georgia	1 research nuclear reactor (IRT-2M), 3 irradiators, 1 neutron generator, 3 Co-60 therapy unit, about 20 brachytherapy sources, 450 diagnostic X-ray units (including 150 dental), 2 nuclear medicine departments, more than 1200 sources used in industry, 330 in research, 30 in education, 30 in geology, 11 X-ray machines at airports, more than 20 lost and abandoned some military and other sources have recently been found (incl. 10 Cs-137 sources found at Lilo military base as well as 6 radionuclide-based electric power generators using Sr-90 with activities 30 to 100 kCi , total number of sources estimated more than 2200
Latvia	1 research reactor (shut-down), 1 irradiator (Co-60), 6 research linacs, 32 radiography sources (28 X-ray units), 1 neutron generator, 25 neutron sources, 4 Co-60 therapy units and 5 linacs, 60 brachytherapy sources, 800 diagnostic X-ray units (including 240 dental), 3 nuclear medicine departments, more than 3000 small sources used in industry, research and education, 12 000 smoke detectors
Lithuania	1NPP (two RBMK units, 2370 MW_e), 130 industrial radiography sources (incl. 105 X-ray units), 8 Co-60 therapy units and 2 linacs, 75 brachytherapy sources, 1330 diagnostic X-ray units (including 400 dental), 10 nuclear medicine departments (2 with therapy applications), more than 10000 sources used in industry, 560 in research and education, 25000 smoke detectors, more than 7000 other sealed and about 150 unsealed as well as 75 X-ray machines, total number of sources estimated 40 300
Republic of Moldova	3 irradiators, 1 accelerator, 28 industrial radiography sources, 2 Co-60 therapy units, 40 brachytherapy sources, 1100 diagnostic X-ray units (including 190 dental and 22 therapy units), 3 nuclear medicine departments, more than 1000 sources used in industry, agriculture, research and education, 4300 smoke detectors, total number of sources estimated 7500
TFYR Macedonia	20 industrial radiography sources, 1 medical linac, 1 Co-60 therapy unit, 20 brachytherapy sources, 320 diagnostic X-ray units (including 100 dental), 2 nuclear medicine departments, more than 50 sources used in industry, research and education, 234 lightning rods, 30 000 smoke detectors

This computerized information system enables the regulatory authority not only to keep and update an inventory of radiation sources but also to keep track of the authorization process, inspection and follow-up actions, and assessment of effectiveness by means of performance indicators [RAI99].

The RAIS was originally introduced in English and later translated and modified for use in Russian and other languages. Two regional training courses were organized for the RAIS administrators where the system was demonstrated and its use practised. Comments from the users were collected and are being used to improve the operational performance of the software.

PROBLEMS AND SOLUTIONS

The initial stage of implementation began with the preparation of workplans where all relevant tasks including the commitments of counterparts were reflected. These plans were aimed at the following issues: 1. Legislation and regulations; 2. Establishment of regulatory authority; 3. System of notification, authorization, inspection and enforcement; 4. Occupational exposure control; 5. Medical exposure control; 6. Public exposure control; 7. Preparedness and response to radiological emergencies; 8. Radioactive waste management; 9. Human resources development (selection and training of personnel); and 10. Technical support services (monitoring, calibration, maintenance).

In facilitating the fulfilment of these tasks, a number of activities were carried out in assisting Member States (in close co-operation with NSRW and other technical divisions of the IAEA) during the last three years:

- 114 external expert missions and Regional Manager missions (1998: 26 and 15; 1999: 18 and 11; 2000: 15 and 9, respectively), good results were obtained using specialists from the region as well as IAEA experts (6);
- 50 fellowships and scientific visits (22 and 28, respectively); it was a problem to place more fellows and visitors in western countries because of the language barrier and the unwillingness of some institutions to accept persons for training; another obstacle was related to a relatively high turnover of personnel (although increased attention was paid to the selection of candidates, many trained persons left their jobs, mainly for financial reasons);
- more than 160 instruments, electronic personal dosimeters and radiation monitors mainly for inspections, QC and individual and workplace monitoring (including an advanced TLD reader for each participating country);
- more than 800 persons trained in regional, subregional and national training courses (some information for the last three years in Table 2) addressing such issues as legislation and organizational aspects of regulatory control of radiation sources; harmonization of national radiation protection framework with IAEA and other internationally accepted requirements; inventory of radiation sources using the RAIS; system of notification, authorization, inspection and enforcement; individual dosimetry; discharge control and environmental monitoring; calibration of dosimeters and radiation monitors; radioactive waste management; and a number of courses on radiation protection in medicine and industry; two nine-week Basic Radiation Protection Training Courses (one in English and one in Russian organized in 1997 and 1999, respectively) have had significant impacts;

- more than 550 IAEA and other sets of materials, including electronic versions of the BSS and many TECDOCs, and RAIS software and manuals were sent to counterparts, handed out at training courses and distributed by the Regional Manager;
- preparation of a number of technical documents and regulatory guides (e.g. Assessment by Peer Review of the Effectiveness of Regulatory Programme for Radiation Safety, Safety Assessment Plans for Authorization and Inspection of Radiation Sources, Radiation Safety in Diagnostic Radiology, Radiation Safety in Radiotherapy, Radiation Safety in Nuclear Medicine, Radiation Safety in Industrial Radiography) — the cost was shared with the other three regional Model Projects; and
- assistance in translating some important regulatory documents into Russian and other languages.

Table 2. Training courses during past three years: regional, subregional, national

Training course and number of participants	1998	1999	2000
Regional — addressing selected issues	3	4	4
Regional — basic radiation protection course	–	1	–
Subregional	1	1	1
National	4	6	9
Workshop (for decision makers)	1	–	1
Total number of participants	185	250	320

In drafting and preparing legal documents, the IAEA sample law and regulations [ORG96] were used as guidance to countries to incorporate the BSS into their legislation.

Problems arose from the poor economic situation and insufficient local commitment in many participating countries. Most countries in the region typically have a high staff turnover staff (many leave the job after having received special training). A great number of radiation sources used in failing industry are abandoned or lost; similar fates befall some sources in areas affected by military operations or civil disturbances. A vast majority of facilities with intensive sources, such as research reactors, irradiators and accelerators, are no longer in operation and are going through decommissioning processes in which there is a lack of know-how. Moreover, because of some administrative restrictions (originally aimed at reducing bureaucracy), it has not been easy to form new governmental bodies or agencies, making the establishment of a new single regulatory authority very difficult and time consuming. Also, the promulgation of laws and adoption of other documents (including regulations) has been lengthy and tedious due to the congestion of legislators and also due to the fact that government was busy with other urgent issues directly related to the transformation from a centrally planned economy to a decentralized market system (in some countries the interest in harmonizing their legislation with that of the EU has compensated for this factor to a certain extent).

PRESENT SITUATION AND ACHIEVEMENTS

Due to different initial conditions, available human and economic resources, political instability, local commitment and dissimilarities in general safety culture, the countries have been progressing in the implementation of the project at different rates. The present situation is illustrated in Table 3 where points relating to laws, regulations, the regulatory authority, the system for individual monitoring, and the number of radiation workers monitored are compared.

As regards the law, nine countries have promulgated a basic legislation compatible with the BSS, two countries (Cyprus, TFYR Macedonia) are in the process of adopting such laws within the next few months. In some countries, more than one law concerning radiation protection has been introduced (Belarus, Lithuania), while in a few countries, the existing laws will be modified or amended soon in order to improve the status of the regulatory authority (Armenia, Georgia, Latvia, Rep. of Moldova). The quality of adopted laws differs: some laws are unnecessarily detailed (Cyprus); some, after consultations with the IAEA, have been changed in parliament mainly in order to incorporate them into a specific national legal environment (Bosnia and Herzegovina, Cyprus, TFYR Macedonia).

The degree of independence of the regulatory authority is another criterion on for evaluating the radiation protection infrastructure. In five countries (Estonia, Belarus, Latvia, Republic of Moldova) regulatory control is effectively independent although in some cases (Belarus, Latvia, Republic of Moldova) the Ministry of Health is still partly involved in this control. There are also cases where the regulatory authority is attached to the Ministry of Health (Albania, Lithuania) but in these cases legal mechanisms exist to ensure effective independence of the regulatory authority function. Some steps have already been taken to eliminate the regulatory involvement of the Ministry of Health (Armenia, Cyprus, Georgia, Latvia, TFYR Macedonia). The situation will also change soon in Republic of Moldova where three elements of the present regulatory authority will merge to form a single national competent body under the office of the Prime Minister. The newly established Regulatory Authority in Bosnia and Herzegovina has a special feature: positioned at the Ministry of Health of the Federation of Bosnia and Herzegovina, its regulatory control is limited to the Federation, which means that the other entity — Republika Srpska — is, so far, not in direct contact with the IAEA and apparently without any adequate regulatory procedures.

The number of staff at a regulatory authority also varies from one country to another. The comparison is distorted by the fact that some inspectors are entrusted with other duties not directly related to the control of radiation sources (controlling other pollutants, engaged in supporting services, etc.). It is recognized that a certain minimum number of personnel is required in order to cope with regulatory tasks. In a number of cases, regulatory authorities are actively involved in providing supporting services, e.g. individual monitoring (Estonia, Lithuania, Rep. of Moldova), which in principle can be carried out by outside authorized laboratories.

A system of notification, authorization, inspection and enforcement has been introduced in six countries (Albania, Belarus, Estonia, Latvia, Lithuania, Republic of Moldova) while in the remaining countries some visible progress has recently been noted.

As far as occupational exposure control is concerned, seven countries have fully implemented individual monitoring and four (Armenia, Bosnia and Herzegovina, Georgia and TFYR Macedonia) are partially operational. Workplace monitoring, where objectives cannot be defined so unequivocally, still needs some improvement.

Table 3. The present status in accomplishing main tasks of Milestones 1 and 2

Country	Laws	Regulations	Regulatory Authority	Individual monitoring	Tot.(mon.) workers
Albania	Law on Ionizing Radiation Protection (1995)	Licensing and inspection of nucl. installations, Safe handling of radioactive materials	Radiation Protection Commission (Ministry of Health and representatives of other ministries and institutions); grossly understaffed	TLD Bicron fully operational	620 (200)
Armenia	Law on Safe Utilization of Atomic Energy for Peaceful Purposes (1999), 2 other laws	Sanitary protection of the population (1997?) and 10 other sanitary rules and norms	Armenian Nuclear Regulatory Authority (1993) & Dept. of Hygiene and Radiation Control (Ministry of Health)	TLD Bicron partially operational	1500-800 at NPP (800+450)
Belarus	Law on Radiation Safety of the Population (1998), Law on the Use of Nucl. Energy and rad. prot. (2000)	Regulations on radiation-hygienic passports (1999), Radiation safety standards (2000), 3 other regulations	PROMATOMNADZOR (State Committee. for Supervision of Industrial and Nuclear Safety) & Rep. Centre of Hygiene and Epidem. (Ministry of Health)	TLD Bicron fully operational	7500 (3800)
Bosnia and Herzegovina	Law on Radiation Protection and Safety (1999)	Basic radiation protection regulations rafted	Federal Administration for Radiation Protection and Radiation Safety (Ministry of Health of the Federation of Bosnia and Herzegovina	TLD Bicron partially operational	600 (480)
Cyprus	Ionizing Radiation Protection Law (under promulgation)	Ionizing protection regulations, radiation protection in medicine, radioactive waste management, transport of dangerous goods - being drafted	Department of Labour (Ministry of Labour and Social Insurance)	TLD Bicron fully operational	350 (350)
Estonia	Radiation Protection Act (1997)	Procedures for issuing licenses (1997), Radioactive waste management (1998), Transport of radioactive material (2000), 25 other regulations	Estonian Radiation Protection Centre (Ministry of Environment) in 1996	TLD RADOS fully operational	880 (880)
Georgia	Law on Nuclear and Radiation Protection (1999)	Regulations on licensing and inspection, and on radwaste - being drafted	Nuclear and Radiation Safety Service (Ministry of Environment) in 1999	TLD Bicron partially operational	250
Latvia	Law on Radiation and Nuclear Safety (1994, amended 1997, 2000)	Regulations on protection against ion. radiation (1997, 1998), regulations on licenses (1996), regulations on safe transport (1998), and 5 other regulations	Radiat. and Nuclear Safety Inspectorate (Ministry of Env. Protection and Regional Development & Ministry of Health), a single RA – Radiation Safety Centre – to be established in 2001	TLD RADOS fully operational	1200 (1200)
Lithuania	Law on Nucl. Energy (1996, amended 1999), Law on Radiation Protection (amended 1999)	Basic radiation prot. standards (1998), more than 25 Hygiene Standards and Orders	Radiation Protection Centre (Ministry of Health Care)	TLD RADOS fully operational	6800 (3000 at NPP)

Republic of Moldova	Law on Radiation Safety and Prot. (1997), Law on Licensing (1999)	Transport of dangerous goods (1994), Reg. on radiation safety and protection (1998), 6 other regulations	Nat. Sci. and Applied Centre of Prev. Medicine (MH) & Dept. of Standards, Metrology and Technical Supervision & Dept. of Civil Protection and Emergencies	TLD Bicron fully operational	1230 (950)
TFYR of Macedonia	Law on Radiation Protection (in the promulgation process)	Being drafted	Institute of Public Health (Ministry of Health); in accordance with a new law Radiation Safety Directorate	TLD Bicron partially operational	950 (950)

In medical exposure control, attention has been directed mainly towards upgrading safety in radiotherapy where most countries were able to meet basic requirements. Progress has also been made in the use of radiation and radionuclides in medicine (diagnostic radiology and nuclear medicine). However, there are still many uncompleted tasks, mainly in adopting national programmes aimed at patient dose reduction based on internationally agreed QC procedures.

The impact of the Model Project was evaluated on a number of occasions and particularly at the December meeting of the Board of Governors in 1999 [GOV99] and by Peer Review Mission teams (three missions to Cyprus, Belarus and Republic of Moldova in 1999, four missions to Albania, Estonia, Latvia and Lithuania in 2000).

Further details and a general overview of the radiation protection situation regarding the implementation of the Model Project RER/9/056 in medical exposure control, public exposure control and preparedness to radiological emergencies in all regions are presented in other reports. [BAR99, BAR00]

A FOLLOW-UP OF ACTIVITIES IN FURTHER STRENGTHENING AND DEVELOPING OF RADIATION PROTECTION INFRASTRUCTURE

In order to complete the outstanding tasks and to make the regulatory structure fully operational in the countries which participated in the Model Project RER/9/056, and to assist other Member States in the region to achieve an adequate level of regulatory control of radiation sources, two new Model Projects have been proposed and approved for the next cycle of the IAEA TC programme.

The first project, RER/9/062 “National Regulatory Control and Occupational Radiation Protection Programmes”, addresses issues mainly related to the establishment of legal framework and upgrading occupational exposure control. In addition to some countries which participated in the present Model Project RER/9/056 (Armenia, Bosnia and Herzegovina, Cyprus, Georgia, TFYR Macedonia), other countries have expressed their interest in using this project as a vehicle to enable them to fully meet the BSS and thus also EU requirements.
The second project, RER/9/065 “Development of Technical Capabilities for Sustainable Radiation and Waste Safety Infrastructure” will focus on medical exposure control and public exposure control, including radioactive waste management, discharge control and environmental monitoring and on preparedness and response to radiological emergencies. It is anticipated that that a number of other countries will also participate in this new project.

Regarding future TC programmes in radiation protection, it has to be emphasized that the two new projects account for most regional activities in this field. The proposed projects reflect the needs of the Member States related to radiation safety as expressed in their requests for specific national projects that consequently were incorporated into these model projects.

CONCLUSION

All the countries participating in Model Project RER/9/056 had one thing in common: initially their radiation protection infrastructure was considered insufficient to ensure adequate regulatory control of radiation sources. At present, nine of eleven countries have been able to promulgate legislation based on the BSS requirements and to establish a regulatory authority. Seven countries adopted various radiation protection regulations compatible with IAEA recommendations. All eleven countries were provided with sophisticated TLD systems, which have created a solid base for reliable individual monitoring. Significant progress in terms of specific training, upgrading QA/QC and formulation of national programmes has also been made in other areas, particularly in medical and public exposure control. Representatives of participating countries have expressed the opinion many times that without IAEA assistance, they would not have been able to reach the present level of regulatory infrastructure.

Taking into account the positive outcome of the model project, most recipient countries consider the two new Model Projects (RER/9/62 and RER/9/65) addressing specific radiation protection infrastructure issues as high priority.

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REGULATORY INFRASTRUCTURE FOR THE CONTROL OF RADIATION SOURCES IN THE AFRICA REGION: STATUS, NEEDS AND PROGRAMMES

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Abstract. In recent years, several African countries have taken steps towards creating or strengthening legal, administrative and technical mechanisms for the regulation and control of peaceful uses of nuclear technology, and towards improving the effectiveness and sustainability of radiation protection measures based on international standards. This stems from a growing awareness that a proper national infrastructure is a prerequisite for the implementation of safety standards to achieve and maintain the desired level of protection and safety, particularly in such sectors as public health and industry. Also, other issues of global and regional interest, such as the control of radiation sources, including the handling of hazardous waste, and response capabilities in the case of a radiological emergency, have contributed to a better perception of risks associated with deficiencies in or lack of adequate national radiation protection control mechanisms. Too often, however, this awareness has not been matched with adequate progress in the establishment of a regulatory framework for the control of radiation sources.
This paper presents a summary of the current status of radiation protection infrastructure in all African Member States. On a background of still existing weaknesses and challenges, an overview of the Agency's response to assistance needs and programmes in this field is discussed.

INTRODUCTION

In recent years, several African countries have taken steps towards creating or strengthening legal, administrative and technical mechanisms for the regulation and control of peaceful uses of nuclear technology, and towards improving the effectiveness and sustainability of radiation protection measures based on international standards. This stems from a growing awareness that a proper national infrastructure is a prerequisite for the implementation of safety standards which can help in achieving and maintaining the desired level of protection and safety, particularly in such sectors as public health and industry. Other issues of global and regional interest, such as the control of radiation sources, including the handling of hazardous waste, and response capabilities in the case of a radiological emergency, have also contributed to a better perception of risks associated with deficiencies in or lack of adequate national radiation protection control mechanisms.

Over the years, authorities in many African countries have demonstrated their increased awareness of the benefits that can be derived from international co-operation and harmonization in this field. The International Atomic Energy Agency has played a key role in this process, notably through its programmatic activities aimed at setting forth and developing international safety standards, and through its technical co-operation programme designed, among other things, to assist Member States in establishing and upgrading their radiation protection infrastructure in compliance with these standards.

EXTENT OF RADIATION PRACTICES

For over 20 years, many African countries have been implementing national programmes for peaceful uses of atomic energy in medicine, industry, agriculture, hydrology and research. Specifically, noticeable progress has been reported in the application of radiation producing machines, radiation processing and the use of radiation sources for everyday practices in the region. In spite of persistent economic problems and budgetary constraints, at times coupled with political instability and local hostilities in some countries, there has been steady development in the transfer of nuclear technology and the introduction of modern techniques based on the use of ionizing radiation. Even though an inventory of all radiation sources and radiation generating machines used in the African Member States is still too sketchy, and for many countries incomplete, the available data and information provide some indication on the trends and measures of development.

In the field of nuclear technology, today there are:

- nine multipurpose irradiation facilities for sterile insect technique (SIT), food irradiation and/or product sterilization;
- about 20 linear accelerators;
- about seven neutron generators;
- over 100 teletherapy units;
- several thousand X-ray units for diagnostic radiology;
- more than 200 brachytherapy units;
- several thousand industrial radiography projectors; and
- several thousand nuclear gauges and other instruments based on ionizing radiation.

Many of these facilities, installations and instruments have been provided through IAEA assisted technical co-operation projects. Although there is evidence that radiation protection, safety of installations and safety practices in managing radioactive waste have improved in many African states, there is still a need for an internationally harmonized and co-ordinated effort to assist in this process.

Table 1 presents a qualitative overview of peaceful uses of atomic energy and radiation sources in the region.

OVERVIEW OF ASSISTANCE PROGRAMMES

Past Assistance

The IAEA's assistance to African Member States in radiation and waste safety dates back to the seventies when several countries embarked on programmes for peaceful uses of atomic energy. The programmes were aimed at establishing the necessary infrastructure to enable the use of ionizing radiation and radiation sources for socioeconomic development. The IAEA's technical co-operation programme has been delivered through national, regional or interregional projects involving, in general, expert services and assistance in the provision of training and equipment.

TABLE 1

MAJOR NUCLEAR FACILITIES, INSTALLATIONS AND RADIATION SOURCES IN AFRICAN MEMBER STATES

Member State \ Type of Radiation Source	Power reactor	Research reactor	Mining and milling	Accelerator	Neutron generator	Neutron source (Am-Be…)	Large irradiation source	Teletherapy	Brachytherapy	Industrial radiography	Nuclear gauge	Large calibration source	Radwaste storage	Radwaste final deposition	Sites
ALGERIA	-	+	+	+	+	+	+	+	+	+	+	+	+	-	Phosphate mines
ANGOLA	-	-	+	-	-	-	-	+	-	+	-	-	-	-	Gold mines
BENIN	-	-	-	-	-	na	-	na	na	na	na	-	-	-	
BURKINA FASO	-	-	-	-	-	-	-	-	-	na	na	-	-	-	
CAMEROON	-	-	-	-	-	-	-	+	-	+	+	-	-	-	
CONGO, Rep. Dem. of	-	+	+	-	-	+	-	+	+	+	+	-	+	-	Cu/Au mines
COTE d'IVOIRE	-	-	-	-	-	-	-	+	+	+	+	-	+	-	
EGYPT	-	+	-	+	+	+	+	+	+	+	+	+	+	-	
ETHIOPIA	-	-	-	-	-	-	+	+	+	+	+	+	-	-	
GABON	-	-	+	-	-	+	-	+	-	+	+	-	-	-	Uranium mines
GHANA	-	+	+	+	+	+	+	+	+	+	+	+	+	-	Gold mines
KENYA	-	-	-	+	-	+	-	+	+	+	+	+	-	-	
LIBERIA	-	-	na	-	-	na	-	na	na	na	na	-	-	-	
LIBYAN A.J.	-	+	-	+	+	+	-	+	+	+	+	+	+	-	
MADAGASCAR	-	-	-	-	-	+	-	+	+	+	+	+	+	-	
MALI	-	-	-	-	-	-	-	-	-	+	+	-	-	-	
MAURITIUS	-	-	-	+	-	-	+	+	+	+	+	-	+	-	
MOROCCO	-	-	+	+	+	+	+	+	+	+	+	+	+	-	Phosphate mines
NAMIBIA	-	-	+	-	-	+	-	-	+	+	+	-	-	-	Uranium mine
NIGER	-	-	+	-	-	-	-	+	-	+	+	-	-	-	Uranium mines
NIGERIA	-	(+)	-	(+)	+	+	-	+	+	+	+	+	-	-	
SENEGAL	-	-	-	-	-	+	-	+	+	+	+	-	-	-	
SIERRA LEONE	-	-	-	-	-	na	-	-	-	na	na	-	-	-	
SOUTH AFRICA	+	+	+	+	+	+	+	+	+	+	+	+	+	+	Gold mines
SUDAN	-	-	+	+	+	+	-	+	+	+	+	+	+	-	Phosphate mines
TUNISIA	-	-	-	+	-	+	+	+	+	+	+	+	-	-	Phosphate mines
UGANDA	-	-	+	-	-	-	-	+	+	+	+	-	-	-	Gold mines
U.R. TANZANIA	-	-	+	-	-	+	+	+	+	+	+	+	+	-	Phosphate mines
ZAMBIA	-	-	+	+	+	+	+	+	+	+	+	+	-	-	Cu/Co mines
ZIMBABWE	-	-	+	+	-	-	-	+	+	+	+	-	-	-	Gold mines

Significant assistance effort made by the IAEA in the past can be highlighted by such activities as:

- the RAPAT[1] programme (1984–1995) which included missions to 19 African countries;
- broadly based regional projects on radiation protection development in Africa (1988–1995), involving the participation of 24 Member States, and
- a number of national projects addressing specific priority needs in radiation protection infrastructure (e.g. training, setting up and/or upgrading radiation safety services)

Moreover, since 1990 assistance has also been provided under the African Regional Co-operative Agreement (AFRA) for research, development and training related to nuclear science and technology. The radiation protection and safety programme under AFRA initially addressed such issues as improving the capability of managing radioactive waste (1991–1996) and harmonizing environmental monitoring approaches and measuring methods (1993–1998). The current two AFRA five-year projects, which commenced in 1997, focus on the harmonization of radiation protection practices and the strengthening of waste management infrastructure in the region. AFRA, however, is not intended to create infrastructure or to establish facilities. The agreement rather aspires to build on achievements attained through national efforts and/or previous IAEA assistance.

Present Programme: Model Project

In 1994 an interregional Model Project on "Upgrading Radiation Protection Infrastructure" was included in the TC programme for that year and beyond. Seventeen African Member States[2] were invited to participate in the project which, in 1997, was transformed into five regional model projects for Africa (RAF/9/024), Europe, Latin America, East Asia and West Asia, respectively.

The establishment of the Model Project followed a review and evaluation of relevant infrastructures in the Member States concerned. It revealed that although joint effort by the governments and the IAEA contributed to an increased awareness of radiation and waste safety issues among many countries in the region, there was still considerable room for improvement in all aspects of radiation protection infrastructure, and, in general, the progress reported was not sufficient to meet the requirements of the international Basic Safety Standards (BSS). Major deficiencies included[3]:

- absence of a regulatory framework including the system for notification, authorization and the control of radiation sources;
- shortage of the necessary trained staff;
- lack of a system or severe weaknesses in the system for occupational radiation protection;
- insufficient funding; and
- inadequate level of protection and safety even in the countries with some infrastructure formally in place.

[1] RAPAT was the IAEA Radiation Protection Advisory Team, which provided — upon the request from a Member State — a comprehensive assessment of the country's radiation protection status, including the identification of relevant needs and priorities.
[2] Cameroon, Côte d'Ivoire, Dem. Republic of the Congo, Ethiopia, Gabon, Ghana, Madagascar, Mali, Mauritius, Namibia, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Uganda, Zimbabwe.
[3] "Progress Report on the Implementation of the Model Project on Upgrading Radiation Protection Infrastructure (INT/9/143), GOV/1999/67, 16 November 1999.

The goals of the project have been determined by five milestones, as defined in GOV/1999/67[4], and set to meet the requirements of the BSS. The project is based on comprehensive country-specific workplans with well-identified activities, the implementation of which is essential for the milestone to be attained. These activities are indicative of the high priority the Agency has assigned over the years to assistance in radiation protection under its technical co-operation programme. Since 1993, the overall expenditure for this assistance in Africa alone has amounted to over US $8.7 million.

REGULATORY FRAMEWORK: STATUS AND TRENDS

An overall evaluation of the regulatory infrastructure in the region is based on the IAEA guidelines[5], Model Project approach *(Milestone 1*) and factual information provided by:

- country Radiation and Waste Safety Profiles,
- questionnaires on *Radiation Protection Activities and Infrastructure*, submitted by most Member States, and
- expert reports from assignments under relevant TC projects, including the Model Project.

A distinction has been made at the following levels:

(i) Relatively comprehensive updated information is available on the 17 Member States participating in the Model Project, whereas relevant data on other Member States is still in the process of compilation and verification. The adopted evaluation criteria, however, are analogous for both groups of countries.
(ii) South Africa is the only country in the region with *Practice Group 3 uses*, as defined in the "Guidance" and is considered to have a well-developed infrastructure including the regulatory framework.
(iii) Fifteen Member States (50%) already have, or are about acquire, facilities and installations categorized as *Practice Group 2 uses*. Therefore, due to the nature of relative hazards associated with this practice group, more requirements for appropriate radiation protection infrastructure apply to these countries. The criteria, however, for the evaluation of the regulatory framework of these countries are the same as for
(iv) the remaining 15 Member States to which *Practice Group 1 uses* and associated relative hazards apply.

As stated before, in many Member States, an awareness of radiation and waste safety issues has been enhanced over the years. Too often, however, this awareness has not been matched with adequate progress in the regulatory control of radiation sources. Notwithstanding the reasons for such a situation, it should be noted that:

- infrastructure for radiation protection is largely inadequate in eight countries[6], including three Member States which joined the Agency only recently, and

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[4] *Milestone 1: The establishment of a regulatory framework. Milestone 2: The establishment of occupational radiation protection comprising individual and workplace monitoring programmes. Milestone 3:The establishment of medical exposure control.*
Milestone 4: The establishment of public exposure control. Milestone 5: The establishment of emergency preparedness and response capabilities.

[5] "Guidance for the Assessment of Radiation and Safety Infrastructures in Developing Member States and Strategies for Enhancement of Infrastructure", 1995.

[6] Angola, Benin, Burkina Faso, Gabon, Liberia, Mali, Senegal, Sierra Leone.

- in eight other countries[7], although some form of infrastructure is formally in place, the regulatory programme is still to be established or is inadequate for the types of practices used.

While 20 countries have a radiation protection law in force or are in the final stage of its promulgation, 15 of them have enacted regulations which follow the principal requirements of the international BSS. In seven other Member States the process is likely to be completed shortly. Twelve Member States have a system for notification, authorization and control of radiation sources (Milestone 1), although in most cases it has been reported, as for example in the results of project monitoring and Peer Review missions (1999–2000), that the systems have not been fully operational or are at their early stage. A positive development is that all countries in this group have progressed in the establishment of their national inventory of radiation sources using the Regulatory Authority Information System (RAIS) provided by the IAEA as software and related training, but here again, it appears that in several countries the system is not always complete or updated.

The shortage of qualified experts and trained staff required for radiation protection in general, and for the regulatory programme in particular, is still a major obstacle to attaining Milestone 1 for several countries. This is also largely due to:

- institutional instability;
- general infrastructural weaknesses;
- inadequate support at the decision-making level;
- changes in national development programme priorities;
- lack of or limited incentives for career development, resulting in a high turnover of staff already trained; and
- inability to solicit and allocate the necessary resources to recruit and retain specialists.

For many years now, the IAEA has provided a wide spectrum of education and training opportunities which has enabled African professionals to upgrade their academic background, gain expertise and develop practical skills in various areas of radiation protection. In 1999 and 2000 alone, 34 fellowships and scientific visits were awarded, and over 160 participants attended nine regional specialized training events and seminars organized under the Model Project[8]. The opening, in June 1999, of a Regional Centre for Radiation Protection Training in Johannesburg, South Africa, established with the IAEA assistance, marked a major milestone in addressing the problem of capacity building for radiation and waste safety in Africa. The two University-based regional postgraduate training courses in radiation protection held to date were successfully completed by 31 IAEA-supported students from 16 countries.

The situation in other elements of infrastructure, defined as Milestones 2, 3, 4 and 5 (ref. GOV/1999/67), is summarized below.

Occupational Radiation Protection

Significant progress can be reported in establishing a system for individual monitoring of occupationally exposed personnel, now in place in 24 countries. Thirteen of them have

[7] Cameroon, Côte d'Ivoire, Dem. Rep of the Congo, Mauritius, Niger, Nigeria, Uganda, Zimbabwe.

[8] One workshop was organized jointly with the AFRA programme.

benefited from assistance provided by the IAEA under the Model Project. There has been a steady expansion of the system, and in eight Member States the coverage of workers in this category is at about 80% or more. In seven countries, including the three new Member States, the system is still to be established[9].

Even though information on workplace monitoring is not comprehensive enough, and its verification is more complex then it is in the case of individual monitoring, in recent years a national programme in this area has been initiated in five countries participating in the Model Project [10]. In the majority of countries, however, the programme is still very limited or non-existent.

Medical Exposure Control

The lack of or very limited use of quality assurance programmes for radiation protection in medical practice is common to most countries in the region. The problem is particularly acute in diagnostic radiology in the public medical sector, where serious difficulties with the operation and maintenance of generally obsolete equipment, are increased by the shortage of qualified medical physicists and radiographers. The trend causing much concern is that the availability of qualified personnel, even in principal medical institutions, has plummeted in many countries, largely due to the progressive privatization of that sector.

With a few exceptions, the status of radiation protection in radiotherapy and nuclear medicine is rather unsatisfactory. It appears that a programme in these areas is still to be set up in the majority of countries where such services are offered or due to be established.

The need to introduce and develop a quality-based approach to radiation protection in medical practice is prevalent in practically all countries in the region, and will remain one of the great challenges in the follow-up programme to the Model Project.

Public Exposure Control

The status evaluation in this component of radiation protection infrastructure is focused primarily on radioactive waste safety. The major problem, common to many countries, is a large number of spent radium sources awaiting conditioning and disposal. For many years, the IAEA has been giving advice on how that can be done. It is recognized, however, that there are countries where technical infrastructure is not developed enough to ensure that conditioning operations be managed properly. Some nuclear medicine departments in African Member States use significant quantities of radioisotopes or radioactive labelled compounds in their routine practice. This results in radioactive waste, in the form of diluted solutions, patient excreta, liquids used for cleaning equipment, etc. In most cases, it is necessary to establish a temporary storage facility at a work place, and arrange for controlled discharges of these solutions to sewage or similar liquid waste outflow systems. In certain cases, conditioning of liquid waste prior to discharge may be necessary.

So far, progress in improving the safety of spent sources, with few exceptions, has been too slow in the region. Assistance effort to address the needs of African countries in the area of

[9] **Angola, Benin, Burkina Faso**, Gabon, Liberia, Senegal, Sierra Leone.
[10] Ethiopia, Ghana, Madagascar, Namibia, Sudan.

waste safety has been initiated under the Model Project, and is due to intensify in the years to come (ref. next section). Assistance in the technical aspects of waste management will continue to be streamlined under the AFRA regional project on Strengthening Waste Management Infrastructure[11].

The safety of radioactive waste in the form of mine tailings is still more complex. The problem applies to several Member States, particularly those with uranium or phosphate mines (ref. Table 1). Mining companies in a few countries (D.R. of the Congo, Gabon, Niger) seem to be reluctant to take responsibility for the waste they generate. In the case of redundant mines there would appear to be no easy solution as the countries generally do not have the financial resources for remedial action at mining sites.

In this regard, activities carried out by the IAEA under the regional projects include:

- the identification and assessment, with expert assistance, of hazards from naturally-occurring radionuclides, including the identification of areas of particularly heavy contamination; and
- recommendations on appropriate precautions for those living or working in or near these areas.

Planning for and Response to Radiological Emergencies

With the exception of South Africa and some, but not all, countries with operational research reactors (Algeria, Egypt, Libya) where national and facility plans for response to a nuclear or radiological emergency are in place, the current status in this area is largely inadequate. The situation is characterized by the same general problems, referred to above, affecting radiation safety infrastructure and human resource development in many countries in the region. Additionally, in most African Member States there is still insufficient awareness amongst agencies and institutions in charge of dealing with emergency situations of the organizational and technical issues involved in setting up an effective national plan in case of a radiological accident or incident. There is justified concern that, in this area, principal requirements of the international BSS are not being met and, therefore, the need to improve preparedness and make use of assistance, including training, remains urgent.

Activities have been initiated under the Model Project to set up an emergency response plan in Ghana, operating a research reactor and an irradiation facility. A similar assistance programme is badly needed for the D.R. of the Congo. These activities are due to be completed by 2004.

High priority has also been assigned to assist other countries with relatively developed regulatory framework in attaining this milestone (ref. next section). Country-specific workplans will focus on designing overall national response plans for emergencies involving radiation sources or radioactive material. The plans will be commensurate with the extent of radiation practices in each country concerned.

A qualitative summary of radiation and waste safety infrastructure in the African Member States is presented in Tables 2 and 3.

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[11] RAF/4/015 (AFRA I-14).

Table 2. Radiation Safety Legislation in the African Member States

MEMBER STATE	GENERAL LAW IN FORCE	REGULATIONS TO IMPLEMENT BSS	REMARKS
ALGERIA	yes	a set of regulations exists	update in progress
ANGOLA	no	no	joined IAEA in 1999; action initiated
BENIN	no	no	joined IAEA in 1998
BUKINA FASO	no	no	joined IAEA in 1998; action in progress
CAMEROON	no	no	final draft revised law and regulations in progress
COTE D'IVOIRE	yes (old)	no	draft in progress; action delayed
EGYPT	yes	a set of regulations exists	update in progress
ETHIOPIA	yes	yes	new regulations in progress
GABON	no	no	final draft law and regulations in progress
GHANA	yes	a set of five regulations exists	new regulations in progress
KENYA	yes (old)	a set of regulations exists (old)	revision of law and regulations in progress
LIBERIA	no	no	institutional instability in the country
LIBYAN A.J.	yes	a set of several regulations and codes of practice exists	update in progress to comply with BSS; to be enacted in 2001
MADAGASCAR	yes	yes (basic)	final draft new regulations in progress
MALI	no	no	draft legislation exists; action delayed
MAURITIUS	yes (old)	yes	final draft approved by Board and sent to State Law Office, action delayed
MOROCCO	yes	a set of regulations exists	update in progress
NAMIBIA	yes (old)	no	final draft law and regulation ready ; to be enacted in 2001.
NIGER	yes (Nov.99)	yes (Nov. 1999)	to be implemented
NIGERIA	yes	no	action delayed
SENEGAL	no	no	draft legislation exists; action delayed
SIERRA LEONE	no	no	draft legislation exists; action delayed by institutional instability in the country
SOUTH AFRICA	yes (new; 2000)	well established	
SUDAN	yes	yes	new regulations in progress
TUNISIA	yes (old)	a set of several regulations and codes of practice exists	revision of the law and regulation in progress
UGANDA	no	no	draft legislation being prepared; action delayed, but much progress made in 2000
TANZANIA	yes	yes	revision of regulations in progress to incorporate medical exposure, mining transport, waste safety
DEM. REP. OF CONGO	yes	yes	final draft legislation ready; to be enacted by Dec. 2000
ZAMBIA	yes	yes	being extended to include waste safety
ZIMBABWE	yes (to be amended)	no	draft in progress; action delayed

Table 3. Elements of Radiation Protection Infrastructure in the African Member States

Member State	System of notification, authorization, inspection and enforcement	Inventory of radiation sources	Occupational radiation protection		Medical exposure control QA/QC prog.			Public exposure control: waste safety programme	Emergency response plan
			Individual monitoring	Workplace monitoring	DR	RT	NM		
Algeria	established; operational	yes	yes	yes	ltd*	yes	yes	yes	in progress
Angola	to be established	in progress	no	no	no	no	no	no	no
Benin	to be established	no	no	no	no	no	no	no	no
Burkina Faso	to be established	in progress	no	no	no	no	no	no	no
Cameroon	to be established	in progress	yes	no	no	no	no	no	no
Cote d' Ivoire	to be established	yes	yes	yes	no	no	no	no	no
Egypt	established	yes	yes	yes	ltd	yes	yes	in progress	in progress
Ethiopia	established	yes	yes	yes	no	ltd	no	in progress	no
Gabon	to be established	incomplete	no	no	no	no	no	no	no
Ghana	established; operational	yes	yes	yes	no	ltd	no	in progress	in progress
Kenya	established	incomplete	limited	no	no	no	no	no	no
Liberia	not established	no	no	no	no	no	no	no	no
Libyan A.J.	not established	yes	yes	limited	ltd	ltd	ltd	in progress	in progress
Madagascar	established; initiated	yes	yes	yes	no	ltd	ltd	no	no
Mali	to be established	incomplete	limited	limited	no	no	no	no	no
Mauritius	to be established	yes	yes	yes	ltd	ltd	ltd	in progress	no
Morocco	established; operational	yes	yes	limited	ltd	ltd	ltd	in progress	in progress
Namibia	being established	yes	limited	limited	yes	yes	yes	no	no
Niger	being established	incomplete	U mines only	limited	no	no	no	no	no
Nigeria	not established	incomplete	very limited	limited	no	ltd	ltd	no	no
Senegal	not established	no	limited	limited	no	no	no	no	no
Sierra Leone	not established	no	no	no	no	no	no	no	no
South Africa	established; operational	yes	yes	yes	yes	yes	yes	established	established
Sudan	established; operational	incomplete	limited	limited	no	ltd	ltd	established	in progress
Tunisia	established; operational	yes	yes	limited	no	ltd	ltd	in progress	in progress
Uganda	to be established	incomplete	limited	limited	no	ltd	ltd	no	no
U.R. Tanzania	established	yes	yes	yes	no	ltd	ltd	in progress	in progress
D.R. Congo	to be established	incomplete	initiated	limited	no	no	no	in progress	no
Zambia	established	yes	limited	limited	no	no	no	in progress	no
Zimbabwe	to be established	yes	yes	yes	ltd	ltd	ltd	no	no

*ltd - limited.

THE AGENCY RESPONSE. REGIONAL OUTLOOK 2001–2004

The above overview shows that the needs of many countries in the region for assistance in attaining an adequate level of self-sustainable and effective regulatory mechanisms for the control of radiation sources and practices, in compliance with principal requirements of the international Basic Safety Standards, still remain persistent. As indicated in the contributed report on "Upgrading Radiation Protection Infrastructure in Developing Countries: A Successful Experience" (by Mr. Paulo M. C. Barretto), the IAEA's effort in this statutory responsibility will continue on a regional basis in the years to come. The following projects for Africa have been included in the IAEA's mid-term technical co-operation programme:

National Regulatory Control and Occupational Radiation Protection Programme

This Model Project is aimed at improving regulatory framework for radiation protection in participating countries, and at establishing adequate regulatory mechanisms for the control of radiation sources in new Member States (milestone 1). Focus will also be on setting up a national programme for occupational radiation protection (milestone 2). Fourteen African countries, including new Member States (Angola, Benin and Burkina Faso) have been invited to participate.

Development of Technical Capabilities for Sustainable Radiation and Waste Safety

The objectives of this new Model Project are to develop and consolidate adequate systems with technical capabilities for sustainable medical and public exposure control consistent with international standards (milestones 3 and 4), and to establish a national system for preparedness and response to radiological emergencies (milestone 5). The project is expected to involve 16 Member States, presumed to have attained milestones 1 and 2.

Postgraduate Training in Radiation and Waste Safety

This new project is designed to support all Member States in the region in their effort to attain a core number of managers, qualified experts and trainers in radiation protection, and to develop adequate expertise and skills required for self-sustainable national radiation protection infrastructure, with its major component: qualified human resources.

REGULATORY INFRASTRUCTURE IN EAST AND WEST ASIA: PRESENT STATUS AND PERSPECTIVES

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Abstract. A detailed assessment carried out by the IAEA showed that five Member States in East Asia (Bangladesh, Mongolia, Myanmar, Sri Lanka, Vietnam) and nine Member States in West Asia (Jordan, Kazakhstan, Lebanon, Qatar, Saudi Arabia, Syria, United Arab Emirates, Uzbekistan, Yemen) did not have an adequate radiation and waste safety infrastructure in general and a basic regulatory infrastructure in particular. This indicated the partial or complete lack of control of radiation sources, i.e. location, identification, registration, licensing & inspection. Since 1996, these countries have been participating in the Model Project on Upgrading Radiation and Waste Safety Infrastructure with the primary objective of establishing or upgrading their basic regulatory infrastructure. The results achieved in the establishment/upgrading of this infrastructure and the follow-up and extension to other Member States are presented in this paper.

INTRODUCTION

For many years, the IAEA has provided assistance to the Member States in radiation protection and radioactive waste management, through national technical co-operation projects, regional and interregional activities and co-ordinated research projects. Two advisory programmes have been established by the IAEA: Radiation Protection Advisory Teams (RAPAT) and Radioactive Waste Management Programme (WAMAP), to assist Member States in reviewing and assessing their ongoing activities in these fields and identifying priorities and needs for their future development and to make recommendations for their future assistance.

Building on this experience and subsequent policy reviews, the IAEA took steps to evaluate the needs for technical assistance more systematically in nuclear and radiation safety. The outcome was the development of an integrated system designed to more closely assess national priorities and needs for upgrading their infrastructures for radiation and waste safety.

The work draws upon the IAEA's long record of safety assistance through avenues of technical co-operation and assistance. By its Statute, the IAEA is authorized to establish or adopt safety standards for the protection of health and the minimization of danger to life and property, and to provide for the application of these standards to its own operations as well as to operations making use of materials, services, equipment, facilities, and information made available by the IAEA or at its request or placed under its control or supervision. The safety standards which are being promoted are the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS), which are described in this paper.

Regarding technical assistance to be provided in the next cycle, the IAEA Board of Governors, in its report GOV/1999/67 — "Progress Report on the Implementation of the Model Project on Upgrading Radiation Protection Infrastructure (INT/9/143)" — recommended in para. 21 (a) that "Member States which are unlikely to have completed the activities relating to *milestones 1* and *2* by the end of the year 2000" should be informed that

“TC projects involving the use of radiation sources will be submitted to the Board for approval only after they have attained those milestones”.

With this perspective, this paper reviews the IAEA’s integrated management approach and establishment of a TC Model Project to upgrade radiation and waste safety infrastructures in its Member States, and in particular, the basic regulatory infrastructure. The project today assists 51 countries, 14 of which are in East and West Asia.

STATUS

The Model Project on Upgrading Radiation and Waste Safety Infrastructure, and in particular the basic regulatory infrastructure, in East and West Asia was started in 1996–1997 by the gradual establishment of the common ground and understanding between the IAEA and the 14 participating Member States on:

- the status of the radiation and waste safety infrastructure in each Member State, taking into consideration the previous experience of assistance provided by the IAEA;
- the aim of the project;
- the design of the project.

Status:
Assessment of the status of the radiation and waste safety infrastructure for each Member State has been carried out through the five milestones identified by the IAEA on the basis of the International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources (BSS).

This assessment identified where States fall short of the milestones, i.e. do not meet the requirements of the BSS.

Aim:
The aim of this project is that all Member States involved will have a radiation and waste safety infrastructure in accordance with the BSS.

Design:
This project has been designed on the basis of the above assessment, which identified deficiencies in the 14 States’ radiation and waste safety infrastructures. The infrastructures needed to be established or upgraded to comply with the BSS. These 14 Member States are:

East Asia: Bangladesh, Mongolia, Myanmar, Sri Lanka, Vietnam

West Asia: Jordan, Kazakhstan, Lebanon, Qatar, Saudi Arabia, Syria, United Arab Emirates, Uzbekistan, Yemen

The implementation of the project began by setting up individual workplans based on the initial needs assessment. The workplans were prepared, finalized and approved by the participating countries and the IAEA during 1996–1997.

In order to achieve the project objectives and to undertake the appropriate actions, the nature and number of radiation sources and the main users in each participating country were identified.

- Medical practices: radiodiagnosis, radiotherapy and nuclear medicine in public hospitals, private hospitals and clinics represent 80–90 % of the practices in each Member State.

- Industrial and research practices: NDT sources, irradiators, gauges and well-logging, research reactors, neutron generators, cyclotrons, isotope production, mining and milling used in national agency or commissions or in the mineral industries represent 10–20 % of the practices in each Member State.

The workplans prepared and approved by Member States cover activities related to the five milestones:

Milestone 1: **Establishment of a regulatory framework** covering radiation safety law, regulations, system of notification, authorization and control of radiation sources, including inventory of radiation sources;

Milestone 2: **Establishment of occupational exposure control,** i.e. individual workplace monitoring (including dose assessment);

Milestone 3: **Establishment of medical exposure control,** i.e. controlling exposure of patients in radiodiagnosis, radiotherapy and nuclear medicine;

Milestone 4: **Establishment of public exposure control,** i.e. registration control and safe disposal of radioactive waste, control of consumer products, environmental monitoring;

Milestone 5: **Establishment of emergency preparedness and response capabilities.**

The implementation of the five milestones, and in particular Milestone 1, involved two main parties:

The regulatory authority with a mandate to implement the law, regulations (radiation protection, waste management and transport regulations), system of notification, authorization, inspection and enforcement (including the inventory of radiation sources and radiation workers); and

The users with responsibilities to prepare, implement and manage the radiation protection programme to comply with the above requirements (law, regulations).

One of the main difficulties encountered in the implementation of the project in the participating countries was the lack of compliance with the obligation, as described in the Preamble of the BSS, to establish an adequate national infrastructure which included:

- an appropriate national legislative and regulatory framework (law, regulations, codes of practice, guidelines, etc.);
- a regulatory body empowered and authorized to inspect and to enforce the legislation and regulations;
- an adequate number of qualified staff; and
- sufficient resources.

As a result of the above, the role and responsibilities of the regulatory authority or the acting regulatory authority and the users were either not identified or were not clearly defined.

In order to resolve difficulties and to speed up the implementation of the project:

- The five milestones were prioritized in order to facilitate the monitoring of progress and the optimization of resources;
- firm commitments were obtained from all participating countries to comply with their obligations as described in the BSS through the approval of the workplans which took place at the beginning of the project in each Member State (1996–1997);
- an integrated and synchronized approach was established in terms of actions to be taken by the Member States and the assistance to be provided by the IAEA.

Milestone 1 was given top priority in order to established a basic regulatory infrastructure in each participating Member State, which should result in the control and safe use of radiation sources through an adequate system of notification, authorization, inspection and enforcement and a continuously updated inventory of radiation sources and radiation workers.

The establishment or the upgrading of this milestone required:

- a legal framework, including radiation safety legislation;
- regulations, codes of practice, etc.; and
- procedures for notification, authorization and enforcement.

The legal framework should be implemented and managed through an adequate regulatory programme for which there was a need to establish/strengthen a regulatory authority. Adequate resources in terms of premises, equipment (vehicles) and qualified professionals should be provided to this body.

In order to achieve the above, actions to be undertaken by the Government, the counterpart and the IAEA were clearly defined in the workplans for each Member State, involving close partnership between the IAEA and the counterpart(s). The IAEA through the Regional Manager, had to carry out the actions at two levels: that of high-level decision-makers at the operational level.

At the first level, the Regional Manager had to meet Prime Ministers, Ministers (Ministries of Health, Justice, Science & Technology, etc.), Chairmen or Directors General of National Atomic Energy Commissions, Members of Parliament, etc. Additionally, high-level decision-makers seminars were organized with IAEA assistance in the People's Republic of China in 1998 and in Malaysia in 1999.

The purpose of these two actions was to make Member States aware of the importance of a basic regulatory infrastructure and to get their commitment and continuous support for the achievement of the goals of the project.

At the operational level, the IAEA assisted each Member State with the following provision of:

- model radiation safety law, model radiation protection, waste management and transport regulations, model guidelines prepared by the IAEA and also similar documents from Member States in the region with the same practices;
- expert services for reviewing, drafting and finalizing the national legal framework;
- expert services in order to prepare, together with the counterpart, a regulatory programme involving procedures for an adequate system of notification, authorization, inspection and enforcement for radiation sources;
- on-the-job training and scientific visits for all Member States. A total of 200 people benefited form on-the-job training and scientific visits were provided to Member States in the East Asia region and 160 in the West Asia region;
- regional and national training events which involved 660 participants in the East Asia region and 500 participants in the West Asia region.

All these actions involved the regulators as well as the users. Particular emphasis was always put on the definition of their role and duties with regard to the establishment and management of regulatory controls.

Furthermore, special assistance was provided to main medical practices through the establishment of national programmes on radiation protection and quality assurance in radiodiagnosis, radiotherapy and nuclear medicine, implemented by the Ministry of Health with the assistance of the regulatory authority through an appropriate operational unit, which had been or would be established. This approach was intended to establish of a partnership between the regulatory authority and the main users in order to clarify their roles and duties.

The programme of implementation was monitored on a regular basis by the Regional Manager through field missions, the annual appraisal meeting organized by the IAEA and through five Peer Review Missions conducted in 1999 and four in 2000.

The lack of qualified staff in the regulatory authority and also with the users was the main obstacle encountered during the implementation of the project in the fourteen Member States. The majority of the existing staff received short-term on-the-job training in the past as also under the Model Project. This approach alone did not lead to the establishment of the professionals needed for the sustainability of activities which have to be carried out in different aspects of radiation and waste safety.

Therefore, there was an urgent need to assist these countries in the establishment of the minimum critical mass of professionals required for the organization, management and sustainability of an adequate radiation and waste safety infrastructure in particular for the basic radiation safety infrastructure. This could only be done through appropriate long-term training in a specialized centre. In keeping with the recommendation made by the decision makers of the fourteen participating Member States during their last appraisal meeting held in Kuala Lumpur, Malaysia, in June 1999, one-year postgraduate diploma training courses in radiation protection were established by Syria and Malaysia during the year 2000. Participants from Model Project countries who were selected to attend these courses, were supported by the IAEA.

To a large extent, this progress has been the result of good co-operation between the IAEA and participating Member States. However, vital assistance was also given by other Member States (including Australia, the Czech Republic, France, Germany, India, Japan, Malaysia, Pakistan, Sweden, the United Kingdom) by providing expert services, and hosting on-the-job training, scientific visits and training courses.

In conclusion, it can be said that progress has been made in upgrading the radiation and waste safety infrastructure in the fourteen participating Member States, particularly in the regulatory framework, including a system for notification, authorization and control of radiation sources which includes the inventory of radiation sources and radiation workers.

The status of the System of Control of Radiation Sources can be summarized as follows:

Region	**a**	**b**	**c**
East Asia	3	3	–
West Asia	3	3	3

a: in place, b: being implemented, c: Law and/or regulations in final stage of promulgation

It is expected that the majority of the Member States participating in the Model Project will establish a regulatory authority with a regulatory programme at different stages of implementation.

REGULATORY INFRASTRUCTURE IN EAST & WEST ASIA: PERSPECTIVES

Taking into account the recommendations of the Board of Governors (GOV/1999/67, para. 21 (c)), namely, to adapt this model approach to other national and regional projects on radiation protection and waste safety, TC assistance will be provided in the 2001–2002 cycle through a new regional project, "National Regulatory Control Framework and Occupational Radiation Protection".

The objective of the project is to establish or improve the regulatory framework for radiation protection in all East and West Asia Member States and to harmonize and streamline regulatory controls.

Member States expected to participate in this project are:

- those which did not complete Milestone 1 and those which need to finalize and issue waste management regulations, transport regulations and codes of practice; and
- those which are not participating in the present Model Project and for which establishing/strengthening the basic regulatory infrastructure has either been requested by the Member State or identified by the IAEA.

The Member States which are likely to participate in the project are:

East Asia: Bangladesh**,** China, Indonesia, Malaysia, Mongolia, Myanmar**,** Pakistan, Philippines, Singapore, Sri Lanka, Vietnam
West Asia: Iran, Jordan, Kazakhstan, Kuwait, Lebanon, Qatar, Saudi Arabia, Syria, Uzbekistan, United Arab Emirates, Yemen.

The new project will be integrated and harmonized under the radiation protection programme, i.e., national projects, regional agreements, regional projects, etc., to be implemented in each region.

CONCLUSIONS

Considerable progress has been achieved in the establishment/upgrading of the basic regulatory infrastructure in the 14 Member States participating in the Model Project on Upgrading Radiation and Waste Safety Infrastructure. This successful experience will be extended to other Member States in the East and West Asia region in order to achieve the objective of the Agency which is to ensure that all Member States should have an adequate radiation protection infrastructure in the near future.

DEVELOPMENT AND IMPLEMENTATION OF THE REGULATORY CONTROL OF SOURCES IN LATIN AMERICAN MODEL PROJECT COUNTRIES

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Abstract. After a general assessment of the situation regarding radiation safety and the radiation protection infrastructure in Latin American countries, several of them were invited to participate in a Model Project oriented, in some cases, towards establishing a mechanism for national regulatory control of radiation sources, and in others, towards upgrading their national control programme. All these activities aimed at reaching an effective and sustainable radiation protection infrastructure based on international basic safety standards. The paper presents a general overview of the current situation with regard to radiation protection within the Model Project countries in Latin America after almost five years of activities. It includes: the implementation of regulatory issues; the control of occupational, medical and public exposures; emergency response and waste safety issues. The paper also presents some lessons learned during implementation concerning the numerous activities involved in this interregional project.

INTRODUCTION

The Model Project "Upgrading Radiation Protection Infrastructure" has its origin in the RAPAT (Radiation Protection Advisory Team) missions carried out by the IAEA between the years 1984 and 1995 in more than 60 countries. The results of the missions showed that, in spite of the work done by countries within the framework of national radiation protection projects, the radiological safety infrastructure could and should be upgraded in order to fulfil the established requirements of the Basic Safety Standards (BSS).

During the years 1993–1994, additional and independent assessment of the information existing in the countries visited confirmed the need to work with 52 countries (10 of which were in Latin America, *Table 1*) that did not have the minimum radiation and waste safety infrastructure to ensure the control of radiation sources and their safe use.

In the meantime, the present BSS were elaborated and discussed by radiation protection specialists from different Member States. These Basic Safety Standards were approved in 1996 and signed by six international organizations, namely FAO, IAEA, ILO, OECD/NEA, PAHO and WHO. Finally, the BSS were published in February 1997.

This important document has been the fundamental pillar for the design of a programme of activities aimed at establishing an adequate national radiation protection infrastructure.

STARTING POINT OF THE PROJECT

Taking into account the outcome of the RAPAT missions and the results mentioned above, a decision was taken to assist the countries in a "personalized way", i.e. in some cases to focus assistance on establishing the national infrastructure, and in others on upgrading an existing national infrastructure.

Table 1. Latin American Member States participating in the Model Project on Upgrading Radiation Safety Infrastructure in Latin America

1	Bolivia
2	Colombia
3	Costa Rica
4	Dominican Republic
5	El Salvador
6	Guatemala
7	Jamaica
8	Nicaragua
9	Panama
10	Paraguay

In 1996, an invitation was sent to the Governments of selected Latin American countries. This invitation letter included the working guidelines to be followed for the implementation of this interregional project (INT/9/143). It also requested the nomination of a national counterpart with a suitable level of responsibility within the national government structure and with sufficient power and autonomy to discuss, adjust, take decisions and implement a national workplan which would be proposed by the IAEA. Workplans were to be designed for a period of four to five years.

Within this general framework, the IAEA project manager would then be able to start discussing this "personalized" workplan prepared by the IAEA and, once approved by the Member State, carry out all necessary activities agreed in this workplan through the official national counterpart. The national counterpart would have the responsibility, within the country, to develop and co-ordinate the activities with the relevant governmental agencies in order to implement the legislative and regulatory framework at the national level.

The main topics included in these workplans were:

1. Establishment/upgrading of the national legal and regulatory framework;
2. Establishment or enhancement of the national regulatory authority;
3. Establishment of an effective regulatory control of radioactive sources and practices;
4. Occupational exposure control;
5. Medical exposure control;
6. Public exposure control;
7. Waste safety;
8. Emergency response and preparedness;
9. Technical support services.

IMPLEMENTATION OF THE MILESTONES

In order to achieve the objective of the project, five milestones were identified.

MILESTONE 1:

Milestone 1 addresses the first three topics. It requests the establishment of a system of notification, registration, inspection, licensing, and enforcement, including an inventory of radiation sources. For this purpose an effective regulatory framework should be set up, including the establishment of a national regulatory authority[1] with a clearly defined role. Regulations regarding radiation protection, transport, radioactive waste and licensing procedures need to be established.

IAEA assistance included the provision of a Model Safety Law, Model Radiation Protection Regulations, Model Guidelines (prepared either by the IAEA or within the ARCAL programme), and copies of similar documents prepared by other countries. Expert missions were sent to the Member States to prepare, review and discuss legal and regulatory documents, and to establish, together with the national regulatory staff, a suitable system of notification, registration, authorization, inspection and enforcement.

Regional and national training courses involving both regulatory staff and users were carried out during this cycle. On-the-job training was developed to reinforce the achievement of this milestone.

A national inventory of radioactive sources, including spent sources, was prepared by all countries at the outset of the project, with the commitment to keep it updated.

The computer software RAIS (Regulatory Authority Information System) was also provided to the countries to expedite the regulatory control of radiation sources and practices.

Table 2 shows the state of the regulatory framework in the Latin American countries of the Model Project as of September 2000.

MILESTONE 2:

Milestone 2 refers to the establishment of a national system of control for occupationally exposed personnel. It was recommended that dose control and dose assessment programmes be established by monitoring of individuals. In addition, several activities were developed with the countries to establish a reliable system of dose measurement. Since 1997, two training workshops for specialists in individual monitoring have been held. Moreover, two intercomparison exercises have been carried out. The results of these exercises have shown that the countries participating in this project have reached an adequate level of quality and reliability of dose measurement.

Whenever necessary, an additional intercomparison exercise was carried out to ensure the expected quality. Some countries participating in the Model Project also took advantage of ongoing national TC projects focused on preparing protocols for individual monitoring quality assurance (QA) programmes. At present, all the countries have operational individual monitoring services; two of them in the final phase of implementation.

Expert missions to assess the progress of this practice were conducted in several countries. On-the-job training programmes for specialists were carried out in order to reinforce the attainment of this milestone.

[1] The National Regulatory Authority has the same tasks as indicated in the preamble to the BSS.

Equipment, calibration sources, monitors etc. have been provided to the countries to ensure a degree of independence to calibrate and characterize the individual monitors. As a consequence, control of occupationally exposed personnel has been considerably improved.

Several national training courses for Radiation Protection Officers (RPOs) have been organized with the objective of standardizing the operational radiation programme and also to train RPOs to ensure an adequate level of radiation safety within the facilities. Around 100 RPOs have been trained so far.

Table 3 shows the situation regarding this milestone as of September 2000.

MILESTONE 3:

This milestone relates to the control of medical exposures. Priority was given to the control of exposure of patients in radiotherapy and nuclear medicine practices. The implementation of activities relating to the control of exposures in diagnostic radiology practices was considered less urgent. Another task within this milestone is the establishment of adequate quality assurance programmes.

Several actions have been undertaken to attain the first priority within this milestone. Regional training courses on radiation protection and QA for medical practices have been organized. Regulators and users have been invited to participate jointly in order to clarify the complementary role that each has in the field of radiation protection of the patient.

It has been found useful to provide expert advice to regulators and users on adequate and specific programmes on radiation protection and quality assurance. The project has also included follow-up missions and peer review missions to control the degree of implementation of the planned tasks oriented towards achieving this milestone.

The implementation of these programmes is progressing. However, the general status of radiation protection in this area is still unsatisfactory and consequently much still remains to be done. More qualified personnel are needed, in particular qualified medical physicists and qualified personnel in the medical sector. Certainly this fact should be taken into consideration when preparing and implementing national radiation protection and QA programmes.

Table 3 shows the status with regard to the control of medical exposures as of September 2000.

MILESTONE 4:

This milestone is related to the control of public exposure. The activities focus on radioactive waste safety, control of foodstuffs, and environmental monitoring.

With regard to radioactive waste safety, it should be recognized that the lack of national policies or decisions on waste management and the shortage of centralized waste storage facilities has delayed advancement. Nevertheless, in most of the countries actions have been taken to promote the registration, storage and control of spent sources within the workplace.

Table 2. Summary of the implementation of milestone 1 by activities in workplans in Latin America

	Activity													
	1 Law				**2 Regulations**				**3 Regulatory authority**		**4 System of notification, authorization, inspection and enforcement**			
	a	**b**	**c**	**d**	**a**	**b**	**c**	**d**	**a**	**b**	**a**	**b**	**c**	**d**
Latin America (10)	**–**	**1**	**1**	**–**	**6**	**2**	**–**	**2**	**8**	**2**	**6**	**1**	**1**	**2**

1a: Promulgated
1b: In final stage of promulgation
1c: In drafting form
1d: No action taken

2a: Enacted
2b: In final stage of enactment
2c: In drafting form
2d: No action taken

3a: Established
3b: Not established

4a: In place
4b: Being implemented
4c: At initial stage of implementation
4d: Not established

Table 3. Summary of the implementation of milestones 2–5 by activities in action plans in Latin America

	Milestone 2						*Milestone 3*									*Milestone 4*						*Milestone 5*		
	Occupational exposure control						**Medical exposure control**									**Public exposure control**						**Emergency response plan**		
	Individual monitoring			**Workplace monitoring**			**DR***			**RT****			**NM*****			**Environmental monitoring**			**Waste management**					
	a	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**
Latin America (10)	7	1	2	4	3	3	2	4	4	4	2	4	1	2	7	5	1	5	1	1	8	1	–	9

a: National programme in place & operational
b: National pogramme being established
c: National pogramme not established

* Diagnostic radiology
** Radiotherapy
*** Nuclear medicine

Regarding the existing ^{226}Ra sources in the Latin American Model Project countries, co-ordinated actions have been undertaken under project INT/4/131 (Sustainable Technology for Managing Radioactive Wastes). Five missions have been carried out in the Model Project countries for conditioning spent radiation sources. Similarly, project INT/4/131 has organized an annual regional workshop to train waste management staff in the conditioning of low level wastes and low activity spent sealed sources. About 20 professionals from Model Project countries have already been trained in this area.

Concerning foodstuff control, on the basis of qualitative–quantitative analysis through gamma spectrometry, a basic infrastructure to carry out this task already exists in five of the Model Project countries with a different level of development. Although this task was not a priority, the Model Project has provided expert services to several countries, and on-the-job training programmes for technicians in order to improve control.

Table 3 shows the status with regard to public exposure control as of September 2000.

MILESTONE 5:

This milestone refers to the establishment of a system of emergency response and preparedness. Although the achievement of this milestone is essential to the establishment of a national radiation protection infrastructure, its implementation has been subordinated to the achievement of the previous milestones, especially milestones 1 and 2.

For most countries, radiological emergencies are not their main concern. However, during this cycle, a regional course on this subject was carried out in order to alert all countries to the scope, infrastructure, administrative and legal support necessary to establish a national system for radiological emergencies. As a result of that regional training course, many countries have initiated necessary actions to include the component of radiological emergencies in the national emergency network for natural emergencies and disasters.

Taking into account the specific and urgent needs of the individual countries, expert missions and national training courses were held with the support of specialists from the region.

CONCLUSIONS

The project has had a great impact on the participating countries and significant progress has been achieved. This project has strengthened co-operation between the countries at the regional and the national level.

The approach followed in this project has been recognized as effective by the participating countries and also by other countries in the region. The IAEA Board of Governors has recommended the extension of this approach to other TC projects (GOV/1999/67).

It should be pointed out that the approach taken in this project has involved the highest decision makers, such as ministers, viceministers, Chairmen of the National Energy Commissions, in the implementation of the activities. This has led to a strong commitment and support at the highest governmental level.

NATIONAL REPORTS
(Session 3)

Chairperson

I. OTHMAN
Syrian Arab Republic

THE SAFETY OF RADIATION SOURCES AND RADIOACTIVE MATERIALS IN CHINA

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Abstract. The report describes the present infrastructure for the safety of radiation sources in China, where applications of radiation sources have become more and more widespread in the past years. In particular, it refers to the main functions of the National Nuclear Safety Administration of the State Environmental Protection Administration (SEPA), which is acting as the regulatory body for nuclear and radiation safety at nuclear installations, the Ministry of Public Health which issues licences for the use of radiation sources, and the Ministry of Public Security, which deals with the security of radiation sources. The report also refers to the main requirements of the existing regulatory system for radiation safety, i.e. the basic dose limits for radiation workers and the public, the licensing system for nuclear installations and for radioisotope-based and other irradiation devices, and the environmental impact assessment system. Information on the nationwide survey of radiation sources carried out by SEPA in 1991 is provided, and on some accidents that occurred in China due to loss of control of radiation sources and errors in the operation of irradiation facilities.

INTRODUCTION

Radiation sources are anything that may cause radiation exposure — for example, by emitting ionizing radiation or releasing radioactive substances. Radiation and radioactive substances are natural and permanent features of the environment, and the risks associated with radiation exposure can therefore only be restricted, not eliminated entirely.

Applications of radiation sources are becoming more and more widespread in China. At present, about 50 000 radioisotope-based and about 100 000 other irradiation devices are being used there in industry, agriculture, medicine and scientific research.

Also, in China, which has had a nuclear industry for over 40 years, there are currently 11 power reactors in operation or under construction, 17 civilian research reactors in operation and six civilian nuclear fuel cycle facilities. In this paper, however, the term “radiation sources” means radioisotope-based and other irradiation devices and does not include nuclear installations.

THE MANAGEMENT INFRASTRUCTURE FOR THE SAFETY OF RADIATION SOURCES IN CHINA

The Chinese Government, which established a licensing system for the regulation of nuclear installations in 1986 by adopting Regulations for the Surveillance and Control of Civilian Nuclear Installations, established a licensing system for the regulation of radiation sources in 1989 by adopting Radiation Protection Regulations for Radioisotope-based and Other Irradiation Devices. Since that time the Chinese Government has issued a number of regulations and safety standards relating to nuclear safety and radiation protection. The management infrastructure for the safety of radiation sources in China is described below.

The National Nuclear Safety Administration (SEPA)

The NNSA/SEPA is the regulatory body for nuclear and radiation safety at nuclear installations in China. Its radiation safety functions are as follows:

- to establish general and specific policies, regulations, standards and technical guidelines for radiation protection and radioactive waste management and to monitor their implementation,
- to carry out environmental radiation monitoring nationwide and monitoring at installations such as nuclear power plants,
- to review the environmental radiation impact reports for all relevant construction projects,
- to maintain radiation protection controls at nuclear installations, at establishments where nuclear techniques are being used and at radioactive ore mines and mills,
- to inspect the on-site emergency plans and monitor the environmental emergency response activities of the operators of nuclear installations,
- to deal with environmental contamination caused by applications of and by losses of control over radiation sources and with disused or spent radiation sources, and
- to carry out monitoring and inspection activities in connection with radioactive waste management.

The Ministry of Public Health (MOPH)

The functions of MOPH are as follows:

- to issue licences for the production, sale and use of radiation sources,
- to register radiation sources, collect data relating to their use and provide information about them to the NNSA/SEPA and the Ministry of Public Security, and
- to investigate, in co-operation with the Ministry of Public Security and the NNSA/SEPA, accidents and other incidents involving radiation sources.

The Ministry of Public Security (MOPS)

MOPS is responsible for:

- the security of radiation sources, and
- investigation and search activities when radiation sources are lost.

The provincial radiological hygiene agencies, environmental protection bureaux and public security departments

These bodies are implementing organizations under the instructions of MOPH, the NNSA/SEPA and MOPS respectively. Their radiation safety functions are as follows:

- to implement the policies, regulations, standards and technical guidelines established by the Chinese Government for the safety of radiation sources,
- to carry out environmental radiation monitoring locally and monitoring at nuclear installations, to review environmental radiation impact reports on projects which will result in applications of nuclear techniques and to issue radioactive effluent release permits (functions of the provincial environmental protection bureaux),

- to issue licences for the production, sale and use of radiation sources, to register radiation sources, to investigate accidents and other incidents involving radiation sources and to deal with the resulting environmental contamination (functions of the provincial environmental protection bureaux), and
- to endeavour to ensure the security of radiation sources and, when radiation sources are lost or otherwise escape from regulatory control, to carry out investigation and search activities (functions of the provincial public security departments).

REGULATORY REQUIREMENTS

A preliminary regulatory system for radiation safety has been established in China. Its main features are described below.

Basic dose limits for radiation workers and the public

China's radiation protection regulations (GB8703) are based on three elements: justification of the practice, the optimization of radiation protection and dose limits. The basic dose limit is 50 mSv/year for radiation workers, and 1 mSv/year for the public. These limits are to be changed in the light of the ICRP 60 recommendation and the BSS.

The NNSA/SEPA requests the operators of nuclear installations to work to a conservative dose limit of 0.25 mSv/year for the public, taking account of the overall radiation exposure due to other radiation sources, and also to apply the ALARA principle in the case both of radiation workers and of the public.

Licensing system for nuclear installations

The civilian nuclear installations in China include nuclear power plants, research reactors, critical assemblies and nuclear fuel cycle facilities. The NNSA/SEPA implements a licensing system for nuclear installations which is based on the 1986 Regulations for the Surveillance and Control of Civilian Nuclear Installations.

China has more than one hundred technical standards and safety guides relating to nuclear safety and radiation protection. They describe in detail the technical requirements which must be met in order to maximize nuclear and radiation safety in the siting, construction, operation and decommissioning of nuclear installations and in radioactive waste management; they also describe how those requirements may be met.

Licensing requirements for radioisotope-based and other irradiation devices

Applying the 1989 Radiation Protection Regulations for Radioisotope-based and Other Irradiation Devices, MOPS, in co-operation with the NNSA/SEPA, implements a licensing system for the manufacture, sale and use of radiation sources — i.e. of radioisotope-based and other irradiation devices (in this paper, radioisotope-based irradiation means either simply radioisotopes or devices containing radioisotopes, while "other irradiation devices" means X-ray machines, accelerators and neutron generators).

(a) Authorization and registration of radiation sources

Anyone intending to manufacture, sell or use radiation sources must apply for a licence from the provincial public health department and inform the provincial public security department and environmental protection bureau. If releases of liquid, gaseous or solid effluent are involved, an environmental impact report must be submitted to the provincial environmental protection bureau.

(b) Radiation protection

The owners and users must — for the purpose of complying with the radiation protection regulations and standards — have competent radiation protection staff and install radiation protection shielding, safety interlocks, monitoring instrumentation and alarm systems.

(c) Radiation safety inspections

The local public health departments are responsible for carrying out radiation safety inspections at the premises of radiation source owners and users. The provincial environmental protection bureaux are responsible for monitoring effluent releases and carrying out associated inspections.

(d) Radiological accident management

In China, radiological accidents are divided into three categories, with four classes in each category.

- Category I: accident with exposure in excess of the dose limit
  - Radiological incident: H_E > 1/2 of the annual dose limit for the whole body
  - Radiological accident Class I: H_E > 0.05 Sv for the whole body
  - Radiological accident Class II: H_E > 0.25 Sv for the whole body
  - Radiological accident Class III: H_E > 1.0 Sv for the whole body
- Category II: surface contamination accident

  The classification of surface contamination accidents is based on the ratio (F) of the average surface contamination following the accident to the surface contamination limit in China's radiation protection regulations.
  - Radiological incident: F >1
  - Radiological accident Class I: F >10
  - Radiological accident Class II: F >300
  - Radiological accident Class III: F >10 000
- Category III: accident with loss of control of radiation sources
  - Incident: source activity > exemption value, for sealed and unsealed sources
  - Radiological accident Class I: sealed sources:activity > 4×10^6
  - unsealed sources: activity > 4×10^5
  - Radiological accident Class II: sealed sources: activity > 4×10^8
  - unsealed sources: activity > 4×10^7
  - Radiological accident Class III: sealed sources: activity > 4×10^{10}
  - unsealed sources: activity > 4 × 109

Every radiological accident must be reported immediately to the local public health department and public security department. In cases of environmental contamination, the local environmental protection bureau must be informed. The organization at whose establishment the accident has occurred must take measures to control the accident and protect the public. If necessary, the various governmental agencies will take measures to protect the public and the environment. The NNSA/SEPA has established an emergency centre for responding to nuclear and radiological accidents.

Environmental impact assessment system

Pursuant to the 1999 Environmental Protection Regulations for Construction Projects, China operates an environmental assessment system whereby, before the relevant governmental agencies approve a radiation-related construction project, the NNSA/SEPA (or its agencies at the provincial level) reviews the environmental impact assessment report submitted by the applicant. If satisfied, the NNSA/SEPA (or its agencies at the provincial level) approves the report. In the case of large radiation-related construction projects, the competent governmental department pre-reviews the environmental assessment report.

The design, construction and acceptance of environmental protection systems must proceed in parallel with the design, construction and acceptance of the main facilities, and these systems must be inspected by the NNSA/SEPA.

If there are going to be radioactive effluent releases into the environment, the operator must obtain an effluent release permit from the NNSA/SEPA or the provincial environmental protection bureau. In the siting of a nuclear installation, the possible impact on the public of radioactive releases due to a nuclear accident must be taken into consideration; the long-term impact of the installation must also be considered.

INVENTORY OF RADIATION SOURCES IN CHINA

The licensing system for radiation sources was established in 1989. Some sources which were in use before 1989 have not been registered (most of them are disused sources). Because of the widespread uses of radiation sources, and as some sources have been transferred without registration, it has been impossible to compile an exact inventory of the radiation sources in China. According to data from the Ministry of Public Health, there are now about 50 000 sealed sources (with a total radioactivity of 5×10^{17} Bq) and about 100 000 X-ray machines and accelerators in use in China.

In 1991, SEPA carried out a nationwide survey of radiation sources in China; the results are shown in Tables 1 and 2. However, the survey did not cover all radiation sources; it is estimated that about 30% were not covered. According to the survey, the number of orders for radiation sources was increasing by 20% and that of new users by about 15% annually.

Table 1

Category	Number of users	Number of radiation sources
Sealed sources	4150	16 141 Total activity: 2.66×10^{17} Bq
Unsealed sources	964	Total activity: 2.06×10^{14} Bq
Accelerators	136	219
Neutron generators	20	45
X-ray machines	23 828	Total: 45 279 Medical: 37 955 Industrial: 5921

Table 2. Sealed sources in 1991

	Number of users	Number of sources	Activity (Bq)
Co-60	966	2647	4.90×10^{16}
Cs-137	1663	4520	5.46×10^{14}
Ra-226	341	1471	3.31×10^{13}
Am-241	313	607	5.57×10^{13}
Ir-192	118	202	2.98×10^{14}
Pu-239	76	270	7.72×10^{10}

ACCIDENTS WITH RADIATION SOURCES

In China there have been accidents due to loss of control of radiation sources and to errors in the operation of irradiation facilities.

According to a paper published in 1998 by Fan Shengen, Wang Hongtao et al. in the China Journal of Radiological Health (Vol. 7, No. 2), a total of 1281 radiation accidents occurred in China during the period from 1954 to 1994, with 3393 individuals exposed to radiation (on average, 31 accidents and 83 exposed individuals a year). Four of the accidents resulted in fatalities — see Table 3.

Table 3

	Location	Accident description	Number of fatalities
1963	Anhui	0.43 TBq ^{60}Co source lost	2
1985	Heilunjiang	3.7×10^{11} ^{137}Cs source lost	1
1990	Shanghai	0.85 PBq ^{60}Co irradiation facility, operating error	2
1992	Shanxi	4×10^{11} Bq ^{60}Co source lost	3

Table 4 gives a breakdown of the accidents which occurred during the period 1954–94 by category; Table 5 gives a breakdown by Class.

Table 4*

Category	Number of accidents	Percentage
Exposure in excess of dose limit	240	18.9 %
Surface contamination accident	53	4.2%
Loss of control of radiation source	866	68.4%
Other	83	8.5%

* Because of the incompleteness of the information relating to them, 15 accidents which occurred in the 1960s have not been included.

Table 5*

Accident class	Number of accidents	Percentage
Class I	665	53.7%
Class II	446	36.0%
Class III	127	10.3%

*Because of the incompleteness of the information relating to them, 23 accidents which occurred in the 1960s have not been included.

RADIATION SOURCE SAFETY CHALLENGES

The Chinese Government, which has paid great attention to radiation safety, is continuing to strengthen the regulations and controls relating to applications of radiation sources and nuclear techniques. The licensing system for civilian nuclear installations and that for radioisotope-based and other irradiation devices have proved their value, but major challenges remain owing to the large number of users, the wide distribution of sources, and the great variety of source and facility types in China. For example,

(a) in the case of a few sources, especially ones which were in use before the establishment (in 1989) of the licensing system, there are no records or the records do not match the sources;
(b) it is necessary to establish an integrated national database for radiation sources, so that basic information regarding numbers, types, radiation characteristics, applications, users, transfers etc. can be collated and analyzed by governmental agencies;
(c) some sources have been lost or stolen as a result of improper or insecure storage;
(d) not enough education and training is being provided for the users.

PROPOSALS FOR ACTION

With a view to improving the safety situation as regards radiation sources, the relevant Chinese governmental agencies are reviewing past activities and considering possible future actions. Chinese experts are calling for:

(a) the establishment of a national database on radiation sources
The NNSA/SEPA and MOPH support the establishment of such a database, and to this end a team headed by the Nuclear Safety Centre has been set up by three SEPA institutions, the MOPH and the China Nuclear Industry Group Corporation. It is hoped that the IAEA will provide support during 2001–2002 through its technical co-operation programme. The project will involve an intensive survey of the radiation sources in China, and it is expected that the resulting database, which will provide governmental agencies with detailed information on radiation sources in all parts of the country, will be a valuable aid to experience feedback and decision-making. The NNSA/SEPA and the IAEA will hold a technical training workshop in China at the beginning of 2001 to introduce the IAEA's Regulatory Authority Information System (RAIS).

(b) improvements in the regulatory system and strengthened enforcement
The relevant governmental agencies will do more to improve the authorization and registration system and the regulations and technical standards relating to the safety of radiation sources. Local public health departments are carrying out inspections to ensure that all owners and users of radiation sources have licences. Local environmental protection bureaux are improving their monitoring systems.

(c) cand steelworks
Chinese radiation protection experts suggest that customs establishments be equipped with radiation monitoring systems to prevent illicit trafficking in radiation sources from other countries and that iron- and steelworks be equipped with such systems to ensure that there are no radiation sources in scrap metal which is going to be melted.

(d) the strengthening of education and training
The NNSA/SEPA has compiled radiation protection teaching material to meet the training needs of technical staff working in the field of environmental protection. The relevant governmental agencies will organize workshops and seminars on radiation source safety for staff of – inter alia – MOPH and its provincial radiological hygiene agencies, SEPA and the provincial environmental protection bureaux, MOPS, the State customs authority, the China Commodity Inspection Bureau, and various technical institutions and universities.

SITUATION IN THE RADIATION PROTECTION FIELD IN COSTA RICA

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Abstract. The report describes the radiation protection infrastructure in Costa Rica and makes reference to the existing legal framework. The national inventory of significant radiation sources and structure of the Ministry of Health as the national regulatory authority for radiation safety is illustrated; information is also provided on the radiation monitoring equipment available, on programme activities related to the control of radiation sources by authorization and inspection, and on technical support services.

INTRODUCTION

Costa Rica is a small country in Central America with an area of about 50 000 km^2 and a population of about three million people.

The Ministry of Health is the national authority in the radiation protection field, covering all applications of radioactive materials in medicine and industry and of X-ray equipment.

Table 1. Medicine

SOURCE	INSTITUTION	IN OPERATION SINCE
Cobalt-60 (Theratron 80)	Hospital San Juan de Dios Caja del Seguro Social [Social Security System]	1970
Cobalt-60 (ALCYON II)	Hospital San Juan de Dios Caja del Seguro Social	1991
Cobalt-60 (Theratron 60)	Hospital México Caja del Seguro Social	1972
LINAC (Varian 1800) 6 and 10 MV photons 6,9,12,16 and 20 MeV electrons	Centro de Radioterapia IRAZU (private)	1999
LINAC (Therapy-4) 4 MV photons	Centro de Radioterapia CENTRACAN (private)	1998
LINAC (Siemens Mevatron 12) 10 MV photons 6,9 and 12 MeV electrons	Centro de Radioterapia CENTRACAN (private)	1998
Low-dose-rate brachytherapy, caesium-137 (525 mg) Bought in 1974	Hospital San Juan de Dios Caja del Seguro Social	Not in operation
Low-dose-rate brachytherapy, caesium-137	Hospital México Caja del Seguro Social	Not in operation
250 conventional X-ray machines in governmental and private centres	56 centres of the Caja del Seguro Social 23 private centres	

Table 2. Industry

SOURCE	INSTITUTION	IN OPERATION SINCE
Industrial radiography Iridium-192 (100 Ci) SPEC 2-T	SARET S.A.	1993
Industrial radiography Iridium-192 (100 Ci) GAMMAMAT	Instituto Tecnológico	1994
Industrial radiography Iridium-192 (100 Ci) SENTINEL 660B	JAMÁS	1997
Industrial radiography Iridium-192 (100 Ci) SENTINEL 660B	Instituto Costarrisence de Electricidad (ICE) [Costa Rican Electricity Institute]	1999
Industrial irradiator GAMMACEL 220 11 000 Ci cobalt-60	Universidad de Costa Rica (UCR)	1993
33 industrial enterprises with a few radioactive sources and X-ray machines in quality assurance programmes	Strontium-90, americium-241, americium-beryllium, caesium-137, krypton-85, etc.	

Table 3. Disused sources

SOURCE	INSTITUTION	IN OPERATION SINCE
Industrial irradiator Gammacel 220 1500 Ci	OIRSA- UCR	1992
Industrial irradiator Cobalt-60 and caesium-137 Activity unknown	CATIE	1960
Gauge Caesium-137 5 devices with 125 mCi each	Kimberly Clark	1986
5 small radioactive waste gauges with activities between 20 and 100 mCi		

NATIONAL INVENTORY OF SIGNIFICANT RADIATION SOURCES

The following inventory was prepared with help received through the IAEA's interregional Model Project INT/9/ 143 for upgrading radiation protection infrastructure.

NATIONAL RADIATION PROTECTION INFRASTRUCTURE

Legislative infrastructure

GENERAL HEALTH LAW

It establishes that the Ministry of Health is the national authority responsible for the control of ionizing radiation.

BASIC ATOMIC ENERGY LAW

It establishes that licences shall be granted to industrial enterprises after authorization by the Ministry of Health.

IAEA technical officers and experts visiting Costa Rica within the framework of Model Project INT/9/131 stated that it was essential to establish clear lines of authority. On 12 July 2000, following consultations with executives of the institutions involved, the Atomic Energy Commission of Costa Rica agreed that the task of granting licences would be assigned to the Ministry of Health as the control authority and that the Atomic Energy Commission would continue to be responsible for promotion, training, projects, assistance, and national and international co-operation. We are drafting the necessary law with the agreement of the institutions involved.

PRESIDENTIAL LAW

This law on protection against ionizing radiation specifies the requirements for issuing authorizations for the operation, handling, buying, selling and transport of radiation sources and irradiation equipment.

The present licensing situation is shown in the following tables.

Table 4. User installations

INSTALLATION	UNIVERSE TOTAL	QUANTITY WITH P.S.F.	% WITH P.S.F. RESPECT TO UNIVERSE	ANNUAL INSPECTIONS %
Private linear accelerators	2	2	100	100
Governmental radiotherapy units (cobalt)	2	2	100	100
Governmental nuclear medicine services	3	0	0	100
Governmental diagnostic radiology service	300	1	0.35	100
Private diagnostic radiology services	48	44	90	90
Private odontology (diagnostics)	1200	10	0.85	90
Governmental odontology (diagnostics)	200	0	0	100
Industry[1]	43	12	28	100

[1] *Includes all industrial applications (gamma radiography, irradiators, Am-Be sources, etc.).*

Table 5. Licences issued to operators

APPLICATION AREA	1997	1998	1999	2000	TOTAL
Medicine	25	79	57	26	187
Industry	4	160	39	0	203
Odontology	0	47	49	6	102
Research	0	2	21	0	23
TOTAL OPERATOR LICENCES					515

STRUCTURE OF THE NATIONAL AUTHORITY

The Ministry of Health has the following structure for fulfilling the legal requirements:

EQUIPMENT

The equipment used for inspections and calibration has been largely (95%) donated by the International Atomic Energy Agency through Model Project INT/9/131.

ACTIVITIES

Table 6. Radiation protection programme activities during the period July 1999–July 2000

ACTIVITY	TOTAL
Authorizations of equipment and radioactive sources	723
Inspections of medical installations	156
Inspections of odontology installations	167
Inspections of industrial installations	52

The Government of Costa Rica provides the resources for the authorization and control activities. No charges are made for the issuing of licences or the conduct of inspections.

ANNUAL SALARIES (all staff): $70 000

ANNUAL ADMINISTRATIVE EXPENSES (inspections, office supplies, telephone, lighting, etc.): $ 20 000

TOTAL ANNUAL EXPENSES: $ 90 000

TECHNICAL SERVICES

Personal Dosimetry: A personal dosimetry service is provided for all occupationally exposed persons by three private companies, using thermoluminescence dosimetry systems.

- DOSIMED S.A (CPHR), 1998

- DOSIMED S.A (CPHR), 1998
- CENTRO DE ESTUDIOS CLINICOS [Centre for Clinical Studies](Landauer), 1999
- UNIVERSIDAD DE COSTA RICA (Nuclear Physics Laboratory), 2000

CALIBRATION OF INSTRUMENTS

Costa Rica does not have a secondary standard dosimetry laboratory (SSDL), so this service is provided by recognized laboratories through the SSDL network of the IAEA and the Pan American Health Organization (PAHO).

REPORT ON RADIATION PROTECTION IN CROATIA

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Abstract. The Ministry of Health in the Republic of Croatia is in charge of radiation protection, and new Ionizing Radiation Protection Act defines the responsibilities of the different organizations and institutions. The report explains the existing national system of notification and registration in Croatia and some of the main provisions of the above referred Act. Reference is made to the national provisions for the management of disused sources, recovery or control of orphan sources, and to the national inventory of radiation sources in the country with the data collected during 1998 and 1999.

REGULATORY INFRASTRUCTURE

The Ministry of Health is in charge of radiation protection and enforcement of regulatory provisions in the Republic of Croatia. Sanitary inspectors of the Ministry provide inspection services covering radioactive sources and materials.

The Ministry has authorized three institutions to carry out the technical tasks related to radiation protection, such as radiation source inspection and personal dosimetry (legal authority).

Such distribution of work demands co-ordination of the involved institutions, control of their work and record keeping. Control of their activities, and the setting up of the central national registry of radiation sources and workers, and of occupational doses received by the staff, as well as the co-ordination of their work, has been entrusted to the Croatian Radiation Protection Institute (CRPI).

NATIONAL SYSTEM OF NOTIFICATION AND REGISTRATION

In order to ensure that records are maintained and updated, the new Ionizing Radiation Protection Act redefines responsibilities of individual institutions. Pursuant to the law, sources are registered and workers enrolled for dosimetry control at the CRPI. For that purpose, the CRPI has developed software enabling data exchange between the legal authority, the Ministry and the CRPI.

Communication and data exchange take place mostly through the Internet. The Ministry of Health is an exception since it is connected with the CRPI through a leased line that ensures secure and fast operation. However, in the case of connection failure, the Internet can still be used.
Wherever possible, the WEB interface was used, because of its simplicity, intuitivity and ease of acceptance by users.

The basic advantage of the work with the WEB interface is that it enables the data to be updated concurrently with their change in the real life, which was our main objective.

For personal dosimetry, the CRPI developed a program in MS Access. The Access file is created on a monthly basis (which is the control period for dosimetry stipulated under the law), and it includes all the data necessary for dosimetry analysis for the relevant control period and the necessary programs. This is possible because all the registrations and cancellations are carried out through the CRPI. The file is compressed, encrypted, electronically signed and sent to the authorized institutions. On the basis of the data from those files, institutions deliver dosimeters, enter the measured doses into the file, print out the reports for the end users and return the file (filled out, compressed, encrypted and signed) to the CRPI.

The central registry of the radiation sources maintained at the CRPI is based on Oracle RDBMS, the leading manufacturer of database management systems, and it includes three groups of data.

The first group includes the data that define the device or source, such as the name of the manufacturer, model and year of manufacture. That data are part of the device registration and are entered at the CRPI when the registration is received.

The second group includes the technical data of the source which are subject to change during its lifetime. They include the tube serial number and the related technical data. The legal authorities enter the data together with the inspection reports.

The third group of data are document-related. The CRPI keeps only references to those documents. These references are entered during the process where the documents are created.

Simplified, the new source registration procedure includes the following steps:

1. An institution submits the registration for a device to the CRPI on a mandatory form.
2. The CRPI gives the device an identification number and enters the data from the first group into the database, which makes them accessible to the legal authority.
3. An authorized institution inspects the source and enters the related data with comments through the WEB. These data are printed out in the report, together with the data entered at the CRPI. As soon as the report is printed out, the sanitary inspector at the Ministry of Health is advised thereof.
4. Once this application has been received, the sanitary inspector enters the application identification and prepares the decision based on the opinion given by the authorized institution.

For the annual inspections, steps 3 and 4 are repeated. The personal dosimetry database includes:

1. basic personal data necessary for identification
2. data on dosimetry control registrations
3. data on released/returned dosimeters and received doses.

All data, with exception of the status and dose, are entered/created at the CRPI.

Since Croatia does not have industrial production of radiation sources, all radiation sources used in industry, medicine and research are imported and therefore all control is conducted on the basis of the border sanitary inspection report.

LEGISLATION

The Ionizing Radiation Protection Act of 1999 regulates protection against ionizing radiation, and ten rules and the National Plan and Programme of Ionizing Radiation Protection Measures in Case of Accident support it.

The law stipulates dose limits for individuals from critical groups: workers, trainees, students and other persons. The law clearly defines that it relates to production, processing, handling, storage, import and export and management of radioactive waste. There is clear difference between interventions in radiological accidents from earlier and current activities. The law encompasses all the electrical devices emitting ionizing radiation and operating at voltages above 5 kV.

The law does not encompass radon in residential buildings, on which the European Commission passed separate recommendations in 1990, radiation of natural radionuclides in the human body, radiation from space to the earth's surface, and radiation of radionuclides from the earth's crust not attributable to humans.

Pursuant to the law, all the activities conducted in the Republic of Croatia which are not exempted must be registered with the Ministry of Health and their performance must be approved. The difference between the EU guidelines and ICRP 60 covering specified doses in Croatia has been resolved so that the ICRP's original concept has been maintained with the average dose of 20 mSv over five years and maximum yearly dose of 50 mSv. However, the dose must not exceed 100 mSv during the five-year period.

Croatian law has not followed the ICRP 60 recommendations and the EU guidelines that group the workers with regard to expected doses. The workers are not grouped in categories A and B, depending on possibility that the received dose will exceed 6 mSv in one year. In Croatia, all workers assumed to be receiving the dose in excess of 1 mSv must carry their personal dosimeters and be under permanent medical supervision. The law has been almost completely harmonized with the ICRP 60 principles, the Basic Safety Standards (BSS) of the IAEA, and the European Community's requirements. Tabulated numerical values applied in Europe are also applicable in Croatia. The principles are the same, and personal dosimetry methods, record keeping and inspections are almost identical.

For example, the Ionizing Radiation Source Use Rules encompass all the elements of the Guideline 97743 Euratom of June 30, 1997, on medical protection of persons endangered by ionizing radiation during medical exposure. The Rules incorporated the section on medical exposure from the BSS and the tables contain referenced doses for different diagnostic procedures.

The differences in medical supervision relate to the scope and content, implementation schedules and involved persons. However, there is a clearly specified obligation for all the persons working with or handling ionizing radiation sources to undergo medical checks on an annual basis. The steering body is organized within the Ministry, which has its advantages and drawbacks. However, there is no departure from other legislation that regulates State administration organization.

The interventions differ from the activities, and pursuant to the law will be defined by the National Emergencies Plan.

NATIONAL PROVISIONS

The national provisions for management of disused sources, recovery or control over orphan sources is to be covered by National Emergencies Plan.

Education and training for safe work with ionizing radiation sources is organized by the CRPI.

The lecturers at such courses are experts in radiation protection, and the priority in engagement is given to those who have finished IAEA courses.

NATIONAL INVENTORY

The number of registered users of X-ray machines in Croatia is 654 (Table 1).

Table 1. Registered users of X-ray machines by type of institution

medical institutions	hospital	**59**
	dental	**258**
	health center	**93**
	policlinic	**21**
	other	**15**
industry		**30**
veterinary institutions		**24**
research facilities		**6**
other		**138**
total number		**654**

In those institutions, the total number of machines producing ionizing radiation is 1267, 1094 of which are used in medical institutions (Table 2). The rest are used in non-destructive testing and in research facilities.

Table 2. X-ray machines (medical use) by type

Type	Total
medical diagnostics	**577**
medical diagnostics – mobile	**132**
medical therapy	**11**
dental	**374**

The number of classified workers that undergo personal dosimetry control is 5237 and the number of legal authorities is 3; “Institut Ruđer Bošković”, “Institut za medicinska instraživanja i medicinu rada” and “Ekoteh dozimetrija d.o.o.” (Table 3).

Table 3. Number of classified workers by legal authority

Legal authority	No of persons
Institutut “Ruđer Bošković”	1036
Institutut za medicinska istraživanja i medicinu rada	1422
Ekoteh dozimetrija d.o.o	2355

Legal authorities use the Central Radiation Sources and Dosimetry Database of the CRPI for their everyday work since it contains all relevant data. All changes in the state of sources and classified workers are recorded in the database.

The total number of radioactive lightning-rods in Croatia is 379, and radionuclides used in them are Co^{60} and $Eu^{152,154}$. The number of lightning-rods with Co^{60} is 18 and with $Eu^{152,154}$ is 361. All of them should be removed from use by the year 2005.

The number of sealed sources sorted by use and radionuclide is shown in Tables 4, 5 and 6.

Table 4. Number of sealed sources used in medicine by type and radionuclide (activities on the date of purchase)

Type	No.	Radionuclide	Activity
telecobalt	6	Co^{60}	780.8 TBq
brachytherapy	10	Cs^{137}	1110.6 TBq
brachytherapy	1	St^{89}	370 MBq
brachytherapy	1	Gd^{153}	10 GBq

Table 5. Number of sealed sources (non-medical use) by type (activities on the date of purchase)

Type	No.	Activity (GBq)
calibration instruments	6	19.74
density-meters	26	82.51
geophysical research	61	1053.56
laboratory and other	66	1 416 013.35
level-meters	68	103.14
non-destructive testing	36	51 027.75

Table 6. Number of sealed sources (non-medical use) by radionuclide (activities on the date of purchase)

Type	No.	Activity (GBq)
Am^{241}	14	16.59
Am^{241}/Be	31	981.96
Cd^{109}	2	1.96
Co^{60}	68	1 203 882.47
Cs^{137}	77	223 006,39
Fe^{55}	7	1,01
Ra^{266}	17	3.39
Sr^{90}	14	9.39

Since Croatia does not have industrial production of radiation sources, all radiation sources used in industry, medicine and research are imported. In 1999, the activity of radiation sources was 1 168 930 GBq (Table 7). The inspection of import and transport of radiation sources is carried out by the border sanitary inspection of the Ministry of Health. The data on imported sources are collected daily in the CRPI regarding type and activity of specific radionuclide, and transport details. Users yearly needs are separately registered in CRPI by the users themselves.

Table 7. Activity of radionuclide by border pass and destination in year 1999 (in GBq)

GORIČAN	activity (GBq)
Zagreb	7982.241
Sl. Brod	559 810.231
Varaždin	4.185
Varaždin – Zagreb	4564.319
Zadar – Zagreb	1.268
Varaždin – Osijek	64.058
Ludbreg – Koprivnica	74.000
Varaždin – Sl.brod	5700.000
total:	**578 200,302**

PASJAK	activity (GBq)
Split	2090.386
Zagreb	10.030
Rijeka – Split	58.708
Zadar – Split	0.556
Rijeka	20 300.000
Total:	**22 459.680**

MACELJ	activity (GBq)
Varaždin – Zadar	94.845
Varaždin – Šibenik	228.730
Varaždin – Rijeka	1360.479
Varaždin – Osijek	267.087
Varaždin – Zagreb	4881.992
Zagreb – Varaždin	33.874
Zagreb – Zadar	0.000
Varaždin	1524.480
Split	0.073
Šibenik	568.454
Rijeka	216.753
Osijek	186.751
Zagreb	42 82.721
Zadar	240.008
Dubrovnik	0.002
total:	**51 886.247**

PLESO	activity (GBq)
Zagreb	410 610.942
Osijek	126.142
Split	0.136
Pula	0.014
Rijeka	0.468
Dubrovnik	0.014
Varaždin	0.042
Zagreb – Osijek	99 268.861
Zagreb – Pula	0.023
Zagreb – Rijeka	0.092
Zagreb – Rovinj	1.860
Zagreb – Split	6375.155
Zagreb – Varaždin	0.028
Total:	**516 383.775**

total for Croatia	**1 168 930.00**

Data were collected during 1998 and 1999, and are subject to verification during 2000, except for transport related and personal dosimetry data.

PRESENT SITUATION OF REGULATORY CONTROL OF RADIATION SOURCES IN CUBA

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Abstract. The report explains the basis for an effective regulatory control and in particular refers to the system established in Cuba for such purposes. Reference is made to the new Decree-Law No. 207 "On the Use of Nuclear Energy" and the main topics it covers and to the "Rules for Authorization of Practices Involving the use of Radiation Sources" which have been in force since 1998. Following it, the report illustrates the existing Cuban system of notification, registration and licensing, and of inspection and enforcement, including information of the established classification of radiation practices in the country.

BASIS FOR EFFECTIVE REGULATORY CONTROL

The core of the regulatory system designed for an effective control of radiation sources and radioactive materials are provisions which 1) establish the need for authorization to engage in a practice involving radioactive sources, 2) enforce the legal person responsible to address the competent authority before beginning the practice, 3) define prerequisites with regard to radiation protection and safety which shall be met by that person and 4) enable the authority to prescribe specific measures for radiation protection and safety and verify if they are accomplished in an unrestricted manner.

The regulatory infrastructure, as the underlying structure of the systems and organizations involved, requires clear lines of authority and responsibilities, and adequate resources to operate at all levels.

REGULATORY CONTROL OF RADIATION SOURCES AND RADIOACTIVE MATEIALS IN CUBA

Legislation

Recently, as a consequence of the accumulated national experience over the past 10 years and as a result of the growing need to update and enhance the legal bases for the utilization of nuclear techniques in several socioeconomic fields, the new Decree-Law No. 207 "On the Use of Nuclear Energy" was approved and entered into force as the top-level document of Cuba's restructured legal framework for radiation protection and safety. It was elaborated according to the latest approaches in this field. This legislation revoked the former basic Decrees and Decree-Laws, which had been in force since 1979.

The Decree Law 207 is applicable to occupational, public and medical exposure. The main topics it covers are:

- Objectives and scope
- Principles governing the use of nuclear energy
- Regulatory authorities involved: Ministry for Science, Technology and Environment through the National Center for Nuclear Safety for regulation and control of all practices except X-ray medical diagnostic devices, which are controlled and regulated by the Ministry of Public Health.

- Obligation of applying for authorization for use of radiation sources
- Licensees´s responsibilities
- Personnel authorization
- Inspections
- Radioactive waste and spent fuel management.

Regulations

As a necessary complement, regulations containing specific protection and safety requirements were also updated. The Basic Safety Standards for Radiation Protection has recently entered into force. They are based on The International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (Safety Series No 115) [1] and the Rules for the Safe Transport of Radioactive Materials, based on Safety Series ST-1.

According to the "Rules for authorization of practices involving the use of radiation sources", in force since 1998, the regulatory elements of notification, registration and licensing were established.

Notification

It is the requirement to submit a document to the Regulatory Authority to notify the intention to carry out a practice. Basically, it is a mechanism that provides information about a planned or intended action. A typical example is the low activity sources for teaching purposes.

Registration

This is a form to authorize practices, which involves a safety assessment that has to be submitted to the authority for evaluation of the fulfilment of the established prerequisites. If necessary, conditions or limitations can be prescribed. Basic criteria considered to grant this type of authorization are 1) the radiation safety as an inherent component of the design of equipment, 2) simplicity of operations which demand minimal training requirements and 3) standardization of operations and small operation problems.

Typical practices subject to registration are the use of medium activity sources in industrial gauges and radioimmunoassays.

Licensing

This is a process of granting authorization for practices involving higher risks or more complex operations. Detailed descriptions are required of the involved operations and related exposures and comprehensive safety and risk assessments for submission to the authority. The license issued frequently contains specific conditions or limitations for operations. Typical cases of practices requiring licensing are 1) industrial radiography, 2) industrial irradiators, 3) radiotherapy and 4) use of non-sealed sources in nuclear medicine, industry and research.

Classification of practices

For these administrative requirements, practices are divided into four categories according to the risk and complexity of the practice. Consequently, three types of authorizations are granted: licenses (Categories I and II) and registrations (Category III) for entities and permits for specific operations.

Fourth category practices should be formally notified to the regulatory authority. The notification shall include characteristics, technical data and location of the sources. They do not receive any authorization.

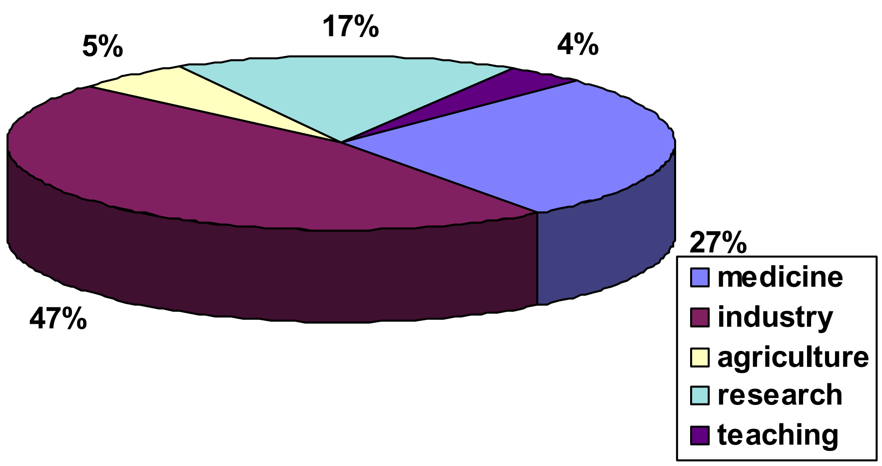
To date about 200 entities, which use around 8000 radiation sources and ionizing radiation emitting devices, are controlled. Many of them execute several practices, mainly in research. The distribution by the three first categories is as follows:

Category	Number of entities	%
1	3	1.34
2	95	42.60
3	125	56.05
Total	223	100

The geographic distribution for these categories is:

Region	Cat. 1	Cat. 2	Cat. 3
Western	3	51	49
Central	_	13	16
Central eastern	_	7	16
Eastern	_	24	44

The distribution of practices by field of application is as follows:



Inspection and enforcement

It is a shared experience that a notification and authorization system must be supported by a system of periodic inspections needed to verify the compliance with the requisites prescribed in regulations and with the conditions and limitations laid down in the authorization process. On-site verification is an essential part of regulatory control; however, the request for information or data (e.g. calibration certificates, leakage test results and dosimetric reports) has proved to be useful in some situations.

The frequency and level of on-site inspection are established taking into account risk and complexity of operations and the history of previous non-compliance or unusual events. The frequency for the above-mentioned categories is as follows:

Category I (License)	twice a year
Category II (License)	every year
Category III (Registration)	once every two years
Category IV (Notification)	if necessary

The new Decree-Law No. 207 gives inspectors authority to:

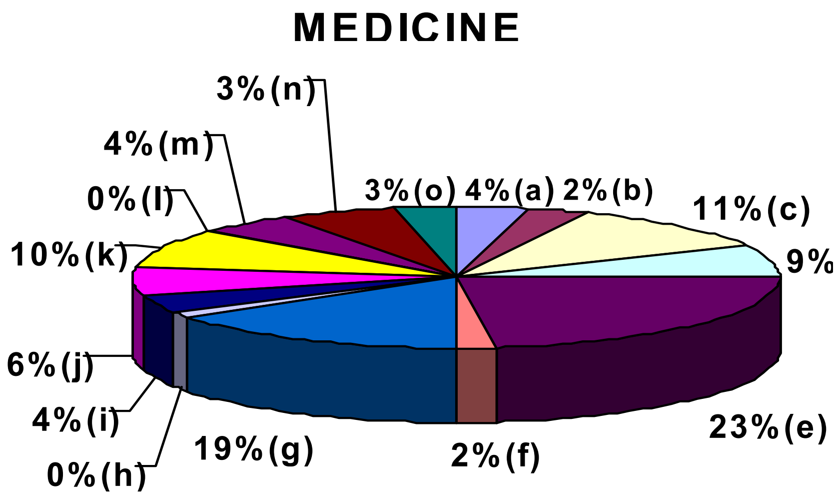
- enforce instructions to correct adverse safety conditions or regulatory infractions;
- suspend or restrict operations;
- assure, retain or confiscate unsafe radiation-emitting devices;
- temporarily or partially close rooms or installations where safety is threatened.

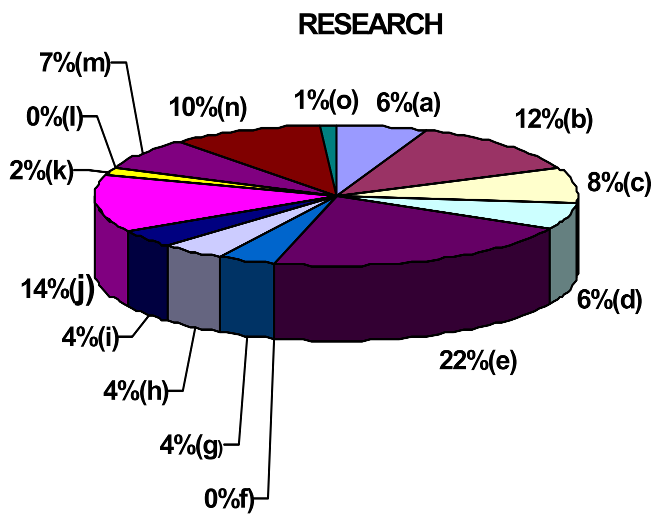
During the licensing process, it can be verified "in situ" whether the safety conditions and regulatory requirements are met.

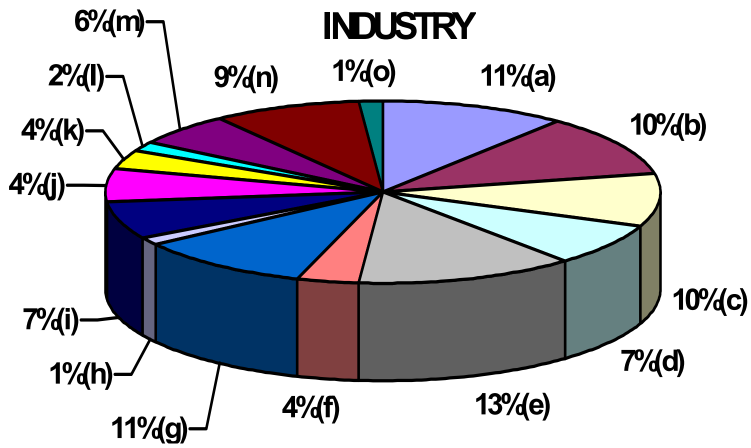
In 1999, 155 inspections were performed. Main irregularities detected during inspections have been classified in 15 different fields:

a) Update license
b) Update radioactive material inventory
c) Radiation protection measurement devices (calibration, verification, adequacy)
d) Radiation workers (training, medical examinations, occupational exposures records)
e) Records (workplace monitoring, maintenance)
f) Radiation emitting device (labelling, accessories)
g) Installation (safety systems, shield)
h) Emergency preparedness
i) Radiation protection officer designation
j) Waste management (segregation, collection, labelling, storage conditions)
k) Update dosimetric reports
l) Update legal person designation
m) Radiation protection procedures (correctness, adequacy)
n) License conditions
o) Protection devices

The results for each practice are shown in the following figures:







Radiation Safety Infrastructure
The availability of appropriate and effective technical services to both the users of radiation sources and the regulatory authority has played a key role in the regulatory programme for radiation safety in our country. It has allowed the Regulatory authority to conduct sound evaluations and verification of compliance of radiation protection requirements, particularly in such areas as suitability, adequacy and operational performance of radiation protection equipment, occupational exposure records, safe management and storage of radioactive waste, radiation protection training and leakage tests for sealed sources.

CONCLUSIONS

During the past 10 years, the radiation safety regulatory infrastructure in Cuba has been subject to a continuous process of strengthening and updating of its main components (legislation, regulation, staffing and training), as result of a Government decision to support the safe use of nuclear techniques in different fields of our socioeconomic development, and has made the necessary co-ordination and co-operation more effective between the regulatory authority and other governmental organizations [2]. International co-operation has greatly contributed to the development of the professional skills of our staff, who are strongly committed and exhibit great stability and an average experience of more than 10 years.

The accumulated experience of our system of regulatory control (notification, authorization, inspection and enforcement) has enabled us to contribute with our expertise to strengthen the regulatory programme in other countries of our region which are in early stages of implementation.

REFERENCES

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REGULATORY CONTROL OF RADIATION SOURCES AND RADIOACTIVE MATERIALS IN THE CZECH REPUBLIC

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Abstract. The paper describes legal and regulatory provisions for radiation protection and safe use of sources of ionizing radiation in the Czech Republic with special emphasis on aspects of bringing activities under regulatory control and releasing them from it. It covers the development of a new legal framework, the work of the regulatory body, an overview of sources in use and provisions to achieve effective regulatory control of facilities and releases of radioactive material into the environment. Also, it describes reported unusual events with a proposed scheme for their classification and evaluation.

ENABLING LEGISLATION

Owing to political and economic changes in the Czech Republic, the entire legislative system is undergoning extensive reconstruction.

There have been substantial changes in legislation and organization of the State's regulation of radiation protection in the past three years, which also affect the system of accountancy and control of practices involving radiation sources. Act No. 18/1997 Coll., the "Atomic Act" was approved by the Czech Government in December 1996, by Parliament on January 24, 1997 and came into force on July 1, 1997. In parallel with the Atomic Act, twelve follow–up implementing decrees were prepared by the State Office for Nuclear Safety (SONS).

The Atomic Act and these decrees are based on the internationally adopted principles and recommendations in nuclear safety and radiation protection:

- IAEA IBSS, No. 115/1994,
- ICRP Report No. 60/1990,
- EU Directive 96/29/EURATOM, etc.

The Atomic Act and decrees impose strong obligations not only upon users of sources and licensees, but upon whoever:

- performs any activity introducing sources of exposure or exposure pathways,
- extends exposure to additional people;
- modifies the network of exposure pathways from existing sources so as to increase the exposure or the likelihood of exposure of people or the number of people exposed.

The licensee, owner of source or operator shall:

- proceed in such a manner that radiation protection is ensured as a matter of priority,
- ensure that the practices are justified by benefits outweighing their risks;
- maintain a level of radiation protection where the risk to life, health and the environment will be kept as low as reasonably achievable,
- intervene if the exposure could approach levels of acute damage to health or if such measures are expected to provide more benefit than harm; and
- keep exposure of people below the prescribed limits.

Under the national legislation, SONS established a system of authorization — notification, registration, licensing — of different practices involving radiation sources, e.g. transport, import, export, distribution, usage, storage, disposal, with clearly declared:

- responsibilities of persons involved in the practice,
- requirements for ensuring radiation protection, including the security of radiation sources, record keeping of inventory and movement, and notification of unusual events.

Since, any manufacture repair, import, export, acceptance, storage, decommissioning, disposal and other activities with radiation sources, including practices involving natural sources, are activities leading to exposure, a licence issued by SONS in accordance with the legislation is required. All licensees intending to perform practices leading to exposure should handle, assess, monitor or investigate sources in accordance with the radiation protection requirements.

THE REGULATORY AUTHORITY

By governmental decision and in accordance with Act No. 85/1995 Coll., the regulatory/supervisory bodies controlling nuclear safety and radiation protection have been integrated into the State Office for Nuclear Safety (SONS). The province and authority of the Ministry of Health, the Chief Health Officer of the Czech Republic and the Regional Officers of Hygiene Service in the area of radiation protection passed to SONS.

SONS is the regulatory body responsible for governmental administration and of uses of nuclear energy and ionizing radiation and of radiation protection. The authority and responsibilities of SONS are stipulated by Act no. 18/1997 Coll. on Peaceful uses of Nuclear Energy and Ionizing Radiation (Atomic Act). This new legislation necessitated organizational changes. Within SONS, three divisions headed by deputy chairmen and one independent department were established:

- Division of Nuclear Safety
- Division of Radiation Protection
- Division of Management and Technical Support
- Department of Emergency Preparedness.

Regional centres of SONS have been established. The National Radiation Protection Institute serves as the technical and research budgetary support organization of SONS.

SONS shall carry out the following duties:

- State supervision of nuclear safety and radiation protection, and management of radioactive waste, spent fuel, nuclear materials, physical protection of nuclear facilities;
- licensing and inspection;
- evaluation and regulation of occupational, medical and public exposure due to a practice or source within a practice, i.e. normal and potential exposure;
- determination of limits, constraints, guidance and clearance levels;

- co–ordination of a national radiation monitoring network and assurance of international exchange of information on radiation levels; and
- advice to decision makers on a local and governmental level on protective measures in the case of a nuclear or radiological accident.

At present, 45 inspectors fulfil the duties of regulatory authority in radiation protection. The authority of the inspectors is stipulated in the provisions of the “Atomic Act”

- Inspectors are authorized to enter the workplaces where practices are carried out or where the equipment, objects and materials under the supervision are located and to demand the necessary documents and information;
- In the case that inspectors discover deviations from approved documentation, especially from monitoring pogrammes or emergency plans, they are authorized to stipulate the time period within which the licensee shall take necessary measures, and a schedule for remedial actions. If these deviations jeopardize radiation protection, inspectors can impose immediate revocation of the licence;
- Inspectors are authorized to order a technical audit, check or test of equipment, machines or systems if this is necessary for proving compliance with the radiation protection requirements;
- Inspectors are authorized to verify the professional competence of workers

A new system enabling experts from all regions to be engaged was applied within SONS inspection activities in 1998. This system improved the efficiency of the activities even with the limited number of 45 radiation protection inspectors.

Inspections are divided into two classes**: inspections performed by the SÚJB Regional Centres** (RCs)**,** where inspectors only of the RC affected are engaged, and specialized inspections performed by specialized inspection teams comprising inspectors from various regions. Inspections of this kind are carried out for such types of ionizing radiation sources and workplaces handling them where attaining a higher level of unification of the radiation protection practice within the whole country (e.g. for workplaces handling significant and very significant unsealed ionizing radiation sources) and the use of expertise of specialists in other regions are desirable. This system is complemented with **inspections performed by ad hoc inspection teams,** particularly for time–consuming and intricate inspections at workplaces handling very significant radiation sources.

The inspection assessment system uses four rating categories based on the following criteria:

I. Radiation source handling procedures fully comply with legislative requirements;
II. Formal deficiencies exist, not affecting the radiation protection level;
III. Deficiencies exist, requiring corrective measures to be adopted or the activity to be limited or suspended;
IV. Deficiencies exist such as call for licence withdrawal.

Overview of ionizing radiation sources and workplaces handling ionizing radiation sources

The process of privatization in the economy after 1989 brought about discontinuation of the national system of ionizing radiation source accountancy. Therefore, SONS began setting up a new ionizing radiation sources registry. As the first step, an extensive inventory of ionizing radiation sources and institutions possessing them was carried out.

The scope and demanding nature of the work associated with the execution of state administration and supervision in radiation protection is illustrated in the tables describing the numbers of ionizing radiation sources and workplaces where such sources are handled.

In accordance with Act No. 18/1997, ionizing radiation sources are divided into five classes with regard to the increasing extent of possible damate to human health and the environment: insignificant sources, minor sources, simple sources, significant sources, and very significant sources. The higher the source class, the more stringent and extensive are the requirements placed on radiation protection provisions; the licensing procedure is more complex and requires deeper professional knowledge. Supervisory activities are also aimed primarily at the potentially most hazardous sources, for which the inspections should be more frequent, extensive, and detailed.

The following institutions are classed as **workplaces with very significant ionizing radiation sources**:

- Institutions operating nuclear reactors and related technologies, notably the Dukovany nuclear power plant with its four power reactors, Nuclear Research Institute in Řež with two research reactors and the Faculty of Nuclear Sciences and Physical Engineering, and the Czech Technical University in Prague with one teaching reactor.
- Institutions operating large industrial irradiators, notably a workplace for food irradiation (spices in particular) belonging to the company Artim Praha s.r.o., and a workplace for radiation sterilization of medical material, owned by the company Biostér Veverská Bitýška a.s.
- Institutions handling major quantities of radioactive substances (very significant unsealed radionuclide sources), notably workplaces of the companies Cesio Praha s.r.o. and Isotrend Praha s.r.o.

Workplaces handling unsealed radionuclide sources

	Institutions handling significant ionizing radiation sources (Category III workplaces under Regulation 184/97)	Institutions handling simple ionizing radiation sources (Category I and II workplaces under Regulation 184/97)
Medical and veterinary applications	16	130
Industry	0	16
Other applications (research)	11	146
Total	27	292

The risk of radioactive substances being dispersed at the site or leaking into the environment exists at workplaces handling unsealed radionuclide emitters. The potentially possible maximum activity at the site is thus a significant parameter with regard to the hazard and to record–keeping. Therefore, the category of workplaces handling significant ionizing radiation sources (significant workplaces) includes such workplaces as fall in Category III under Regulation No. 184/1997, whereas workplaces in Category I and II handling unsealed sources are classed as workplaces with simple ionizing radiation sources (simple workplaces).

Sealed radionuclide sources

	Significant ionizing radiation sources	Simple ionizing radiation sources
Medical and veterinary applications	74	1422
Industry	250	3527
Other applications (research)	20	909
Total	344	5858

In sealed radionuclide sources, the radioactive substances are well encased, and the sources have been tested so that dispersion at the site and/or leak into the environment should be virtualy impossible under predictable conditions. Sealed radionuclide sources can be handled as units which are countable and fall under mandatory accountancy and record–keeping schemes. The figures representing the numbers of individual simple sealed radionuclide sources are not identical with those representing the numbers of devices where such sources are handled (a facility can handle more than one source, and the number of sources handled by an institution can even be variable; e.g. in brachytherapy).

There are more than 150 thousand minor sources in the Czech Republic, mainly calibration sealed sources and smoke detectors. Obtaining a licence is not mandatory for the use of minor sources of ionizing radiation, particularly in ionization smoke detectors: under Act No. 18/1997 it is sufficient to notify the SÚJB, which keeps records of such sources.

The notifying duty does not apply to the use of **insignificant ionizing radiation sources** because such sources do not pose any health or environmental hazard. Therefore, such sources are not included in the national registry either.

Clearance from regulatory control

The radiation protection system in the Czech Republic deals with the clearance from the regulatory control of airborne, liquid and solid wastes containing very low levels of radioactive materials.

Without a licence from SONS, it is possible to use outside a workplace with ionizing radiation sources, to release into the water flow or into the air, to deposit for waste disposal or in other ways to discharge into the environment only materials, substances and objects containing the radionuclides or being contaminated by them in such measure, for which some of the following conditions hold:

- In any calendar year, the average effective dose for the critical group of the population does not exceed 10 μSv and at the same time the collective effective dose does not exceed 1 Sv;
- During the discharge of solid substances and objects into the environment, neither the sum of the parts of mass activities of individual discharged radionuclides and clearance levels for the mass activity of appurtenant radionuclides given in regulations nor the sum of the parts of area activities of individual discharged radionuclides and clearance levels of area activity of appurtenant radionuclides given in regulations is not greater than one;

- During the release into surface water, with the exception of releases from workplaces with the very significant sources, the sum of products of volume activities of individual released radionuclides and conversion factors h_{ing} for the intake of these radionuclides by the ingestion by the adult member of the public is not greater than 10^{-4} $Sv.m^{-3}$,
- During the release into the air, with the exception of release from workplaces with very significant sources, the sum of products of volume activities of released individual radionuclides and conversion factors h_{inh} for the intake of these radionuclides by the inhalation by an adult member of the public is not greater than 10^{-6} $Sv.m^{-3}$;
- During the deposit on waste disposal, the sum of products of mass activities of individual deposit radionuclides and the conversion factors for the intake of these radionuclides by the ingestion by adult members of the public is not greater than 10^{-4} $Sv.kg^{-1}$, the sum of parts of area activities of individual deposit radionuclides and clearance levels of area activity of appurtenant radionuclides given in regulations is not greater than one and the deposit is performed in a such way that it does not cause in the distance from the surface of disposal the increase of a dose–rate equivalent of more than 0.1 μ Sv/h against the original natural background in the given locality, nor the overall dose–rate equivalent 0.4 μ Sv/h,
- During a release into public drainage, with the exception of release from very significant sources, the sum of products of volume activities of individual released radionuclides and conversion factors for the intake of these radionuclides by the ingestion by the adult member of the public according is not greater than 10^{-2} $Sv.m^{-3}$.

On the basis of a licence issued by SONS, there is possible to permit only the release of materials, substances and objects containing the radionuclides for which average effective doses for the relevant critical group of population do not exceed 250 μSv per year.

Sometimes a release from regulatory control can be allowed under certain conditions. The system of accountancy and monitoring of movement of conditionally cleared contaminated materials is currently being established in the Czech Republic.

IMPROVEMENT OF THE RADIATION PROTECTION IN THE DOMINICAN REPUBLIC

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Abstract. In the Dominican Republic, the National Commission for Nuclear Affairs (CNAN) is the regulatory authority for any activity involving ionizing raidation. In order to fulfil its duties in radiaton protection, the CNAN created to National Centre of Radiological Protection (CNPR) for the control, regulation, inspection and supervision of all radiaton practices. Under Decree 244/95, the "Regulation of Radiological Protection" was promulgated. It defines the legal framework to regulate the use of ionizing radiation in the country, including the requirements and obligations of the users. The report refers to the activities carried out to substitute caesium-137 for radium-226 used in hospitals for brachytherapy practice, and provides information on the national inventory of radiation generators and sources. The report also explains the licensing process initiated in 1999, and the difficulties encountered in enforcing the regulations.

INTRODUCTION

In the Dominican Republic, the National Commission for Nuclear Affairs (Comisión Nacional de Asuntos Nucleares (CNAN) is the regulatory authority for any activity involving ionizing radiation, either by radioactive material or equipment. The CNAN was restructured, by Decree 414-91, and from 1993 reinitiated its operations under the Secretariado Técnico de la Presidencia (STP). Among the first activities to be continued was the creation of a legal framework in order to define its goals and activities.

REGULATORY INFRASTRUCTURE

The CNAN created, in order to fulfil its duties in radiation protection, the National Centre of Radiological Protection (Centro Nacional de Protección Radiológica (CNPR)), in charge of control, regulation, inspection and supervision of all practices related to the use of ionizing radiation.

Figure 1 shows the structure of the regulatory authority, in which it can be observed that the CNPR is involved in all aspects of radiation protection.

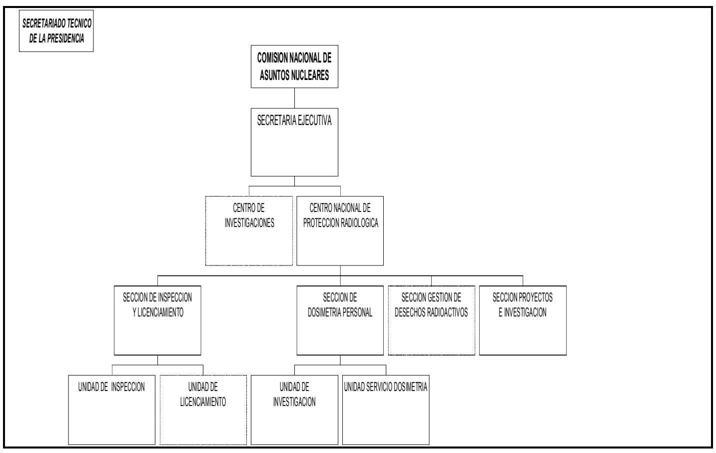

Figure 1. Structure of the "Comisión Nacional de Asuntos Nucleares".

DESCRIPTION OF ACHIEVEMENTS

Legislation

During 1995, the Government, under decree 244-95, published the "Regulation of Radiological Protection", which defines the legal framework to regulate the use of ionizing radiation and establishes the requirement for users to adhere to the regulations of the CNAN for the different practices involved. This regulation established that the CNAN is the only qualified regulatory authority.

To carry out the application of the Regulation of Radiological Protection, Rules and Guides were created in order to initiate the process of licensing and permission for the different practices. Table 1 summarizes them.

Table 1. Regulation, Rules and Guides

Rules	**Date**
Regulation of Radiology Protection	Decree 244-95 18/10/95
Rules to authorize the practice associated with use of ionizing radiation	17/7/98
Security and radiation protection guide for the practice of nuclear medicine	December 1998
Security and radiation protection guide for the practice of X-ray diagnosis	December 1998
Security and radiation protection guide for the practice of radiotherapy	December 1998
Transport regulations	We assumed the IAEA transport regulation
Radioactive waste management	In progress
Radiation emergency response plan	In progress

Radium-226

From the beginning, the CNAN initiated the retirement of all Ra-226 sources in use for brachytherapy, substituting them, with the aid of the International Atomic Energy Agency (IAEA), with Cs-137. Ra-226 sources were found in two medical institutions and in the one that presented appropriated conditions to continue operating, they were substituted by Cs-137 for remote loading with low level dose and manual applications. Table 2 shows the Ra-226 retreat.

Table 2. Radium-226 source retreat

Amount	Institution
320 mCi	Oncology Institute "Dr. Heriberto Pieter"
43 mCi	UCE Hospital

Note: Previously, OPS had retreat the Ra-226 sources from a Medical Institute in which resulted contamination.

Sources in medical and industrial environment

One of the first activities developed by the CNAN was a survey for a national inventory of radiation sources in use and disuse and of ionizing radiation equipment.

The Dominican Republic has 29 provinces and at present, all but two have been surveyed for most of their X-ray equipment for diagnostic use and their nuclear medicine centres

Table 3 shows the inventory for all sources.

Table 3. Inventory of equipment and source in use

345	X-Ray diagnostic equipment
10	(Cs-137) Am-241/Be humidity control
19	Am-241 Level control
9	Sr-90 Humidity and density control
3	Ir-192 Gammagraphy
4	Co-60 Level control

Relevant sources used in the medical environment, Co-60 units and Cs-137 sources, are presented in Table 4.

Table 4. Inventory of relevant sources

Source	Institution	Unit	Practice
Co-60	4	7	Radiotherapy
C-137	4	1300mCi	Braquitherapy

In Table 5 we present the inventory of disused sources.

Table 5. Inventory of disused sources

Unit		**Practice**
5	(Cs-137) Am-241/Be	Humidity control
2	Cs-137	Research
1	Am-241	Industrial
1	Co-60	Radiotherapy
1	Cs-137	Radiotherapy

LICENSING AND OTHER PERMITS

At the end of 1999, CNAN started to license industrial and medical premises and radiopharmaceutical imports. The licenses are institutional and personal.

As of today, the situation is as follows:

1 industrial irradiator
1 centre of nuclear medicine
2 diagnostic centres

1 radiopharmaceutical importer *
2 centres for nuclear medicine *
1 radiotherapy centre *
(* in progress)

SANCTION

One of the limitations that the regulatory authority faces is that, although it has the authority to sanction those that do not comply with the established regulations, the mechanisms to enforce this authority have not yet been created.

STRUCTURAL AND FUNCTIONAL ORGANIZATION FOR RADIOLOGICAL CONTROL AND PRACTICAL GUIDE FOR RADIOACTIVE SOURCES CONTROL IN OPERATION AND FOR EMERGENCIES AT THE ECUATORIAN ATOMIC ENERGY COMMISSION (CEEA)

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Abstract. The new structural organization for the regulation of radiation protection and the control of radiation sources is provided. It was established according with the strategic plan for 2000 of the Ecuatorian Atomic Energy Commission. Reference on the contains of the practical guidance for the control of radiation sources during normal and emergency situations is explained.

INTRODUCTION

- Considering that atomic energy is a scientific and technical heritage for modern civilization and that its peaceful applications in medicine, industry, energy generation, research and education involve risks for the exposed individuals and to humankind;

- Having as a main goal the protection against the harmful effects of ionizing radiation of the entire population and, particularly, of the individuals who work with radiation;

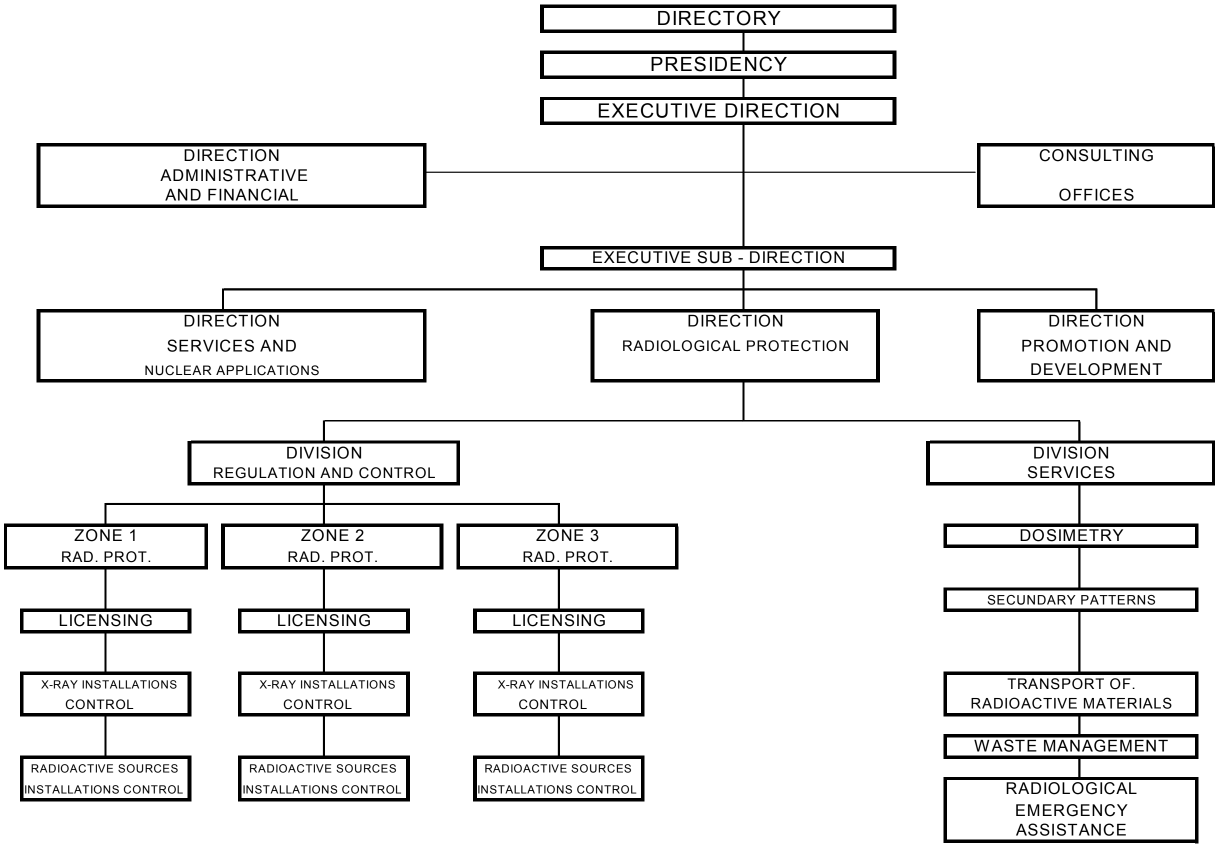
- With the purpose of speeding services to CEEA users and offering them suitable technical assistance.

A new structural and functional reorganization of the radiological control unit was performed, and the technical roles and legal issues of radiological protection were reviewed and modernized in accordance with the CEEA's Strategic Plan for 2000. To improve technical support and administrative matters, the country was divided into three zones with technical departments located in the cities of Quito, Guayaquil and Cuenca.

A practical guide for the control of radiation sources in operation and emergencies was created with the main objective of regulating the use of radioactive material and facilitating aid in initial response to emergencies. This important document was developed as a tool for CEEA's technical staff in accordance with the Strategic Plan 2000. The efforts made are already yielding results and users working with these materials have expressed their satisfaction.

DETAILS

CEEA Structural Organization for Radiation Monitoring



CEEA Functional Organization for Radiation Monitoring

The Division for Regulations and Control through different zones for radiological protection, performs functions related to licensing and control of X ray facilities and radioactive sources.

The Division of Radiological Protection Services performs functions related to dosimetry and metrology of radiation, safe transport of radioactive materials, radioactive waste management and radiological emergency assistance.

PRACTICAL GUIDE FOR THE CONTROL OF RADIATION SOURCES DURING NORMAL OPERATION AND IN EMERGENCIES

The document contains five sections:

(a) an inventory of the main radiation sources and equipment being used in Ecuador, with basic information about them;
(b) details regarding specific radiation sources and equipment - the institution where the source or equipment is being used, the field of activity in which it is being used, the type of source or equipment, the serial or other identification number of the source or equipment, the date of calibration, the activity, and the personnel responsible;

(c) the distribution of installations in Ecuador where radiation is being used, according to the application;
(d) contact points for radiological emergencies; and
(e) general procedures for radiological emergencies.

REFERENCES

[1] Ley de la CEEA, Registro Oficial No. 798 del 23 de Marzo del 1979.
[2] Reglamento de Seguridad Radiológica, Registro Oficial No. 891 del 8 de Agosto de 1979.
[3] Reglamento Orgánico Funcional de la CEEA, Registro Oficial No. 115 del 7 de Julio del 2000.
[4] Documentos de Registro de la Dirección de Protección Radiológica de la CEEA.
[5] Guia SINAER, Versión 1999, Brasil.

ESTONIAN EXPERIENCE IN ESTABLISHING THE NATIONAL RADIATION PROTECTION INFRASTRUCTURE IN THE NEWLY INDEPENDENT STATE

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Abstract. The Estonian Radiation Protection Centre (ERPC) was established on 4 January 1996 as the regulatory authority for radiation protection and safety of radiation sources. The report explains the ERPC's structure and its main functions and activities, and provides information on the regulations that have been approved or are planned to be adopted. Reference is made to radiological emergency preparedness and, in particular, to the status of development of the system of regulatory control by authorization and inspection of radiation practices in the country.

INTRODUCTION

Estonia is a small country on the south coast of the Finnish Gulf, with no more nuclear facilities on its territory. It has been a Member State of IAEA since 1992, from which time a detailed assessment of radiation and waste safety infrastructure has been made. We are very grateful to the IAEA for our inclusion in the project INT/9/143 "Upgrading Radiation and Waste Safety Infrastructure" (Regional Field Manager Alejandro V. Bilbao-Alfonso) and later in the regional Model Project RER/9/056 "Upgrading Radiation Protection Infrastructure" (Regional Project Manager Jozef Sabol).

REGULATORY AUTHORITY

The Estonian Radiation Protection Centre (ERPC) was established on 1 January 1996. The structure of the ERPC is as follows:

Administration (Management) Departments:

1 Environmental Research and Early Warning
  – Radiological Laboratory
2 Radiation Protection
3 Supervision and Inspection
4 Regulations and Standards
5 Information
  – Library
6 Advanced Training

In its activities, the ERPC is guided by national law, governmental regulations, orders of the Minister of Environment and its own statute. Our main tasks are:

- permanent monitoring and early warning;
- advising the government and other public authorities on radiation safety matters;
- making suggestions on implementation of radiation safety measures and initiating the drafting of legal acts;
- evaluating draft legal acts and norms concerning radiation protection;

- harmonizing regulations and norms with EU directives;
- issuing licenses for radiation practice;
- performing supervision and inspection;
- keeping the State Dose Register of radiation workers;
- keeping the Radiation Source Register;
- carrying out regulatory control of waste management;
- organizing and carrying out advanced training;
- disseminating information on radiation safety;
- collecting literature published in Estonia and included in the INIS database.

STRENGTHENING REGULATORY FRAMEWORK

The first important task was the preparation of the Radiation Protection Act. The draft was reviewed by the IAEA experts Mr. Raimo Mustonen and Mr. Alejandro V. Bilbao, who gave us advice and direction. The Radiation Protection Act was passed in Parliament in April and signed by the President on 10 May 1997. The following low level regulations have been or are planned to be adopted:

GOVERNMENTAL REGULATIONS

- Establishing the limits for the total amounts of radioactive substances and the limits for the specific activity thereof exempted from the requirement of licensing for activity involving radiation (30. 01. 98);
- Packaging and marking on transportation (04. 08. 98);
- Statute of the National Dose Register of radiation workers (04. 02. 99);
- Procedure for certifying radiation workers and for issuing certificates (04. 02. 99);
- Establishing the regulations on transport of radioactive material, radiation devices containing radioactive material and radioactive waste (June 2000);
- Training, instruction and assessment of radiation protection of exposed workers, apprentices and students (Nov 2000);
- Establishing the requirements for intervention in the case of radiological emergency (Nov 2000);
- The policy and development plan of radioactive waste management (Dec 2000);
- Organizing the supervision of radiation doses of outside workers (2001);
- Control and supervision of radiation sources and radioactive waste in import, export and transit (2001).

REGULATIONS OF THE MINISTER OF THE ENVIRONMENT

- Procedure for issuing licenses for activities involving radiation (06. 08. 97);
- Procedure for registration of radiation sources (06. 11. 97);
- Establishing the radiation factor and tissue factor values (25. 03. 98);
- Establishing the procedure for radioactive waste management, registration and transfer (08. 09. 98);
- Establishing the procedure for assessment and monitoring of public exposure caused by natural radiation, radiation practice, sources and accidents (08. 09. 98);

- Establishing the list of equipment, materials and consumer goods mandatory for type approval (14. 01. 99);
- Establishing inhalation and ingestion dose coefficients for radiation workers (13.05.99);
- Establishing the requirements concerning the safe use of premises and buildings housing a radiation source and their structure and the requirements for the safe operation of the radiation source (03. 09. 99);
- Procedure for management, registration and transfer of radioactive waste generated in medicine, industry, research and nuclear activities and the limits for the specific activity in their management (Oct 2000);
- Rules for management and registration of radioactive wastes containing natural radionuclides arising from reprocessing of natural sources (Oct 2000);
- Inspection in medical radiology (Nov 2000);
- Procedure for prior information of the population living in an area of potential hazard (Nov 2000).

REGULATIONS OF THE MINISTER OF SOCIAL AFFAIRS

- Establishing the procedure for the medical control of workers (29. 10. 98);
- Requirements for the use of radiation for therapeutic and diagnostic purposes (03.12.98);
- Requirements for protection of medically exposed patients (03. 12. 98).

GUIDELINES ISSUED BY ERPC

- Guidelines for implementation of the regulation on issuing licenses to the radiological services of health protection institutions for activities involving radiation (12. 11. 97);
- Guidelines on radiation protection and safety of radiation workers in Tallinn Engineering Plant (18. 01. 99);
- Guidelines for the structural units of Tartu University using radionuclides and other radiation sources of ionizing radiation (07. 06. 99);
- Guidelines for the customs on detection and response to illicit trafficking in radioactive materials (04. 02. 2000).

EDUCATION, TRAINING AND EXPERTISE

In implementation of the IAEA projects, Estonia and especially the ERPC had successful and important help from Regional Managers Mr. A. V. Bilbao and Mr. J. Sabol and from IAEA experts: R. Becker, P. Booth, G. Brown, K. Coleman, A. Cregut, J. Haider, M. Laraia, I. Petr, R. Pulzer, K. Skornik, S. Deme, V. Aleinikov, V. Tsyplenkov.

Our specialists took part in 15 different basic courses, workshops, seminars and training courses.

The ERPC organized two international courses and one national basic course for participants from various institutions (Rescue Board, customs, border guards, police, medicine) every year.

RADIOLOGICAL EMERGENCY PREPAREDNESS

At present, the network consists of eleven fully automatic stations and three manual measurement units. The artificial radioactivity of air particles and aerosols is monitored by analysing sample filters from three localities. Operative radiological data from automatic monitoring stations of the whole national network is accessible to the public on the Internet website of the ERPC (www.envir.ee/ekk).

A process for drawing up a new national action plan for radiological emergency situation has been initiated.

DEVELOPMENT OF REGULATORY CONTROL

Licences are given to industry, research and medical institutions that use radiation sources. All imported radiation sources are taken into account and included in a source register (Regulatory Authority Information System - the RAIS programme, software developed by the IAEA). All radiation sources from industrial, research, scientific and medical institutions are included in the RAIS register, and are continually updated. Sources that are removed from exploitation must be taken to the radioactive waste management facility at Paldiski in due time.

The procedure for issuing licences for activity involving radiation has been established by a special regulation of the Minister of Environment. The procedure of authorization is obligatory to every legal person who intends to carry out activities specified in the Regulation. In medicine, the licence may be issued in compliance with the decision of the Commission of Qualified Experts, which was established in 1997 and includes experts of the ERPC, quality assurance experts and most qualified radiologists. The licence may be issued for a maximum of five years. The frequency of routine inspections is two years.

Estonia has one central personal dosimetry service for external exposure – the ERPC, and a small laboratory at Tartu University, which is licensed by the ERPC to provide these measurements, too. Until 2000, Estonia did not divide occupationally exposed workers into two categories (A and B). Individual monitoring was performed for all occupational workers. The TLDs (thermoluminescence dosimeters) with LiF pellets are used for dose measurements of occupationally exposed workers. Since 1995, the Hp(10) values are provided on the basis of the Finnish RADOS TLD System. The system includes a reader, an irradiator, a personal computer and the necessary number of dosimeters. According to the order of the Statute on keeping a dose register, individual dosimeters will be replaced once a month. On the way to harmonize our legislation with that of the European Community in 2000, some changes in the Radiation Protection Act should be made. One of the changes would be the division of occupationally exposed workers into two categories. Individual monitoring for category B workers would be carried out taking into account a customer’s decision, and for category A - once a month.

The ultimate quality objective in medical radiology is to ensure a high accuracy of diagnosis and quality of therapy and to keep the radiation exposure of patients as low as reasonably achievable, and also to prevent radiation accidents.

According to a Regulation of the Ministry of Social Affairs, radiologists and other individuals involved in radiological practice must have adequate theoretical and practical training in the field, and recognized diplomas, certificates and qualifications. During 1998–1999, various seminars and training courses for radiological staff in medicine were organized in Estonia, the most recent on quality management in radiology. Materials of this training course will be used for the preparation of Quality Assurance Manuals in radiological departments.

Under the same regulation, the licensee has to make arrangements to control the operation of radiation equipment and related facilities used for medical procedures. This document explains how quality control (QC) must be organized for diagnostic X-ray purposes, for diagnostic X-ray equipment and accessories, radiographic films, radiographic film processors and darkrooms, image recording and viewing facilities and protective devices. The licensee shall document the programme, nominating a person responsible for the QC programme and a person responsible for carrying out the QC. In 1996, the Medical Equipment Training Centre (METC) at Tartu University was established. The METC carries out the QC tests at radiological departments and training in the QC field. In 1998–1999; seventy-three X-ray facilities have been checked by the METC.

To date there is no overall programme for radioactive waste management and safety. In 1999, a strategy for radioactive waste management was initiated and a complete draft is envisaged by the end of 2000.

This strategy should cover the following areas:

- estimation of the future amounts of radioactive waste to be generated over the next 50–100 years;
- storage for all kinds of radioactive waste in Estonia - site estimation, research activities, safety assessment and environmental impact assessment for a long period;
- amendment of the current legislation;
- expertise capacity and ways to improve it;
- specification of the roles of different Ministries;
- public opinion and local authorities;
- cost estimation and sources of funding;
- international co-operation and investment.

CONCLUSIONS AND ACKNOWLEDGEMENT

Now, at the end of 2000, we can say that the radiation protection infrastructure according to the IAEA recommendations has been founded, and that radiation protection and safety is under control in Estonia. This has been achieved through hard work of Estonian specialists and the assistance and support from the IAEA and from Danish, Swedish and Finnish authorities and experts. The ERPC is very grateful for their efficient help.

THE STATUS OF SAFETY OF RADIATION SOURCES AND SECURITY OF RADIOACTIVE MATERIALS IN ETHIOPIA

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Abstract. Since 1993, the National Radiation Protection Authority (NRPA) has been empowered by the "Radiation Protection Proclamation no. 79/1993" to authorize and inspect regulated activities, issue guidelines and standards and enforce the legislation and regulations. The report describes the status of the safety of radiation sources and the security of radioactive materials in Ethiopia and the progress made towards building a sound and effective national regulatory infrastructure. Also, the report highlights the challenges and difficulties encountered and concludes by indicating the way forward towards the strategic goals.

INTRODUCTION

The application of nuclear techniques in Ethiopia started in the early sixties in the medical field and has gradually expanded to other areas such as agriculture, animal health and research, hydrology, mining and industry.

Following this growth, radiation protection in Ethiopia dates back over 15 years. A radiation protection service was initiated as a result of the introduction of irradiation techniques for biological research at the University of Addis Ababa. The service was extended to the users of ionizing radiation, mostly for workers in X-ray departments of hospitals in the country, without any regulatory mandate and legal infrastructure.

The Government of Ethiopia promulgated radiation protection legislation in December 1993, which established an autonomous regulatory authority to control and supervise the introduction and conduct of any practice involving sources of ionizing radiation.

The legislation defined the responsibilities of the regulatory authority so that it could preserve its independence of judgment and decisions as the top safety authority. The legislation empowered the regulatory authority to implement a regulatory programme and contained details of the nature of operational regulations.

Before 1998, there was no significant development in building a radiation protection infrastructure but in the last two years, Ethiopia has been actively co-operating with the IAEA in the framework of a regional Model Project. The inputs received through the project coupled with demonstrated local commitment have immensely contributed to a transformation process and the current status of achievement.

This report describes the status of the safety of radiation sources and the security of radioactive materials in Ethiopia and the progress made towards building a sound and effective national regulatory infrastructure. Also, it highlights the challenges and difficulties encountered and concludes by indicating the way forward towards the strategic goals.

THE NATIONAL REGULATORY INFRASTRUCTURE

The main legislation governing the practice of ionizing radiation, called "The Radiation Protection Proclamation No. 79/1993", was issued by the House of Representatives, on 22 December 1993.

This law established and empowered the national radiation protection authority (NRPA) to authorize and inspect regulated activities, issue guidelines and standards and enforce the legislation and regulations.

The NRPA is organized as an autonomous public authority and has now strengthened and developed to a level of competence for effectively fulfilling its legislative mandate under the enabling provisions of the legislation. Its functions are also emerging and developing to cover all aspects of regulatory control.

The main legislation contains some detailed provisions, with the nature of regulations which are being used to bridge the gap until the issuance of detailed regulations. The drafting and review of a set of regulations based on the BSS, including the IAEA regulations for safe transport of radioactive materials, is nearly completed. They will shortly be submitted to the Government for approval and promulgation.

The NRPA has developed and implemented provisional practice-specific procedural guides. The designing of the detailed and final version is also complete.

As an essential part of the national infrastructure, the NRPA is now empowered to enforce the law and develop national credibility and recognition as the top safety authority. It has all the required resources to effectively implement its regulatory programme, which includes:

- an independent and centrally located office and laboratory facility, and an adequate number of vehicles for inspection and administration work;
- adequate regular and capital budget to fund all the NRPA's regulatory and support activities;
- an approved organizational structure, which is used as a guiding document for the functional classification of tasks and staff assignment. The organigram and the staffing plan is currently being updated and revised in order to address emergent needs.

See Annex 1 for details.

In line with the ongoing changes and the status of organizational development, the level of staffing in the NRPA has substantially changed. Total staff amount to 38, consisting of:

1	General Manager
1	Legal Officer
10	Technical staff/ regulatory, technical support etc.
6	Administrative support staff
20	Other general service staff.

THE NATIONAL REGULATORY SYSTEM

The regulatory activities are designed in line with the main regulatory instruments, notification, authorization, inspection and enforcement. In its effort to develop a systematic regulatory regime in a professional transparent and sustainable manner, the NRPA has developed and tested in practice pertinent guidelines and procedural manuals.

This manuals and guidelines are:

- General procedural manual on regulatory process and principles;
- Procedural guidelines on the systems of notification, authorization, inspection and enforcement;
- Procedural guides for the authorization of diagnostic radiological facilities;
- Procedural guides for the authorization of nuclear gauges.

After improvement based on test feedback, the manuals have been issued as a permanent systemic instrument. Effort has also continued for preparing and issuing other guides such as;

- Procedural guides for the authorization of industrial radiographic sources;
- Procedural guides for the authorization of nuclear medicine facilities.

NOTIFICATION

The system of notification for effectively identifying and locating radiation sources subject to regulatory control is in place. Users of radiation sources and equipment notify the NRPA through application for import and authorization for practice.
Arrangements have been made with the Ethiopian Customs Authority and the Investment Authority of Ethiopia so that any importation of radiation sources and equipment is subject to the clearance and approval by the NRPA.
The NRPA has an inventory of sources and equipment and periodically updates the source/ equipment user and inventory status.

AUTHORIZATION

The NRPA has developed a system of authorizing practices by registration or license. A final set of procedural guide documents and application forms, safety assessment protocols, and practice-specific guides are currently being designed and put in practice.

INSPECTION

In the 1999/2000 budget year, the NRPA has established and activated an inspection plan and priority listing based on the degree of hazard associated with the practices and past inspection history. Now all practice centres and sources are routinely inspected once a year and the frequency can be increased according to the degree of hazard.
Inspections are carried out according to procedural and technical guidance documents, and a system of monitoring is in place to ensure that inspection findings are communicated to the users in a timely and clear manner.

ENFORCEMENT

The issue of enforcement is complex in an environment where a limited alternative for health service provision exists with a retrospective regulatory exercise. However, the NRPA has developed a coherent set of strategies to further enforcement actions gradually, starting from the most recent practices.
A new co-operative framework arrangement has been established between the Ministry of Health, the Addis Ababa regional Government Health Bureau and other

regional governments to co-ordinate actions for the enforcement of the radiation protection. An enforcement guide is now in use to maintain consistency and objectivity. Regularly improving the enforcement guide document is also a follow-up task for the NRPA to ensure continual systemic improvement.

NATIONAL INVENTORY OF RADIATION SOURCES AND RADIOACTIVE MATERIALS

Registration of radiation sources and radioactive materials started in 1996 by distributing questionnaires to different institutions and departments in the country and simultaneously issuing announcements in the media. Since then the inventory has been regularly updated.

In June 2000, the NRPA issued the final and clearing public call for registration of all radiation sources and radioactive materials and launched a co-ordinated campaign. The response was significant; an up-to-date inventory now accounts for about 95% of radiation sources and radioactive materials in the country.

The NRPA has now fully implemented the Regulatory Authority Information System (RAIS), which provides a systemic integration and will be instrumental in enhancing the effectiveness of the regulatory system.

The total number of registered equipment (X-ray) currently stands at 338.
The classification of the equipment is as follows:

- Plain radiographic 264
- Dental 51
- CT scanners 2
- NDT 6
- Others 15
- Total 338

The radioactive source inventory stands at 35 with the following breakdown:

- Nuclear gauges 18
- NDT 2
- Research (sealed sources) 10
- Research (unsealed sources) 1
- Medical application 4
- Total 35

For details, see Annex 2.

PROVISION OF SUPPORT AND TECHNICAL SERVICES

A substantial progress has been made in the development and provision of support and technical services in the following areas:

a) Metrology and Calibration Services

- Construction of an “Irradiation Bunker Building” has been finalized.

- Installation of equipment for the secondary standards dosimetry laboratory (SSDL) is complete, the equipment is also commissioned for operation and training of operating personnel has been carried out.
- Two electrometers and ionization chambers of the SSDL were sent to the IAEA Seibersdorf Laboratory for calibration and calibration factors were obtained.
- A fully responsible SSDL expert has been assigned, the working system is being established and the laboratory is ready for routine service.
- Arrangements are under way with the Ethiopian Authority for Quality and Standards to get official accreditation.

b) Instrument Maintenance Service

The instrument maintenance workshop for maintaining radiation monitoring equipment has been reorganized into the new office/lab complex. Recruitment is under way to get a full time instrument maintenance engineer/technician and provide maintenance services on a regular basis.

c) Individual Monitoring of Personnel

Personal monitoring of radiation workers involved in radiological and other activities is being provided using thermoluminescence dosimetry technique (TLD). The current estimate of the total number of radiation workers needing to be monitored is about 1200, and a total of 560 workers have so far been receiving this service every month.

Installation and commissioning of the newly delivered Harshaw 4500-TLD reader, subsequently the upgrading of WIN-REMS and installation of the Health Physics Recording System and training of operating personnel has been finalized. With this augmented capacity, the NRPA will expand the coverage of personal monitoring services with a priority for medical radiologists and radiographers to achieve full coverage by the end of year 2001.

d) Environmental and Food Monitoring

A high-resolution gamma spectrometry system is used to analyse food and environmental samples. A certificate of radioactivity concentration is provided to customers for export food-stuffs. The NRPA is planning to expand this activity to import food control in the near future. Ambient level radiation measurement is currently carried out at seven synoptic meteorological stations within and outside the capital. The TLD technique is employed and crystals will be collected and read on a quarterly basis.

NATIONAL PROVISION FOR MANAGEMENT OF DISUSED SOURCES

There is a need to organize a central interim storage/repository facility in Ethiopia. The NRPA has prepared a project profile for its establishment. Preparatory work for developing a detailed project document is under way. Preparation is also under way to prepare a national waste management strategy based on the assessment of the realistic needs. This is an area where the NRPA seeks co-operation with international bodies in the immediate future.

EMERGENCY PREPARDENESS AND RESPONSE

With the number of sources which are in use at present and a possible increase in the future, the likelihood of an emergency cannot be ruled out. An organized structure for emergency response does not exist. The Ethiopian Science and Technology Commission is the contact point in the event of such emergencies. To close this gap, the NRPA is planning to design a national radiological emergency preparedness and response plan and elaborate the mechanism for subsequent approval by the appropriate bodies in the near future.

TRAINING AT NATIONAL LEVEL

Despite a serious limitation of capacity, in the past two years the NRPA has promoted training in protection and safety among key target groups and such programmes will expand in content and outreach as the capacity limitation is alleviated. Training events organized so far:

- A national training programme on the safe uses of ionizing radiation has been designed and implemented with the support of an expert from the IAEA.
- In this programme, over 80 radiologists, radiographers, officers in charge of radiology departments, delegates from sealed source users and Ethiopian customs officers participated in two sessions of a week's duration each.
- A seven-week in-house training programme on basic radiation protection and regulatory functions of the NRPA has been designed and implemented for newly recruited staff of NRPA.
- Basic organizational development training was organized for the NRPA staff in order to raise awareness and provide the essential skills of basic management, planning, communication and performance monitoring and evaluation.
- A one-day awareness promotion seminar for Addis Ababa regional Health Bureau officers was conducted.

Besides such efforts, an awareness promotion programme was also transmitted by public media on two occasions and this will continue quarterly.

INFORMATION DISSEMINATION

As an important supplement to the regulatory system, the NRPA periodically disseminates information to relevant users and stakeholder groups about protection, safety and related findings. The system has two basic components characterized by the type of information conveyed, i.e. regulatory or public awareness. Regulatory inspection findings are promptly communicated to users and partners. In the case of any irregularity, the NRPA informs the relevant party about such occurrences and this system is continually being upgraded for effectiveness. The NRPA intends to publish a description of the radiological safety condition of the facilities and practice centres in the country together with the annual reports.

To increase public awareness, besides using the mass media and targeted event-based promotion, the NRPA has also established an information and documentation centre, which will expand its public information outreach.

EXTERNAL RELATIONS AND CO-OPERATION

In this area, activities have been carried out to promote the objectives and regulatory mandates of the NRPA and the Radiation Protection Proclamation.

A number of consultative meetings have been organized and discussions held with several public and governmental bodies mainly on issues related to the implementation of the Radiation Protection Proclamation and co-operation on that matter.

The major parties involved are:

- Regional Governments and pertinent bureaus;
- The Ministry of Public Health;
- The Department of Pharmacy and Drug Control;
- The Ministry of Foreign Affairs;
- Ethiopian Air Lines;
- The Customs authority;
- The Ethiopian Authority for Quality and Standards;
- The Federal and regional police departments.

MAJOR OBSTACLES

There have been numerous challenges faced and tackled in the course of the NRPA's development. The major ones which reflect on its long term performance are:

- challenges and complexity associated with retrospective licensing;
- sources imported long ago without proper documentation and lacking appropriate storage;
- lack of a centralized repository facility;
- stretching activities while developing the basic capacity.

THE WAY FORWARD

The national radiation protection authority has implemented with success activities pertaining to the formative/organizational and development/implementation phases of the regulatory programme development. Through this exercise, the NRPA has developed the key strategic assets and appropriate capabilities for building a credible and appropriate radiation protection infrastructure. The lessons learned through the organizational development exercise are also significant for shaping our future strategies.

The challenges of today and the near future are:

- consolidating the current achievements and ensuring sustained operational effectiveness;
- continually ensuring appropriate performance monitoring, measurement and evaluation system;
- maintaining a continuous performance improvement programme;
- building the required flexibility in order to achieve an appropriate fit with the dynamically changing transition environment in Ethiopia.

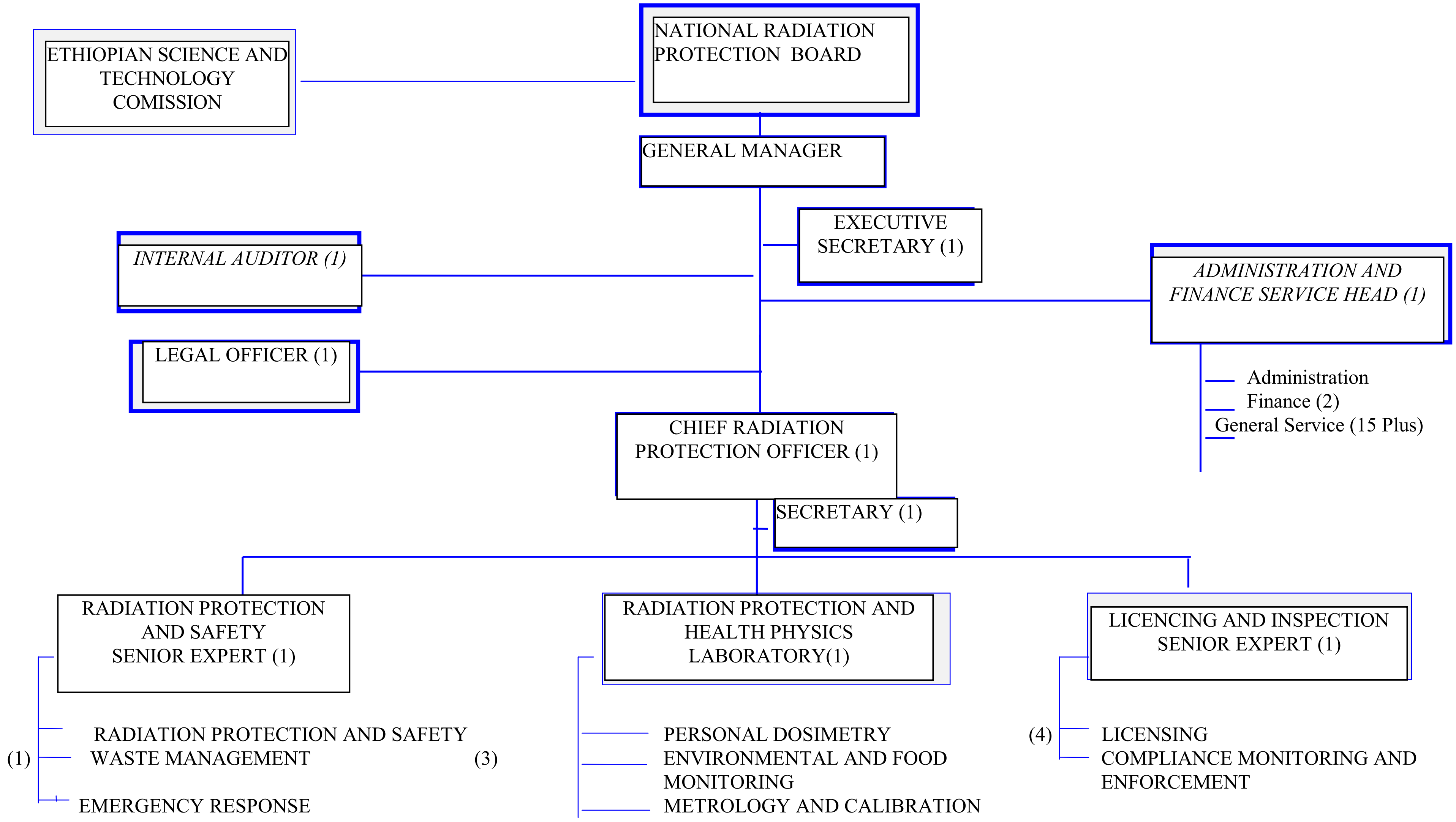
To this end, among the available strategic routes, the NRPA will pursue the following to achieve sustained effectiveness and efficiency:

- building a collaborative framework for strategic partnership and maximizing the degree of support provided by its key stakeholders;
- continually augmenting technical competence and building credibility and confidence in different public sectors;

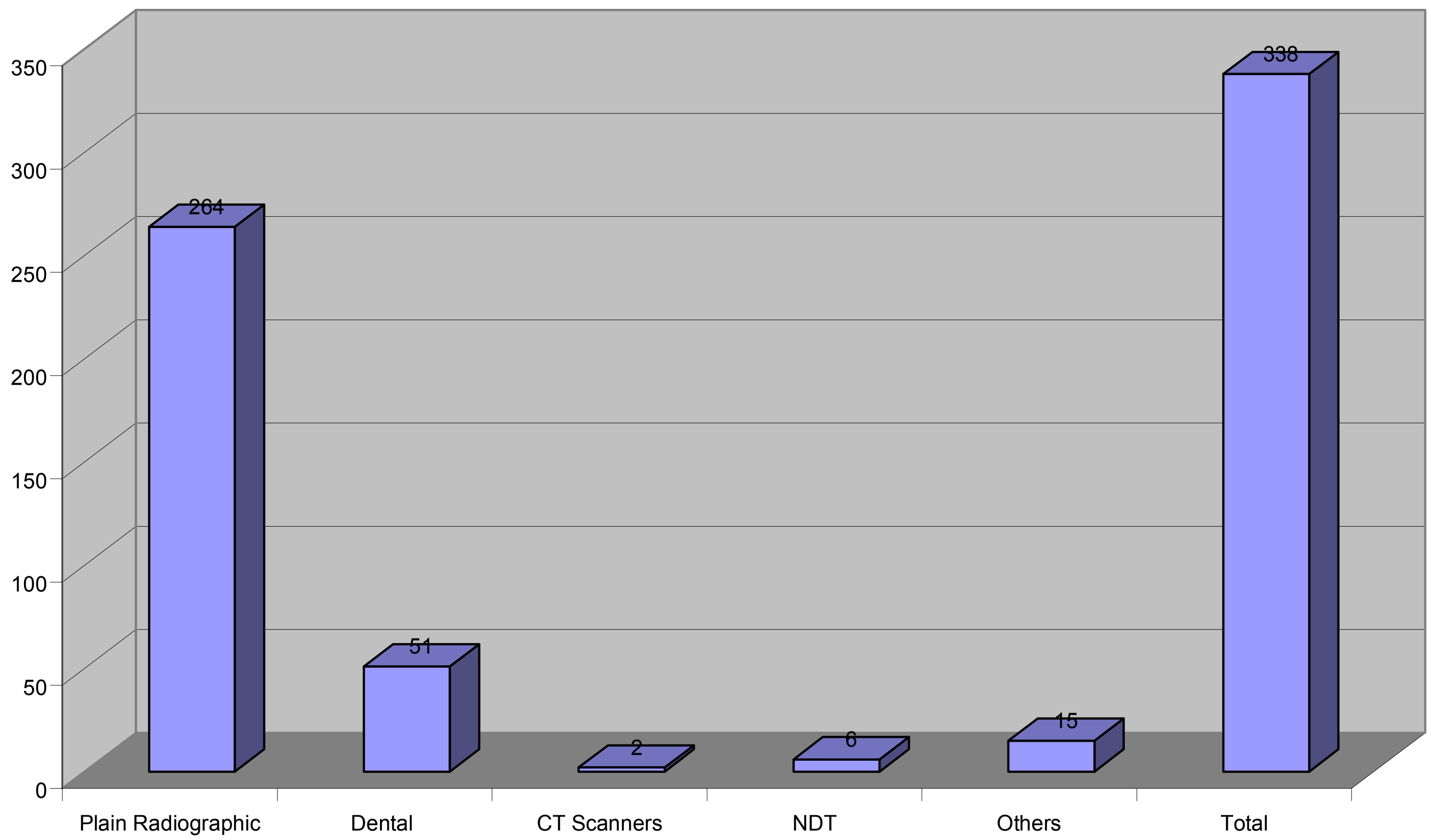
- building its ability to recruit, develop and maintain people with the required core competencies;
- ensuring adequate budgetary provision to support sustained operational effectiveness;
- maintaining dynamism and the ability to anticipate and respond to the emerging needs of the public;
- pursuing excellence in management and promoting professionalism.

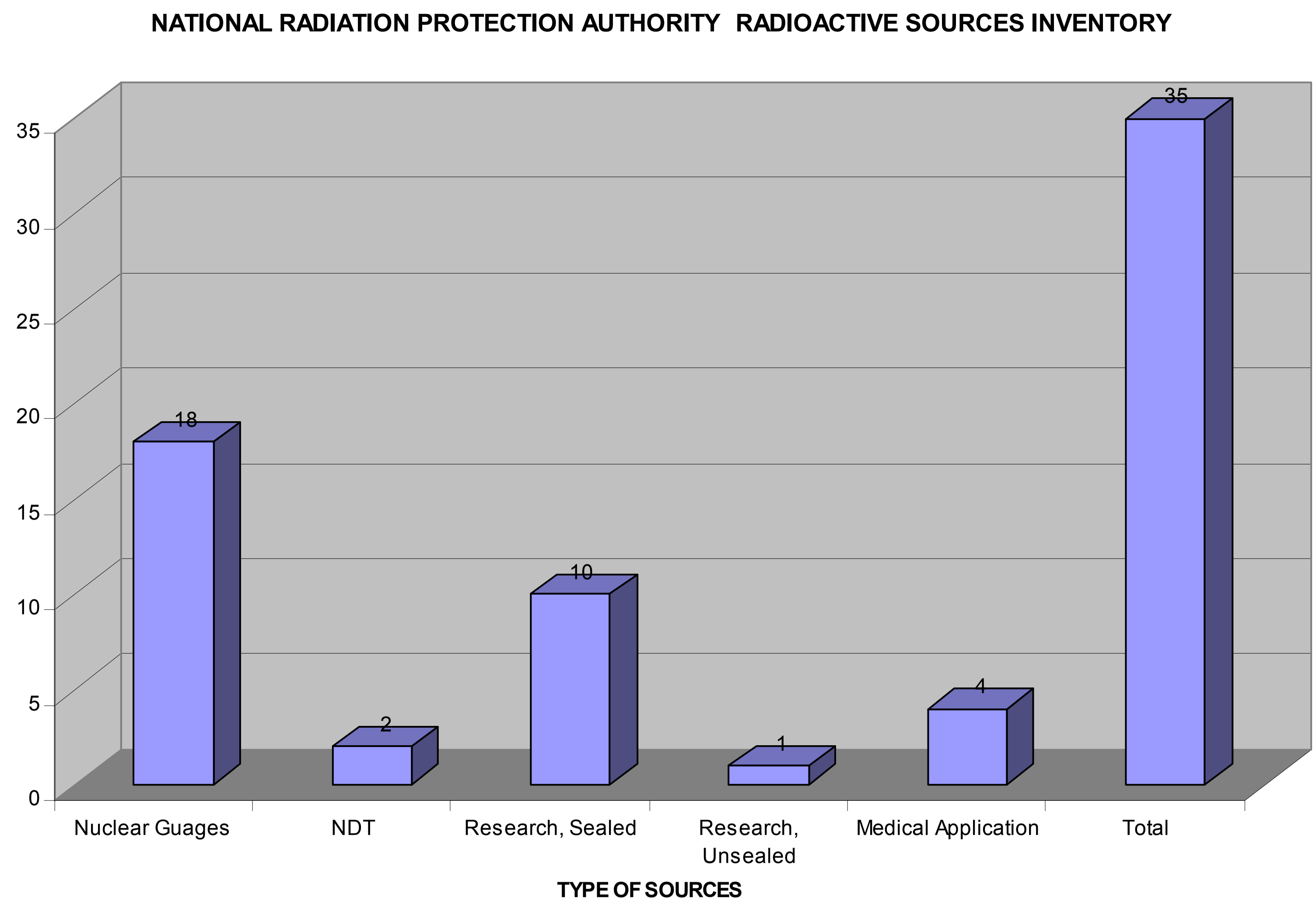
Finally, with NRPA now well established dedicated enthusiasm towards the attainment of its organizational goals is the prime prerequisite for success and believed to be solidly available, hence optimism about its future is well founded.

THE ORGANIZATIONAL STRUCTURE OF NRPA ANNEX 1



NATIONAL RADIATION PROTECTION AUTHORITY X-RAY EQUIPMENT INVENTORY DATA




NATIONAL RADIATION PROTECTION AUTHORITY RADIOACTIVE SOURCES INVENTORY
35
30
25
20
15
10
5
0
18
2
10
1
4
35
Nuclear Guages
NDT
Research, Sealed
Research, Unsealed
Medical Application
Total
TYPE OF SOURCES

ANNEX 2

NATIONAL RADIATION PROTECTION AUTHORITY
ADDIS ABABA, ETHIOPIA

X-RAY EQUIPMENT INVENTORY DATA

Type of Equipment	Quantity
Plain Radiographic	264
Dental	51
CT Scanners	2
NDT	6
Others	15
Total	338

RADIOACTIVE SOURCES INVENTORY

Type of Source	Quantity
Nuclear Guages	18
NDT	2
Research, Sealed	10
Reaserch, Unsealed	1
Medical Application	4
Total	35

SOME ASPECTS OF THE REGULATORY CONTROL OF RADIATION SOURCES IN GEORGIA

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Abstract. The report refers to the responsibilities of the different governmental bodies in Georgia regarding radiation protection and safety of radiation sources. In particular, it explains the role and main activities that are carried out by the Nuclear and Radiation Safety Service which is subordinated to the Ministry of the Environment and Natural Resource Protection. The report emphasizes the important assistance provided by the IAEA in the improvement of the national radiation safety infrastructure.

INTRODUCTION

From the day of its establishment, the Nuclear and Radiation Safety Service has been receiving considerable support from the IAEA within the framework of the latter's technical co-operation Model Project on upgrading radiation and waste safety infrastructure in Europe (RER /9/056).

This support has taken the form of equipment supplies and training. The Service now has portable field-searching equipment that is being used both in operational activities and for permanent observation, and since receiving Genitron gamma tracers it is monitoring the natural radiation background at selected locations. Of the ten employees of the Service, eight have, through training courses and fellowships, improved their skills relevant to radioactive waste management and to the control of radiation sources and irradiation equipment used in medicine. Particular benefit was derived from a regional basic training course on radiation protection held in Dubna, Russian Federation, which three of the Service's employees attended, and from fellowship training in the Czech Republic received by one of the Service's employees and two employees of the State Public Health Inspectorate, which is co-operating very closely with the Service.

Georgia became a Member State of the IAEA in February 1997. Since that time, it has been co-operating very actively with the IAEA, which has been providing advice, information and technical assistance. Thanks to the IAEA's support, Georgia has since 1997 taken several important steps, including the drafting of a nuclear and radiation safety law which was promulgated by Georgia's Parliament in October 1998.

Pursuant to that law, the regulatory functions in the area of nuclear and radiation safety have been assigned to the Service, which is subordinated to the Ministry of the Environment and Natural Resources Protection. Formation of the Service began in February 1999. It is expected that the scope of its activities will expand, mainly through the establishment of regional inspection offices.

Also pursuant to that law, the Service has supervisory and co-ordinating functions relating to the safe use of radiation sources. The law distributes radiation protection responsibilities among the following:

- the **Ministry of Health**, which is planning to modernize, in the near future, the system for supervising — from the medical and technical safety points of view — all institutions and persons connected with the use and storage of radiation sources;
- the **State Department of Standardization, Metrology and Certification**, which verifies the compatibility of the equipment items used in radiation protection;
- the **Emergency Department** at the **Ministry of Internal Affairs**, which is responsible for dealing with emergency situations, for helping the Ministry of the Environment and Natural Resources Protection to ensure the safety and security of the sites where nuclear materials and radioactive sources are present, and for "liquidation" activities in the event of radiological accidents; and
- the **Ministry of the Environment and Natural Resources Protection,** which, through the Nuclear and Radiation Safety Service, co-ordinates the activities of all these entities.

Immediately Georgia joined the IAEA, it became obvious that the country faced far more problems than had been expected. According to the latest data provided by the State Public Health Inspectorate, there are about 1400 units entered in Georgia's Register of Ionizing Radiation Sources, and some of them are out of order as they have been in use for a long time. Also, there is the problem of orphan sources, several of which have been found with the help of the IAEA. Since these sources are highly radioactive (for instance, the activity of each of the orphan sources found in the mountainous region of Svaneti is about 35 000 Ci) and in most cases located near populated areas, they represent a serious hazard. In addition, Georgia does not have a modern radioactive waste storage repository (a "minirepository" has been set up for the storage of conditioned orphan sources).

GEORGIA'S RESEARCH REACTOR

The most significant ionizing radiation source listed in the above-mentioned Register is the IRT-2M research reactor located near the town of Mtskheta (there is no other nuclear reactor in Georgia). This research reactor, which belongs to the Institute of Physics of the Georgian Academy of Sciences, was installed in 1959, and at that time its maximum power was 2 MW. It is a pool-type reactor in which distilled water is not only the coolant but also the neutron moderator and reflector and the biological shield. Research reactors of this type, produced in the former Soviet Union, have been installed also in China, Iraq and the Democratic People's Republic of Korea.

In 1988, the regulatory body of the former Soviet Union carried out a thorough safety inspection of the reactor and estimated its "lifetime reserve" to be 1.7 years.

Decommissioning of the shut-down reactor requires that a number of quite expensive operations be carried out. According to widely accepted technological standards, the reactor equipment should be dismantled and the radioactive materials conditioned and transferred to a radioactive waste repository. However, Georgia has neither sufficient funds, nor the special equipment and the qualified personnel necessary for dismantling, nor a radioactive waste repository where highly radioactive waste could be stored.

Consequently, it was decided to bury the highly radioactive parts of the reactor beneath reinforced concrete. Under a project prepared in Georgia and co-ordinated with the IAEA, the lower part of the reactor tank (i.e. nearly one third of its total volume), where the radioactivity is especially high (the reactor core being located there), will be packed with concrete. All horizontal experimental channels and the so-called “dry channels”, where radioactive waste with an activity of ~$2 \cdot 10^{13}$ Bq (~10^3 Ci) is stored, will be hidden beneath a concrete block.

ORPHAN SOURCES

Most of the orphan sources in Georgia are directly connected with activities which took place at former Soviet military bases located within Georgian territory. A programme for the conduct of detailed inspection at those bases is currently being drawn up.

FUTURE LAWS AND DECREES

Two further laws are being prepared — one on the transport of radioactive substances and one on radioactive waste and radioactive waste storage. However, some IAEA experts consider that it would be better to issue two decrees rather than waiting for the adoption of those laws.

A decree on the licensing of nuclear — and radiation-related activities is in the process of finalization by the Ministry of the Environment and Natural Resources Protection, with assistance provided by IAEA experts within the framework of technical co-operation project RER/9/056. One of its most important provisions will be that the holder of a licence must have a certificate issued by the Department of Public Health.

ACTIVITIES OF THE NUCLEAR AND RADIATION SAFETY SERVICE

Currently, the two main areas of activity relate to:

- the conditioning and safe storage of orphan sources, and
- the registration, inventorying and storage of radiation sources, checking on conditions of radiation source utilization, and the preparation of documentation for implementing the law on nuclear and radiation safety.

Although dealing with orphan sources should be the responsibility of the Emergency Department and the Civil Defense Department at the Ministry of Internal Affairs, the Service has so far carried out the work involved in conditioning and storing the orphan sources found in Georgia. In order to make the storage facility safe and secure, the Service has spent part of a grant received for a programme on the radiation safety of the population and the environment; it has spent the money on purchasing technical equipment and having several special storage and transport containers made. The work done has been highly commended by IAEA experts.

The most important operation so far carried out by the Service took place during the period 28 May–14 June 2000 in Western Georgia (in and around the towns of Kutaisi, Poti and Senaki). It was an aerial-radiometric survey conducted with the help of IAEA experts for the purpose of discovering orphan sources and identifying areas contaminated with radionuclides. According to the preliminary results, one caesium-137 source of medium activity (in the mCi range) was found in a residential part of Poti and has been neutralized; also, some areas with very high radionuclide concentrations were identified. Precise information will be available in approximately two months’ time, after analysis of the radiometric data, which will be used in producing large-scale background radiation maps of Georgia.

Currently, a major problem for the Service is the conditioning of radioactive sources which have been used in mining and liquified petroleum gas production.

The Service has begun to organize training in medical aspects of radiation safety in co-operation with the Ministry of Health.

Also in the medical sphere, the Service is planning to have X-ray specialists retrained in accordance with international standards and to carry out technical inspections of X-ray apparatus, the aim being to establish an effective national programme for preventing the over-exposure of patients during X-ray examinations. It will carry out such inspections at — among other establishments — the State Oncology Centre, which is responsible for supporting an X-ray radiological network and organizing individual dosimetric monitoring in Georgia.

There has not been a detailed survey of the radioactive sources situated in Georgia since Soviet times, so one cannot exclude the possibility that extraordinary situations will arise with non-registered or lost sources or with sources which are being used or stored under unsafe conditions, particularly as during the Soviet era many sources being used for military purposes and even some being used for civilian purposes were not registered.

In spite of the difficulties being encountered, the Nuclear and Radiation Safety Service hopes that Georgia will, thanks to the help of the IAEA, soon have a modern system of radiation safety.

THE GERMAN RADIATION PROTECTION INFRASTRUCTURE WITH EMPHASIS ON THE SAFETY OF RADIATION SOURCES AND RADIOACTIVE MATERIAL

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Abstract. Through federalism, Germany has a complicated but well functioning regulatory infrastructure for the safety and security of radiation sources based on a clear legal system. The main features of this infrastructure include the legal framework, the authorization and control systems and the responsibilities of different regulatory authorities, which this paper will describe. In connection with the legal framework, the provisions to control the import/export of radiation sources are briefly discussed and some information is given about the registries of sources. Protection and response measures related to unusual events concerning radiation sources, including orphan sources, will be cited. Also, the education and training of different target groups and punitive actions are touched upon in the paper. Conclusions will be drawn for future national and international actions.

INTRODUCTION

One of the major findings of the conference on Safety of Radiation Sources in Dijon 1998 [1] was that an effective national regulatory authority operating within a suitable national infrastructure is a key element for safety. Besides an efficient regulatory system, the radiation safety infrastructure includes relevant laws, regulations and guidelines, supporting experts or expert groups and services [2].

The experience of more than 40 years of the widespread use of radiation sources in research, industry and medicine in Germany shows good practice. For some decades (since 1976 in West Germany, and 1965 in East Germany) a systematic registration of all unusual events in the use and transport of radioactive material and of the loss and find of radiation sources has taken place. Although in Germany good practice has been established in these decades, 700 incidents have been registered since 1991 (after reunification) mostly without any radiation exposure of individuals. Nevertheless, these events have sometimes had a potential for a non-negligible exposure. Therefore, it is important to register and to analyse events deviating from normal operation or, for near misses, to recognize potential exposures in the initial phase and, if necessary, to initiate measures at an early stage, especially for losses and finds.

The German governmental system is a federal system of 16 independent federal states (Länder). An overview is shown in Fig. 1. A regulatory infrastructure on the supreme level and also on the subordinate level supported by a clear legal system ensures the safety and security of radiation sources.

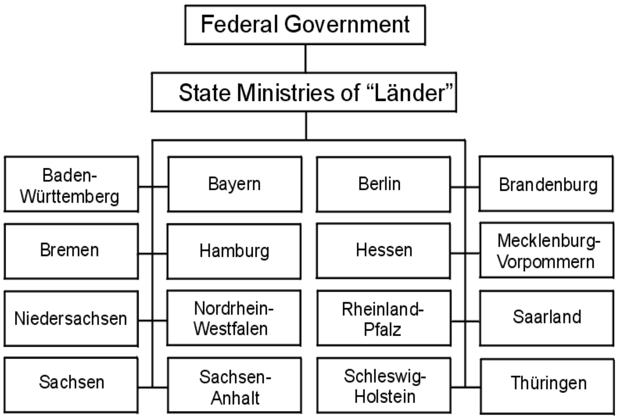

Fig. 1. German federal system.

REGULATORY INFRASTRUCTURE

Legislation

In Germany, there are typically three levels of binding regulations in the field of radiation protection, especially for the safety of radiation sources outside nuclear industry:

Laws: Atomic Energy Act (AtG)

Ordinances: Radiological Protection Ordinance (StrlSchV)
X-ray Ordinance (RöV)

Guidelines: (Codes of Practice) e.g.
Education and training
Licence specimen for gamma radiography
Check of sources tightness
Type approval *)
Contamination control on leaving contamination areas *)

*) in preparation

Guidelines are binding for the competent “Länder” authorities and transposed via licence obligations or supervising procedures to the user of radioactive sources. In accordance with the German constitution, the “Länder” governments are responsible for the implementation of the laws in behalf of the federal Government. The federal Government has to ensure uniform implementation and legality, called expedience supervision. Fig. 2 shows a comprehensive survey.

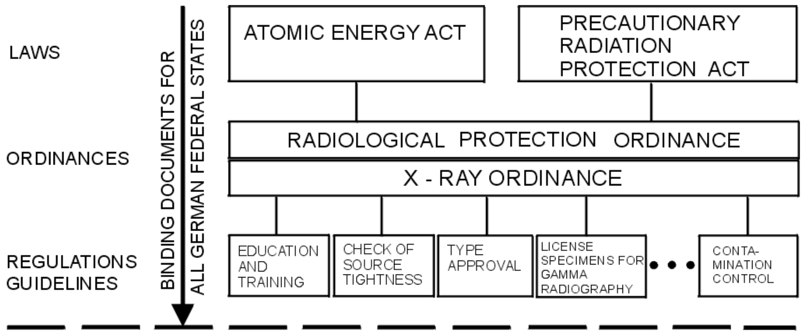

Fig. 2. Legislation concerning safety of radiation sources.

Primarily, the Atomic Energy Act stipulates legal requirements in general for radiation protection and detailed ones for safety and security of the peaceful use of nuclear energy. The purpose concerning radiation protection of this act is:

- to protect the life and health of human beings and property against the hazards of nuclear energy and the harmful effects of ionizing radiation/radioactive sources and to compensate damages caused by nuclear energy or ionizing radiation;
- to prevent danger to the internal or external security of the Federal Republic of Germany arising from the application or release of nuclear energy and fissile material;
- to guarantee the performance of the international duties of the Federal Republic of Germany in nuclear energy and radiological protection.

In the Atomic Energy Act, the responsibilities of different administrative authorities are laid down. The provisions of the Act are amended by the further above mentioned ordinances.

The purpose of the Radiological Protection Ordinance is the regulation of principles and requirements for precautionary and protection measures which are applied at utilization and influence of radioactive materials and ionizing radiation from artificial and natural origin to protect people and the environment against the dangers arising from ionizing radiation, within the framework of the AtG. This ordinance regulates the following practices concerning the safety of radiation sources:

- the use of radioactive substances, which means all parts of the authorization process including the establishment of dose limits for workers and the public;
- the purchase of radioactive substances, their delivery, the transportation and transboundary movement;
- the licensing and operation of state and federal facilities for taking possession and for disposal of radioactive waste;
- the licensing and operation of facilities to produce ionizing radiation (accelerators, energy >5 keV), except for X-ray units;
- the addition of radioactive substances in the production of consumer products, drugs, pesticides and fertilizer and the activation of these products.

The X-ray Ordinance covers the operation of X-ray units and other electrical equipment emitting ionizing radiation due to accelerated electrons at a potential difference of more than

5 keV and up to 3 MeV. This group of sources is not covered by the topic of the conference and therefore it will not be considered in this report.

Following these laws and ordinances, a number of binding regulations and guidelines were specified and had to be implemented by the "Länder" authorities. In the ongoing process to amend our radiation protection legislation converting the EURATOM Directive 96/29 [3], these regulations have to be revised.

Regulatory Authorities
The *Federal Ministry for Environment, Nature Conservation and Nuclear Safety* is accountable for the enforcement of the Atomic Energy Act, the Radiological Protection Ordinance and the X-ray Ordinance. It regulates the radiation protection through "administration by order" and is responsible for the expedience supervision. All international co-operation and co-ordination is organized the Ministry, which may delegate the implementation of tasks.

To solve important scientific problems and to prepare political decisions in the field of radiation protection, the Ministry for Environment, Nature Conservation and Nuclear Safety has an independent advisory body – the German Radiological Protection Commission. This commission issues recommendations for topical problems in radiation protection which can be implemented in regulations.

The various responsibilities for nuclear safety and the radiation protection, including the safety and security of radiation sources, are laid down in the Atomic Energy Act. In general c*ompetent administrative authorities of the "Länder"* empowered by their "Länder" governments are responsible for implementation of all laws, ordinances and guidelines concerning radiation protection.

Federal institutions are responsible only for:

- Import and export
  The import and export of radiation sources is regulated by the Federal Export Office (BAFA) and supervised by the Federal Ministry of Finances (esp. customs offices).
- Transport of high activity sources (>10^{12} Bq)
  The licensing process of the transport of high activity sources has to be conducted by the Federal Office for Radiation Protection except for the transport with ships and on railway and the supervision is performed by the competent "Länder" authorities (e.g. traffic police) or the Federal Railway Office.

The tasks of the "Länder" authorities are authorization (notification, registration, licensing), supervision (inspection), surveillance (environment, external and internal occupational exposure), approval of training, prototype approval and interim storage of radioactive waste. The licensing authority is not necessarily the same as the authority for supervision. The "Länder" government can engage different administrative offices with these tasks, such as

- The State Office for Environmental Protection
- Mining authorities
- District administrations
- The State Office for Maintenance of Industrial Health and Safety Standards.

Altogether, nearly 80 competent “Länder” authorities work in radiation protection in the 16 “Länder”. Fig. 3 gives an overview of the regulatory authorities.

Within the German radiation protection infrastructure, each of the “Länder” has its own “micro-infrastructure”. This structure with its peculiarities mentioned above demands measures for harmonization of all regulatory aspects. Therefore, a *Joint Radiation Protection Committee,* which representatives of “Länder” authorities and of the Federal Ministry (BMU) attend, was founded. In regular meetings, this committee discusses topical radiation protection issues, participates in the preparation of ordinances, regulations and guidelines and in the implementation of licensing, inspection and enforcement items. Practically, all regulatory authorities closely follow the decisions of this committee, thus taking on nearly binding obligations.

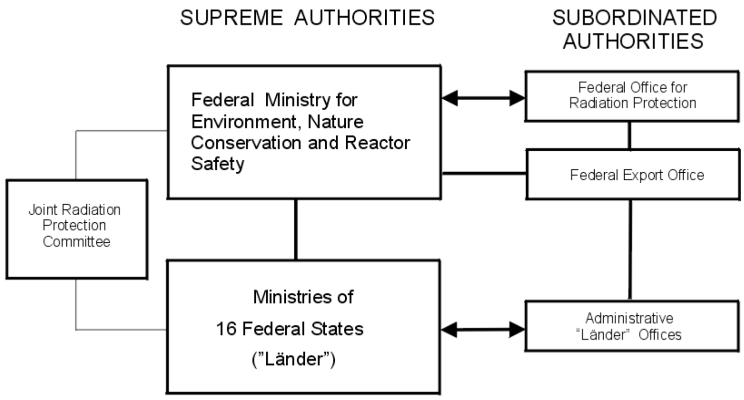

Fig. 3. Regulatory authorities concerning radiation sources.

The Federal Office for Radiation Protection (BfS) established by law in 1989 as an authority subordinated to the BMU is responsible for the:

- scientific support for the ministries;
- licensing of transports of nuclear material and high activity sources (mentioned above);
- central dose registry;
- quality assurance of surveillance in the Länder.

Important tasks concerning the quality assurance, calibration, prototype approval of radioactive sources and transport containers are solved centrally by the Federal Institute of Physics and Metrology (PTB) and the Federal Institute for Material Research and Testing (BAM).

Furthermore, the Federation and the “Länder” are supported by institutions like Technical Agencies (TÜV) and those providing expertise, e.g. large research centres, universities, private companies, employers and trade unions.

In addition to the competent authorities in all “Länder”, six approved dosimetric services for external personal dosimetry and about 24 services for bioassay and body counting are established in Germany. The licensing authority stipulates which dosimetric service has to be used by the licensee.

AUTHORIZATION

In 1999 in Germany, about 20 000 licences covering practices with radioactive substances in non-nuclear fields were registered. Roughly, this number corresponds to an average of about 12 000 licensees. Half of them use only sealed radiation sources in medicine, research, teaching and industry. The application of sealed sources in industry (level gauges, density gauges, gamma radiography) is the most common practice (see Fig. 4). [4]

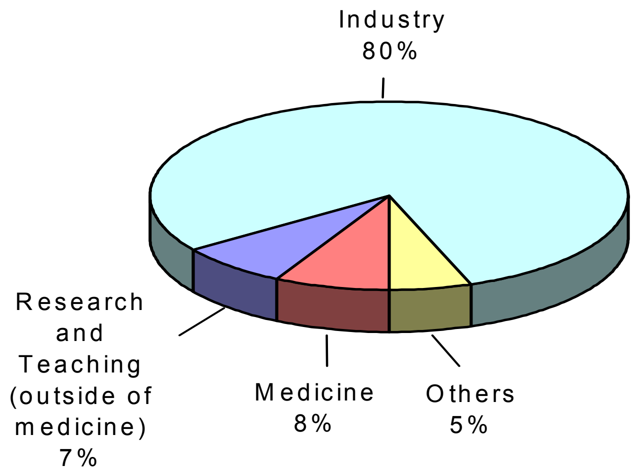

Fig. 4. Licensees of sealed sources.

Because of the presently running process for implementation of the EURATOM Directive 96/29 into the German radiation protection legislation both modi operandi – hitherto and in future – will be shortly explained.

In the past, *registration and licensing* were practised for the use of radiation sources. The registration process is managed predominantly through notification. The main criterion for registration of the use of radioactive substances is the activity, which must not exceed the exemption level for the radionuclide by a factor of 10; otherwise a licence would be necessary. Instruments or equipment containing a radioactive source with higher activity may be registered only if they have a *prototype approval* in accordance with the Radiological Protection Ordinance; otherwise — here, too — a licence is necessary. The legal procedure for the type approval is regulated by the Radiological Protection Ordinance and the preconditions are laid down there. The type approval granted by the competent "Länder" authority in one state is valid for all "Länder". The Federal Government envisages to centralizing the type approval at its Federal Office for Radiation Protection in the course of implementation of the new EURATOM Basic Safety Standards.

The efforts for licensing radiation practices vary broadly depending on the radiation protection problems and potential hazards encountered. Some applications need only a standardized licence with the stipulation of the legally responsible person, qualified experts, details about the source and the device, storage and waste specifications, dose assessment for radiation workers and for the public etc. For more complex radiation practices, independent experts and scientific institutions have to be involved in the licensing process.

Inspections

An essential component of the radiation protection infrastructure to increase the safety of radiation sources is the inspection which is conducted, announced and unannounced, by the competent “Länder” authorities. At an early stage, the inspection allows corrective measures if radiation safety requirements are violated, e.g. to avoid the loss of control over a radiation source. Mostly the inspection is carried out according to a checklist which is adapted to the application in consideration of all legal obligations and other safety requirements. [5] The decentralized inspections are effective especially because of their high frequency and the close contact to the licensee.

NATIONAL PROVISIONS

Registries/Inventories

An important tool for well functioning and effective supervision is a radiation protection registry where all information about the licensee, the licensed practice or the licensed device, the properties of the source, their registration number, the present stay etc. are stored. On such a basis, the supervision and analysis issues can be handled efficiently (e.g. an inspection plan can be prepared precisely, technical parameters are available immediately, search/identification of an orphan source is supported more effectively). Each of the German “Länder” has an extensive registry or a number of registries of significant radiation sources. A good example of such a database exists in Hessen [6].

The purpose of this database is mainly to:

- record all licences concerning the use of sealed and unsealed radioactive substances, the construction and operation of installations to produce ionizing radiation (accelerators, afterloading, irradiators, gamma radiography);
- evaluate the licensing facts and produce a current overview;
- assess the annual utilization of the granted licences (purchase, existence, delivery and residues of radioactive substances);
- collect information for radiological calculations.

Experience has shown that a centralized database in each of the “Länder” is an optimal administrative solution to achieve the objectives mentioned, also being close enough to the administrative authority and its licensees for prompt updating and management.

On the basis of the “Länder” registries, the Ministry for Environment, Nature Conservation and Nuclear Safety in pursuance of the expedience supervision continuously renews a central database with information on devices with sources of higher activity, e.g. for afterloading and for medical and technical gamma irradiation and the licensees. For instance presently 217 afterloading devices are in operation in the different “Länder” with following activities:

Ir–192	200–1000 GBq	(85%)
Cs–137	30–100 GBq	(10%)
Co–60	150–250 GBq	(1%)
Sr–90	1.5–10 GBq	(4%).

160 high activity sources (30–500 TBq) — mainly Co-60 and only a few Cs-137 — are in use for medical therapy.

Transboundary movement

Because border control is no longer practised within the European Union (EU), it has been necessary to find a solution for continuing the information about the transboundary movement of radiation sources and waste. A system is now installed which demands a priori declaration about a planned transboundary movement of sealed radiation sources. The obligations are set out in the Euratom Regulation 1493/93 and compliance is mandatory for all member countries of the EU. The German Government empowered the Federal Export Office (BAFA) with supervision.

The movement of a radiation source into a non-member country of the EU can be conducted without prior authorization if the source has an activity lower than a factor of 10^8 of the exemption limit in accordance with the Radiological Protection Ordinance and if notification is given to the competent authority. Notification deadlines are prescribed in the ordinance.

Furthermore, facilities, institutions, offices etc. have to notify the import at their competent authority. For cross checking the correctness of possession, licence and use, BAFA regularly sends information to the competent authorities about the transboundary movement (import and export) of all radiation sources. For example, 585 high activity sources (>1,86 TBq) were imported in 1998 from 12 countries and 296 sources were exported into 40 countries. The following Table 1 gives an overview of the main nuclides [7].

Table 1. Exported and imported radiation sources with A >1,85 TBq

Nuclide	Number of sources	
	Imported	exported
Ir–192	179	176
Cs–137	40	17
Se–75	178	85
Co–60	188	18

Education and training

Since 1982, guidelines on the education and training of qualified experts in radiation protection exist, supplemented in 1990 by the regulations on the education and training of qualified experts in nuclear installations. In addition the regulation on radiation protection in medicine contains specific commitments in that field.

Depending on the intended task/work (e.g. the use of radiation sources), the regulation prescribes the training which the expert has to have: its content, type and minimal duration (in hours). The regulations also prescribe that a training course, including the detailed training programme and the names of the lecturers for the different training groups has to be approved by the competent "Länder" authority. In this way, quality control is possible by the regulatory authority and should also be reinforced by inspections. In pursuance of their expedience supervision, the Federal Ministry for Environment, Nature Conservation and Nuclear Safety publishes a list of all approved training courses annually. Presently, nearly 150 organizers of approved radiation protection training courses exist in Germany [8].

Moreover, many other courses, workshops, seminars, colloquia and practical training are held which are not approved. These events are target group oriented, for instance for workers in facilities of the recycling and steel industry or for customs officers.

Abnormal events and emergencies

Part of all licences concerns emergency preparedness. The user itself has to draw up an emergency plan, make available response measures and inform the workers involved in the radiation practice about the emergency measures and train them in response actions.

On the federal level, a network of 12 regional radiation protection centres exists for the medical treatment of persons who have been unpredictably exposed to ionizing radiation. The staff of these centres are trained regularly. In addition, many scientific institutions and also the employers and trade unions responsible for dealing with accidents and occupational diseases and their compensation support these centres, for instance by providing measuring methods.

Recovery of control of orphan sources

To recover the control of orphan sources, Germany has a number of possibilities – on the one hand different facilities for detecting or searching for sources and, on the other hand, equipment for reducing the likelihood of the occurrence of a large scale event.

Nearly all melting facilities (steelworks) and most scrapyards in Germany are equipped with measuring systems to detect orphan sources or contamination. These are stationary truck and railway wagon facilities, mobile measuring devices and, to a lesser extent, also devices for laboratory measurements for slag, dust and melts. Ship monitors are rare but in such cases, detectors are installed at the cabin of the crane. Furthermore, the truck lock in the port of Hamburg is equipped with big plastic detectors (2 x 25 l). At the border crossings to Eastern Europe, customs use stationary detectors in car locks (plastic 1l) and also mobile devices. Additionally, up to 10 mobile measuring cars are working on streets and highways (NaJ(Tl) detectors).

These controls are not legally regulated. For the transport of dangerous goods, a limit of 5 μ Sv/h at the outside of a vehicle is prescribed. In the Joint Radiation Protection Committee, the regulatory authorities and customs authorities agreed to an intervention level of 1 μSv/h for further measurements and investigations at the border lines.

The following alarm values are used in Germany [9]:

Customs, Hamburg port	4 μSv/h natural activity
	10 nSv/h artificial activity
Customs	1 μSv/h (mobile detectors)
Recycling industry	10...15 nSv/h total
	8.... 10 nSv/h artificial
Steel industry	8.... 15 nSv/h total
	6......8 nSv/h artificial
Incinerating plants	1 μSv/h total
	200 nSv/h artificial

These values are restrictive (from the radiological point of view), only valid for internal control by industry and, as mentioned above, not prescribed by regulations. The competent authority is informed about finds.

Last year in incinerating plants, nine events were registered where radioactive material was detected. In the recycling and steel industries (including scrapyards), 11 events were notified where radioactive sources were found (e.g. 2 Cs-137 sources with 2.22 GBq and 2.77 GBq in scrap) [4].

To date, no controls have been prescribed by the European Union for delivery from a non-member country. Agreements are necessary.

For searching for a high activity orphan source in the open country and for a rapid estimation of widespread contamination of the environment, helicopters of the German Federal Border Police equipped with sensitive gamma ray spectrometric systems are available at short notice[10]. For technical support, e.g. to get a source back under control, some companies are equipped with state-of-the-art facilities such as remote control tools.

Management of disused sources

In general, the management of disused sources in an individual case is prescribed in the licence. Disused sources should be returned to the producer. This should be part of the contract between producer and user. In cases where such a return is not achievable, the source has to be given to one of the authorized State facilities for waste storage ("Landessammelstelle") or to other approved facilities of companies for waste management, or to be sold for recycling.

Information about incidents with radiation sources

Licensees are obliged to notify incidents with radiation sources. The competent authorities have to register unusual events in the use of radiation sources and to report about it to their "Länder" Ministry and to the Federal Ministry for Environment, Nature Conservation and Nuclear Safety, which carries out expedience supervision. The Ministry is responsible to inform all other relevant "Länder", Ministries and bodies about the event, the conclusions drawn and the lessons learned. Information about unusual events is published annually.
The procedure will be demonstrated by an example:

In 1997 a source Cs-137 with an activity of around 200 GBq was found on a scrapyard in Sachsen-Anhalt. The first notice was given by the owner (he discovered it by monitoring at the site) to the competent authority, which initiated — in close co-operation with the Federal Ministry for Environment, Nature Conservation and Nuclear Safety — the necessary measures and informed all relevant bodies. The Ministry took subsequent steps of information exchange with the other "Länder" (searching for former holder) and concerned neighbouring countries (manufacturer, transporter), the EU Commission and the IAEA. So far, the former holder of the source has not been identified.

National punitive actions

The Atomic Energy Act and the subsequent ordinances contain regulations for the event of an infringement of the law or rule. An infringement is committed by anyone who, for example:

- runs a practice with radioactive materials without a licence;
- does not comply with all regulations of the Radiation Protection Ordinance and the obligations in the licence.

These infringements can be punished with fines of up to DM 100 000.

In addition, the “Criminal Code of the Federal Republic of Germany” has regulations for the punishment of all severe violations of licence conditions or unauthorized activities with radiation sources and radioactive materials during use, transport, supply, import, export or disposal.

The misuse of ionizing radiation to cause damage or injuries to another person is punished by imprisonment from six months to ten years and, for certain serious misuses, by imprisonment for not less than five years. Attempted exposure of people to ionizing radiation is punishable by imprisonment for not less than five years, and more serious offences by life imprisonment or imprisonment for not less than ten years. Planning and preparing such criminal activities is punishable by imprisonment from six months to ten years.

The “Foreign Trade Ordinance” 22 November 1993 provides that any person who exports goods enumerated in the list related to nuclear energy without any authorization wilfully or negligently, or markets such goods as part of transit trade, or who organizes a prohibited transit of such commodities, is liable to a fine up to DM 500 000.

CONCLUSIONS

- The German system for radiation protection is strongly meshed because it has developed over a period of more and more widespread use of radioactive substances. Even through the German radiation protection system is functioning well, it would be recommendable for countries about to set up a radiation protection system to establish a centralized system for the safety of radiation sources, especially those countries with few practices.
- In countries with a frequent and extensive use of radioactive substances, it could be advantageous to work with a decentralized system especially for licensing and inspection of practices concerning radiation sources. Such a solution is more efficient because of proximity to the user of the source, local knowledge about special details etc.
- Otherwise, a registry of those sources which have the potential to create severe hazards when uncontrolled should be built up at least by the competent regulatory authority and preferably should be centralized nationally. Search operations can be supported and international co-operation and assistance is easier [11].
- Furthermore, it would be preferable for the safe management of radiation sources, to develop guidelines for the measurement and evaluation of radioactivity in recycling materials which could be a binding document for all “Länder” and based on unified international recommendations and agreements.
- For decentralized systems, an advisory body like the Joint Radiation Protection Committee is important to harmonize decisions and actions of the authorities responsible for authorization of practices with radiation sources and to disseminate information about experience.

- To recognize danger or potential hazards caused by radiation sources at an early stage, the establishment of a centralized national registration and information system of incidents and accidents concerning radiation sources (outside the INIS information system) is advantageous. A unique scheme for registration increases the quality of information, evaluation and feedback. Also, the necessary subsequent dissemination of the lessons learned will be broader and continuously.

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SUMMARY OF DISCUSSION

Session 3

GENERAL DISCUSSION

Chairperson: **I. Othman** (Syrian Arab Republic)
Co-Chairperson: **C. Englefield** (United Kingdom)

D. Cancio (Spain): It is clear that the issue of radiation source safety is an international one. I should therefore like to see further gatherings like this one convened for the purpose of frequent information exchange among representatives of national regulatory authorities, especially those of developing countries, with each gathering focused on one or a few specific problems.

I. Othman (Syrian Arab Republic – *Chairperson*): I agree with Mr. Cancio entirely.

J. Piechowski (France): One problem which, in my view, should definitely be covered at future gatherings like this one is international standardization, with the involvement of the International Organization for Standardization (ISO).

D.J. Beninson (Argentina): I also agree with Mr. Cancio, and I believe that radiation source designers should be invited to gatherings where the focus is to be on radiation source design, disposal facility operators should be invited to gatherings where the focus is to be on disposal facilities, and so forth.

K. Skornik (IAEA): In Session 2, after the presentation of Ms. Velasques de Oliveira, a question was asked about the relationship between the ARCAL XX project and the IAEA's regional Model Projects for upgrading radiation protection infrastructure in Latin America and the Caribbean.

I should like to say a few words about the broader question of the relationship between, on one hand, the projects relating to radiation protection which have been or are being implemented within the framework of all three regional co-operative agreements concluded under the auspices of the IAEA — AFRA (African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology), ARCAL (Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean) and RCA (Regional Co-operative Agreement for Research, Developing and Training Related to Nuclear Science and Technology (for Asia and the Pacific)) and, on the other hand, the IAEA's regional Model Projects relating to radiation safety.

The AFRA, ARCAL and RCA projects have been under way for longer than the regional Model Projects, and they are funded mainly by the participating IAEA Member States (rather than from the IAEA's Technical Co-operation Fund), which have greater independence in deciding on priorities than the IAEA Member States participating in the Model Projects.

The IAEA-supported activities being carried out within the framework of the AFRA, ARCAL and RCA projects relating to radiation protection are declining in scale, whereas the regional Model Project activities are expanding. For example, the ratio of the IAEA support being provided for the Model Projects relating to radiation protection in Africa to the IAEA support being provided for the one current AFRA project relating to radiation protection (a project on the harmonization of radiation protection) is about 12:1.

In order to minimize duplication of effort, the activities being carried out under both types of project are being co-ordinated and harmonized by the Office of the Regional Project Manager in the IAEA's Department of Technical Co-operation.

H. Liu (China): In my country there are over 10 000 disused sources in temporary storage, at — for example — the premises of former users or of local government agencies, because they have not been accepted for disposal at any of the existing facilities for the disposal of low- and intermediate-level waste. Other countries may well be in a similar situation, and I was wondering whether the IAEA could help in the formulation of guidance on the storage and disposal of disused sources. We are at present waiting for the finalization of a high-level waste disposal policy for China.

V. Friedrich (IAEA): I know of several European countries in a similar situation. In my view, the issue is a regulatory — not a technical — one, and I should welcome an international discussion of the question regarding which radioactive waste category disused sources belong to. Until that question is decided, disused sources will continue to be kept in temporary storage, at facilities which may or — because of, for example, political circumstances — may not be safe.

C. Schandorf (Ghana): In my view, the fate of disused sources will depend to some extent on whether they are described as "disused sources" or as "radioactive waste", and that is linked to the concept of "source life-time".

I. Othman (Syrian Arab Republic – *Chairperson*): I have had problems with disused sources because they were described as "radioactive waste", despite the fact that they were still fit for further use.

D.J. Beninson (Argentina): [My country] [The National Atomic Energy Commission] produces radiation sources (for example, it produces each year cobalt-60 sources with a total activity of 48–50 million curies) and exports some of them. As many of its customers have no facilities for managing radiation sources, it is prepared to take back disused sources, but it cannot do so if they are described as "radioactive waste".

The existing disposal facilities for low- and intermediate-level waste are not really suitable for disused sources, and the longer you keep disused sources in storage the greater the probability of incidents involving them. The idea of disposing of disused sources into boreholes, which is not a new one, should be followed up more vigorously.

V. Friedrich (IAEA): It is true — the idea is not new; relatively shallow boreholes (10–20 m deep) were used 30–40 years ago in the former Soviet Union and in some countries of eastern Europe for the disposal of spent sealed sources. Those boreholes are now being examined with a view to determining whether the sources can be left in them or should be retrieved and finally disposed of in some other way.

The IAEA is supporting a programme under which a South African expert team is looking into the suitability of boreholes 50–100 m deep under various geological, hydrological and climatic conditions. Such boreholes might well be the answer to the disposal problems of countries where virtually all the radioactive waste consists of spent sealed sources and where not more than, say, 20 such sources accumulate each year — so that it is difficult to justify the establishment of a large near-surface repository.

NATIONAL REPORTS
(Session 4)

Chairperson

J.R. CROFT
United Kingdom

NATIONAL SYSTEM OF NOTIFICATION, AUTHORIZATION AND INSPECTION FOR THE CONTROL OF RADIATION SOURCES IN GHANA

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Radiation Protection Board, Ghana Atomic Energy Commission, Legon-Accra, Ghana

Abstract. The Radiation Protection Board (RPB) was established in 1993 in Ghana as the regulatory authority for radiation protection and safety of radiation sources; its functions are prescribed in the 1993 national radiation protection regulation. The report describes how the country's radiation protection and safety infrastructure have been established, including the RPB's organizational structure, with reference in particular to the main activities carried out by both the Regulatory Control Department and the Radiation and Waste Safety Department. It also briefly mentions the existing RPB human resources; the national system of notification, authorization and inspection of radiation sources; the inventory of radiation sources; and the management of disused radiation sources. Finally, the report identifies the two main problem areas regarding the regulatory control of radiation sources in the country.

INTRODUCTION

The Radiation Protection Board (RPB) was established in 1993 by amending the Atomic Energy Act 204 of 1963 by the Provisional National Defence Council law 308 in 1993 as the sole regulatory authority for the purposes of radiation protection and safety of radiation sources. The Authority and functions of the Board are prescribed in the radiation protection regulations LI 1559 of 1993 [1–3]. Under part ii — control of radiation sources of the regulations a national system of notification, authorization by registration or licensing, safety inspections and enforcement for the control of radiation sources has been established.

A national radiological emergency response plan to deal with all foreseeable accidents which may occur for radiation sources which give rise to potential exposures is under development.

The International Atomic Energy Agency (IAEA) has been instrumental in the establishment of a basic infrastructure for radiation protection and safety of radiation sources through technical co-operation projects (GHA/1/007, GHA/9/004, RAF/9/005, INT/9/143 and Regional Model Project RAF/9/024) spanning a period of twenty years.

RADIATION PROTECTION AND SAFETY INFRASTRUCTURE

The RPB has established a national inventory of radiation sources and has introduced administrative and technical procedures through a system of notification, authorization by registration or licensing, safety inspections and enforcement. Radiation protection and safety guides [4–9] have been developed to make the regulations consistent with the BSS [10] and assist registrants and licensees to notify and apply for appropriate authorization before engaging in any activity (practice) involving radiation exposure.

A National Radioactive Waste Management Centre (NRWMC) was established in June 1995 and designated as a national centralized facility for the collection and transportation of all waste requiring more than one year decay period to below clearance level. Requisite facilities for the treatment, conditioning and interim storage of all waste generated in the country is under development. Waste generators are required by the waste management regulations for on-site segregation, collection, characterization and temporary storage of all waste arising from their activities [11]. Those Practices which cannot manage their own waste can engage the assistance of the NRWMC.

ORGANIZATIONAL STRUCTURE OF REGULATORY AUTHORITY

The RPB is currently structured as shown in Figure 1. The regulatory activities are distinct from the radiation and waste safety services provided by the Board.

REGULATORY CONTROL DEPARTMENT

This department initiates notification, authorization, safety inspections and enforcement procedures for the control of irradiating devices (X-rays) and radiation sources used in practices that involve radiation exposure. Operating staff in this department review applications for authorization, perform pre-authorization inspections and regular inspections and advise the Board on the issuance of authorization by registration or licensing.

RADIATION AND WASTE SAFETY DEPARTMENT

This department provides radiation and waste safety services comprising personal monitoring, safety assessment of ionizing radiation facilities and sources, food and environmental monitoring, calibration services for protection level dosimeters and quality audit at radiotherapy centres in Ghana.

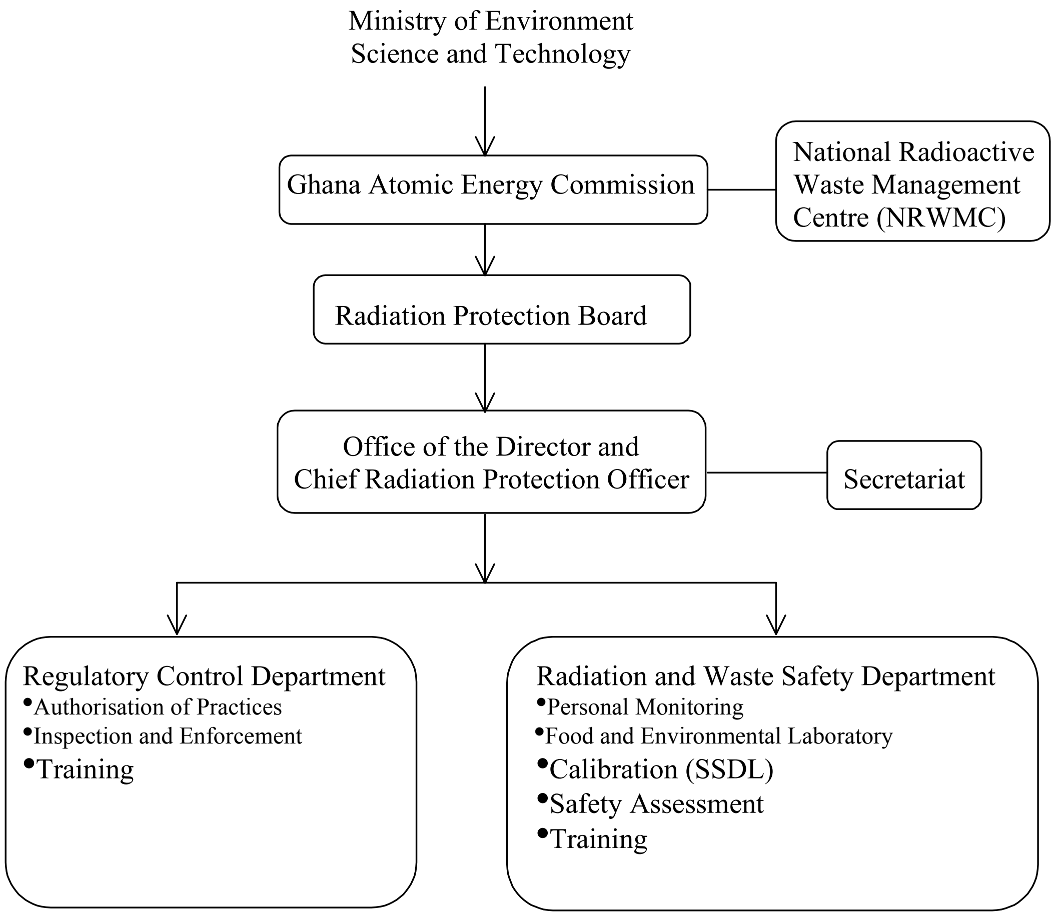

Fig.1. Organisational structure of Radiation Protection Board.

HUMAN RESOURCES

The Board has staff strength of 23. The chief radiation protection officer, five radiation protection officers and three technicians staff, operate the regulatory control department. Four radiation protection scientists and three technical staff carry out radiation and waste safety services. there are seven other staff members that provide administrative support services for the directorate and the two departments.

NATIONAL SYSTEM OF NOTIFICATION, AUTHORIZATION AND SAFETY INSPECTIONS FOR THE CONTROL OF RADIATION SOURCES

Based upon sections 7, 8 and 9 of the regulations, a system of notification for activities involving radiation exposure and authorization by registration or licensing is in place. Pre-authorization and regular inspection procedures are established and are being implemented.

INVENTORY OF RADIATION SOURCES

A national level inventory of sources is established. Information from the Regulatory Authority Information System (RAIS) indicates the types of radiation sources and practices in Ghana as shown Figures 2 and 3.

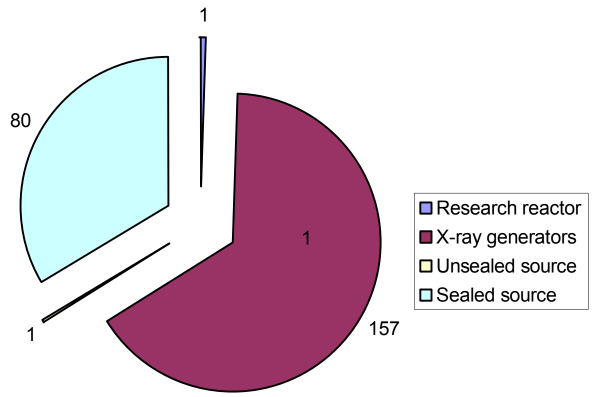

Fig.2. Types of radiation sources used in Ghana.

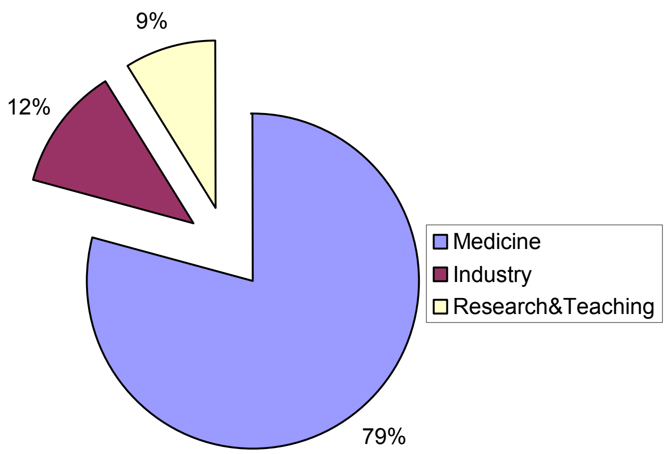

Fig. 3. Facilities in Ghana that make use of ionising radiation.

MANAGEMENT OF DISUSED RADIATION SOURCES

Authorization procedures require registrants and licensees to provide information about the radioactive waste management options for their spent sources and waste. Since many sources have no previous agreement with suppliers for return, the NRWMC was set up to assist registrants and licensees to manage their spent sources.

Disused radiation sources so far managed by the NRWMC include 90mg radium-226 needles which have been encapsulated and conditioned in concrete matrix in a 200L drum in 1999. The activities of waste generated by applications in hospitals, industries, research and teaching range from a few Bq to GBq The radionuclide composition in interim storage include ^{14}C, ^{137}Cs, ^{60}Co, ^{241}Am, ^{3}H, $^{90}Sr^{90}$, ^{99m}Tc generators and ^{109}Cd.

For new sources imported into the country from 1995, registrants and licensees are required to enter into an agreement to return spent sources to the suppliers for sources with activities greater than 100 MBq 10 years after their purchase.

PROBLEMS AREAS OF REGULATORY CONTROL

Two main problem areas have been identified: logistics and human resources. These are being addressed by a medium term expenditure framework for the period 2000–2002 to recruit more staff to be trained as inspectors and investment in the acquisition of three field vehicles. Another problem area is the security of radiation sources in existence before the introduction of the regulatory control programme in 1993. All sources in recognized institutions are currently under control.

Backtracking of orphan sources is ongoing, effected through a strategy of periodic press releases and information from our collaborators from other regulatory authorities, such as the Environmental Protection Agency; the Customs, Excise and Preventive Service; the Ghana Standards Board; and the Factory Inspectorate Division of the Ministry of Employment and Social Welfare. The effectiveness of the backtracking mechanism depends upon the collaboration and co-operation of all stakeholders and the general public in notifying the Board about orphan sources.

TRAINING AND EDUCATION IN RADIATION PROTECTION

In order to improve upon the level of compliance and safety culture of licensees and registrants seven national level training programmes have been organized since 1993 in radiation and waste safety. Ghana has also hosted ten IAEA fellows and four regional level IAEA training courses in radiation protection and safety involving about eighty-five participants.

EMERGENCY PLANNING AND PREPAREDNESS

The development of a national radiological emergency response plan (NREP) became necessary due to the existence of practices in Ghana such as the 30kW research reactor, GHARR-1, 1850 TBq gamma irradiator, 185TBq teletherapy facility and two 216 TBq Ir-192 industrial radiography facilities, which could lead to accidents with radiological consequences. In collaboration with the IAEA, Ghana initiated the NREP in March 2000.

The Radiation Protection Board is the lead technical agency for the co-ordination of appropriate national level radiological emergency response. The plan covers the following types of radiological emergencies:

(a) Accidents with radiation sources or radioactive materials, which include accidents that could occur at a facility or practices licensed by the RPB, found radioactive materials or contaminated areas, lost or missing sources and unshielded sources;
(b) Transportation accidents involving radioactive materials;
(c) Environmental impact from a foreign source: an emergency involving radiation from a foreign source that could pose an actual, potential or perceived threat to Ghana; and
(d) Re-entry of a satellite with nuclear materials: an emergency in which a spacecraft with nuclear material could land on the territory of Ghana.

CONCLUSION

Ghana, through the consistent commitment of regular IAEA technical assistance, has established a national radiation protection and safety infrastructure for the past two decades and within the last six years has upgraded the infrastructure to be consistent with the BSS.

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THE ROLE OF THE CENTRAL REGISTRY IN THE SAFETY AND SECURITY OF RADIOACTIVE MATERIALS IN HUNGARY

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Abstract. After a brief overview of the Hungarian legislation and regulatory infrastructure the report provides information on the number of companies and licensees using radioactive materials and explains also the role of the established central registry of radiation sources and radioactive materials in Hungary for improving the safety and security of radioactive materials in the country. It concludes that a reliable nationwide central registry can be very useful tool for increasing the safety and security of radiation sources and radioactive materials.

INTRODUCTION

The application of radioactive materials in Hungary started in the early '60s. At that time, the only company authorized to import and distribute artificially produced radioactive material was the Institute of Isotopes of the Hungarian Atomic Energy Commission. As new applications emerged and the demand continuously increased, the Institute of Isotopes became the first – and only – domestic producer of radioactive material. Realizing the serious health issues involved, the Institute exercised strict control over radioactive materials and established a registry of the imported and manufactured products at a very early stage. Many years later, when new legislation established the central registry of radioactive materials, the registry of the Institute of Isotopes served as the starting point, and the Institute was mandated to maintain the central registry. Due to this continuity, the central registry has an almost complete inventory and history of radiation sources and open radioactive substances in Hungary. After a brief overview of the Hungarian legislation and regulatory structure the paper discusses the role of the central registry in improving the safety and security of radioactive materials in Hungary.

LEGISLATION

The basic piece of Hungarian legislation related to the application of atomic energy is the Act on Atomic Energy[(1)]. The Act declares that 'in the use of atomic energy, safety has priority over all other aspects'. In its last article, the Act describes in detail the responsibilities and authorizations of the different ministries in providing legislation to ensure that the above principle prevails in practice as well.

On the basis of this authorization, recently the Minister of Health issued a new Decree[(2)] defining the basic rules of the application of radioactive materials. According to the Decree, all activities related to radioactive substances (application, production, marketing, export, import and transportation) are subject to licensing. Licences are granted for a fixed period, and the licensees must be regularly inspected. In order to increase the safety of radiation sources, the Decree requires that sealed sources should be regularly checked. Also, unused, superfluous radiation sources and old sources which have exceeded their service lifetime should be disposed of. The Decree also defines the basic qualifications necessary for the different types of activities related to radioactive materials, and describes the requirements of a training programme for radiation workers.

The Act on Atomic Energy also provides the legal basis for the central registry of radioactive materials. On the basis of this, a ministerial decree[(3)] regulates the system of local and central registries of radioactive materials. Under the system, all licensees (producers, distributors, users and radioactive waste disposal facilities) should have a local registry of all radioactive materials in their possession. In parallel, the central registry should be maintained in such a way that the quality, quantity and location of all radioactive materials in Hungary could be established in any given time. In order to achieve this goal, licensees are required to report any changes in their stock (distribution, transfer, disposal, export, import etc.) to the central registry.

REGULATORY INFRASTRUCTURE

Licences for the application of radioactive materials are issued by the national or regional offices of the State Public Health and Medical Officer Services (SPHAMOS). General inspections is performed by the 20 regional SPHAMOS offices. The frequency of inspections are determined according to the level of hazard (type and amount of radioactive materials and the type of activity) involved. In the case of abnormalities, SPHAMOS may impose a fine or suspend or withdraw the licence.

The central registry of radioactive materials is supervised by the Hungarian Atomic Energy Authority (HAEA), and maintained by the Institute of Isotope and Surface Chemistry (IISC, a successor of the Institute of Isotopes mentioned in the Introduction). The registry contains information on the licensees, the licences (issued, expired or withdrawn) and on the actual amounts of radioactive materials on the premises of the licensees.

The central registry helps the SPHAMOS inspections by regularly providing the regional offices with a list of radioactive materials being held at the premises of licensees within their jurisdiction. In addition to that, the HAEA together with the IISC performs its own inspections as well. These inspections focus on the proper maintenance of the local registries, and they are vital for ensuring the validity of the central registry. In the case of irregularities the findings of the inspection are reported to the relevant authorities (SPHAMOS, Police etc.). In the case of serious or continued abnormalities, the HAEA may impose a fine, or initiate the withdrawal of the licence.

RADIOACTIVE MATERIALS IN HUNGARY

There are approximately 1000 workplaces where radioactive materials are being used regularly. Most of them are industrial facilities and hospitals, but there are many research places as well (see Table 1).

Table 1. The number of companies and licensed workplaces using radioactive materials

	INDUSTRY	*AGRICULTURE*	*HEALTHCARE*	*RESEARCH*	*OTHER*
WORKPLACES	*370*	*7*	*277*	*131*	*154*

The number of ‘significant’ radiation sources (with an activity greater than 10^{10} Bq at the time of writing this report) is about 3000. The most important ones are listed in Table 2. It is obvious, that the largest number and highest activity of sources are in industry and in the medical sector. ^{60}Co and ^{137}Cs are still the most popular nuclides. ^{192}Ir is still extensively used in industrial radiography, while ^{3}H is mainly used in research applications. There are a relatively great number of ^{241}Am sources in industry and research, and the number of neutron emitting sources (Pu-Be and Am-Be) cannot be neglected either. In addition, many other isotopes are used in smaller numbers in industry, research and other applications.

Table 2. The number and total activity of radiation sources above 10^{10} Bq (as of 1. Oct. 2000)

	INDUSTRY		*HEALTHCARE*		*RESEARCH*		*OTHER*		*TOTAL*	
	PCS	*Bq*	*PCS*	*Bq*	*PCS*	*Bq*	*PCS*	*Bq*	*PCS*	*Bq*
Am-241	124	5.8E12	1	1.8E10	6	1.4E11	8	2.3E11	139	6.2E12
Am-Be	55	1.6E13	3	1.3E12			5	1.2E12	63	1.9E13
Cm-244	11	2.8E11							11	2.9E11
Co-60	1181	2.2E16	180	4.7E15	38	5.2E13	9	2.4E13	1408	2.6E16
Cs-137	171	4.6E14	4	1.2E14	8	1.8E12	36	1.8E14	219	7.7E14
H-3	437	8.4E13	4	8.2E11	1053	2.1E14	39	2.8E13	1533	3.2E14
Ir-192	81	1.5E13	24	2.2E12			194	7.6E13	299	9.4E13
Kr-85	4	4.0E10							4	3.9E10
Pm-147	4	1.2E11							4	1.2E11
Pu-238					4	1.3E12	1	2.1E11	5	1.5E12
Pu-239	3	4.4E10			20	4.7E12	5	2.7E11	28	5.0E12
Pu-Be	47	7.7E12			40	6.5E12	6	1.5E12	93	1.6E13
Se-75	1	6.4E11							1	6.4E11
Sr-90	7	1.4E11	4	4.2E11			39	1.3E11	50	6.9E11

THE ROLE OF THE CENTRAL REGISTRY IN INCREASING THE SAFETY OF RADIOACTIVE MATERIALS

As mentioned above, according to the regulations, all radioactive materials — sealed sources and open substances (radiopharmaceuticals) alike — must be reported to the central registry. The initial reporting is the duty of the distributor. Currently, there are only three licensed distributors (one of them is the only Hungarian producer of radioactive materials), so it is relatively easy to ensure that all materials really are registered. At the other end, before final disposal, the radioactive waste management company also reports to the central registry. During the useful lifetime of a radiation source, it is the duty of the user (licensee) to report all changes (transfer, export, etc.) in the status of the source. Throughout this stage, only continuous attention can ensure that the data in the central registry reflects the real owner, location and status of the sources. In order to facilitate this, the HAEA, together with the IISC, performs regular inspections and checks the local registries at the premises of the licensees. Our experience shows, that no matter how low scale these inspections may be, they are very useful in drawing the attention of licensees to the importance of the safe handling of radiation sources. In the following, we list a few of the most interesting cases of inspections contributing to the safety and security of radioactive materials.

- A major industrial company reported some minor changes in its inventory to the central registry. During careful checks of the reports, the central registry revealed more minor discrepancies. To solve the problem, an inspection of the local registry was announced. Discrepancies found between the central and local registries during the inspection triggered a physical inventory taking. This revealed several dozens of old, unregistered radiation sources, which had been shipped to the site during the construction of the plant by the building company, and long forgotten. Now, all these sources are registered and most of them are disposed of.

- An inspection at a former manufacturer of radiation detectors revealed that over a hundred radiation sources listed in the central registry were missing from the local one. It also revealed that the company no longer engaged in radiation activities and, as a consequence, personnel responsible for the local registry had been laid off years before. The HAEA ordered a physical inventory taking, which established, that most of the sources in question had been exported as parts of radiation instruments, and others had been disposed of without the necessary reports having been sent to the central registry. The prolonged investigation — involving other authorities (SPHAMOS, police) as well — closed successfully with the updating of both the local and central registries, and drawing the attention of the managers of the company to the importance of the safety of radioactive materials.

- From the response to the announcement of inspections at a small company, the central registry learned that the company had recently gone out of business, and the personnel responsible for the local registry and radiation sources had been laid off. After the inspectors had draw the attention of local authorities to the few radiation sources on site, the sources were secured.

CONCLUSIONS

The Hungarian example demonstrates that a reliable nationwide central registry can be a very useful tool for increasing the safety and security of radiation sources and radioactive materials. Under normal operation the central registry, the reporting requirements and the regular inspections of local registries may draw the attention of licensees to the importance of handling radioactive materials properly. Our recent experience shows that even a limited inspection effort can have major effects. The central registry may be useful in cases of abnormal events as well. On the one hand, regular checks of inventories based on the local and central registries may facilitate early discovery of lost sources, or even prevent the operator from forgetting about or losing unused ones. On the other hand, the registry can be used to identify found sources or their owners or origin, or at least may help in narrowing the scope.

Taking into account the positive effects of our recent efforts spent on inspection and on improving the performance of the central registry, the HAEA is considering various ways of improving these activities. Since the HAEA and the IISC have rather limited resources to devote to the on-site inspection of the local registries, the HAEA has decided to promote the use of computerized local registries and plans to exploit the opportunities provided by the modern devices of information technology.

REFERENCES

[1] Act CXVI of 1996 on Atomic Energy

[2] EüM Decree 16/2000 (VI. 8.) on the execution of several orders of the Act CXVI of 1996 on Atomic Energy

[3] IKIM Decree 25/1997 (VI. 18.) on the Registration of Radioactive Materials and Preparations

MEASURES TO ENSURE SAFETY OF RADIOACTIVE MATERIALS IN INDIA

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Abstract. In India, the use of ionizing radiation sources in industry, medicine, agriculture and research registered a significant increase during recent years. The basis of legislative control of the use of radiation in India is the Atomic Energy Act from 1962, which empowers the central Government to provide control over radioactive substances. Exercising these powers, the central Government has promulgated several radiation safety rules, which specify the requirements of licensing, the duties and responsibilities of radiation safety officers, powers of inspection, etc. Later in 1983, by the Act, the Atomic Energy Regulatory Board (AERB) was constituted by the central Government to exercise regulatory and safety functions. The report describes the existing system of regulatory control of radiation sources in India and in particular, refers to the regulatory documents prepared by the AERB, the type approval of radiation equipment, the regulatory consent for every person handling radioactive sources, and the inspection activities and enforcement of regulatory actions. The report also explains how management of disused sources is carried out in India, including the handling of accidents and emergency activities.

INTRODUCTION

The use of ionizig radiation sources for various applications in industry, medicine, agriculture and research registered phenomenal growth during the last decade. The equipment containing radioactive sources used includes gamma irradiators, gamma chambers, industrial gamma radiography exposure devices and industrial ionizing radiation gauging devices. Consumer products such as radioluminous timepieces, gaseous tritium light sources (GTLSs), gaseous tritium light devices (GTLDs), ionisation chamber smoke detectors (ICSDs), fluorescent light starters, antistatic devices and incandescent gas mantles containing thorium are in use.

Industrial radiography is widely in use for NDT and quality control. It is an important method of quality assurance for welding and casting of products used in various spheres of industrial activity. The sources, in common use are Ir-192 and Co-60. Around 1100 gamma radiography exposure devices housing integrated activity of approximately 1100 TBq (30 000 Ci) of Ir-192 and 110 TBq (3000 Ci) of Co-60, 200 industrial X-ray machines and 9 high energy accelerators are deployed in this field.

The number of gamma irradiation facilities is increasing all over the world. In India twelve high intensity gamma irradiation facilities using 10^{16} Bq or more of activity of cobalt-60 source are in operation and one more facility is under construction. The most widespread use of these facilities is for the sterilization of medical and pharmaceutical products, the preservation of food stuffs, the vulcanization of rubber latex, the production of composite materials such as wood plastic polymers and in the management of public health and environment.

There has been a phenomenal increase in the use of radiation sources for therapeutic and diagnostic purposes in the medical field. Around 230 teletherapy units containing Co-60 and Cs-137 radioactive sources, and 141 brachytherapy units of both remote afterloading and manual afterloading versions are in operation at the various centres located all over the country. These are 600 nuclear medicine centres including the radioimmunoassy (RIA) laboratories. Radioisotopes generally used in nuclear medicine departments are I-131, Tc-

99m, P-32, Tl-201 and Ga-67 for therapeutic applications such as treatment of thyrotoxicosis, polycythemia vera and thyroid cancer.

Nucleonic gauges are used in several industries for the measurement and control of process parameters such as thickness, density, level and composition. A nucleonic gauge is a very vital tool in oil exploration field. Over 6500 nucleonic gauges are used in various industries in India. These gauges contain very insignificant quantities of different radioisotopes and are used as level gauges, density & moisture gauges, thickness gauges, well logging devices, betascopes etc.

Radionuclides are added in consumer products to make use of ionizing radiation to achieve a particular intended performance. The most widely used consumer products in India are gas mantels containing Th-232. Around 225 institutions are involved in manufacturing of consumer application products such as radiotracers, gas mantles, dial painting, fluorescent lamp starters etc.

REGULATORY FRAMEWORK

ACT AND RULE

The basis of legislative control of use of radiation in India is the Atomic Energy Act, 1962, which provides the basic regulatory framework for all activities related to atomic energy and the use of ionizing radiation in India. The use of the radioactive substances and radiation generating equipment is governed by the Act. Of its 32 sections, those related to safety are sections 3(e) (i), (ii), (iii), 16, 17 and 23. Sections 3 (e) empowers the central Government to provide control over radioactive substances. Sections 16 and 17 deal with the control of radioactive substances and special safety provisions. Section 23 relates to the administration of the provisions of the Factories Act, 1948.

Sections 24 and 26 of the Act stipulate offences and penalties of imprisonment/fine in accordance with the offence. Section 27 empowers the central Government to delegate any authorities conferred or any duty imposed on it by the Act to relevant officers or authorities of the central or state Governments.

Exercising the powers conferred by the Atomic Energy Act, 1962, the Central Government promulgated the following radiological safety related rules:

1. Radiation Protection Rules, 1971, GSR 1691, The Gazette of India, Part II Section 3 (i), October 30, 1971
2. Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987, GSR 125, The Gazette of India, Part II, SEC 3 (i), February 28, 1987
3. Atomic energy (Control of Irradiation of Food) Rules, 1996, G.S.R. 254, The Gazette of India Part II, SEC 3(i), June 22, 1996.

The rules specify the requirements of licensing or authorization, power to revoke or modify or withdraw licences, the duties and responsibilities of radiological safety officers, their qualifications, radiation surveillance procedures, powers of inspection of radiation installation, sealing and seizure of radioactive material among others. Each of these rules also confers authority on the central Government to designate a competent party to enforce the rules.

ATOMIC ENERGY REGULATORY BOARD

The Atomic Energy Regulatory Board (AERB) was constituted by the central Government in November 1983 to exercise the regulatory and safety functions envisaged under Sections 16, 17 and 23 of the Atomic Energy Act, 1962. The Board has five members including a full time chairman an ex-officio member, three part time members and a full time secretary. In India, the Chairman, of the AERB is the competent authority to enforce provisions of radiation safety. The AERB has powers to lay down safety standards and frame rules and regulations about regulatory and safety requirements envisaged under the Act. The regulatory control covers radiation safety and industrial safety of all the nuclear fuel cycle activities and radiation facilities under the Department of Atomic Energy (DAE) and of radiation installations in the medical, industrial and research institutions in India.

SYSTEM OF REGULATORY CONTROL

AERB NOTIFICATIONS

AERB has published several safety standards specifications, codes, guides and manuals. They elaborate safety requirements and the way to fulfil them. Rule 15 of the Radiation Protection Rules, 1971, empowers the competent authority to notify appropriate surveillance procedures. The competent authority incorporates safety requirements through such notifications. Such surveillance procedures are prescribed for medical applications of radiation, safe transport of radioactive material and industrial radiography. It is mandatory for any person handling radiation sources to comply with the requirements of all the above notifications issued by the competent authority. The handling of radioactive source means manufacture, possessing, storage, use, transfer by sale or otherwise, export, import, transport or disposal.

TYPE APPROVAL OF RADIATION EQUIPMENT

In India, it is mandatory that any device designed to handle radioactive sources and radiation generating equipment should have a type approval certificate from the competent authority. Type approval is primarily concerned with the built-in safety requirements. The AERB has published several standard specifications for radiation equipment such as industrial radiography devices, telecobalt & brachytherapy units, medical X-ray units, and medical accelerators. These documents have been prepared by AERB in accordance with the international standards. These standards specify the built-in safety design features to be incorporated into the design, manufacture and operations, quality assurance programme, probabilistic safety analysis etc. Demonstration of compliance with AERB standards is mandatory for type approval.

The AERB has issued type approval for eight types of gamma chamber, 130 types of nucleonic gauge, 14 types of industrial radiography device and 28 types of ionization chamber smoke detectors.

REGULATORY CONSENT

Every person handling radioactive sources has to obtain regulatory consent from the competent authority. Consent is granted in the form of a licence, an authorization, a registration and an approval depending upon the category of the facility, the particular activity with associated hazard potential and radiation sources involved. A licence is applicable to the highest hazard radiation sources and mere registration to lowest hazard sources while the practices and devices using very small quantities of radioactive materials are exempted from regulatory consent e.g. consumer products. The consent for high intensity gamma irradiators, high-energy accelerators, and medical teletherapy machines is in the form of a licence valid for three years. The consent for brachytherapy, gamma radiography is issued as an authorization while for diagnostic X-rays, nuclear medicine laboratories, and nucleonic gauges, registration is issued in the form of consent. Consent is issued at the stages of manufacture, possession, use, transport, disposal, import, export or transfer of radiation sources and stipulates conditions such as validity, surveillance requirements, and submission of periodic safety status reports to the office of the competent authority.

INSPECTION AND ENFORCEMENT

The strict adherence to recommended regulatory measures by every user of radioactive materials is verified through the compliance assurance programme (CAP) of the competent authority. One of the main organs of CAP is a periodic review of the detailed inventory of radioactive materials received in the Office of the Board. Submission of a safety status report of radiation installation, including details of the source inventory, is a mandatory condition for issue of regulatory consent by the competent authority. Another organ of CAP through which the effective control can be exercised over safety and security of sources is periodic regulatory inspections. The AERB created the Directorate of Regulatory Inspection and Enforcement (DRI & E) on 31 December 1993 and one of its major functions is to carry out regulatory inspections and enforce appropriate regulatory actions.

The regulatory inspection can be routine or special. Any person duly authorized by the competent authority carries out the inspections. The inspector can inspect any radiation installation, equipment or transport package and carries out the tests and measurements as may be necessary for radiation hazard evaluations etc. The inspection is carried out through the examination of procedures, records and documents, direct surveillance of structures, systems and components, and personal interviews. The inspections are carried out for site approval, during construction, precommissioning, commissioning, routine operations and decommissioning of radiation facilities. All radiation equipment and installations are checked regularly before source replenishment to ensure the proper functioning of the built-in safety features.

The possibility of incidents or malfunctioning involving high exposure is greater in industrial gamma radiography. Therefore, the ad hoc inspections are carried out to find out the actual working conditions at field radiography sites and to evaluate the authenticity of the information periodically provided by the user. A committee convened by the chairman of the AERB, reviews the violations observed during the inspection. The AERB enforces regulatory actions as per the RPR-1971 on the basis of assessment of radiological risk to the occupational workers and members of the public from unsafe handling and inadequate physical security of radioactive materials. The regulatory action can include warning to the institutions, suspension or withdrawal of licence and withdrawal of certificates of certified staff according the nature of violations and severity of the hazards. Show-cause notices and warning letters are issued before enforcement of regulatory actions.

MANAGEMENT OF DISUSED SOURCES

Radioactive waste management in India is governed by the Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987, GSR-125. It is mandatory for every user of radioactive material to obtain authorization from the AERB for the disposal of disused sources or waste. The AERB permits the disposal of disused sources only by transfer to an authorized waste management agency for disposal at specially designed facilities. A specialist committee reviews the applications from industrial, medical and research institutions. The authorizations specify terms and conditions, and are valid for three years. The renewal of the authorization is issued only after reviewing the annual reports from the institution. India has a well-structured regime of safety regulations for radioactive waste management.

ACCIDENTS AND EMERGENCIES

The AERB has published safety guides on handling radiation emergencies in different applications and has made it mandatory for every user of radioactive material to have written emergency procedures in the regional and national languages, displayed in strategic locations, and for appropriate emergency handling tools to be made available at working sites. The emergency procedures include descriptions of probable types of emergency that can arise, required actions by the authorized persons and recovery procedures of radioactive material and shielding along with a list of names and telephone numbers of persons to be contacted in such a situation. Only the radiological safety officer/site-in-charge is authorized to handle the radiation emergency and it is the responsibility of the user to inform the AERB immediately regarding an unusual incident and the actions initiated to normalize the situation. The AERB along with BARC extends its full co-operation with the user if he fails to normalise the emergency. The responsibilities of the user, operator and safety personnel are outlined in the safety guide.

The loss or theft of radiography sources is viewed seriously by AERB, because the source can affect members of public who are totally ignorant of the hazards associated with radiation sources and if the source loss is reported AERB deploys technical experts to help. The user makes every possible effort to locate the source by employing all available radiation survey meters with reasonably high range, the management of the facility lodges a complaint with the local police authority and the expert team carries out extensive search and interrogation with the help of local police. If the expert team fails to locate the source, the management may announce the details of the loss of source, preferably with photographs, the radiation symbol and precautions to be taken by the public if the source is found through the media. The search for the source is abandoned only after confirming that the source has not reached members of the public or is not likely to result in radiation doses.

Most cases of loss or theft of radioactive sources and radiation injuries are reported from industrial radiography practice, which has made regulators further strengthen existing regulatory control over safe handling and adequate physical security of radioactive materials in this field. For the physical security of radiography sources, the AERB advises, through the safety guides, on the size and shape of source storage rooms. For the storage of radiography radiation sources, the size of room is of the order of 300 cm X 300 cm housing at the centre, a storage pit of 90 cm X 90 cm with MS cover and locking arrangements including fencing around the main storage room. Similar advice is rendered by the AERB for other applications of radiation sources and, additionally, the required administrative controls are approved by the AERB for all the radioactive sources to ensure their physical security.

CONCLUSION

The radiation protection programme has been in existence in the country since the inception of the nuclear programme and today, an adequate regulatory infrastructure ensures radiation safety and security in various applications of radioactive materials. Nevertheless, the regulatory programme is constantly being reviewed, taking into account experience, and newer national/international standards and every effort is being made to avoid theft, illicit trafficking and misuse of radioactive materials.

CONTROL OF RADIOISOTOPES AND RADIATION SOURCES IN INDONESIA

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Abstract. Radioisotopes and radiation sources are extensively used in Indonesia in medicine, industry, mining, agriculture and research. These materials are controlled by the regulatory authority, according to established legal procedures. The Nuclear Energy Control Board of Indonesia (BAPETEN), which was established in 1998 through the Nuclear Energy Act No. 10/1997, is entrusted with the control of any application of nuclear energy, including the application of radioisotopes and radiation sources, through regulation, licensing and inspection. The control is aimed to assure welfare, security and peace, the safety and health of workers and the public, and environmental protection. The number of licences issued to date is around 2400, consisting of 1600 licences for radioisotopes and radiation sources used in hospitals, 347 in radiography, 256 in industry, 53 in mining, and the rest in many other areas such as research and agriculture. A licence can cover one or more radioisotopes or radiation sources, depending on the location of the user institution. These radioisotopes and radiation sources are Co-60, Cs-137, Ir-192, Ra-226, Am-241, Sr-90, Kr-85, Pm-147, linear accelerator and X-ray, and short half-life radioisotopes such as I-125, I-131 and Tc-99m. There are 10 LINACs, 27 X-ray medicines, 61 radioisotope devices for Co-60 and Cs-137, and 10 mHDR Ir-192 for therapeutic purposes currently used in Indonesia and some Ra-226 in storage. Any activity related to the application of nuclear energy is required to be conducted in a manner which observes safety and security. According to the legal requirements, each user has to employ at least one radiation safety officer. To improve the control of the application of radiation sources and radioactive material in the country, BAPETEN introduced some new approaches to the users, including regular dialogues with radiation safety officers and the management of the users, requalification for radiation protection officers twice in five years, periodical newsletters and the establishment of a radiation safety officers' association, under BAPETEN supervision. The implementation of radiation safety control involving licensing, inspection, training and the regulatory framework are described in detail in this paper.

INTRODUCTION

Indonesia has no nuclear power plant in operation yet, although it has had a nuclear energy programme since the late 1970's. At present, it is operating three research reactors, one nuclear fuel fabrication plant for research reactors, and one experimental fuel fabrication plant for nuclear power, one isotope production facility and some other research facilities. However, radioisotopes and radiation sources are being extensively used medicine, industry, mining, agriculture and research. In anticipation of the expansion of the present nuclear activities, the Indonesian Government has, since April 10, 1997 enacted the new Law No. 10/1997 on Nuclear Energy. The law addresses several key requirements for the successful conduct of Indonesia's nuclear industry, including the establishment of both an executing body responsible for nuclear research and development, mining and processing of nuclear fuels and materials, production of radio-isotopes and management of radioactive waste and an independent Nuclear Energy Control Board, which will have the power to regulate, license and inspect all facets of any activity using nuclear energy. It also sets out the basic principles for regulating practices in the application of nuclear energy, the basic arrangements for managing and disposing of radioactive waste and the allocation of liability for nuclear damage. The law is being implemented through the application of further Government regulations. In brief, the Law on Nuclear Energy consists of 10 chapters with 48 articles. One chapter of eight articles is devoted to the basic principles of the regulation of nuclear energy, one chapter of six articles to the basic arrangement for radioactive waste management, and one chapter of 13 articles to nuclear damage liability. The penal stipulations are contained in one chapter of four articles.

REGULATORY FRAMEWORK

The Nuclear Energy Law No. 10/1997 fully separates the promotional and regulatory functions in accordance with Article 3 and 4, and establishes the regulatory body for the control of the application of all nuclear energy through regulations, licensing and inspection. The regulatory body, Badan Pengawas Tenaga Nuklir (BAPETEN) and the Nuclear Energy Control Board (NECB), was then established by the Presidential Decree No. 76/1998 in May 1998 and is now in full operation.

Utilization of nuclear energy is defined in the law as "any activity related to nuclear energy utilization that includes research, development, mining, fabrication, manufacturing, production, transportation, storage, transfer, export, import, decommissioning and radioactive waste management to enhance people's welfare".

The authority and responsibilities of BAPETEN are described in Articles 14-21, 27, 38, and 39 of the law. Article 14, for example, stipulates that "the control of the application of all nuclear energy should be implemented through regulation, licensing, and inspection", and aims to (Article 15):

- assure welfare, the security and peace of the people;
- assure the safety of the health of workers and public, and the environmental protection;
- maintain the legal order in implementing the use of nuclear energy;
- increase the legal awareness of nuclear energy user to develop a safety culture in nuclear field;
- prevent the diversion of the purpose the nuclear material utilization; and
- assure the maintenance and increase of worker discipline in the implementation of nuclear energy utilization.

BAPETEN is established as a governmental agency, under and directly responsible to the President of the Republic of Indonesia. BAPETEN's status, tasks, function, structure and organization were established in the Presidential Decree No 76/1998. BAPETEN has, inter alia, the following functions:

- rulemaking for national policy in the control of nuclear energy utilization;
- planning the national programme for the control of nuclear energy utilization;
- guiding and rulemaking in the implementation of nuclear safety, radiation safety, and safeguards assessments;
- implementing licensing and inspection in the development and operation of nuclear reactors, nuclear installations, nuclear material facilities, and radiation sources, and developing nuclear preparedness;
- implementing co-operation in the control of nuclear energy utilization with the Government agencies or other organizations either internally or externally to the Government of Indonesia;
- implementing safeguards and the State's system of accounting for and control of nuclear material (SSAC);
- implementing guidance and counselling related to the safety and health of workers and the people, and to environmental conservation;

At present BAPETEN has 173 staff, 120 of whom are professional staff. It has, excluding staff salaries, around US $1 million annual operating costs. The organizational structure of BAPETEN can be seen on the Attachment. It is chaired by a chairperson, who is assisted by two Deputies, one Head of Administration and one Head of Safeguards Centre. One Deputy is responsible for the assessment of nuclear safety, who is in turn supported by three Directorates, each responsible for the assessment of reactor safety and of radiation safety and – for drafting nuclear and radiation safety rules. The other Deputy is responsible for licensing and inspection, and is supported by three Directorates, namely the Directorate for Licensing Radiation Sources and Radioactive Materials, the Directorate for Licensing Nuclear Installations and the Directorate of Inspection and Emergency Preparedness.

The law stipulates that any activity related to the application of nuclear energy is required to be conducted in a manner which observes safety, security and peace, and protects the health of workers, the public and the environment, which will further be implemented by Government Regulation (Article 16). Government Regulation No. 63/2000 on Radiation Safety was issued recently to administer these requirements. This Government Regulation is based on the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, IAEA Safety Series No. 115, and is issued to replace the old GR No 11/1975 which was based on old basic safety standards.

The law further stipulates that any use of nuclear energy, the construction and operation of nuclear reactors and other nuclear installations, and the decommissioning of nuclear reactors shall be subjected to licensing. A Control Board is authorized to license nuclear reactor operators and certain designated employees in other nuclear installations or those using ionizing radiation sources. Such employees will include radiography experts and operators, radiation safety officers, dosimetry officers and maintenance officers. The licensing process for this personnel shall include examinations. The requirements and procedures of the licensing process on utilization of radioisotopes and radiation sources is further detailed in Government Regulations No. 64/2000 on Licensing Process, and in some technical and standard requirement rules issued by BAPETEN. To date, BAPETEN has issued 23 various technical and standard requirements and guides. The requirements and procedures of the licensing process of the construction and operation of nuclear reactors is still under review.

The law provides the Control Board for the inspection of nuclear installations and any installation that applies ionizing radiation with the aim of controlling the fulfillment of the requirements in the licensing process and regulations in nuclear safety. An inspector appointed by the Control Board shall carry out such inspections and the results of such inspections shall be published in an open and transparent manner.

WASTE MANAGEMENT

Law No.10/1997 on Nuclear Energy contains some provisions on radioactive waste management that need further elaboration and regulation. Article 1, for example, stipulates that radioactive waste is defined as any radioactive material and any material or equipment that has been contaminated by radioactive material or becomes radioactive due to the operation of a nuclear installation and cannot further be used.
In general, the basic principles underlying the law are:

- Radioactive waste management shall be conducted to mitigate radiation hazards to the workers, the public and the environment (Article 22 (1));

- Radioactive waste management shall be accomplished by the Executing Body, which may designate a state or private company or cooperative to conduct commercial waste management activities (Article 23);
- Users generating low and intermediate level of radioactive wastes shall be obliged to collect, segregate, or treat and temporarily store the waste before its transfer to the Executive Body (Article 24 (1));

Further,

- The transportation and storage of radioactive waste shall observe the safety of workers, the public and the environment (Article 27 (1)).
- The provisions on radioactive waste management, including waste transportation and disposal, shall be further implemented by Government regulation (Article 27 (2)).

The Government regulation to administer the waste management requirements as mentioned in Article 27 paragraph 2, is now under preparation. The law also contains some provisions on high-level waste management.

Elucidation of Article 25 prohibits the use of any part of Indonesian territory by any foreign or other country as a radioactive waste repository.

LICENSING AND VERIFICATION PROCESS

Issuance of a licence is subject to the fulfilment of the requirements set out in BAPETEN's rules and procedure such as providing the document of procurement or importation, technical specifications of the radioisotopes and/or radiation sources, design of facility, necessary monitoring equipment, standard operating procedure including emergency handling, waste management and availability of trained and certified personnel or radiation safety officer at the user institution. The fulfilment of radiation safety requirements is ensured through safety assessments, surveillance of the installations and review of the standard operating procedure. If it is considered necessary, verification on site will be carried out. During the useful life of radioisotopes and/or radiation sources, prior approval of BAPETEN is required for transfer, transport, resale, re-export or storage. If later on the radioisotopes will not be used any more, it is advised to arrange for temporary safe storage before final re-export to the original supplier.

As stated earlier, the National Nuclear Energy Agency is the competent authority to manage radioactive waste in the country. Any radioactive waste can be temporarily stored on site only with a special licence from BAPETEN. It is advised that waste should be stored finally in the facility belong to the National Nuclear Energy Agency.

RADIOISOTOPES AND RADIATION SOURCES IN INDONESIA

The radioisotopes in Indonesia are used mainly in hospitals, industry, mining and research activities. Two types of sources are used, unsealed and sealed. Unsealed sources are generally used up during their "useful life". In hospitals, they are used for diagnosis and for treatment of patients. Except for those used for therapeutic purposes in medicine, and for gauging in industry, these isotopes are of short half-life.

The following are various radioisotopes commonly used in hospitals, industries and mining:

- Co-60, from a few mCi to a hundred thousand Ci, is used for gauging, radiography, therapy, and radiation sterilization;
- Cs-137, from a few mCi to a few thousand Ci, is used for gauging, radiography, logging and therapy;
- Am-241, only a few mCi, is used for gauging and logging;
- Cd-109, Cf-252, Cm- 244, Fe-55, Kr-85, Pm-247, and Sr-90 are used for gauging;
- Gd-153, Hg-203, Ra-226, Sc-46, Sb-124, Th-228 and Th-232 are used in companies provide logging services;
- Ir-192 is used in radiography;

The following are various radioisotopes used in education, research and development and in nuclear medicine:

Ag-110m, Am-241, Au-198, Ba-133, Bi-207, Bi-210, Br-82, Br-85, C-14, Ca-45, Cd-109, Cm-244, Co-57, Co-60, Cr-51, Cs-137, Eu-152, Fe-59, Ga-167, Ge-68/Ga-68, H-3, Hg-197, Hg-203, Hg-204, Hg-207, I-125, I-131, In-111, In-115m, Ir-192, Kr-85, La-140, Mn-54, Mo-99, Na-22, Na-24, P-32, Pb-210, Po-209, Pu-242, Ra-226, S-35, S-36, Sc-46, Se-75, Sm-153, Sn-113, Sn-113/In-113, Sn-119, Sr-80, Sr-85, Tc-99m, Te-132/I-132, Th-229, Th-232, Ti-204, Tl-201, Tl-204, U-236, U-238, Xe-133, Y-80, Y-87/Sr-87, Y-88, Yb-169, Zn-65, Zr-95.

For radioisotopes not in use or unlikely to be used for further application, the licensee is advised to get a licence from BAPETEN to temporarily store the waste on site, before it is finally transferred to a waste management facility of the National Nuclear Energy Agency, the institution authorized by law to dispose of radioactive waste. Radioactive waste is now accumulating from industries with gauging equipment and from hospitals with disused Cs-137 and Ra-226 from therapy practices. Many users are reluctant to send their disused radioisotopes to the waste management facility, due to the high fee this facility changes. The users prefer to keep them on site by extending their storage licence as this practice is much cheaper. Although this radioactive waste is properly controlled, BAPETEN is now starting to worry in view of the increasing number of accidents connected with unused radioisotopes. BAPETEN is now trying to offer a solution in co-operation with other Government institutions to tackle this waste problem.

LAW ENFORCEMENT AND COMMUNICATION

Law No. 10/1997 states that the control of the utilization of nuclear energy aims to maintain legal order and increase the legal awareness of the nuclear energy users. The law authorizes BAPETEN to inspect nuclear installations and any installation that applies ionizing radiation with the aim of controlling the fulfilment of the requirements in the licensing process and regulations in nuclear safety. BAPETEN is the only institution in the country authorized by the law to appoint inspectors.

To achieve this goal, BAPETEN organizes periodic and unprogrammed inspection. During the past two years, no major misconduct has been found in industrial application of radiation and radioisotopes. All user institutions respect legal administrative requirements and operate according to the safety standards and operating procedures approved by BAPETEN. Some minor administrative failures have been found but they are usually rectified immediately.

In hospitals, particularly in public hospitals, however, there were some infringements. Not only were legal administrative requirements not always fulfilled but, in some cases, safety procedures were not carried out. For example, many licences had expired, the radiation logbook was missing, medical checkups for radiation workers were not performed. In addition, the recalibration of teletherapy equipment was not carried out; in some hospitals calibration had not been performed at all. One fatal accident occurred in 1998, a few days before BAPETEN came into being; a patient with breast cancer received unpredicted doses and died four months after irradiation. The accident was not reported to BAPETEN until a few months later.

Since its inception, BAPETEN has given the problems associated with teletherapy practices high priority. No sanctions have been imposed so far; rather visits to hospitals to meet the hospital managers and radiologists is seen as the most appropriate way to improve the situation. To improve communication with institutional users, BAPETEN organizes periodic dialogues in many big cities. Radiation safety officers working for these users are also invited. These modalities are part of the major policy of BAPETEN to pursue the establishment of a safety culture, and to create an atmosphere of mutual understanding, trust and respect. The results have been encouraging. At present, almost all teletherapy equipment in Indonesia has been re-calibrated, and their licences extended. Unused radiation sources have been reported, managed, stored and licensed properly.

The Ministry of Health supports the policy and programme of BAPETEN for restoring medical practices using radioisotopes and radiation sources in hospital to the expected normal and safe condition. A MOU between the two institutions was signed recently, under which a joint committee was created to plan joint action. It is anticipated that in the year 2001, legal action will be taken against those hospitals and clinics that do not respect legal administrative requirements or honour safety procedures.

TRAINING AND COUNSELLING

An important component of the nuclear regulatory practices in Indonesia is the organization of comprehensive training for new radiation safety officers, and requalification training for radiation safety officers holding working licences from BAPETEN. A new radiation safety officer has to pass an examination to obtain a working license from BAPETEN. Requalification training is carried out twice in five years. It is a new modality and mandatory for radiation safety officers to obtain automatic extension of their working licence. During the requalification process, an interview was organized to get information from the field. From these dialogues, BAPETEN has concluded that the existence of a professional association for radiation safety officers is important to support their work. It is expected that through this association, the role and responsibilities of a radiation safety officer will become more visible and recognized. The establishment of such an association under BAPETEN supervision is under way. Better communication and exchange of views among radiation safety officers and between them and BAPETEN is also a feature in establishing safety culture. A periodical newsletter is now published by BAPETEN to accommodate this need.

Training programmes are also organized for customs, airport and seaport officials, to bring about a general awareness regarding the general policy, the legal requirements, the nature and dimensions of the problem of radiation safety and security, and the role of these officials in supporting the work of BAPETEN to ensure safety of radioisotopes by checking all necessary importation documents and checking the possibility of any illicit trafficking of radioisotopes.

With regard to counselling, Article 21 of the Nuclear Energy Law No. 10/1997 states that “the Control Board provides guidance and counselling on the implementation of efforts related to the health and safety of workers, the public, and environmental protection”. To carry out this mandate, BAPETEN organizes several counselling activities in many big cities, where the managers of user institutions, their radiation safety officers, local government officials, local authorities of the Ministry of Health and the Ministry of Industry, and university staff are invited. They are given up-to-date information about radiation safety, procedures and legal requirements in performing activities utilizing radioisotopes and radiation sources, and the regulatory authority and its mandate.

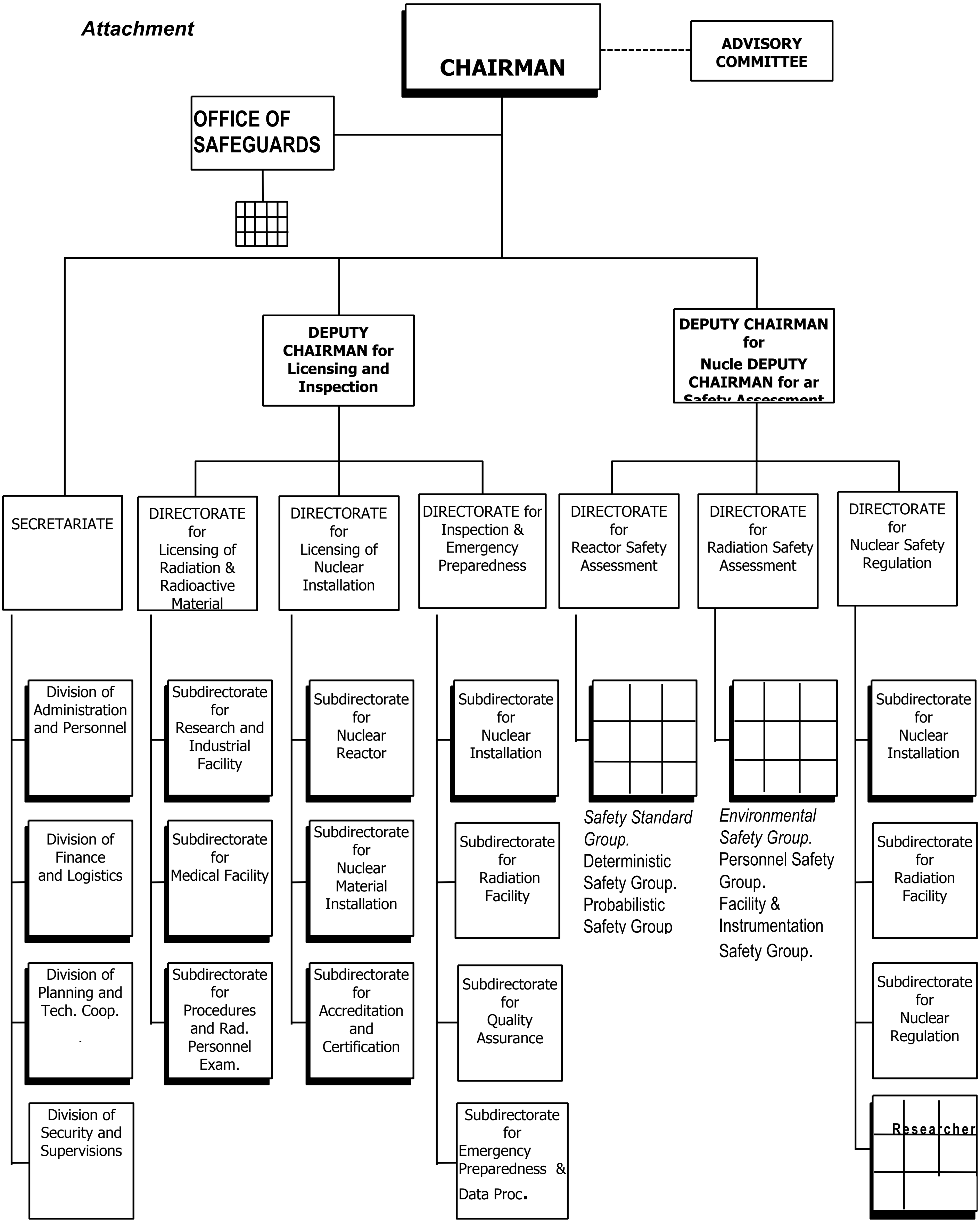
EMERGENCY PREPAREDNESS

From the time of the establishment of BAPETEN, an emergency preparedness unit has been considered important to be created to respond to any radiological emergencies. This Unit was established under the Directorate of Inspection and Emergency Preparedness. Some incidents connected with the loss of the radioisotopes for logging equipment in wells have been reported. An incident connected with melting, due to fire, of two casks each containing radioisotope 15 mCi and 50 mCi Cs-137 in gauging equipment belonging to a refinery company was reported. The unit responded immediately by sending its staff to the site to give advice and take action. In all cases reported to BAPETEN, there were no injuries or fatalities. So far, no other incident or accident has been reported.

REFERENCES

[1] Act No. 10/1997 on Nuclear Energy, BAPETEN PPN 0100.0599.
[2] Presidential Decree No. 76/1998 on BAPETEN, BAPETEN 0200.0599.
[3] Government Regulation No. 63/2000 on Radiation Safety.
[4] Government Regulation No. 64/2000 on Licensing Process.
[5] Chairman BAPETEN Decree No. 01/Ka-BAPETEN/V-99 on Radiation Safety.
[6] Chairman BAPETEN Decree No. 03/Ka-BAPETEN/V-99 on Waste Management.
[7] Chairman BAPETEN Decree No. 04/Ka-BAPETEN/V-99 on Transport of Radioactive Materials.
[8] Chairman BAPETEN Decree No. 15/Ka-BAPETEN/VIII-99 on Inspector.
[9] Chairman BAPETEN Decree No. 17/Ka-BAPETEN/IX-99 on Licensing Procedure.
[10] Chairman BAPETEN Decree No. 20/Ka-BAPETEN/II-00 on Licensing Exception.

Attachment


CHAIRMAN
ADVISORY COMMITTEE
OFFICE OF SAFEGUARDS
DEPUTY CHAIRMAN for Licensing and Inspection
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DIRECTORATE for Licensing of Radiation & Radioactive Material
DIRECTORATE for Licensing of Nuclear Installation
DIRECTORATE for Inspection & Emergency Preparedness
DIRECTORATE for Reactor Safety Assessment
DIRECTORATE for Radiation Safety Assessment
DIRECTORATE for Nuclear Safety Regulation
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Division of Finance and Logistics
Division of Planning and Tech. Coop.
Division of Security and Supervisions
Subdirectorate for Research and Industrial Facility
Subdirectorate for Medical Facility
Subdirectorate for Procedures and Rad. Personnel Exam.
Subdirectorate for Nuclear Reactor
Subdirectorate for Nuclear Material Installation
Subdirectorate for Accreditation and Certification
Subdirectorate for Nuclear Installation
Subdirectorate for Radiation Facility
Subdirectorate for Quality Assurance
Subdirectorate for Emergency Preparedness & Data Proc.
Safety Standard Group.
Deterministic Safety Group.
Probabilistic Safety Group
Environmental Safety Group.
Personnel Safety Group.
Facility & Instrumentation Safety Group.
Subdirectorate for Nuclear Installation
Subdirectorate for Radiation Facility
Subdirectorate for Nuclear Regulation
Researcher

REGULATORY CONTROL OF RADIATION SOURCES AND RADIOACTIVE MATERIALS IN IRELAND

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Abstract. The primary legislation governing safety in uses of ionizing radiation in Ireland is the Radiological Protection Act, 1991. This Act provided for the establishment in 1992 of the Radiological Protection Institute of Ireland, and gives the Institute the functions and powers which enable it to be the regulatory body for all matters relating to ionizing radiation. A Ministerial Order made under the Act in 2000 consolidates previous regulations and, in particular, provides for the implementation in Irish law of the 1996 European Union Directive which lays down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation.
Under the legislation, the custody, use and a number of other activities involving radioactive substances and irradiating apparatus require a licence issued by the Institute. Currently some 1260 licences are in force. Of these, some 850 are in respect of irradiating apparatus only and are issued principally to dentists and veterinary surgeons. The remaining licences involve sealed radiation sources and/or unsealed radioactive substances used in medicine, industry or education.
A schedule attached to each licence fully lists the sealed sources to which the licence applies, and also the quantities of radioactive substances which may be acquired or held under the licence. It is an offence to dispose of, or otherwise relinquish possession of, any licensable material other than in accordance with terms and conditions of the licence. Disused sources are returned to the original supplier or, where this is not possible, stored under licence by the licensee who used them.
Enforcement of the licensing provisions relies primarily on the programme of inspection of licensees, carried out by the Institute's inspectors. The Institute's Regulatory Service has a complement of four inspectors, one of whom is the Manager of the Service. The Manager reports to one of the Institute's Principal Scientific Officers, who in turn reports to the Chief Executive.
The Institute's licensing system and inspection programme constitute the principal means of ensuring safety and security of radiation sources and radioactive materials. They are backed by powers of prosecution which the Institute typically uses a few times each year.
The management of abnormal events and of orphan sources, education and training, and the dissemination of information to the public are also considered in the paper.

REGULATORY INFRASTRUCTURE

The Radiological Protection Act

The primary legislation governing safety in the uses of ionizing radiation in Ireland is the Radiological Protection Act, 1991 [1]. This Act provided for the establishment in 1992 of the Radiological Protection Institute of Ireland, and Section 7 of the Act lists the general functions of the Institute. These include:

- monitoring radiation levels in the environment;
- monitoring the exposure of individuals;
- advising the Government on measures for the protection of individuals from radiological hazards, and in relation to relevant international standards;
- assisting in the planning and implementation of measures to deal with radiological emergencies; and
- providing information to the public on matters relating to radiological safety.

The Institute is under the aegis of the Department of Public Enterprise, the Government department dealing with energy and transport.

The Act gives the Institute the functions and powers which enable it to be the regulatory body for the control of radiation sources and radioactive materials in Ireland. In particular, Section 8 of the Act requires the Institute "*to carry out a licensing system relating to the custody, use, manufacture, importation, distribution, transportation, exportation or other disposal of radioactive substances, nuclear devices or irradiating apparatus*". Section 30 of the Act elaborates the framework for the licensing system; in particular, it provides for conditions to be attached to licences issued by the Institute, for the amendment or revocation of licences and for the charging of licence fees. Sections 28 and 29 deal with the appointment and powers of inspectors, while Sections 40 and 41 deal with offences and prosecutions.

The Ionizing Radiation Order

A Ministerial Order (The Radiological Protection Act, 1991 (Ionizing Radiation) Order, 2000) [2] made under the Act in May of 2000 consolidates previous regulations and, in particular, provides for the implementation in Irish law of 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. This legislation designates the Institute as the competent authority.

It requires all practices, including the custody, production, processing, handling, holding, storage, use, manufacture, importing into and exporting from the European Union, distribution, transportation, recycling, re-use or other disposal of radioactive substances and nuclear devices, to be licensed by the Institute unless the exemption conditions are met. The exemption levels do not apply to disposal, recycling or re-use of radioactive substances arising from a licensed practice and, at present, there is no provision for clearance of contaminated material.

The principles of justification and optimization are included in the legislation and the annual effective dose limits are 20 mSv and 1mSv for exposed workers and members of the public, respectively. Other requirements include those relating to classification of areas (controlled and supervised), radiation safety procedures (written statement of procedures to be followed to minimize risk of exposure), appointment of a Radiation Protection Adviser (qualified expert), dose monitoring, and information and training to be provided for exposed workers. With regard to the control of radioactive substances, nuclear devices and irradiating apparatus, Article 28 of the Order requires that an up-to-date inventory of the locations and quantities of all sources of radiation be maintained by the licensee and that these sources be clearly labelled and kept in secure and safe storage when not in use. In the case of unsealed radioactive substances, the licensee is required to maintain records of the quantities used and the dates and method of disposal.

INVENTORY OF RADIATION SOURCES AND RADIOACTIVE MATERIALS

Currently, there are approximately 1260 licences in force. The Institute issues licences based on the type of source to be used and the nature of the use. The number of licensees by category is given in the table below. Of the total number of licences, some 850 are in respect of irradiating apparatus only and are issued principally to dentists and veterinary surgeons. The remaining licences involve sealed radiation sources and/or unsealed radioactive substances, which are used in medicine, industry or education.

Band	Licence Category	Number in Category
Industrial	Level 7 -process irradiation facility	3
	Level 6 - industrial radiography using X rays and/or sealed sources, gauge manufacture	25
	Level 5 - 20 or more sources (X ray sets or sealed sources other than for use in industrial radiography)	9
	Level 4 - 6-19 sources (X ray sets or sealed sources other than for use in industrial radiography)	9
	Level 3 - 1-5 sources (X ray sets or sealed sources other than for use in industrial radiography)	83
	Level 2 - sealed sources with activity < 10 MBq	9
	Level 1 - cabinet type X ray set	63
	Lightening preventors	11
	Static controllers	8
	Logging	2
	Gaseous Tritium	1
	Custody Only	15
Medical	Level 5 - hospital with radiotherapy facilities	4
	Level 4 - hospital with radiology and nuclear medicine facilities	15
	Level 3 - hospital with X ray facilities which also uses unsealed sources for in-vitro application only	6
	Level 2 - hospital with X ray facilities only	57
	Level 1 - hospital with one simple X ray set (i.e. not CT, mammography or fluoroscopy)	21
Education,	Level 3 - more than 5 sealed sources, at least one of which has activity >1 MBq, and/or unsealed sources	28
Research &	Level 2 - 1 - 5 sealed sources (1 with activity > 1 MBq), or >5 sealed sources of activity <1MBq, or unsealed sources	1
Labs	Level 1 - < 6 sealed sources of activity < 1MBq and/or simple X ray sets	1
Distribution	Level 2 - distributor of sources other than Ionisation chamber smoke detectors (ICSD's)	40
	Level 1 - distributor of ICSD's only	11
Others	Dental surgeons	713
	Veterinary surgeons	119
	Chiropractors	5
	Miscellaneous	3
Total		**1258**

LICENSING

Application for a licence to the Institute must be made before possession of the source can occur and must include all relevant documentation (i.e. risk assessment, radiation safety procedures, and, in the case of sealed sources, written assurance that the supplier will accept the return of the source when it is no longer required by the applicant). Depending on the licence category, licences are issued for terms of between one and four years, with shorter terms for more hazardous activities. An application for renewal of a licence must be submitted to the Institute by the licensee 30 days prior to the expiration date of the licence. At the time of renewal, the licensee must ensure that the inventory of sources is up-to-date and that the radiation safety procedures have been reviewed.

A licence amendment process allows licensees to request changes to their authorization and other licence conditions as required. Supporting documentation for amendment applications must be provided. In some instances, i.e. purchase of a new source or change in work practice, modification of the risk assessment and radiation safety procedures may be required and any revisions must be forwarded to the Institute within 30 days of the date of licence amendment.

INSPECTION

A routine announced inspection programme based on the licence band (industrial, medical, education/research, distribution and others) is drawn up at the beginning of each year. As a guideline, the Institute aims to inspect each licensee (with the exception of dentists and veterinary surgeons) at least once during the licence period. In the first place, the programme is designed to ensure that those licensees where the greatest potential radiological risks exist are inspected. Priority is then given to those licensees who have not been visited by Institute inspectors or who were last inspected outside the current licence period. In 1999, a total of 132 inspections were undertaken, while in 2000, the programme identifies 135 licensees due for inspection. In advance of the inspection, the licence, radiation safety procedures, previous inspection reports and incident or event reports are reviewed. Standard inspection audit forms (based on the category of licence) are used to guide the inspector and document the inspection details. Approximately five to ten days following the inspection, a summary letter specifying the required actions is forwarded to the licensee with a response deadline of four to six weeks.

ENFORCEMENT

The Ionizing Radiation Order, which came into force in May 2000, contains provisions for the issuance of enforcement notices, but these provisions have yet to be used. The enforcement notice may require the licensee to cease performing the practice. The existing legislation provides for the prosecution of an undertaking for failure to fulfil the licensing requirements or for failure to observe the conditions attached to a licence. Since the Institute was established in 1992, 17 prosecutions have been undertaken for various offences, the majority in respect of failure to hold the appropriate licence.

THE MANAGEMENT OF DISUSED SOURCES

Currently, there is no waste repository in Ireland, but consideration is being given to establishing a national centralized storage facility for disused sealed sources. Consequently, unless provision has been made to return disused sources to the supplier, sources must be stored by the licensee in a safe and secure location. The Institute’s inspectors have the power to take custody of sources, but these powers have not been exercised because of the lack of a suitable store. Altogether, approximately 7550 sources are in store in 70 different locations around the country, with a nominal total activity of 14 375 GBq. Approximately 7000 of these are the Mo-99 cores of Tc-99m generators. The database operated by the Institute's Regulatory Service contains records of all sources held for custody only, i.e. in storage.

EMERGENCY RESPONSE

In 1998, the Irish Government approved a revised National Emergency Plan for Nuclear Accidents, which details the response of the various government agencies and departments to accidents in other countries involving the release or potential release of radioactive substances into the environment. Under the plan, the Institute has significant responsibilities, principally with regard to the assessment of the consequences of an accident and the provision of advice and information to the public and others. The Institute has established a number of communication pathways with international agencies and provides an on-call service for the receipt of messages giving early notification of any radiological incident. It also operates a gamma dose-rate monitoring network and a country-wide system for air sampling and rainwater collection. Exercises of various aspects of the plan have been conducted over the last number of years and a full scale exercise is due to take place in 2001.

With regard to incidents or accidents occurring in Ireland, it is a condition of licence that the Institute be notified as soon as possible and, at the latest, within 24 hours. Outside office hours, the Institute's on-call duty officer can be contacted and a member of the Regulatory Service alerted. Since 1990, over 60 incidents involving ionizing radiation have been reported to and investigated by the Institute's Regulatory Service. The incidents have principally involved industrial users, distributors and hospitals. In most cases, the radiological consequences were low. Details of incidents are published in the Institute's annual report.

ORPHAN SOURCES

To date, there have been three discoveries of orphan sources in Ireland. In one case, the source was hidden in a consignment of scrap steel and was inadvertently melted down. The resulting contaminated material was shipped back to the supplying country. In the second case, the country of origin of a source concealed in a consignment of scrap metal could not be determined and the source is now held, under licence, by the steel recycling plant. In the third case, the source was discovered by a member of the public and it is now held, under licence, by an existing licensee (a hospital).

LOST SOURCES

Incidents involving the loss of sources have occurred mainly during the transport of the source from supplier to customer. In general, the Institute has adopted a policy of alerting all those who might come in contact with the source to the potential hazard. For example, when a source was lost in transit at an airport, all airport personnel, the airport police and the Gardai (national police) were notified. In cases where a source has been stolen, the public at large are alerted through the issue of a press release to the media.

EDUCATION AND TRAINING

The Ionizing Radiation Order requires all employers using ionizing radiation to provide appropriate information and training in radiation protection to exposed workers. It also requires that adequate information is given to other persons directly involved with the work with ionizing radiation to ensure their health and safety. Training courses in radiation protection are provided both in Ireland and in the UK and the staff of the Regulatory Service give lectures and presentations on a number of Irish training courses.

REFERENCES

[1] Radiological Protection Act, 1991 (Number 9 of 1991), The Stationery Office, Dublin.

[2] Radiological Protection Act 1991 (Ionizing Radiation) Order, 2000 (S.I. No. 125 of 2000), The Stationery Office, Dublin.

THE SAFETY OF RADIATION SOURCES AND THE SECURITY OF RADIOACTIVE MATERIALS: THE SITUATION IN ITALY

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Abstract. An outline of the relevant Italian legislation is provided in the report in order to give an overview of the country's situation concerning the safety of radiation sources and the security of radioactive materials. The main rules making up the Italian system are itemized in the report, as regards statutes and legislative acts. Legislative Decree no. 241, 2001, will transpose into Italian legislation the directive 96/29 Euratom, which lays down European Basic Safety Standards in accordance with the recommendations of ICRP Publication 60. The report also refers to the Italian regulatory system and how it is structured and operated.

INTRODUCTION

An outline of the relevant legislation is necessary with a view to giving an overview of the country's situation concerning the safety of radiation sources and the security of radioactive materials.

The Italian regulatory system is made up of three types of rules that have different legal force as per their source:

- legislation proper, that is, statutes and legislative decrees;
- governmental or ministerial decrees;
- technical guides and standards.

In the Italian system, the source of legally binding rules must be either an act of Parliament (statute) or a legislative decree issued by the Government thus empowered by Parliament; the Government can also issue governmental or ministerial decrees indirectly biding in law; the practice of laying down numerical limits and minute regulations in decrees issued by the various branches of the executive is very frequent indeed. An important feature of legal rules concerning safety and radiation protection in Italy is that contravention to obligations by users constitutes a misdemeanor and entails a penal sanction; compliance can be enforced, *inter alia*, by means of criminal proceedings after due process of law. The main rules making up the Italian system are itemized below, as regards statues and legislative acts.

The first legislative act governing radiation sources, nuclear installations and third party liability is Statute no. 1860, promulgated by Parliament in December 1962. It mainly provided, and still provides at least in part, for an administrative framework dealing with notification and authorization of, *inter alia*, radioactive sources. The statute is supplemented by an array of ministerial decrees laying down thresholds above which an authorization by the Ministry of Industry to use radioactive sources is necessary under the statute.

Rules governing radiation sources and nuclear installations as well as radiation protection provisions for workers and members of the general public were laid down in Presidential

Decree no. 185 of February 1964; this decree, which was also supplemented by an array of decrees issued by various ministries, was replaced by Legislative Decree no. 230.

Legislative Decree no. 230 was promulgated in 1995 in order implement six Euratom directives on radiation protection and has been in force since 1 January 1996. In May 2000, the Government promulgated Legislative Decree no. 241; this act, which will enter into force on 1 January 2001, modifies Legislative Decree no. 3230 in order to transpose into Italian legislation directive 96/29/Euratom which lays down European Basic Safety Standards in accordance with the recommendations of ICRP Publication 60. The regulatory system resulting in Italy after the promulgation of Legislative Decree no. 241 will be outlined.

A practice is subject to radiation protection requirements if certain thresholds of activity and concentration are exceeded, the concentration threshold being 1 Bq/g for all radionuclides, the activity thresholds being the lesser ones laid down in the European directives of 1984 and 1996 setting out European Basic Safety Standards. For certain practices, such as medical applications, adding radioactivity to consumer goods, importing and exporting such goods, discharges, reuse or recycle of radioactive materials, the decree's provisions apply even below the thresholds.

For the purposes of the presentation, suffice it to say that articulate safety and radiation protection provisions for workers, the public and the environment apply if the practice is above the appropriate thresholds.

The Italian regulatory system is based on a two tiered structure: authorization for the more important applications of ionizing radiation is administratively within the competence of the Ministry of Industry, which — acting in accordance with other relevant Ministries — releases authorizations. The advice of the National Agency for the Protection of the Environment (ANPA) is sought under law in order to determine technical specifications applicable to the installation. For industrial and research installations of a less important character, the prefect of the province has administrative competence to issue authorizations after seeking the advice of regional technical bodies and of the Fire Corps; for medical installations the authorization is issued by the regional authorities, which are responsible for health in the Italian system.

Technical annexes of Legislative Decree no. 241/2000 lay down thresholds in order to determine which installations are authorized by the Ministry of Industry and which ones by local authorities; thresholds are set in terms of values of activity and neutron yields for radioactive sources, and of energy for accelerators. The same annexes also lay down the technical features of the radiation sources and of the installation which have, *inter alia*, to be specified in the application:

- layout of the installation and of relevant areas within;
- criteria chosen for the classification of work areas and workers from the safety and radiation protection viewpoint;
- detailed description of operations to be carried out in each area of the installation and of relevant technical standards and codes of practice adopted;
- choice and analysis of scenarios giving rise to potential exposures, evaluation of potential exposures and planning of intervention measures with a view to preventing and mitigating radiological consequences to workers and the public;

- production and management of waste, material for recycling or reuse and measures of radiological surveillance;
- structures and measures to be implemented for the radiological surveillance of workers and the public in normal conditions.

Since the promulgation in 1964 of the first Radiation Protection Decree it has been a practice in the authorization procedure to request the applicant to provide an analysis of possible accident scenarios and of their radiological consequences, together with appropriate measure to implemented with a view to preventing and controlling accident conditions, and mitigating their consequences; even then, separate provisions laid down in Decree no. 185/1964 applied to nuclear installations.

Given that nuclear installations continue to be subject to a special, separate regime, *ad hoc* provisions in the new Decree no. 241/2000 require each installation to be authorized by the Ministry of Industry that evaluations of potential exposures should be made by the applicant seeking an authorization for radioactive sources and submitted to licensing authorities so that an intervention plan can be prepared by civil defence authorities. For those installations which fall under authorization by the prefect or by the regions, licensing authorities will review evaluations of potential exposures made by the applicant and will decide whether such potential exposures are likely to exceed 1 mSv of effective dose; in this case an intervention plan must be prepared by civil defence authorities as well. No new installation can start operations before approval of an intervention plan if it is necessary.

To give an idea of the number of installations authorized by the Ministry of Industry, suffice it to say that this means about 65 hospitals with large installations for therapy and nuclear medicine and more than 70 research and industrial installations. More than 5000 installations have been licensed by local authorities.

Ad hoc provisions in the new Legislative Decree no. 241 govern notification. Before the entry into force of the decree, local authorities were to be notified within 10 days of the possession of sources by the holder; this requirement gave rise to a tremendous lot of paperwork and exists no longer. In the new provisions, the emphasis is on authorizing practices, and notification is only required, as per directive 96/29/Euratom, for those practices which are not subject to licensing requirements: in this case, the holder is required to notify local authorities of the intention to carry out the practice at least 30 days before the start of the practice itself. Concerning notification, detailed instructions apply which closely mirror those for authorization.

With regard to controls of importing, exporting, and trading radioactive and nuclear materials, specific provisions for authorization by the Ministry of Industry and for record keeping and accounting have existed since 1962 in Italian legislation; seizure and confiscation of the sources are in any case provided for. Besides, transboundary movements of radioactive materials among Member States of the European Union are governed by Euratom regulation 1493/93, which establishes specific authorization requirements on movements of radioactive sources have been stiffened by specific provisions introduced by Legislative Decrees no. 230 and 241.

ANPA plays a central role in the system. Apart from its function regarding nuclear installations, which are always subject to NAPA review, ANPA is required by law to give advice and lay down technical specifications for installations which are authorized by the Ministry of Industry; moreover, ANPA has general inspection powers for every kind of radiation source and installation falling under the provisions of the statute and the decrees. In the fulfillment of their duties, ANPA inspectors are vested with police powers: that is, they even have power of seizure on sources or installations that they deem to be non-compliant with relevant provisions laid down in law.

Apart from ordinary powers given to police, other civil servants such as those in the Labour Inspectorate, local health bodies and regional agencies for the protection of the environment are vested with competence in the fields entrusted to their surveillance.

The Italian compliance and inspection system is based upon the fact that legislation provides for penal sanction s in cases of non-compliance; penalties are meted out by the courts at the instigation of the Office of Public Prosecution to which inspectors are required under law to communicate every case of non-compliance. Particular measures are laid down in legislation in order to prompt and/or force swift compliance, especially for non-compliance concerning provisions for radiation protection of workers; in these cases, inspectors are bound to evaluate whether the user could avoid undergoing a trial by complying with *ad hoc* specifications established by inspectors and paying a fine.

While provisions have been extent in legislation since 1964 to the effect of ensuring a strict regime concerning discharge of effluents and waste disposal, requiring prompt communication to competent authorities of cases of lost sources, in the country there is no central repository for disused sources yet, even though a bill to that effect, drafted with APN's technical advice, has been presented for discussion in Parliament. In the main, every user either has its own deposit, which is covered by *ad hoc* provisions in the licence, or has access to medium or small size interim deposits.

Although provisions are in place in Italy for the control of radioactive sources and other radioactive material, challenges to the system primarily from radioactive materials penetrating Italian borders. In recent years, events were determined by metal scrap shipments entering Italy from foreign countries examples of such events, i.e. accidental meltdown of sources of Cs^{137} and Co^{60}, occurred twice, causing contamination and consequent shutdown of foundries; other events of contaminated metal scrap or of sources within scrap consignments, even of considerable activity, occurred at the borders when radioactivity was detected and the consignments were not allowed to enter the country.

Legislative provisions with a view to setting up detection apparatus measurements at the borders and at foundries or at facilities collecting metal scrap are already extent; in many instances, apparatus and/or surveillance procedures are already in place. In addition, ANPA is permanently connected with the early warning network of the IAEA Emergency Response Centre, this has provide very useful also in relation with recent scares about Co^{60} contaminated bracelets of watches.

The Italian regulatory authority is well aware of the issues related to security of radioactive material, and in particular of the need to strengthen all existing measures with a veil to preventing unauthorized access to and also loss and possession of the materials in question.

The dangers of breakdowns in security must be seen in the light of illicit trafficking, and the importance of the issue is clearly connected with the two-dimensional associated risk: public health and diversion.

At the international level, much more attention was part in the past to the security of nuclear materials in order to prevent proliferation. This led, on one side, to the implementation of the safeguards agreements and, on the other, to the Convention on the physical Protection of Nuclear Material and to the development of physical protection guidelines such as those in INFCRIC/225, now progressed to Revision 4. A similar internationally established framework does not currently exist for the security of radioactive sources and efforts should be made to achieve further progress in this sensitive area. In this context, we look with interest and attention at the Agency's plans in progress on the safety and security of radioactive material.

CONTROL OF RADIATION SOURCES IN JAPAN

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Abstract. The report refers to the regulations for radioactive material in force in Japan, and to the organizations with responsibilities for regulating radiation sources. An outline of the law regulating the use of radiation sources and radioactive materials is provided, including its scope, types of radiation sources under control, exemptions and the system of notification, authorization and inspection. The experience of Japan with orphan sources is presented in three different cases, and the measures carried out to store the orphan sources in safe conditions.

REGULATIONS FOR RADIOACTIVE MATERIAL IN JAPAN

1. Regulation of radioactive material:

- Law Concerning Prevention of Radiation Hazards due to Radioisotopes (RI), etc. (hereinafter called "Law for the regulation of RIs");
  - Regulation on the use of the radioactive sources
- Law for the Regulation of Nuclear Source Materials, Nuclear Fuel Materials and Reactors;
  - Regulation on the radioactive materials which are available for nuclear fuel (= Uranium, Thorium and Plutonium)
- Pharmaceutical Law;
  - Regulation on short-lived RIs for pharmaceutical use.

2. Organizations for the regulation of radioactive sources

- Nuclear Safety Commission:
  - Discusses matters concerning regulation for nuclear safety
- Radiation Council:
  - Establishes uniform technical standards concerning radiation protection
- Science and Technology Agency (STA), Nuclear Safety Bureau:
- Issues safety regulations for the use of RIs, etc.

The competent authority for the regulation of RIs will be the Ministry of Education, Culture, Sports, Science and Technology (MEXT) after the administrative reform in January 2001

OUTLINE OF LAW FOR THE REGULATION OF RIS

1. Purpose
   - To prevent possible radiation incidents and to secure public safety

2. Scope of RIs under the Law for the regulation of RIs
   - Sealed RIs

   (Quantity: more than 3.7 MBq per item, Concentration: more than 74 Bq)

– Unsealed RIs

(Quantity: more than 3.7 KBq ~ 3.7 MBq (classified into four groups by nuclides), Concentration: more than 74 Bq)

– Radiation generator

Exemptions:

– Radioactive materials under the Law for Nuclear Fuel
– RIs under the Pharmaceutical Law
– Consumer goods which contain small quantity of RIs

3. Licensing and notification
   – Use of RIs (licensing (3.7GBq~/site) or notification (~3.7GBq/site))
   – Sale (or lease) of RIs (licensing)
   – Disposal of RIs (licensing)
   – Use of radiation generator (licensing)

Table. Number of sites under the Law for the regulation of RIs

(End of March 2000)

Use		Sale (Licensing)	Lease (Licensing)	Disposal (Licensing)	Total
Licensing	Notification				
2 526	2 434	175	2	11	5 148

4. Restriction of possession
   – Restriction of possession
   – Restriction of transfer

5. Inspection
   – On-the-spot inspection by the STA (Average; 300 sites per a year)
   – Facility inspection by Nuclear Safety Technology Centre (Storage capacity; Sealed RI ≥37TBq, Unsealed RI ≥740 MBq)
   – Periodical inspection by Nuclear Safety Technology Centre (Storage capacity; Sealed RI ≥111TBq, Unsealed RI ≥740 MBq)

6. Obligations for users
   – Ensuring the necessary technical standards
   – Executing some administrative obligations
   – Monitoring
   – Drawing up and submitting the internal rules for the prevention of radiation hazards
   – Education and training
   – Check the health of persons entering the facility
   – Keeping records of use, transport, disposal
   – Appointing a supervisor of radiation protection

– Taking measures when accidents (loss, leak, fire) happen
– Reporting to the STA, police and other authorities

7. Closure of business
   – Notification
   – Measures for cleaning

ORPHAN SOURCES: EXPERIENCES IN JAPAN

Case 1: A radiation source found in an imported scrap container in Wakayama city'. On 28 April 2000, the Science and Technology Agency was informed that radiation had been detected from a stainless steel scrap container in Sumimoto Metal Industry Ltd. Wakayama Steel Works.
The STA dispatched an inspector to Wakayama city on the same day. The inspector detected a gamma exposure dose rate of 75 Sv/h and a neutron beam exposure dose rate on the surface of the container.
After two weeks' preparation, the container was opened at the steel works and the radiation levels were monitored. As revealed through later surveillance by Japan Radioisotope Association (JRIA), the radiation sources were Cs-137 (230 MBq) and Am-241/Be (1800 MBq) combined in a capsule. The source was considered to be a moisture and density gauge.

Case 2: A radiation source found in scrap metal in Kobe city
On 9 May 2000, the STA was informed by a metal scrap dealer in Kobe City about a lead container found in scrap metal from which radiation had been detected.
The STA dispatched an inspector to Kobe city. The inspector detected 1.4 mSv/h on the lead container's surface. Immediately, the lead container was removed and disposed of by JRIA. Measurements showed four needle sources of radium-226 in the lead container, which were considered to be for medical use, and their radioactivity was 74 MBq per needle.
On the surface of the lead container, a radiation symbol was printed, which was with parcel tape. The local police investigated this incident as illegal disposal, and arrested those responsible.

Case 3: Old radiation sources for medical use found in some hospitals
Recently, old radiation sources, mostly radium, have often been found in hospitals. Before 1958, when the Law for the regulation of RIs entered into force, many radiation sources were already in use but were not licensed or registered. When the discovery of the old radiation sources are reported to STA, the sources are usually disposed of by JRIA.

MEASURES FOR THE SAFETY OF ORPHAN SOURCES

In August 2000, five ministries (the STA, the Ministry of Foreign Affairs, the Ministry of Finance (Customs and Tariffs Bureau, the Ministry of International Trade and Industry, and the Ministry of Transport) drew up a document on measures related to radiation sources found in scrap metal.

The document described the measures required:

1. to manage radiation sources appropriately according to regulations
2. to attract the attention of importers of scrap metal

3. to support measures by scrap metal suppliers and the steel industry
4. to prepare for the detection of radiation sources in scrap metal at borders
5. to prepare emergency response
6. to facilitate international co-operation

The STA established an Ad-Hoc Advisory Committee for the appropriate management of radioactive materials in August 2000. The committee will recommend some measures for the management of orphan sources.

Japan proposed an international co-operation project on the safe management of spent radiation sources at the Forum on Nuclear Co-operation in Asia (FNCA) held in Thailand in November 2000.

SAFETY OF RADIATION SOURCES AND OTHER RADIOACTIVE MATERIALS IN JORDAN

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Abstract. Since joining the IAEA Model Project for upgrading radiation protection infrastructure in countries of West Asia, Jordan has amended its radiation safety legislation. The Regulatory Authority is improving its inventory system for radiation sources and other radioactive materials and also its notification, registration, licensing, inspection and enforcement systems. It has established national provisions for the management of orphan sources after they have been found. The system for the control of the radiation sources and other radioactive materials entering the country has been improved by the Regulatory Authority.

INTRODUCTION

Jordan started to strengthen its Regulatory Authority by amending its radiation safety legislation. It has adopted the IAEA's Regulatory Authority Information System (RAIS), and its notification, registration, licensing and inspection systems are being brought into line with international standards. All radiation sources and other radioactive materials entering the country are now subject to control through radiation monitoring.

INVENTORY SYSTEM FOR RADIATION SOURCES AND OTHER RADIOACTIVE MATERIALS

The Regulatory Authority has an electronic database on radiation sources and other radioactive materials, together with a manual recording system. The inventory system has been improved by the adoption of RAIS, provided by the IAEA. A year ago the Regulatory Authority started collecting information on radiation sources and user facilities and entering it into the database. The information sent by users is checked by the Regulatory Authority and, if necessary, corrected immediately. When misunderstandings occur as a result of the way in which the Regulatory Authority's questionnaire has been completed by the user, inspectors correct the information in the light of inspections carried out at the user facility.

When there is only very incomplete information about a radiation source (for example, when the source is an old one), the Regulatory Authority, after determining the radioactive nuclide and assessing the activity, issues a so-called "Regulatory Authority certificate" which identifies the user. One copy of this certificate is given to the user and one is placed in the user's file at the Regulatory Authority's office, and the details are entered into the database.

Class B sources are checked through annual declarations from the user. Class A sources are checked through semi-annual inspections.

THE REGULATORY AUTHORITY'S RESPONSIBILITY FOR THE SAFETY OF RADIATION SOURCES

The Regulatory Authority requires users to provide for the safety of the sources used by them. The safety arrangements at user facilities are checked by the Regulatory Authority through inspections before licensing; the safety of the radiation source is a condition for granting a licence. Any failure to provide adequate protection for the radiation source is a reason for withdrawal of the licence. The Regulatory Authority takes the action necessary to ensure that the source will be safe if it suspects that the user's safety arrangements are not adequate, and the user reimburses the Regulatory Authority for the costs incurred by it.

The Regulatory Authority carefully evaluates the user's system for the protection of radiation sources, in order to avoid failures to provide adequate protection in critical situations. All incidents related to the safety of radiation sources are taken seriously by the Regulatory Authority and appropriate action initiated immediately.

SYSTEMS OF NOTIFICATION, REGISTRATION, LICENSING AND INSPECTION

Under Jordan's nuclear energy and radiation protection legislation, no one may import, export or use - or take any other action related to - radiation sources without authorization from the Regulatory Authority. Anyone wishing to import and use a radiation source must notify the Regulatory Authority before taking any action. Upon notification, the Regulatory Authority studies the request and, if appropriate, gives its approval for the radiation source to be imported. The Regulatory Authority applies the BSS when registering the source and licensing its use. The user must make all necessary arrangements for the safety of the radiation source before receiving approval for its use, and the arrangements are checked *regularly* by the Regulatory Authority.

THE NATIONAL PROVISIONS FOR THE SAFETY OF RADIATION SOURCES

The Regulatory Authority is responsible for disused sources. Users have full responsibility for the radiation sources being used by them, but, if a user facility shuts down or stops using radiation sources, the sources at the facility must be returned to the supplier or placed in storage under the Regulatory Authority's supervision.

The Regulatory Authority will collect and deal with any orphan sources that are found. It will try to identify the owners with a view to taking legal action against them. It will deal with the sources by conditioning them and placing them in final storage.

The Regulatory Authority collects disused sources from the radiotherapy and nuclear medicine departments of hospitals and from universities, research centres and industrial establishments and treats them as radioactive waste, charging the costs to the users and recording all information about the treatment procedures.

The Regulatory Authority visits user facilities to ensure that no sources have been left there by mistake.

The Regulatory Authority maintains plans for responding immediately to incidents.

CONTROLLING THE ENTRY OF RADIATION SOURCES AND OTHER RADIOACTIVE MATERIALS INTO THE COUNTRY

The Regulatory Authority has, in co-operation with the police and customs authorities, installed radiation monitoring portals at the main points of entry into the country in order to prevent the illegal entry of unauthorized radiation sources and other radioactive materials. In addition, it carries out inspections of scrap with the co-operation of the police authorities.

At the main points of entry, there are also hand-held radiation detectors available.

EMERGENCY RESPONSE

For major incidents there is a National Emergency Plan and a response team with members drawn from many national institutions. For smaller incidents, the Regulatory Authority has its own emergency response team. The members of both teams undergo regular training.

Each radiation source user is required to have an emergency response plan. Regular training is organized for user personnel under the supervision of the Regulatory Authority.

The Regulatory Authority holds radiation protection training courses which include training in the safety of radiation sources and radioactive materials.

SUMMARY OF DISCUSSION

Session 4

GENERAL DISCUSSION

Chairperson: **J.R. Croft** (United Kingdom)
Co-Chairperson: **R. Czarwinski** (Germany)

S. Maki (Japan): I should like to mention that about two years ago Japan proposed the establishment of an Asian co-operative programme relating to the management of disused sources.

I. Zachariašova (Czech Republic): We are establishing a database with photographs of orphan sources that have been found, sometimes no longer with the trefoil symbol. The database will be accessible on our web site.

R. Czarwinski (Germany): Perhaps that database — and similar ones being established by other countries — could be included in the *International Catalogue of Sealed Sources and Devices* which the IAEA is preparing.

J.R. Croft (United Kingdom – *Chairperson*): That's a good idea. It would be useful to have a central repository of photographs of radiation sources. The information accompanying the photographs would have to be in a language understood by the local workforce, which means that in many cases it would have to be translated.

V. Friedrich (IAEA): The computer framework for the *International Catalogue of Sealed Sources and Devices* has been established, and we are in the process of inputting data (including photographs and drawings) received from IAEA Member States in response to a request for data made by the IAEA's Secretariat in August. We already have data on more than a thousand types of sealed source.

The database will contain some data of a commercial nature, and the IAEA's Secretariat has not yet decided how it will disseminate such data — a question which it intends to settle in consultation with IAEA Member States.

J.R. Croft (United Kingdom – *Chairperson*): As much as possible of the data should be made available on the Internet.

C. Schandorf (Ghana): We are working on guidelines relating to enforcement, and I should like to hear views about when the regulatory authority should take cases of non-compliance with the safety regulations to court. The prosecution of users who are thought to be at fault can be a very time-consuming business.

J.R. Croft (United Kingdom – *Chairperson*): There are ways of putting pressure to comply on users without resorting to the courts.

In the United Kingdom, for example, we have an enforcement system involving "improvement notices". A regulator who considers that something is not right at a user facility fills out an improvement notice stating — with reasons — what the user must do in order to put matters right and giving the user a specified period of time in which to do it. If the user does not complete the required action within the specified time, that is an infringement of the law — and one which is easy to prove.

A. Bilbao Alfonso (IAEA – *Scientific Secretary*): In a Safety Guide on regulatory infrastructure for radiation protection and for the safety of radiation sources in medicine, agriculture, research, industry and education which the IAEA's Secretariat is preparing there will be recommendations regarding enforcement policy.

The present draft will be examined by the IAEA's Radiation Safety Standards Committee (RASSC) in April 2001 and the resulting text sent soon afterwards to IAEA Member States for comment. We expect that the final text will be submitted to the IAEA's Commission on Safety Standards (CSS) for endorsement towards the end of 2001 and published soon after that.

J.R. Croft (United Kingdom – *Chairperson*): Although prosecutions can be very time-consuming for regulatory authorities, it may be worthwhile prosecuting when a user is clearly guilty of a serious infringement in order to have a successful prosecution which can be referred to in dealings with other users. Examples of successful prosecutions will tend to "encourage" users to comply with the radiation safety laws and regulations.

NATIONAL REPORTS
(Session 5)

Chairperson

I. ZACHARIAŠOVA
Czech Republic

ORPHAN SOURCES CONTROL IN THE REPUBLIC OF KOREA

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Abstract. In this paper, the orphan source control programme in Korea will be discussed. Orphan sources are, in general, classified into three groups: 1) Illegally trafficking radioactive sources; 2) Domestic loss of radioactive sources due to the bankruptcy of licensees or authorized suppliers; and 3) Contaminated metal scrap, which has been imported.

There are, currently, two approaches going on to control and manage orphan sources in Korea. First, the Korean regulatory authority (Ministry of Science and Technology: MOST) will fully run an information system on radiation safety to effectively trace and monitor all radioactive sources in the country by the year 2001. Second, the regulatory authority strongly advises steel mill companies to closely scrutinize and inspect scrap metal through a scrap monitoring system when they attempt to reutilize it in order to prevent it from being contaminated by uncontrolled sources.

The Korea Institute of Nuclear Safety (KINS), a regulatory expert organization, is carrying out a three-year multiphase project to control and monitor orphan sources in Korea. The system, called the Information System on Integrated Radiation Safety (ISIRS) on the inter- and intra-net system has been developed to effectively control and accurately monitor radioactive sources on a real time basis since 1998. If the system is successfully set up as scheduled by the middle of May next year, the regulatory authority will be able to control any reutilization of uncontrolled sources efficiently. At the same time, the system can also provide, not only licensees, suppliers, or perspective end users but also the Korean general public of interests with information on radiation safety, safe radiation management tools and public services.

The system has been created because of the necessity to effectively control radioactive sources safely. Also, it serves to prepare necessary protective measures in a timely manner for abnormal events of uncontrolled radiation from radioactive sources such as those involving loss of radioisotopes. By the 2001, the system will be able to provide both licensees and the general public with information on radiation safety more actively and effectively. At the same time, it will serve to guarantee the right to knowledge of the Korean people and to facilitate and effectuate the control of radioactive sources both by industry and by the regulatory authority. The system is composed of three parts; 'Information System on Regulatory Activities for Radioactive Sources including Radiation Generators', 'Cyber Information System Radiation Safety', and 'Radioactive Source Life-Cycle Tracking and Inventory Management System'. With this system, we are going to trace the life cycle of radioactive sources; enabling inventory, prophylactic measures for accidents or abnormal events such as from loss of radioactive sources, usage history, transportation, waste management, etc. Since the system traces radioactive sources 'from the cradle to the grave', we expect to prevent illegal trafficking of the radioactive sources.

All steel mill companies and suppliers of scrap metals in Korea should install the Scrap Monitoring systems to detect the contamination of recycled metals in the nearest future. Currently, large numbers of major steel mill companies have installed fixed-type scrap monitoring systems and operate them to detect any contaminated scrap metals existed before melting for reutilization. They have detected radioactive substances in recycled scrap metals before melting more than 20 times since 1998. However, the levels of radioactivity were found to be very low.

The orphan sources programme being developed in Korea will be a timely and efficient method for bringing orphan sources under control. The dissemination of information to the public and industry will increase awareness of the problem of orphan sources. The improved oversight of licensed devices by MOST will help reduce the number of sources that have become orphaned and MOST is encouraging the installation of additional fixed radiation monitoring systems at seaports and at other locations where radiation sources may appear. Finally, international action is necessary to control sources.

INTRODUCTION

In the Republic of Korea, radioactive sources are being used in various areas; industries, industrial radiography, medical facilities, research laboratories, educational institutions and public organizations. There are many different types of radioactive sources, including sealed and unsealed radioisotopes, X-ray generators, ion implanters and medical accelerators.

The Ministry of Science and Technology (MOST), Korea's regulatory authority, began its regulatory management of radioactive sources in 1962 when it issued the first licence for radioactive-source users. In Korea, more and more companies or institutions are applying for licences for the use of radioactive sources, increasing by about 10% every year. Currently, there are about 1600 nuclear and radiation facilities, including medical facilities using radiation sources. However, this number does not include medical uses of radiation generators for diagnostic purposes. They are under the regulation of a different authority, the Korean Food and Drug Administration (KFDA). Table 1 shows the increase in the number of radioactive-source users in Korea.

Table 1. Licensing Status of Users of Radioisotopes and Radiation Generators in Korea

Year	19622	1990	1995	1996	1997	1998	1999	2000 Sept
No. of Licensees	2	698	1064	1175	1315	1394	1570	1660

As the number of licenses for radioactive source user was growing rapidly, MOST decided, in 1985, to entrust part of its duty of regulation of radiation safety to the Korea Institute of Nuclear Safety (KINS), an expert regulatory organization. Hence, the MOST and KINS are currently both responsible for the control of radioactive sources in Korea.

Orphan sources occur when radiation sources slip from the grip of regulation. We can classify the causes of orphan sources into three categories: 1) illicit trafficking 2) the loss of sources due to the bankruptcy of licensee or suppliers and 3) contaminated metal scrap imported for recycling.

Presently, the Korean Government uses three approaches for controlling orphan sources. Firstly, a regulatory authority has conducted a three-year project to build an information system on the web which is supposed to be in full operation by the year 2001. By then, the authority will be able to effectively manage radiation sources by overseeing them through the system. Secondly, the Government strictly monitors the recycling procedures for scrap metal to prevent the inflow of scrap from uncontrolled sources. Currently, all licensed steel mills are supposed to install radiation detecting systems in their mills and at docks to make sure that the scrap metal is radiation source free. Lastly, MOST sees the need for taking some concrete measures and actions to bring these unwanted radioactive sources under regulatory control and thus reduce the potential hazards of exposure of the general public, workers and the environment to the radiation from these radioactive sources.

This paper introduces Korea's orphan source control programme, which is designed to reduce the number of radioactive sources which might be contained in scrap metal.

ILLICIT TRAFFICKING SOURCE CONTROL IN KOREA

Illicitly-trafficked radiation sources are usually either in the possession of unlicensed entities of licensees which are not authorized to possess those particular radioactive materials. These sources can be categorized, based on our findings, as follows:

- Items not declared, identified or legally cleared by the Korea Custom Services (KCS);
- Tax-free items imported by public or Government organizations;
- Items illegally administered by an agent to evade customs control, charges or taxes;
- Items deemed as tax-exemption items by KCS officers, without recommendation or inspections from radiation or nuclear regulatory authority.

In 1999, the Korean Government investigated all the illicit trafficking and successfully convinced the owners of radioactive sources to inform and report all the illicitly-trafficked sources in their possession to the regulatory body (in this case, to KINS) for registration. To encourage reporting, the regulatory body did not question the informers about their knowledge of the radioactive sources beforehand. MOST conducted the investigation in the following manner:

- The regulatory authority urged unidentified owners to report all the illegally possessed sources to KINS for registration by publicizing efforts through mass media.
- it ordered the unlicensed users, who were identified by the sales records of suppliers of radiation sources, to register all the sources in their possession at KINS; and
- it encouraged users to report and register all the unlicensed imported sources to KINS.

This type of sources are often identified when the end users submit the applications for the purchase of new sources to replace old ones. Old sources are usually found to be almost decayed and no longer in use, since their radioactivity levels are not strong enough.

INFORMATION SYSTEM ON RADIATION SOURCES IN KOREA

KINS has been carrying out a three-year multiphase project to control and monitor all orphan sources imported to Korea. In order to effectively control and closely monitor radioactive sources on a real time basis, Korea has begun to develop the so-called Information System on Integrated Radiation Safety (ISIRS) on the web, using both the inter- and intra-net since 1998. If the system is successfully set up as planned by May 2001, the regulatory authority will be able to control any possible contamination by radioactive sources efficiently and effectively.

The system is designed to effectively control radioactive sources. For example, in case of emergencies like loss of radioisotopes, the system can track them and prepare any possible protective measures in a timely manner.

The system consists of three subsystems; 1) 'Information System on Regulatory Activities for Radioactive Sources including Radiation Generators', 2) 'Cyber Information System on Radiation Safety', and 3) 'Radioactive Source Life-Cycle Tracking and Inventory Management System'.

The first and second parts of the ISIRS system have been completed in the second quarter of 2000 and are now in full operation. Comprehensive data on the radiation sources currently in use or owned by licensees in Korea is accurately collected through the system almost in real time. All the information on licensing activities conducted by the regulatory authority since 1996 has been stored in the system. Previous licensing information will have been deposited in the system by late 2001. MOST and KINS can now conduct a wide range of statistical analyses using the data in the information system. They can also monitor licensing processes on a real time basis through the system.

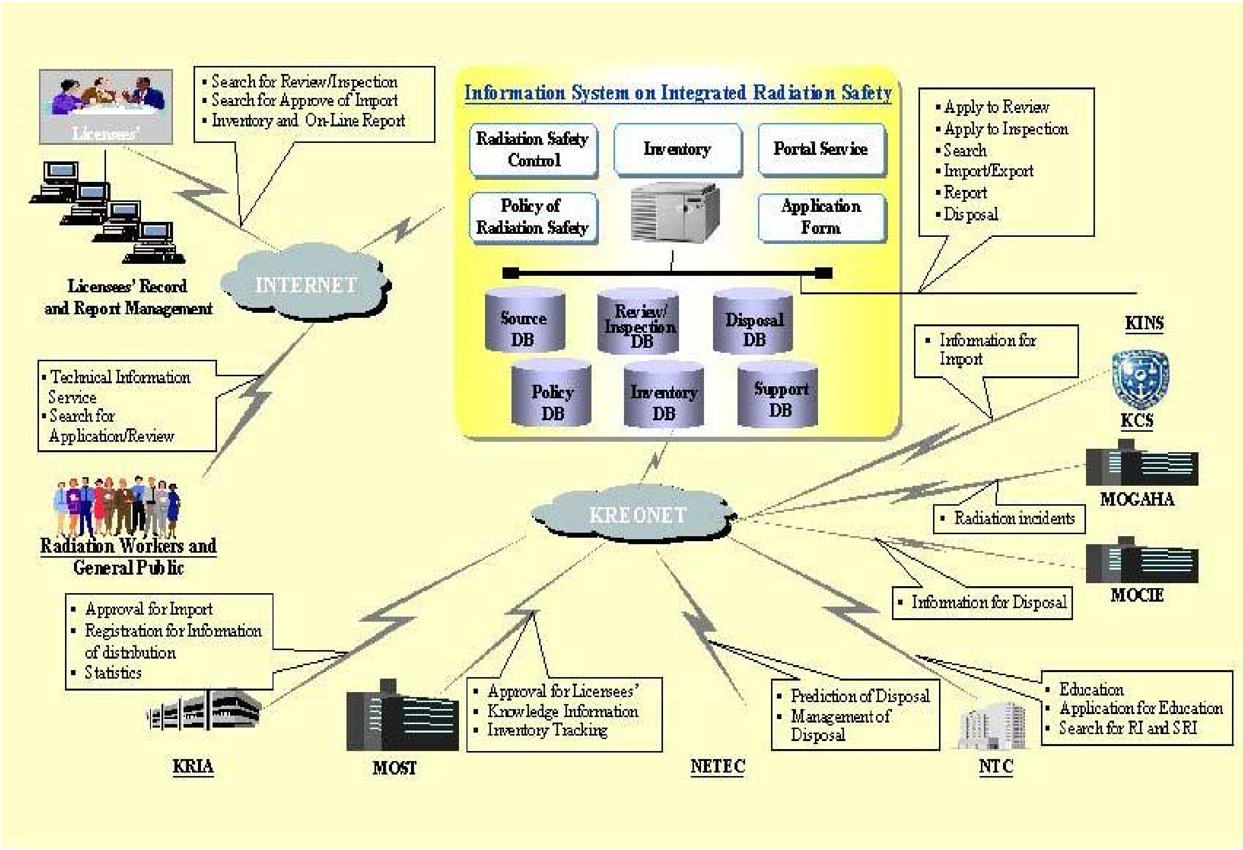

Figure. 1. Layout of the network of the ISIRS, which shows the inter- or intra- net used among the organizations.

With this system, we are going to actively trace the life cycle and from an inventory of radioactive sources to prevent accidents or emergencies resulting, for instance, from loss of radioactive sources. We can also keep track of usage record, transportation, and waste management of radioactive sources. In other words, the system serves as a comprehensive tool to trace radioactive sources 'from the cradle to the grave', and we expect to prevent all illegal trafficking of radioactive sources. Figure 1 shows a layout of networking among various government offices, the regulatory authority, competent organizations, licensees and the general public and also information available either through inter- or intra-net when the system is completed.

MONITORING OF RADIATION SOURCES IN SCRAP METAL

All steel mills and suppliers of scrap metal in Korea shall install the fixed-type scrap monitoring systems in the near future to detect any contamination of metals. Currently, a large number of major steel mills have already installed the monitoring systems and are operating them to detect any contamination of scrap metal prior to the melting process for recycling. Figure 2 shows a typical scrap monitoring system installed at a steel mill's yard in Korea.

Figure 2. Fixed type scrap monitoring system installed in a steel mill company in Korea, photographed in November, 1999.

Table 2. Monitoring of Radioactive Substances in Scrap Metal in Korea

Date	Company imported	Radioactive Materials	Imported from	Arrangement
’98.04.03	POSCO	NORM	Japan	Stored by NETEC
’98.06.04	POSCO	I-131	Domestic	KINS
’98.07.13	Young-il Industry	Ra-226	Indonesia	NETEC
’98.10.03	POSCO	NORM	Ukraine	NETEC
’98.10.16	Young-il Industry	Unknown	Malaysia	Returned
’98.11.05	POSCO	NORM	Ukraine	Returned
’99.11.01	Kangwon Ind.	Ra-226	Domestic	NETEC
’99.05.10	Kia Steel Co.	Cs-137	Russia	NETEC
’00.01.10	Inchon Steel Co.	NORM	USA	NETEC
’00.05.29	Young-il Industry	Unknown	Mexico	Returned

Many steel mill companies have detected radioactivity in scrap metals and more than 30 times have detected radioactive substances in the scrap before the melting process. Most of the scrap metal found to be contaminated was suspected to be either demolition debris from chemical plants or from those used for industrial purposes. In a few cases, we were not able to identify the sources at all.

We have also found that most of the contaminated scrap metal were imported from foreign countries. In almost half of the contaminated scrap metals, the source of radioactivity was the accumulated precipitation on the inner wall of piping with naturally occurring radioactive material (NORM). Table 2 shows a result of our survey on the contaminated scrap metals before the melting process. Most of the contaminated metal was imported from southeast Asian countries or from Russia. The rest, not shown in Table 2, were imported from countries such as Hong Kong, Thailand, the Philippines, the Netherlands, or the United Arab Emirates.

The levels of radioactivity in the scrap metal were very low except in a few cases. We also detected orphan sources of Ra-226 and Cs-137 from scrap metal used for industrial purposes.

When Korean steel mills or suppliers find scrap metal contaminated with radioactive substances before melting or at the docks, they shall return all the scrap metal to the original supplying countries as soon as possible. Otherwise, steel mills must transport contaminated scrap metal to the Nuclear Environment Technology Institute (NETEC) in Taejon for disposal. NETEC is the one and only organization licensed by the Korean Government to dispose of radioactive waste.

According to the Minister's Notice, wastes contaminated with extremely low radioactivity may be exempted from the stipulation for the disposal of radioactive waste. According to the standards, special radionuclides with 100Bq/g radioactivity may be disposed of by the users themselves. However, we do not have any standards on the contamination of scrap metal. Therefore, the regulatory authority advises users to return all scrap metals to the original suppliers if they are monitored to be contaminated above a certain level.

The Korean Government is going to prepare a provision for recycling, such as standards for scrap metals for recycling, regulatory guidelines on the monitor and control of scrap metals so that they are free of radioactive contamination.

CONCLUSION

The orphan source control programme which the Korean Government is working on will bring all the orphan sources under regulatory control as much as possible in a timely and efficient manner. The Government's publicizing efforts targeting the general public and industry will raise their awareness of the problems of orphan sources. We believe that the improved supervision procedures of the regulatory authority will help reduce the number of orphan sources. For instance, the Korean regulatory authority is encouraging industry to install fixed-type radiation monitoring systems at the docks of Korean seaports and at other locations where radiation sources may appear.

Finally, we strongly believe that all countries concerned should co-operate closely so that we may be able to prevent any possible accidents involved with orphan sources throughout the world.

RADIATION SAFETY SUPERVISORY SYSTEM IN LATVIA AND ITS ROLE IN PREVENTION OF UNAUTHORISED PRACTICES WITH RADIATION SOURCES

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Abstract. This report provides an overview of the practical and legal aspects of the use of radiation sources. The existing regulatory infrastructure is briefly analysed and proposed systems are described. The proposed interactions between the regulatory body and the advisory board are presented and some details about joint activities of different institutions concerning radiation safety are given. An implementation example of the supervisory system in combating illicit trafficking is analysed and the essential components in the prevention of illicit trafficking are assessed. Some findings of investigations are quoted regarding improvements in protection and prevention on the national and the international level.

SOME INSIGHTS INTO SPECIFIC ACTIVITIES WITH RADIOACTIVE MATERIALS

Latvia has a limited use of atomic energy, but the use of radiation sources is extensive.

- The nuclear energy option was not planned; however a research reactor was constructed.
- A large scientific establishment existed which developed applications of radiation
- sources, tested them locally and promoted their use in industry, so a variety of technical devices, are still in use.
- The former military centre of the Baltic region was in Latvia. As Latvian authorities had no supervisory authority over military facilities, a decision was made to dispose of all radioactive waste at the Baldone site regardless of the status of the waste producers. Consequently, there is a significant amount of defence related waste.

The use of radioactive materials at present has decreased because of changes in applications and due to the transitional economical situation. In several cases, the isotopic sources have had been replaced by X-ray fault detectors, LINACs, IR smoke detectors etc.

DEVELOPMENT OF A NATIONAL LEGAL FRAMEWORK

The initial system was established by environmental protection legislation, which empowered the Government to issue regulations and authorized institutions to control radiation safety. There was a transitional period when some former regulations were partly in force to prevent loss of control over radiation sources and to avoid a legal vacuum. The next step was the adoption of legal requirements set out in international agreements for the national use.

Since 1994, the *Law on Radiation Safety and Nuclear Safety* has been the main relevant legislation, and several regulations have been issued under this law. In this process, Latvia received assistance within the frame of the IAEA's technical co-operation and also from the OECD/NEA, the EC and the Nordic countries.

Based on main safety goal introduced by the Law, the protection of people and the environment against radiation, legal documents were adopted by the Cabinet of Ministers on:

- protection against ionizing radiation;
- state accounting and control system of nuclear materials;
- committee of strategic export and import;
- dosimetric control on the border;
- issuance of licences and permits for activities with radioactive substances and other sources of ionizing radiation;
- safe transportation of radioactive materials;
- radioactive waste management.

For this report we analysed in more detail the system aimed to prevent unauthorized practices with radiation sources. The major fields that shall be regulated, preferably from the very beginning, are:

- accountancy and control of radiation sources,
- penalties for non-authorized practices with such sources,
- control system on the border to prevent illegal import or export.

In addition to national laws, there are relevant international legal documents:

- The *Treaty on Non-proliferation of Nuclear Weapons* sets out the system to prevent non-authorized practice with nuclear materials. More detailed procedures are in subsidiary arrangements and additional protocols.
- The *Physical Protection Convention* covers mainly international transport of nuclear materials, but for full scope of the system we need to elaborate requirements for all practices with nuclear and radioactive materials and for all nuclear and radiation facilities.
- Under the *Nuclear Safety Convention* each contracting party shall develop its national legislative and regulatory provisions. With regard to combating illicit trafficking, it means having a supervisory system.

Regarding unauthorized practices, *the Law on Radiation Safety and Nuclear Safety* enforces the main rule – only authorized practices are legal. Under the law, several regulations have been issued, but there are also some specific articles in the law itself. In the new version of the law, the radiation safety centre is empowered to solve the problem of orphan sources.

Legislation on administrative penalties and criminal law also include provisions regarding unlicensed practices and violations of regulations relevant to the illicit trafficking.

PRESENT AND ENVISAGED RADIATION SAFETY REGULATORY INFRASTRUCTURE

The main problem for Latvia is not the enforcement of legislation, but the implementation of a full radiation protection concept, including legislation, education, training, and awareness-building. We have to take into account the transition situation, when certain specific needs do not always prevail over the basic daily needs of the general public. Although a safety culture still has to be developed, we have had no radiation accidents or overexposures to date, and therefore it appears that regulatory system has answered the need so far.

At present, two ministries share the responsibilities of supervising the implementation of the new law and the relevant regulations. The system will be changed in nearest future — the

Radiation Safety Centre will be established in 2001. To ensure effective supervision, Parliament has approved necessary amendments to the administrative penalties law and some changes in criminal law.

THE RADIATION SAFETY CENTRE AND THE RADIATION SAFETY BOARD

According to the new law a Radiation Safety Board will also be established to consult the Radiation Safety Centre and other institutions regarding radiation safety. It is a rather unusual situation – the Board has a dual role – as the consulting organization and as the decision-making organ. Therefore, the law specifies main interrelations between the Board and the Centre. To ensure such capabilities, the Board should have at least three radiation safety experts and high-level civil servants from all relevant ministries.

The main interactions between the Board and Centre will be in two forms:

1. In regular meetings of the Board, the Centre will provide the secretariat services and will present to the Board a status report, which will allow the Board to consult other State institutions and the Government about radiation safety in the country.
2. In seeking to improve the situation, the Centre will call for ad-hoc meetings of the Board for advice. In such a way, through expert advice and through information available from the ministries, it will be possible to analyse proposals in depth and to justify which option should be recommended to the Government.

JOINT REGULATORY, CONTROL AND IMPLEMENTATION ACTIVITIES

A single regulatory body may not be able to cover all aspects of radiation safety. In certain cases, it is more cost-efficient to use larger systems to cover certain tasks:

1. For a country without an NPP, emergency preparedness can be managed by the fire protection and rescue services that keep necessary resources and have capabilities to manage large accidents, but the radiation safety authority can advise them.
2. A specialized authority monitors all aspects of food quality. The system should be modified only if the country or its trade partners are affected by a nuclear accident.
3. Combating illicit trafficking is a multi-institutional problem, which also depends on international co-operation.
4. For basic education and retraining, the regulatory body will propose requirements for radiation workers, but cannot execute such a programme by itself.
5. For the recovery of lost nuclear materials or radiation sources, the regulatory body has to seek assistance from the police, but for decontamination activities, it must request assistance from a radioactive waste management company.
6. The implementation of a nuclear supplier group regime is always connected with the joint activities of several institutions.

BORDER CONTROL

During early activities regarding the combating of illicit trafficking, the Ministry of Environmental Protection and Regional Development (VARAM) recognized the need to have an organization for co-ordination of activities. VARAM is the leading ministry regarding the development of the control systems for radiation applications and must help other institutions in this field of radiation safety. In 1989, we assisted customs offices in establishing control by providing portable measuring devices.

An important issue is co-ordinating activities in detecting smuggling cases. Border guards, customs and professionals working for railway, air traffic, and seaports had to find their own way of co-operation. Since 1996 the leading organization has been the border guards. However, for all situations that can occur, they have to establish specific working procedures. Before specific regulations were developed, there were agreements between border guards, customs and transport companies or some other organizations e.g. airport and sea port administrations.

JOINT INVESTIGATIONS OF LATVIA–SWEDEN–NORWAY ON COMBATING ILLICIT TRAFFICKING

When Latvia started to analyse the system for the prevention of illicit trafficking, it was clear that one single country could not cope with all problems. There are at least four areas relevant to combating illicit trafficking of radioactive and nuclear materials, e.g. human resources, technical capabilities, legal framework and co-operation. Co-operation can speed up upgrades of the national system, but also there is a need to find a system which can be used as the prototype.

Our co-operation with the Nordic countries has been very successful. An investigation was undertaken together with Sweden and Norway, which stressed the need for direct communication and information sharing among similar institutions on both sides of borders.

In addition to national activities, there are several proposals for improving the combating of illicit trafficking internationally. Many issues can be handled by the existing international system. The IAEA introduced a "Code of Conduct on the Safety and Security of Radiation Sources and Radioactive Materials", which should improve the situation. Its main aim is full implementation of the IAEA Basic Safety Standards, in order to minimize the threat of lost control over sources and maximize response capabilities.

The IAEA always plays an important role, but some specific questions have to be considered separately. As illicit trafficking should be a short-term phenomenon, probably some new arrangements which can work very fast would be needed. The strengthening of a national infrastructure can take several years, but in the meantime, the threat from outside must be tackled. Moreover, there is a need for an international audit and follow-up, which States have to accept, but the IAEA peer reviews are based on voluntary requests from countries.

EFFORTS TO UPGRADE CONTROL AND ACCOUNTING SYSTEMS TO PREVENT THE LOSS OF CONTROL OVER RADIATION SOURCES

Several IAEA TC projects provide support to prevent loss of control and to improve training capabilities. Firstly, human resources and motivation have to be considered. Secondly, we need capabilities for detection, assessment etc., for several institutions it seems to be the main factor in combating illicit trafficking. We need to control cross border movement of radioactive materials. Thirdly, combating trafficking a complex problem and no single authority can do the job alone. It leads to the need for internal co-operation e.g. joint educational programmes and many activities pending access to information require the promotion of information sharing.

THE RADIATION PROTECTION INFRASTRUCTURE IN MADAGASCAR

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Abstract. Madagascar is participating in the Model Project RAF/9/024 on "Upgrading Radiation Protection Infrastructure". Its radiation protection legislation is based on the BSS. The efforts being made to upgrade the country's regulatory infrastructure and the problems encountered are described below, as is the national information and training programme for the authorities, the public, workers and students .

NATIONAL INVENTORY OF SIGNIFICANT RADIATION SOURCES AND RADIOACTIVE MATERIALS

In Madagascar, work on drawing up an inventory of radiation sources for safety and security reasons was initiated in 1995 by the INSTN, acting as the technical body of the competent authority. The INSTN started with the capital, Antananarivo, and then extended its activities to other regions. At least once a year, users are now being made aware through the mass media of the need to notify the competent authority regarding the radioactive materials and other radiation sources in their possession. Customs officers have been trained by the INSTN to identify radioactive packages, and co-operation between the INSTN and the customs authority has helped to increase the number of radiation sources discovered entering Madagascar illegally.

Most activities involving radiation sources are still in the medical field, but there is some utilization of radiation sources in industry and in laboratories too.

In medicine

Source	Application	End user	Number
X-ray generator	Radiography	Hospitals	70
X-ray generator	Radiography	Dentists	17
X-ray generator	Mammography	Hospital	1
X-ray generator	Scanning	Hospital	1
X-ray generator	Contact therapy	Hospital	1
Co-60	External therapy	Hospital	1
I-131	Diagnosis	Nuclear medicine	unsealed
Cs-137	Brachytherapy	Hospital	1

In industry

Sources	Application	End user	Number
Sr-90	Density gauging	Tobacco industry	2
Kr-85	Density gauging	Paper industry	1
Co-60	Level indicating	Oil industry	2
Co-60	Level indicating	Shipbuilding	1
Am/Be	Density gauging	Civil engineering	1
Am/Be	Level indicating	Dairy industry	1
Am/Be	Level indicating	Aircraft	1
Am/Be	Industrial gauging	Oilwell logging	2
Cs-137	Industrial gauging	Oilwell logging	1
Ir-192	Gamma radiography	Oil industry	1
U-Th	Standard	Mining	1
X-ray generator	Radiography	Shipbuilding	1

In laboratories

Sources	Application	End user	Number
Ni-63	Chromatography	Research laboratory	1
H-3	Liquid scintillation counting	Research laboratory	unsealed
Co-60	Irradiation	Calibration laboratory	1
Cs-137	Irradiation	Calibration laboratory	1
x-ray	Irradiation	Calibration laboratory	1
Sr-90	Irradiation	Calibration laboratory	2
Sr-90	Calibration checking	Calibration laboratory	2
Cd-109	X-ray fluorescence	Research laboratory	1
Fe-55	X-ray fluorescence	Research laboratory	1
I-125	Radioimmunoassay	Research laboratory	unsealed

THE NATIONAL REGULATORY INFRASTRUCTURE

Law 97-041 on protection against the harmful effects of ionizing radiation sources and on radioactive waste management was promulgated on 2 January 1998. It is based on the BSS.

Pursuant to this law, the regulatory authority is the Autorité Nationale de Protection et de Sûreté Radiologiques (ANPSR). For activities related to the use of radiation sources and to radioactive waste management, ANPSR has to

- prepare the necessary regulations,
- issue the necessary authorizations,
- specify the responsibilities of the parties involved, and
- take decisions regarding the application of the law and the regulations.

In the field of radiation protection, ANPSR is assisted by the Organe Technique de Radioprotection (OTR).

In the field of radioactive waste management, ANPSR is assisted by the Office Central de Gestion de Déchets Radioactifs (OCGDR).

The law has following main sections:

- basic principles of radiation protection
- authorizations and controls
- conditions for workers exposed to ionizing radiation
- responsibilities in the production and management of radioactive waste
- sanctions and legal proceedings
- the fiscal and customs arrangements

Following the promulgation of Law 97-041, four drafts decree were prepared:

1. a draft decree dealing with the roles and functions of the regulatory authority;
2. a draft decree dealing with the basic principles of protection against ionizing radiation;
3. a draft decree dealing with the basic principles of radioactive waste managment; and
4. a draft decree dealing with the possession and utilization of radiation sources in the medical field.

THE NATIONAL SYSTEM OF NOTIFICATION, REGISTRATION, LICENSING AND INSPECTION OF RADIOACTIVE MATERIALS AND OTHER RADIATION SOURCES

These draft decrees have been examined by lawyers of different ministries and been revised in order to be consistent with other national regulations. The last step will be their promulgation after examination in the Council of Government. Pending their promulgation, governmental decree 93/243 issued on 29 April 1993 and based on ICRP 26 is still in force. Under this decree, the Ministry of Higher Education is the competent authority in the field of radiation protection and the INSTN is its technical body. In application of this decree, nine national regulations have been issued:

Madagascar is currently in a transition period as ANPSR, OTR and OCGDR are not yet functioning. Therefore, the following activities are being carried out by the INSTN as the technical body of the competent authority:

AUTHORIZATION AND INSPECTION

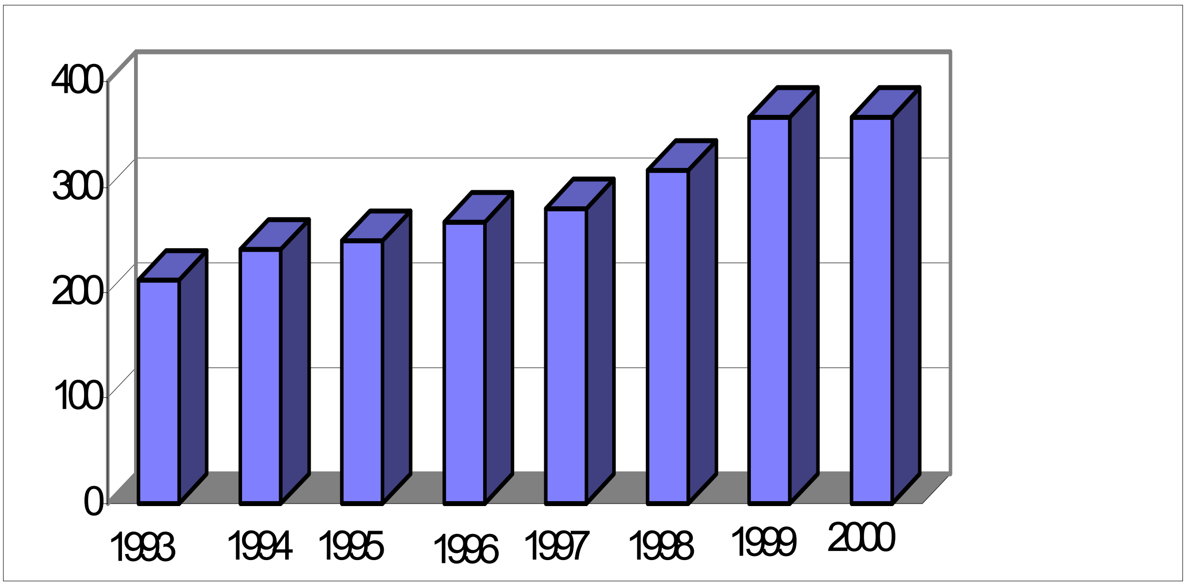
Any use of ionizing radiation must be authorized by the national competent authority. Exemption levels are defined in the regulations. A safety assessment must be carried out, on the basis of the technical documentation and an inspection, before an authorization is issued for the use of a source.

At present, the INSTN is responsible for carrying out inspections and safety checks. When the new regulations are issued, inspectors appointed and empowered by the regulatory authority will be in charge of inspections.

INDIVIDUAL MONITORING

The INSTN continues to carry out personal monitoring of those working with ionizing radiation. The thermoluminescence technique is used.

The growth in the number of workers monitored by the INSTN between 1993 and 2000 is shown in the following graph:



QUALITY ASSURANCE IN MEDICAL PRACTICES

X-ray radiology

Under the regulations, each X-ray machine must undergo quality control at least once a year.

Radiotherapy

The INSTN is responsible for quality control and dosimetry measurements at the only cobalt therapy centre in Madagascar - the Oncology, Haematology and Radiotherapy Department of the Centre Hospitalier Universitaire; the two institutions have concluded an agreement for this purpose.

THE INSTN'S SECONDARY STANDARD DOSIMETRY LABORATORY (SSDL)

The SSDL at the INSTN was established in 1996 with the help of the IAEA. It has one therapy level standard and one radiation protection level standard for calibration.

The SSDL and the radiotherapy centre of the Centre Hopitalier Universitaire's Oncology, Haematology and Radiotherapy Department are involved in the IAEA/WHO Intercomparison Network in External Radiotherapy. Since 1997, they have participated in three TLD Postal Dose Quality Audits.

In April 1999 and April 2000, the SSDL participated in an IAEA TLD Postal Quality Audit for Cs-137 radiation protection calibration.

In November 1999, the SSDL participated in an intercomparison of radiological measurements for monitoring purposes. At a meeting held in February 2000, with 35 participating laboratories, the results for Madagascar were considered excellent.

THE NATIONAL PROVISIONS FOR EDUCATION AND TRAINING IN THE SAFETY OF RADIATION SOURCES AND THE SECURITY OF RADIOACTIVE MATERIAL

TRAINING

At the University

Radiation protection is included as a subject in the medicine, physics and chemistry programmes.

Training for users of radiation sources

Once a year, the INSTN organizes a training course in radiation protection for users of radiation sources. The course programme includes lectures and practical, on-site training. The first such course was held in October 1996.

Training for radiation protection technicians

The INSTN has, starting with the 1999-2000 academie year, introduced training for radiation protection technicians. The trainees (initially 25 of them), who must possess a "Baccalaureat" diploma, attend a theoretical and practical course followed by on-site training. After two years of study, those who qualify become responsible for radiation protection at their place of work.

SEMINARS AND WORKSHOPS

In April 1997, an information seminar on radiation protection was held in Antananarivo for the benefit of the staff of national authorities.

The INSTN and the Association Nationale de Radioprotection (ANARAP - a society for users of radiation sources which, in June 1999, was accepted for membership of the International Radiation Protection Association) held two-day information meetings on radiation protection for radiologists and industrialists in October 1997 and October 1999.

In May 1998, the INSTN and the Customs Directorate of the Ministry of Finance held a workshop for customs officers on the export-import control of foodstuffs and the use of X-ray baggage scanners.

THE NATIONAL PROVISIONS FOR RADIOACTIVE WASTE MANAGEMENT

As the decrees for implementing Law 97-041 on protection against the harmful effects of ionizing radiation and on radioactive waste management have not yet been promulgated, the decree on protection against ionizing radiation promulgated on 29 April 1993 still applies.

SPENT RADIUM SOURCES (BRACHYTHERAPY)

The conditioning of spent radium sources from the radiotherapy centre of the Centre Hospitalier Universitaire's Oncology, Haematology and Radiotherapy Department was carried out in February 2000 with the assistance of the IAEA and a South African team. These sources are now in temporary storage at the INSTN.

COBALT-60 (RADIOTHERAPY)

The selected option for the management of spent cobalt-60 sources is return to the original supplier.

IODINE-131 (NUCLEAR MEDICINE)

For this radionuclide (with a half-life of 8.04 days) the preferred option is storage for decay. In many cases, after storage for ten half-lives disposal as exempt waste is possible.

ORPHAN SOURCES

Under Madagascar's legislation, the State is responsible for orphan sources.

PRESENT ACTIVITIES OF THE NUCLEAR ENERGY COMMISSION IN THE FIELD OF SAFETY OF RADIATION SOURCES AND SECURITY OF RADIOACTIVE MATERIALS IN MONGOLIA

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Abstract. The Radiation Safety Department of the Nuclear Energy Commission (NEC) is a regulatory body in Mongolia established in 1997. The paper gives a general overview of the main activities of the NEC on regulatory control of radiation sources in Mongolia. Mongolia declared itself a nuclear-weapon-free zone in 1992. Legal framework and waste management issues are described. The regulatory authority's co-operation with other agencies in radiation protection is also presented in this paper.

INTRODUCTION

Mongolia is a land-locked country in Central Asia, with 1.5 million km^2 territory and 2.4 million people. It borders the Russian Federation to the north and the People's Republic of China to the south.

Since there are no nuclear power plants or research reactors in Mongolia, the application of nuclear technology is limited to the increasing uses of radiation sources and radioactive substances, radiotherapy, medical diagnostics, industrial technological processes, geology, mining and research. Mongolia is participating in the IAEA's technical co-operation model project on upgrading radiation protection infrastructure and the first project milestone aimed at bringing about a system for notification, authorization and control of radiation sources has been reached. An action plan for the implementation of the project provides for the development of legal basis for radiation protection and safety, the establishment of a body responsible for radiation monitoring, revision of radiation safety standards, management of radioactive waste substances and some other measures. This model project has played an important role in improving the radiation protection infrastructure in our country, especially in regulatory control and establishment of radiation protection legislation. Also, it has provided appropriate training for professional staff and supplied necessary equipment and expert services, which has produced valuable recommendations for our future activities. Now we are waiting for the final report of a peer review mission after completion of its on-site assessment, at the beginning of September 2000, of the effectiveness of a regulatory programme for radiation safety in Mongolia.

MONGOLIA'S NUCLEAR-WEAPON-FREE STATUS

Mongolia declared itself in 1992 a nuclear-weapon-free zone. Recently, the United Nations General Assembly adopted its resolution on Mongolia's international security nuclear-weapon-free status. A law enacted in Mongolia institutionalizes this status.

INTERNATIONAL LEGAL FRAMEWORK

Mongolia has ratified the Treaty on Non-Proliferation of Nuclear Weapons, and a few international agreements relating to the uses of nuclear material, namely:

- the Convention on the Physical Protection of Nuclear Material
- the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency
- the Convention on Early Notification of a Nuclear Accident.

Currently, Mongolia is considering signing the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Some of the necessary arrangements have been made.

LEGAL FRAMEWORK

The Radiation Safety Law was drafted and approved by the Government, and in June 2000 submitted to the Parliament for its enactment. The July 2000 election established a new Parliament, so we are preparing to resubmit the law to the Government for approval. The relevant ministries and agencies have provided their views in accordance with the established procedure.

The Government Decree No.56. dated 12 April 2000, is the most important act for ensuring radiation protection and safety. This regulates the activities related to radiation sources and will be replaced by the above-mentioned law.

REGULATORY AUTHORITY

The first radiation control unit was established in 1973 under the Ministry of Health and has started to carry out inspection of X-ray rooms in hospitals as an acting regulator. The Radiation Safety Department of the Nuclear Energy Commission is the regulatory body in Mongolia, established in 1997. We have a national inventory of radiation sources and small calibration sources are also registered. Most radiation sources are used in medicine for radiodiagnosis and in industry for NDT and gauging. In Mongolia there are four licensed radiotherapy facilities, four nuclear medicine units, 222 X-ray units, 5 NDT facilities and 168 gauges or well logging sources. An electron accelerator Microtron, neutron generators and Californium-252 sources are being used for research purposes. All institutions which use radiation sources are licensed and all sources inventoried. We use radiation sources relatively little in our country. Inspectors from the regulatory authority carry out routine inspections of the users. New application forms and inspection checklists for different practices were prepared in 2000 using IAEA guidance.

RADIOACTIVE WASTE MANAGEMENT

As far as the issue of safety of radioactive waste management and safe transport of radioactive material is concerned, the Isotope Bureau of the Nuclear Energy Commission, located about 30 km from Ulaanbaatar, is responsible for the safe storage of radioactive waste and the safe transport of radioactive material. A basic regulation on radiation sanitation regulates the activities related to radioactive waste management since Mongolia does not have specific legislation for waste management. New regulations on waste management and transport of radiation sources have been drafted.

Mongolia does not produce radioactive material, so the amount of the radioactive waste is respectively low and is mostly generated from the spent sources of medical and industrial practices. Spent sources, as waste or disused sources, are stored in the Isotope Bureau, which is under guard 24 hours a day. In 1997, abandoned caesium gauges were found in a storehouse and transferred to the Isotope Bureau.

CO-OPERATION WITH OTHER GOVERNMENT AGENCIES

The Nuclear Energy Commission (NEC) has made specific arrangements with the Customs Department, the State Security Department, civil defence, the criminal police, the Ministry of Health and the Ministry of Environment to ensure radiation protection and emergency response, and has good collaboration. For example, the regulatory authority has a specific arrangement with the customs organization to prevent unauthorized import of radiation sources into the country. The State Security Department is responsible for security control of radiation sources in co-operation with the regulatory authority to prevent unauthorized use or theft of radioactive sources. Civil defence is responsible for emergency planning, response and preparedness and co-operates with the NEC in a radiation accident or radiological emergency. The criminal police should investigate cases described in the criminal code and prevent trafficking or smuggling of radioactive material. The NEC has good co-operation with the Ministry of Health on QA and QC for medical diagnostic equipment and with the Ministry of Environment on environmental radiation monitoring network.

There is a need for more uniform and more effective checks at the frontiers. In order to achieve more targeted customs controls, the NEC is endeavouring to develop appropriate risk analysis techniques and needs to support special training and education for customs on radiation protection aspects. There is a need for supporting, assisting, and improving the close co-operation between national and international organizations, Government authorities and regulatory bodies and also for more staff and funding for the regulatory authority.

IAEA-CN-84/70

REGULATORY AUTHORITY INFRASTRUCTURE FOR NAMIBIA

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Abstract. The Republic of Namibia is participating in the International Atomic Energy Agency's Model Project for the Improvement of National Regulatory Authority Infrastructures in Member States. The paper illustrates our experience in solving problems and difficulties confronted in establishing an effective regulatory authority operating within the existing national infrastructure that should be supported by the Government. An effective regulatory authority is seen as part of the wider administrative scope of our Government through ministerial mandates given by the State from time to time, guaranteeing its independence when implementing legal provisions under statutes. Sections of the report illustrate our experience in the following areas:

- National radiation protection policy
- Structure of our national regulatory authority
- Laws and regulations
- Provisions for notification, authorization and registration
- In-depth security measures for radiation sources and radioactive material
- Systems for the inspection of radiation sources, radioactive materials, enforcement of legal provisions.
- Extent of the applications of radiation sources and radioactive materials in the country.

The paper provides information regarding existing Government policy on radiation protection; structure and legal aspects of the national regulatory, including statutes and regulations; the extent of application and uses of radiation sources and security of radioactive materials; human resources: strengths and constraints; management practices and financing of regulatory authority; and plans for emergency recovery of orphan sources.

National plans for management of disused sources, recovery of orphan sources, abnormal emergencies, communication of information to affected persons on exposure effects, and the safety training of persons using these applications are discussed. the paper provides a summary and some suggestions of the way forward for Namibia.

INTRODUCTION

The Republic of Namibia is participating in the IAEA's Model Project for the Improvement of National Regulatory Authority Infrastructures in member States. Significant achievements have been recorded in the past few years, in view of the fact that Namibia has been independent for only ten years.

The IAEA Action Plan was approved by the 43rd General Conference. The objective of the Action Plan is the development and implementation of activities that will assist Member States in maintaining and improving the safety of radiation sources and security of radioactive materials. The information we provide will indicate our efforts in setting up administrative, technical, and managerial mechanisms required to ensure the regulatory control of radiation sources and safety of radioactive materials by our national authority.

NATIONAL RADIATION PROTECTION POLICY

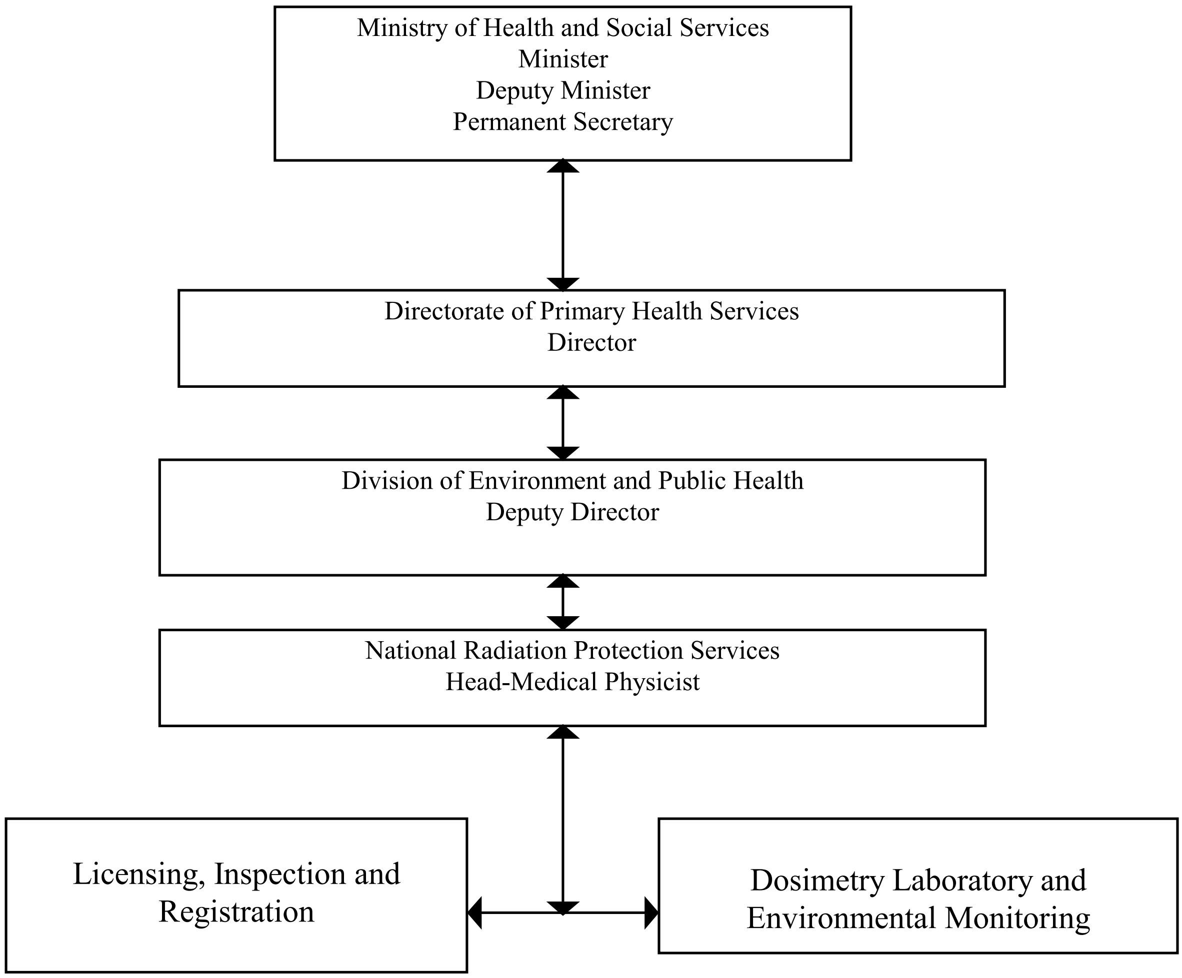
In 1994, the Government of the Republic of Namibia approved the National Policy on Radiation Protection which articulates Government intent on radiation sources and radioactive materials including all matters related to management; peaceful applications of nuclear energy; and most important the regulatory aspect and its organizational structures. The policy set out the requirements for the establishment of an Atomic Energy Board as an independent advisory body to the Government on the implementation of the policy and National Radiation Protection Services as the enforcement agent of the regulatory provisions.

The policy further provides that the two regulatory authority bodies be established either by a new law or through regulations. A national policy on the safety of radiation sources and security of radioactive material is a useful managerial tool because through it we will be able to monitor the effectiveness and the rate of implementation of the recommendations of the Agency's Basic Safety Standards and national regulatory mechanisms.

STRUCTURE OF THE NATIONAL REGULATORY AUTHORITY

The national regulatory authority structure was approved by the Government in the national policy. The new law will provide the powers and functions of both the Board and the National Radiation Protection Services, which will act as an inspectorate unit. Currently, there is no provision for the Board are carried out through consultations with relevant stakeholders and the office of the Permanent Secretary.

Table1. Organizational structure of the regulatory authority in Namibia



At the operational level the head of the National Radiation Protection Services is directly responsible to the divisional head for the enforcement of the law. The head of the Unit co-ordinates the activities of the other two sections. Each section is headed by a radiation expert who is supported by two technical officers. The national regulatory authority has provision for seven technical and scientific officers who are supported by other officers from the Administrative Support Services of the Ministry. The new law shall set up an appropriate structure. We hope to exchange views and get ideas at this conference in this area in view of Namibia's industrial, mining and technical applications in the field of radiation sources and safety of radioactive materials. Namibia has one of the largest open pit uranium mines in the world (Rossing Uranium) and we have signed and ratified the safeguards agreement with IAEA. The majority of our nuclear activities are limited to health, industrial applications and mining.

Our broader objective on radiation protection policy in Namibia is to protect human beings (workers, patients, the public) from risks resulting from the harmful effects of radiation sources, while allowing for its beneficial applications in medical, industrial, scientific and other purposes, and protecting the environment from unauthorized disposal of radioactive material.

LAWS AND REGULATIONS

The safety of radiation sources and security of radioactive materials in Namibia is regulated by the Hazardous Substances Ordinance, 1974. This law provides for the Government to promulgate regulations for the control of electronic products as group III and radioactive materials as Group IV. Under the law, electronic products include radiation sources but not radioactive materials. the Regulations for the Control of Electronic Products, 1974, provides the systems for the enforcement of the requirements of the law. We are now promulgating the regulations for control of radioactive materials as provided under Section 3(1)(c) of the Ordinance. Other legal instruments relevant to this area are the Labour Act of 1992, the Regulations Concerning the Health and Safety of Workers at Work Places and the Constitution of the Republic of Namibia. Article 95(1) of the Constitution states that the Government shall provide measures against the dumping or recycling of foreign nuclear and toxic waste on Namibia territory.

The regulations in force also require that all workers be provided with training in radiation safety and radiation monitoring devices. The Diamond Protection Act, 1939, provides for the screening of mine workers with radiation sources. This practice is under our regulatory control for the safety of workers and the public in the mining industry. it is important to note that we have restricted this practice to an exposure unit of 1 mSv (milli-Sievert) per worker per year, which is the same dose assigned for the general public in the IAEA Basic Safety Standards.

PROVISION FOR NOTIFICATION, AUTHORIZATION AND REGISTRATION

The Hazardous Substances Ordinance provides under Section 3(1)(b) for the Government to declare any radiation source as a Group III hazardous substance, while under Section 3(1)(c) any radioactive material is classified as Group IV hazardous substance. The grouped hazardous substances are subject to regulations for their safety and security under the law. The law also stipulates under Section 4 (1) that "no person shall:

(a) use, operate or apply any Group III hazardous substance unless it is registered under Section 5(b) and otherwise than subject to the conditions prescribed or determined by the Permanent Secretary;
(b) install or keep installed any Group II hazardous substances on any premises unless such premises are registered in terms of Section 5(c) and otherwise than subject to conditions prescribed by the Permanent Secretary."

The law goes further and declares that: "the Permanent Secretary may on application in the prescribed manner and on payment of the prescribed fee if any, and subject to the prescribed conditions and such further conditions as the Permanent Secretary may in each case determine,

(a) register any Group III hazardous substance for the purpose of this law,
(b) register any premises as premises on which a Group III hazardous substance may be installed. In our law install includes storage."

The regulations for the safety of radiation sources referred to as Regulations Concerning the Control of Electronic products provide in Regulations II that, no person shall use a listed electronic product is licensed and subject to any conditions imposed by the Permanent Secretary. No person shall use a listed electronic product on any premises unless such premises have been licensed and subjects to any conditions imposed by the Permanent Secretary. No person shall modify or dispose of any licensed electronic product or modify any licensed premises or the layout of equipment, including the electronic products on any premises expect with approval of the Permanent Secretary who shall endorse the relevant license accordingly.

SECURITY OF RADIATION SOURCES AND SAFETY OF RADIOACTIVE MATERIALS

Legal requirements for the provision of measures to ensure the safety of radiation sources and the security of radioactive materials are aimed primarily at the protection of workers, the public and the patients from potentially harmful effects of exposure. However, performance safety indicators for protection against potential exposures call for detailed design analysis of radiation generators, sources and source materials. To this end, the licensee is responsible for the safety of the sources and security of materials under a license which includes liability for any failure to comply with licensing conditions.

All users of radiation sources and radioactive materials are required to notify the authority of their intention to possess, use or install sources or radioactive materials. They are subsequently authorized in a licence and appropriate registration is being done through the use of IAEA Regulatory Authority Information System (RAIS).

We require the licencee, in co-operation with the suppliers, to ensure conformity with the requirement of the law and International Electrotechnical Commission (IEC) and the International Standards Organisation (ISO) in procurement of new sources, and equipment, and in facility design. The regulatory authority has the legal powers to impose local regulatory requirements to enhance the security of sources and materials. Finally, sources and equipment are tested during commissioning and decommissioning to ensure compliance with the standards. With regard to radioactive materials, the provisions of the IAEA's Basic Safety

Standards (BSS) are being applied in our regulatory procedures as they are not covered in the present law. However, this gap will be closed through regulations as provided by the law.

INSPECTION OF RADIATION SOURCES, RADIOACTIVE MATERIALS AND ENFORCEMENT OF REGULATORY PROVISION

Inspection of radiation sources and radioactive materials is carried out by the National Radiation Protection Services inspectors. The law empowers inspectors to enter licensees's premises or nay facility deemed to use or store radiation sources and radioactive materials. They have the authority to seek police assistance in enforcing the provisions of the law and conditions of the licence. The law provides for penalties including fines and imprisonment for failure to comply with the requirements of the law or the licence.

All licence holders are inspected annually in order to monitor compliance with legal provisions, and renewal of licenses is subject to a report from radiation inspectors. The biggest problem facing our country is the lack of sufficient local radiation safety inspectors and local institutions to train them. This is an area where we would like to have bilateral discussions with other countries that have training facilities for such officers so that we may increase the number required to cover the entire country. This is also an area that consumes a large portion of the budget for the regulatory authority because it involves traveling throughout the country to areas with licences. On the one hand, the licence holders are demanding to be inspected in order to meet the requirements of the law. On the other hand the trade unions are exerting pressure on the employers to comply with safety and security of potentially harmful applications.

APPLICATION FOR RADIATION SOURCES AND RADIOACTIVE MATERIALS

PATIENT EXPOSURE IN RADIOTHERAPY

In therapeutic radiation procedures, including teletherapy and brachytherapy, calibration and dosimetry are conducted by or under the supervision of a qualified medical physicist. Theraupeutic exposure is prescribed by a radiation oncologist. In order to ensure safety and protection of the patient,personnel are trained and periodically retrained in this. The main objective is to ensure quality through prevention of failures and errors. High energy radiotherapy, such as cobalt-60, has an independent "fail to safety" system for terminating irradiation and is also provided with safety interlocks designed to prevent the clinical use of the machine in conditions other than those selected at the control panel. Other useful accessories available include a patient dose verification system, patient immobilizers, computerized treatment planning and dosimetry calculations, and facilities for shielding radiosensitive organs such as the gonads, lens of the eye and spinal cord.

OCCUPATIONAL EXPOSURE

The Government is responsible for providing facilities for monitoring occupational exposure. Modern equipment also minimizes occupational exposure risks. For example, in the past, brachytherapy sources were introduced into the patient manually, but now a remote after-loader is used.

In this area we focus on the key statutory provisions on the health and safety requirements that affect the radiation worker. The principle of justification of practices is applied and supplemented by the as low as reasonably achievable (ALARA) principle. If an employer's objectives are not realized, the business or service could fail, making health and safety concerns academic. Our aim is to ensure that health and safety becomes an intuitive and everyday part of the workplace routine that is an integral part of the job, and not an appendage to it.

MINING INDUSTRY AND EXPOSURE OF MINEWORKERS

Rossing Uranium Limited mines uranium bearing ores by open cast mining and processes them in a mill to recover concentrated uranium oxide, which is exported. The mining and milling of uranium involves potential radiation hazards to the workers and to members of the public, for example through:

(a) inhalation of the by-products of radon gas;
(b) external radiation exposure; and
(c) inhalation or ingestion of dust particles containing by-products of uranium.

Uranium in itself is a chemically toxic element and, in the absence of protection , can damage the kidneys. Radium is deposited in the skeleton and can cause bone cancer. The by-products of radon gas can cause lung cancer. The processing of the uranium bearing ores in the mill results in a slurry of fine particles, known as the tailings. Since the grade of uranium ore processed by Rossing Uranium Limited is very low (0.035), practically the entire quantity mined as ore results as tailings. The tailings are disposed of in an impoundment. Radon gas is emitted from the tailings impoundment.

INDUSTRIAL APPLICATIONS

It is estimated that about 200 nuclear gauges are used in Namibia. A large number of fixed nuclear gauges are used in the mining sector, particularly NAMBDEB, Rossing Urainum Limited and Ongopolo Mining Ltd, for belt mass meters, level gauges, density gauges and calibration purposes. These nuclear gauges contain mainly sealed sources of radioactive caesium. Fixed nuclear gauges containing sealed radioactive americium are used for level control in bottling plants of beverage producers. the nuclear gauges offer many technical and economic advantages. Being non-contact devices, they can be operated unattended in hostile environments (e.g. corrosive, high temperatures etc.). They can be easily incorporated into automated systems, thereby facilitating high throughputs, consistency of product quality and reduction of wastage.

Portable nuclear gauges containing a sealed caesium source are used in the construction sector, for example, to control the thickness and density of bitumen used for surfacing roads. Portable gauges containing other sealed sources are also used in the construction sector to optimize the amount of water used for preparing cement concrete mix. The portable nuclear gauges are used by the Ministries of Agriculture, Water and Rural Development, Works, and Transport and Communications, by municipalities and by a few private construction companies. External exposure is the principal radiation hazard posed by sealed sources contained in the nuclear gauges. However, if the seal id damaged, as is likely during use of portable nuclear gauges in the field, radioactive contamination may occur, which can pose an inhalation/ingestion hazard thereby giving rise to an international radiation hazard.

Table 2. Radiation sources and radioactive materials

1.	Diagnostic X-ray units (Government and private sectors)	• ±200 under license • 1 simulator
2.	Namibia Breweries	• 6 gauges of strontium-90 and americium-241 sources
3.	Rossing Mines	• 36 gauges of caesium-137 • 4 are destined for disposal in RSA
4.	Windhoek Central Hospital Nuclear Medicine Department	• Unrestricted source for in-vivo use
5.	Windhoek Central Hospital Radiotherapy Department	• 1 Theratron-cobalt-60 (8 Kilo-Curie) • 30 pellets of Cs-137 for Ca Cx low dose rate (25 milligram equivalent) • 1 iridium-192 high dose rate generator for Ca Cx • 2 strontium-90 for eye treatment
6.	CT scanners	• 4 in the country
7.	Sources not declared: Ongopolo Mine NAMDEB	• 17 of unknown type • unknown type and quantity

MEDICAL APPLICATIONS

X rays are widely used in medical diagnosis and in dentistry and also as an aid during surgical intervention. There are approximately 180 X-ray units, three radiologists and 200 radiographic assistants and radiographers in Namibia to perform general and specialized radiography procedures. There are three computerized tomography (CT) scanners in private hospitals an done in a government hospital. Radiology plays a vital role in early diagnosis of disease and its management. The use of X rays in medical diagnosis has increased rapidly in the industrialized countries and has become the largest contributor to population dose amongst all human-made sources of radiation.

Nuclear medicine is authorized only at Windhoek Central Hospital. The department has a planner gamma camera and a single photon emission computer tomography (SPECT) gamma camera for on-line data acquisition and processing. A variety of static and dynamic studies on the functioning of different body organs are performed using ready-to-use kits of pharmaceuticals, which are labelled with radioactive technetium. Other radiopharmaceuticals which are used in Namibia include cobalt, gallium, iodine, xenon and thallium.

Radioimmunoassay (RIA) tests are performed in the Medical Laboratory of the Windhoek Central Hospital, using ready-to-use kits and radioactive iodine to determine the levels of hormones, immunoglobulins, vitamins and drugs in serum.

With the development of the petroleum and petrochemical sector, one may envisage increased use of neutron gauges during the exploration and production phase of petroleum and natural gas. Industrial radiography will be applied on a large scale during the construction of refineries, and in downstream petrochemical plants for the inspection of welding on pipes, storage and process vessels. Nuclear gauges will be used in the petroleum product processing plants, petrochemical plants and liquefied petroleum gas bottling plants. Radioactive tracer techniques may be used to locate leakage in buried pipes and installations.

NATIONAL PLAN FOR MANAGEMENT OF RADIOACTIVE MATERIAL

The Government has established a National Emergency Management Unit. In cases of emergency such as airport accidents involving an aircraft transporting radiation sources or radioactive materials, the national regulatory authority has contacts with the unit and the airport fire and police. The national regulatory authority also assists affected persons by informing them of their rights if there is evidence that the exposures were due to negligence of the license holder and also arranges for medical treatment by radiation oncologists.

As indicated earlier, we are now establishing a system of registering all the radiation sources and radioactive materials in the country. We have not as yet come across orphan sources and should they be found, they will be repossessed and put under the regulatory authority for safe storage or disposal. The regulatory authority has made funs available in the national budget for the training of users in safety. In 2000 alone, more than four such training seminars have been conducted for all the radiographers in Windhoek and in the northwestern regions.

Finally, if an authorized practice or a radiation source within a practice has a potential for accident which may precipitate unplanned exposure to any person or initiate an emergency situation, the licensee is required to have emergency plans as provided under other national laws such as fire service safety at workplaces and as appropriate for the scale of operations. This is endorsed on the license as a contingent condition.

INDUSTRIAL SOURCES IN NORWAY — REGULATIONS AND REQUIREMENTS

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Abstract. On 12 May 2000, a new Act on radiation protection passed the Norwegian parliament. The report explains the requirements for the licensing process of sealed industrial sources and provides information, in particular, on the national inventory of industrial gauges, industrial radiography and logging sources.

INTRODUCTION

On 12 May 2000, a new Act on radiation protection passed the Norwegian Parliament and was given Royal sanction. This replaces the old law from 1938 on radiation protection. The principal input to this new law has been the IAEA Basic Safety Standards 115, the ICRP 60 Recommendations and the European directives on radiation protection (Council Directive 96/29/Euratom and 97/43/Euratom). Both ionizing and non-ionizing radiation are covered. The Act covers protection from and prevention of harmful effects from radiation on the human health and radiation protection of the environment. The law has 25 articles and authorizes the necessary legal instruments to implement radiation protection in society, including emergency preparedness for nuclear accidents.

In Norway, sealed and unsealed radioactive sources are used in a number of medical, industrial, and research applications. In this presentation, only sealed industrial sources will be discussed.

LICENSING

Using sealed sources in a Norwegian industrial practice requires a licence from the Norwegian radiation protection authority. The licensing procedures check if the applicant fulfils the formal requirement specified in the regulations for the application in question. Similar licensing is required also for the dealers involved. Generally, all regulations concerning the licensing of radiation sources in the industrial area require:

- a description of the responsible company (owner);
- identification of a responsible (authorized) radiation protection officer;
- procedures for educating/informing staff;
- a detailed description/identification of equipment, applicable equipment standards;
- a description of protective measures including personal dose control, if applicable;
- a description of emergency plans for accident/incidents, if applicable;
- procedures for the use, transport, repair and maintenance of equipment;
- reporting and notification to the authorities if licensed activities stop or if there are major interruptions;
- local administrative control;
- informing the authorities about changes;
- obligation to answer enquires from the authorities; and
- time limitation of licence validity, if applicable.

INDUSTRIAL GAUGES

The national inventory of industrial gauges is approximately 2300 registered, distributed among 300 industrial practices.

Many of these sources were licensed many years ago and the reporting from the users about changes in the status of these sources has not always been perfect. Thus, this is an area where the potential for orphan sources, i.e. sources out of administrative control, is rather large.

A project has recently been initiated to assess the status regarding administrative control of these sources in Norwegian industry. Questionnaires have been returned from the users with information on their equipment with integrated sealed sources.

So far, old datasets compared with the new information have shown that about 20 per cent of the sources are not accounted for. This high percentage is probably due to lacking notification and is expected to be considerably reduced when further information is gathered. The project is expected to yield better information regarding the number of this type of orphan sources in the Norwegian industry.

In addition to the licensing, registration and notification procedures, the NRPA perform some inspection activities where the fulfilment of the regulatory provisions is checked at the local premises. In this work, the question of orphan sources has high priority and if sources are missing, a lot of work is initiated by checking archives, conducting interviews, and other search activities.

Some incidents of loss during transport have been notified, but in most cases the items reappear somewhere after some time through active search by the parties involved.

Only a few accidents with industrial gauges have been reported, typically two to four per year. Usually these accidents occur during work inside tanks while the sources are in "open" position.

INDUSTRIAL RADIOGRAPHY

In the sector of industrial radiography there are about 200 radiography sources held by 135 licensed companies in Norway. The isotopes used are Ir-192, Se-75 or Co-60. Many of these companies operate in connection with the offshore oil activities.

Before a licence is issued to a company that wants to perform industrial radiography, the applicant must demonstrate a system of safe handling and storage of the sources. This system fulfils the minimum of control and safety of the sources described in the national regulations and requirements. These comprise administrative requirements, requirements of use and storage, and technical requirements of the equipment. There are also given requirements with regard to handling foreseeable accidents.

There is also an authorization system for persons using industrial radiography equipment. Each candidate must undergo, as a minimum, a one-week course in radiation protection for industrial radiography and pass a test before being given the opportunity to supervise in industrial radiography.

In recent years, the authorities have reduced the time of validity for the licence. So far, this seems to be an effective strategy for the enforcement of the regulations. The applicants seem to become more actively responsible in these matters, especially with regard to administrative control.

The maximum authorization period is now three years, whereafter the company has to reapply for a new licence. Reapplying means also giving an account of all radioactive sources held by the company. Also, the licensee is obliged to report immediately during the licence period if the company purchases a new source. The containers for industrial radiography sources must be type approved by NRPA. The maximum activity under each licence issued is respectively for Ir-192/1500GBq, Se-75/3000GBq and Co-60/400GBq. A national database is maintained for these radioactive sources.

In 1999, a total of seven accidents were reported in this field. So far, the question of orphan sources in industrial radiography does not seem to be a big issue in Norway, but the first theft of a radiography source was reported in 1999. After police investigations and news spread in media, some young boys found the container with the source intact.

LOGGING SOURCES

In Norway, oil production from offshore installations is a large industrial sector where radioactive sources are used for many purposes. Sealed sources are used to obtain important information about the oil wells, called “logging” activities.

For well logging, a total of 12 licences have been issued and, typically, big international companies are involved. As in the industrial radiography sector, the responsibility for the security and safety of the radioactive source rests with each company. To be issued a licence for well logging using radioactive sources, a company must show a system for control and safety of the sources. This system shall, as a minimum, include the national requirements. The maximum issued licence period is three years, where the applicant company must give an account of the number of sources to be used at the time they apply.

In 1999, nine incidents of sources stuck down-hole were reported. Of these, three incidents resulted in the abandonment of six sources. In six incidents, the radioactive sources were successfully recovered. A record of abandonment of radioactive sources in the Norwegian sector of the North Sea is kept under the supervision of the Norwegian Petroleum Directorate. If a logging source has to be abandoned, responsibility has to be taken by the Norwegian Petroleum Directorate and some requirements have to be fulfilled.

After many years with logging activities in the Norwegian offshore sector, the situation with respect to the administrative control for these sources is good.

CONCLUDING REMARKS

With regard to the new Act on radiation protection that has come into force in Norway, revision of existing regulations will be of high priority for all uses of radiation sources in the years to come. In this work, the issue of administrative control will be given much attention and high priority.

RADIATION SAFETY AND INVENTORY OF SEALED RADIATION SOURCES IN PAKISTAN

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Abstract. Sealed radiation sources (SRS) of various types and activities are widely used in industry, medicine, agriculture, research and teaching in Pakistan. The proper maintenance of records of SRS is mandatory for users/licensees. Since 1956, more than 2000 radiation sources of different isotopes having activities of Bq to TBq have been imported. Of these, several hundred sources have been disposed of and some have been exported/returned to the suppliers. To ensure the safety and security of the sources and to control and regulate the safe use of radiation sources in various disciplines, the Directorate of Nuclear Safety and Radiation Protection (DNSRP), the implementing arm of the regulatory authority in the country, has introduced a system for notifying, registering and licensing the use of all types of SRS. In order to update the inventory of SRS used throughout the country, the DNSRP has developed a database.

INTRODUCTION

Sealed Radiation Sources (SRS) of various types and activities are widely used in industry, medicine, agriculture, research and teaching in Pakistan. The proper maintenance of records of SRS is mandatory for users/licensees under the Pakistan Nuclear Safety and Radiation Protection (PNSRP) Regulations of 1990. No major incident has so far occurred; however, there is always a risk associated while handling any type of SRS. Loss of control of radiation sources may give rise to unplanned exposures of workers, patients and members of the public. In order to control and regulate the safe use of radiation sources in various disciplines, the Directorate of Nuclear Safety and Radiation Protection (DNSRP), the implementing arm of the regulatory authority in the country, has introduced a system for notifying, registering and licensing the use of all types of SRS. In order to update the inventory of SRS used throughout the country, the DNSRP has developed a database.

REGULATORY FRAMEWORK FOR THE USAGE OF RADIATION SOURCES IN PAKISTAN

The Government of Pakistan promulgated the Pakistan Nuclear Safety and Radiation Protection (PNSRP) Ordinance in 1984 [1]. The Ordinance prohibited all activities involving ionizing radiation except under license to be issued by the Pakistan Atomic Energy Commission (PAEC), investing authority in PAEC to append such conditions to licence, as it deemed necessary for enforcement.

Pursuant to the ordinance, PAEC constituted the Directorate of Nuclear Safety and Radiation Protection (DNSRP) in 1985 in order to formulate the Pakistan Nuclear Safety and Radiation Protection (PNSRP) Regulations and implement them thereafter. The Regulations were prepared and gazette notified in 1990 [2]. To make the regulatory body more independent and distinct from PAEC, the Pakistan Nuclear Regulatory Board (PNRB) was created in 1994 [3].

The Organizational setup of the Board is shown in Figure 1.

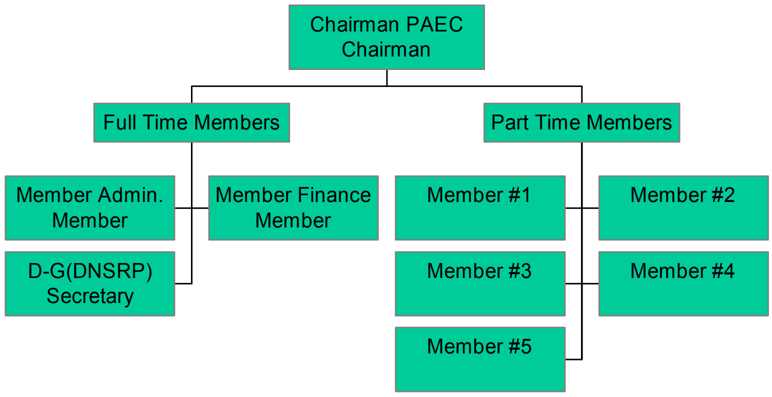

Fig 1. Organization structure of PNRB.

IMPLEMENTING THE REGULATIONS

Pursuant to the PNSRP Regulations, a system has been developed for the implementation of these regulations. Salient features of this system are discussed in this paper.

MODE OF NOTIFICATION

The first step in the implementation process is to communicate the regulatory requirements to the users of radiation sources. In Pakistan, the official mode of communicating the regulations passed by the Government, or any amendments made therein, is the Gazette of Pakistan. The PNSRP Regulations were gazette notified on September 12, 1990. Subsequently any amendments that are made are notified in the official gazette.

REGISTRATION OF PREMISES FOR INSTALLATION OR STORAGE OF RADIATION SOURCES

According to the PNSRP Regulations, any premises in which radiation sources/apparatus, radioactive material are to be stored or installed require registration. On receiving application by the owner, the DNSRP:

a) gets plans, maps, blueprints, and statement of type, capacity, description, quality and quantity of the proposed radiation source/apparatus of radioactive material;
b) checks the suitability of the site and gets the feasibility and preliminary assessment reports;

The DNSRP registers the premises if it is satisfied that they meet the safety requirements.

LICENSING OF PREMISES USED FOR RADIATION SOURCES

After registration, any person or firm desirous of obtaining a license for radiation sources is required to apply to the DNSRP. The applicant has to provide all relevant information to establish that the purpose for which license is required is not hazardous to workers or the public.

After considering all the aspects relating to safety and security of radiation sources, the DNSRP — if satisfied — issues a license for a specified period, purpose and terms and conditions.

NO OBJECTION CERTIFICATE FOR IMPORT/EXPORT OF RADIATION SOURCES

Pursuant to the PNSRP Ordinance, the policy on import/export of radioactive materials/apparatus was gazette notified on July 17, 1993 [4]. According to this, any person desirous of importing or exporting radiation sources, radioactive material, or radiation apparatus must apply to DNSRP to obtain a No Objection Certificate (NOC). The DNSRP may ask the applicant to fulfil such requirements as it may deem necessary under the safety standards laid down in these regulations.

INSPECTION OF RADIATION SOURCES

A regulatory inspection of every licensee is performed at the time of licensing, followed by annual inspections on a routine basis. In addition to these routine inspections, additional inspections may also be performed whenever needed.

ENFORCEMENT AND IMPLEMENTATION OF REGULATIONS

The DNSRP has established a Regulations Enforcement Division, which works in co-ordination with the Regional Radiation Protection Inspectorate of the DNSRP and keeps a check on the activities of licensees. If the licensee violates any provision of the PNSRP Regulations or Ordinance or any of the terms and conditions of the license, DNSRP may order immediate stoppage of work, or order any other such action as may be necessary to stop, minimize or check the increase in level of radiation.

MANAGEMENT OF DISUSED SOURCES

According to the National Policy on Management of Sealed Radiation Sources (SRS) [5], SRS with a half-life greater than one year and initial activity of 100 GBq or more should be purchased by the users/importers with the undertaking from the manufacturer/supplier, to accept the return of these sources when no longer useful for the intended purpose. This condition shall be included in the purchase contract as binding to the supplier. Without the inclusion of this condition, an NOC will not be issued by DNSRP.

The policy also provides guidelines for the disposal of disused sources that have already been acquired without the condition of returning to the vendor being incorporated in the purchase contract. These sources may be transported within Pakistan only with prior information to DNSRP. Special arrangements have been made for disposing of such sources at two sites where pits have been constructed for this purpose, namely at KANUPP for users in Sindh and Balochistan provinces, and at PINSTECH for users in Punjab province, NWFP and Capital Territory.

EMERGENCY PREPAREDNESS

The guidelines on emergency preparedness [6] require all licensees/users of radiation and nuclear facilities to ensure that emergency plans and procedures are prepared and properly maintained. Furthermore, the national regulatory body and its regional inspectorates ensure that an effective emergency preparedness and response capability together with sufficient infrastructure exists at all radiation and nuclear facilities.

The primary responsibility of an accident lies with the licensee/user, who is required to prevent an accident the first place or to reduce the release of radioactive materials, and prevent exposure of workers and of members of general public. The licensee/user is also responsible to inform the regulatory body immediately.

The regional inspectorates will also inform the duty officer at the National Radiation Emergency Coordination Center (NRECC) at the DNSRP. The DNSRP is the National Contact Point under the International Conventions on Early Notification of Nuclear Accident and Assistance in the Case of Nuclear Accident or Radiological Emergency.

RECOVERY OF ORPHAN SOURCES

The matter of safety and security of radiation sources is given utmost importance at the DNSRP. The owners of radiation sources are recommended to ensure safe custody by keeping the sources under lock and key and maintaining movement registers for their location. However, if in — spite of all efforts — a radioactive source is lost, the licensee is required to inform the DNSRP immediately.

Considering the gravity of this issue, the PNSRP Regulations address the loss of radioactive material in a special clause. According to the regulations, when a radioactive source is lost, the DNSRP may direct the owner to submit a report pertaining to the circumstances of the loss or theft along with any remedial action taken or proposed to be taken in this regard. The DNSRP may also direct such other action to be taken that seems necessary to minimize the consequences.

EDUCATION AND TRAINING IN THE SAFETY OF RADIATION SOURCES AND SECURITY OF RADIOACTIVE MATERIAL

Under its public awareness programme, the DNSRP/RRPI officers deliver lectures on radiation safety at various educational institutions, medical centres etc. Also, elaborate training programmes are organized in collaboration with the teaching institute of PAEC, i.e. the Pakistan Institute of Engineering and Applied Sciences (former Centre for Nuclear Studies). In addition, a brochure “Living With Radiation” and display charts have been printed and distributed to the users of radiation.

BRIEF DESCRIPTION OF USES OF SRS

The uses of SRS in medicine, industry, research and teaching are varied. They may be categorized under the following principal techniques:

i. Irradiation
ii. Industrial radiography
iii. Gauging
iv. Miscellaneous

Each of the techniques involving the use of SRS is briefly described in the following sections.

IRRADIATION TECHNIQUES

The specific applications are:-

- Radiation beam therapy (teletherapy)
- Brachytherapy
- Radiation sterilization of medical products.
- Food preservation on experimental basis.

Teletherapy and brachytherapy

About 20 institutes and centres in the Government and private sectors use teletherapy and brachytherapy techniques for the treatment of a wide range of cancers, from superficial skin cancers to deep seated tumors. Sources used are Co-60 and Cs-137 for teletherapy and Co-60, Cs-137, Sr-90 and Ir-192 for brachytherapy.

Radiation sterilization

A commercial irradiation plant using a Co-60 source is operational for radiation sterilization of medical products like disposable syringes, operation theatre accessories, bandages and some types of ointments.

Food preservation

Presently, three agriculture research institutes in Pakistan are using pilot scale food irradiation plants with Co-60 and Cs-137 sources on an experimental basis for the preservation of a variety of foods and improvement in the technological properties of foods.

INDUSTRIAL RADIOGRAPHY TECHNIQUES

The specific applications include industrial gamma radiography, using non-destructive testing (NDT). Several firms in the public and private sectors use this technique. The major sources used are Co-60 and Ir-192.

GAUGING TECHNIQUES

A number of government and private industries and firms use the following types of gauges

- Transmission (beta and photon)
- Beta and gamma backscatter
- Photon level
- Gamma scattering
- Thermalization of neutrons

These gauges are used for thickness measurements, monitoring of bulk flow of material, process control of the contents of large vessels, measurement of soil density and moisture etc. Beta and gamma sources used are Pm-147, Kr-85, Tl-204, Sr-90, Y-90, Am-241, Cs-137 and Co-60; neutron sources used are ^{241}Am-Be and Cf-252.

MISCELLANEOUS TECHNIQUES

The specific applications include:

- Smoke detectors and lightning warning systems
- Research
- Calibration

Some industrial premises such as factories, mills and hotels. use smoke detectors and lightning warning systems. Sources used are Am-241 and Pu-239. The calibration sources are most commonly used for checking various types of detectors and radiation monitors. Sources used are Co-60, Cs-137, Ra-226 and Sr-90 etc. A number of organizations use various types of SRS for research purposes.

DATA BASE OF SRS USED FOR DIFFERENT PURPOSES

The DNSRP has developed a database for compiling information received from various users/licensees of SRS in the country. In the database, SRS have been further categorized into the following nine groups:

i. Brachytherapy
ii. Radiotherapy
iii. Irradiation
iv. Industrial radiography
v. Nuclear gauging
vi. Research
vii. Calibration
viii. Well logging
ix. Smoke detection and other consumer products

These denote the major purposes for which SRS are used in a number of public and private establishments. SRS used for a particular purpose can be easily retrieved from the databank. Under “smoke detectors” (consumer products using SRS), representative data of only few sources have been entered because we have not formally registered them as SRS in our data bank record. In future, if required, the data for this purpose may be further updated.

SECURITY AND ACCOUNTANCY

According to the recommendations of the IAEA (IAEA Safety Series-115, 1996), the regulatory authority shall have the powers for verification and inspection of sources and practices to ensure compliance with the regulations and conditions imposed on the licensee. Under the PNSRP Regulations of 1990, the licensees (i.e. owners/users) are responsible for the security of SRS. The licensees are required to ensure that all devices or sources are adequately marked to indicate radioactive material and must maintain a safe and secure storage location such that the people in nearby accessible areas are not inadvertently exposed. Also it is unlikely that the sources could be removed, transported or disposed of by unauthorized persons. It has also been made mandatory that the licensees shall maintain an inventory of the sources under their control and shall submit it to the DNSRP in such form and containing such particulars and information as required by the Director-General of the DNSRP.

COMPILATION OF DATA

The users/licensees are required to submit the inventory of SRS in their possession on the prescribed forms (Import and Export/Disposal) on an annual basis in order to the records. The data received from the licenses/users is added to the user's databank record.

This data is further verified through physical survey of the sites of licensees, and by checking documents during regulatory inspections of the premises.

The following types of reports may be obtained from the databank:

i. Import summary of individual SRS.
ii. SRS which have been disposed of or exported.
iii Distribution according to purpose and activity and related details.
iv. Annual status of SRS imported along with activity.
v. One year profile along with other details.
vi. Details of individual SRS.

Provision has been made in the database for tracing any type of SRS using a search program and inserting the identification number provided by the user/licencee. Also a search for a particular SRS by activity and purpose is available in the program. There are provisions for addition, deletion and editing of data of any type.

CONCLUSION

The DNSRP has been maintaining data on SRS for the past ten years. However, the centralized inventory was not updated till 1994. Since then, the DNSRP has been making continuous efforts to maintain an updated record of various types of SRS imported and installed by different Government and private users in the country. It has been observed that some of the users/licensees do not maintain the records of SRS in their possession in a format as required by the DNSRP, or provide information such as identification number, date of import, and activity of the SRS. About 95% of sources used in various disciplines with activities from few Bq to PBq are registered in the database. Moreover, almost all of the major sources have been physically verified by radiation protection inspectors of DNSRP and regional inspectorates. More efforts are being made for the maintenance of records by the licensees in accordance with the provisions of the PNSRP Regulations 1990.

The safety and security of radiation sources is given utmost importance in Pakistan. A sound regulatory infrastructure is available, which provides for checks at the various stages, right from the import of sources till their disposal. Clear guidelines have been provided for all major aspects, including acquisition, storage, transportation, emergency preparedness, dealing with loss, and disposal of radiation sources.

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CONTROL OF SEALED RADIOACTIVE SOURCES IN PERU

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Abstract. The paper describes the inventory of radioactive sources in Peru and assesses the control. Three groups of source conditions are established: controlled sources, known sources, and lost and orphan sources. The potential risk, described as not significant, for producing accidents is established and the needed measures are discussed. The paper concludes that, while the control on sealed sources is good, there is still room for improvement.

INTRODUCTION

The radioactive sources in Peru have been under control for 20 years in a formal inventory. This first inventory was concluded in two years, and was performed on the radioactive sources currently being used in that time. The other radioactive sources possibly used beforehand were not included because they were no longer sued or because the users were not found and the radioactive sources were abandoned.

In order to know the real quantities, several information sources were used, such as importation enterprises, past documentation or even historical references.

MEASURES TO PERFORM AND UPDATE THE SOURCE INVENTORY

The information which has been used comes from several combined sources.

The first information came from data supplied by importing enterprises which sold equipment and radioactive sources. These enterprises had operated since before regulatory measures were implemented but many of them had disappeared so it was not possible to have complete information at the beginning.

Another data source has been old documents collected by the former agency for atomic energy where information coming from 30 years ago was found. This information had been previously classified.

Industries and other organizations where radioactive sources were possibly used were reviewed. Radioactive sources and equipment possibly used in mining companies (weight and density gauges), manufacturing companies (thickness gauges, static eliminators, etc.), and oil service companies (well logging sources) were searched for.

Finally, inspections formally established since 1980 have allowed continual searching for and updating of the inventory.

APPRAISING THE SITUATION

The inventory has been put on a database where radioactive sources are categorized by use and condition. In the database, the radioactive sources are described as sources for specific use, spent sources, not found sources and lost sources.

The current inventory contains 1254 radioactive sealed sources in all practices shown in Table 1. The radioactive sources with higher activity comprise nearly 13% of the total. It is estimated that the total activity in Peru ranges up to 10 PBq.

Table 1. Percentage distribution of sealed radioactive sources

PRACTICE / CONDITION	SPECIFIC USES	PERCENTAGE CONTRIBUTION
Medicine	Teletherapy, brachytherapy, etc.	31.0%
Industry	Irradiators, nuclear gauges, industrial gammagraphy, etc.	43.4%
Teaching and research	Teaching, research, calibration, etc.	7.3%
Spent	Temporaly or final source disposal	16.6%
Not found, or lost.	Several	1.7%

TOTAL SOURCES: 1254

In the inventory, ^{226}Ra sources are in the greatest quantity, which means the problem of their future disposal has to be solved. The other significant sources are ^{137}Cs and ^{241}Am sources. The distribution is shown in Table 2.

The inventory also includes the radioactive sources which used to be under control but now are not accounted for or are lost, and amount to 1.7% of the total.

Table 2. Percentage distribution of sealed sources by radioisotope

RADIOISOTOPE	PERCENTAGE
^{226} Ra	39%
^{137} Cs	30%
^{241} Am-Be	8.6%
^{60} Co	6.2%
^{241} Am	5.8%
^{192} Ir	5.3%
^{90} Sr	2.4%
Others	2.7%

With regard to the strength of the radioactive sources, those of ^{60}Co are of the most relevancy and associated with operating irradiators and teletherapy units. This radioactive source is the main contributor to the total activity currently in the country. The total activity of ^{60}Co radioactive sources comes to almost 87.7%.

Other radioactive sources not included in the inventory are radioactive lightning rods. These devices were not under control – they were considered consumer products – and are installed at several sites countrywide. The accurate inventory is not known but it has been estimated that 1500 devices are installed, containing basically ^{241}Am (45 MBq per device), which means nearly 68 GBq as total. Radioactive lightning rods have not yet been specifically prohibited in the country but currently a comparative study is being carried out in order to make a decision about continuing or stopping this practice.

Also, it is almost certain that other radioactive sources (orphan sources) may exist in the country, about which condition and location is not known. These radioactive sources would be contained inside old nuclear gauges, without signals or marks. To date, no any incident or accident with this kind of source has been reported. Just two radioactive sources have been found inside their equipment and in safe condition in an old mine and in an old manufacturing plant. These sources were sent to the radioactive waste plant.

The other radioactive sources are those located in the radioactive waste plant in the Nuclear Centre, where they remain safely stored with provisions for future final disposal.

CONTROL AND CURRENT RISK

Practices with radioactive sources are under the control and supervision of the national authority. The extent of the control measures depends on the risk relevancy to safety and health. The regulatory authority has established a system of authorization and inspection for all radiation sources. Authorization differences are established for non-relevant and relevant installations. Those deemed relevant must be licensed whereas non-relevant practices just need registration. The radioactive sources used in teletherapy, industrial gammagraphy, brachytherapy, well logging, industrial irradiation, or waste management require a licence. These relevant installations have to demonstrate that the safety and protection provisions fulfil the regulations and that appropriate preparedness for emergency situations is well established.

The inspections are performed on a routine basis, the frequency according to the kind of installation under control. The installations with higher relevancy of risk are inspected once a year as a minimum while other installations need to be verified once every two or three years. Currently, this scheduling is under revision in order to increase the frequency for inspecting such practices as industrial gammagraphy and brachytherapy. It is expected that more continuous and prevailing inspections will persuade the user to adhere to the rules and license conditions strictly.

With regard to lost or orphan sources, the control system makes estimations about possible accidental scenarios affecting the public, property and the environment. It is assumed that the radioactive source most likely to cause an accident would be a ^{137}Cs source with an activity of 700 GBq — an abandoned nuclear gauge — which may cause moderate doses to the public and restricted damage to property and the environment.

CONCLUSIONS AND REMARKS

The current control on sealed radioactive sources is quite good but some improvements need to be made, especially in the tracking of sources under control. The loss of radioactive sources can be reduced but it is unavoidable. The users need to improve their awareness of the risk and of their responsibility for keeping it reasonably low.

The orphan source problem is not an easy one to solve even though the quantity of discovered sources is small. Working is being done to establish appropriate co-ordination with the national police and customs authorities.

Finally, it may be concluded that the risk which may arise from radioactive sources in Peru is reasonably low but measures must remain permanently in place to ensure this condition.

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REGULATORY CONTROL AND MANAGEMENT OF RADIOACTIVE MATERIALS IN THE PHILIPPINES

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Abstract. The Philippine Nuclear Research Institute (PNRI) by virtue of Republic Act 2067, as amended, Republic Act 5207 and Executive Order 128 (1987), was mandated to promote, advance and regulate the safe and peaceful applications of nuclear science and technology in the Philippines. The PNRI was formerly the Philippine Atomic Energy Commission, established in 1958. This report aims to share the information and experience of PNRI as a regulatory authority on the administrative, technical and managerial aspects to ensure the safety and security of radioactive material in the country. It describes the country's regulatory framework, operational experiences, international co-operation including reporting system and database, and radiological safety assessment and compliance monitoring. It also briefly discusses the current development of the country's radiological emergency response plan and the radiation protection services offered by the PNRI. In the discussion and recommendations, some of the results of the regulatory information conferences conducted with the end-users are enumerated.

INTRODUCTION

The Philippine regulatory programmes concerning radioisotopes and nuclear materials are based on two Republic Acts dating back to 1958 and 1968 and on related Executive Orders. These laws have mandated the Philippine Nuclear Research Institute (PNRI) as the sole Government agency to advance and regulate the safe and peaceful applications of nuclear science and technology.

At present, the country has a stable national infrastructure of radiation protection with an applicable system for the control and security of radioactive materials. This report describes the country's regulatory status, regulatory body structure, control mechanisms to ensure security, international co-operation, radioactive material inventory process, radiological safety assessment and compliance monitoring. It also covers the country's status in responding to radiological emergencies and its capabilities to provide radiation protection services to the users of radioactive materials.

The results of regulatory conferences conducted with the end-users and licensees a few years back are enumerated in the discussion and recommendations.

NATIONAL LEGAL FRAMEWORK

Republic Act 2067, also known as the "Science Act of 1958", amended by Republic Act 3589, created the Philippine Atomic Energy Commission and provided for the licensing of the importation, acquisition, ownership, possession, and use of radioactive material in the country. Republic Act 5207, also known as the "Atomic Energy Regulatory and Liability Act of 1968", as amended, set forth the basis for the promulgation of rules and procedures pertinent to the issuance of licences for the construction and operation of nuclear power plants and nuclear energy materials.

In January 1, 1987, Executive Order No. 128 (Series of 1987) reorganized the PAEC into the Philippine Nuclear Research Institute (PNRI) headed by a director and deputy director under the Department of Science and Technology (DOST). The order maintained for the PNRI the mandate from Republic Act 2067, as amended, and 5207 as the regulatory authority for atomic and nuclear energy materials, facilities and other related activities. Hence, the PNRI has remained the sole Government agency responsible for regulating and licensing radioactive materials and atomic energy facilities in the Philippine to ensure that they do not pose undue risks and to safeguard the health and safety of the users and the general public.

REGULATORY STRUCTURE

The PNRI under the DOST is composed of four divisions: Finance and Administrative Division (FAD); Nuclear Regulations Licensing and Safeguards Division (NRLSD); Nuclear Services and Training Division (NSTD); and the Atomic Research Division (ARD). An organizational chart of PNRI illustrated in [1].

NRLSD is the regulatory arm of PNRI. The NRLSD, headed by a Division Chief, is charged with the responsibility of implementing the regulatory functions of the institute. It is composed of five sections with corresponding functions:

1. The Standards Development Section (SDS) develops criteria, rules and regulations, guides and bulletins for the licensing and regulation of radioactive material;
2. The Licensing, Review and Evaluation Section (LRES) evaluates applications for licences.
3. The Inspection and Enforcement Section (IES) verifies and monitors the compliance of licensees to applicable regulations, licence specific conditions and various licensees' commitments.
4. The Safeguards Section (SS) conducts special nuclear material accounting and implements the safeguards agreement with the International Atomic Energy Agency, under the Non-Proliferation Treaty.
5. The Radiological Impact Assessment Section (RIAS) undertakes studies on radiological and environmental impact of the use/application of radioactive material, and develops radiological emergency plans.

The above-mentioned functions showed that each section of NRLSD has its own concern regarding radiation safety but they must all be co-ordinated to attain this common goal. The radiation safety programme as applied in all fields of use is being evaluated by the LRES as a requirement for the issuance of the licence. The IES verifies and monitors the licensees' compliance with the PNRI's licensing requirements and conditions specified in a radioactive material licence.

The PNRI has established radioactive material licensing procedure [1] and compliance monitoring [9]; however, the concept of notification, authorization and registration are still being developed.

The NRLSD is currently composed of 32 personnel, 19 of whom are registered engineers.

CODE OF PNRI REGULATIONS (CPR)

The Code of PNRI Regulations consists of all the rules and regulations promulgated by the PAEC (PNRI). These CPRs are published in the Philippine Official Gazette [2] and form the legal basis of licensing and regulating radioactive materials.

INFORMATION BULLETINS

The SDS likewise, develops and issues information bulletins regarding recent regulatory incidents to alert licensees to additional controls, etc. of similar procedure applicable to their operations.

CONTROL AND MANAGEMENT OF RADIOACTIVE MATERIALS

The regulatory control and security of radioactive materials are achieved by issuing licences and by requiring the submission of quarterly and/or annual reports on the use of radioactive materials as specified in the licence. Before issuing a licence, the NRLSD-PNRI requires sufficient information to demonstrate that the required training and experience of users, qualification of the radiological health and safety officer (RHSO), design of the equipment and the facility, and protocols and procedures will be met and maintained, and that any waste will be properly disposed of according to the regulations. The licence with specific conditions and Code of PNRI regulation (CPR) and the licensee's commitments in his application is the reference for the regulatory inspectors in their annual compliance monitoring.

REGULATORY OPERATIONAL EXPERIENCE

With 40 years of regulatory experience, several recent related materials [3–8] have been published or are in the draft stage with objectives similar to those of this conference, i.e to disseminate information and share our radioactive material regulatory experience.

INTERNATIONAL CO-OPERATION, REPORTING SYSTEM AND DATABASE

The Philippines became one of the early members of the IAEA in 1959 and a signatory to Non-Proliferation Treaty in 1972. The PNRI was also one of the original members of the Regional Co-operative Agreement (RCA) for Asia and the Pacific. Aside from these international linkages, the PNRI has also entered into bilateral agreements with some institutions that are also concerned in radiation safety.

In order to monitor the movement of radioactive materials in the country, the NRLSD has developed several reporting schemes such as the submission of annual report on the use of radioactive materials attached to the annual request to renew the radioactive material licence, a quarterly report on the lease/sale/transfer of radioactive material and the issuance of release certificate before imported radioactive material can be released from the Bureau of Customs. A memorandum of agreement was signed with the Bureau of Customs to help PNRI in monitoring and controlling the inflow of radioactive materials into the country. The LRES has a computerized data base file of all licensees in the country including the specifications of the radioactive material and equipment under licence and the personnel being authorized to use the said material.

The PNRI has availed itself of the national registry of radiation sources computerized program developed by the IAEA. The data are maintained by our Safeguards Section which is also responsible in the implementation of the safeguards agreement.

Recently, the LRES has come up with the comprehensive inventory of all radiographic exposure devices (indicating its operational status) and the "orphan" or uncontrolled radioactive sources in the country. The reports are now with the Division Chief for further action.

COMPLIANCE MONITORING AND RADIOLOGICAL SAFETY ASSESSMENT

Compliance monitoring is carried out by our IES. An annual inspection of the facility is being carried on all licensed facilities. The inspectors follow the procedures written in the PNRI regulatory inspector's manual [9]. A PNRI official inspection report is sent to the licensee following inspection, indicating whether the licensee has complied or not with the relative CPRs, licence's specific conditions and their commitments. Twenty-five calendar days are allowed licensees to rectify any non-compliance found during the inspection. A notice of violations (NOV) is sent to a licensee with serious non-compliance.

The RIAS has published several research results of their radiological safety assessment on the use of radioactive material [10, 11]. These research results aid the formulation of the CPR.

RADIATION PROTECTION SERVICES

As sole institution in the country with expertise in nuclear science and technology, the PNRI is the only facility that provides complete radiation protection services to the licensed users of radioactive material. It provides a dosimetry system, public exposure control and monitoring, calibration and quality assurance of radiation detection instruments, calibration and quality assurance of teletheraphy and brachytheraphy machines, leak testing of radioactive sealed sources, decontamination, decommissioning and management of radioactive waste and disused radioactive materials.

With these services being offered by the PNRI, the NRLSD can constantly monitor the status of licensed radioactive material.

RADIOLOGICAL EMERGENCY RESPONSE

The PNRI has already come up with a written "National Radiological Emergency Preparedness and Response Plan", which covers any radiological emergency that has or is expected to have a significant radiological effect within the Philippines and its territorial waters and which requires a response by several Government organizations. It also includes emergencies occurring at fixed nuclear facilities, field activities, or during the transportation of radioactive materials and accidents occurring outside the Philippines but which have a significant impact on the country [12]. Emergencies or hazards from lost, missing or stolen radiation sources are also covered by this plan.

DISCUSSION AND RECOMMENDATIONS

The PNRI initiated various nuclear regulatory conferences with its licensees in 1995 and 1996 [13]. The purpose of these conferences was mainly to reach a common understanding of the provisions of the code of PNRI regulations (CPR) and to foster openness between the PNRI and the licensees. The following general and specific issues and concerns were raised during the conferences: accreditation of professional organizations to certify the qualifications of personnel to be authorized in handling and using radioactive material, delayed issuance of license resulting in expired licences or unauthorized use of radioactive material, PNRI issuance of transport certificates, standardized calibration of radiation related equipment or machines and the use of radium sources.

In order to have a more effective and efficient regulatory control and management of radioactive material, we need the co-operation and commitment of the licensees. It must be well emphasize to them that the principal responsibility for the security and safety of radioactive materials lies on their hands and the regulatory authorities are established to assist and guide them and monitor their compliance with the regulations.

It is highly recommended to regularly conduct regulatory conferences involving all concerned organizations and licensees. Through these meetings, we can emphasize the importance of the following factors relative to the safety and security of radioactive material: specialized training, institutionalizing safety culture within the organizations, delineation of responsibilities within an organization, maintenance of records and reports relative to the use and transport of radioactive materials, legal and proper disposal of disused radioactive sources, and the role of other Government agencies.

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SAFETY OF RADIOACTIVE SOURCES IN PORTUGAL

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Abstract. The safety of radioactive sealed sources is assured in Portugal through a control system with a main goal of prevention of lost of control and inappropriate waste. The legal tools of the regulatory system are: authorization to use, keep, transfer or transport; a deposit of money as a guarantee; civil liability insurance; periodical information. The competent authority shall keep a national inventory of sealed sources. About 50% of the new sources authorized in 1999 were to be used in medical brachytherapy and industrial radiography. The radionuclide Ir-192 contributed with 99.6 % to the total amount of activity. The control system implemented in the country appears to be effective for activities over some GBq but quite ineffective for lower activities. It is supposed that the law will be revised in the near future to increase the effectiveness of the sealed source control system.

INTRODUCTION

In Portugal, all users of ionizing radiation and radioactive materials must obtain an authorization (1) from the competent authority — the General Directorate of Health. Besides this authorization for the practice, other authorizations are required to keep, use, or transfer radioactive sealed sources. Those additional authorizations are obtained from a different authority — the Technological and Nuclear Institute on behalf of General Directorate of the Environment.

The objective of the additional authorizations is the prevention of loss of control, inappropriate storage or waste, and the prevention of incidents and accidents with orphan sources.

REGULATORY CONTROL

Radioactive sealed sources shall be under regulatory control according with Decree-Law No.153/96 (2) that establishes:

- *Authorization* is required for all sealed sources, not classified as exempted, to be received, used (if practice have been previously licensed), kept, transferred or transported;
- *Guarantee* in the form of a certain amount of money should be deposited in an account of the competent authority. The deposit is refunded when the source ownership is transferred.
- *Civil liability* should be covered by an insurance company to provide financial protection against damage resulting from any incident or accident with loss of life, personal injury or loss of or damage of property or any other economic loss;
- *Emergency planning* should be prepared by sealed source owner and approved by the competent authority whenever the activity exceeds 1 TBq;
- *A periodical report* should be completed yearly and sent to the competent authority, to update information concerning use, location, and individual responsible for the source, and to confirm validity of the insurance.

The applicant for any authorization should give the following information: identification and address of the applicant; sealed source nominal activity and isotope; source purchaser; identification and address of the future owner; address of the place where the sealed source will be used; identification and address of the person that will be responsible for the source; number of the authorization for a practice under which the source will be used.

The owner of a sealed source must guarantee that it will be under control for the entire time that the source is to be used or kept. The guarantee consists of a deposit of money, in the amount of 10 % of the cost of the sealed source, in an account of the licensing authority. This deposit will be refunded when the source ownership is transferred. When the source is transferred, or no more usable or in use, a refund can be requested if it can be proved that the source has been sent back to the purchaser or sent to an official centre of radioactive waste management. This legal requirement is not applied to public service establishments.

Besides that guarantee, the owner of a sealed source is always responsible for any event related to the source with deleterious consequences to the environment or to individuals, even when the source is used, kept or transported, according to the conditions stated in the licence issued by the competent authority. It is compulsory for the owner to transfer of its civil liability to an insurance company through a contract when the source activity exceeds 1 GBq. The values covered by that insurance contract are approximately the following: 100 000 € (1 euro = 0.883 USD) for activities between 1 and 10 GBq; 250 000 € for activities between 10 GBq and 1 TBq; 500 000 € for activities exceeding 1 TBq.

The applicant for a licence should prepare emergency planning for abnormal events — incidents or accidents — when the source activity exceeds 1TBq. These plans should be attached to the licence application.

ROLE OF THE COMPETENT AUTHORITY

The main role of the competent authority is the prevention of loss of control, inappropriate waste, and incidents and accidents with orphan sources.
The tools available are: *authorization*, issued if the source is to be used in a licensed practice and if safety conditions will be assured; retention of a *deposit of money* for any sealed source; *inventory* of sealed sources in the country; *inspection*.

The inventory of sealed sources in the country can be carried out by using the registries of sources authorized and sources sent to waste or to permanent storage. Besides using those registries, the competent authority could use the information on sealed sources sent annually by their owners to update the inventory.

In 1999 the number of authorizations issued for new sealed sources (imported sources) was 84. About 50% of the new sources were used in medical brachytherapy and industrial radiography. The radionuclide Ir-192 contributed with 99.6 % to the total amount of activity.

CONCLUSION

The legislation to control radioactive sealed sources will be revised in the near future because it has been recognized that its efficacy is good for high activity sources (> some GBq), but for sources with medium and low activity, the efficacy is poor. It is supposed that this situation is due to complexity of the legal requirements and to lack of inspection.

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SAFETY OF RADIATION SOURCES AND SECURITY OF RADIOACTIVE MATERIALS. A ROMANIAN APPROACH

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Abstract. After a brief explanation on the scope of applications of nuclear energy and practices with ionizing radiation in Romania, the report explains the current national infrastructure for radiation safety making reference in particular to the National Commission for Nuclear Activities Control as the regulatory authority for the safety of radiation sources. The report also describes the existing legal framework, provides information on the list of normative acts in force, and on the system of authorization, inspection and enforcement, which operates effectively.

INTRODUCTION

In the seventies, Romania began an ambitious programme of building nuclear power plants. In order to support this programme, in 1969, a centralized State Committee for Nuclear Energy (CSEN) was created. This committee covered both development, and regulation and control. In the nineties, through successive reorganizations, a new structure for the regulation and control branch was achieved, composed of 10 people. A strong legal basis had been created for regulation at the beginning of eighties, namely, Law 61/1974 and a set of norms for working with radiation sources. This legislation covered radiation protection (in accordance with ICRP 9), transport (in accordance with SST no. 6/1973), and physical protection (in accordance with INFCIRC/225/rev.2) All applications of ionizing radiation, including medical X-ray devices, came under CSEN authorization and control competence.

At the beginning of 1990, after the Romanian political regime changed, an independent structure for the regulation, authorization and control of nuclear activities, the National Commission for Nuclear Activities Control (CNCAN) was set up. After one year, this structure was included as a department of the Ministry of Environment. In 1998, by modification of Law 111/1996, CNCAN became an independent body directly responsible to the Government.

TOPIC DIMENSIONS

In Romania there are all types of civil applications of radiation sources and radioactive material use. There are about 2500 legal persons, spread over the whole Romanian territory that are engaged in nuclear activities, which require authorization and control in accordance with the provisions of law. This includes nuclear power plants (one unit), research reactors (two units), subcritical assemblies, entities of the nuclear fuel cycle (mines, preparation plants, fuel plant), particle accelerators (research, medical, or industrial), irradiators used in research or industry, radioactive unsealed and sealed source producers, facilities for conditioning radioactive waste (two units), a national deposit for low level waste, sealed high activity sources used in oncology treatment, unsealed sources used in diagnosis, X-ray generators used in radiology (about 5000 facilities), sealed sources and generators used in non-destructive testing, sealed sources used in geological prospecting (logging), many low activity sources used in research, education or control and determination of physical parameters in industrial processes. Many devices with low activity radiation sources (e.g. fire detectors, radioluminescent indicators) are excepted from the authorization process.

Table 1 show numbers of significant radiation sources (with an activity higher than 3.7 GBq). Table 2 shows their distribution depending on the application type.

Table 1. Number of sealed radiation sources in use

Radionuclide	3,7GBq<Activity<3,7TBq	Activity>3,7TBq
^{60}Co	80	240
^{192}Ir	450	-
^{137}Cs	20	2
Ra-Be, Am-Be	60	-
^{241}Am	20	-

Table 2. Distribution by practice

Practice	Radionuclide				
	^{60}Co	^{192}Ir	^{137}Cs	Ra-Be, Am-Be	^{241}Am
Irradiators	6	-	2	-	-
Therapy	40	150	-	-	-
Gammagraphy	14	300	2	-	-
Other	-	-	16	60	20

NATIONAL INFRASTRUCTURE

The responsibilities for radiological safety and physical protection of radioactive materials are divided between many State bodies. The national regulatory authority has the main responsibility, the co-ordination and integration roles. Also, the Ministry of Health has been assigned important legal responsibilities. It authorizes the introduction of products that have been subject to irradiation or which contain radioactive materials, and the introduction for medical treatment and diagnosis purposes of radiation sources and of pharmaceutical products containing radioactive materials. The Ministry of Health has to organize the surveillance of contamination with radioactive materials of food, of drinking water and other goods destined to be used by the population. The Ministry of Health is also responsible for the surveillance of the health condition of personnel professionally exposed to radiation and of the hygiene conditions in units in which radiation sources are used. The Ministry of National Defence leads the co-ordination of intervention preparedness in the case of a nuclear accident. The Ministry of the Interior is in charge of physical protection issues and the Ministry of Finance through the General Direction of Customs develops the control of entrance in Romania of the radiation sources.

National regulatory authority

The national competent authority in the nuclear domain is CNCAN. This authority exercises regulation, authorization and control as an independent body directly repsonsible to the Government. CNCAN has its own budget and collects taxes for the authorization activity from which a quota, established by the Government, is used by CNCAN to cover part of its expenses. CNCAN is organized as a governmental agency led by a president, with the rank of State Secretary, named by the Prime Minister. In accordance with its functioning and organizing regulation approved by Government decision, CNCAN informs the Government about its activities twice a year. Figure 1 presents the organizational structure; CNCAN has 306 positions, the radiological safety division having 33 positions (this division's domain covers all radiation sources except the nuclear fuel cycle). From these 33, eight positions have inspection attributions only and they are spread throughout the country.

Legal framework

To set up a nuclear legal framework, a legislative pyramid was created that is headed by a law adopted by the Romanian Parliament. At the next level there are the regulations issued by the national competent authority in the nuclear domain and the other authorities established by law. These regulations were approved by the head of the competent authority, are published in Romania's official bulletin and are compulsory. The competent authority has the right to issue guides and instructions for the regulation application.

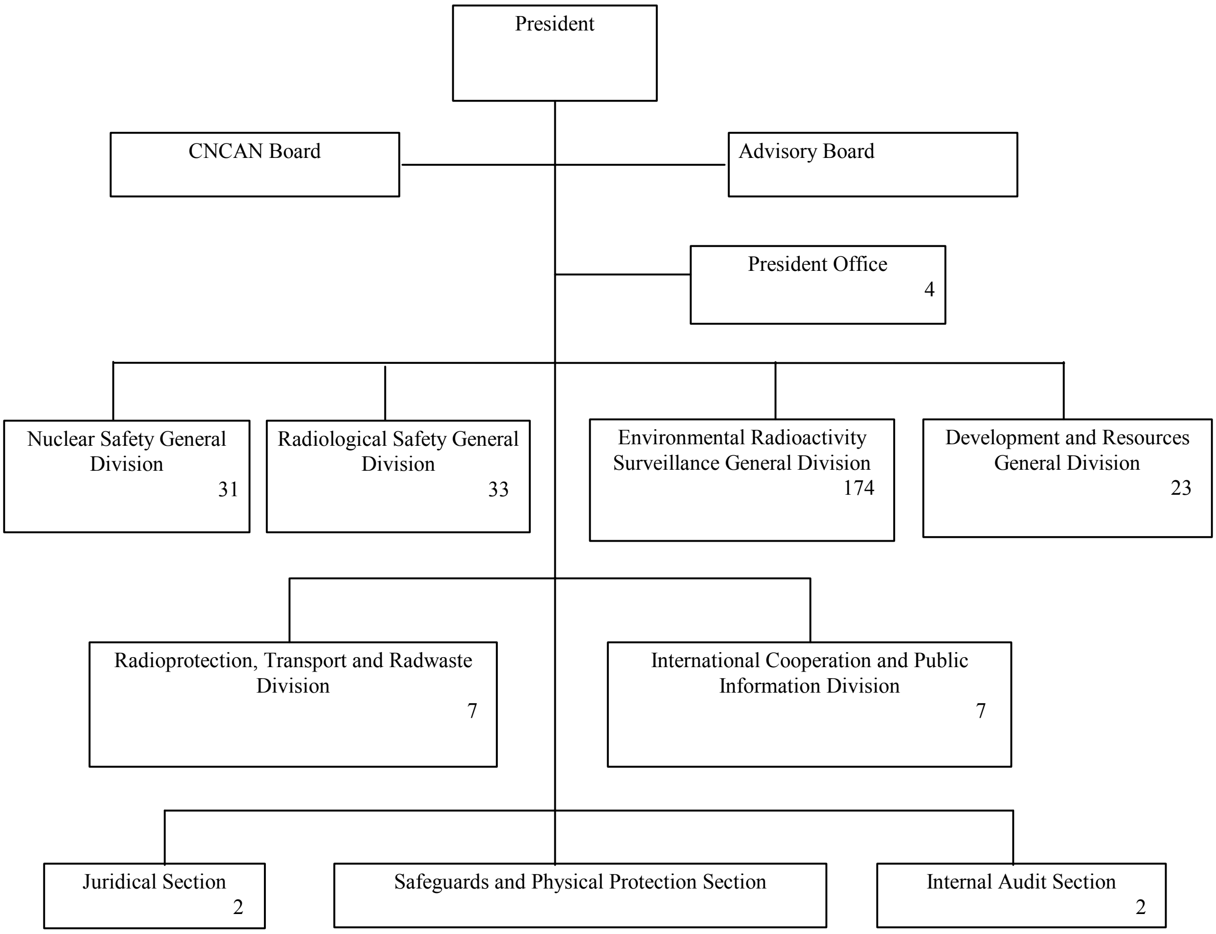

Figure 1. Flow chart of CNCAN.

These documents have recommendation character and explain the position of the competent authority about the way to fulfil the requirements established by the regulations. At the next level are the standards that were issued by the national standardization association or by similar international organizations (such as ISO, IEC, ASTM, CENELEC) and endorsed by the regulation authority. Their application is recommended and provides the possibility to assess the radiological safety system implemented by a facility. Finally, at the pyramid base are the instructions and procedures that have to be elaborated by each user. These documents have a limited application range, normally only for the activities developed by their issuer. They describe and specify the provisions of regulations positioned higher on the pyramid and are compulsory for employees designated to nuclear activities. The existence and enforcement of a set of corresponding instructions and procedures fulfil the necessary condition for obtaining legal authorization to develop specific nuclear activities. In what follows, we describe the characteristics of the most important elements of the legislative pyramid.

The fundamental law adopted by the Romanian Parliament, namely Law No. 111/1996 regarding the safe deployment of the nuclear activities, was modified and reissued in 1998. It establishes the activities and radiation sources to which it is applicable and defines the competent national authority in the nuclear domain. The law also determines the tasks and scope of the national authority and other ministries and agencies (e.g. Ministry of Health, Ministry of National Defence, General Division of Customs, Romanian Bureau of Legal Metrology), establishes the authorization regime, the duties that licensees and other physical and legal persons must fulfil, the control regime and the applicable sanctions in case of violation of the provisions.

The normative acts (level two) in force, applicable to radiological safety domain and physical protection of radioactive materials are shown in Table 3. There is also a set of regulations that are applicable for nuclear power plants, nuclear fuel cycle and safeguards.

Table 3. List of normative acts in force

Item	Regulation	Issuing year
1	Radiological Safety Fundamental Norms	2000
2	Republican Nuclear Safety Norms – Work Rules with Nuclear Radiation Sources, as amended 1979, 1981 and 2000	1976
3	Republican Nuclear Safety Norms for Emergency Preparedness	1993
4	Republican Nuclear Safety Norms for the Transport of Nuclear Materials	1975
5	Rules for issuing the permits to work in the nuclear domain	1991
6	Norms for designation of notified bodies in the nuclear domain	2000
7	Republican Norms for Physical Protection of Nuclear Materials	1976
8	Rules for establishing the fees applicable in nuclear activities	2000

A very important regulation with general application is the Radiological Safety Fundamental Norms, adopted in 2000. It replaces the Republican Norms for Radioprotection in force from 1975. The Radiological Safety Fundamental Norms represent the transposition in the Romanian legislative system of the "Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the health of workers and of the general public against the danger arising from ionising radiation". Its application in Romania is not difficult because of the existent system of radiological safety, which requires only minor corrections.

Among the international standards endorsed by the regulatory authority, there are standards on radiation sources (ISO 2919), quality assurance (ISO 9000 series), authorization (ISO 45000 series) and some technical standards for medical radiation devices (IEC 601) and X-ray tubes, issued by the IEC.

Authorization, control and enforcement

The compulsory authorization of practices and the main conditions the applicant should comply with are established by law and developed by the Radiological Safety Fundamental Norms. In principle, all activities should be authorized prior to practice. The applicant should prove that he fulfils the conditions for obtaining the authorization, such as: he is a company recognized as a legal person, has implemented a radiation protection system for the practice that he intends to develop, employs qualified personnel, has elaborated an adequate system of instructions and procedures, respects the provisions of specific regulations. The authorization is time limited and the legal rights cannot be transferred to a third person unless the issuer agrees to it. Authorization can impose limits and conditions to the activity (e.g. type of sources that can be used and their maximum activity). The law punishes the non-observance of limits and conditions, which can lead to authorization withdrawal. The abusive authorization withdrawal can be contested in court and may determine an adequate compensation. The authorization also mentions the persons responsible for radiological safety.

Radiological Safety Fundamental Norms give details and specify the authorization conditions stipulated by law. The nuclear domain exclusion level and an authorization exempting level are established by these norms. The materials with radioactivity below the exclusion level are legally considered non-radioactive. For such activities as fabrication, import and commercialization of radioactive materials with activity under the exempting level, authorization is still necessary. Activities using radioactive materials with activity over the exemption level should be registered or authorized, as the regulatory authority stipulates, according to norms regulating these activities.

A specific legal requirement of the Romanian authorization system is that the persons developing nuclear activities should have a special practice permit for nuclear activities, issued by the competent authority if he/she has special radiation protection responsibilities or acts as a qualified expert, or by the employer in the other cases. These persons should demonstrate specific radiation protection preparedness, be declared in proper health condition and pass a knowledge verification test. The practice permit is time limited, issued for a specific practice (e.g. for non-destructive testing with radiation sources) and can be withdrawn by the issuer.

The specially empowered personnel of the regulatory authority carry out the control activity. The empowered personnel have permission of access, according to the law, to all places in which there are practices with radiation sources, or where nuclear facilities are assumed to exist. The inspector should draw up a written statement of violations found, establish dates for solving them and give the necessary orders for solving regulation non-compliances. The law gives inspectors the right to sanction violations. The sanctions stipulated by law are from imprisonment for carrying out unauthorized activities, reported to the prosecution department by the inspector, to minor-offence fines sanctioned directly by the inspector. The fines can be applied both to individuals, and to companies. Usually, the control for authorization purposes is developed during and after the practice activity starts. For example, an economic agent is usually inspected once in two years.

Infrastructure efficiency

The appropriate performance of the radiological safety infrastructure is shown by the fact that no radiation damage has been registered. The number of lost or stolen sources is insignificant (maximum 5 cases/year), many of them being quickly retrieved without producing significant irradiation or contamination. The licensees are recorded in relational databases, which will shortly also include the radiation sources. In this way, a strict and individualised control of radiation sources will be accomplished, from their appearance until decommissioning, reducing the likelihood of orphan sources. Setting up this evidence became urgent following the massive privatization of the Romanian economy and the frequent change of owners. The national regulatory authority was evaluated by IAEA missions and found to be adequate within the requirements (IRTT mission 1990 and 1996). Among the deficiencies found, which are so far unsolved, were those related to personnel (due to the low level of payment) and to equipment (due to low budget). The regulation system is undergoing continuing modernization and alignment with the latest recommendations of the IAEA and the EU directives.

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THE ROLE OF THE GOSATOMNADZOR OF RUSSIA IN NATIONAL REGULATING OF SAFETY OF RADIATION SOURCES AND SECURITY OF RADIOACTIVE MATERIALS

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Abstract. As at the end of 1999, the Gosatomnadzor of Russia supervised 6551 radiation sources, including 1285 unsealed sources with individual activity from a minimal level to $1X10^{12}$ Bq and a total activity of $585X10^{12}$ Bq, and also 5266 sealed sources with individual activity from 30 to $1X10^{17}$ Bq and the total activity of more than $11X10^{17}$ Bq.

A national infrastructure has been created in the Russian Federation in order to regulate the safety of nuclear energy use. The infrastructure includes the legal system and the regulatory authorities based on and acting according to it. The regulation of radiation safety, including assurance of radiation source safety and radioactive material security (management of disused sources, planning, preparedness and response to abnormal events and emergencies, recovery of control over orphan sources, informing users and others who might be affected by lost source, and education and training in the safety of radiation sources and the security of radioactive materials), is realized within this infrastructure.

The legal system includes federal laws ("On the Use of Nuclear Energy " and "On Public Radiation Safety"), a number of decrees and resolutions of the President and the Government of the Russian Federation, federal standards and rules for nuclear energy use, and also departmental and industrial manuals and rules, State standards, construction standards and rules and other documents.

The safety regulation tasks have been defined by these laws, according to which regulatory authorities are entrusted with the development, approval and putting into force of standards and rules in the nuclear energy use, with issuing licenses for carrying out nuclear activities, with safety supervision assurance, with review and inspection implementation, with control over development and realization of protective measures for workers, population and environment in emergencies at nuclear and radiation hazardous facilities.

Russian national regulatory authorities are the Gosatomnadzor of Russia, the Ministry of Health, the Gosgortechnadzor of Russia (mining and technical supervision authority) and the Ministry of Internal Affairs. Nuclear and radiation safety regulation is assigned to the Gosatomnadzor (technical and organizational aspects including licensing and inspections) and the Ministry of Health (health aspects of radiation safety normalization). Fire safety and activities to detect, prevent, suppress and disclose illegal actions regarding radioactive materials and radioactive waste are assigned to the Ministry of Internal Affairs.

The key elements of the Russian regulatory infrastructure are:

For ensuring the safety of radiation sources - standards and rules for nuclear energy use and for ensuring the security of radioactive materials - the State's system of accounting for and control of radioactive material and radioactive waste, which is being created now.

The role of the Gosatomnadzor of Russia and other national regulatory authorities consists in implementing State regulation of radiation source safety and ensuring radioactive material security according to the authority's assigned competence.

INTRODUCTION

During the past decade the Government of the Russian Federation and the authorized executive in the field of nuclear energy use has paid significant attention to issues of safety of radiation sources (RS) and security of radioactive materials (RM).

This is connected with changes in the State political and economic system occurring in this period, which are characterized, first of all, by decentralization of property and industrial control. The unified system of State ownership of all resources, which had existed prior to the beginning of 90's, in combination with unified systems of industry control and of safety regulation, had ensured sufficiently high level of RS safety and RM security.

However, denationalization of the economy resulted in the occurrence of a huge number of RS and RM users with weakened (and in a number of cases unavailable) links with State bodies of control and safety regulation in nuclear energy use in Russia.

This situation required creation of a new infrastructure of safety regulation in nuclear energy use, unavailable up to that time in Russia. The objective of this report is to describe the situation in assurance of RS safety and RM security existing in Russia, and also to outline the role and competence of Gosatomnadzor of Russia in this field in the light of IAEA recommendations.

THE RS AND RM INVENTORY IN RUSSIA

As at the end of 1999, the Gosatomnadzor of Russia supervised 6551 radiation sources, including 1285 unsealed sources with individual activity from a minimal level to $1X10^{12}$ Bq and a total activity of $585X10^{12}$ Bq, and also 5266 sealed sources with individual activity from 30 to $1X10^{17}$ Bq and a total activity of more than $11X10^{17}$ Bq.

These data are a result of the implementation by Gosatomnadzor of Russia of State supervision of radiation safety in RS and RM use in industry, medicine and science, for which the safety and security reports are the most up to date. The data do not include sources used in NPPs and nuclear fuel cycle facilities, since in these facilities the supervision of their RS and RM is an integral part of facility control and does not foresee compilation of summary data of RS and RM. Sources applied at facilities of the Ministry of Defence of Russia also are not included here, since the supervision over assurance of radiation safety at those facilities is assigned to competence of the Ministry of Defence by the President of Russia.

To assure RS safety and RM security all over the country, it is important to create a unified national inventory of all significant RS and RM. The Government considers this task as one of the most important for safety assurance in nuclear energy use. In this connection, according to governmental order, the work is being carried out now in order to create a system of State accounting for and control of RM and radioactive waste (RW).

This system (further – AC system) foresees implementation of unified accounting and control of RS, RM and RW at all the stages of their life cycle, from manufacturing (in the case of RW – generation) or border crossing on importation to disposal or border crossing on exportation.

RUSSIAN NATIONAL REGULATORY INFRASTRUCTURE

In order to regulate the safety of nuclear energy use, including RS safety and RM security a national infrastructure was created in the Russian Federation. The infrastructure includes the legal system and safety regulatory authorities based on and acting according to it.

The legal system includes federal laws ("On the Use of Nuclear Energy " and "On Public Radiation Safety"), a number of decrees and resolutions of the President and the Government of the Russian Federation, federal standards and for rules nuclear energy use (regarding the present report theme, first of all the Radiation Safety Standards NRB-99 and the Basic Radiation Safety Assurance Rules OSPORB-99 must be mentioned), and also departmental and industrial manuals and rules, State standards, construction standards and rules and other documents. Development of this legal system is progressing: in addition to the above mentioned laws, draft laws "On Radioactive Waste Management" and "On Nuclear Damage" are under development now.

The safety regulation tasks have been defined by these laws according to which regulatory authorities are entrusted with the development, approval and putting into force of standards and rules for nuclear energy use, covering licence issuing for carrying out nuclear activities, safety supervision assurance, review and inspection implementation, and control over development and realization of protective measures for workers, the public and the environment in emergencies at nuclear and radiation hazardous facilities.

The Russian national regulatory authorities are the Gosatomnadzor, the Ministry of Health of Russia and also the Gosgortechnadzor (mining and technical supervision authority) and the Ministry of Internal Affairs. Nuclear and radiation safety regulation is assigned to the Gosatomnadzor (technical and organizational aspects including licensing and inspections) and the Ministry of Health (health aspects of radiation safety normalization). Fire safety and activities to detect, prevent, suppress and disclose illegal actions regarding radioactive materials and radioactive waste are assigned to the Ministry of Internal Affairs.

In general, the Russian regulatory system can be evaluated as corresponding to the main recommendations formulated by the IAEA in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS). This can be illustrated by the following.

Suitable legislation providing a basis for nuclear energy use and for its regulation and also a safety regulatory system, including authorized regulatory bodies has been created in Russia. The implementation of the main tasks assigned to regulatory infrastructures by the BSS is foreseen in the Russian legislation. For example, providing methods and means of elimination of public concern which are beyond the framework of legal duties of persons having permission to carry out a practical activity, connected with RS, is assigned to the Government of the Russian Federation by the law "On the Use of Nuclear Energy".

The control over RS which are outside the responsibilities of any other organizations, for example natural sources and radioactive tails from former practical activities, is realized within the framework of radiation-hygienic passportization (certification) of territories, which is carried out by the Ministry of Health and Gosatomnadzor according to governmental order based on the law "On Public Radiation Safety".

Support of the appropriate responsible persons to take measures to educate and train specialists in radiation protection and safety and to ensure information exchange is realized by the establishment of appropriate conditions during the licensing of radiation-hazardous activities. Informing people, public representatives and the media concerning hazardous aspects of these activities related to health and safety and also about their regulatory process is carried out by regulatory authorities by means of regular information releases about the nuclear and radiation safety status in Russia, bulletins about regulatory authorities’ activity, annual State reports on the environment and also separate publications in the mass media.

It has been a little more difficult to follow the IAEA recommendations to provide regulatory bodies with sufficient resources, including the material, technology and services necessary for radiation protection and safety. They are currently beyond the resources available to those persons who have the permission to carry out the required practical activities. These economic difficulties, caused by the social and economic changes in the Russian Federation, objectively compel postponement of the implementation of these recommendations to the future.

THE NATIONAL SYSTEM OF REGISTRATION, LICENSING AND INSPECTION OF RS AND RW AND FOR THE ENFORCEMENT OF REGULATORY PROVISIONS

According to the law "On the Use of Nuclear Energy", RM and RW are subject to State accounting and control, which have to be carried out at the federal, regional and departmental levels in the system of State accounting for and control of RM and RW. The goals of the AC system are to determine quantities of these materials at their location points, to prevent their loss, unauthorized use and theft, to provide information about availability and transfer of RM and RW and also about their export and import to State authorities, bodies of the nuclear energy use control and State regulatory bodies.

A procedure for organizing the AC system and also the bodies carrying out the State RM and RW accounting and control are defined by the rules of this system arrangement, which are approved by the Government, and also by the Provisions on the State Accounting for and Control of RM and RW.

According to these documents, the subjects of the State accounting and control are the RM and RW in quantities and with activities (and/or radiating ionizing radiation with intensity or energy), which values exceed a minimum value established by the federal standards and rules and which require permission of regulatory bodies to carry out activities with these RM and RW.

Organizations with any form of ownership and any organizational-legal form, which carry out activities in manufacturing, use, utilization, transportation, storage and disposal of RM and RW (further – operators), have to implement their accounting and control and to present the obtained information to the information-analytical organizations and centres of information collection, processing and transfer.

In the case of RM and RW export and import, the State Customs Committee ensures their accounting and control at their border crossing and also presents the obtained information to the information-analytical organizations and centres of information collection, processing and transfer, which provide functioning of the AC system at the federal level.

The AC system control body at the federal level is the Ministry of Atomic Energy of Russia (Minatom). The AC system control bodies at the regional level are executive authorities of Russian Federation subjects (Regions). The AC system control bodies at the departmental level are federal executive authorities (such as ministries) and the Russian Academy of Science, which control the organizations carrying out activities connected with manufacturing, use, utilization, transportation, storage and disposal of RM and RW.

Gosatomnadzor, the Ministry of Health, Gosgortechnadzor and the Ministry of Internal Affairs ensure State regulation of nuclear, radiation, technical and fire safety in the AC system, functioning within the framework of their competence.

The Ministry of Internal Affairs and the Federal Security Service, within the framework of their competence, carry out activities to detect, prevent, suppress and disclose illegal actions regarding RM and RW.

Licensing of activities connected with nuclear energy use is foreseen by the law "On the Nuclear Energy Use" (Article 26). The list of types of activities (including RS and RM management) which require licences for their implementation, the procedure of issuing and cancellation of licences and also the licensing authority (namely Gosatomnadzor) are defined by the Government of Russian Federation in the Provisions on Licensing Activities in the Field of Nuclear Energy Use.

Authority to carry out inspections is assigned to State safety regulatory bodies according to their competence. The Gosatomnadzor competence includes carrying out inspections which are directed to implement supervision over compliance with standards and rules for nuclear energy use and also with issued licenses conditions; over nuclear and radiation safety status, over RS and RM physical protection and safeguards and also over the AC system.

To enforce fulfilment of regulatory provisions, the Gosatomnadzor as the State safety regulatory body is authorized:

– to issue prescriptions to eliminate detected violations of licence conditions, nuclear and radiation safety standards and rule requirements, to eliminate the causes and conditions that resulted in these violations, to suspend work carried out with violations of nuclear and radiation safety requirements which are dangerous to human health and the environment. It is obligatory for operatoring officials to fulfil these requirements.
– to suspend or to cancel issued licences in cases of detected violations of legislation related to nuclear energy, nuclear materials and RM use, or violation of licence conditions;
– to prohibit the use of products and technologies which do not ensure nuclear and radiation safety of personnel, public and environment;
– to hear (to require and to get) explanations from officials of ministries and departments, other executive bodies, operators and other organizations on issues of compliance with requirements of legislation, standards and rules, related to nuclear and radiation safety, and also on other issues being within Gosatomnadzor competence;
– to control (to check) the implementation by owners (users) of investigations into conditions and causes of violations affecting nuclear and radiation safety that have occurred in the work at the supervised objects, and to take decisions necessary for execution.

SOME NATIONAL PROVISIONS IN THE FIELD OF RS SAFETY AND RM SECURITY ASSURANCE

DISUSED RS MANAGEMENT

Disused RS management in the Russian Federation is regulated by requirements of the main safety standards in Russia – OSPORB-99.

According to this document, the operator is responsible for the security of RS and accordingly for providing appropriate conditions for their receipt, storage, use and write-off, under which any possibility of their loss or uncontrolled use is impossible.

Disused RS must be stored in specially assigned places or equipped depositories assuring their security and excluding unauthorized access to them. In a case of termination of their use, them the operator must inform the supervisory bodies.

Unusable RS must be promptly written off and transferred for treatment or disposal RS transfer to another organization, including one for disposal, must be followed by informing the supervisory bodies of the local organization in charge of RS transfer and of the local organization in charge of RS receipt. All these steps have to be traced by the recently created AC system.

THE PLANNING, PREPAREDNESS AND RESPONSE TO ABNORMAL EVENTS AND EMERGENCIES

The importance which is attached in Russia to this field of RS safety assurance is evidenced by the fact that its regulation is assured by documents on different levels of the safety regulatory legal system, namely the law "On Public Radiation Safety" and the safety standard OSPORB-99.

Article 19 of this law obligates organizations where emergencies are possible to have:

- a list of potential radiation accidents with their consequences and radiation conditions forecast;
- a decision-making criteria for when a radiation accident arises;
- a plan of measures to protect personnel and the public against a radiation accident and its consequences, which has to be approved by local government institutions and State radiation safety regulatory bodies;
- means of notification and elimination of radiation accident consequences;
- medical remedies for prophylaxis and relief action against radiation effects; and
- emergency response units formed from facility personnel.

Pursuant to the law requirements, the OSPORB-99 prescribe that:

- territorial administrations should create, support and improve the system of prompt and effective response in case radiation accidents occur on their and adjacent territories;
- operators should promptly inform executive authorities authorized to implement State control and supervision in radiation safety about an emergency or accident occurrence;

- personnel working with the RS should fulfil established requirements on radiation accident prevention and rules of behaviour in case of radiation accident.

THE RECOVERY OF CONTROL OVER ORPHAN RS

Measures to recover control over orphan RS are defined by documents regulating the AC system's functioning. These documents foresee that in a case of detection of loss or of found or unaccounted for RM and RW, an organization immediately informs a higher organization, such as an internal affairs body, radiation safety supervisory bodies and appropriate regional or departmental information-analytical centres of the AC system. Found and unaccounted for RM and RW are registered in the AC system.

Carrying out activities to detect, prevent, suppress and disclose illegal actions regarding RM and RW is assigned in these documents to the Ministry of Internal Affairs and Federal Security Service in the frame of their competence by the Government.

INFORMING USERS AND OTHERS WHO MIGHT BE AFFECTED BY LOST RS

According to Article 20 of the law "On Public Radiation Safety", in case of a radiation accident, the operator must inform State authorities, including nuclear and radiation safety authorities, and also local authorities and population of territories on which increased irradiation is possible.

EDUCATION AND TRAINING IN THE RS SAFETY AND THE RM SECURITY

This question is reflected in law ("On Public Radiation Safety") and in safety standards (SPORB-99), according to which the duty of the operator includes carrying out radioactive safety assurance training and qualification of managers, workers, specialists from radiation safety services, other persons working with RS and also regular briefings and tests in radiation safety.
The main documents regulating the AC system foresee training and retraining of personnel who carry out the accounting and control at all levels. The training should be conducted by the institutes that qualify Minatom managers and experts.

CONCLUSION

Currently, the regulatory infrastructure for RS safety and RM security corresponding to the main IAEA recommendations exists in the Russian Federation. The Gosatomnadzor role in this infrastructure according to its assigned competence consists in implementing the State regulation on RS safety and ensuring RM security.

REGULATORY CONTROL OF RADIATION SOURCES IN SLOVAKIA

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Abstract. In Slovakia, there are two regulatory authorities. Regulatory control of the utilization of nuclear energy, based on the Slovak National Council's law No. 130/1998 on the peaceful uses of nuclear energy, is exercised by the Nuclear Regulatory Authority of the Slovak Republic. The second regulatory authority — the Ministry of Health — is empowered by law No. 72/1994 on the protection of human health to license radiation sources and is responsible for radiation protection supervision (there are nearly 3000 establishments with sealed sources, radiation generators and unsealed sources in Slovakia). Pursuant to a new radiation protection regulation based on international standards, radiation sources are to be categorized in six classes according to the associated exposure and contamination hazards. A national strategy for improving the safety of radiation sources over their life-cycle and for the management of disused and orphan sources is being prepared for governmental approval.

INTRODUCTION

In Slovakia, radioactive materials and other radiation sources are used widely in medicine, industry, research and other fields. However, the number of radiation sources relative to the number of establishments with such sources has been declining slowly during the past ten years, especially in industry, since the decommissioning of radiation sources is very expensive and radiation-based techniques have therefore, where possible, been replaced by ultrasonic and other techniques.

An indication of Slovakia's inventory of radiation sources is given in the following tables.

NUCLEAR FACILITIES	Number of reactors
Bohunice NPP	4 in operation 1 being decommissioned
Mochovce NPP	2 in operation

MEDICINE	Number of establishments
Diagnostic radiography and fluoroscopy, including CT scanning	2200
Teletherapy, remote-controlled after-loading brachytherapy, accelerators	70
Unsealed sources (nuclear medicine departments, radioimmunoassay laboratories)	50
RESEARCH	
Unsealed sources	150
Sealed sources	30
INDUSTRY	
Nuclear gauges, radiography (X-rays, gamma rays), X-ray fluorescence, diffraction and spectrometry applications using X-ray generators, neutron capture and activation analysis techniques using radioactive sources.	380

REGULATORY AUTHORITIES AND LEGISLATIVE INFRASTRUCTURE

There are two regulatory authorities responsible for the safety of radiation sources and the security of radioactive materials in Slovakia.

NUCLEAR FACILITIES

The regulatory authority responsible for nuclear safety is the Nuclear Regulatory Authority of the Slovak Republic. Governmental administration and supervision in the field of nuclear energy utilization is based on the Slovak National Council's law No. 130/1998 on the peaceful uses of nuclear energy, which has been supplemented by 16 regulations.

OTHER RADIATION SOURCES AND RADIOACTIVE MATERIALS

Regulatory control relating to the safe use of radiation sources, to the security of radioactive materials and to radiation protection is based on the Slovak National Council's law No. 272/1994 on the protection of human health as amended by law No. 290/1996. The national regulatory authority is the Ministry of Health, and there are four regulatory bodies — four State institutes of public health with radiation protection departments, located in Bratislava (2), Košice and Banská Bystrica.

The current legislative system consists of the laws mentioned above, regulations (recommendations), guides, national standards and EC/IEC/ISO standards adopted as national standards.

THE NEW NATIONAL SYSTEM FOR THE NOTIFICATION, REGISTRATION, LICENSING AND INSPECTION OF RADIATION SOURCES AND RADIOACTIVE MATERIALS

New radiation protection legislation was approved by the Government on 14 September 2000.* It is based on the BSS and empowers the regulatory authority to:

- require notification of all uses of ionizing radiation;
- require notification of proposed imports of sources;
- require imported sources to be returned to the manufacturer/supplier at the end of their useful life;
- issue authorizations (licences) for sources in categories 4, 5 and 6; and
- require appropriate qualifications and training for "qualified experts".

The amendment of the current legislation will improve the licensing and supervisory system. Radiation sources are to be categorized in six classes according to the associated exposure and contamination hazards. Certain categories of practices will be subject to prior authorization by the competent authorities — the use of radiation sources in categories 4 and 5 will require prior authorization (a licence) from the regional authority. In particular, a licence issued by the Ministry of Health — the national regulatory authority — will be required for the entire nuclear fuel cycle, for large irradiators and for other sources in category 6 (e.g. irradiation facilities, isotope production units and radioactive waste disposal facilities). The holder of a

* The new legislation entered into force on 1 January 2001.

source in category 2 or 3 will be required to notify the regional authorities. A radiation protection regulation will prescribe the manner of notification. No reporting will be required for practices involving radioactive substances at activity levels or activity concentrations below the nuclide-specific *exemption values* listed in an annex to the law — such practices will be classified as category 1 practices. No reporting will be required for apparatus satisfying criteria listed in the new regulation and classified as a category 1 radiation source. In general, licences will be granted by the competent authority in response to individual applications. The production, disposal, recycling and reuse of materials containing radioactive substances will be subject to prior authorization.

MANAGEMENT OF SPENT SOURCES

The regulations relating to the handling of disused sources require that, if it is not possible to return such sources to the producer, they should be collected by an authorized organization and transported to the national decommissioning centre for conditioning and safe storage in an authorized radioactive waste disposal facility. The problem with radium needles has not yet been resolved; they are being temporarily stored at the hospitals where they were used. A proposal to establish a State agency responsible for the management of all legally used radiation sources during their life-cycle is awaiting approval by the competent ministries. There are plans to construct a facility for the temporary storage of radiation sources that have been in legal applications, of radiation sources that have been the objects of illicit trafficking and of orphan sources and radioactive materials found in metal scrap, the aim being to reduce the risk of their getting out of control.

SAFETY OF RADIATION SOURCES IN SLOVENIA

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Abstract. The Republic of Slovenia, a central European country which has been independent since 1991, has about 2 million inhabitants and an area of 20 256 km^2. The Constitutional Law on Enforcement of the Basic Constitutional Charter on the Autonomy and Independence of the Republic of Slovenia, adopted on 23 June 1991 (Off. Gaz. of the R of Slovenia No. 1/91), provided that all the laws adopted by the Socialist Federal Republic (SFR) of Yugoslavia should remain in force in the Republic of Slovenia pending the adoption of appropriate legislation by the Slovene Parliament. Under the Slovene Constitution, all international treaties ratified by Slovenia constitute an integral part of Slovenia's legislation and can be applied directly. In Slovenia, all regular types of ionizing radiation source are being used for peaceful purposes and are covered by a system for their safe use and control. All radiation sources and radioactive materials are registered and under regulatory control. Inspections are carried out periodically by the Health Inspectorate of the Republic of Slovenia (HIRS) and, in the case of nuclear installations, the Slovene Nuclear Safety Administration (SNSA). Technical checks on radiation sources are carried out periodically by technical support organizations: the Jožef Stefan Institute and the Institute for Occupational Safety (IOS).

INVENTORY OF SIGNIFICANT RADIATION SOURCES IN SLOVENIA

Radiation sources are used in medicine (for therapy and diagnostics), industry, research and education. The largest radiation sources are the Krško Nuclear Power Plant and Slovenia's one research reactor.

SOURCES IN MEDICINE AND VETERINARY DIAGNOSTICS

X-ray machines
In 1999 there were 683 registered X-ray devices in use at medical and veterinary institutions: 330 were being used for dental diagnostics, 15 were CT scanners, 313 were being used for medical diagnostics, 3 for therapy, 2 for simulation and 20 for veterinary diagnostics.

Sealed sources
The Institute of Oncology uses sealed sources for therapy: two Co-60 sources with activities of 400 TBq and 150 TBq for teletherapy. One Ir-192 and two Cs-137 sources with individual activities of up to 20 GBq are being used for brachytherapy.

Unsealed sources
There are seven medical facilities (clinics and hospitals) which use unsealed sources (radiopharmaceuticals) for diagnostics and therapy.
There are also three linear electron accelerators being used for teletherapy.

SOURCES IN INDUSTRY AND IN OTHER USES

Sealed sources
In 1999 there were 514 registered sealed sources being used or stored at 99 organizations:

- 50 sources for industrial radiography (mostly Gammamats), Ir-192, Se-75, Co-60 or Cs-137 with activities of up to 2 TBq, usually in low radioactivity containers made of depleted uranium;
- nuclear gauges:
  - 141 moisture and density gauges (mostly Troxler), containing Cs-137 as gamma source and Am/Be alloy as neutron source, with individual activities of 0.3 GBq and 1.5 GBq respectively;
  - 181 level gauges for liquids or grain, containing Co-60, Cs-137 and Am-241, activities mostly between 3.7 MBq and 3.7 GBq, the sole exception being the source at one ironworks (370 GBq);
  - 120 thickness and density gauges for production processes, containing Am-241, Sr-90, Cm-244, Fe-55, Co-60, Tl-201, Pm-147, Kr-85;
- lightning rods with radioactive materials (Eu-152, Co-60 – initial activities up to 20 GBq) installed on 22 objects (the installation of new ones has been prohibited).

The inventories of old and disused sealed radiation sources are periodically updated. Of the 514 registered sources, 233 were disused in the year 2000.

X- ray machines and an electron microscope
There are 97 X-ray machines and 1 electron microscope being used in industry and at other facilities.

Since 1998 the HIRS has developed a comprehensive central register of X-ray machines with a view to their better control.

SOURCES IN RESEARCH AND EDUCATION

Particle accelerators
One Van de Graaff (U=1.7 MV) and one Tandetron (U=2 MV) accelerator are being used at the Jožef Stefan Institute, which also has significant sealed radiation sources in its laboratory for secondary standards (three Cs-137, two Co-60 and three Am-241 sources with maximum activities of up to 194 GBq).

Unsealed radioactive materials in low quantities and with low activities and ***sealed sources with low activities*** are being used in many institutions (approximately 30 radiochemical and other laboratories) for research and teaching purposes.

NUCLEAR FACILITIES

Krško Nuclear Power Plant
The Westinghouse pressurized-water reactor has a thermal output of 2000 MW and an electrical output of 700 MW. The total activity of the operating reactor core and the associated nuclear and other radioactive materials is about 5×10^{19} Bq. The spent fuel stored in the spent fuel pool has an activity of about 10^{17} Bq, and the low- and intermediate-level radioactive waste stored in the radioactive waste building has an activity of about 10^{13} Bq.

Research Reactor
The TRIGA Mark II is at the reactor centre of the Jožef Stefan Institute, at Brinje, near Ljubljana. With a power of 250 kW, it has been operating since 1966, mostly for scientific

work involving neutrons and gamma radiation in reactor physics and neutron activation analysis and for the training of personnel. Its total activity in full operation is 10^{15}-10^{16} Bq.

Uranium mine and mill at Žirovski vrh
These are at the decomissioning stage. Uranium ore extraction began in 1982, and uranium concentrate production started in 1984. In course of their operation (until 1990), 620 000 t of uranium ore were mined and 452 t of U_30_8 were produced. The total activity of the deposited waste is about 50 TBq.

Interim storage for low- and intermediate-level radioactive waste
This facility, located at Brinje, near Ljubljana, is classified under Slovene legislation as a nuclear facility. Since 1999, Slovenia's Agency for Radioactive Waste Management has been responsible for its operation. Spent or useless radiation sources and solid radioactive waste from medical, industrial and research organizations - also found orphan sources - are safely stored there.

Three kinds of solid radioactive waste are stored at this facility:

- contaminated laboratory materials and materials with induced radioactivity due to irradiation in the TRIGA research reactor; this waste, stored in closed drums, is contaminated with Co-60, Cs-137, Eu-152 and Ra-226 and has a total estimated activity of about 20 GBq;
- contaminated and/or activated solid materials that are too bulky to fit into drums, with an estimated total activity of about 4 TBq;
- disused sealed sources stored in shielded containers - altogether 337 sources (Cs-137, 450 GBq; Co-60, 65 GBq; Kr-85, 30 GBq; Sr-90, 6 GBq).

At present, the contents of the facility are being sorted out systematically, according to isotope category and activity, and the facility is being reconstructed so as to enable further radioactive waste to be stored there. Owing to this situation, some disused sources are being kept in provisional storage by their former users.

The safety of radiation sources is the responsibility of the source users even after the cessation of usage, until final disposal of the sources at the radioactive waste storage facility.

NATIONAL REGULATORY INFRASTRUCTURE FOR THE SAFETY OF RADIATION SOURCES AND THE SECURITY OF RADIOACTIVE MATERIALS

LEGISLATIVE INFRASTRUCTURE /FRAMEWORK

The national legislation for protecting workers, the general public and the environment against the dangers arising from radioactive sources is based on acts and regulations taken over from the former SFR of Yugoslavia.
The legal framework for all secondary legislation is provided by two laws:

(a) the law on protection against ionizing radiation and on the safe use of nuclear energy (Off. Gaz. of the SFR of Yugoslavia No. 62/84); and

(b) the law on implementing protection against ionizing radiation and measures for the safety of nuclear facilities (Off. Gaz. of the SR of Slovenia No. 28/80 and No. 32/80).

These two laws are the basis for regulations relating to specific areas of nuclear, radiation, radioactive waste and transport safety.

The following radiation safety regulations are based on the 1984 law:

Regulation Z4 on trade in and the utilization of radioactive materials exceeding certain limits, X-ray machines and other apparatus producing ionizing radiation and on measures for protection against radiation from such sources (Off. Gaz. of the SFR of Yugoslavia No. 40/86 and No. 45/89);

Regulation Z10 on keeping records of ionizing radiation sources and of population and occupational exposure (Off. Gaz. of the SFR of Yugoslavia No. 40/86);

Regulation Z5 on the education and health of and medical examinations for personnel working with ionizing radiation source (Off. Gaz. of the SFR of Yugoslavia No. 40/86);
Regulation Z3 on collecting, accounting for, processing and storing radioactive waste and on its final disposal and release into the environment (Off. Gaz. of the SFR of Yugoslavia No. 40/86) - it encompasses the management of disused sources.

There are also regulations covering environmental radiation monitoring, safeguards, the storage, transport and import of radioactive and nuclear materials, dose limits for occupationally exposed persons and for members of the public, and the control of medical exposures.

The following regulations based on the 1980 law are in force:

- regulation on the mode and frequency of record keeping and of reporting to the regulatory body by authorized technical support organizations and by organizations operating nuclear facilities (Off. Gaz. of the SR of Slovenia No. 12/81); and

- regulation on the education, experience and compulsory qualification and training of personnel working with ionizing radiation sources or in radiation protection services and on the procedure for verifying their qualifications (Off. Gaz. of the SR of Slovenia No. 9/81).

New legislation on nuclear safety and radiation protection which will include international documents (the BSS, EURATOM Directives of the EU) and recommendations (ICRP 60) is being prepared.

Of the existing new legislation, the following laws and decrees are important for radiation protection:
- *the law on health inspections* (Off. Gaz. of the R of Slovenia No. 99/99), which clearly defines the responsibility of Slovenia's Health Inspectorate in the area of radiation protection;

- *the law on protection against natural and other accidents* (Off. Gaz. of the R of Slovenia No. 64/94) and *the decree on the organization and operation of the monitoring, information and alarm system* (Off. Gaz. of the R of Slovenia No. 45/97), which lay down general emergency provisions relating also to radiation emergencies (a "National emergency plan" was prepared on the basis of this law and of the 1984 law and approved by the Slovene Government in 1999; all radiation emergency plans at the local and the enterprise level are consistent with an emergency scheme at the State level); and

- *the law on the transport of dangerous goods* (Off. Gaz. of the R of Slovenia No. 79/99) and *the decree on the export and import of specific goods* (Off. Gaz. of the R of Slovenia No. 75/95), which provide for control over the trade in radioactive materials and radiation sources within Slovenia.

Under the current legislation, every intention to purchase a source and engage in a radiation or nuclear practice must be reported in advance to the competent authority, which will, after checking on the ability of the applicant to use the source safely, issue the appropriate licence. Satisfactory emergency plans and an appropriate storage area are among the preconditions for the issuing of the licence. The technical control of sources is the responsibility of the technical support organizations, and inspections are carried out by a competent regulatory body.

All radiation sources in use and the radioactive waste in the temporary storage for low- and intermediate-level waste at the Krško Nuclear Power Plant and at the reactor centre at Brinje are stored in compliance with the legislation, and the records are being kept correctly and consistently.

REGULATORY AUTHORITY

MINISTRIES

The following Ministries are involved, either directly or through the governmental bodies acting within their frameworks, in the different regulation and control aspects of the safety of nuclear installations, radiation protection and radioactive waste safety.

The ***Ministry of the Environment and Regional Planning*** acts, with the ***Slovene Nuclear Safety Administration (SNSA)***, as a national regulatory authority for nuclear safety and radiation protection at nuclear installations. The SNSA also deals with: the handling of, the trade in and the transport of nuclear and radioactive materials; nuclear material safeguards; the physical protection of nuclear installations and materials; liability for nuclear damage; the licensing of operators of nuclear installations; quality assurance; radiological monitoring; early notification in the event of a nuclear or a radiological accident; international co-operation in the field of nuclear and radiological safety; and other tasks defined in Slovenia's nuclear and other legislation.

The ***Ministry of Health*** acts, with the ***Health Inspectorate of the Republic of Slovenia (HIRS)***, as a national regulatory authority for radiation protection of the general public and of workers against the dangers of ionizing radiation.

The HIRS is empowered to:

- assess applications for licences to perform practices which cause or could cause exposure to radiation,
- authorize such practices and the sources associated with them, subject to certain conditions,
- carry out periodic inspections to verify compliance with the legislation,
- take any enforcement action necessary for ensuring compliance with the regulations and standards.

The safety of all radiation sources, of all radiation practices and of the transport of radioactive and nuclear materials is controlled by the HIRS.

The ***Ministry of Economic Affairs*** is, with the ***Agency for Radioactive Waste Management (ARAO)***, responsible for the safe disposal of low- and intermediate-level radioactive waste in the Republic of Slovenia.
The ***Ministry of Defence*** plays, with the ***Administration for Civil Protection and Disaster Relief***, a co-ordinating role in the national radiological and nuclear emergency preparedness system. The Ministry of Defence is involved also in the supervision of fire protection at nuclear installations.

The ***Ministry of Internal Affairs*** performs control activities relating to the physical protection of nuclear installations and materials and the transport of radioactive and nuclear materials.

TECHNICAL SUPPORT ORGANIZATIONS

The Jožef Stefan Institute and the Institute of Occupational Safety act as technical support organizations authorized by a competent regulatory body (since 1981) to control the safe use of radiation sources in medicine, industry and research, to monitor radioactive contamination in the working, living and natural environment and to train and educate workers in the safe use of radiation sources.

SUMMARY

All radiation sources in Slovenia are under regulatory control. The level of radiation safety culture is high; no radiological incidents/accidents have been reported so far.

The main current issues are radioactive waste disposal and the preparation of new radiation and nuclear safety legislation.

REFERENCES

[1] HIRS, National records on sources of ionizing radiation in Slovenia;

[2] SNSA, Nuclear and radiological safety in Slovenia, annual reports for 1995, 1996, 1997, 1998 and 1999, Slovene Nuclear Safety Administration, Ministry of the Environment and Regional Planning, Ljubljana, Republic of Slovenia;

[3] IAEA report on the International Regulatory Review Team (IRRT) mission to Slovenia, Ljubljana, December 1999.

THE SPANISH SYSTEM FOR THE RADIOLOGICAL SURVEILLANCE AND CONTROL OF SCRAP AND THE PRODUCTS RESULTING FROM ITS PROCESSING

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Abstract. Despite the fact that the use of radiation technologies has always been subjected to strict controls in most countries, the presence of radioactive materials in scrap has been detected relatively often in recent years. This has led to the implementation of a series of international initiatives aimed at detecting and preventing illicit international trafficking with radioactive material, intentional or otherwise.

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 its uses as raw material. Experience has shown that that countries that import large quantitities of scrap should complement the aforementioned international initiatives with others of national scope, in order to reduce the risks arising from the presence of radioactive material in scrap.

In this context, the Spanish radiological protection authorities, along with the business associations involved in the metal recovery and smelting industry, have established a national system for the radiological surveillance and control of scrap and of the products resulting from its processing.

The system consists of a set of legal bases, the installation of specific radiological surveillance equipment and the enhancement of other general purpose equipment that existed prior to these initiatives, the development of radiological training and information plans for the professionals involved in the metal recovery and smelting sectors and improvement to the national radiological emergency response system.

BACKGROUND

Until the incident that occurred at the ACERINOX factory in May 1998, the presence of radioactive material in scrap had been considered a potential risk in Spain. The event underlined the fact that it was very much a real risk, which might have important health, environmental and, especially, economic consequences.

Prior to the ACERINOX incident, there was general concern regarding this risk. This had not, however, led to any system for systematic action, although certain steelyards had installed detection systems at their entrances and the Nuclear Safety Council (CSN) had initiated a campaign aimed at informing workers in the metal recovery and smelting industries of the risks arising from the presence of radioactive material in scrap.

The event that occurred at ACERINOX was the direct reason for the Ministry of Industry and Energy (MINER) and the CSN to implement two courses of action oriented towards:

- the recovery of affected installations
- the development of measures to avoid other similar events in the future.

The first of these was implemented with direct intervention by the companies owning the affected installations — ACERINOX, EGMASA and PRESUR — and the second with the collaboration of the Spanish Recovery Federation (FER), the Union of Iron and Steel Companies (UNESID) and the National Radioactive Waste Management Agency, Empresa Nacional de Residuos Radiactivos, S.A. (ENRESA).

RECOVERY OF THE AFFECTED INSTALLATIONS

On 30 May 1998 a source of Cs-137 was accidentally smelled in one of the furnaces at the plant owned by ACERINOX in Los Barrios (Cádiz). This source had arrived at the steelyard incorporated in a maritime consignment of scrap that had probably come from the United States.

As a result of smelting of the source, both the ACERINOX plant itself and the industrial organic waste inerting plant belonging to EGMASA, located in Palos de la Frontera (Huelva), which manages fume dust from the steelyard, and the PRESUR experimental metallurgy plant in Fregenal de la Sierra (Badajoz), which uses steelyard dust for its processes, were contaminated. Also contaminated were the Inert Materials Recovery Centre (CRI-9) in Marisma de Mendaña (Huelva), where the inerted materials from EGMASA are tipped and, to a much lesser extent, the garage where some of the trucks that transported the contaminated material are washed.

ACERINOX informed the CSN of the contamination at the steelyard, and the Council immediately ordered that the installation be inspected. The results of the inspection were used for a preliminary assessment of the situation. It was concluded that there was an urgent need to perform a radiological characterization of the affected facilities, the surroundings and those geographical areas which, according to the meteorological information available, might have been affected by the possible release of Cs-137 to the atmosphere via the plant stack. Collaborating with the CSN in the performance of these actions were the Centre for Energy-Related, Environmental and Technological Research (CIEMAT), ENRESA and the PROINSA Radiological Protection Technical Unit (UTPR[1]), which provides support for the CSN in emergency situations.

In view of the results of the radiological characterization, the CSN concluded that the contamination was limited to the affected installations, and recommended that the owners carry out a survey of the internal contamination of the workers and that the MINER urgently adopt adequate radiological protection measures to resolve the radiological situation existing at the affected facilities.

The owner companies of the installations performed an internal dose measurement campaign on the workers, with technical support from the UNESA Mobile Internal Dosimetry Unit.

The Directorate General for Energy (DGE) of the MINER required each of the three companies owning the affected installations to draw up an action plan for decontamination of the facilities and management of the radioactive wastes generated.

ACERINOX, EGMASA and PRESUR prepared their respective action plans, which contained the following:

- a detailed radiological characterization plan.
- a plan for cleaning and decontaminating the affected facilities.
- a radiological protection plan for the cleaning and decontamination operations.

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[1] Organizations legally recognized for the rendering of the radiological protection services required by the regulations governing protection against ionising radiations at facilities not having their own radiological protection services.

The action plans were evaluated by the CSN, which established the radiological protection requirements to be met during the operations. The following are particularly important among these requirements:

- The individual doses occurring during the recovery operations were to be lower than 1 milisievert[2].
- The operations were to be supervised by an UTPR.
- The radioactive wastes were to be managed by ENRESA, in accordance with a specific management plan.
- The results of the operations would be inspected by the CSN prior to this organization's issuing a favourable report, required for performance of the action plans to be declared completed.

ACERINOX, EGMASA and PRESUR carried out the operations foreseen in the action plans, adhering to the conditions established by the CSN, and the latter performed various inspections to check for compliance with these plans[3].

ENRESA drew up a management plan for the radioactive wastes generated during the cleaning and decontamination operations, which was accepted by the CSN. In accordance with this plan, the radioactive wastes generated were removed from the installations for management at the El Cabril radioactive waste disposal facility. The criterion adopted for distinction between conventional and radioactive wastes was the criterion for the exemption of practices contained in Directive 96/29/EURATOM[4].

The CSN continuously informed the local, regional, national and European Community authorities of the progress of the work, and issued various reports on the event and the cleaning and decontamination operations performed. These reports included data on the radiological characterisation of the installations, workers' dosimetry, environmental radiological surveillance, the waste generated and the facility recovery operations.

PREVENTIVE MEASURES

For the development of preventive measures, the MINER and the CSN, with the collaboration of ENRESA, FER and UNESID, have implemented national system aimed at reducing the risks posed by the presence of radioactive material in scrap. The system is structured around:

- regulation of the radiological surveillance and control of scrap;
- installation and improvement of radiological surveillance systems;
- implementation of radiological training and information programmes; and
- enhancement of radiological emergency response plans.

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[2] For informative purposes, it should be pointed out that the annual dose limit for members of the public established by Directive 96/29/EURATOM is 1 milisievert/year.

[3] As of 31 March 2000, all the actions had been completed at the PRESUR and EGMASA plants and the final interventions were being performed at ACERINOX and CRI-9.

[4] The individual doses produced by the management of wastes considered to be non-radioactive are required to be less than 10 microsievert/year.

REGULATION OF THE RADIOLOGICAL SURVEILLANCE AND CONTROL OF SCRAP

A soon as news of the ACERINOX incident became known, the Popular, Socialist and Izquierda Unida parliamentary groups of the Spanish Congress urged the Government to develop specific regulations for the radiological control of scrap. In response to these parliamentary initiatives, a study began of the national and international situation and of the practices adopted in other countries, leading to the actions described below.

INTERNATIONAL PRACTICE REGARDING THE RADIOLOGICAL SURVEILLANCE AND CONTROL OF SCRAP

ANALYSIS OF THE INTERNATIONAL SITUATION AND OF PRACTICES ADOPTED IN OTHER COUNTRIES

No international organization responsible for radiological matters, and more specifically neither the International Atomic Energy Agency (IAEA), the European Commission (EC) nor the OECD Nuclear Energy Agency (NEA/OECD), had established standards or directives applicable to the radiological surveillance and control of scrap.

The EC, through the EURATOM Treaty Article 31 Group of Experts, had issued recommendations regarding levels of declassification for the recycling of scrap from nuclear installations. The IAEA had issued provisional recommendations on levels of declassification for solid materials containing low concentrations of radioactivity and, in collaboration with other international organisations, had published a safety guide on the prevention of illicit international trafficking in radioactive materials.

Systems for the radiological surveillance of scrap had been installed at steelyards, at certain recovery centres and at the borders of most OECD countries. In nearly all cases such installations had been voluntary and based on recommendations issued by the industry itself or by national or regional organizations responsible for radiological protection.

In summary it may be said that, with the exception of Italy, there is no systematic practice in place regulating the radiological surveillance of scrap at an international or national level.

ACTIONS TAKEN

In view of this situation, the Spanish Government, through letters from the Secretary of State for Energy to the Commissioners for Industry and the Environment, requested that the EC adopt Community-wide measures to preclude the radiological risks arising from the recycling of scrap.

In 1999, the EC called three meetings of experts from European Union countries in response to these letters, including the active participation of technicians from the MINER and from the CSN. At these meetings, Spain’s actions regarding the legal development of the radiological surveillance of scrap were seen to be among the most advanced in Europe. The EC has announced the setting up of a Group of Experts to study the possibility of developing specific standards and establishing controls at ports and frontiers with non-member nations.

DEVELOPMENT OF NATIONAL STANDARDS

ANALYSIS OF THE NATIONAL SITUATION

At the time of the ACERINOX incident, the Spanish standards did not specifically contemplate the risks deriving from the presence of radioactive material in scrap, and did not require the radiological surveillance of such material. Likewise, no specific functions had been assigned to any body of the administration for control in this area.

ESTABLISHMENT OF THE LEGAL FRAMEWORK

The Law governing Tariffs and Public Prices for the Services Rendered by the Nuclear Safety Council, Law 14/1999, of 5th May, has modified the Organisation's areas of competence, assigning to it the following functions:

- *"inspect, assess, control, report and propose to the competent authority the adoption of whatever prevention and correction measures might be required in the event of exceptional emergency situations .... when such situations arise in installations, equipment, companies or activities not subject to the system of authorisations included in the nuclear legislation"*
- *"control and watch over the radiological quality of the environment throughout the national territory... and collaborate with the competent authorities in relation to environmental radiological surveillance outside the areas of influence of nuclear or radioactive installations"*

Likewise, Law 14/1999 established that management of radioactive waste generated in such exceptional cases might be undertaken with expenses applied to the financial yield of the fund set up for management of the radioactive waste pertaining to the back-end of the nuclear fuel cycle (ENRESA Fund), in those cases in which the MINER were so to determine.

THE PROTOCOL FOR THE RADIOLOGICAL SURVEILLANCE OF SCRAP

With a view to enacting the provisions of Law 14/1999, the MINER and the CSN have begun drawing up a specific regulation governing the radiological surveillance and control of scrap and the management of radioactive materials detected therein. As an intermediate step in this process, a collaboration protocol has been subscribed by the Administration and the companies involved in the metal recovery and smelting industries. The regulation to be implemented in the future will be the result of the experience acquired in applying this Protocol and of the evolution of the international standards applicable to this issue, especially at European Community level.

The protocol is a voluntary commitment subscribed by the Ministry of Industry and Energy, the Ministry of Public Works, the Nuclear Safety Council, the radioactive waste management agency, Empresa Nacional de Residuos Radiactivos, S.A., the Spanish Federation of Recovery Industries and the Association of Iron and Steel Companies, and is aimed at establishing a national system for the prevention of risks arising from the presence of radioactive material in scrap and in the products resulting from its processing. Subsequent to signing the protocol, the most representative trade unions in the metal industry decided to ratify its terms.

For implementation of the Protocol, the MINER created a register including all those scrap processing installations that had voluntarily accepted its terms. Following the entry of a facility on this register, the MINER formally notifies both the company registered and the CSN.

The commitments acquired by each of the parties signing the protocol are as follows:

The MINER undertakes to:

- generically authorize the transfer to ENRESA of radioactive material detected in order to facilitate to the maximum extent the actions necessary for its removal;
- create and maintain a register of companies subscribing to the protocol; and
- direct whatever actions are required in the event of a situation of generalized contamination or the dispersion of radioactive material.

The Ministry of Public Works undertakes to:

- demand a certificate explicitly stating that merchandise has been subjected to radiological controls at the place of origin, prior to authorizing unloading at any Spanish port; and
- report to the CSN on any incident relating to the above.

The Nuclear Safety Council undertakes to:

- issue the recommendations and technical instructions required for implementation of the protocol;
- establish the radiological criteria to be used as a basis for the investigation and exemption levels necessary for implementation of the Protocol;
- inspect the radiological surveillance and control systems of the facilities;
- advise the different parties on issues relating to the radiological protection of people and the environment; and
- promote and co-ordinate training and information plans on instrumentation and radiological protection for the personnel of companies involved in the metal recovery and smelting industries.

ENRESA undertakes to:

- remove and store the radioactive materials detected in scrap and in the products resulting from its processing, when they exceed the exemption levels;
- provide technical advice to the companies subscribing to the Protocol, especially with regard to the return of radioactive materials to the supplier when such materials come from overseas;
- collaborate in the training and information plans; and
- establish a contract with the subscribing companies for the management of radioactive material detected.

The subscribing companies undertake to:

- establish a radiological surveillance and control system for each facility at which scrap is processed, deploying the technical, human (in-house or UTPR), organizational, training and logistical resources required to detect, isolate and analyse whatever radioactive material might be contained in scrap;

- require a certificate from overseas suppliers demonstrating that the merchandise supplied has been subjected to a radiological surveillance system;
- adopt the measures required to prevent the dispersion of radioactive material and isolate it under safe conditions pending removal by ENRESA;
- notify the CSN of the detection of radioactive materials in quantities or concentrations in excess of the exemption levels;
- transfer radioactive material exceeding the exemption levels, for which the corresponding contract will be subscribed to ENRESA;
- make whatever arrangements are in their power to return to overseas suppliers whatever radioactive material might be detected in their supplies; and
- collaborate in training and information plans.

The protocol establishes the course of action to be implemented whenever radioactive material is detected in scrap or in the products resulting from its processing, which consists basically of the following:

- subjecting all metallic materials and products resulting from their processing and entering steelyards and scrap processing facilities to radiological surveillance.
- immobilising shipments and interrupting processes in which radiation has been detected in excess of the investigation levels;
- performing detailed inspections of shipments or process lines in which radiation has been detected in excess of the investigation levels;
- carrying out the inspections using personnel with suitable knowledge of instrumentation and radiological protection, and a UTPR shall be called in if the radioactivity is detected in process materials;
- including the results of the inspection in a report that explicitly indicates whether the radioactive material exceeds the exemption levels;
- isolating radioactive materials exceeding the exemption levels, under safe conditions, pending removal by ENRESA.;
- notifying the CSN, attaching the report by the specialist;
- the CSN notifying both the facility and ENRESA of the applicability of the generic Authorisation for transfer, and shall register the event;
- ENRESA removing radioactive wastes exceeding the exemption levels, in the terms foreseen in the contract established with the subscribing company, and shall keep such wastes in custody pending their return, transfer to an authorised user or management as radioactive wastes; and
- in the event of the dispersion of radioactive material, the MINER establishing the actions to be taken, with advice from the CSN.

The Protocol establishes that the actions will be financed by the subscribing companies, except as regards the costs arising from the detection of radioactive sources of national origin, which shall be financed through the ENRESA Fund, and that the subscribing companies may pass on such costs to third parties.

The implementation of the protocol is complemented by the development of the following documents:

- *Communication of Entry* on the Register of subscribing companies.
- The generic *Authorization for Transfer*[5], which establishes the criteria to be used to define investigation and exemption levels and other additional precautions required to guarantee the safety of the system established and the transfer to ENRESA of radioactive materials.
- A *CSN Safety Guide,* including recommendations on the technical characteristics of the surveillance and control system, the training of specialist technicians, the capacities of the UTPR, etc.
- The *Type Contract* between ENRESA and the subscribing companies, establishing the conditions of a civil nature for the transfer of radioactive materials detected.
- The *Notification Forms* for cases of detection, included in the Protocol itself.
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INSTALLATION AND IMPROVEMENT OF DETECTION SYSTEMS

INSTALLATION OF SPECIFIC DETECTION SYSTEMS

From the instrumental point of view, the implementation of the protocol refers specifically to the installation of radiation detection systems at metal smelting facilities and those recovery centres at which the scrap is processed (compaction, fragmentation, shearing, etc).

The surveillance and control systems of the subscribing companies may include different types of detection instruments, depending on the dimension and characteristics of the process carried out:

- automatic gate monitors, located at the entrances and exits of plants, for the detection of radiation in shipments of metallic materials;
- portable detection systems for the detailed inspection of shipments in which radiation has been detected or for use at smaller recovery facilities; and
- systems for γ spectrometry analysis of samples taken from the process, in order to guarantee that the resulting products are free from radioactive materials.

In addition, certain facilities may install beacon-type radiation detection equipment in areas of special interest.

IMPROVEMENT OF ENVIRONMENTAL RADIOLOGICAL SURVEILLANCE

The CSN has an environmental radiological surveillance network made up of automatic stations and a network of university laboratories, the objective of which is to maintain a permanent watch over environmental radiological quality.

The lowest levels of radiation that the network stations and laboratories are capable of detecting are sufficient to guarantee the health of persons but not to detect events such as the one that occurred at ACERINOX.

The CSN network is being complemented with a new system which is less dense but equipped with high sensitivity apparatus designed to detect extremely low concentrations of

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[5] Resolution of the Directorate General for Energy, of February 2000, authorising the transfer to ENRESA of radioactive material detected during the radiological surveillance of metallic materials and their processing.

radioactivity in the air. The detection thresholds are close to the levels of contamination that would be expected as a result of events having the characteristics of the ACERINOX incident.

TRAINING AND INFORMATION PROGRAMMES

A training programme on radiological protection and instrumentation has been set up for the management and technical staff of steelyards and scrap storage facilities, along with an information programme for the rest of the personnel. These consist of:

- a *general level* on the fundamentals of radiological protection and the risks deriving from the presence of radioactive material in scrap, aimed at the management and technical staff of steelyards and scrap storage facilities.
- a *technical level* on instrumental techniques and initial actions, aimed at technicians who are required to intervene whenever radioactive material is detected in scrap shipments.
- an *information level* aimed at all the personnel working in the metal smelting and recovery industries, to promote the prevention of risks arising as a result of the presence of radioactive material in scrap.

ENHANCEMENT OF EMERGENCY PLANS

The Basic Nuclear Emergency Plan (PLABEN) is oriented towards emergencies occurring at major nuclear installations, and does not specifically contemplate radiological emergencies at other facilities.

With a view to covering the latter, the CSN and the Ministry of the Interior are reviewing the PLABEN, the aim being to cover a wider spectrum of emergency situations, such as the one that occurred at ACERINOX.

CONCLUSION

The MINER, the Ministry of Public Works, the CSN, ENRESA and the business associations of the metal smelting and recovery industries have established a national radiological surveillance and control system aimed at preventing the risks arising from the presence of radioactive material in scrap and in the products resulting from its processing.

This surveillance and control system:

- is based on a specific legal framework;
- consists of a protocol for collaboration between the companies recycling metals and the Administration, in which the parties undertake to voluntarily establish a set of technical, administrative and safety measures aimed at detecting, segregating, characterizing and managing, without risk, whatever radioactive material might potentially be contained in scrap or in the products resulting from its processing; and
- is complemented by a radiological training and information programme oriented towards the managers, technicians and workers of companies involved in the metal recovery and smelting industries, by improvements to the national environmental radiological surveillance systems and by the enhancement of the radiological emergency plans, in order to take into account events occurring outside the installations subject to the nuclear legislation.

RADIATION PROTECTION IN SUDAN

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Abstract. The regulatory framework as established by the Sudan Atomic Energy Commission (SAEC) Act, promulgated in 1996, is described in the report. Three levels of responsibility in meeting radiation protection requirements are established: the Board, the Radiation Protection Technical Committee as the competent authority in the field of radiation protection, and the SAEC Department of Radiation Protection and Environmental Monitoring as the implementing technical body. The report also refers to environmental activities, patient doses in diagnostic radiology, the management of disused sources, emergency preparedness and orphan sources, and the national training activities in the radiation protection field.

INTRODUCTION

The use of ionizing radiation in Sudan started in the early 1930s, in the field of diagnostic radiology. The use of radioisotopes and nuclear techniques in medicine started in 1965 and gradually spread to other disciplines (agriculture, animal research, hydrology, etc.).

Radiation protection as a discipline started on a limited scale in 1967. In 1971, a law entitled "***Regulation of the Use of Ionizing Radiation, 1971***" established a committee responsible for licensing medical radiation practices.

The "***Atomic Energy Committee Act, 1973***" established, under the supervision of the Chairman of the National Research Council, a committee with a mandate to promote the use of nuclear techniques and to oversee safety in all activities involving the use of ionizing radiation.

However, the two laws did not provide for the establishment of a regulatory framework or a technical authority for radiation protection.

THE REGULATORY FRAMEWORK

The "***Sudan Atomic Energy Commission (SAEC) Act, 1996***" created three levels of responsibility for meeting radiation protection requirements:

THE BOARD

Membership
The Council of Ministers appoints the Board from among high-level officials and scientists; currently the Board has 21 members. The Board is empowered to issue regulations, to promote the use of radiation and nuclear techniques and to ensure radiation safety.

Functions
The Board is responsible for:

(a) approving the structure of the promotional body and of the regulatory body and issuing regulations governing their functions and relationships,
(b) regulating the use of radiation and nuclear techniques,

(c) ensuring the safety of humans and the environment from possible adverse consequences of the use of radiation and nuclear techniques,
(d) appointing the Radiation Protection Technical Committee (RPTC) as the competent authority in the field of radiation protection,
(e) issuing regulations and safety guides drafted and submitted to it by the RPTC,
(f) licensing practices recommended to it by the RPTC, and
(g) licensing sites of radiation and nuclear installations recommended to it by the RPTC.

THE REGULATORY AUTHORITY - THE RPTC

Membership
The RPTC is a national committee whose members are drawn from major institutes and departments connected with the use of ionizing radiation and from bodies responsible for the safety and security of humans and the environment in Sudan.

Functions
The RPTC has the following functions:

(a) preparing drafts of radiation protection regulations and technical guidelines, to be issued by the Board;
(b) establishing radiation protection and environmental monitoring policies and priorities and securing the necessary funds;
(c) supervising the implementation of regulations and safety guides by the designated radiation protection institution;
(d) establishing a technical body to implement regulations and recommendations or assigning their implementation to an existing technical body;
(e) making recommendations to the Board with regard to the issuing of licences for practices and sites;
(f) issuing permits to initiate the operation of licensed practices; and
(g) issuing licences, at the recommendation of the designated radiation protection department, for:
   - designs and drawings of buildings,
   - radiation workers,
   - the export and import of radioactive materials for licensed practices,
   - the certification of radiation sources,
   - the transport and storage of radioactive sources and waste,
   - the management of radioactive waste, and
   - the disposal of cleared radioactive waste.

THE IMPLEMENTING TECHNICAL BODY

The RPTC has designated the Department of Radiation Protection and Environmental Monitoring (DRPEM) of the SAEC as its technical body.

Staff of the DRPEM
The DRPEM, which collaborates closely with departments of analytical chemistry, applied physics and instrumentation, employs 17 scientists and technicians (3 Ph.D., 5 M.Sc. and 7 B.Sc., and 2 with 3-year post secondary school diplomas).
Functions of the DRPEM

The DRPEM has the following functions:

(a) examining licence applications;
(b) carrying out inspections;
(c) keeping an updated inventory of sources;
(d) supervising waste management and storage facilities;
(e) establishing an environmental monitoring programme;
(f) enforcing regulation and safety guide requirements;
(g) providing quality control and monitoring services;
(h) issuing:
  - certificates authorizing licensees to clear sources through customs,
  - certificates stating the radioactive contents of imported and exported commodities, and
  - radiation measuring instrument calibration certificates; and
(i) making recommendations to the RPTC regarding the issuing of licences.

In carrying out its responsibilities, the Board has issued a number of regulations and safety guides. The following are still operational:

(a) a regulation on general procedures for radiation protection (1966);
(b) a regulation on basic radiation protection requirements and dose limits (1996);
(c) a regulation on licensing procedures for the use of radiation sources (1996);
(d) a regulation on the control and management of radioactive waste (1998);
(e) a regulation on the safe transport of radioactive materials (1998);
(f) a safety guide on radiation protection in nuclear medicine (1998); and
(g) a safety guide on radiation protection in industrial radiography (1998).

Inventory of sources
One of the first activities started by the DRPEM was the establishment of a comprehensive inventory with detailed information on sources, sites, functions, owners and operators. The DPREM uses the IAEA's Source Registry System (SRS) and Regulatory Authority Information System (RAIS).

The total number of registered sealed sources in Sudan now stands at 454, of which 319 are used Ra-226 sources. It is believed that the inventory of sealed sources is complete, but we are constantly on the look-out for possible orphan sources, particularly from the industrial sector.

Radioactive sources
(a) Co-60 sources in functioning (3) and disused (1) cobalt therapy machines,
(b) disused Ra-226 needles and rods, with a total activity of about 3.7×10^{10} Bq,
(c) disused Co-60 gamma cells (2),
(d) Cs-137 sources used in LDR after-loading brachytherapy,
(e) damaged and in-use Sr-90 eye applicators,
(f) Sr-90 check sources for therapy level dosimeters,
(g) neutron sources (Am-Be and Ra-Be),
(h) sources used in protection level SSDL and other small calibration sources,
(i) sources used in NDT,
(j) Ir-192 sources used in HDR brachytherapy (also disused sources),
(k) Co-57 flood sources used in calibration of gamma cameras, and
(l) Co-57 sources used in Mössbauer spectroscopy.

Radiation generators

(a) about 400 X-ray machines (in diagnostic radiology and NDT),
(b) one 6 MV linear accelerator (in therapy),
(c) five CT scanners,
(d) one neutron generator (14 MeV),
(e) two XRD units, and
(f) one X-ray calibration unit (SSDL).

RADIATION WORKFORCE (REGISTERED AND MONITORED)

		NUMBER OF	
	FIELD	**INSTITUTES**	**WORKERS**
1	Diagnostic radiology	12	196
2	Radiotherapy	2	48
3	Nuclear medicine	4	48
4	Radiography (students)	2	250
5	NDT	4	68
6	Research	1	10
	Total	25	620

OTHER ACTIVITIES*

A. Environmental

In a country with high hopes as regards mining and petroleum extraction, the existence of a baseline radiation map is essential. In view of the size of the country, the monitoring programme is focused on areas which, from the available geological information, appear to have high probabilities of elevated natural radioactive contents. Radioactive concentrations in different environmental media, gamma dose levels, transfer factors and resulting population doses have been estimated (1,2,5,6 and 8). Also, the marine environment along the Red Sea coast is under investigation (7 and 9). Rn-222 concentrations in the most common types of dwelling have been studied (3). The NORM associated with oil exploitation and gold mining is being examined (10).

B. Patient doses in diagnostic radiology

A plan for studying levels of dose to patients in different diagnostic radiology investigations under existing conditions has been prepared (4).

C. System of notification, registration, licensing, inspection and regulatory provision enforcement

- Applicants (institutions or persons) are granted a provisional licence to start a practice in which ionizing radiation sources are to be used only if the information provided on functions, sites, building plans, personnel and equipment meets the requirements.

* The numbers in round brackets relate to the References later in the paper.

- Sources and equipment may be imported only if the following conditions have been met:
  - the practice has been licensed by the Board,
  - an import licence, stating any special conditions, has been issued by the RPTC,
  - the customs authorities have been informed in advance that authorization exists for delivery of the source to the user, and
  - adequately safe storage arrangements have been made with the harbour administration for sources arriving by sea and with the Civil Aviation Authority for sources arriving by air.
- Personnel of the customs authorities have been trained and made familiar with the requirements, and they are equipped with radiation monitors.
- A transport licence is mandatory for movements of sources within the country.
- The need for storage en route and at the destination must be determined and the necessary procedures worked out and followed.
- An operating licence for the specific practice is issued after a final inspection of the building(s) and the installed equipment and a check on the qualifications of the technical personnel, and after it has been ascertained that all the conditions and requirements stated in the provisional licence have been met.

D. Management of disused sources

A laboratory and an interim storage facility have been constructed mainly to condition and store Ra-226 needles and rods acquired in 1967 for use in radiotherapy (total activity about 3.7×10^{10} Bq). While a final solution is being sought, the interim storage facility is to be used for other small sources and for any orphan sources that are found.

E. Emergency preparedness and orphan sources

There is no written emergency preparedness programme, but there are plans to prepare one during 2001-2002.

As regards orphan sources, all stores belonging to the custom authorities have been inspected; one Ir-192 source was found. All institutes and organizations which may have made use of sources over the years have been requested to provide information about any possible sources in their possession; some requested inspection missions, and their requests were met.

F. National training activities

The relevant departments of the SAEC, in collaboration with other specialized bodies, hold radiation protection training courses and workshops, primarily for medical personnel and customs officers.

In addition, lectures on radiation protection form part of almost all training organized by the SAEC and other users in connection with different applications.

TRAINING COURSES AND WORKSHOPS HELD DURING 1999

Subject	Dates	Target group	Participants
Basic radiation protection	28 March-7 May	SAEC staff and safety officers	24
Radiation monitoring	12-15 June	Customs officers, Khartoum	20
Radiation protection in medicine	7-11 September	Radiation and Isotope Centre, Khartoum	25
Radiation monitoring	10-12 October	Customs officers, Khartoum	22
Radiation protection seminar	10 October	Radiological Sciences Institute	40
Radiation monitoring	17-20 October	Customs officers, Port Sudan	35

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APPENDIX

THE SUDAN ATOMIC ENERGY COMMISSION (SAEC) ACT, 1996

1. PROHIBITS ANY ACTIVITY INVOLVING RADIATION SOURCES WITHOUT A LICENCE.
2. Gives the Board legislative powers to issue regulations and safety guides, as well as a mandate to establish the competent authority (RPTC) and to license practices.

REGULATIONS

The Board has issued five regulations by which:

(a) general radiation protection rules and requirements are set,
(b) internationally recommended dose limits are endorsed,
(c) licensing conditions and procedures and detailed responsibilities of different parties are specified,
(d) transport is covered,
(e) waste management, storage and disposal requirements are specified,
(f) a competent authority is established and its membership, responsibilities, functions and powers are specified, and
(g) a technical department is designated as control body and given all the powers and means necessary for licensing, performing inspections and carrying out other radiation protection operations.

SAFETY GUIDES

It is planned to prepare and issue safety guides for different applications. So far two have been issued:

- Safety guide for radiation protection in nuclear medicine (1998),
- Safety guide for radiation protection in industrial radiography (1998).

Four other safety guides are in different stages of preparation:

(a) Safety guide for diagnostic radiology
(b) Safety guide for radiotherapy
(c) Safety guide for uses of radiation in research and education
(d) Safety guide for uses of neutron sources

Major problems

1. Brain drain problems.
2. Scarcity of equipment and maintenance difficulties due to shortages of suitable manpower and of spare parts.
3. Retrospective licensing - especially at private diagnostic X-ray clinics with old and poorly maintained equipment.
4. Difficulties in confirming the non-existence of orphan sources.

5. Difficulties in bringing NDT operations under control (such operations tend to be performed by foreign companies in remote areas).
6. Public awareness.
7. Financial constraints and government priorities.
8. Problems of spent sealed sources other than Ra-226 needles and rods.

SUMMARY OF DISCUSSION

Session 6

GENERAL DISCUSSION

Chairperson: **J. Loy** (Australia)
Co-Chairperson: **C.-G. Stålnacke** (Sweden)

S. Risica (Italy): I understand that under the IAEA's interregional technical co-operation Model Project INT/4/131 on "Sustainable technologies for managing radioactive wastes" IAEA Member States are receiving assistance with the conditioning of radium needles. The collection of radium needles can be a time-consuming and, more importantly, expensive operation, and I therefore urge the IAEA's Secretariat to recommend to the governments of Member States that they provide financial support for the collection of radium needles.

NATIONAL REPORTS
(Session 7)

Chairperson

J. PIECHOWSKI
France

NATIONAL SYSTEM FOR REGULATORY BODY IN THE DEVELOPING COUNTRIES

I. OTHMAN
Atomic Energy Commission of Syria (AECS), Damascus, Syrian Arab Repubilc

Abstract. The status of radiation protection infrastructures varies from one region to another, and from one country to another in the same region. Some countries are very well advanced, others at an intermediate level, and others way behind.
The Syrian Arab Republic is one of the countries using radiation generating machines, and sealed and unsealed radionuclide sources. The Atomic Energy Commission of Syria (AECS) has the direct responsibility of assuring proper safety for handling such sources on the basis of a solid regulatory infrastructure and conforming with the international standards. The AECS was approached by the IAEA to assist other countries in the area participating in the interregional Model Project on Upgrading Radiation Safety and Radiation Safety and Waste Management Infrastructure by providing them with the available facilities and experience in radiation safety.

COUNTRY PROFILE

Syria lies on the eastern coast of the Mediterranean Sea, bounded by Turkey to the north, Iraq to the east, Palestine and Jordan to the south, and by Lebanon and the Mediterranean Sea to the west. Its capital is Damascus.

The population is 16 673 282. The total area of the country is 185 180 sq km., of which six million hectares are cultivated land and the rest is desert and rocky mountains. The economy is based on agriculture.

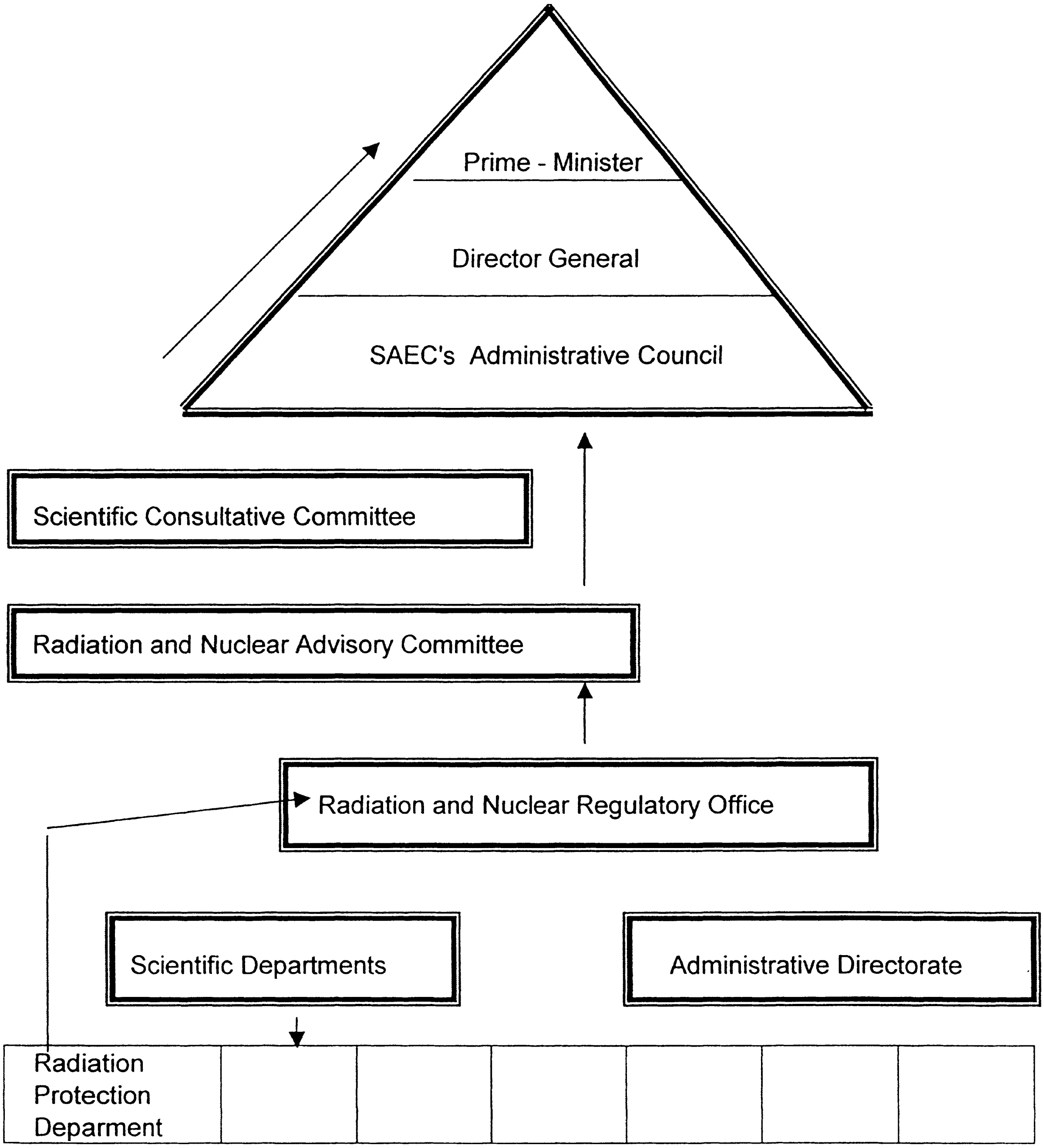
The rate of the population growth is 3.23% with a birth rate of 37.83 births/1000 and a death rate of 5.55 (children/woman).

BACKGROUND

Syria has been a Member State of the IAEA since 1963. Syria has also been party to Non-Proliferation Treaty since 1963. In 1992, Syria signed a safeguards agreement with the IAEA, for a miniature neutron source reactor. The large majority of practices involving the use of various kinds of radiation sources are in medicine, agriculture, industry and research.

The status of regulatory and operational radiation protection infrastructures varies from one region to another, and from one country to another in the region. Some of them are very well advanced and others are in the intermediate level, while some countries are way behind.

The Syrian Arab Republic is one of the countries using radiation generating machines, and sealed and unsealed radionuclide sources. Syria ensured regulatory and operational radiation protection measures which conform with the international standards. In 1996, the Atomic Energy Commission of Syria (AECS) was approached by the International Atomic Energy Agency to assist neighbouring countries participating in the interregional Model Project on Upgrading Radiation Safety and Waste Management Infrastructure by providing them with the available facilities and experience in the field of radiation safety.



Atomic Energy Commission of the Syrian Arab Republic.

BASIC ELEMENTS OF RADIATION PROTECTION INFRASTRUCTURE

The two basic elements in Syrian radiation protection infrastructures are the:

- regulatory infrastructure; and
- operational radiation protection infrastructure.

REGULATORY INFRASTRUCTURE

The regulatory infrastructure consists of the following important elements:

LEGAL FRAMEWORK

In 1998, AECS assigned the Radiation and Nuclear Regulatory Office (RNRO) as an independent office from the Radiation Protection and Safety Department and from other departments. The RNRO reported directly to the Director General of the AECS.

In June 1999, RNRO finalized and implemented a system of notification, registration and licensing with the assistance of IAEA experts. Eleven technical persons work in the RNRO

LEGISLATION

Based on the national law for the AECS's establishment, No. ***12/1976***, is a Ministerial Decree for Radiation Safety no. 6514 dated 8.12.1997, issued by the Prime Minister. This Decree authorizes the Syrian Atomic Energy Commission to regulate all kinds of radiation sources. It set out the basic requirements for radiation protection and the corresponding rules and regulations.

The main components of the Decree are:

1. objective, the competent authority, scope, tasks, authorization, non-compliance, regulatory rules, entry into force.
2. nominating a technical supervision committee for nuclear and radiation safety at the State level (radiation and nuclear safety committee).
3. issuing the required regulations, guides and standards in radiation safety.
4. applying the notification, registration licensing and inspection system for all kinds of ionizing radiation sources.
5. providing the legal rights of inspectors to assure full implementation of this Decree.
6. providing the suspending conditions of licensing, including penalties.
7. supplementation with national regulations for safety and protection.

REGULATIONS FOR RADIATION PROTECTION AND NUCLEAR SAFETY

The RNRO is responsible for preparing the draft regulations. In 1999, the General Regulations for Radiation Protection were issued by the Director General of the AECS, under Decision No. ***112/99*** dated 3.2.1999. It is based on the IAEA publication, the International Basic Safety Standards, Safety Series no. 115 (1996), and adapted to meet the national requirements.

The main items of the decision as a general basic rules are:

- general rules.
- basic principles of radiation protection.
- requirements of licensing of radiation sources, users and producers.
- duties and responsibilities of licensees.
- requirements of radiation safety in medical exposures.
- requirements of radiation safety in occupational exposures.

- requirements of radiation safety in public exposures.
- safe transport of radioactive materials.
- safe management of radioactive waste.
- definitions.
- legal rules.

INSPECTION AND COMPLIANCE PROCEDURES

The regulatory authority under Decision No. ***112/99***, established an inspection and compliance system for staff and facilities to carry out inspections in order to enforce compliance with the national radiation protection regulations.

Another Decision, No. ***814/2000***, dated 10 August 2000 was established to specify the required qualifications and experience of the nominated inspectors, including the examination requirements and the passing conditions in both written and practical exams. The Decision also empowered the AECS to license those inspectors and to provide them with a special identification card to facilitate their inspection activities in the medical field and the industrial one. It also specified the conditions for withdrawal of an inspector's licence and inspection ID.

TRAINING IN RADIATION PROTECTION

The level of qualification of personnel is in general reasonably good, although with some gaps in some hospitals. There is a need for a large number of training events such as courses, workshops, fellowships and on-the-job training to be performed in 2001.

OPERATIONAL RADIATION PROTECTION INFRASTRUCTURE

ADMINISTRATIVE REQUIREMENTS

The responsibilities of employers and workers have been defined under Decision ***112/99***, in addition to the full provision of safe working conditions and of protective equipment, recording and inspections.

OCCUPATIONAL EXPOSURE CONTROL

The control of worker exposures of personnel monitoring is carried out within the Occupational Exposure Section in the Human Protection Division in the Department of Radiation Protection and Safety of the AECS, which is authorized to register all radiation workers in Syria and monitor them periodically. In the Health Surveillance Section, a periodic medical examination (clinical and laboratory tests) for health control is carried out by a qualified and trained team. Monitoring of the workplace is covered by the medical exposure and calibration SSDL in the same division and same department, either independently or in co-operation with Radiation and Nuclear Regulatory Office.

About 1445 workers are monitored. Moreover, individual monitoring is conducted by using two different dosimeter systems: *Film dosimeter*; whereby the dosimeter films are manually developed and their optical densities are measured with one Parry DT 1505 density-meter which, however, is not connected on-line to the computer which is used for the calculation of doses. The film processing capability is of more than 2000 films / month (~ 12 000/year), but these film dosimeters are, so far, only distributed to control the 1445 radiation workers in different fields.

The other dosimetric system is based on *TLD*. The dosimeters are processed with an automatic harshaw model 8800 reader. This reader has a potential to evaluate more than 4000 dosimeters per month. However, only 200 dosimeter cards appear to be available at the AECS and, in reality, only a few of these dosimeters seem to be routinely used, mainly for AECS staff. For other radiation workers, the AEC uses film dosimeters.

It was noticed that the monitored number of persons (~ 1445) is much smaller than the actual estimated ones, approximately ~ 3132 working and distributed in the following fields:

Practices	**No. of Facilities**			**No. of Radiation Workers**	
	Total	Licensed	Inspected	Total	Under control
Radiodiagnostics	800	109	160	2400	1445
Radiotherapy	2	1	1	46	46
Nuclear medicine	19	18	19	50	50
NDT sources	15	3	14	106	106
Industrial irradiator	1	1	1	12	12
Gauges & well logging	38	3	21	220	220
Neutron generator	None	-	-	-	-
Research reactor	1	1	1	13	13
Isotope production	1	1	1	16	16
Waste storage facility	2	2	2	31	31

MEDICAL EXPOSURE CONTROL

In Syria, a relatively large number of practices carry out medical diagnosis and possibly dental radiography while the number of institutions practicing cancer radiotherapy is only found in the nuclear medical centres in Damascus. The second center will start operating in the near future at Teshrean University in Latakia City. A third centre is planned to be established in Aleppo in 2001.

Currently, our new updating regulations enforce medical exposures - covering the equipment used in medical practices, their quality and operational characteristics and patient protection provisions — to have and implement a proper medical exposure control for radiological patients.

In radiotherapy, the amount of equipment available is considered insufficient for our country. Brachytherapy is correctly carried out with appropriate equipment although to a limited degree.

There is a shortage of qualified physicists who have attended proper training courses in radiation protection, and of radiographers and doctors who practice the medical procedures.

To cover this shortage of physicists and technicians, the AECS is planning, for 2001 and in co-operation with the IAEA, to hold a postgraduate programme (radiation protection diploma) in medicine.

Syria has a national secondary standards dosimetry laboratory (SSDL) at the AECS, which is managed by a well qualified and trained team.

ENVIRONMENTAL PUBLIC EXPOSURE CONTROL

A new organizational structure for the Environment Protection Division has been developed. Two sections have been introduced, the Environment Monitoring Section and the Food Chain Monitoring Section.

The AECS is in the process of establishing a National Environmental Monitoring Programme. The AECS's laboratories have the equipment and the ability to carry out the analytical and measurement procedures required by a comprehensive environmental monitoring programme, which seems to be satisfactory.

RADIOACTIVE WASTE MANAGEMENT

Radioactive waste management has priority in the Syrian radiation safety programme. The AECS, in co-operation with the IAEA, is establishing a radioactive waste management facility. In 1991, AECS engineers of the waste management group worked out a conceptual design. In July 1993, the design was discussed with members of WAMAP during their visit to Syria, and later, it was modified with the assistance of the IAEA representative in Istanbul during a meeting on the demonstration of pre-disposal of radioactive waste management methods and procedures. All civil engineering drawings with modifications were discussed and reviewed during an IAEA mission in December 1996. Some modifications were elaborated, taking into account technological solutions in other Member States. Civil construction of the facility is completed. The AECS is procuring the technical equipment to be installed in the facility by early 2001.

In 1998, a Registration and Storage Section was established in the Radiation Waste Division in the Department of Radiation Protection and Safety to survey the situation of waste generation in the country and to keep a record of the production of radioactive waste and spent sources.

A particular problem is the management of the large amount of residues from operations involving natural radionuclides. This includes primarily the disposal of radium and radon isotopes from scale formed in the oil industry and earth contaminated by the evaporation of water from lagoons. A code of practice to deal with the radiation protection and management problems caused by this waste and the associated contaminated equipment is being considered and capping techniques to contain the large volumes of contaminated waste soil are in progress.

In addition, mining and milling operations produce natural radionuclides, the management of which is currently under consideration.

General Regulations for Protection of Ionizing radiation issued by the AEC in 1999 include the principle requirements for the safe management of radioactive wastes, which is already being implemented in the decontamination of the oil fields. The detailed regulations are planned for early 2001.

TRANSPORT SAFETY

The principle regulations on safe transport of radioactive materials were mentioned in the general regulations issued in 1999. The detailed regulations in have been approved and were issued under Decision No. 813/2000 dated 10 August 2000.

EMERGENCY RESPONSE AND PREPAREDNESS

Various initiatives to produce regulations in emergency planning and preparedness are under consideration. The first draft of a general plan of emergency response and preparedness is available, and its final draft version is expected to be submitted early in 2001.

This plan needs to be finalized in co-operation with some other concerned public institutions in the country.

On the basis of the General Protection Regulations of Ionizing Radiation issued in 1999, each radiological practice has to submit its emergency plan to the AECS for licensing.

An emergency intervention mobile unit is being studied and the assistance of the IAEA has been requested to identify medical facilities able to deal with overexposed and contaminated persons.

A GENERAL DESCRIPTION OF THE SWEDISH RADIATION PROTECTION REGULATIONS OF RADIOACTIVE SOURCES

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Abstract. The regulation of ionizing radiation in Sweden is based on both the Radiation Protection Act and Ordinance from 1998. The Swedish Radiation Protection Institute (SSI) acts as the regulatory authority for radiation safety and issues detailed regulations in specific areas. The report summarizes how the SSI controls radiation sources, including orphan sources for which a process for analyzing their occurrence has started in Sweden. A number of proposed procedures for the control and follow-up of sealed radioactive sources is provided.

REGULATION GENERALLY

The legal basis for the regulation of ionizing radiation in Sweden is the Radiation Protection Act from 1988. Together with the Radiation Protection Ordinance of the same year, these two legal documents form the basis for the activities of the radiation protection authority, the Swedish Radiation Protection Institute (SSI). Both documents have recently (year 2000) been updated to comply with 96/29/EURATOM, the European Union's version of the Basic Safety Standards (BSS). This elucidates the influence of the European Union that forces member countries like Sweden to comply with EU law and implement directives. The two Swedish documents mentioned above are both based on the ICRP recommendations but written in a general style. The radiation protection authority, the SSI, writes more detailed regulations of specific areas. These regulations are also undergoing an updating to comply with the EC directives. Furthermore, there are also specific conditions associated with individual user licenses. In Sweden, matters concerning occupational exposure in non-nuclear industry and research facilities are controlled by a subgroup within the Department of Occupational and Medical Exposure at the SSI.

This kind of regulation structure has both advantages and disadvantages depending on the cultural environment where it is applied. For some other countries, it may be preferable to have more enforcement built into basic legislation. A functional competent authority is assumed to have the resources to write and to supervise detailed regulations.

The level of knowledge about radiation physics, the biological effects of radiation and existing regulations possessed by both licensees and workers is vital for implementing radiation protection. The licensee is usually a legal person, such as a company, which should have the resources to comply with regulations but the physical actors at an event with radiation protection consequences are usually people with limited knowledge to help them make decisions.

NATIONAL CONTROL OF SEALED SOURCES

The Swedish control of sealed sources can be summarized as follows: Within the non-nuclear industry, almost every single source is given a separate licence connected with a justified activity of the user, the licence holder. For research facilities, there is another type of licence covering all radiation related activities of the licence holder. In this case, there is no clear registration of each single source below 0.5 GBq at the authority but the user is obliged to keep such a record. This difference is based on the assumption that research facilities such as universities are more competent in radiation protection then some industries are. To make the work at the authority less time-consuming, there is a tendency to move against the latter type of licensing using more advanced computer based registers for the administrative control and to demand more knowledge and quality assurance at the industry. The time gained is then spent on physical control of sources by means of inspections focused on the stronger sources and more complex radiation protection situations. In these inspections a substantial part of the effort is spent on checking the organization of radiation protection, including the documentation of the licensee and the level of knowledge of the employees.

A significant part of the Swedish control of industrial sources is obtained through the control of those national companies that supply such sources or equipment to the user industry since a limited number of these suppliers control most of this market. These trading companies should be forced to check that their customers have both knowledge of the equipment and proper licensing for it before any source is physically transferred to the user. Most of the equipment containing radioactive sources should also have radiation protection built into its design. The suppliers should report to the sold sources to the authority. Many of these radioactive sources are part of some measuring equipment that the user is not always is aware of.

Another way of possessing a source is to import it directly to the user company, which is becoming more common with more porous borders. Within the EU, there is a union law, EURATOM 1493/93, that requires a receipt from the authority in the receiving country to verify that the receiver of a source is licensed for that source before it is allowed to be sent by the supplier and to transverse the boarder. Also, sources that leave Sweden for countries outside the EU now need an exit permit and the sender is obliged to show that the receiver is licensed to handle such a source within the receiving country.

Due to national and international focus on safety and security of sealed sources (EU and IAEA) a process of analysing the associated problems such as the occurrence of orphan sources has started in Sweden. The first part of this is to check the actual source inventories with all known holders of industrial source licenses. These data will be used to update the source register at the authority. The computer based register should contain data on source/license holder identity (registration number from commercial registration authority), source identity (ID-number/ commercial identification), place for installation, nuclide, date, type, routines for exchange etc. The sources should stay traceable through the register until they are safely placed in long time storage, decayed below exemption limits or transferred to the register of some other nation.

Orphan sources often tend to show up in scrap yards and smelting facilities. In Sweden there are a limited number of large dominating scrap-handling companies, large enough to be considered as credible and law abiding. Many of these large scrap companies have, on their own initiative, installed gamma detectors for all entering incoming transports of scrap material, as have the large smelting facilities. Such detector installations at critical crossroads for goods may be very useful, e.g. at border customs. Swedish transport legislation is not covered by the SSI but it is based on the IAEA safety series on transportation. It is part of the dangerous goods regulation that follows the ADR, the European agreement concerning the international carriage of dangerous goods by road, and is supervised by the police and the national rescuing authority.

FUTURE

How the safety of sources will be further handled depends, to a large extent, on international bodies such as the IAEA and especially on a foreseen EC directive on “the control and follow-up of sealed radioactive sources”. A number of proposed controlling procedures are of interest including:

- introducing an international and unique source identification number that could be used to trace any source worldwide from its origin to decommissioning and long term safe storage;
- agreeing internationally upon one or two activity limits to which such a formalized registration should apply;
- establishing an international channel for exchange of information on the movements of sources across borders. Through this channel, it should also be possible to circulate inquiries about lost or found sources;
- limiting the number of radioactive sources used by encouraging the use of alternative technology when applicable.

Special attention should be paid to common problems such as fast undeclared transferring of goods as part of the activities of illegal organizations, multinational companies, or companies going bankrupt, changing name or owner. Another problem is the substantial cost today associated with the legal decommissioning of sources in many countries, which may very well create orphan sources for economic reasons. These problems all need to be minimized by national regulations and economic conditions. It should not be profitable to handle radioactive sources in any illegal way.

THE REGULATORY CONTROL OF RADIATION SOURCES IN TURKEY

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Abstract. In Turkey, the national competent authority for regulating activities involving radioactive sources is the Turkish Atomic Energy Authority, which implements the responsibility for the safety and security of radiation sources through its Radiation Health and Safety Department. The report describes the organization of the regulatory infrastructure for radiation safety in Turkey and, after a brief explanation of the current legal framework for such purpose, it refers to how the management of radiation sources is carried out and to the new provisions regarding radiation sources, including inspections of licensees and training on source safety. Finally, the report provides information on the Ikitelli radiological accident in Turkey and the current public concern about radiation sources after it happened.

REGULATORY INFRASTRUCTURE OF TURKEY

In Turkey, the national authority for regulating activities involving radioactive sources is the Turkish Atomic Energy Authority (Turkish abbreviation TAEK). As can be seen from Figure 1, the Radiation Health and Safety Department (RSGD) of the TAEK is responsible for the safety and security of radiation sources. The RSGD operates radiation monitoring centres in five regions; the Health Physics Division of the Çekmece Nuclear Research and Training Center (ÇNAEM) operates radiation monitoring centres in the other two regions, the measurement results being sent to the RSGD for evaluation.

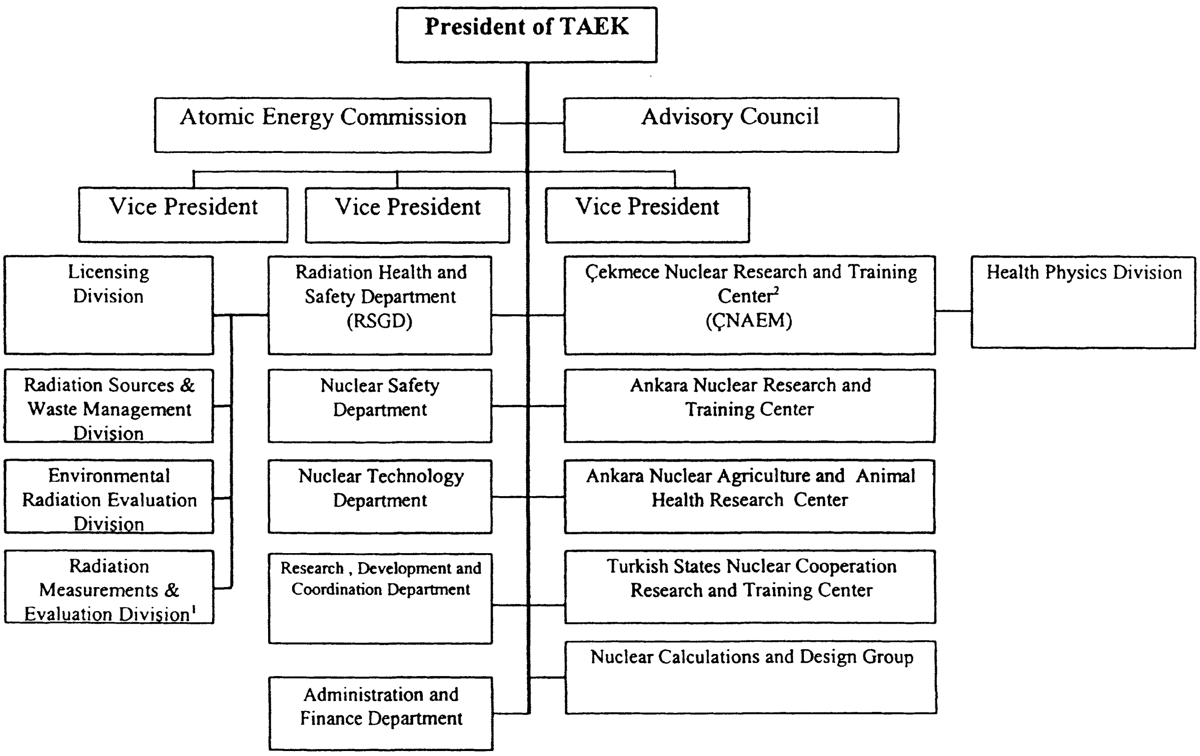

Figure 1

CURRENT LEGISLATION

The Turkish Atomic Energy Act, the basic law, states as its objective the promotion of nuclear energy R & D and utilization for peaceful purposes; it deals in very broad terms with the control of nuclear materials, nuclear reactors and nuclear waste and with protection against radiation hazards. A Radiation Safety Decree provides for a licensing regime for the use, production, import, export, transport and storage of radiation sources. The recently published Radiation Safety Regulation is based on the BSS and EC Directive 96/29/Euratom.

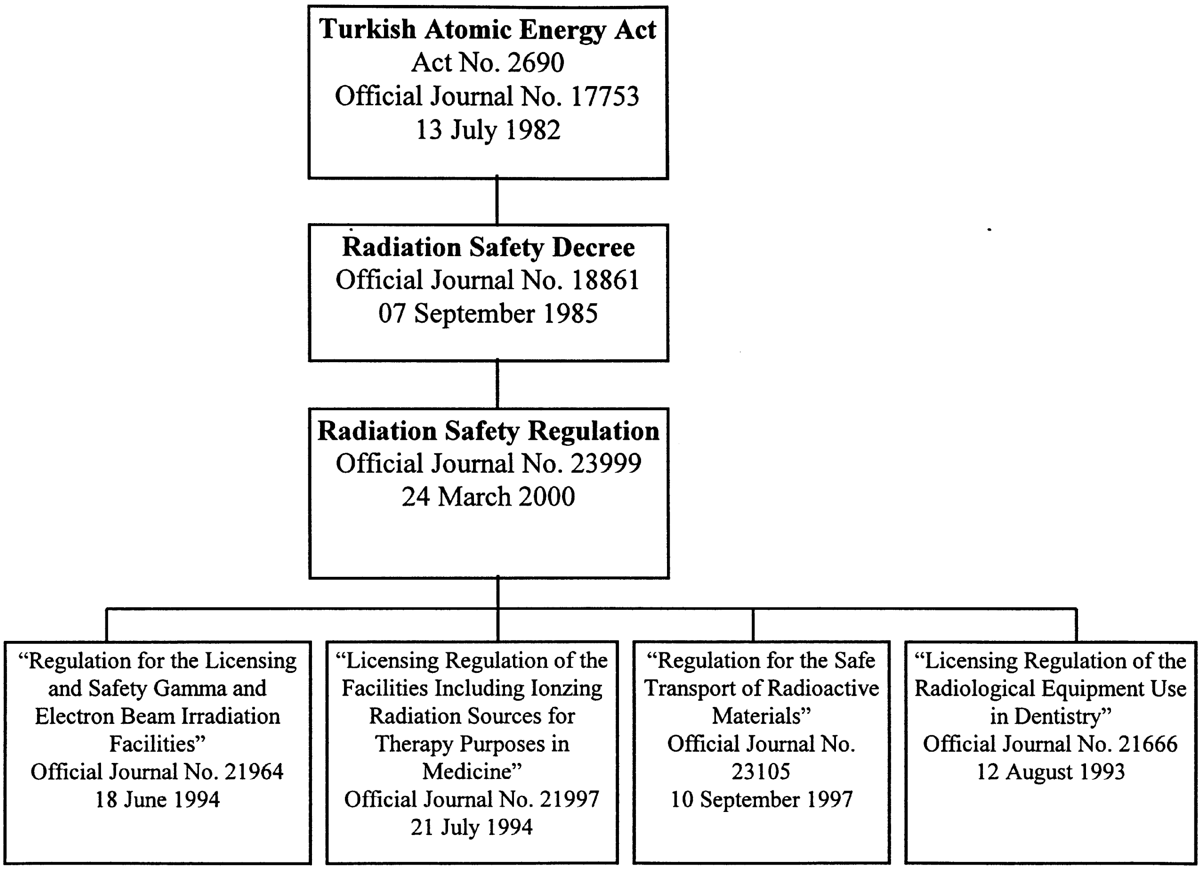

Figure 2

THE MANAGEMENT OF RADIATION SOURCES

The Radiation Source and Waste Management Division of the RSGD is responsible for granting permission for the import, export, transport, maintenance, etc. of radiation sources and of devices containing radiation sources. The Radiation Safety Regulation requires that companies wishing to engage in such activities first obtain a licence. Some other important aspects of the national system for ensuring the safety of radiation sources are as follows:

(a) Permission is needed also from the TAEK every time a source is imported into, exported from or transported within Turkey. In order to obtain permission to transport sources, the consignor must comply with the Turkish Regulations for the Safe Transportation of Radioactive Substances; the consignor must provide the TAEK with, inter alia, details of the transport route and emergency plans. Imported sources are subject to customs controls by TAEK officials.

(b) Radiotherapy facility operators must notify the TAEK each time a source is changed. The TAEK then carries out dose rate measurements to ensure that the shielding specifications of the installation for the new source are satisfactory. In addition, the output values of cobalt-60 teletherapy sources are checked, using TLDs, by the dose comparison method at the Secondary Standard Dosimetry Laboratory (SSDL) of the TAEK.

NEW PROVISIONS RELATING TO RADIATION SOURCES

The TAEK will take the following actions to prevent radiation accidents:

(a) All radiotherapy centres (46) will be routinely inspected. Licence conditions will be reviewed and the details of cobalt-60 sources will be compared with the TAEK inventory. Furthermore, licensees will be informed of the procedures for re-exporting used teletherapy sources, and the TAEK will offer temporary storage at the ÇNAEM for such sources if necessary.
(b) The output of all cobalt-60 teletherapy machines will be checked regularly with TLDs supplied by the TAEK's SSDL.
(c) Companies which apply to the TAEK for permission to re-export sources will be required to specify the exact date when the sources will be delivered to the consignee. The re-export must take place not later than 15 days after [submission of] [approval of] the application, and the consignor must ensure that the consignee confirms receipt of the source(s).

INSPECTIONS OF LICENSEES

The Radiation Safety Regulation requires that the users of radiation sources and of devices containing radiation sources be inspected regularly in order to ensure that they are complying with the Regulation. Additional inspections may be necessary - for example, after an incident or accident. Inspections may involve one or more of the following:

(a) ensuring that equipment, facilities, systems, buildings and operational procedures correspond to the Radiation Safety Regulation,
(b) the examination of records relating of personnel, to the collection of radioactive waste, to radiation sources and to incidents or accidents,
(c) interviews and/or consultations with licensee staff,
(d) visual examinations of working practices,
(e) checking systems operations and warning signs,
(f) checking on the follow-up to previous inspections,
(g) seeking deficiencies and problems not previously identified.

TRAINING IN THE SAFE USE OF RADIATION SOURCES

The provision of theoretical and on-the-job training in radiation safety, particularly for regulatory authority staff, is one of the most important activities of the TAEK (20 new regulatory officials have been recruited by the RSGD this year). The main topics are: the operation of systems of notification and authorization; the development of regulatory requirements; the inspection of premises; and the enforcement of the Radiation Safety Regulation.

One- and or two-day educational programmes have been organized for customs and civil defense officers who may encounter orphan sources in the course of their duties.

Training programmes have been organized for the purpose of making users of radiation sources thoroughly aware of the requirements of the Radiation Safety Regulation; booklets and other information material have been distributed to users, who — like regulatory officials — need to know how to deal with radiological emergencies that may arise owing to a breakdown of controls.

PUBLIC CONCERN ABOUT RADIATION SOURCES AFTER THE İKİTELLİ ACCIDENT

The İkitelli accident was the first major radiological accident in Turkey. News of the accident spread immediately after its discovery, and it was the main story in the next morning’s newspapers. The media coverage continued for several days, and this created great public anxiety. Both the ÇNAEM and the medical authorities had to deal with many inquiries from members of the public concerned about their health.

Initially, the media compared the accident with the Chernobyl accident, which resulted in a significant overestimate of the effects, and public discussions tended to focus on identifying and punishing the responsible persons. Subsequently, a positive interaction developed between the media and the nuclear sector; journalists were free to interview radiation protection experts and were regularly provided with details of the actions being taken to minimize the health and environmental effects of the accident, and the authorities were perceived by the public to be providing accurate information.

The successful recovery of the abandoned source was reported by the media, and this, in conjunction with the open public awareness policy of the ÇNAEM administration, helped to reduce public concern.

The psychological impact of the accident on the public was high, as expected. The family most involved in the accident experienced great anxiety and social isolation from friends and relatives.

Previously, public concern about nuclear energy had related to the operation of nuclear power plants, to the production of isotopes at research centres and to nuclear weapon tests. This accident created a general awareness that medical and other applications of radioactive materials can also pose a considerable risk to the public and therefore require strict regulation.

RADIATION PROTECTION SAFETY IN UGANDA — EXPERIENCE AND PROSPECTS OF THE NATIONAL RADIATION PROTECTION SERVICE

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Abstract. The Uganda National Radiation Protection Service (NRPS) is a technical body under the Atomic Energy Control Board, established by Law — the Atomic Energy Decree of 1972, Decree No. 12, to oversee and enforce safety of radiation sources, practices and workers; and to protect the patients, members of the public and the environment from the dangers of ionizing radiation and radioactive wastes. The Ionizing Radiation Regulations (Standards) — Statutory Instruments Supplement No. 21 of 1996 — back up the Law.

The Law requires all users, importers and operators of radiation sources and radioactive materials to notify the NRPS for registration and licensing. The NRPS is responsible for licensing and for the regulatory enforcement of compliance to the requirements for the safety of radiation sources and practices.

There are about 200 diagnostic X-ray units, two radiotherapy centres, one nuclear medicine unit, several neutron probes, about three level gauges and two non-destructive testing sources and a number of small sealed sources in teaching and research institutions. About 50% of these sources have been entered in our inventory using the RAIS software provided by the IAEA.

There are about 500 radiation workers and 250 underground miners. The NRPS covers about 50% of the radiation workers. It is planned that by June 2001, all occupational workers will be monitored, bringing coverage to 100%.

The Government of Uganda is making the necessary legal, administrative and technical arrangements aimed at establishing the National Radiation Protection Commission as an autonomous regulatory authority. The Atomic Energy Decree of 1972 and Regulations of 1996 are being revised to provide for the National Radiation Protection Commission and to make it comply with the requirements of the International Basic Safety Standards Safety Series No. 115.

BACKGROUND

Uganda is one of the few countries in Africa that established legislation on radiation protection and safety in the 1970s. The Uganda National Radiation Protection Service (NRPS) is a technical body under the Atomic Energy Control Board, established by law (the Atomic Energy Decree of 1972, Decree No.12, Section 14(1)) to:

(a) determine the extent of exposure to ionizing radiation of the public and workers and, subject to the provision of this decree, determine the degree of risk of such exposure;
(b) be responsible for examining, as may be deemed necessary by the chief radiation safety officer, all premises in respect of which a licence to use radiation and all places of disposal for radioactive material and wastes is in force;
(c) advise the Board on the extent of exposure to persons in Uganda; and
(d) advise licence holders and recommend steps desirable to reduce exposure to acceptable limits.

The Ionizing Radiation Regulations (Standards) — Statutory Instruments Supplement No. 21 of 1996 — back up the Law. The Atomic Energy Decree of 1972 and Regulations of 1996 are being revised to provide for the establishment of the National Radiation Protection Commission as the regulatory authority and its technical secretariat, and to make it comply with the requirements of the International Basic Safety Standards Safety Series No. 115.

The NRPS is under the Ministry of Energy and Mineral Development and it is presently housed in the Department of Physics, Makerere University. It is supported by the International Atomic Energy Agency (IAEA) under its technical co-operation programme. The IAEA support includes provision of equipment, training of NRPS staff and expert missions to advise project counterparts.

REGULATORY INFRASTRUCTURES IN UGANDA — THE NATIONAL RADIATION PROTECTION COMMISSION

The Atomic Energy Decree No.12 of 1972 set up the Atomic Energy Control Board and the Radioisotope Advisory Committee as policy organs for the safety of radiation sources and practices and other aspects related to applications of nuclear technology in Uganda. The Atomic Energy Control Board and the Radioisotope Advisory Committee, however, have been non-functional. The members of the Atomic Board were appointed in 1995 and met only once in five years. Members to the Radioisotope Committee have not yet been appointed.

The NRPS took on the role of supervision and enforcement of safety of radiation sources and practices. It started as an activity in the Radiation Physics Group, Department of Physics, Makerere University. Six staff linked to NRPS are employees of Makerere University or scientists with interest in radiation physics.

The Government of Uganda is to establish the National Radiation Protection Commission (NRPC), consisting of a policy organ and a technical secretariat. The NRPC as the regulatory authority shall be responsible for the control and safe use of radiation sources, through requirements for notification, registration, authorization and licensing.

The proposed structure of the NRPC consists of a Commission of four people headed by the chief regulator and a technical secretariat of 18 people headed by the executive secretary.

MICROSTRUCTURE FOR NATIONAL RADIATION PROTECTION COMMISSION

Minister
Energy & Mineral Development

As the activities increase and more resources become available, the NRPC shall expand further.

CURRENT ACTIVITIES OF NRPS IN RADIATION PROTECTION

The use of ionizing radiation in Uganda is on the increase. Major users of ionizing radiation include the Ministry of Health (radiotherapy, nuclear medicine, radiology, virus research institute); the Ministry of Agriculture (Kawanda Research Centre, Animal Breeding Centre, tsetse control), the Ministry of Industry and Commerce (level gauging and non destructive testing), the Ministry of Works (road and other construction services), Makerere University (National Radiation Protection Service, veterinary medicine, agriculture), the Civil Aviation Authority and several others. Sealed radiation sources in the Ministries of Health, Agriculture and Works have high activities and are potentially dangerous in a case of error or accident.

With the support of the IAEA, the NRPS set up a laboratory for personnel monitoring, quality assurance/control and food monitoring programmes. An inventory of radiation sources in Uganda has been started.

FOOD MONITORING

Food monitoring is conducted using a NaI gamma spectrometer. Imported foodstuffs are analysed for possible radionuclide contamination, resulting mainly from accidents or discharges at nuclear reactors in the countries of origin. Monitoring is done in collaboration with the Uganda National Bureau of Standards (UNBS). Studies of concentrations of radionuclides in locally grown foodstuffs have started.

PERSONAL MONITORING

There are about 500 radiation workers and 250 underground miners countrywide. The NRPS monitors about 300 radiation workers. The majority of workers not monitored are from upcountry hospitals and private clinics. Workers in mines are exposed to high natural radiation but are not monitored. We hope to extend occupational exposure monitoring to 100% coverage by June 2001.

QUALITY ASSURANCE/CONTROL

In Uganda, the number of people undergoing X-Ray examinations is steadily rising. There are about 200 known X-ray machines in both Government and private hospitals. An unspecified number of X-Ray Units have been imported and are in use, some without proper licensing and supervision, particularly in small private clinics/health centres.

Quality assurance/control has been running on a regular basis in major hospitals and health centres in Kampala, and the Civil Aviation Authority in Entebbe. Quality assurance and control of many X-ray machines, radioactive sources and radiation detectors is not performed on a regular basis. We plan to achieve 75% of medical exposure control and regular quality assurance of radiation sources and detectors by December 2001.

INVENTORY OF RADIOACTIVE SOURCES

Besides the 200 X-ray units, there are several small radioactive sources in schools and tertiary institutions used for teaching and research. There are two Co-60 teletherapy sources; one brachytherapy unit using Cs-137 and Sr-90 sources; one nuclear medicine unit using a Tc-99m generator, I-131 and I-127. There are about five neutron probes, three level gauges and two non-destructive testing sources. Some construction companies have without licenses imported sealed radioactive sources into the country. The NRPS does not have facilities for handling "hot" or long lived radioactive wastes. One area of concern has been relatively high activity ores illegally brought into Uganda.

The NRPS has started the task of locating, identifying, categorizing and collecting all radiation sources both in use and spent. The RAIS software and fieldSPEC doserate meter provided by the IAEA are being used to prepare this inventory. About 50% of the sources have been registered. We hope to achieve 100% coverage by March 2001.

EMERGENCY PREPAREDNESS

Emergence preparedness and response for radiological disasters has not been set up. The Government, however, has a general disaster management framework under the Prime Minister's office.

PROSPECTS

The Government is committed to setting up and securing funding the National Radiation Protection Commission — the regulatory authority. The legal framework is almost complete and consultations with the IAEA have been carried out. The National Radiation Protection Service/Commission will soon have the means and infrastructure to provide safety of radiation sources and security of radioactive materials.

RADIATION SOURCES SAFETY AND RADIOACTIVE MATERIALS SECURITY REGULATION IN UKRAINE

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Abstract. Radiation sources are widely used in Ukraine. There are about 2500 users in industry, science, education and about 2800 in medicine. About 80 000 sealed radiation sources with total kerma-equivalent of 450 Gy∗м^2/sec are used in Ukraine. The exact information about the radiation sources and their users will be provided in 2001 after the expected completion of the State inventory of radiation sources in Ukraine.

In order to ensure radiation source safety in Ukraine, a State System for regulation of activities dealing with radiation sources has been established. The system includes the following elements: establishment of norms, rules and standards of radiation safety; authorization activity, i.e. issuance of permits (including those in the form of licences) for activities dealing with radiation sources; supervisory activity, i.e. control over observance of norms, rules and standards of radiation safety and fulfilment of conditions of licences for activities dealing with radiation sources, and also enforcement.

Comprehensive nuclear legislation was developed and implemented from 1991 to 2000. Radiation source safety is regulated by three main nuclear laws in Ukraine: On the use of nuclear energy and radiation safety (passed on 8 February 1995); On Human Protection from Impact of Ionizing Radiation (passed on 14 January 1998); On permissive activity in the area of nuclear energy utilization (passed on 11 January 2000). The regulatory authorities in Ukraine are the Ministry for Ecology and Natural Resources (Nuclear Regulatory Department) and the Ministry of Health (State sanitary-epidemiology supervision).

According to the legislation, activities dealing with radiation sources are forbidden without an officially issued permit in Ukraine. Permitted activities with radiation sources are envisaged: licensing of production, storage and maintenance of radiation sources; licensing of the use of radiation sources; obligatory certification of radiation sources and transport packages for shipment of radiation sources; State registration of radiation sources; licensing of radiation material transportation.

In 1997, the Government of Ukraine decided to establish a unified computerized system of accountancy, control and registration of radiation sources – the State Register of Radiation Sources (Register). In 1998, under the Ukrainian State Production Enterprise “Isotope” a separate subdivision “State Register of Radiation Sources” was established. This subdivision functions as the main registration centre, and has been supplied with computer equipment with the assistance of the IAEA. During 1999-2000, the basic documents that regulate the legal status of the Register, the radiation source registration procedure and the State inventory of radiation source procedure were developed and approved by the relevant ministries.

Urgent commissioning of the Register and starting the State registration of radiation sources will form a good basis for considerable upgrading of the level of safety and security of radiation sources, reduction of illicit trafficking in radiation sources, and investigation of illicit trafficking cases. Lack of funds is the main problem impeding the commissioning of the Register.

On the basis of analysis of safety regulation system for activities dealing with radiation sources in Ukraine, we can draw a conclusion about its sufficiency for effective safety regulation of radiation sources and security of radioactive materials.

INTRODUCTION

Radiation sources are widely used in Ukraine. Nowadays radiation sources are in use at more than 2500 non-medical enterprises (organizations, institutions). In medical application, there are 2435 X-ray rooms where 10 677 X-ray instruments are in use; 64 departments for radionuclide diagnostics; 130 gamma-therapy and 176 X-ray apparatuses are in use for radiation treatment. According to the data available for 1995, in Ukraine 80 000 sealed radionuclide sources with total KERMA- equivalent of about 450 Gy-m2/c were in use, 1000 items of which are sources of high power. In 2001, the State inventory of radiation sources will be completed, which will provide an accurate list of all the sources that are in use in Ukraine to the end of 2000.

LAWS OF UKRAINE

1. On the use of nuclear energy and radiation safety
2. On human protection from impact of ionizing radiation
3. On permissive activity in the area of nuclear energy utilization

Regulations (normative-legal acts) approved by resolutions of the Government and orders of the President of Ukraine. Main documents of this level in the area of radiation sources safety are:

- Resolution #1020 dated of 03.07.98 of the Cabinet of Ministers of Ukraine "On procedure to license enterprise activity" should be replaced by currently prepared for approval "Provision on the procedure to license separate types of activity in the area of nuclear energy utilisation";
- Resolution of the Cabinet of Ministers of Ukraine "On some issues related to activity dealing with radiation sources" - is developed and in 2000 it will approve list of radiation sources, the activity to deal with those is released from licensing, and the procedure for state registration of radiation sources;
- Provision on the procedure to define an amount of fine and imposition of a penalty on enterprises, institutions and organisations in the area of nuclear energy utilisation in case of their violation of safety rules, norms and standards or conditions of permits to perform the works;
- Resolution #847 dated of 04.08.97 of the Cabinet of Ministers of Ukraine "On establishment of State Register of Radiation Sources";
- Procedure for ecology control by subdivisions of State Ecology Inspection of Minecosafety of Ukraine over exports of ferrous and non-ferrous metal scrap (approved by Resolution # 999 dated of 02.07.98 of the Cabinet of Ministers of Ukraine)

- Safety Radiation Norms of Ukraine (NRBU - 97);
- Main sanitary rules to deal with radioactive substances and other radiation sources (OSP-72/87) which in 2000 will be replaced by Main sanitary rules to deal with radiation sources of Ukraine (OSPU);
- Instruction on the procedure to issue license to subjects of enterprise activity for purchase, possession, sale, operation, the use of radiation sources and conditions and rules to perform these activities and exercise control over their observance. It should be replaced by currently prepared for approval "Instruction on conditions and rules for production, maintenance and storage of radiation sources, and also the use of radiation sources and exercise control over their observance";
- Procedure to issue safety certificates during radioactive material transportation;
- Provision on ecology control at access points of the state border of Ukraine;
- Documents of State Accountancy and Control System of Radiation Sources – register of Radiation Sources, in particular: "Procedure for radiation sources registration", "Form of registration card", "Instruction on State inventory of radiation sources", "Procedure for the use of the Register";
- Supplement to list of goods which are subject to obligatory certification in Ukraine

Figure 1. Legislative basis of Ukraine in the area of radiation sources safety.

STRUCTURE AND LEGISLATIVE BASIS OF RADIATION SOURCE SAFETY REGULATION

In order to ensure safety of activities dealing with radiation sources in Ukraine, a State system for regulation of activities dealing with radiation sources has been established. The system comprises:

- the establishment of norms, rules and standards of radiation safety;
- permissive activity, i.e. issuance of authorizations – permits (including in a form of licence) for activities dealing with radiation sources;
- supervisory activity, i.e. control over:
  - observance of norms, rules and standards of radiation safety;
  - fulfilment of conditions of permits for activities dealing with radiation sources;
  - enforcement.

LEGISLATIVE BASIS FOR RADIATION SOURCE SAFETY

From 1991 to 2000, during nine years of independence, Ukraine has developed and implemented comprehensive nuclear legislation. Safety of activities dealing with radiation sources is regulated by three main nuclear laws:

- On the use of nuclear energy and radiation safety (passed on 8 February 1995);
- On human protection from the impact of ionizing radiation (passed on 14 January 1998);
- On permissive activity in the area of nuclear energy utilization (passed on 11 January 2000).

These three laws create the first level of the legislative basis for activities dealing with radiation sources. On the basis of these laws, regulations (normative-legal acts) have been developed. These regulations can be conditionally called documents of second and third levels.

The second level is composed of regulations approved by resolutions of the Government and orders of the President of Ukraine. The third level is represented by regulations approved by separate or joint orders of State regulatory authorities and other central executive authorities discharging separate regulatory functions.

STRUCTURE OF STATE REGULATION OF RADIATION SOURCES SAFETY

In accordance with the law of Ukraine “On the use of nuclear energy and radiation safety”, State regulatory authorities on nuclear and radiation safety in nuclear energy utilization, including the activity dealing with radiation sources, are Ministry for the Environment and Natural Resources of Ukraine (Minecoresources) and Ministry of Health of Ukraine (see Figure 2).

Pursuant to the “Provision on the Ministry for the Environment and Natural Resources of Ukraine”, approved by the President of Ukraine, this Ministry is in charge of the central co-ordination role in discharging regulatory functions of other executive authorities and all three main regulatory functions that are mentioned in Section 2. The Ministry for the Environment and Natural Resources of Ukraine is authorized by the Cabinet of Ministers of Ukraine to grant permission for nuclear energy utilization and is the State authority to issue licences (permits) to carry out activities dealing with radiation sources.

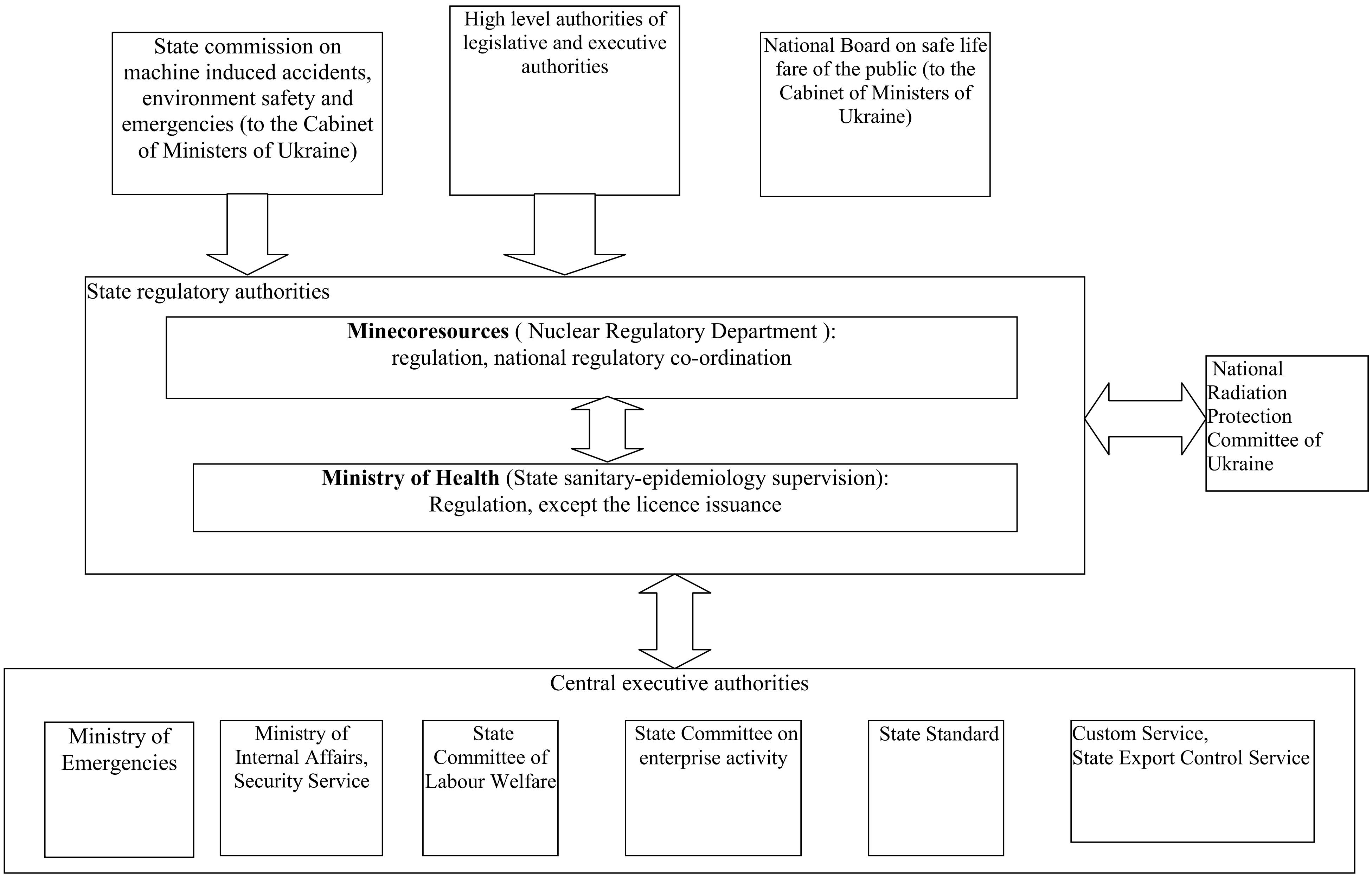

Figure 2. Infrastructure of State Radiation Sources Safety Regulation.

One of the key principles of the State regulation is not implemented in the existing system: this is the principle of independence of the regulatory authority. The Ministry for the Environment and Natural Resources to a lesser extent and the Ministry of Health to a larger extent are a part of the infrastructure performing activities dealing with radiation sources and are responsible for the development of some types of these activities. The Ministry of Health is in charge of medical application of radiation sources; the Ministry for the Environment and Natural Resources is in charge of the use of radiation sources in geology and environmental studies. During a nine-year period, an independent regulatory authority of the central executive authority has been established twice but then was terminated due to administrative reform. Recently, the authority — the State Nuclear Regulatory Administration of Ukraine — was established in 1999, but since 2000 has discharged its functions with reduced a number of personnel and is functioning as a part of Minecoresources headquarters.

Separate regulatory functions are carried out by the National Commission on Radiation Protection of the Population of Ukraine, the Ministry for Emergency Situations and Protection of the population from the consequences of the Chernobyl Accident, the Ministry of Internal Affairs, the Security Service, and the State Committee on Regulatory Policy and Enterprise Activity.

In the creation of State system of radiation protection, Minecoresources co-operates closely with the State Supervisory Department of Labour Welfare of Ukraine. A joint order “On arrangement of radiation safety training” of the State Nuclear Regulatory Administration and State Supervisory Department of Labour Welfare of Ukraine defined the main measures to establish a common State system of training and verification of knowledge on radiation safety. The State Committee on Standardization and Certification of Ukraine is in charge of certification of radiation sources and metrology control over instruments and methods of radiation monitoring.

PERMISSIVE AND SUPERVISORY SYSTEM FOR ACTIVITIES DEALING WITH RADIATION SOURCES

In Ukraine, the performance of activities dealing with radiation sources is forbidden without an officially issued permit.

Permissive activity for radiation sources envisages:

- licensing of production, storage, maintenance of radiation sources;
- licensing of the use of radiation sources;
- licensing of radioactive material transportation;
- obligatory certification of radiation sources, transport packages for shipment of radiation sources; and
- state registration of radiation sources.

No permit is required for an activity dealing with radiation sources if the radiation impact is so low as not to require preventive measures. These sources meet exemption levels freeing them from regulatory control.

The exempt sources are entered into a “list of radiation sources of activity that is exempted from licensing”. At present, the list comprises some types of smoke detectors, sources for calibration and verification of radiometric instruments, reference sources. Levels of release from licensing are established for different types of sources and exceed relevant exemption levels not more than 20 times. The regulatory field is presented in Figure 3.

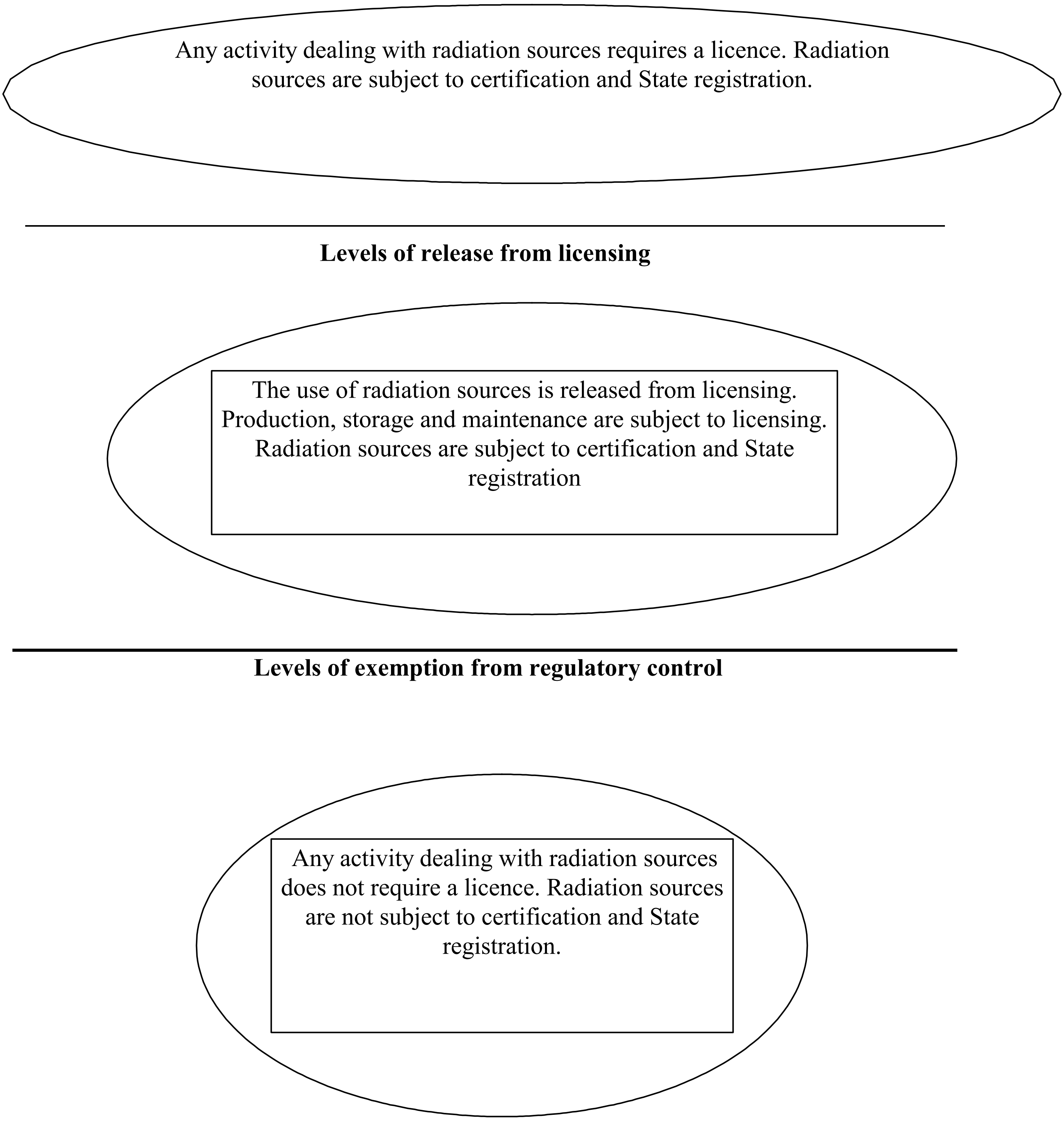

Figure 3. Regulatory field.

LICENSING

The Ministry for the Environment and Natural Resources of Ukraine is in charge of licence issuance for the production, storage, maintenance and use of radiation sources and transportation of radioactive materials. "Instruction on procedure for licence issuance to a subject of enterprise activity to purchase, own, sell, operate, use radiation sources, and for conditions and rules for performance of these activities and control over their observance" was approved by Order of Minecoresources of Ukraine. The instruction gives a detailed procedure for licence issuance. The Ministry for the Environment and Natural Resources has delegated the right to issue licences to use radiation sources with relevantly low level of potential hazard to 27 territory authorities.

The Licence issuance process started in 1995. At first enterprises dealing with high activity level radiation sources were granted licences. However, the legal basis for licensing medical application of radiation sources has been created only recently. Previously, medical institutions were not subject to licensing and medical application of radiation sources was under the control of Ministry of Health of Ukraine. Licensing of industrial enterprises is planned to be completed in 2002. In 1997, 20 licences were issued; in 1998, 52 licences were issued; in 1999, 99 licences; in 2000, more than 200 licences. The dynamics of issued licences is presented in Figure 4.

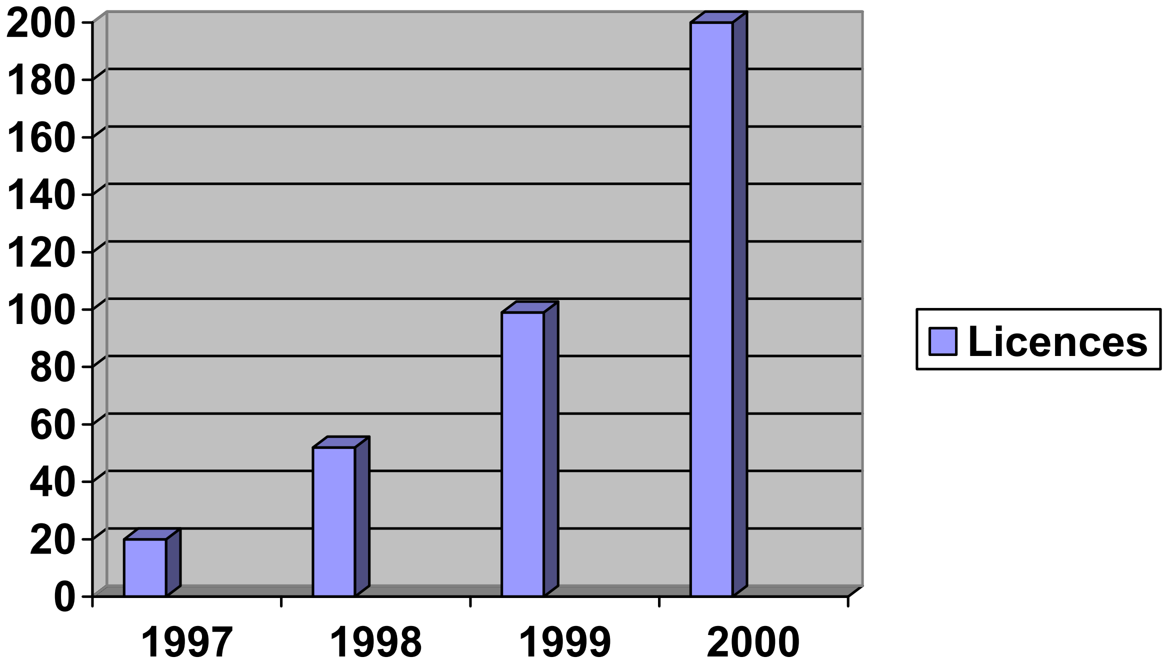

Figure 4. Dynamics of the licence issuance for 1997–2000.

STATE REGISTRATION OF RADIATION SOURCES

In order to ensure national system for accountancy and control of the status and location of radiation sources in 1997, the Government of Ukraine decided to establish a computerized national system of accountancy and control of radiation sources – the State Register (hereinafter referred to as the Register). In 1998 under the Ukrainian State Production Enterprise “Isotope”, a separate subdivision , the “State Register of Radiation Sources”, was established. This subdivision discharges the functions of a main registration centre, which has been equipped with the assistance of the IAEA. Establishment of a network of regional registration centres is under way.

All radiation sources that are not exempted from regulatory control shall be subject to registration. Registration is obligatory and is chargeable. The Register shall file the data of all radiation sources in electronic form starting from the moment the appear on the territory of Ukraine till their export from Ukraine or transfer to a special enterprise for radioactive waste disposal (or for radiation generators — till their liquidation). According to the established procedure of the Cabinet of Ministers of Ukraine, an interaction between the Register and State Customs Service, the State Export Control Service and the Radioactive Waste Register is ongoing.

Information about registered sources shall be updated not less than once per year and also when there is a change of owner of radiation source, place of location (address) of a storage facility, or during import or export of a radiation source across a border of Ukraine. Information about type of source, isotope, activity, accelerating potential, manufacture number, the facility to which a source is allocated, the owner of the source, postal address, licence number etc. is entered in the Register.

Upon request of State authorities involved in handling radiation sources, the Register provides information of sources in illicit trafficking. Upon request of regulatory authorities, the Register provides any information on sources. The Register also provides an annual report to regulatory authorities.

Urgent launching into operation of the Register and State registration of radiation sources will perform a good basis for considerably upgrading the level of safety and security of radiation sources, reduction of illicit trafficking of radiation sources, and investigation of illicit trafficking cases. Lack of funds is the main problem impeding the commissioning of the Register.

SUPERVISION

Inspection of enterprises during licensing and day-to-day supervision over their activity dealing with radiation sources are performed by the following agencies: at nuclear facilities — Main State Inspectorate of Nuclear Safety of Minecoresources, at the rest of enterprises — Main Ecology Inspectorate of Minecoresources.

SECURITY OF RADIATION MATERIALS AND PREVENTION OF ILLICIT TRAFFICKING OF RADIATION SOURCES

PREVENTION OF ILLICIT TRAFFICKING OF RADIATION SOURCES

The Ministry for the Environment and Natural Resources of Ukraine, acting through special subdivisions, exercises control at access points of the State border of Ukraine. One of key elements of this control is radiation monitoring. The access points are equipped with fixed detecting systems of ionizing radiation. The Ecology Control Service has at its disposal portable radiometric instruments.

Furthermore, Ukraine carries out obligatory radiation monitoring of exported metal scrap which is followed by issuance of the relevant certificate. Enterprises dealing in metal scrap procurement are under the vigilant control of the State Ecology Inspection and State Sanitary Supervision. This attention on a large scale is related to contaminated metal scrap resulting from the Chernobyl accident in 1996, which is constantly revealed in Ukraine. Also this attention brings positive results in detection of abandoned radiation sources.

ENSURING SAFETY AND SECURITY OF RADIATION SOURCES

An applicant's emergency preparedness and security of radiation sources through strict accountancy and physical protection shall be examined during the course of the licensing process and planned inspections. A condition for licence issuance is that the applicant shall have an emergency plan and suitably trained response personnel and financial capabilities to indemnify for damages in a case of radiation accident. As a probable radiation accident, an applicant must take into account loss (smuggling) of radiation sources.

NATIONAL DECISIONS ON SEPERATE SAFETY ISSUES FOR RADIATION SOURCES

MANAGEMENT OF SPENT SEALED SOURCES

During the obtaining of a licence for an activity to deal with radiation sources, an applicant must demonstrate his spent source management plans in a safety analysis report. The optimal way is when an applicant concludes an agreement for procurement of sealed radiation sources by assuming obligations of a procurer to return the radiation sources to the originating country upon the request of the customer. Since at this time radionuclide radiation sources are not produced in Ukraine, spent sources are subject to return to the country of origin. However, problems arise when the matter concerns the return of radiation sources procured by Ukraine from Russian vendors during the time of the former Soviet Union, especially since the Russian Federation has legislative constraints for the mentioned return. During the past two years, preparations for negotiations with the Russian Federation concerning the return of spent radiation sources have been under way.

The current rules in Ukraine state that when the service life of a radiation source has expired, the user must transfer this radiation source to a special enterprise for radioactive waste storage or prolong the service life of the radiation source.
In Ukraine, the procedure to prolong the service life of radiation sources by conducting a certification test at accredited test centres and certificate issuance has been developed and is being put into effect. If a user does not plan to prolong the service life of radiation sources or the radiation source fails to pass certification tests, the radiation source shall be transferred to a special enterprise for radioactive waste storage, i.e. to one of six State interregional special enterprises of the Ukrainian State Enterprise "Radon".

In recent years, the number of radiation sources transferred to special enterprises for long-term storage has increased. Due to the unfavourable economical situation, the activity of such enterprises has been suspended or terminated and, according to the current legislation, these enterprises are obliged to transfer all radiation sources to other licensees or special enterprises. The State Ecology Inspection of Minecoresources of Ukraine is in charge of supervision over the observance of this rule.

The inspection keeps a continuos control over enterprises that have disused radiation sources but lack funds to pay the transfer of the radiation sources to special waste disposal enterprises. In certain cases, local authorities assign funds to pay for the transfer of radiation sources and sometimes the funds are appropriated from the State Budget for this purpose.

RESTORING CONTROL OVER ORPHAN SOURCES

The Cabinet of Ministers of Ukraine by the Resolution # 207 of 04.03.97 approved "Procedure for interaction of executive authorities and involved legal entities in the case of revealing of radiation sources in illicit trafficking". The procedure specifies that legal or physical persons who have detected suspicious material (a physical object with properties or characteristics of a radiation source) shall inform to local executive authorities or internal affairs bodies. These authorities shall arrange for the security of the material and detected site and also inform local authorities of the State sanitary epidemiology supervision, which shall conduct a preliminary examination of the material and inform the local executive authorities and territory authorities of the Ministry of Emergencies, and internal affairs bodies about necessary individual protection measures. Law enforcement authorities shall institute criminal proceedings and conduct an investigation. The source shall be taken away by a team of specialists in waste management to a waste disposal, where the source will be stored until an owner is found or the criminal case is closed. Minecoresources of Ukraine shall be responsible for searching for the owner of the radiation source through the Register of radiation sources, and for informing the IAEA, competent authorities of interested countries and the mass media. Every case of radiation source detection (in 1999 – five cases, in 2000 – 12 cases; in two cases the owners of the sources were found) is reported on television and in newspapers. Radiation inspections of a considerable number of buildings, houses, land areas have been conducted in Ukraine.

CONCLUSION

On the basis of the analysis of the safety regulation system for activities dealing with radiation sources in Ukraine, we can draw a conclusion about its sufficiency for effective regulation of radiation sources safety including radioactive material security.

REGULATORY CONTROL OF RADIATION SOURCES AND RADIOACTIVE MATERIALS: THE UK POSITION

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United Kingdom

Abstract. The paper presents the organizations involved in the regulation of the safety of radiation sources and the security of radioactive materials across the UK.
The safety of radiation sources is within the regulatory remit of the Health and Safety Executive, under the Health and safety of Work Act 1974 and associated regulations. Any employer using radiation sources has a statutory duty to comply with this legislation, thereby protecting workers and the public from undue risk.
From a radioactive waste management perspective, the storage and use of radioactive materials and the accumulation and disposal of radioactive waste are regulated by the environment agencies of England and Wales, Scotland, and Northern Ireland, under the Radioactive Substances Act 1993.
Special regulatory arrangements apply to nuclear sites, such as power stations and fuel cycle plants, and some additional bodies are involved in the regulation of the security of fissile materials.
An explanation is given in the paper as to how these organizations to work together to provide a comprehensive and effective regulatory regime.
An overview of how these regulators have recently started to work more closely with other enforcement bodies, such as the Police and Customs and Excise is also given, to illustrate the approach that is being applied in the UK to deal with orphan sources and illicit trafficking.

THE SCALE OF USE OF RADIOACTIVE MATERIALS IN THE UK

Radioactive materials are widely used in the UK in the nuclear industry; medical/dental uses; manufacturing; construction; engineering; paper; offshore; education (colleges, schools) and non-destructive testing.

There are approximately 6000 permits relating to users of radioactivity in the UK, and some 400 000 movements of radioactive material are undertaken each year. In addition there are some 30 sites which are licensed under the Nuclear Installations Act 1965.

THE REGULATORY FRAMEWORK

Regulatory responsibilities in the UK concerning the storage and use of radioactive sources and the management of radioactive waste are split between the environment agencies and the Health and Safety Executive (HSE). The regulation of transport of radioactive materials is the responsibility of the Department of the Environment, Transport and the Regions (Radioactive Materials Transport Division – RMTD).

The Health and Safety Executive (HSE) regulates the safety of any use of ionizing radiation, including uses associated with radioactive sources, under the Ionizing Radiation Regulations 1999. The HSE has further powers to regulate the operational safety of UK nuclear installations under the 1965 Nuclear Installations Act 1965.

Where radioactive waste is *stored* on sites licensed under the Nuclear Installations Act 1965, (NIA65, as amended), it is the HSE, rather than the Environment Agency, which has the statutory powers to regulate such storage. However, the Environment Agency is responsible for regulating *disposals* of all forms of radioactive waste (solids, liquids and gases) on or from the sites that HSE license.

The Environment Agency has a major role, under the Radioactive Substances Act 1993 (RSA93), as amended by the Environment Act 1995, in regulating the disposal and storage of radioactive waste in England and Wales. The Scottish Environment Protection Agency (SEPA) and the Industrial Pollution and Radiochemical Inspectorate (IPRI) have similar roles in Scotland and Northern Ireland respectively.

The HSE and the Environment Agency (EA) have set down and agreed on their responsibilities and working arrangements on matters of joint interest, within a Memorandum of Understanding, to ensure that the regulatory system is applied in a consistent and comprehensive manner.

This paper will not deal with nuclear licensed site issues, but will focus on the issues of the wider safety and security issues of sealed and unsealed sources. Special arrangements apply to nuclear sites, such as power stations and fuel cycle plants, and some additional bodies are involved in the regulation of the security of fissile materials.

The principles described in this paper are written from the perspective of the regulator for England and Wales, but the arrangements in the other environment agencies are identical for the purposes of environmental radiation protection legislation.

THE IONIZING RADIATION REGULATIONS 1999

In 1996, the revised Basic Safety Standards (BSS) Directive of the European Union (96/29/Euratom) was adopted, allowing four years for implementation. The Directive reflected the 1990 recommendations of the International Commission on Radiological Protection.

In the United Kingdom, the BSS Directive is being implemented by a combination of existing and new legislation developed by several Government departments and agencies. The key legislation in the context of this paper is the Ionizing Radiation Regulations 1999.

The Ionizing Radiation Regulations 1999 are made under the Health and Safety at Work Act 1974. Their purpose is to impose duties on employers to protect employees and other persons against ionizing radiation arising from work with radioactive substances and other sources of ionizing radiation. They are enforced by the HSE.

The regulations impose a number of controls on the use of sources of ionizing radiation, whether these are radioactive sources, or radiation generators.

The controls that are particularly relevant to this paper include:

- Notification — the HSE must be notified in advance of the intention to use radiation sources;
- Appointment of Radiation Protection Advisers (RPAs) and other competent people in accordance with the HSE's defined criteria for core competence;

- Requirements for co-operation between employers;
- Arrangements for the control of radioactive substances: including requirements for:
  - accounting for and recording the quantity and location of radioactive substances, and requirements to keep records following disposal;
  - requirements for radioactive materials to be kept in a suitable receptacle, both during transport and a suitable store when not in use;
- Requirements for notification to HSE of releases above prescribed thresholds, when the releases are not covered by the provisions of the Radioactive Substances Act; and to notify the HSE of losses or theft of those materials, and also a requirement to investigate the occurrence.
- Requirements in certain cases for contingency plans to ensure that the risks of exceeding a dose limit are minimized in the event of reasonably foreseeable accidents.

Finally, the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR95) is a separate piece of legislation under which certain types of incident must be reported to the HSE.

Regulation under the Radioactive Substances Act 1993 (RSA93)

The regulatory arrangements in use today can be directly related to the first Radioactive Substances Act of 1960. The basic structure of the legislation has been considered effective over forty years of regulatory experience.

The provisions of this legislation apply only to an "undertaking". That is, any kind of trade, business or profession. Before a business can keep or use radioactive materials, it must apply for a permit from the EA.

This legislation provides two main types of permit: the registration of the possession and use of radioactive materials, and the authorization of the accumulation and disposal of radioactive wastes. A premises registered for storing and using radioactive materials may also be separately authorized under the act.

The only exceptions to these are where the user can establish that an Exemption Order (made under RSA93) is relevant to this use of radioactivity, or disposal of radioactive wastes. The user may then operate with exemption from holding a specific permission as normally required. Such exemptions apply when :

- a widespread use or disposal exists;
- either the use of radioactivity is justified, or its presence is unavoidable; *and*
- radiological hazards can be shown to be negligible, or can be made so by observance of conditions in an order. (Negligible means an individual dose no greater than 10 microSieverts per year; and a collective dose no greater than 1 man Sievert per year).

The Exemption Order system has the dual benefit of reducing the administrative burden, thus allowing more effort to be directed towards higher risk areas, and encouraging the conduct of a useful practice or product, rather than discouraging it by overregulation.

Where exemption is not an option, applications for permits made under RSA93 must be accompanied by the appropriate fee. For most types of permit, there is also an annual subsistence charge intended to cover the cost of enforcement.

Following receipt, the application is subject to the technical scrutiny of the purpose to which the material will be put, and the quantity and type of material that it is proposed to use. A key consideration is the issue of "justification" of a practice.

"Justification", i.e. the concept of weighing the benefits from a practice involving the use of radioactive substances against its detriments, and considering whether a net benefit accrues to society, is a legal requirement in EC Directives, most recently the 1996 Basic Safety Standards Directive. In the UK, the High Court ruled in 1994 that justification had to be considered before the EA granted any authorization under RSA93. Over the past five years, the EA has considered justification when issuing its permits under RSA93.

The question of whether justification should be considered by Government or by the regulators is currently being reviewed by the UK Government.

When satisfied with the application, the regulator then issues a permission document to the responsible person in the undertaking. The document certifies that the undertaking is duly registered or authorized under the act, and it also prescribes limits on inventory and conditions under which the radioactive materials (or waste) must be managed and stored.

For the use of mobile radioactive sources, conditions are imposed to ensure that continuity of control of the radioactive material is maintained by a clearly identified and accountable registered owner. This includes restrictions on the sources being lent or let on hire to a third party.

A registration to keep or use radioactive materials includes conditions and limits. Conditions include:

- the provision of competent persons for the purposes of supervising the radioactive materials in use (in parallel to the requirements made by the HSE for a radiation protection supervisor);
- the requirement for copies of the permission document to be displayed on the premises of the user, so as to ensure that the limits and conditions can be conveniently read by persons whose duties might be affected;
- the keeping of detailed records of use, and audit checks of the source; and
- specific requirements prescribe the general security and conditions of storage.

Further regulation of the premises is based on the conditions prescribed by the registration document. Frequency of inspection is normally risk-based. Indicative frequencies are used for resource planning purposes. For example, a nuclear site will be inspected several times a year, a radiography user or major hospital radiotherapy unit is likely to be inspected once every two years, whereas a minor user may be inspected only once in five years. Full audits for major sites may involve several inspectors for up to two weeks of full time on-site work.

The planned frequencies for inspection are currently under review, and it is intended to increase the frequency for minor users.

On-the-ground inspection visits may demonstrate failures to comply with the conditions of permission issued under the provisions of RSA93. The inspector may manage compliance in a variety of ways. In the first instance, corrective action may be formally required by means of a statutory "enforcement notice". In the event of evidence of imminent risk of pollution of the environment, or of harm to human health, a "prohibition notice" must be served on the undertaking to require that activity to cease immediately.

For serious offences, including failure to comply with the provisions of a statutory notice, the EA may prosecute an offender under RSA93.

Offences and penalties

Offences under RSA 93 include:

- keeping and using radioactive materials without being duly registered under RSA93;
- accumulating or disposing of radioactive waste without due authorization under RSA93;
- failing to comply with the conditions laid down in the permit, including its display;
- exceeding a limit on keeping radioactive materials, or a limit on disposing of radioactive wastes;
- making false statements either in an application for permit under the Act, or in purported compliance with a requirement to furnish information imposed under the Act;
- intentionally making a false entry in any record required by a permission made under the Act.

Penalties vary according to the nature of the offence, the circumstances, and the type of court in which the charge is heard. In a magistrate's court, a maximum fine of £20 000 may be imposed. For conviction on indictment (following a full trial), an unlimited fine may be imposed, or imprisonment for a period up to two years, or both.

The UK and Europe: transfrontier shipments

RSA 93 provides for the "domestic" control of the possession and use of radioactive material, and the accumulation and disposal of radioactive waste. There are additional European provisions for the control of movements of radioactive materials between member countries of the European Union (EU).

As a member country of the EU, the UK complies with the requirements of Council Regulations made under European Directives. Council Regulation 1493/93/Euratom on shipments of radioactive substances between member countries, applies to transfrontier shipments of radioactive substances between EU member countries. Shipments to and from member countries and third countries outside the EU are not covered. The regulations apply to sealed sources, and open sources, but not radioactive waste, which is dealt with by separate regulations (described below).

For shipments of sealed sources, the holder of sealed sources has to obtain a prior written declaration from the consignee to the effect that the consignee has complied, in the member country of destination, with all applicable provisions of Article 3 of the Directive. The declaration must be noted and stamped by the competent authority of the member country to which the shipment is being made prior to the declaration being sent to the holder of the sealed source.

For open sources, the suppliers are required to provide the competent authorities of member countries of destination with a summary of deliveries.

The transfrontier shipment of radioactive waste is regulated under UK statutory regulations (SI 1993 No 3031: The Trans-frontier Shipment of Radioactive Waste Regulations 1993). The regulations provide for a system of prior authorization and approval for the shipment of radioactive waste.

The EA is a competent authority for England and Wales. (The HSE is also a competent authority for the transfrontier shipment of radioactive substances in respect of nuclear licensed sites).

Incidents involving loss of control of radioactive materials

Despite the extensive regulatory provisions described above, incidents involving loss of control of radioactive materials inevitably occur. Two different types of incident will be described.

In the first case, (a wholly "domestic" incident), a waste incineration company, was recently prosecuted by the HSE and the EA following the loss of two radioactive sources from an old incineration plant.

The sources, each 740 MBq (original activity) of caesium-137, were in two level gauges installed in the feed chutes of the old incinerator plant at the site. When a new plant was commissioned on the same site, the old plant was demolished. The company failed to make arrangements for the safe removal or disposal of the sources, or to make other persons aware of their presence, and the sources were lost.

The company had previously been reminded by the EA of their responsibilities for safe removal and disposal of the sources from the plant pending its demolition.

There were no records indicating that the gauges had been removed from the plant and stored safely on site pending disposal by an authorized route; and there was no evidence to suggest that the demolition consultant or the demolition contractors were informed of the continued presence of the two radioactive sources on the plant.

The key factors contributing to all these failures were changes in management and weak arrangements for control of radioactive sources. Employees who were familiar with the local rules and operation of the gauges had been moved off the old plant as soon as it ceased operation, sometime before it was demolished. Local rules appear to have been abandoned. Indeed, there was no evidence of any management control over the gauges; it appears that they had simply been forgotten!

The second type of recent incident is illustrated by the next example:

A terminal from a lightning conductor system, containing nine radium-226 sources, was detected at a weigh-bridge monitoring system. Surface dose rates at the surface of the skip containing the scrap were up to 100 microSv/h. Activity was estimated at around 1.85 GBq. The sources are alleged to have originated in a load of non-ferrous scrap imported into the UK from Angola.

Under arrangements that have recently been adopted in the UK, details of the discovery of these orphan sources were compiled into a report known as an "ECO-MESSAGE". A blank pro-forma ECO-MESSAGE is given in Appendix 1, together with notes for users. The ECO-MESSAGE is the product of Interpol.

There is an increasing awareness in the UK of the hazards associated with radioactive contamination finding its way into the scrap metal chain. The EA, the HSE and other Government departments are working with intermediaries in the ferrous and non-ferrous industry in the UK to raise awareness of the radiological and financial implications of such incidents, and to emphasise how they may be avoided by the deployment of radiation monitoring equipment and associated procedures at key stages in the supply chain. Existing systems have already detected several orphan sources which have probably originated from scrapped industrial equipment containing radioactive material.

The Interpol ECO-MESSAGE system

The organizations listed in Appendix 2 have agreed to use the ECO-MESSAGE arrangements to communicate with relevant enforcement bodies in other countries around the world, using the channels of Interpol to promulgate the information.

There are two objectives of the ECO-MESSAGE system. The first is to alert regulators in the country where the radioactive material is alleged to have originated in case they wish to establish whether an offence may have occurred under their own legislation. Should they choose to use it, the regulators will have as much information made available to them as the UK regulators can provide, within the legal, evidential and operational constraints of a given case.

The second objective is to ask the overseas regulator for information that may be useful for enforcement against any breaches of UK legislation. This facility is infrequently used at present since most cases of illicit imports of radioactive material have not involved any offence by the recipient, under RSA93. Indeed, almost invariably, it is because of the proactive co-operation of a recipient trader in the metal recycling industry supply chain that such incidents have been detected and reported to the EA and HSE. The trader may accrue commercial liabilities in these cases, but rarely has there been a legal liability under RSA93. The EA encourages industry to take control of orphan sources and welcomes their support in protecting the environment.
Experience indicates that the ECO-MESSAGE system still has to achieve widespread use, and outgoing UK ECO-MESSAGES exceed those received from other countries. However, one case from an EU member country notified the EA of an undertaking in the UK that warranted investigation to ensure that the undertaking in question was not in breach of the Radioactive Substances Act.

The downstream effects of orphan sources have been described elsewhere. Like many countries, those of the UK are concerned about the safety and environmental implications of orphan sources. There are risks to the workforce of ports, haulage, and metal recycling companies, and potentially significant impacts on the UK environment.

In order to address these risks, the major stakeholders in "environmental crime" issues in the UK have been working together to overcome the lack of knowledge, and then to provide a proportionate response to the prevailing threat.

The UK Interpol Environmental Crime Groups

The Association of Chief Police Officers (ACPO) for England and Wales chairs a UK wide Environmental Crime Group, which draws on the communication channels of Interpol, and makes them available to all legitimate organizations concerned with threats to the UK environment, in the widest sense of the term.

The aim of the group is to strengthen the fight against any environmental crime, by improving the sharing of information and co-operation between stakeholders. The main group (the UK Interpol Environmental Crime Group – UKIECG), has three subgroups. These address the specific issues of:

1. wildlife crime;
2. hazardous waste; and
3. radioactive substances.

ACPO chairs the first of these subgroups, and the EA chairs the other two. For the purposes of this paper, only the work of the Radioactive Substances Subgroup will be explored further.

The Work of the UKIECG Subgroup on Radioactive Substances

The subgroup meets four times per year, and its membership includes senior representatives of the organizations listed in Appendix 2.

The first agreement of the membership was the need to co-operate so as to ensure a co-ordinated approach by all those involved in the UK. The second agreement, already mentioned, was the adoption of the Interpol ECO-MESSAGE system.

The next output from the group was a position paper, explaining the nature and scale of the problem of illicit trafficking. The position paper particularly highlights the high probability of the first point of detection of an orphan source being at a scrap metal yard or metal melting works. It is for this reason that the subgroup places great importance on having industry representatives amongst its members.

The position paper has been presented to UK government departments, and is being used as a basis for developing wider interdepartmental policies to ensure "joined-up" arrangements at government level.

The subgroup is now working up a "National Response Plan" which has two facets.

The first facet is the existence of arrangements internal to the UK for the effective sharing of any intelligence relating to illicit trafficking acquired by a stakeholder organization that may be of use to the others. The aim is to increase the probability of finding an orphan source, for example due to association with other illegal activity.

A hypothetical example illustrates the principle: the EA may detect a case involving fissile material. This may be of interest not only to the Office of Civil Nuclear Security, but may have implications for counter-terrorist stakeholders, and / or Customs and Excise. More routinely, the arrangements also ensure the effective dissemination of incoming ECO-MESSAGES from other countries.

The second facet comprises a basic response plan to ensure the effective co-ordination of the various stakeholder organizations in the event of a discovery of an orphan source. This may involve a few, or many of the organizations that contribute to the subgroup.

The need for these co-ordinated arrangements arises from two issues. Firstly, as already explained, more than one government body may have an interest in some types of potential cases. To ensure all interests are protected, a co-ordinated response will mean that a lead investigator will neither neglect the interest of other bodies, nor find their own interests compromised by the activities of others.

Secondly, and more fundamentally, the statutory powers of the various bodies are diverse, and none of them can meet all the potential enforcement needs. It is hoped, though not yet tested, that by sharing knowledge in the form of a "powers and interests " matrix, which is a key part of the plan, staff at operational level will be able to obtain support from colleagues in other organizations.

An example that occurred before work on the plan was started may illustrate this. Customs officers at a port in England became aware of radioactive contamination in a consignment of containerized scrap metal intended to be imported to the UK from a former Soviet Union country. They have statutory powers only where fissile materials are involved. They therefore sought advice and support from the EA, and the broker was apprised of his potential obligations under the RSA93. The broker then decided to arrange for the return of the consignment to its point of origin, so that his UK customer did not acquire unforeseen and unwanted liabilities. The local regulators were apprised of the situation.

At the time of writing, the plan is still being formulated but it is expected to enable the stakeholders to draw on the technical knowledge, legal powers, and networking of each other when it is implemented.

CONCLUSION

The UK operates a comprehensive and generally highly effective regulatory regime to ensure the safety of radiation sources and the security of radioactive materials. This involves the environment agencies and the HSE of the UK.

Despite this strong regulatory framework, the UK enforcement bodies recognize the probability that sources will be lost from control, creating threats to people (especially workers) and to the environment. In some cases, there may be other regulatory interests to be met also.

The UK approach to these cases is for enforcement bodies to work collaboratively, not only with each other, but with representatives of the industries where orphan sources are most probably detected. UK regulators are also committed to collaborating with regulators in other countries as part of a managed approach to this problem.

APPENDIX 1

UNITED KINGDOM

Information from:...

INTERPOL ECO-MESSAGE
Radioactive Substances

1. Subject Code name/ Reference number Legislation violated	
2. Place and circumstances of discovery	
3. Date/Period	
4. (a) Radioactive Substances (b) Number or quantity and value	
5. Identity particulars of person(s) involved (a) Date of arrest (b) Family name (and maiden name for women) (c) Forenames(s) (d) Sex (e) Aliases (f) Date and place of Birth (g) Nationality (h) Address (i) Information appearing in passports and on identity documents (j) Occupation (k) Position in one of the companies listed under 6, if any (l) Other information	
6. Particulars of companies involved (a) Type of company (b) Name (c) Activities (d) Business address and telephone/fax number (e) Address and telephone/fax number(s) number(s) of Head Office	
7. Route and means of transport	
8. (a) Country and town of origin (b) Country from which the substances arrived (c) Transit country or countries (d) Country and town of destination	

9. Particulars of documents used	
10. Law enforcement agency involved	
11. Modus operandi	
12. Additional information	
13. Information requested	

Additional information attached:

1. Contents checked for correctness so far as can be determined:
Signed................. Date..................................
Tel: (+44)..........Fax: (+44)....................

2. Forwarded to
(a) Environment Crime Office Signed..................................

Date..................................

(b) NCIS Signed..................................

Date...................................

APPENDIX 1 (cont.)

NOTES FOR COMPLETION OF ECO-MESSAGE FOR RADIOACTIVE SUBSTANCES

The following numbers refer to the sections of the Eco-message form. Please enter as much information as is available and if further enquiries are in hand regarding any point, please indicate this.

1. Brief account of the case.
   Code name given to the operation, if any, reference number of the case.
   Reference of applicable laws or regulations and maximum and minimum penalties imposable.

2. Port of entry into the territory and exact address where discovery occurred.
   If the discovery occurred on a motorway, or a waterway, or in territorial waters, specify the distance of that location from the nearest town and its position in relation to that town.
   Specify how the offence was discovered (eg. by X-ray examination of baggage, checking of documents, profiling of offenders, etc.).

3. If appropriate, specify the period of time over which the offence was committed.

4. (a) Specify the substance(s) and radionuclide(s) involved.
5. (b) Information on quantity and, if possible, the value.

6. (i) Numbers, places and dates of issue, expiry date.
   (ii) Telephone and fax numbers, vehicle registration numbers, etc.

   (NB Items 5(a) and 5(l) should be filled in for every person involved in the offence.)

7. Legal status of the company.
   Both full official name and name currently used.

   (NB Items 6(a) to 6(e) should be filled in for every company involved in the offence.)

8. Please give as many details as possible.

9. For waste products, specify place of production.
   (c) If the specimens were taken from the sea, please state "sea"
   Specify both the destination declared on the transport documents and the real destination.

10. Specify the types of documents, eg. authorisations, transport documents, permits and certificates, invoices, analysis reports, etc.
    Specify if documents were counterfeit, forged or invalid.

11. Name and full address

12. Give full details of the modus operandi including the concealment technique, type of packaging, method used to forge documents, financial backing of the companies involved, estimated value of the substances or specimens, possible links with other cases.

    If possible, attach photocopies of false documents and photographs (e.g. of containers) illustrating the modus operandi.

13. Please add any other details considered relevant.

14. Do your investigators need information that may be available in other countries?

APPENDIX 2

Membership of the UK INTERPOL Environmental Crime (Radioactive Substances) Sub-Group
Environment Agency (Chair and Secretariat) Scottish Environment Protection Agency (SEPA) Northern Ireland Environment and Heritage Service (IPRI) National Radiological Protection Board (NRPB) Health & Safety Executive (HSE) HM Customs and Excise National Criminal Intelligence Service (NCIS) Metropolitan Police Special Branch ACPO Scotland Office of Civil Nuclear Security (OCNSy) Department of the Environment, Transport and the Regions (RMTD) Department of Trade and Industry UK Atomic Energy Authority (UKAEA) British Steel British Secondary Metals Association British Metals Federation

CURRENT STATUS OF CONTROL OF RADIATION SOURCES AND RADIOACTIVE MATERIALS IN THE UNITED REPUBLIC OF TANZANIA

M.M. NYARUBA, W.K. MOMPOME
National Radiation Commission, Arusha, Tanzania

Abstract. A Protection from Radiation Act was enacted in Tanzania in 1983 to regulate the use of ionizing radiation and protect people against its danger. The Act established a regulatory authority known as National Radiation Commission (NRC), which is the corporate body to enforce the law and regulations.
From the beginning of 2000, the NRC has kept inventory of 200 and 324 radiation installations, and radiation sources and radioactive materials in the country, respectively; and has provided personnel monitoring services to 665 radiation workers.
However, due to the trade liberalization that is currently being experienced in the country, the increase in the number of radiation practices is observed yearly. To cope with the situation, the whole system of notification, authorization, registration and licensing needs to be improved. The improvement has now started by amending the existing Protection from Radiation Act.

INTRODUCTION

A Protection from Radiation Act was passed in Tanzania in 1983 (Act of Parliament No. 5 of 9 May 1983) to regulate the use of ionizing radiation and protect people against its danger. In the same year, this Act established a regulatory authority known as the National Radiation Commission. Thus, by Act, the Commission became, on the 22 July 1983, the body corporate responsible for atomic energy matters. Emphasis in the Act was mostly put on medical applications due to the fact that more than 90% of sources of ionizing radiation were X-ray generators, and in particular, diagnostic X-ray machines. However, to date applications of nuclear technology in industry, agriculture and research have steadily increased in the country. In recognition of this, the existing Act is now under amendment so that the promotion of the technology and protection against its associated dangers are also included.

RADIATION SOURCES AND RADIOACTIVE MATERIALS

At the beginning of this millennium the leading sources of radiation in the country were still diagnostic X-ray equipment (71%) followed by sources used in research and industry (24 %), and therapeutic and nuclear medicine (4%) (Fig. 1). The ratio of the number of diagnostic X-ray facilities to other radiation sources is becoming smaller compared to that of a decade ago. Hence these figures suggest that, with the trade liberalization policy that the country is currently experiencing, the number of radioactive materials in the country will continue to rise. In order to contain the foreseeable situation, the regulatory authority should have a sustainable radiation infrastructure.

THE NATIONAL REGULATORY AUTHORITY AND LEGISLATIVE INFRASTRUCTURE

Tanzania enacted the Protection from Radiation Act [1] in 1983, under which the regulatory authority known as “National Radiation Commission” (NRC) was established (Fig. 2). Its mission is to enforce the legislation and deliver radiation protection services in the country. Under the Act, a code of practice was prepared, approved and put into force by the Minister responsible for atomic energy matters in 1990. However, since more that 90% of the applications of radiation were mainly in the medical field, the code of practice focused on the applications of ionizing radiation in medicine.

FIG. 1: RADIATION SOURCES AND RADIOACTIVE MATERIALS IN THE COUNTRY IN THE BEGINNING OF Y2K

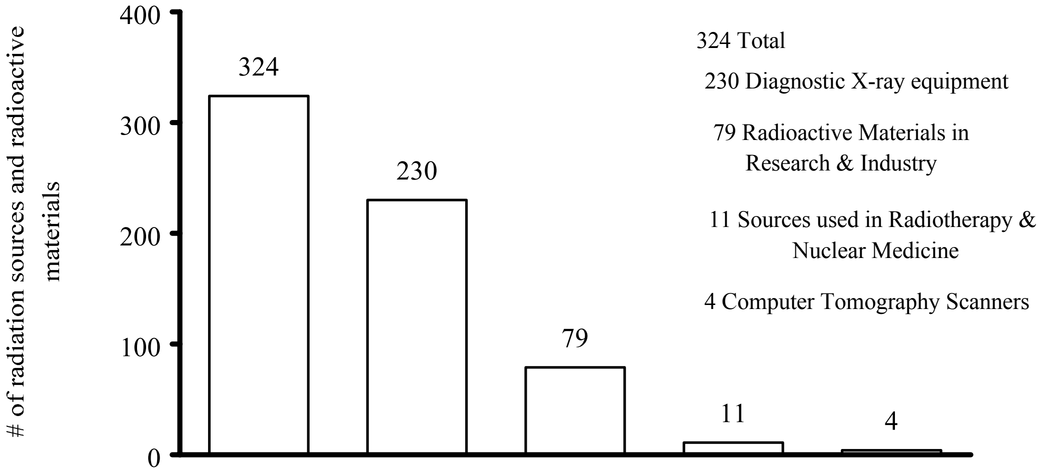
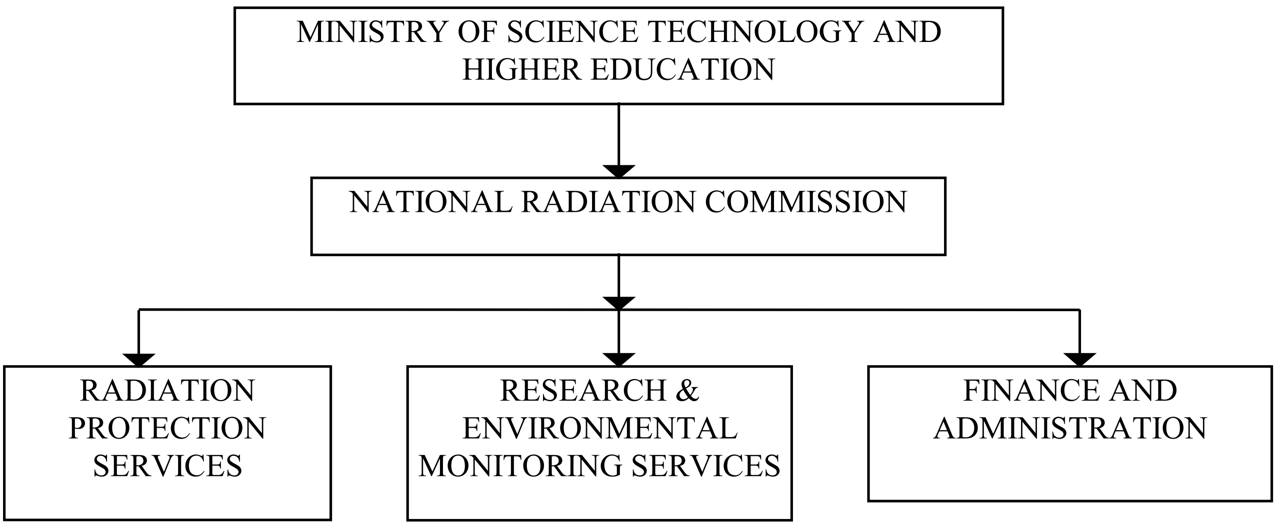


FIG. 2: NATIONAL RADIATION COMMISSION ORGANIZATIONAL CHART



The use of radioactive sources and radioactive materials in research, agricultural and industry has tremendously increased in the country. This has been a result not only of nuclear applications established through IAEA technical assistance projects but also of a current trade liberalization policy. Radiation protection services, which until 1986 were provided by the USA and the UK to two institutions in the country, are provided by the Commission with the assistance of the IAEA and include personnel monitoring services to all persons working with sources or generators of ionizing radiations (Fig. 3); radiation surveillance and safety inspections to all the respective centres (Fig. 4); radiation analysis of imported/exported foodstuffs and other environmental samples; and the calibration of dosimetry systems and survey meters for the regulatory authority and radiation users. The RAIS program provided by the IAEA has been very helpful to keep the data updated especially of personnel monitored and radiation surveillance and safety inspections in the country.

FIG. 3: THE NUMBER OF RADIATION WORKERS MONITORED IN THE BEGINNING OF Y2K

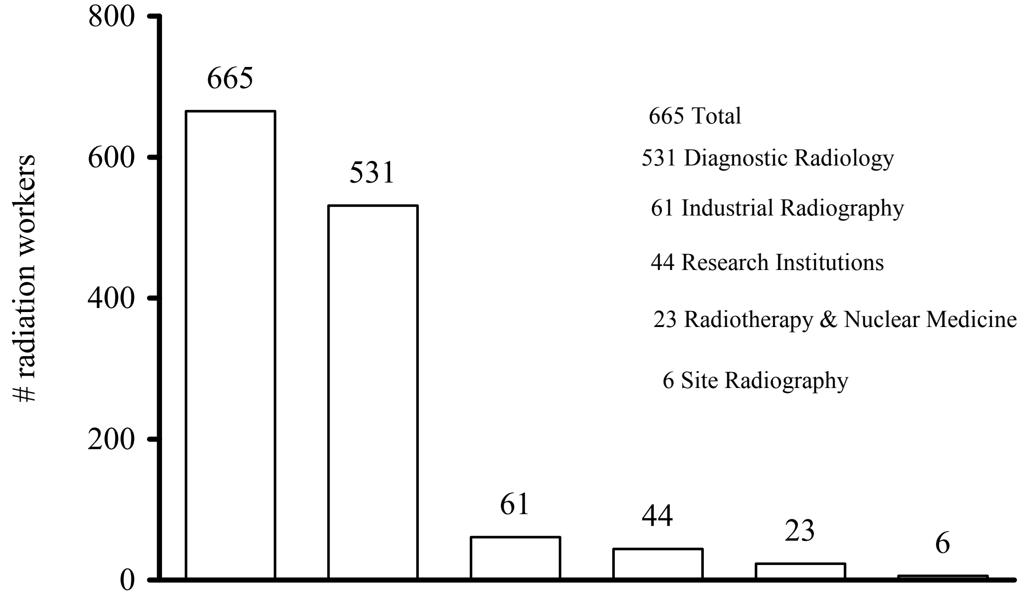
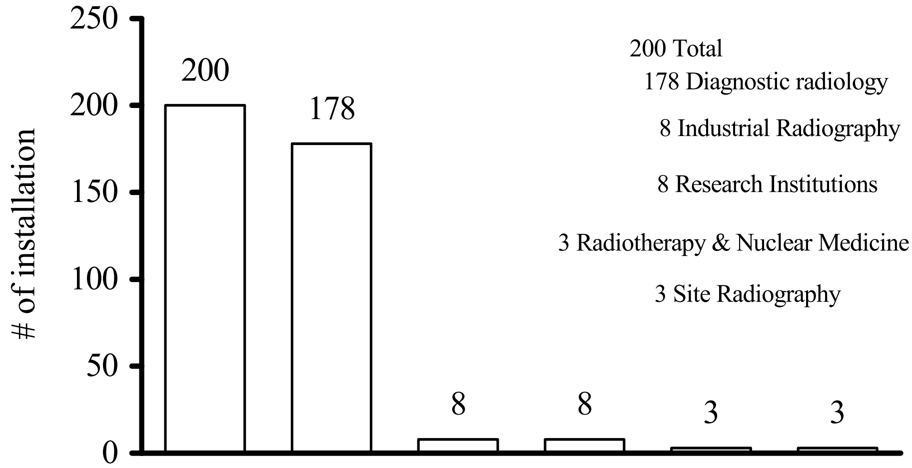


FIG. 4: THE NUMBER OF IONIZING RADIATION INSTALLATIONS BY PRACTICE



THE NATIONAL SYSTEM OF NOTIFICATION, REGISTRATION AND LICENSING, AND INSPECTION OF RADIATION SOURCES AND RADIOACTIVE MATERIALS

Figure 1 shows a total number of 324-registered radiation sources and radioactive materials in the country at the beginning of 2000. The number does not include dental units since they safety are not subjected to license. The Act requires every radiation user, radiation-generating device and mobile radioactive apparatus be registered. It further requires that every person wishing to import and/or install any instrument, which is a source or is intended to emit ionizing radiation should be licensed to do so. However, in practical terms, whoever/whichever is registered should be licensed.

Any person/party intending to import and/or use a radioactive source/material or radiation emitting devices should notify the regulatory authority. Registration and licence application forms will be immediately sent to the applicant to fill in all the necessary information regarding the substance to be imported. The NRC will evaluate the form and permission will be granted if the radiation practice is justified. After the source or device is imported, a team of inspectors will visit the premises to perform a thorough radiation safety inspection. The radiation safety report will be evaluated, and if it conforms to the stipulated safety standards, both registration and licence certificates to use the radiation source will be granted. The licences, which last for one year, are renewable subject to confirmation of the safety status of the installation. In that case, a reinspection is done prior to evaluation of licence. On the other hand, if the safety criteria are not met, recommendations to improve the situation will be made. The Act empowers the NRC to take legal action against offenders.

THE NATIONAL PROVISIONS FOR:

MANAGEMENT OF DISUSED SOURCES

In Tanzania, regulations for the management of radioactive waste exist [2]. According to the regulations, the management of disused sources is the same as that of spent sealed sources. The regulations require the return of the source to the supplier, and this can be implemented if there is a contract signed between the supplier and the user. It is the regulatory authority, which advises the future licensee on this need for a contract. If the option of the return of source to the supplier is not applicable either due to a contract not signed or the supplier no longer existing, then it remains the responsibility of the licensee to safely store the disused source till the responsibility is transferred to another person or organization. For this, each licensee is required to make interim storage available for the waste/disused sources. The regulatory body (NRC) is empowered to establish and operate a central radioactive waste management facility (CRWMF). At present, the NRC operates a temporary CRWMF and spent sources are in place including conditioned medical radium needles of a total activity of 3.5 GBq (95mg). However, for a such system to be operated by the regulatory authority is not in agreement with the BSS [3].

The NRC is yet to collect and condition other spent sources from various institutions, the total activity of which is not known due to the fact that most of them are historical sources and documentation is missing.

THE RECOVERY OF CONTROL OVER ORPHAN SOURCES

The regulations [2] require the NRC to take over the responsibility for the management of radioactive waste/sources where the owner is not capable of appropriate management of the source. This is also the case when either the license is revoked or the owner of the source no longer exists. The NRC has already experienced such a situation when police arrested a person for illegal possession/trafficking of an industrial gauging source. The source Cs-137 had calculated activity of 2.3 GBq as of 1997-04-24 and was in its assemble. After hearing the case, no adequate evidence was adduced to show that the suspect was in possession of the source; and therefore the court of law acquitted him. As per the regulations the control of the source become the responsibility of the NRC. The source is now stored at the NRC's temporary CRWMF.

INFORMING USERS AND OTHERS WHO MIGHT BE AFFECTED BY LOST SOURCES

Emphasis is placed on raising awareness of workers and members of the public about the hazardous effects of radiation sources. Radio and TV programmes are broadcast under the national radio/TV programme on science and technology. From 1994 to 1999, the NRC broadcast about 18 topics related to radiation safety issues, such as applications, hazards, protection, identifying a radiation source, legislation, regulations and the like. The programme is intended to inform radiation users and others who might encounter situations where a radiation source is involved.

In the case of a lost source, the licensee is required to inform the NRC within the shortest possible time. The NRC, upon receiving the information, takes the necessary measures depending on the circumstances. A team will visit the suspected area with radiation survey instruments. The process involves informing the local authority, disseminating information on the loss of the source through posters at the suspected locations, announcements made by local authorities that will be moving around the area with loudspeakers. Information is also broadcast through radio and TV, and announcements are made in the popular press. Photographs of the lost or similar source are displayed. The dangers are clearly documented and announced.

We have had the experience of a stolen Troxler surface density moisture gauge with Am-241 and Cs-137 sources. The theft took place on 31 July 1997. The above procedures of dissemination of information were followed of which the announcement/posters were made in *Kiswahili* (local language). To date the source has not been recovered.

EDUCATION AND TRAINING IN THE SAFETY OF RADIATION SOURCES AND THE SECURITY OF RADIOACTIVE MATERIALS

Training is the best precondition for enforcing the required protective measures within the institutions and the best precaution against unusual occurrences and unnecessary radiation exposure to radiation workers, members of the public and contamination of the environment. Training for all radiation workers and the staff of the NRC is well documented in the code of Practice [4]

Training Targets

Since 1986, the NRC has been conducting five-day training courses in radiation safety to radiation workers and customs officials (Table 1). Customs has also been essential to help the

NRC in enforcing the law by controlling the movement/trafficking of radioactive materials. Due to lack of funds by both trainees and the NRC, it has not been possible to conduct the training in some of the years.

Table 1. Years with corresponding number of trainees

YEAR	# RADIATION WORKERS TRAINED	# CUSTOMS & BORDER OFFICIALS TRAINED
1986	28	
1991	50	
1992	20	
1993	16	
1994		10
1995		6
1996	28	
2000		14

However, it should be noted that the radiation workers possess academic qualifications in the relevant fields and the courses conducted by the NRC are only intended to supplement their knowledge in radiation safety issues. The NRC neither issues State qualifications nor conducts examinations; however, records are kept for those who attend such training. Certificates of attendance are issued.

Training for the Staff of the Regulatory Authority

The level of education of the NRC staff ranges from university graduates to technicians. New employees receive in-house training prior to making applications to the IAEA for training courses or fellowships.

CONCLUSION

The current status of control of radiation sources and radioactive materials, and the whole system of notification, authorization, registration and licensing need to be improved in order to match the trade liberalization system that is taking place in the country. The amendment of the existing Act [1] and the current use of the RAIS program provided by the IAEA are steps ahead towards the improvement.

REFERENCES

[1] The Protection from Radiation ACT, 1983, Dar-es-Salaam, Tanzania.

[2] "Radioactive Waste management for the Protection of Human Health and Environment Regulations 1999", Dar-es-Salaam, Tanzania.

[3] Safety Series No.115 (1996): International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Vienna, Austria.

[4] The Protection from Radiation (Code of Practice) regulations, 1990, Dar-es-Salaam, Tanzania.

THERE ARE RADIATION SOURCES OUT THERE!

M.Y. BAHRAN
National Atomic Energy Commission, Republic of Yemen

Abstract. During the past few years we have been working in the area of the safety of radiation sources and radioactive materials. In this paper we summarize our findings and describe the recovery of an abandoned source. We call for further international co-operation in this area. In particular, we suggest an international system for the tagging and tracking of radioactive sources.

INTRODUCTION

A regulatory authority has existed in Yemen for only a few years, but radiation sources started to be introduced into the country early in the development of industry — particularly the oil industry — in Yemen.

Before May 1990 Yemen was divided and an authoritarian government controlled the southern part, which included a large area of mostly desert land, and to this day we do not have a clear idea of the activities that may have taken place in that area before unification.

The National Atomic Energy Commission (NATEC), the regulatory authority, has four general directorates connected with radiation protection and waste safety. Three of them are currently active, the most important of them being the General Directorate for Inspection, Licensing and Registration (NATEC-GDILR). In the past couple of years, we have not only established the necessary infrastructure but also embarked on a comprehensive programme. We have the law, the technical people and some equipment, and also excellent success stories to tell. Our successes mean two things – on one hand, that NATEC is up to the job, assigned to it by the law, of protecting Yemen's people and environment from the dangers of radiation and, on the other, that dangers exist buried under the sand.

RADIATION SOURCES AND RISKS

The sealed and unsealed radiation sources of concern here were brought into Yemen mainly by foreign companies in connection with developmental activities which started in the late 1960s and early 1970s, reached a peak in the late 1980s and are continuing. The nuclides of interest are basically cobalt-60, caesium-137 and iridium-192, and the intensities range from a fraction of a curie to thousands of curies. The sources entail the risk of chronic and acute radiation injuries; the environmental risk is hard to quantify.

THE CASE OF AN ABANDONED COBALT-60 SOURCE

One day, in a junk yard belonging to a sub-contractor to an oil company, we stumbled across an old receptacle that looked like a large paint drum (in fact, it was initially mistaken for one by the yard supervisor). It was together with a number of paint drums although it was much heavier than a paint drum. Clearly, the yard workers had assumed it to be a paint drum and had ignored the fact that it was unusually heavy.

We were pleasantly surprised to find that the receptacle was properly closed and that its contents were intact. Inside the container was a sphere of lead (a lead container) surrounded by protective material. The receptacle had the “radioactivity” sign engraved on it, but the colour of the sign was the same as that of the receptacle. No information was available to indicate the type and amount of radioactivity inside.

From the volume and weight of the lead container and the residual activity measured at the surface, assumptions were made as to the kind, form and amount of radioactive material inside. On the basis of these assumptions, the decision was taken to unseal the lead container by remote control and carry out spectroscopic measurements to identify the source and assess its intensity. The lead container was unsealed, measurements were carried out and the lead container was sealed again with the help of a home-made remotely controlled set-up.

It turned out that in the lead container was a moderately hot cobalt-60 source in metallic form. Clearly, the source was old (later, it turned out that it had entered the country in the early 1980s). In the light of an assessment of the risk associated with the source, we were glad that the source had been found intact and untouched. Subsequent investigations revealed information pointing to “criminal” ignorance on the part of the companies involved. Fortunately, no injuries were caused.

OTHER INCIDENTS

We have encountered a few incidents in which violations of the law took place. Most of the violations were minor, but there was an illegal attempt to dispose of an industrial source by burying it in the ground. It was discovered in time, by mere chance, and again no injuries occurred. Still, we are particularly worried about sources that entered Yemen before NATEC was established.

We have been lucky so far, but we cannot foresee the future. We just hope that, through hard work and the stringent control of new sources, we will not experience incidents where people and/or the environment are at risk. Certainly we believe that there are radiation sources out there, and although two incidents involving two sources does not sound much, one accident is an accident too many.

CONCLUSIONS

Foreign companies, if not properly watched, may choose to ignore regulations relating to the safety of radiation sources, with detrimental effects on people and the environment. In order to make them accountable and enable regulatory authorities such as NATEC to ensure the safety of sources, we propose the establishment of an international tagging system for manufactured radiation sources. With this system, each source would be registered with the IAEA. Such registration would facilitate the identification of abandoned sources, helping to ensure that the guilty parties are made accountable. The system should make it possible to track any source from the place of manufacture to the place of storage and/or treatment, ensuring that no sources are abandoned or lost without the international community noticing.

ACKNOWLEDGEMENTS

This paper has been prepared on the basis of internal NATEC reports which cannot be distributed for legal reasons; they refer to issues that are still legally pending. Thanks are due to the men and women — physicists, engineers and other staff members — who serve NATEC.

REPORT ON THE LEGISLATION IN THE FIELD OF NUCLEAR SAFETY AND REGULATORY CONTROL OF RADIATION SOURCES AND RADIOACTIVE MATERIALS IN YUGOSLAVIA

V. KOLUNDZIJA
Federal Ministry of Economy, Federal Republic of Yugoslavia

Abstract. The national regulatory infrastructure in Yugoslavia is described in the report, including the legal framework governing the safety of radiation sources and the security of radioactive materials. The organization and competencies of the Yugoslav Nuclear Safety Administration are explained, in particular regarding the national system of notification, registration, licensing, inspection and enforcement of radiation sources and radioactive materials, where the Federal Ministry of Economy and the Federal Ministry of Labour, Health and Social Policy are sharing competencies. Finally, the report refers to the national provisions on the management of disused sources; on planning, preparedness and response to abnormal events and emergencies; on the recovery of control over orphan sources; and on the education and training in the safety of radiation sources and the security of radioactive materials.

INTRODUCTION

Yugoslavia became a member of the IAEA in 1958. In 1970 it signed The Treaty on the Non-proliferation of Nuclear Weapons (NPT) and in 1973 the agreement between Yugoslavia and the IAEA on the application of safeguards in connection with the NPT.

Subsequently, Yugoslavia also signed the following documents:
1977 Vienna Convention on Civil Liability for Nuclear Damage,
1985 Convention on the Physical Protection of Nuclear Material,
1989 Convention on Early Notification of a Nuclear Accident;
1991 Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency

THE NATIONAL REGULATORY INFRASTRUCTURES

Yugoslavia consists of the two republics (Serbia and Montenegro). The legislation governing the safety of radiation sources and the security of radioactive materials is currently based on:

- the Law on the Prohibition of Construction of Nuclear Plants in Yugoslavia (1995)
- the Law on Protection against Ionizing Radiation (1996)
- the Decision on Conditions for siting, construction, pre-operational testing, commission and shutting down of nuclear facilities (997)
- the Decision on the drafting and contents of nuclear safety reports and other documentation for the establishment of compliance with nuclear safety measures
- the Decision on modes and conditions of systematic monitoring of radionuclides in the environment surrounding nuclear facilities (1997)
- the Decision on conditions for trafficking and using of nuclear materials and recording methods of nuclear materials by material balance areas (1997)
- the Decision on eligibility requirements for personnel in charge of production process management in nuclear facilities and of supervision of these tasks (1998)
- the Decision on the criteria for the assessment of nuclear facility safety (1998)

YUGOSLAV NUCLEAR SAFETY ADMINISTRATION (ORGANIZATION AND COMPETENCIES)

Government of the Federal Republic of Yugoslavia

Commission for peaceful application of Nuclear Energy

The Commission is entrusted with:

- Discussing and proposing measures and activities related to:
- long term policy of national of nuclear energy and technology application
- nuclear safety and ionizing radiation protection
- conversion and storage of radioactive waste materials
- cases of nuclear accident

Providing relevant options on:

- international bilateral and multilateral agreements in the field of nuclear energy
- stands to be taken for negotiations with other countries and international organizations

Federal Ministry of Economy

Federal Ministry for Labour, Health and Social Policy

Sector for Nuclear Energy
Nuclear safety administration dealing with:

- current legislation and inspection tasks
- international co-operation in the field of nuclear safety
- timely exchange of information in case of nuclear or radiation emergencies

- health inspectorate of the FRY
- authorizing body for transportation of hazardous goods
- national focal point for notification of radiation sources for use in medicine and industry

For radiation protection issues, the competencies are divided between the Federal Ministry of Economy and Federal Ministry for Labour, Health and Social Policy.

THE NATIONAL SYSTEM OF NOTIFICATION, REGISTRATION, LICENSING AND INSPECTION OF RADIATION SOURCES AND RADIOACTIVE MATERIALS AND FOR THE ENFORCEMENT OF REGULATORY PROVISIONS.

The competencies for the above mentioned are divided between the Federal Ministry of Economy and the Federal Ministry for Labour, Health and Social Policy.

The Federal Ministry for Economy is entrusted with the following:

- Nuclear and radiation safety of nuclear facilities
- Full application the national system of accounting for and control of nuclear material pursuant to article 7 under Yugoslavia's safeguards agreement in connection with the NPT.
- Development and approval of the radiation monitoring programme in the surroundings of nuclear facilities
- Implementation of administrative procedures and issuance of licenses related to nuclear facilities (including decisions to decommission nuclear facilities and remediate of the site)
- Analyses of events and operating experience
- Reporting on the state of nuclear safety
- In case of nuclear accidents activation of a special expert team for accident analysis
- Liability for nuclear damage
- Storage and disposal of radioactive waste
- Organization of expert commissions in the field of nuclear safety, relevant regulation, harmonization of the national legislation with the IAEA nuclear safety recommendations
- Co-operation and co-ordination in the implementation of multilateral and bilateral agreements.

Federal Ministry for Labour, Health and Social Policy is in charge of the following:

- Radiation protection issues-inspectorate for radiation protection
- Trade, transport and handling of nuclear and radioactive materials (issuance of expert and import licenses)
- Regulations on technical equipment and professional qualifications of employees in medical, educational and research organizations
- Measurements of exposure to ionizing radiation of the employees engaged at radiation sources.
- Degree of exposure in various occupations (collection of data on the exposure of the population, medical patients and workers working with radiation sources)
- Methodical monitoring of radionuclides in the environment:
  (a) under regular conditions
  (b) in unusual events

*Physical protection of nuclear facilities and materials is under the authority of the Republican Ministry of the Interior

NATIONAL PROVISIONS ON THE MANAGEMENT OF DISUSED SOURCES

The national regulatory authority based on The Law on Protection against Ionizing Radiation (1996) and the decision on modes of collecting, keeping, record, conditioning, disposal and storage of radioactive waste (1999) is in charge of ensuring safety in the handling of radioactive waste depending on the type.

NATIONAL PROVISIONS ON PLANNING, PREPAREDNESS AND RESPONSE TO ABNORMAL EVENTS AND EMERGENCIES

At the national level there is a general plan for measuring radiation protection and safety in case of abnormal events and emergencies (articles 6 and 23 of on The Law on Protection against Ionizing Radiation). This plan has established specific subordination between participants. Depending on the type of emergency, the competent national authority is engaged.

As a Member State of the IAEA, Yugoslavia participates in INES (International Nuclear Event Scale), IRSSR (Incident Reporting System for Research Reactors) and mutual sharing of information on illicit trafficking in nuclear materials and other radioactive sources.

NATIONAL PROVISIONS ON THE RECOVERY OF CONTROL OVER ORPHAN SOURCES

In Yugoslavia, the Federal Ministry of Labour, Health and Social Policy is the national focal point for notification of radiation sources for use in medicine and industry. The legislation governing the safety of radiation sources and the security of radioactive materials is currently based on the Law on Protection against Ionizing Radiation as well as 11 accompanying regulations. In preparing mentioned 11 accompanying regulations were used recommendation by the International Commission on Radiological Protection issued in 1991 and basic safety standards issued by the IAEA in Safety Series no. 115.

Over the past few years, the federal administration was notified of three cases of orphan sources:

- In 1995, radiation source J 131, activity 150 mCi, was stolen on the railway station in Belgrade (Serbia) during the manipulation procedure. The parcel was marked properly. It was found in Bar (Montenegro), when thieves tried to sell it.

- In 1998, Eu (europium) 152,154, activity 300 mCi from the radioactive lightning rod, was missed during its removal/transportation. The source (small and bright) was picked up by unknown person who put it in his bag and left it in front of his weekend cottage. The orphan source was searched for and the local radio and TV station were engaged to inform domestic population of the possible radioactive contamination of the numbers of persons in manipulation with source. In the end there were no serious consequences at all.

- In 1999, during a NATO strike on certain industrial facilities in Serbia, the ionization smoke/fire detector were missed. There were sources of americium (Am) 241 activity 1-2 microCi.

In order to recover of control over orphan sources, the competent authority shall take the following necessary steps:

1. Information will be sent to the police (Republican Ministry of the Interior) and authorized radiation protection service. On the basis of the data gathered, Republican Ministry of the Interior shall prepare a public statement on the effects of lost sources.
2. If necessary, border checkpoints shall be informed in order to prevent illicit trafficking.
3. A special properly equipped authorized service for radiation protection shall be engaged to find and recovery of control over orphan sources. In Yugoslavia, authorized service is Laboratory for radiation protection in the Institute of nuclear science "Vinca" and possesses 10 vehicles and 15 training staff.
4. The level of medical aid to persons irradiated or contaminated will depend on the severity of the accident.

NATIONAL PROVISIONS ON THE EDUCATION AND TRAINING IN THE SAFETY OF RADIATION SOURCES AND THE SECURITY OF RADIOACTIVE MATERIALS

Article 5, paragraph 8, of on The Law on Protection against Ionizing radiation stipulates of education and continued professional training of personnel in radiation protection. Other acts or regulations prescribe modality of establishing qualifications for employees such as the Decision on necessary educational qualification for personnel in charge of production process management in nuclear facilities and supervision of these tasks. The competent authority in charge of organizing and carrying out programmes of permanent professional education for nuclear facility personnel informs the Federal Ministry of Economy thereon.

NUCLEAR FACILITIES IN YUGOSLAVIA

In Yugoslavia, there are two nuclear facilities:

- research reactor "RA"- tank type 2% enriched U, heavy water moderated and cooled,
- Graphite reflected 6,5 MW reactor (since 1985 not in operation due to still unfinished reconstruction),
- Research reactor "RB"-tank type zero power critical assembly, 2% enriched or natural U, heavy water moderated.

SUMMARIES OF DISCUSSIONS:

ROUND TABLES

SUMMARY OF DISCUSSION

ROUND TABLE 1

TOWARDS AN EFFECTIVE CONTROL OF RADIATION SOURCES

***Chairperson:* A.A. Oliveira (Argentina)**

J.W. Hickey (United States of America — *panellist*): I should first like to say a few words about the balance of resources as between, on one hand, the users of radiation sources and, on the other, the regulatory authority. We regulators have all had to cope with problems due to the very limited resources available to us, but we should remember that the expenditure of a certain amount of resources by the regulatory authority may well prove to be less beneficial than the expenditure of an equivalent amount by users for ensuring the safety of their sources. The users are responsible for their sources; the job of the regulatory is simply to ensure that the users meet their safety responsibilities.

I should then like to say a few words about incentives which will help to ensure that users do the right thing from the safety point of view. The most important incentive is undoubtedly a thorough understanding of the hazards associated with radiation sources. That is a question not only of education and training, but also of adequate information; in the United States, we now require source manufacturers to provide their customers with written safety information, so that the customers may become aware of the hazards associated with the sources which they have purchased. That is particularly important in the area of industrial radiography, where the people working with sources tend not to have received the education and training received by those who work with sources at — say — medical facilities. In that connection, I would mention that we have introduced a "third-party examination" process whereby people who are earmarked to work with radiation sources have to pass a written examination administered by a third party — not by, for example, their employers, as that would be less objective.

Another important incentive is the levying of severe penalties on users who violate safety regulations. However, the threat of such penalties may not be sufficient. Accordingly, it may be necessary to require that users take out insurance for an amount which will cover any liabilities they are likely to incur as a result of incidents involving the sources being used by them. We require licensees who are working with unsealed sources to take out insurance (or post a bond) against the costs of cleaning up contaminated facilities, but there is no similar requirement in the case of licensees working with sealed sources.

We are trying to intensify our contacts with users of radiation sources, mailing communications to them regularly and investigating in cases where they do not respond to those communications — because, say, the user has gone out of business.

Besides the users of radiation sources, we regulators need to think of non-users who are likely to come into contact with such sources — for example, scrap metal dealers, law enforcement officers and even members of the general public. In the United States, we have, for their benefit, distributed brochures explaining the "radiation" trefoil and carrying pictures of — for example — a radiography device and a teletherapy head.

In conclusion, I should like to mention one way in which regulators can help innocent parties who discover an orphan source and fear that. if they report the discovery, they will be liable for the costs of disposing of it safely — for example, a scrap metal dealer who is tempted to get rid of the source without telling anyone. Regulators can help by trying to trace the responsible party and, if successful, ensuring that the responsible party pays the costs of safe disposal. That is an incentive to report the discovery of orphan sources.

I. Zachariašová (Czech Republic — *panellist*): I should like to say a few words about our experience at the State Office for Nuclear Safety's Department of Radiation Sources and Nuclear Facilities, as it may be of particular interest to those of you who are from East European countries or countries of the former Soviet Union.

The State Office for Nuclear Safety was established in 1995, and we moved to it at that time from the Ministry of Health, where we had been responsible for providing radiation sources needed in areas such as medicine, industry and research as well as for "supervision" of the sources provided by us; the "supervision" was the responsibility of "inspectors" whose powers, however, were very limited. With the move we became an independent body with its own budget, and we acquired greater inspection powers. Our situation is much better now than it was before 1995.

We have developed a source categorization with five categories, ranging from sources of no significance from the radiation safety point of view to sources of very great significance. The use of sources belonging to the first two categories does not have to be authorized; notification is sufficient. For sources belonging to categories 3–5, the licensing procedures range from the very simple to the very complex. In addition the inspection procedures and the frequency of inspections depend on the source category.

Using IAEA-TECDOC-1113 ("Safety assessment plans for authorization and inspection of radiation sources"), we have drawn up checklists for different applications — medicine, industry, research etc. We try to ensure that uniform inspection procedures are followed throughout the country, in contrast to the time when the local inspectors — who used to be "kings" in the regions covered by them — did more or less whatever they wanted.

We have established a system for the qualification of inspectors, who have to possess a university degree and — after training or retraining — to pass an oral examination. The qualification procedure is a lengthy one, but in my view the results have been good.

The inspections carried out by us are of three types: simple, routine inspections at minor locations; "specialized" inspections, with more than one inspector taking part (so that junior inspectors can gain experience), at major locations; and "ad hoc" inspections, with — in addition to local inspectors — staff from the Department of Radiation Sources and Nuclear Facilities in Prague and other experts taking part, at locations where it is suspected that something has gone wrong.

Adapting the IAEA's Regulatory Authority Information System (RAIS) to our needs, we have established a comprehensive inventory of sealed radiation sources and are now adding X-ray generators and information about licences.

Many people from developing countries, including some of the participants in this International Conference, have received inspector training in the Czech Republic. For example, we have trained at least 40 inspectors from countries taking part in the IAEA's Model Projects for upgrading radiation infrastructure.

T. O'Flaherty (Ireland — *panellist*): In Ireland, a relatively small country with no nuclear power plants, we have for about 20 years had a regulatory system for the usual range of applications of ionizing radiation in medicine, industry, research and so on. At our request, the Agency's Secretariat recently organized a review of our regulatory system. The preliminary conclusions of the review, which took place at the beginning of November, may be of interest to regulators from some other countries.

I shall start with things which the review team found to be reasonably satisfactory.

The team concluded that the IAEA's performance criterion relating to legislation and regulations had been satisfactorily met — the essential legal infrastructure for radiation protection, including legislation for implementing European Union directives, was firmly in place.

Also, it concluded that the performance criterion relating to the notification of sources was being satisfactorily met — there was a national inventory of radiation sources in existence; there was good control of the procedures involved in licensing and accounting for sources; and the inspection arrangements were satisfactory at the administrative level.

In addition, it concluded that the regulatory provisions for enforcement were adequate, incidents being investigated in an appropriate manner, and that co-operation between the regulatory authority and the various technical support agencies was reasonably effective.

That's the good side of the story. Now for things which the review team was less happy about.

The team concluded that the number of staff in the regulatory service was insufficient; of the seven staff members, three have managerial or administrative functions, so that there are effectively only four inspectors. To put that into perspective, I would mention that there are about 1200 licences in force in Ireland at present.

Also, the team concluded that the practice-specific skills of the inspection staff were deficient — that the inspection staff were not sufficiently expert in the applications being inspected.

It called for more rigorous scrutiny of radiation safety procedures at the time of licence renewal, so as to ensure that the procedures were up-to-date and satisfactory.

The review team concluded that there was a need for a more efficient system for processing applications to operate low-risk devices such as dentists' X-ray systems, which account for over half of the licences in force at present; it called for a shift of focus away from the formal checking of compliance with administrative requirements. In this connection, I should like our regulatory system to develop an ability "to read between the lines" — a kind of sixth sense which would alert inspectors to less obvious causes of weakness in licensees' structures or management procedures.

A further point made by the review team was that inspections were being carried out almost always by just one person. The team considered that more than one person should be involved in some inspections.

The team concluded that the giving of general advice to licensees was taking up too much time; licensees should be encouraged to acquire greater expertise and become less reliant on the regulatory service for general advice.

The team felt that investigation levels should be more practice-specific, rather than generic.

The follow-up to investigations was considered to be insufficiently systematic; for example, we did not make enough use of the information acquired through the investigation of incidents in educating other licensees. In fact, the review team called for a more systematic approach to the provision of information generally to licensees — and also to persons such as radiation protection officers.

Lastly, the review team felt that, particularly in the health area, co-ordination with other relevant bodies should be improved.

To sum up, I think it can be said that the review team was of the opinion that the regulatory system in Ireland is effective but should be more closely focused on matters of radiation safety rather than administration.

M. Ridwan (Indonesia — *panellist*): My country's regulatory authority, the Nuclear Energy Control Board, was established in 1998 and became operational in January 1999.

What is the mission of a regulatory authority? In my view, it is not only to protect people, especially the users of radiation sources, but also to give them a feeling of security about applications of nuclear energy.

The regulatory authority should be independent, completely separated from all promotional and operating organizations. It should be able to perform assessments and arrive at technical judgements in an unbiased manner, without interference from outside. Hence, our Nuclear Energy Control Board reports directly to the President of the Republic.

In order to carry out its mission, the regulatory authority should keep the public well informed about its work. Its channels of communication with the public should always be open. Hence, our Nuclear Energy Control Board is required to report to the public periodically, in a transparent manner, on the results of its inspection activities. Nothing should be hidden from the public, whose support may help to strengthen the position of the regulatory authority.

The regulatory authority should have a strong legal framework and be empowered to issue technical rules, lay down safety procedures and set standards, and also to initiate the drafting of governmental regulations and decrees.

Lastly, the regulatory authority should be provided with sufficient professional staff and operational funds.

These are necessary conditions, but they are not sufficient. They make for control "from the top down", which tends to work only when the "controller" is watching. There is also a need to educate users through dialogue. Fortunately for us, the users in Indonesia are well educated, so that it is fairly easy to communicate with them. Soon after becoming operational, the Nuclear Energy Control Board began organizing meetings at which topics such as the legal requirements for various applications of nuclear energy, regulatory principles, responsibility for radiation safety (which rests solely with the licensee), the state of the art of and current trends in radiation safety, and emergency preparedness are discussed.

The ultimate objective is a safety culture based on mutual trust between users and regulators. The process is a time-consuming one, but I think it is working. Mutual trust is being built up without safety being compromised.

A key figure in this process is the radiation safety officer. In Indonesia, all user organizations must have a radiation safety officer, and these professionals may be regarded as “the invisible hands” of the Nuclear Energy Control Board. The Board requires all radiation safety officers to requalify twice every five years. The requalification exercise enables the Board to maintain close contact with them and provides additional opportunities for them to talk freely about their problems.

An indication of the importance attached by the Nuclear Energy Control Board to these professionals is the fact that an Association of Radiation Safety Officers is being established under the Board’s auspices.

Will the measures taken by the Board contribute to the effectiveness of the control of radiation sources? Only time will tell.

C.J. Englefield (United Kingdom – *panellist*): In my country, we have been regulating radioactive materials since 1947, and I would say that we have as mature a regulatory system as any country in the world — although the system is not perfect. For example, because of “Crown exemptions” there are areas not covered by the system — a feature of the system which we are still trying to correct.

The regulation of radioactive materials in the United Kingdom is a multi-organizational operation. There are regulators who focus on safety issues, with the emphasis on radiation dose control, while my organization — the Environmental Agency — and other environmental protection bodies take a broader view, treating environmental impact as an issue distinct from the radiation doses received by humans. The regulators focusing on safety issues are concerned mainly with the radiation sources used in industrial radiography, where the doses are relatively high; the environmental protection bodies are concerned mainly with the radiation sources used in other applications, where the environmental — and commercial — consequences of an incident such as the loss of a source may well be greater.

In the United Kingdom, the Radioactive Substances Act applies only to “undertakings” (e.g. commercial companies); a private individual who acquires radioactive materials is not subject to the Act’s provisions. That can create problems for us regulators. In the case, for example, of a person who collects minerals and has thereby accumulated significant amounts of radioactive materials, all we regulators can do is offer advice.

As regards the question of responsibility for the safety of radiation sources, we consider that the responsibility lies with the user. We expect the user to comply with the regulations, and we see our role as one of providing a kind of quality assurance service.

As regards the question of depleted uranium, about which there has been a lot of talk recently, radiography source containers made with depleted uranium are regulated in the United Kingdom. However, we at the Environment Agency who are responsible for radioactive substances do not regulate — for example — the depleted uranium counterbalance weights in aircraft; they become subject to regulation in the United Kingdom only when the aircraft is scrapped there.

We charge regulation fees, which affects the frequency with which we carry out inspections. We are in any case now tending to increase inspection frequencies owing to — in particular — the growing concern about the wide range of risks associated with orphan sources.

We do not have a national radiation source inventory in the United Kingdom. We regulate premises, where inventories are kept on the basis of radionuclide types and quantities — we do not regulate individual sources. The reason for that situation is that for a long time there have been very many sources in the United Kingdom, including many which are not amenable to tracking and unique identification.

As regards the disposal of radiation sources, radioactive waste management is a matter of governmental policy in the United Kingdom; we regulators, as servants of the Government, implement its policy. In the United Kingdom, the disposal of radioactive waste is a costly commercial operation, and the costs often act as a disincentive to people with radioactive waste in their possession, who are tempted to dispose of it illegally. We therefore underwrite disposal costs to a limited extent.

In the area of enforcement, our experience suggests that judges tend not to understand the implications of the non-compliance cases which we bring before them, despite the fact that we have put a lot of effort into making magistrates (judges in lower courts) aware of those implications. The law provides for maximum fines equivalent to about US $30 000 in the lower courts and for unlimited fines and maximum prison sentences of two years in the higher courts. As far as I recall, the longest prison sentence imposed so far in the United Kingdom was one of nine months, for a loss of control over a very significant amount of radioactive material, but it was suspended because of extenuating circumstances. The fines imposed have tended to be so low that many users may find it cheaper not to comply with the regulations. For our part, we shall continue trying to make magistrates aware of the risks to humans and the environment which are associated with things such as orphan sources.

P.K. Ghosh (India — *panellist*): In my country, we endeavour to take care of radiation sources "from the cradle to the grave".

Each radiation source must be of an approved type, complying with international standards, so that its design safety is ensured, and there must be regulatory consent for its manufacture or import, its possession, its use, its transfer and its disposal. Regulatory consent is contingent on safety surveillance and periodic reporting at all stages in the life of the source. With regard to the import of sources, the import procedures are proving useful in helping to detect illegal transfers.

We are now categorizing sources and drawing up inventories on the basis of IAEA-TECDOC-1191 ("Categorization of radiation sources").

We carry out inspections at user establishments in order to see whether source licensing conditions are being complied with. Through unannounced inspections, we have uncovered numerous cases of non-compliance, especially in the industrial radiography area. In such cases, we have suspended the certifications of the establishments in question, which have promptly gone to court and contested the suspensions. So far, all suspensions have been upheld in court, and the compliance situation is now improving.

We also carry out periodic inspections at locations such as scrap yards, airports, railway stations and major harbours. In this connection, I would mention that India's railway network extends into all parts of the country and that there are many small railway stations to which radiation sources are sent (for use in, for example, oil exploration) where the staff are not aware of the hazards associated with them. Sometimes, a source remains unclaimed at such a station for a long period, being removed to safe storage only when we find it during a periodic inspection.

With regard to emergency response, we have a central emergency control centre and response mechanism and also emergency control centres at the nuclear establishments scattered about the country. The Atomic Energy Regulatory Board has established procedures and guidelines for the recovery of orphan sources, indicating the pathways likely to be followed by them. It has also established procedures for dealing with disused sources and, after their recovery, with orphan sources.

In the area of education and training, we run certification courses tailored to different applications — industrial radiography etc. We also run refresher courses in order to appraise operating personnel of changes that have taken place in the radiation safety field.

The Atomic Energy Regulatory Board has — as a follow-up to the International Conference on the Safety of Radiation Sources and the Security of Radioactive Materials held in Dijon, France, in 1998 (the Dijon Conference) — held workshops for customs and narcotics control personnel which have been greatly appreciated by the participants.

A.A. Oliveira (Argentina — *Chairperson*): From what we have heard so far during this Conference it seems clear to me that a great deal has been done since the Dijon Conference to improve the control of radiation sources, but how can we assess the effectiveness of such control?

A.M. Boccas (Philippines): I should like to suggest some indicators of effectiveness: the number of incidents involving radiation sources; the number of orphan sources; the number of cases of user non-compliance with radiation source safety regulations; and the participation of user staff in radiation safety workshops and similar events.

A. Salmins (Latvia): In the Baltic region, we have found it difficult to compare the effectiveness of the regulatory bodies of different countries, because national circumstances, including the types of source present, differ.

However, we have come up with some effectiveness indicators — for example, the response time of the emergency response team in the event of a radiation accident; the frequency of the detection of illegal movements of radioactive materials at national borders; the recovery time when a source is lost; and the doses received by emergency response teams in the event of a radiation accident. An indicator of efficiency, rather than effectiveness, might be the number of facilities or sources covered by an inspector during a given period.

M. Bahran (Yemen): The IAEA is doing a great deal — for example, through the Model Projects for upgrading radiation protection infrastructure — to increase the effectiveness of control of radiation sources, but I feel that still more can be done at the international level.

Old sources probably present an insoluble problem, but in the case of new sources it might be possible to require that manufacturers register them with the IAEA and to devise a system whereby the IAEA tracks their movements.

P. Ferruz-Cruz (IAEA): In my view, that idea is a good one — but not feasible.

The IAEA has a complete record of the radiation sources which have been provided through it to its Member States, but it does not have anything like complete information about where those sources are now and virtually no information about sources which Member States have acquired by other means. The IAEA is not an international regulatory body, and I do not think that countries should be required to make such information available to it.

R.H. Rojkind (Argentina): One way of increasing the effectiveness of control of radiation sources might be for the regulatory bodies in all countries which export sources to require the exporter, in the case of each source to be exported, to obtain from the importer a certificate stating that the prospective user is authorized to use that source. When we in Argentina wish to import sources from the United States, we have to provide such certificates to the exporters.

I. Othman (Syrian Arab Republic): In my country, all radiation sources are imported. We register them when they enter the country and track their subsequent movements. In most cases, the purchase contract provides for the source to be re-exported when it is no longer needed. Hence, we have not had major problems with radiation sources.

Where we have had major problems is with the import of radioactively contaminated commodities such as wheat, barley and dried milk. After the Chernobyl accident, such commodities were bought up cheap by dealers who then sold them to developing countries. We discovered the radioactive contamination in the course of checks or by chance. The situation is not as bad as it was, but we still have to be vigilant.

A.A. Oliveria (Argentina — *Chairperson*): Some years ago I saw with my own eyes the consequences of the loss of a very powerful radiation source, and I therefore feel very strongly that it is important to impress on users what can happen when radiation sources are “orphaned”.

SUMMARY OF DISCUSSION

ROUND TABLE 2

HOW TO LOCALIZE AND REGAIN CONTROL OF THE EXISTING RADIATION SOURCES

Chairperson: **J.R. Croft (United Kingdom)**

R. Czarwinski (Germany — *panellist*): With regard to the question of regaining control of radiation sources, I should like to describe a problem which we are facing in the eastern part of Germany.

In the former German Democratic Republic, cobalt-60 sources installed in wells were used for sterilizing the water. The practice was terminated when the German Democratic Republic and the Federal Republic of Germany united, and we found ourselves having to recover nearly 6000 sources from a large number of wells and dispose of them. In all but two cases we have already recovered the sources and closed the wells. The two wells where we have not yet done that are badly damaged and it is therefore difficult to reach the sources, which are at depths of 100-120 m. The recovery operations will be very expensive, which raised the question whether the risks involved in simply leaving the sources where they are would be acceptable. It has been decided that, despite the great expense, we shall recover these sources also, but could such a decision be taken in countries which are much poorer than Germany? What is regarded as an acceptable level of risk may well depend to a large extent on financial considerations.

I should also like to say a few words about the sensitivity of monitoring equipment and alarm levels.

At Hamburg's customs port, we have radiation monitoring systems capable of measuring 4 μSv/hour in the case of natural radioactivity and nearly 10 nSv/hour in the case of artificial radioactivity. We have monitoring systems at most incineration plants in Germany, and the alarm level is 1μSv/hour.

I. Uslu (Turkey — *panellist*): I should like to start by drawing your attention to a recent report entitled "Management and Disposal of Disused Sealed Radioactive Sources in the European Union" (report EUR 18186 EN); its conclusions and recommendations are probably to a large extent valid also for countries outside the European Union.

The authors of the report summarize the reasons — given by respondents — for sealed sources not being under regulatory control. The three reasons given most frequently were: the sources (for example, old radium needles) were never under regulatory control in the first place; the sources were imported in scrap; and whoever was using or storing the sources had gone out of business (for example, as a result of bankruptcy). In my view, the regulators in each country should try to determine the most likely reasons why sources might escape from regulatory control in that country. In developing countries, one likely reason is the storing of disused sources on user premises for very long time periods. One way of coping with the long-term storage problem, and with the problem of communicating with licensees generally, might be to require licensees to report to the regulator periodically via the Internet regardless of whether the status of the sources in question had changed; failure to report would be an indication that the licensee had gone out of business since the transmission of the previous report.

Among the authors' conclusions there are three which I should like to highlight: further detailed study of the detection, identification and control of sources arising in scrap should be carried out with a view to establishing improved regulatory controls and practical approaches; regulatory systems should encourage payment, or commitment to pay, for source disposal at the time of disposal; and simple systems should be put in place to give the public easy access to facilitate the reporting of suspect items or to obtain advice.

With regard to the third conclusion, I would mention that in Turkey we are preparing stickers which state, in Turkish, that the items to which they are affixed are radioactive and dangerous; we shall send these stickers to the manufacturers of radiation sources, notifying them that henceforth the import into Turkey of sources without the sticker will be prohibited. In that connection, I would also mention the possibility of efforts to make the public aware of the hazards associated with radiation sources backfiring; persons opposed to nuclear power generation may well exploit such efforts for their own purposes, saying that, if radiation sources are dangerous, then nuclear power plants (being huge by comparison) are really dangerous. Public awareness programmes must be conducted very cautiously.

In my view, inspections of radiation sources can in many cases be made to serve two purposes — ensuring that the source is indeed where it is supposed to be and ensuring that the source is doing its job properly. For example, after some years the cobalt source being used for therapy at a hospital may be doing more harm than good.

Lastly, I think more attention should be paid to possibilities of leasing radiation sources rather than buying them.

C.-G. Stalnacke (Sweden — *panellist*): In my country, we know that there are radiation sources, of Swedish and foreign origin, which have become "orphaned" and will manifest themselves in due course; however, we do not know when or where. At the same time, we know that they are most likely to manifest themselves in scrap.

In my view, most of those sources have escaped from the regulatory control system simply by being forgotten. In the many companies in Sweden that use radiation sources, the people who know about their existence ultimately leave (moving to new jobs or retiring) and are sometimes not replaced. The sources may be in devices which other people in those companies do not regard as devices containing radioactivity.

What should happen when an orphan source is found? At the Swedish Radiation Protection Institute, we believe that everything possible to make the source safe and secure should be done immediately, regardless of considerations of cost and responsibility; nobody should feel hesitant about reporting the discovery of an orphan source to the proper authorities.

In Sweden, we have gamma radiation detection portals at the entrances to facilities such as scrap yards and melting plants, but we do not have any at border crossings; perhaps we should. Also, we can perform GPS-supported surveys using airborne and car-carried detectors. We do not yet follow up the recorded information on sources in a continuous, systematic manner; usually we investigate only when there are indications that something exceptional has happened.

The detection portals at the entrances to various facility types were installed not because of pressure exerted by the authorities, but because the facility operators wanted to avoid the cleanup and other costs which would arise if orphan sources penetrated their facilities.

Most alarms are false, many of them triggered by NORM. Also, when an alarm is triggered and, say, the truck which triggered it is refused entry into the facility, the resulting situation — with a truck driver not knowing what to do about a possibly radioactive cargo — may well not be adequately covered by the regulations.

Moreover, a detection portal may fail to detect a source, as happened in Sweden a few years ago, when an undetected source was melted down together with scrap metal at a melting plant — a fact discovered only later, when radiation measurements were performed on the resulting material. We believe that the source entered the facility undetected because it was old and the radioisotope had a short half-life, so that there was not much radioactivity left, and also because it was still in its shielding container.

In Sweden, as in other countries, there is room for improvement.

R.E. Pacheco Jiménez (Costa Rica — *panellist*): In my country, a body responsible for — inter alia — localizing and regaining control of orphan sources was established, within the Ministry of Health, in 1975; it is, in effect, the national regulatory authority. We have the necessary legal framework (the General Health Act and general radiation protection regulations) and we have benefited from the support of national and international professional associations and of international organizations like the IAEA and PAHO.

In 1999, the Ministry of Health issued authorizations for the import of 104 radiation sources into Costa Rica. Accordingly, we have trained customs officials to recognize packages containing radiation sources, with good results, and through the customs authorities we have obtained information as to which companies in Costa Rica use radiation sources.

For us, events like international workshops and training courses are very useful for learning how orphan sources are localized in other countries and what types of facility use radiation sources. After attending such an event a few years ago in Guatemala, I was able to pinpoint a large number of facilities in Costa Rica — for example, a brewery, a paper mill, a metal goods manufacturing plant and factories producing electronic and medical devices — where radiation sources were being used.

I should like to close by saying a few words about the impact of a serious accident involving a cobalt-60 source which occurred in Costa Rica in 1996. For a long time the accident was the biggest news item in the country, but as a result both the general public and high-level decision-makers have become very much aware of the hazards associated with radiation sources. The Government has paid some US $2.5 million in compensation to victims of the accident, so I hope that people in Costa Rica are going to be very careful with regard to radiation sources in the future.

V. Holubiev (Ukraine — *panellist*): In my country, the process of regaining control of orphan sources involves the Ministry for Emergencies, the Ministry of Health, the Ministry of Internal Affairs, the Ministry for the Environment and Natural Resources, the security service and local authorities.

In 1997, the Cabinet of Ministers approved a document specifying how the relevant executive and legal authorities should interact when an orphan source is discovered. The document covers the various procedures involved in regaining control of the source — from the securing of the source through preliminary examination and subsequent detailed examination to storage. It states that a legal or physical person detecting suspicious material should notify the local executive authorities. The local executive authorities should arrange for the material and the detection site to be secured and inform the local representatives of the Ministry of Health's epidemiological service, who should perform a preliminary examination of the material and tell the local executive authorities and the relevant regional offices of the Ministry for Emergencies and the Ministry of Internal Affairs what protective measures they consider to be necessary.

If the suspicious material is found to be radioactive, it should be removed by a special emergency response team and put, in accordance with approved radioactive waste management procedures, into storage for safe-keeping until the owner has been located or any criminal investigation instituted by the law enforcement authorities have been concluded. If a detailed examination of the radioactive material is necessary, it is performed at the Nuclear Research Institute of the Academy of Sciences.

The Ministry for the Environment and Natural Resources is responsible for carrying out searches in the country's registry of radiation sources and for informing the competent authorities in other potentially interested countries, the IAEA and the media about any discoveries of orphan sources. There were five cases in 1999 and 12 in 2000, the increase in the number of orphan source discoveries being attributed to more extensive radiation monitoring at Ukraine's national borders and at scrap yards and melting plants.

With regard to the costs of regaining control of orphan sources, the document approved by the Cabinet of Ministers in 1997 leaves that question to be resolved on a case-by-case basis. In my opinion, no decision can be completely fair. From a political point of view, it would seem reasonable to make the local authorities of the territory within which the orphan source is found responsible for meeting such costs.

Finally, a few words about how helpful publicity via the media can be. Last September, two caesium sources, each with an activity of about 10 MBq, were stolen from a facility near the town of Donetsk. Immediately, the local authorities arranged for photographs of the sources and their containers to be shown and the radiation hazard associated with the sources explained on television. A few days later, the sources were left by an unknown person next to the boundary fence of the facility from which they had been stolen, presumably because the thief or thieves had become aware of the radiation hazard thanks to the television publicity.

R. Mezzanotte (Italy — *panellist*): In my country, we have not so far had many serious problems with orphan sources, although such sources are occasionally detected in imported metal scrap. In my view, the likelihood of serious problems will tend to decline with the increasing maturity of a country's control system — and Italy's control system is now almost 40 years old.

We have had quite a few problems with old radium sources which belonged to physicians or radiologists and, typically, were kept in the family safe long after the owner had retired and then died, and also with sources belonging to commercial enterprises which have gone out of business. However, such problems have been minor ones.

A problem which is becoming increasingly serious in Italy is that of the storage of disused sources. The special storage facilities available are insufficient, so more and more disused sources are being stored at the facilities where they were used. Considerable surveillance and inspection efforts are necessary in order not to lose control of them.

Orphan sources can appear in any country, so I think the general public should be taught to recognize typical radiation source shapes and the “radioactivity” trefoil, and be told to notify the police or some other local entity regarding any suspicious object; there is no need for members of the general public to know the telephone number of the national radiation protection authority, only that of someone who can contact that authority quickly. In Italy, reporting of the discovery of orphan sources is mandatory — even for members of the general public.

No country has the resources necessary for the permanent monitoring of all locations within its territory where orphan sources might be present or pass by. Consequently, there is a need for a radiation monitoring strategy in every country.

Radiation detection systems should be installed at locations where there is a high probability of detecting any orphan sources that are moving about (border crossings, foundries, scrap yards, landfill sites etc.), and the people working at those locations should receive the necessary education and training. In that connection, I welcome the IAEA’s Action Plan for the Safety of Radiation Sources and the Security of Radioactive Materials, and in particular the work being done by the IAEA’s Secretariat on the formulation of criteria for the development, selection and use of radiation detection and monitoring equipment intended for use at border crossings and other key locations. In Italy, the installation of radiation detection systems at certain types of location is mandatory.

Lastly, I should like to see the European Union becoming more active in the area of the regulatory control of radiation sources.

D. Cancio (Spain): I agree very much with Mr. Mezzanotte that, because of resource limitations, every country needs a radiation monitoring strategy.

M. Bahran (Yemen): Almost all the radiation sources in my country belong to foreign companies engaged in activities such as oil prospecting, and our experience suggests that such companies tend to ignore the radiation safety regulations of the countries where they are operating.

Recently, when processing a foreign company’s application to import a new source, we discovered by chance that the company in question had some 30 undeclared disused sources in its possession within Yemen. We did not issue an import licence until we had received an inventory of the disused sources, but we were left with the question as to how a regulatory authority can ensure that foreign companies do not accumulate sources without its knowledge.

J.R. Croft (United Kingdom – *Chairperson*): In my view, a regulatory authority cannot expect to know about all the sources within the territory for which it is responsible. In the circumstances which Mr. Bahran described, it should keep a close look on border crossings and other nodal points which sources must pass through and try to find ways of pressuring foreign companies into keeping — and disclosing if requested — inventories of all the sources in their possession.

M. Ridwan (Indonesia): I should like to say a few words about an incident which occurred a few months ago in my country. Twenty-one sources (mostly cobalt-60 sources, with activities of up to 4.8 mCi; one americium-241 source with an activity of 1 Ci) were stolen from the storage bunker at a steelworks. Around the steelworks there are several scrap yards, and we spent two weeks with radiation detection equipment looking for the stolen sources in those scrap yards — without success. About ten weeks later we found three of the sources in their containers, but the other 18 are still at large.

We believe that the thieves broke into the steelworks in search of metal scrap and, not finding any, forced open the storage bunker. They were attracted by the source containers, not realizing that the contents were dangerous.

I. Othman (Syrian Arab Republic): In my view, it is important to keep a constant check on source inventories, with frequent verification of the records and also frequent inspections of the storage areas — for sources are often removed from or returned to storage without the movements being recorded.

Our experience has shown that even at establishments which use radiation sources there may well be workers who do not know what the "radioactivity" trefoil means. We have encountered situations where a worker has slipped away into a storage room in order to have a rest and is sitting on a package marked with the trefoil. Clearly, it is important to explain to the workers at such establishments the hazards associated with radiation sources. I am not so sure about the advisability of trying to educate the general public in the same way; one may trigger unnecessary fears about various beneficial applications of nuclear energy. For example, even in advanced countries there are people who believe that irradiated foodstuffs are radioactive.

In this connection, I was interested to hear from Mr. Uslu how his organization is preparing stickers with a warning in Turkish to supplement the "radioactivity" trefoil.

T. O'Flaherty (Ireland): A question which I should like to see examined in due course is whether every enterprise handling scrap metal should be required to install radiation monitoring equipment, or only enterprises above a certain size. A related question is who should pay for the installation of such equipment if it is mandatory — the enterprise or, say, some governmental agency.

J.R. Croft (United Kingdom – *Chairperson*): In my view, the answers to those questions will vary from country to country, depending on the safety culture.

C.-G. Stalnacke (Sweden — *panellist*): I should like to make three comments, partly in the light of things which have been said during this Conference.

Firstly, in my view it would be interesting to have — for networking purposes — a comprehensive address list of regulatory authorities and perhaps also of suppliers of radiation sources.

Secondly, I think it would be a good idea to look into the feasibility and usefulness of establishing an international registry of radiation sources.

Thirdly, within the European Union there are arrangements for certifying, before a radiation source is allowed to move from one country to another, that the prospective recipient of the source has a licence to possess it. In my view, those arrangements could be usefully extended to cover countries outside the European Union.

J.R. Croft (United Kingdom – *Chairperson*): Regarding Mr. Stalnacke's first comment, I should like to see more networking — nationally, regionally and internationally.

H. Liu (China): Many enterprises prefer to store disused sources on their premises, rather than incurring the costs of sending them for storage at an official facility under strict regulatory control. That being so, perhaps thought could be given to trying to reach an international consensus on the regulatory control of disused sources in storage.

I. Uslu (Turkey — *panellist*): We have suggested to our Ministry of Education that, as they travel about Turkey, our inspectors lecture at schools on the advantages and disadvantages of using radioactive materials, explaining the meaning of the "radioactivity" trefoil.

Also, we have been assigned a three-digit telephone number (172) which anyone finding a radiation source can call toll-free in order to inform the Turkish Atomic Energy Authority's Radiation Health and Safety Department. The telephone number will appear on the stickers which I mentioned in my presentation.

G. Weimer (Germany): A measure which might help to improve the regulatory control of sources is the introduction of mandatory periodic tightness tests. Firstly, it would oblige those with sources in their possession to seek them out at regular intervals for testing. Secondly, if a charge was made for testing, the holders of unwanted sources might be more likely to hand them over to the regulatory authority — rather than pay the charge.

A.M. Borras (Philippines): I agree with Mr. Croft that a regulatory authority cannot expect to know about all the sources within the territory for which it is responsible; the best it can do is — as suggested by Mr. Othman — to keep a constant check on source inventories, with frequent inspections of storage areas.

Regarding what Mr. Holubiev said about the value of publicity via the media, I would recommend caution in dealing with the media. When we used the media to publicize the loss of two sources within one month, there was media pressure to abolish the Philippine Nuclear Research Institute because it was "sleeping on the job".

K. Shangula (Namibia): One problem in dealing with the media after an incident or accident is that it usually takes a long time for the experts to assemble and interpret all the facts so that they can give a true account of what happened. Meanwhile, the media have given an inaccurate account which is very difficult to correct subsequently via the media, which are reluctant to admit that they got it wrong.

Long-term public education efforts can help, and in that connection I was interested to hear what Mr. Uslu said about radiation safety inspectors lecturing at schools.

J.R. Croft (United Kingdom – *Chairperson*): Also in that connection I would mention that two weeks ago the Nuclear Energy Agency of OECD held a meeting in Paris on what regulators should do in order to gain and keep the trust of the media and the general public.

J. Ford (IAEA): I work in the IAEA's Division of Public Information, which is trying to ascertain the needs in IAEA Member States as regards communicating with the media, the general public, decision-makers and special groups in order that it may help Member States.

H. Liu (China): I too agree with Mr. Croft that a regulatory authority cannot expect to know about all the sources within the territory for which it is responsible. However, I believe that the IAEA — using the Internet — could do more, along the lines of what it did in developing the Regulatory Authority Information System (RAIS), to help regulatory authorities ensure that their records are as near-complete as possible.

J.R. Croft (United Kingdom – *Chairperson*): In my view, it is essential that the source owners or users — rather than the regulatory authority — have complete records; it is the job of the regulator to put the necessary pressure on the owners or users.

In a country with few sources, establishing a national inventory and keeping it up to date may be feasible. In a country with many sources (tens of thousands), however, trying to establish a national inventory may well not be cost-effective, unless one focuses just on high-risk sources.

SUMMARY OF DISCUSSION

ROUND TABLE 3

HOW TO GENERATE A REGULATORY CONTROL SYSTEM WHERE IT DOES NOT EXIST

***Chairperson:* J. Loy (Australia)**

J. Loy (Australia): With regard to the title of this Round Table, Mr. González of the IAEA has spoken of regulatory control systems which exist "on paper only" — the legal infrastructure is there, but not the people with the necessary experience. The six panellists taking part in this Round Table, however, represent a vast amount of experience.

C. Schandorf (Ghana — *panellist*): The generation of a regulatory control system will normally start with the development of a legislative infrastructure — the enactment of a law establishing a regulatory authority and the promulgation of regulations for protection against ionizing radiation and the safety of radiation sources. The technical document IAEA-TECDOC-1067 ("Organization and implementation of a national regulatory infrastructure governing protection against ionizing radiation and the safety of radiation sources") may be useful in this connection. For socio-economic reasons, in some countries the development of a legislative framework may take a long time.

Once the regulatory authority has been established *de jure*, it must be established *de facto*. This is partly a question of the provision of financial resources. Very important in this connection is the positioning of the regulatory authority with the country's governmental structure.

With regard to the organizing of the regulatory authority, the defining of its structure and the assignment of responsibilities, it is important to involve senior policy- and decision-makers in order that they come to understand the issues and hence support the regulatory authority's activities.

The regulatory authority needs to have a good manager. During implementation of the IAEA's Model Projects for strengthening radiation protection infrastructure we have seen how important good management is.

As regards the personnel who implement the regulatory control programme, they should be thoroughly educated and trained in the technical aspects of the programme and be deeply committed to it.

No matter how thorough the education and training of the implementation personnel may be, there will probably be a need for outside technical and legal advice from time to time, so advisory committees should be provided for.

As regards the development of the regulatory control programme, it will be necessary to establish a system of notification, an inventory of radiation sources, authorization procedures and inspection and enforcement procedures. Close co-ordination and collaboration with all stakeholders (the Ministry of Health, the environmental protection authority, the customs authorities etc.) will be particularly important in that context. At this stage, the Regulatory

Authority Information System (RAIS) may be useful, especially for devising a source tracking mechanism and assessing the effectiveness of the regulatory control programme.

In the area of human resources development, it will be necessary to establish training profiles for regulatory staff and operators, and also for the providers of radiation and waste safety services (personal monitoring, food and environmental monitoring, safety assessments and monitoring equipment calibration), unless those services are provided by some other accredited institution.

With regard to staffing levels, I suggest that in most cases the regulatory authority will need a minimum of 11 staff members. However, I have not seen any guidance on staffing levels in relation to the extent and complexity of the regulatory control programme.

Lastly, a few words about budgeting. It seems to me that in most regulatory organizations some 60–70% of the budget goes to salaries and related staff payments, leaving only 30–40% for control programme implementation. In Ghana, we are trying to work with a 50:50 split.

A.M. Borras (Philippines — *panellist*): Regulatory control systems which do not exist "on paper only" nevertheless involve a great deal of paperwork, much of which — for example, that associated with the evaluation of licence applications — can be very boring; moreover, routine inspections can be very boring. In order to avoid boredom, the regulatory authority must be dynamic and proactive, trying to anticipate events rather than waiting for them to occur.

On the basis of my experience, I also believe that the managers of regulatory authorities must be decisive — ready to take quick decisions in any situation — and that they must possess a strong political will. A strong political will is essential when, for example, a facility should be shut down because of non-compliance with the radiation safety regulations; nobody should be a friend when it comes to enforcement.

In addition, the managers of regulatory authorities must, in my view, be able to prioritize the regulatory activities.

The staff of regulatory authorities should undergo continuing education and training; they should never stop learning, through activities sponsored by organizations such as the IAEA and also through in-house activities.

Lastly, good documentation is very important, in order that one may learn from the past and develop sound procedures. I assume that the countries with nuclear power programmes have good documentation, but my experience suggests that the documentation in many countries without such programmes is poor and hence the procedures are not sound. We need to do something about that.

A. Salmins (Latvia — *panellist*): In Latvia, there has fortunately always been some form of regulatory control, and I find it hard to imagine a situation where someone is using a high-activity radiation source without any awareness of the associated hazards and hence without taking any precautions.

One of our problems was that we did not have the powers necessary for exercising regulatory control over certain facilities (especially military establishments). In order to forestall incidents, we offered to accept, with minimum formalities, all radioactive waste (including all spent sealed sources) deriving from defence-related activities.

Another of our problems was that we did not have good contacts with certain other State bodies. We succeeded in improving matters by providing advice and equipment to bodies such as the customs authority before any formal relationship had been established and by involving personnel from some bodies in training activities and meetings sponsored by organizations such as the IAEA. Officials of other State bodies began to understand what we were doing, and it became easier to obtain their support for our efforts to strengthen the regulatory control system and enforce regulations.

A regulatory control system cannot exist without data regarding the radiation sources to be controlled. In Latvia, which does not produce radiation sources and therefore has to import whatever sources it needs, the customs authority provides most of the data available to us. We have worked together with the customs authority in making its source classification more detailed, and we are now receiving fuller information. In addition, we have obtained information about the past utilization of radiation sources from the operators of facilities which have used sources and of facilities where disused sources are in storage.

With Latvia going through a period of political and economic transition, it was not easy for us to explain to senior governmental officials why high priority should be given to the establishment of a regulatory body in the radiation safety field. We could not argue that all other countries had such bodies, since that is by no means the case, and we could not argue that accidents involving radiation sources were likely to occur — what is the frequency of such accidents in countries the size of Latvia? Moreover, in the radiation safety field it costs about US $0.5 million to avoid the loss of 1 man.year of working ability, while the corresponding figure for the standard medicine sector is US $10–50, so that it was difficult to persuade the Ministry of Health.

In conclusion, I would recall that in 1998 the Dijon Conference concluded — inter alia — that further efforts should be made "to investigate whether international undertakings concerned with the effective operation of national regulatory control systems and attracting broad adherence could be formulated." We now have a Code of Conduct on the Safety and Security of Radioactive Sources, but I believe that there is a need for a stronger, legally binding international instrument in the radiation safety field.

A.A. Miranda Cuadros (Bolivia — *panellist*): I should like to say a few words about our experience in Bolivia.

For a long time, the need for a regulatory authority in the radiation safety field was questioned by various governmental bodies, members of the general public and users of radiation sources — on the grounds that Bolivia did not have a nuclear power programme and there had been no accidents involving radiation sources.

Ultimately, however, a law establishing a regulatory authority was passed in 1982.

The first thing the regulatory authority did was to draw up an inventory of the radiation sources in Bolivia, with information about — inter alia — the users and the practices in which the sources were being used.

It then arranged for the training of inspectors and other regulatory personnel, with the emphasis on radiation sources used in teletherapy and industrial radiography.

The regulatory authority has helped to improve radiation protection at facilities where radiation sources are being used and has established strong ties with the health, environmental and customs authorities and with various professional associations.

However, the regulations drawn up by the regulatory authority were not approved for application until 1997 — 15 years after the passing of the law establishing the regulatory authority.

H. Liu (China — *panellist*): In 1989, China's State Council (Government) issued radiation protection regulations covering radioisotopes and irradiation devices, and our regulatory system for radiation sources is based on those regulations.

At that time there were about 16 000 sealed sources in China; together with X-ray machines, accelerators and other irradiation devices, the total number of radiation sources was about 45 000.

The Ministry of Public Health was — and is — the largest user of radiation sources, accounting for about 40% of the total. Together with the State Environmental Protection Administration (SEPA) it operates a nationwide radiological monitoring network.

Under the 1989 regulations, the Ministry of Public Health is responsible for the regulatory control of radiation sources during their manufacture, distribution and use, and — together with SEPA and the Ministry of Public Security — for the investigation of accidents involving radiation sources; SEPA is responsible for the regulatory control of radioactive waste (including disused sources), for dealing with environmental contamination accidents and for the provision of accident-related information to the public on behalf of the Government; and the Ministry of Public Security is responsible for the security of radiation sources and for finding any that get lost or are stolen. At the provincial level, their functions are performed by Public Health Bureaux, Environmental Protection Bureaux and Public Security Bureaux.

Since 1989 we have drawn up a national inventory of radiation sources, established a system for the reporting of accidents and incidents involving radiation sources and a system for radiological environmental impact reporting, and built facilities for the safe storage of disused sources under the regulatory control of Environmental Protection Bureaux. Thanks to improvements in regulatory control, the frequency of accidents and incidents involving radiation sources — which was high before 1989 — has decreased.

We are currently drafting a law which, if adopted by the National People's Congress, would clarify certain questions of responsibility, ensuring that radiation safety became the responsibility of a single regulatory body completely independent of those concerned with the management, ownership and use of radiation sources.

I. Othman (Syrian Arab Republic): There is no standard way of establishing a regulatory authority; the approach will differ from country to country. In every country, however, for a regulatory authority to be established certain key persons must be convinced of the need for it — convinced by arguments along the lines of "no one should be allowed to use a radiation source without authorization. just as no one should be allowed to open a medical practice without a medical licence or drive a car without a driving licence”.

In order to convince those key persons, one must believe in the importance of the regulatory control of radiation sources and have a good knowledge of radiation protection.

When the key persons have been convinced and work on establishing the regulatory authority starts, one also needs leadership qualities, in order to create a team of inspectors who will convince the users of radiation sources that they are carrying out inspections largely for the users’ benefit and not just because the inspections are prescribed in the regulations. In this connection, the inspectors’ equipment should be reasonably up to date; radiation source users are unlikely to be convinced by inspectors whose equipment is obviously no longer adequate for the job.

In developing countries, the people running regulatory authorities need to have access to the top levels of government; in advanced countries, there are long-standing mechanisms for ensuring that the concerns of such people are heeded.

Lastly, and again in developing countries, it is difficult for the people running regulatory authorities to deal with the media since — in contrast to advanced countries — there are virtually no journalists with a scientific and technical background to whom they can provide information in the knowledge that it will be understood. The IAEA could help in that connection by organizing workshops on various aspects of the utilization of atomic energy for journalists.

M. Bahran (Yemen): I believe that, as indicated by Mr. Othman, it is important — at least in our part of the world — that the regulatory authority be close to the top decision-makers. In Yemen, our regulatory authority is only four years old, but it has already been quite successful, and in my view its success has been due largely to the fact that it reports directly to the President of the Republic.

With regard to education and training, our regulatory authority has benefited greatly from fellowships of 2–5 months arranged through the IAEA, but now its personnel need more advanced training for periods of about two years.

With regard to those who question the need for a regulatory authority, pointing to urgent issues like derelict town sewage systems, I have not found it difficult to find radiation protection issues which can compete — for example, the need to ensure that X-ray machines are used safely.

A. Salmins (Latvia — *panellist*): Further to what I said just now about our difficulties in persuading people of the need for a regulatory authority, those people were persuaded mainly by being involved, through us, in various international activities and learning about the experience (good and bad) of other countries. They realized that one should not wait for a radiation accident to occur in Latvia before acting.

K. Skornik (IAEA): At the IAEA we have been trying to help generate effective regulatory control systems in Member States for many years, and we have found that each Member State has to be treated differently from all the rest. However, it is possible to generalize about certain elements necessary for success.

The first element I would mention is the political will at the highest decision-making level — a determination that an effective regulatory control system shall be established in that country. Such political will normally derives from an awareness of the potential benefits of the peaceful applications of nuclear techniques, so senior decision-makers must be made aware of those potential benefits, which underlines the importance of having access to senior decision-makers. These are most likely to heed the arguments of someone who is energetic, has good scientific and technical credentials and is of undisputed integrity — a further element, and in several Member States the existence of such persons has been the key to success.

Also very important is the realistic prioritization of the stated needs, which should be commensurate with the extent of the radiation-based practices in the country in question and should take due account of the country's national development programme. We should bear in mind that, no matter how important it is, radiation safety may well not be a top priority.

I would then underline the importance of good communications and co-operation among all national agencies concerned with radiation safety, in the interests of avoiding demarcation disputes or "turf fights", which have frequently hampered the IAEA's efforts in the past.

The last element I would mention here is institutional stability within the country. Wherever there has not been institutional stability our efforts have failed.

D.J. Beninson (Argentina): In my view, by far the most important element is knowledge; the regulatory inspectors must know at least as much about the practice in which the radiation source is being used as the users, otherwise they will lose — or not gain — the respect of the users.

I. Uslu (Turkey): The IAEA has produced — or been involved in the production of — many documents which are important for regulators (the Basic Safety Standards, the Code of Conduct on the Safety and Security of Radioactive Sources, the Categorization of Radiation Sources, various IAEA-TECDOCs, reports on the Goi>nia and other radiation accidents, etc.). In my view, it would be very helpful for regulators if the IAEA made those documents available via the Internet.

M. Nghatanga (Namibia): I should welcome advice on how to deal with the media on issues relating to radiation safety. In our country, we have found local journalists to be so ignorant of the basic science that they cannot report on such issues.

J. Ford (IAEA): With regard to the problem of scientific ignorance among journalists, one can offer to give lectures on the basic science to the members of journalists' associations and to people taking courses in journalism at universities.

Before involving the media in radiation safety issues generally, you would do well to seek advice from any departments within your country's governmental structure which have frequent contacts with the media.

C. Schandorf (Ghana – *panellist*): You may find IAEA-TECDOC-1076 ("Communications on nuclear, radiation, transport and waste safety: a practical handbook") helpful.

On the basis of my experience of dealing with the media, I would say that one should avoid being put under pressure by journalists and forced to give snap answers in impromptu interviews. One should try to explain the issues to the journalist before the interview starts and to obtain the journalist's questions in advance, in order to prepare well-thought-out answers.

M. Ridwan (Indonesia): During Round Table 2, I mentioned a recent theft of 21 radiation sources which occurred in my country.

Rather than keeping quiet about it, we invited media people to our offices and told them what had happened. At the same time, with the help of IAEA reports on the Goi>nia and other radiation accidents, we explained the perils of not complying with radiation safety regulations. Subsequently, our budget was tripled.

SUMMARIES BY CHAIRPERSONS OF SESSIONS AND ROUND TABLES

CHAIRPERSON'S SUMMARY OF SESSION 2

NATIONAL REPORTS
(Angola, Argentina, Australia, Bolivia, Brazil, Brazil/Cuba and Chile)

Chairperson: **J.W. Hickey (USA)**

We heard that there is a broad spectrum of comprehensiveness of regulatory schemes, with some schemes just starting to be established and others already well developed.

Even in the case of well-developed regulatory schemes, there is not necessarily unified national jurisdiction; in some countries with a federal structure, the individual provinces or states have primary jurisdiction (as opposed to a central federal authority), and in some countries the governmental agencies which use radioactive material — and promote its use — do not fall under the same regulatory scheme as, say, industrial and medical users (this is the case in the United States).

We heard about the importance attached to international co-operation, and particularly to the IAEA's efforts to encourage, through Model Projects, the establishment of comprehensive and effective national regulatory schemes.

We heard about the importance attached to the proper education and training of user personnel, since users have the primary responsibility for the safety and security of the radiation sources being used by them and need to appreciate the hazards associated with those sources.

There was considerable discussion of the question of radiation monitoring at points where unauthorized radioactive material is most likely to be detected. It was agreed that such monitoring is helpful, but attention was drawn to the problem of false alarms due to naturally occurring radioactive material or to authorized radioactive material; such false alarms may result in scarce resources being diverted away from genuinely hazardous situations.

We heard about the ARCAL XX project on "Guidelines for the control of radiation sources", for enhancing and harmonizing the safety of radiation sources in Latin America — a good example of regional co-operation as part of the worldwide effort to promote the establishment of effective regulatory programmes.

We discussed the question of financial responsibility. It was concluded that, to the extent possible, the financial responsibility for the consequences of an incident should be borne by the user of the source which caused the incident. The users of sources should perhaps be required to take out insurance or make financial deposits which will cover the costs to innocent parties of incidents caused by sources which they are using; a report (to be presented in Session 6) from Portugal, which has a compulsory insurance scheme to cover the civil liability of users, was considered very interesting in that connection.

The report from Angola described a regulatory programme which is just starting up, with a great deal of support from the IAEA, whose support at all stages in the development of effective regulatory bodies is invaluable.

Finally, we discussed the question of teaching physicians — and also members of the general public — to recognize radiation injuries, and also the question of teaching members of the general public to recognize the “radioactivity” trefoil (or some other symbol) and typical radiation source shapes.

CHAIRPERSON'S SUMMARY OF THE SPECIAL SESSION

THE INTERNATIONAL RESPONSE

***Chairperson:* A.A. Oliveira (Argentina)**

It was reported that there are believed to be in European countries almost 30 000 sources for which the present safety management is unsatisfactory and which therefore represent an unacceptable risk. The scope of an envisaged European Union directive relating to this problem is still to be determined.

As regards the risks associated with criminal activities involving radiation sources, it was considered that threat assessments are essential for ensuring that levels of protection are in accordance with risk levels.

The IAEA's Action Plan for the Safety of Radiation Sources and the Security of Radioactive Materials was considered to represent a comprehensive approach to a wide range of issues connected with the safety and security of radiation sources.

The IAEA's Model Projects for the upgrading of radiation protection infrastructures in 52 IAEA Member States were considered to have made substantial progress in many of those States, against the five milestones which have been specified. It was noted that two new projects have now been proposed — one relating to the establishment of regulatory mechanisms for the control of sources and one relating to the establishment of sustainable radiation protection infrastructures.

Among the views expressed were the following:

- the international dimension of the supply of sources and their return to the supplier after use needs to be developed;

- it is essential that the temporary storage of disused sources by the former user be minimized; disused sources should be returned to the supplier (the preferred option) or sent to a licensed waste management facility as soon as possible; for purposes of temporary storage, the former user should have a designated area with specially trained staff; and

- to facilitate the return of a disused source to its country of origin, it may be necessary to ensure that the source is not described as "radioactive waste".

CHAIRPERSON'S SUMMARY OF SESSION 3

NATIONAL REPORTS
(China, Costa Rica, Croatia, Cuba, Czech Republic, Dominican Republic, Ecuador, Estonia, Ethiopia, Georgia and Germany)

***Chairperson:* I. Othman (Syrian Arab Republic)**

In the reports presented there were several references to the value of the support being provided by the IAEA through Model Projects. At the same time, it was made clear that other forms of international co-operation (for example, with neighbouring countries) are often also important for the establishment of effective regulatory systems.

Emphasis was placed on the importance of effective education and training (including awareness training) for decision-makers, radiation protection personnel, radiation source operators and other relevant persons.

Mention was made of the role of customs officers, who, if suitably trained, can provide valuable support to regulators at national borders.

The reports tended to show that in small countries a single regulatory body is achievable and desirable; large countries — or countries with a long history of using radiation sources — are more likely to have multiple regulatory bodies. Each approach has its merits, and countries will adopt the approach which accords best with their national situation. What matters most is that the regulatory body be effective — not just impressive on paper. Similarly, some countries have established single national inventories of radiation sources while others have not — or cannot.

Each presentation provided at least one useful insight into the variety of approaches which may be considered as regulatory systems are established or further developed in the light of experience.

It was noted that a number of States attach conditions to the sale of sources so as to ensure that financial provision is made for the final disposal of the sources at the end of their useful lifetime.

In the discussion it was suggested that regular gatherings like this Conference would be useful for sharing experience and lessons learned and that each such gathering focus on a specific regulatory issue.

CHAIRPERSON'S SUMMARY OF SESSION 4

NATIONAL REPORTS
(Ghana, Hungary, India, Indonesia, Ireland, Italy, Japan and Jordan)

***Chairperson:* J.R. Croft (UK)**

Emphasis was placed on the importance of clear legal provisions relating to the safety and security of sources.

The value of IAEA advice, and of the IAEA's Regulatory Authority Information System (RAIS), was particularly noted.

It was clear that different approaches have been adopted in different countries to the establishment of source registries. There has been a tendency to establish central, national registries in countries where the regulatory infrastructure is new and/or there are only a small number of sources; a regional approach has sometimes been adopted in other countries, although we heard a report from one country — Hungary — where there are a large number of sources but which has a central, national registry. In the discussion, it was noted that some countries with long-standing and widespread uses of ionizing radiation — including my country — would find it difficult to change to a centralized approach.

Registries of sources were considered useful in helping to establish inspection priorities, which in turn were considered important for increasing the awareness of users regarding their role in ensuring the safety and security of the sources being used by them.

Some of the presentations highlighted the need for enforcement programmes to include provision for prosecutions resulting in fines or prison sentences in the event of serious breaches of the law. As the initiation and support of a prosecution can cost the regulator a great deal of time and effort, it was felt that advice on how to use legal powers to the best effect would be useful.

Several speakers stated that their countries had no central facilities for the storage of disused sources, which were being stored at premises of the previous users. It was agreed that such situations were undesirable as they increased the potential for sources becoming "orphaned". I suspect that this is a challenge which many of us face.

It was reported that several countries in south-east Asia are establishing a network for collaboration in addressing the problems of the management of disused sources, and it was felt that networks for collaboration in areas such as border monitoring and metals recycling would also be useful. Perhaps international organizations could promote the establishment of such networks.

Lastly, emphasis was placed on the importance of appropriate training for groups such as customs officers, airport and seaport personnel and metals recycling industry personnel.

CHAIRPERSON'S SUMMARY OF SESSION 5

NATIONAL REPORTS
(Republic of Korea, Latvia, Madagascar, Mongolia, Namibia, Norway, Pakistan, Peru and Philippines)

***Chairperson:* I. Zachariašova (Czech Republic)**

A frequent theme was that of communicating. The importance was emphasized of communicating appropriately with the public when unlicensed radioactive material is found. Care in using the media to locate lost sources was urged, in order not to frighten people unduly. As regards communicating with users, the regular use of questionnaires for verifying source inventories was considered useful, as was the shortening of licence validity periods — especially when the regulatory authority is short of inspectors.

Another frequent theme was co-operation. As regards international co-operation, it was felt that the joint operation of portal monitors at border crossing points and the joint evaluation of results might save money. The importance of close co-operation between, on one hand, the regulatory authority and, on the other, the various other governmental agencies with an interest in radiation protection was emphasized.

It was noted that a regime whereby disused sources are returned to the supplier may entail increased movements of radioactive material within and between countries, which must be taken into account in the allocation of resources for regulatory programmes.

It was felt that, as the costs of disposing of orphan sources after they have been found and secured can be very high, they should not have to be borne by the regulatory authority.

As regards the problem of persons who have in their possession unlicensed radioactive material which they are unwilling to report and hand over to the regulatory authority, it was suggested that an amnesty of limited duration would be a useful incentive.

CHAIRPERSON'S SUMMARY OF SESSION 6

NATIONAL REPORTS
(Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain and Sudan)

***Chairperson:* J. Loy (Australia)**

Most of the countries from which we heard reports have been going through major political, legal and socio-economic transitions, and it was clear that a country's radiation protection system - which does not exist in isolation from other aspects of society - must be consistent with that country's political, legal and socio-economic structure.

As regards the multiplicity of organizations within a country that have a role to play in the radiation protection area, efforts are clearly under way in some countries to achieve greater consistency by broadening the remit of the regulatory authority. That could raise problems due to, for example, differences of view between radiation protection professionals on one hand and medical doctors on the other.

There were frequent references to the difficulties involved in establishing complete inventories of sources, which most countries are trying to do.

It was suggested that the IAEA help regulatory authorities to collect disused sources (particularly old radium needles) and render them safe. Perhaps the IAEA could provide guidance regarding suitable approaches.

CHAIRPERSON'S SUMMARY OF SESSION 7

NATIONAL REPORTS
(Syrian Arab Republic, Sweden, Turkey, Uganda, Ukraine, United Kingdom, United Republic of Tanzania, Viet Nam, Yemen and Yugoslavia)

***Chairperson:* J. Piechowski (France)**

All the countries from which we heard reports appear to have regulatory systems of varying degrees of sophistication with trained personnel, but have nevertheless had problems with sources.

Emphasis was placed on the importance of regulatory authorities gaining the confidence of the users of sources and the operators of facilities where orphan sources are most likely to appear.

It was widely felt that, given uncertainties about the viability of some supplier and user organizations, there should in each country be a system of mandatory financial guarantees (for example, through insurance).

In the interests of worldwide traceability, the establishment of an international system for the unique tagging of sealed sources was proposed. Also, it was proposed that thought be given to creating, with the help of co-ordination activities by organizations like the IAEA and the European Commission, an international registry of sources.

It was widely felt that there is a need to have, in addition to the "radioactivity" trefoil, labelling which will immediately convey to the general public the hazards associated with radiation sources.

It was also widely felt that, with countries splitting up and joining together, the question of the return of sources to the country of manufacture was a critical one.

A proposal was made regarding the establishment of an international network for information exchange through clearly specified channels.

The question of policies designed to prevent illicit trafficking in radioactive material was considered. Efforts to identify and dismantle criminal organizations through co-operation with Interpol and rapid and flexible contacts between countries were called for.

Finally, consideration was given to ICRP's justification principle, given the fact that there are non-nuclear alternatives to nuclear techniques in some applications.

CHAIRPERSON'S SUMMARY OF ROUND TABLE 1

TOWARDS AN EFFECTIVE CONTROL OF RADIATION SOURCES

Chairperson: A.A. Oliveira (Argentina)

Members: **J.W. Hickey (USA)**
I. Zachariasova (Czech Republic)
T. O'Flaherty (Ireland)
M. Ridwan (Indonesia)
C.J. Englefield (UK)
P.K. Gosh (India)

In the presentations and the discussions there was general recognition of the need for independent regulatory authorities with the staff and other resources necessary for the performance of meaningful inspections — both routine and unannounced.

Emphasis was placed on the importance of categorizing sources so that maximum attention may be paid to those sources which represent the greatest risks.

The establishment of national inventories of (i.e. national databases on) radiation sources was recommended.

Emphasis was placed on the importance of close co-operation among those ministries within each country which are likely to become involved in efforts to ensure the safety and security of radiation sources (the ministry of health, the ministry of science and technology, etc.). Emphasis was also placed on the need for efficient channels of communication between the regulatory authority and facility radiation protection officers.

The effective enforcement of radiation protection laws and regulations, including penalties in the event of losses of control of sources with serious implications for the public and/or the environment, was called for.

Among the views expressed were the following:

- regulatory control activities such as the issuing of authorizations for the use of sources and the subsequent conduct of inspections at the facilities where the sources are being used have to be paid for, and the users should therefore budget for the costs of regulatory control activities over the lifetimes of their sources;

- incentives should be devised in order to ensure that disused sources are not kept under unsafe and insecure conditions;

- the education and training of users should be designed to ensure that users are aware of their responsibilities as regards the hazards associated with their sources;

- each licensee should be required to maintain an up-to-date inventory of sources at the facility level, and inventories should be checked physically at sufficiently frequent intervals;

- at each facility there should be a well-trained radiation protection officer with clearly defined duties;

  – quality assurance designed to verify user compliance with regulations is important;

  – promotion of the use of nuclear techniques should be accompanied by the provision of information about the hazards associated with such techniques;

  – the regulatory authority should endeavour to convey to the general public the idea of "safety culture" by maintaining open channels of communication; and

  – in order to avoid situations where users prefer to pay the low fines imposed by the courts, rather than paying the costs of disposing of disused sources in accordance with the radiation safety regulations, judges and magistrates should be made fully aware of the possible implications of non-compliance with those regulations for people and the environment.

CHAIRPERSON'S SUMMARY OF ROUND TABLE 2

HOW TO LOCALIZE AND REGAIN CONTROL OF THE EXISTING RADIATION SOURCES

Chairperson: **J.R. Croft (United Kingdom)**

Members: **R.Czarwinski (Germany)**
I. Uslu (Turkey)
C.-G. Stalnacke (Sweden)
R.E. Pacheco (Costa Rica)
V. Holubiev (Ukraine)
R. Mezzanote (Italy)

J.R. Croft (United Kingdom – *Chairperson*): With the agreement of the Scientific Secretary, the scope of the Round Table was extended to cover also the question of sources which may become "orphaned" and the question of information feedback. The discussion focused on four areas: *monitoring programmes*; *response arrangements*; *dealing with major accidents and incidents*; and *feedback mechanisms*.

As regards *monitoring programmes*, it was concluded that every country needs to develop a monitoring strategy based on an assessment of the threat posed by radiation sources to the health of individuals and on an assessment of the potential economic impact of orphan sources — for example, if they are melted down and incorporated into metal products. The strategy should provide for the detection of orphan sources at borders, scrap yards, foundries, steelworks and incineration plants, with due consideration of the cost-effectiveness and operational practicalities. As monitoring systems will inevitably detect some radioactive material, it is important that every country have a clear policy regarding the action to be taken when radioactive material is detected.

It was noted that sources may become "orphaned" in bankruptcy situations; monitoring strategies should take that possibility into account.

As regards *response arrangements*, the discussion focused on increasing the awareness of the public and on helping members of the public to recognize objects which may contain radioactive material. In the latter connection, it was suggested that the "radioactivity" trefoil alone may not be sufficient; clear labelling in the local language was considered to be important.

Considerable importance was attached to having mechanisms whereby persons who find sources know who to contact, and how, and the persons contacted are able to summon expert assistance. Also, it was considered important that appropriate training be provided to those in the response chain — for example, customs officers — and that such training should include emergency response exercises.

It was felt that persons finding orphan sources should not be required to shoulder the financial burden of dealing with them properly. As a counterpart, it was felt that the owners of orphan sources should be prosecuted and — for purposes of deterrence — publicity should be given to the prosecutions.

As regards *dealing with major accidents and incidents*, the main points raised were: the need to have a clear command structure, with the responsibilities of the participating organizations clearly specified; and the need for adequate resources to be earmarked for communicating with the media and the general public. In the latter connection, attention was drawn to the potential value of using the local media to convey messages about the hazards when sources had been stolen; in a number of cases, use of the media in that way has led to the reporting (usually anonymously) of the whereabouts of stolen sources to the authorities.

As regards *feedback mechanisms*, they were considered to be important in helping both to prevent the occurrence of accidents or incidents and to respond appropriately if an accident or incident occurs.

The IAEA's International Database on Unusual Radiation Events (RADEV) was welcomed, as was the work being done by the IAEA on preparing an International Catalogue of Sealed Sources and Devices. The IAEA was urged to make the information in RADEV and the Catalogue as widely available as possible, including the commercial information in the Catalogue. At the same time, it was recognized that States should play their part in support of IAEA initiatives by establishing mechanisms for the capture of information to be fed to the IAEA and the dissemination of information received from it. In the latter connection, it was pointed out that, to be of value, the lesson learned through RADEV would have to be conveyed to local workforces in a language they knew, so that there would often be a need for translation.

It was considered that, in order to increase awareness, there should be a feedback of information to the general public, including schoolchildren.

CHAIRPERSON'S SUMMARY OF ROUND TABLE 3

HOW TO GENERATE A REGULATORY CONTROL SYSTEM WHERE IT DOES NOT EXIST

***Chairperson:* J. Loy (Australia)**

Members: **C. Schandorf (Ghana)**
A.M. Borras (Philippines)
A. Salmins (Latvia)
A.A. Miranda Cuadros (Bolivia)
H. Liu (China)
I. Othman (Syrian Arab Republic)

J. Loy (Australia – *Chairperson*): What struck me most about the panellists in this Round Table was the vast total experience in the field of radiation protection which they represented.

The title of the Round Table was taken by us to mean "How to generate *an effective* regulatory control system ..." as opposed to an organization which exists on paper only.

In different ways, leadership emerged as the most important factor — leadership in the sense of an ability to convince the political system at the highest decision-making levels that there really is a need for an effective regulatory control system and in the sense of an ability to inspire the people working for the regulatory control system and to ensure that the system is not overwhelmed.

At the same time, it was recognized that each leader needs to be supported by a core group of knowledgeable and well-trained managers and inspectors of high integrity and with a good professional background. In particular, inspectors should know at least as much as users about radiation protection and the practices in which the sources are being used, in order to gain the respect of the users, who should feel that they are gaining from — rather than having to submit to — the inspections. That is largely a question of resources — and of whether the leader can persuade the political system to make the necessary resources available.

Emphasis was placed on the importance of prioritization; the regulatory authority should not try to do everything, and the degree of priority should be commensurate with the extent of the practice and the associated radiation hazards, account being taken also of the country's national development programme.

Although the regulatory authority should not try to do everything, it should avoid being paralysed by the scale of tasks needing to be carried out; it should at least demonstrate that it can be effective.

There are often a number of organizations besides the regulatory authority with a role to play in the radiation protection area — the customs authority, the police, the emergency services etc. That can be a good or a bad thing. It is a good thing if the regulatory body is able to draw on those organizations and thereby increase its effectiveness. It is a bad thing if it leads to demarcation disputes and "turf fights" which reduce effectiveness. Hence the great importance of close co-operation among all organizations having a radiation protection role.

The role of international assistance in capacity-building is clearly still important. Among the questions being asked in that connection are “what should happen after completion of the IAEA Model Projects for upgrading radiation protection infrastructures?” and “how can international assistance respond to the need for leadership and for training — albeit for a relatively small number of people — at a higher level?”

Finally, as regards the issue of communicating with the public, the aim should clearly be to inform people in such a way that they will be helpful and not frightened about the uses of ionizing radiation.

CONCLUSIONS

FINDINGS OF THE CONFERENCE

The major findings of the regulatory officials attending the Buenos Aires Conference were as follows:

Education and training — the key factors

1. *Knowledge is the initial essential component in achieving the required safety and security of radiation sources, and education and training are the most important pathways leading to their achievement. The staff of regulatory authorities should be thoroughly educated and trained in the practices and procedures they will regulate. Since it is the users of radiation sources who should have the primary responsibility for their safety and security, measures should be taken by governments, through their regulatory authorities, to ensure that users are adequately educated and trained and that their knowledge remains up to date. Education and training are also required by other personnel who may come into contact with radiation sources — for example, customs officials and police officers, border guards and members of other security services. It is important that in each country there be, with responsibility for the safety and security of radiation sources, a core group of knowledgeable and thoroughly educated and trained officers at the managerial level having a high standard of integrity and a good professional background.*

States with difficulties

2. *A considerable number of IAEA Member States are still having difficulties in establishing fully effective systems for the regulatory control of radiation sources.[1] The main cause is the lack of a regulatory infrastructure, which manifests itself in the absence of identifiable regulatory authorities or, when they exist, in insufficiently educated and trained staff, inadequate regulations and insufficient financial resources. In this connection, regulatory authorities need officers with the leadership qualities necessary both for convincing national decision-makers that appropriate regulatory infrastructures must be established and receive adequate governmental support and for infusing dynamism into the resulting regulatory systems.*

Knowing the situation

3. *A particularly important function of regulatory authorities is maintaining up-to-date knowledge of the situation as regards the radiation sources which they are regulating. Inspections and safety and security assessments are essential components of that function. This requires setting priorities, developing procedures and technical guidance for inspectors, and establishing appropriate communication between the various relevant authorities within a given country.*

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[1] In addition, there are about 60 countries which are not IAEA Member States and whose regulatory infrastructure for ensuring the safety and security of radiation sources is unknown to the IAEA's Secretariat but believed to be weak.

Effective independence of the regulatory authority

4. Each government should endeavour to ensure that its regulatory authority is effectively independent of the users and promoters of radiation techniques, by providing it with the necessary enforcement powers, support and resources. The enforcement policy should be reviewed periodically and pursued consistently by the regulatory authority. In addition, it is important that governments realize that raising the level of awareness of users regarding their responsibility for the safety and security of radiation sources is as important as increasing the enforcement powers of the regulatory authority.

Insuring radiation sources

5. Consideration should be given by governments to the possibilities for arranging for the insurance of radiation sources so as to cover the costs associated with the harm which radiation sources can cause in the event of an accident.

Learning from accidents

6. Much can be learned from studies of accidents, and also of incidents, involving radiation sources. Therefore, regulatory authorities should establish criteria for determining when investigations need to be undertaken and mechanisms for collecting and disseminating information about the lessons learned. A mechanism for ensuring such feedback of the operational experience of others should be established by regulatory authorities, making use — as appropriate — of the International Database on Unusual Radiation Events (RADEV).

Universal system of labelling

7. Consideration should be given by governments to the possibility of establishing, under the aegis of the IAEA, a universal system for the labelling of radiation sources. It is obviously necessary for radiation sources to be labelled in such a way that the public is immediately aware of the associated hazards, but at present they are not so labelled. The trefoil symbol alone is often not a sufficient warning of the hazards associated with a particular radiation source. Radiation sources should carry a label, preferably in the local language, from which it is immediately clear that they represent a hazard. It would be desirable for such a label to be internationally standardized in co-ordination with the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

Radiation source registry

8. Regulatory authorities should establish a single national source registry. Should control be organized at the local level, it might be sufficient to have other types of registry.

Continuity of control

9. The recommended operational lifetime of radiation sources and of the devices into which they are incorporated should be stated in the accompanying documentation, and regulatory authorities should take measures to ensure the continuity of control over radiation sources during that period. Regulatory authorities should impose on users, *suppliers, manufacturers etc. the responsibility for maintaining continuity of control over each source during the period specified in the authorization for its use.*

The return of sources

10. *Whenever the management of disused sources is not possible within a country, the duty of the supplier to take back sources no longer in use should be established — and the related procedures and financial questions settled — at the time of purchase of the sources.*

Arrangements for handling* orphan *sources

11. *Governments should ensure that arrangements are made between regulatory authorities and facility operators for the detection and future handling of* orphan *sources, which tend to appear at facilities such as scrap yards.*[2]

Emergency arrangements

12. *For prompt and effective action in an emergency, regulatory authorities should ensure that all relevant government agencies participate in developing and maintaining radiation emergency plans which specify the responsibilities and actions to be taken by all participating organizations and agencies for each type of accident which has a reasonable likelihood of occurrence. Radiation emergency response plans should be commensurate with the risk involved, and they should be periodically tested in exercises. In addition, due consideration should be given to establishing the appropriate capabilities for dealing with the diagnosis and treatment of overexposure cases, or to sending overexposed individuals to adequately equipped medical centres. Information exchange among medical practitioners is important in this connection.*

Criminal activities

13. *Measures to prevent the criminal misuse of radiation sources should be seen as complementary to measures to increase their safety and security. Events where individuals are exposed to radiation because of breaches in radiation source safety or security without malice aforethought should be clearly distinguished from events where there is a criminal intent of exposing people to harmful effects of radiation. This distinction has implications — inter alia — for border monitoring*[3]*; consequently, the purpose of such monitoring should be specified and appropriate standards established. The prevention of criminal activities involving nuclear or other radioactive materials requires broader competence and a thorough understanding of the related issues, and closer co-operation at the national and the international level between nuclear*

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[2] Examples of such arrangements are those which have been made in Spain and Italy. In Spain, an agreement concluded by the metal recovery and the smelting industry, a number of governmental departments, the national enterprise for waste management and the National Safety Council provides for — inter alia — a system of radiation monitoring of scrap and improvements in the emergency response system. In Italy, there is legislative provision for installing radiation detectors at the national borders, in foundries and at the entrances to scrap yards, and detection systems are already in place at most of the envisaged locations.

[3] In March 1999, the IAEA's Board of Governors requested the Director General of the IAEA to — inter alia — encourage all States to consider installing radiation monitoring systems at airports and seaports, at border crossings and at other locations where radiation sources may appear. In the course of the Board's discussion, the IAEA's Secretariat was urged to be cautious in connection with the implementation of that request, on the grounds that there would be implementation difficulties.

regulatory authorities and law enforcement authorities (police, customs and intelligence) is therefore essential.

Technical assistance

14. *The technical assistance in support of the safety of radiation sources and security of radioactive materials which is provided by the IAEA to its Member States through — inter alia — its Model Projects for upgrading radiation protection infrastructure and regional co-operation programmes related to radiation safety is highly commendable. The Model Projects have contributed significantly to the improvement of regulatory infrastructures in many participating countries. It is noted that the IAEA assistance directed towards establishing effective regulatory mechanisms for the control of sources and building sustainable radiation protection infrastructures in developing Member States will continue in the years 2001-2004 through two new Model Projects for each of five regions (Africa, East Asia and the Pacific, Europe, Latin America, and West Asia). This assistance is seen as an important means of helping the recipient countries to meet the principal requirements of the International Basic Safety Standards for Protection against Ionizing Radiation and the Safety of Radiation Sources.*

Immediate future actions

15. *For the immediate future, States should, with a view to ensuring the safety and security of radiation sources:*

 (a) *provide for the application and implementation of the* "Code of Conduct on the Safety and Security of Radioactive Sources"[4]*;*

 (b) *when deciding on the degree of care that should be exercised in the consideration of requests for the authorization of radiation sources and on the associated inspection priorities, make use of the categorization scheme provided in the* "Categorization of Radiation Sources"[5]*;*

 (c) *establish strategies for the education and training of regulatory staff, including the on-the-job training of inspectors in the most relevant radiation practices and of radiation users in the management of radiation sources, and, in the case of those States which have fully developed radiation protection infrastructures, participate more actively in the education and training of fellows from developing countries;*

 (d) *establish inventories of disused sources, and ensure that disused sources are kept in an appropriate storage facility if returning them to the supplier or sending them to a disposal facility is not feasible (temporary storage by the user should be minimized, and financial provision should be made — with governmental support if necessary — for taking care of sources after the declared use has been completed);*

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[4] The "*Code of Conduct on the Safety and Security of Radioactive Sources*", of which the IAEA's Board of Governors took note in September 2000, has been circulated by the IAEA's Secretariat to all States and all relevant international organizations at the Board's request.

[5] The "*Categorization of Radiation Sources*", of which the IAEA's Board of Governors took note in September 2000, has been issued by the IAEA as IAEA-TECDOC-1191.

(e) *develop national strategies for searching for and localizing* orphan *sources, including actions to bring sources that are in a vulnerable state (e.g. in inadequate storage) under proper control, programmes for investigating (e.g. monitoring) sites where the presence of abandoned sources is suspected, detection systems (at border crossings, scrap yards, foundries, steelmills, landfill sites and incineration plants), intelligence gathering (for cases of illicit trafficking), arrangements for responding to abnormal events which do not necessarily constitute emergencies (e.g. the finding of a radiation source) and arrangements for dealing with users who have gone bankrupt;*

(f) *provide for inputting to and the utilization of RADEV and, as soon as it becomes available, the International Catalogue of Sealed Sources and Devices being prepared by the IAEA;*

(g) *carry out assessments of the effectiveness of radiation safety regulatory infrastructures, using — as necessary — the Radiation Safety Regulatory Infrastructure Service of the IAEA; and*

(h) *encourage users, manufacturers and regulators to participate in IAEA regional workshops on the safety and security of radiation sources and radioactive materials and to exchange information about problems encountered and successes achieved.*

Follow-up

16. *International follow-up conferences to the Buenos Aires Conference should be held at frequent intervals. They should focus on particularly difficult issues, to be dealt with through — inter alia — specialized round tables. They should be designed to attract not only regulatory authorities, but also — as appropriate — designers, suppliers, manufacturers and users of sources and representatives of international, regional and specialized organizations (ISO, IEC, etc.).*

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