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MEASURES TO STRENGTHEN INTERNATIONAL CO-OPERATION IN NUCLEAR, RADIATION AND WASTE SAFETY

THE ACTION PLAN FOR THE SAFETY OF RADIATION SOURCES AND THE SECURITY OF RADIOACTIVE MATERIALS

BACKGROUND

The Dijon Conference

1. The International Conference on the Safety of Radiation Sources and the Security of Radioactive Materials held in Dijon, France, from 14 to 18 September 1998 (the Dijon Conference) was an important international attempt to address the growing concern about the *safety* of radiation sources and the *security* of radioactive materials.[1]

General Conference resolution GC(42)/RES/12

2. On 25 September 1998, in resolution GC(42)/RES/12, the General Conference - inter alia - welcomed a Secretariat report on the Dijon Conference, noted with interest the major findings of the Conference and 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"*.

3. In that resolution, the General Conference requested the Secretariat *"to prepare for the consideration of the 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

[1] For the purposes of this document, *safety* means measures intended to minimize the likelihood of accidents with radiation sources and, should such an accident occur, to mitigate its consequences; *security* means measures to prevent unauthorized access to, and loss, theft and unauthorized transfer of, radioactive sources.

(ii) whether international undertakings concerned with the effective operation of such systems and attracting broad adherence could be formulated".

In addition, it requested the Director General to report to it at its next (1999) regular session on the implementation of that resolution.

Secretariat action pursuant to resolution GC(42)/RES/12

4. Resolution GC(42)/RES/12 was brought to the attention of the Ministries of Foreign Affairs of Member States in a note verbale (J1.01.Circ) dated 1 December 1998, in which the Secretariat recalled that the Agency had established *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (the Basic Safety Standards)[2] and that it was ready to provide for the application of the Basic Safety Standards at the request of a State to any activity in that State involving radiation sources.

5. On 25 February 1999, the Secretariat submitted to the Board of Governors a report prepared in response to the request made of it by the General Conference.[3] In submitting the report to the Board of Governors, the Secretariat stated that it would, taking into account the conclusions and recommendations in and the Board's discussion of the report, draw up an *Action Plan* for responding fully to resolution GC(42)/RES/12.

Action taken by the Board of Governors in March 1999

6. At its March 1999 session, the Board:

(a) noted the conclusions and recommendations in the report;

(b) 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,

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[2] The Basic Safety Standards - jointly sponsored by the Agency, the Food and Agriculture Organization of the United Nations (FAO), the International Labour Organization (ILO), the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA), the Pan American Health Organization (PAHO) and the World Health Organization (WHO) - were approved by the Board in September 1994.

[3] The report was based on advice from a group of senior experts who had met at the headquarters of the Argentine National Atomic Energy Commission, Buenos Aires, from 7 to 10 December 1998 and at the headquarters of the United States Nuclear Regulatory Commission, Washington D.C., from 27 to 29 January 1999.

- provide their regulatory authorities with sufficient resources, including trained personnel, for the enforcement of compliance with relevant requirements,

- consider installing radiation monitoring systems at airports and seaports, at border crossings and at other locations where radiation sources might 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 were detected, and take similar urgent actions,

(c) requested the Secretariat to prepare an *Action Plan* that took into account the conclusions and recommendations in and the Board's discussion of the report;

(d) requested the Director General to initiate exploratory discussions relating to an international undertaking in the area of the safety and security of radiation sources, it being understood that the international undertaking should provide for a clear commitment by and attract the broad adherence of States; and

(e) authorized the Director General to include the report in the document to be submitted to the General Conference for consideration at its next (1999) regular session.

7. The Board took that action in the light of the following remarks by its Chairman:

"... there had been general support for the conclusions and recommendations in the ... report prepared on the basis of advice from a group of experts. Comments had been made on the individual recommendations - in particular on recommendation (d), concerning the establishment of categorization criteria, recommendation (i), that radiation sources be provided only to States having an adequate infrastructure, and recommendation (k), that monitoring systems be installed at airports and seaports and at border crossings. A suggestion had been made regarding the establishment by the Agency of an international database for use in monitoring transfers of radiation sources. The Secretariat had been urged to be cautious in implementing recommendations (i) and (k), on the grounds that there would be enforcement difficulties.

"As regards the recommendation that exploratory discussions be initiated by the Agency with a view to achieving an effective international undertaking by States in the area of the safety and security of radiation sources, while there had been no opposition to the Director General's initiating exploratory discussions relating to an international undertaking, some members had thought that to aim for an international convention would be too ambitious at the present time. They had felt that it might be more feasible to aim for other types of instrument - for example, codes of practice/conduct.

"Several members had commented on the proposed action plan. Some members had wanted more information about it (particularly information about its financial implications) and had called for prioritization of the envisaged activities. It had been noted that the action plan would come before the Board before being transmitted to the General Conference." [4]

Follow-up to the Board's March 1999 session

8. The Director General distributed the report to the Ministers for Foreign Affairs of all States under cover of a letter (J1-I.03 Circ.) dated 11 May 1999 in which he - inter alia - requested them to transmit it to the relevant national authorities in their countries and invited 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.

9. A proposed *Action Plan* was submitted by the Secretariat to the Board and the General Conference in Attachment 2 to document GOV/1999/46-GC(43)/10 (with a Corrigendum in document GOV/1999/46/Corr.1-GC(43)/10/Corr.1).[5]

Action taken by the Board in September 1999

10. On 20 September 1999, the Board approved the *Action Plan* and requested the Secretariat to implement it.

Action taken by the General Conference in October 1999

11. On 1 October 1999, in resolution GC(43)/RES/10, the General Conference endorsed the Board's decision and urged the Secretariat to implement the *Action Plan*. The General Conference requested the Director General to report to it at its forty-fourth (2000) regular session on the implementation of resolution GC(43)/RES/10.

IMPLEMENTATION OF THE *ACTION PLAN*

12. The *Action Plan* covers the following seven areas:

- Regulatory Infrastructures;
- Management of Disused Sources;
- Categorization of Sources;
- Response to Abnormal Events;

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[4] See paras 96-100 of GOV/OR.967.

[5] The proposed *Action Plan* was based on a draft which the Secretariat prepared with the help of a group of consultants who met in Prague from 25 to 28 May 1999 and was endorsed by a Technical Committee (chaired by Ms. Mary Clark of the United States Environmental Protection Agency and consisting of senior experts from Australia, Canada, China, the Czech Republic, Egypt, Finland, France, Germany, Iceland, India, Israel, Spain, Turkey, Ukraine, the United Kingdom and the United States of America and an observer from the European Commission) which met in Vienna from 12 to 14 July 1999.

- Information Exchange;
- Education and Training; and
- International Undertakings.

It foresees one or more actions in each area. The actions and their status are described in Attachments 1-7 hereto.

13. As indicated in paragraph 9 of document GOV/1999/46-GC(43)/10, the *Action Plan* envisaged certain activities for which no funds had been provided in the Regular Budget for 1999 and the Regular Budget estimates for 2000. The *Action Plan* is being implemented on schedule, however, thanks to the provision - by the United States of America - of extrabudgetary funds for the carrying out of certain tasks in 2000 and of the services of a cost-free expert and to savings achieved during the implementation of Programmes I ("Radiation Safety"), J ("Radioactive Waste Management") and K ("Co-ordination of Safety Activities") of Major Programme 3 ("Nuclear, Radiation and Waste Safety"). The Secretariat hopes that further extrabudgetary funds will be provided by Member States in order that the *Action Plan* may be implemented fully and speedily.

SUGGESTED BOARD ACTION

14. It is suggested that the Board:

(a) encourage 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 (see Attachment 1);

(b) note the progress made in carrying out the actions related to the "Management of Disused Sources" (see Attachment 2);

(c) take note of the *Categorization of Radiation Sources* contained in the Annex to Attachment 3,

authorize the Director General to issue the *Categorization of Radiation Sources*,

authorize the Secretariat to use the *Categorization of Radiation Sources* in discharging the Agency's statutory responsibilities with regard to the safety of the radiation sources under its control or supervision (particularly those used in Agency projects), and

invite Member States to draw on the *Categorization of Radiation Sources* as appropriate;

(d) note the progress made in carrying out the actions related to "Response to Abnormal Events" (see Attachment 4),

invite Member States to make use as appropriate of the technical documents, manuals, training materials and other mechanisms being prepared by the Secretariat in the development of further national response capabilities for dealing with radiological emergencies,

invite Member States to make advance domestic arrangements as appropriate for smooth implementation of the operational arrangements described in the new edition of the Secretariat's Emergency Notification and Assistance Technical Operation Manual (ENATOM) and to ensure that the competent authorities designated by them pursuant to the Convention on Early Notification of a Nuclear Accident and to the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency attend the meeting being convened by the Secretariat in June 2001 for the purpose of considering how to strengthen the Agency's emergency response system and improve those operational arrangements;

(e) note the progress made in carrying out the actions related to "Information Exchange" (see Attachment 5), and

encourage Member States to arrange to be represented by high-level officials and experts from national authorities concerned with the regulatory control of radiation sources and radioactive materials at the *International Conference of National Regulatory Authorities with competence in the Safety of Radiation Sources and the Security of Radioactive Materials*, due to take place in Buenos Aires from 11 to 15 December 2000, and at the regional workshops being organized by the Secretariat, and to make use as appropriate of the international database on unusual radiation events (RADEV) as soon as it becomes available;

(f) note the progress made in carrying out the actions related to "Education and Training" (see Attachment 6), and

authorize 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; and

(g) take note of the report (contained in Attachment 7) of the Chairman of the Open-ended Meeting of Technical and Legal Experts convened by the Secretariat to undertake exploratory discussions on a possible Code of Conduct on the Safety of Radiation Sources and the Security of Radioactive Materials,

take note of the *Code of Conduct on the Safety and Security of Radioactive Sources* which is contained in the Annex to Attachment 7 and request the Director General to circulate it to all States and all relevant international organizations, and

request the Director General to organize consultations on decisions which the Agency's policy-making organs may wish to take, in the light of the report of the Chairman of the Open-ended Meeting, regarding - inter alia - the application and implementation of the *Code of Conduct on the Safety and Security of Radioactive Sources* and to make recommendations thereon to the Board;

(h) commend this document to the General Conference, inviting it to concur with the actions taken by the Board in respect of the document at its meetings immediately before the Conference's forthcoming session and to encourage Member States to support implementation of the *Action Plan* by providing further extrabudgetary funds in order that the *Action Plan* may be implemented fully and speedily, and

request the Director General to report to it on the further progress in implementing the *Action Plan*.

REGULATORY INFRASTRUCTURES

Action: to establish a service for advising States on the establishment of appropriate regulatory programmes.

Status

In order to assist States - whether or not Member States of the Agency[1] - in ensuring compliance with the relevant requirements concerning regulatory infrastructures in the Basic Safety Standards, 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;

- 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 the 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.

In addition to the Basic Safety Standards, in operating the RSRI service the Secretariat will draw on: the Safety Requirements on "Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety", which is being issued as Safety Standard Series No. GS-R-1; IAEA-TECDOC-1067 entitled "Organization and implementation of a national regulatory infrastructure governing protection against ionizing radiation and the safety of radiation sources"; and IAEA-TECDOC-1113 entitled "Safety assessment plans for authorization and inspection of radiation sources". A Safety Guide on the organization and operation of a national regulatory infrastructure for radiation safety, a Safety Report on the "peer review" assessment of the effectiveness of regulatory programmes for radiation safety and a Safety Report on strategies and approaches for establishing a regulatory infrastructure for

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[1] See, in this connection, paras 32-36 of GOV/OR.968 regarding the application of international radiation protection standards in States that are not Member States of the Agency.

radiation safety are in preparation and will ultimately be used in connection with the RSRI service.

MANAGEMENT OF DISUSED SOURCES

Action: to prepare documents on particular aspects of the handling and disposal of disused radioactive sources.

Status

The Secretariat is preparing three technical documents (IAEA-TECDOCs), one on the management of high-activity disused sources, one on procedures for conditioning and storing long-lived disused sources (e.g. sources containing radium-226 or americium-241 and various neutron-emitting sources) and one on disused sealed source management involving storage/disposal in boreholes.

A draft of the first technical document will be worked on at a meeting of consultants due to take place in October 2000. The technical document will describe 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); such sources have been the main cause of serious accidents with disused sealed sources.

A draft of the second technical document has been prepared. It describes procedures for managing (conditioning and storing) 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.

The third technical document will be issued later this year. It summarizes current practices involving the use of boreholes for the storage/disposal of disused sealed sources - a storage/disposal method which, because it is inexpensive, may be an option for many developing Member States.

Owing to the lack of a disposal option in many Member States, now and in the foreseeable future, the conditioning procedures for disused sources with high activities or with long half-lives need to meet stringent requirements for a long time (e.g. 40-50 years). These technical documents will provide management approaches, describe suitable technical procedures and give examples of appropriate current practices.

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.

Status

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.

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). It hopes that the meeting will be attended by representatives of all major source manufacturers, of a substantial number of Member States and of international organizations such as the Commission of the European Communities, the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development and the Pan American Health Organization.

The Secretariat intends, following the meeting, to produce a first draft of a strategy to be sent to all meeting participants for comment. Subsequently, the Secretariat will, if necessary, convene a second meeting to finalize the strategy, whose successful implementation would help to reduce radioactive waste generation in Member States.

The Secretariat 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, to be held on the basis of - inter alia - the final version of the above-mentioned draft technical document on that topic.

CATEGORIZATION OF SOURCES

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

Status

A Technical Committee has endorsed the *Categorization of Radiation Sources* contained in the Annex to this Attachment, which is based on a draft prepared by a group of senior experts.[1]

The categorization is based on the following five attribute groupings:

- Radiological Properties
- Form of Material
- Practice or Activity
- Exposure Scenarios
- End of Life Considerations

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;
- Category 3 (lower risk): fixed industrial gauges with lower-activity sources.

This 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. Also, it would be relevant to

[1] The Technical Committee consisted of representatives of Bulgaria, China, the Czech Republic, Finland, France, Germany, India, Israel, Slovakia, Sweden, Turkey, Ukraine, the United Arab Emirates, the United Kingdom and the United States of America; the senior experts were from Argentina, France, the United Kingdom, the United States of America and the International Organization for Standardization.

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 the radiation sources and the security of the radioactive materials which are under its control or supervision.

GOV/2000/34-GC(44)/7
Attachment 3
Annex

Categorization of Radiation Sources

10 JULY 2000

CONTENTS

INTRODUCTION

BACKGROUND

On 25 September 1998, in resolution GC(42)/RES/12, the General Conference - inter alia - welcomed a Secretariat report on the International Conference on the Safety of Radiation Sources and the Security of Radioactive Materials held in Dijon, France, from 14 to 18 September 1998, noted with interest the major findings of the Conference, 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"*, requested the Secretariat *"to prepare for the consideration of the 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"*

and requested the Director General to report to it at its next (1999) regular session on the implementation of that resolution.

The Secretariat submitted to the Board of Governors at its meeting in March, 1999, a report with a number of proposed actions. One proposed action was a request to the Secretariat to prepare an action plan that took account of the conclusions and recommendations in and the Board's discussion of the report. The report of the Chairman stated that

> *"...there had been general support for the conclusions and recommendations in the ... report prepared on the basis of advice from a group of experts ... and noted that the action plan would come before the Board before being transmitted to the General Conference"*.

The Board of Governors at its meeting on 20 to 24 September, 1999, approved the Action Plan and requested the Secretariat to implement it. The General Conference, which took place from 27 September to 1 October 1999, endorsed the decision of the Board and urged the Secretariat to implement it.

The Action Plan contains a number of activities. One of the activities identified is the need for a system of source categorization.

The action on categorization of sources is given high priority because it is a prerequisite for other actions of the plan. Such a categorization is seen as necessary in view of the wide variety of uses of radiation sources and radioactive materials so that the controls to be applied will be commensurate with the radiological risks that the sources and materials present. Of particular concern are those radiation sources containing substantial levels of radioactivity which have the potential for causing significant harm to persons in the short term. Consideration may also need to be given to the potential for contamination.

OBJECTIVES

The objective is to develop a categorization scheme for radiation sources that could be relevant to decisions both in a retrospective application to bring sources under control and in a prospective sense to guide the application of the regulatory infrastructure. The Action Plan envisages that the preparation of guidance on national strategies and programmes for the detection and location of orphan sources and their subsequent management should commence after the categorization of sources has been carried out. In the prospective application of the system of notification, registration, and licensing, the categorization is relevant to prioritize a regulatory authority's resources and training activities; to guide the degree of detail necessary for a safety assessment; and to serve as a measure of the intensity of effort which a regulatory authority should apply to the safety and security of a particular type of source.

Issues of safety and security for radiation sources may arise during each stage of the life of a source, including, for example, manufacture, supply, transport, use, storage, transfer, repair, and decommissioning or disposal. The categorization scheme for sources is based on a number of factors including the potential for causing serious injury or contamination and the probability of such accidents occurring. The categorization scheme would also be relevant to any future international databases of lost and found sources and of incidents and accidents involving radiation sources.

SCOPE

This report is concerned with radioactive sources that may be used in industry, research and teaching, agriculture, medical practice and military applications. It is not concerned with the nuclear fuel cycle as such, although it is concerned with any uses of radioactive sources within establishments of the nuclear fuel cycle, such as industrial radiography. In addition, issues associated with the non-proliferation of nuclear materials are not taken into account in the development of this categorization scheme.

The focus of this report is upon sealed sources containing radioactive material. Other radiation sources, including unsealed uses of radioactive material and radiation producing equipment such as x-ray machines and particle accelerators, may also induce radiation injury, but are not included in this categorization. Consumer products and other exempted devices have not been included due to the small quantities of radioactive material involved.

All sources, however, exhibit radiological and practice attributes, many of which are similar to the attributes described in this document on sealed sources. Thus, *all* sources need to be managed and maintained safely and securely, to prevent theft or damage and to prevent any unauthorized person from obtaining or misusing them. The methods used to develop the categorization of sealed sources are easily extended to other types of sources in order to develop a set of comprehensive and coherent regulatory structures.

RATIONALE FOR THE CATEGORIZATION OF SOURCES

Sources containing radioactive materials are used throughout the world for a wide variety of peaceful purposes in industry, medicine, research and education, and are also used in military applications. Many uses involve sealed sources with the radioactive materials firmly contained or bound within a suitable capsule or housing.

Because of the wide variety of uses of radiation sources, some sort of categorization is necessary so that the controls that are applied are commensurate with the radiological risks the sources and materials present. Those radiation sources containing substantial levels of activity, and which have the potential for causing significant harm to individuals within a short time or widespread contamination, are of particular concern.

DESCRIPTION OF SOURCES AND USES

Teletherapy units are commonly found in medical institutions, such as hospitals or clinics. The physical dimensions of the source are relatively small, with generally a cylindrical (few cm in diameter by several cm long) shape. The source is contained inside a large shielding device. The facilities within which the unit is located are generally specifically designed and include thick shield walls and have other protective equipment, due to the high activity source strength.

Irradiator facilities are relatively few in number, and contain very high activity sources to sterilize foodstuffs, medical products and supplies, and for other specialized applications. The sources used in performing the irradiation of the material vary in physical size, some being large or others being pencil-sized, and each facility will contain many such sources. The facilities that contain the irradiation sources are specially designed, often including thick shield walls, interlocks, and other protective equipment.

Portable industrial radiography sources and their devices are generally small in terms of physical size, although the devices are usually heavy due to the shielding contained in them. The sources themselves are very small, less than 1 cm in diameter, and only a few cm long, and are attached to specially designed cables for their proper operation. The use of radiography sources and devices are very common, and their portability may make them susceptible to theft or loss. The small size of the source allows for unauthorized removal by an individual, and such a source may be placed into a pocket of a garment. Industrial radiography may also be performed in fixed installations, either using the same small portable devices, or using larger machines which may appear to be similar to teletherapy units.

Brachytherapy applications are of two slightly different varieties. These are generally referred to as Low Dose Rate (LDR) brachytherapy and High Dose Rate (HDR) brachytherapy. Both applications use sources that may be small physically (less than 1 cm in diameter, only a few cm long), and thus are susceptible to being lost or misplaced. HDR sources, and some LDR sources, may be in the form of a long wire attached to a device (a remote afterloading device). The afterloading device may be heavy, due to the shielding for the sources when not in use, and the device may be on wheels for transport within a facility. The remote afterloading device may also contain electrical and electronic components for its operation. Brachytherapy sources are located in hospitals, clinics and similar medical institutions, and such facilities may have a large number of sources. Brachytherapy is less commonly used than teletherapy, but use of the modality is increasing.

Well logging sources and devices are generally found in areas where exploration for minerals is occurring, such as searching for coal, oil, natural gas, or similar uses. The sources are usually contained in long (1-2 m, typically) but thin (< 10 cm in diameter) devices which also contain detectors and various electronic components. The actual size of the sources inside the devices is generally small. The devices are heavy, due to the ruggedness needed for the environments in which they are to be used.

Industrial gauges are of various shapes and sizes, and are either fixed or portable. These devices are generally designed for many years of operation with little or no special tending. They may be used for control over a process, for measurement of flow, volume, density, material presence, and may be placed in locations unsuitable for continuous human presence. Consequently, they may accumulate layers of dirt, grime, grease, oil, material, etc., covering any warning labels that may have been present. Depending upon the specific application, industrial gauges may contain relatively small quantities of radioactive material, or may contain sources with activities approaching 1 TBq. The devices generally are not large, but may be located some distance from the radiation detector, which may have electrical or electronic components located within the detector. A facility may have a large number of these gauges. The locations of such devices or sources within a facility may not be recognized, since the devices may be connected to process control equipment. This lack of recognition may result in a loss of control if the facility decides to modernize or terminate operations.

Moisture/density devices are a type of industrial gauges which are small and portable. These devices contain the sources, detectors and electronic gear necessary for the measurement undertaken. The source is physically small in size, typically a few cm long by a few cm in diameter, and may be located either completely within the device or at the end of a rod/handle assembly. The small size of the device makes it susceptible to loss of control or theft.

Figure 1 presents the typical ranges of source activity for various uses of radioactive sealed sources.

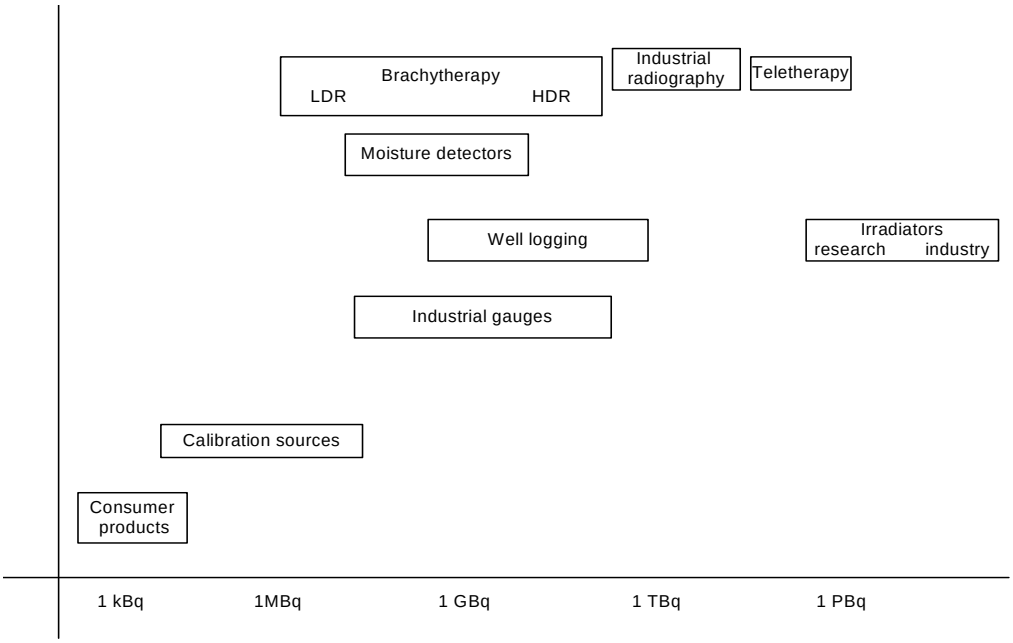

Figure 1. Activity ranges for some important applications of sealed sources

REVIEW OF ACCIDENTS

The potential for accidents as a result of loss of control of radioactive sources depends on the probability of such loss of control, the exposures that might result and the ability to detect the source after control is lost but before it causes further damage.

A part of this information could be derived from an examination of past experience of actual accidents, another part from dosimetric consideration of exposure scenarios, and a further part from known sensitivity of detection instruments.

An examination of the accidents recorded in various databases illustrates that a variety of situations can arise. Two types of situations have presented serious consequences for the regulatory authorities. First are those situations which have

resulted in doses sufficient to cause deterministic effects in one or more individuals[1]. The second situation is where the individual doses resulting from the accident were not significant to cause deterministic effects, but contamination of materials, property, and individuals resulted in the need for significant actions to rectify and control the situation. An analysis of this data in the light of information available on the circumstances, causes, resulting exposure and damages produced by each accident leads to the following observations:

a) ^{192}Ir sources are the most common sources involved in accidents causing deterministic effects, followed by ^{60}Co sources. ^{137}Cs sources are the third most important but accidents involving them are significantly less probable.

b) The sources causing most accidents are industrial radiography sources and teletherapy sources. Industrial radiography sources have also contributed more than teletherapy sources in the number of accidents. Although industrial radiography accidents are more frequent, medical teletherapy sources cause a greater fraction of the reported deaths of exposed people, since teletherapy sources contain larger amounts of radioactivity and expose greater numbers of people.

c) For the main contributor to loss of control accidents (industrial radiography sources) the causes of the accidents are 75% operator errors or failure to follow procedures and 25% equipment errors.

d) Military sources also can cause injury[2] or death, but the number of cases is not as high as events in the commercial area.

e) Radium-226 is still used in medical and non-medical applications in some countries. It has contributed minimally to accidents. In medical applications, losses dominate the accidents (90%), with theft accounting for the remaining 10%. In non-medical applications (accounting for less than 10% of the radium accidents) losses and theft are equally probable (50% each).

f) Many additional accidents result in lower individual doses but significant property damage as a result of contamination of material or equipment. This has been the case in the large number of situations where a source was inadvertently melted in the recycling of scrap for new metal. Depending on the type of source, this has resulted in contamination of the metal product or the by-products of the metal-making process, or of the dust collection system associated with the melting process, or the release of material to the environment.

In each of the above cases, the principal initiating event was the loss of control over a source, and its movement into the public domain where it was not recognized as a

[1] A whole body dose in excess of 0.25 Gy is used to define such accidents.
[2] Cf., the incident in Tbilisi, Georgia,1997, "The Radiological Accident in Tbilisi," IAEA, Vienna,

source. It should be noted that some accidents occurred despite the presence of an ISO radiation symbol on the radioactive device, thus indicating that the ISO trefoil is generally not perceived as a hazard warning. Additional warning statements are almost always needed to increase the likelihood that a radioactive source or device will be recognized. In many situations, damage may be limited and additional damage prevented by prompt location, identification and control of the source.

Although adequately sensitive instrumentation is often available, the presence of radiation shielding significantly reduces the radiation intensity, and hence the possibility that the source will be detected. Similarly, the presence of other material, such as what would be found in a shipment of metal intended to be recycled, also reduces the radiation level, and challenges the ability of instrumentation to detect a radioactive source. Some types of radioactive sources, such as pure alpha emitters, cannot be detected unless the instrument is very close to the source, and could escape detection entirely.

It should be noted, however, that the ability to detect a source presumes that one has knowledge of its approximate location and that the radiation source is not shielded, either by a protective housing or other intervening material. It also assumes that the source is reasonably intact and that there is no wide-spread contamination. IAEA-TECDOC-804, "Methods to identify and locate spent radiation sources (July, 1995)" provides additional guidance.

EXPOSURE SCENARIOS

From the review of accidents presented above, it is clear that there are a number of different situations which can lead to the loss of control of sources and a number of different event scenarios which may result in radiation exposures occurring. The following are three generic exposure scenarios involving radiation injury to an individual which are typical of many situations. These generic scenarios may be used

to estimate potential radiation exposures which may occur if control of sources is lost. Other scenarios which do not involve radiation injury but can have great economic, social or political consequences may also occur.

The generic radiation injury scenarios are, as follows:

1. External exposure to an individual from a source in very close proximity
2. External exposure from unshielded source (involving several individuals)
3. Exposures following rupture of source casing

A detailed description of each scenario is presented below:

External exposure to an individual from a source in very close proximity. One scenario that has occurred a number of times is that an individual has put a radiation source into a pocket. This may be for a number of reasons, including theft, interest in an unknown object or ease of transfer to another location. The individual involved may be another worker at the facility or may be a member of the public. In either case, that individual would not recognize the typical size or appearance of a radiation source, but see a small, shiny metallic object, and perceive that this object has some value. For this generic scenario it is assumed that the source is picked up and put in a pocket[3] and carried.

External exposure from unshielded source (involving several individuals). It is possible that once control of a source has been lost, it may irradiate workers or members of the public without the knowledge of those involved. This scenario may occur, for example, if faulty equipment is left in a facility or a stolen, spent or disused source is present in a house or other location. In a recent situation, the source was removed from its shielding and left in a room or area where other individuals work, resulting in significant doses to several persons.

[3] The following exposure rates are provided for a 37 GBq (1 Ci) source: ^{137}Cs - ~5 Gy per minute @ contact; ^{60}Co: ~20 Gy/min @ contact; ^{192}Ir: ~8 Gy/min @ contact; ^{226}Ra: ~13 Gy/min @ contact.

Exposures following rupture of source casing. If a source which is not controlled becomes ruptured, it may then result in contamination of equipment or individuals, exposures from inhalation of radioactive material, inadvertent ingestion of radioactive material, contamination of the skin and external exposure from the spillage.

These three generic exposure scenarios were developed from actual incidents. For example, the external exposure to a single individual from an unshielded source occurred in Georgia in 1997, and in Peru in 1999. The exposure of multiple individuals from an unshielded source occurred in Estonia[4] in 1994, in Algeria in 1978, in Mexico City in 1962, in China in 1996, in Turkey in 1998, in Thailand in 2000, and in Egypt in 2000. Several of those incidents resulted in the deaths of members of the public. The exposure following the rupture of a source occurred in Juarez, Mexico, in 1983, and in Goiania, Brazil, in 1987[5].

In addition to incidents where radiation injury occurred, other events can also occur. In the absence of adequate regulatory control, devices containing radioactive sources may be discarded with other scrap from a facility, or may be stolen from an abandoned or unused facility and either enter the recycling stream or enter the public domain. In either case, the possibility of radiation exposure from the device itself, or of potential contamination from breaching the encapsulation of a radiation source, may cause radiation injury to individuals or radioactive contamination of individuals and the environment.

A source may be accidentally melted if a device containing radioactive materials were introduced into the scrap metal intended for recycling, following, for example, loss or theft of a device. The resulting potential exposures will depend upon the partitioning

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Assuming a threshold erythema dose of 3 Gy, exposure time is thus ~ 35 sec for 37 GBq of ^{137}Cs, ~12 seconds for ^{60}Co, ~25 sec for ^{192}Ir and ~15 sec for ^{226}Ra.

[4] "The Radiological Accident in Tammiku," IAEA, Vienna, 1998

[5] "The Radiological Accident in Goiania," IAEA, Vienna, 1988

of the radionuclide into the product or to the various waste streams (i.e., the furnace gases and slags or drosses) generated in the recycling process.

The implications of this scenario of melting a radioactive source in a metal manufacturing facility may be less in terms of doses to individuals than those for the three scenarios discussed above, but the financial implications for the metal manufacturing company may be considerable as a result of contamination of equipment, products and by-products. Once the incident is discovered, any clean up activity will also result in exposures to workers remediating the facility, and necessitate effective radioactive waste management. There may be significant social, political, and economic consequences associated with the return to normality of the affected facility and its local environment. There may also be considerable media interest in the event.

SOURCE ATTRIBUTES

Ranking radiation sources on the basis of their radioactivity content is not sufficient to classify the threat or hazard posed by their presence or use. Other attributes relative to the construction and use of the source need to be considered. For purposes of developing a source categorization, two broad groups were identified. These were attributes related to the *properties* of the source being used, and attributes related to the *use* of the source in a particular practice. In relation to the properties of the source, the radiological properties and the form of the material serve as groups for consideration. In relation to the use of the source in a practice, the characteristics of the practice or use activity, the exposure scenarios that may arise, the accident history, and the considerations present at end of life serve as useful attributes for consideration. An effective categorization will take into account a number of attributes of the source, device and application, although rarely will one attribute be the single determining factor. The following is an expansion of each of the groups of attributes.

A. Radiological Properties

The attributes considered under this heading include the types of radiation emitted, the half-life of the radioisotope, the energy of the radiation, and the source activity. Within this heading, the source activity and the half-life of the material are the properties usually considered as the most important.

The radiological properties of the material directly dictate the hazard from external and internal exposure. In general, these can be directly expressed by the gamma constant and energy for external radiation, and by the inhalation and ingestion dose conversion coefficients for internal exposure. For some radioactive materials, such as tritium, the external and internal exposure hazards are generally low. However, if the material poses significant hazards from both internal and external exposure (such as radium), it would be ranked higher than for radioactive material which contributes significantly in only one method of exposure.

Source activity and the half-life are a critical set of attributes. In general terms a higher category would be indicated for sources with a greater level of activity. The influence of the half-life is to rank radioactive materials with a longer half-life higher than those with shorter half-lives, simply due to the fact that they will present a hazard over a longer period of time.

B. Form of the material

The attributes considered under this heading include the physical and chemical form of the material in the source, whether the source is sealed or unsealed, the (chemical) toxicity of the material, and the risk of contamination posed by the source in the event of an accident. In particular, the form of the material will have an influence in the exposure scenarios in accident situations. Material that is dispersible, or in a dispersible form within a sealed source, poses a greater hazard than material that is not dispersible in situations where the source integrity is breached.

Some devices, exemplified by tritium self-luminous signs, may have a relatively high quantity of radioactive material, but the physical form of the material, coupled with its low toxicity (on the basis of either an external or internal exposure hazard) makes devices like these relatively safe.

C. The Practice or Conditions of Use

The attributes considered under this heading include the characteristics of use for the source, including whether the situation is in a fixed facility or is mobile, the type of application (e.g. industrial, medical, research or military), the design and construction of the source and equipment, the source size, the presence of other equipment such as shielding and interlocks, and operational factors such as whether the source is removed from its shielding in order to accomplish the type of use. In many instances, the key attributes within this heading are whether the device is fixed or mobile, and the operational factors associated with using the source.

Within the operational factors associated with using the source, it is recognized that a number of human factors come into play. For example, experience shows that practices where commercial or other pressures exist can create impossible targets. This may result in using inappropriate procedures, short cuts, or other arrangements which reduce the safety and security of the source or device.

The accessibility of the source is a significant influence in the operational hazards posed by the material and application. In general, sources which are moved out of, and in to, their shielding pose greater risks than sources which remain within their shielding during use. Thus, for example, radiographic and brachytherapy sources pose greater operational hazards due to source wire breakage, disconnection, and their unshielded condition than do fixed gauges. In addition, the size of the source may make it more or less prone to removal or loss. In general, small devices are more likely to be removed or misplaced than larger devices, which would be difficult to move.

Whether the device is portable or fixed influences whether other individuals might have or gain access to the device or to the radiation source. For example, teletherapy units are installed in specially designed rooms in medical institutions. Food or product irradiators are also installed in specially designed and equipped facilities to ensure the safety of the device during normal operation. High dose rate brachytherapy units, although they are movable, are designed for use in medical institutions, and are generally housed and used in rooms shielded to reduce radiation levels to areas on their outside. The sources in those latter devices, however, are designed to be moved from their shielded and safe storage location, and such movement may lead to the breakage of the cable containing the source. Devices used in well-logging are meant to be moved from location to location. Likewise, portable gauges are moved, often frequently, in order to make the needed measurements. Fixed gauges are not generally moved to locations different from the location of use unless certain maintenance or facility requirements dictate their removal.

D. Exposure Scenarios

The attributes considered under this heading include the types of exposure scenarios that are available in operation and if control is lost, the presence of stochastic or deterministic exposure outcomes, the ability to detect a source if control is lost, and the historical record of accidents with the type of source and practice. In many cases the previous history of accidents, including the outcomes of those accidents, is the principal attribute considered. This report does not concern the deliberate exposure of patients for medical purposes.

E. End of Life

The attributes considered under this heading include the disposition options which may be available for the source, the costs and availability of those options, the traceability of sources, the frequency with which there may be disused sources (sources that are no longer in use or intended to be used) or spent sources (sources which are no longer useful for their intended purpose), and the net probability that the source will be lost from the regulatory control regime. In this group, the presence of reasonable disposition options[6], and in particular whether arrangements are made for return or exchange of the sources to the manufacturer, play a key role in the hazard presented.

The availability and costs of disposition options have a strong influence on the user's willingness and ability to dispose of the source properly at the end of its use. In situations where disposition options are few, or where the costs associated with those options are high, the user is more likely to remove the source or device from use and simply store it. This has, in many situations, resulted in the gradual degradation of controls and accountability, and has led eventually to situations where the material was lost or stolen. In some cases, or some locations, there may not exist an authorized disposal location, and the source/device could become abandoned. Transportation of a source for return or disposal may also be difficult to arrange and be costly, and the user may store the source or device or try to transfer it to another person without sufficient or adequate approval from the regulatory authority. Storage of a device presents a situation where continuing oversight may be reduced, resulting in an increased likelihood of intrusion, and the possibility of loss of control. A fixed gauge may have been in industrial use, and labels and warning signs may have become obscured or obliterated due to their proximal environment in the facility. In such cases, accountability may be lost, and the device may be disposed as scrap for recycling. The introduction of a radioactive device into the recycling stream could lead to radiation exposure or contamination of the recycling facilities, their workers,

[6] Disposition includes return of source/device to vendor; transfer for use by another authorized recipient; reuse upon device refurbishment; as well as the intentional burial of a source/device in a regulated radioactive waste disposal facility.

and the potential contamination of new products and by-products of the recycling process.

CATEGORIES

The source attributes can be considered in a matrix type of arrangement to determine general categories of sources and uses. For purposes of a general categorization, the source attributes were ranked according to the potential harm the sources may cause. The resulting categories are as follows:

Category 1.	Industrial Radiography
	Teletherapy
	Irradiators
Category 2.	HDR Brachytherapy
	Fixed industrial gauges involving high activity sources
	Well Logging
	LDR Brachytherapy
Category 3.	Fixed industrial gauges involving lower activity sources

The categorization scheme represented above does not rank practices within a category. Practices within each category were broadly considered to be of equivalent hazard to warrant sufficient and appropriate regulatory control.

The use of unsealed radioactive materials, for any purpose, was excluded from consideration in this report. The Regulatory Authority should apply the principles developed here in this categorization scheme when performing its assessment of the

practice, and the need for appropriate regulatory control over the radioactive materials.

Table 1 presents a more detailed description of types of sealed sources and uses, including the typical amounts of material.

CONTROL MEASURES FOR SOURCES IN EACH CATEGORY

The general categorization of sources provides an indication of the priority which a regulatory authority should attach to establishing a regulatory infrastructure and bringing sources under regulatory control. In this situation, where sources are already present, the first priority would be to locate and bring under appropriate controls those sources and devices that are in Category 1. Following this would be efforts to capture those sources in Category 2, and so forth until control had been established over all sources.

The responsibilities of principal parties[7] include developing and implementing a protection and safety programme commensurate with the nature and extent of the risks associated with the practices and interventions under their responsibility. One of the technical requirements of the principal party is to maintain security of sources so that theft or damage or actions by unauthorized legal persons is prevented[8]. The legal person responsible for the radiation source shall have an authorization from the appropriate Regulatory Authority. This authorization may take the form of either a registration or a license. Practices that are amenable to registration include those for which (a) safety can largely be ensured by the design of the facilities and equipment; (b) the operating procedures are simple to follow; (c) the safety training requirements

[7] "International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources," Safety Series No. 115, IAEA, Vienna, 1996. Principal Requirements 1.6

[8] "International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources," Safety Series No. 115, IAEA, Vienna, 1996. Principal Requirements 2. 34

are minimal; and (d) there is a history of few problems with safety in operations[9]. These will generally be sources which are in Category 3, although some types of sources within this category may also be appropriate for licensing.

The (draft) IAEA safety guides on regulatory infrastructures, the safety of sources, and the security of sources provide guidance for implementing the requirements of the Basic Safety Standards. These provide protocols for appropriate notification, registration, licensing, and inspection for uses of radioactive materials. The Code of Conduct presents the basic expectations for implementing the Basic Safety Standards and for interactions between member states of the IAEA.

When a Regulatory Authority is faced with decisions regarding the application of the regulatory infrastructure to a particular source, this source categorization may serve as an indication of the level of intensity and detail that needs to be applied to have confidence that safety and security is being respected. Regulatory Authorities should consider each of the headings of source attributes in determining the hazards presented by a given source, and the level of detail needed to assure proper implementation of the regulatory infrastructure. In some cases, the Regulatory Authority may wish to consider additional measures to assure itself of appropriate safety and security until experience is gained with new types of activities being authorized for the first time. In addition, the frequency and level of detail utilized in inspection of the practices can be considered on the basis of the source categorization.

For sources and devices in Category 1, it would be expected that Regulatory Authorities would expect a great level of detail in the information submitted for the authorization for use. Sources in this category present significant hazards which require examination of the conditions of use, the construction and operation of the facility, the training and competence of users, and the control mechanisms that the

[9] "International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources," Safety Series No. 115, IAEA, Vienna, 1996. Principal Requirements 2.11 [footnote]

user will apply to assure safety and security. In general, a detailed safety assessment would be expected to support the authorization of the source or device, and also of the facility when the use is in a fixed location.

For sources and devices in Category 2, the level of intensity applied to the review and assessment of an application for authorization might be somewhat less than that expected for Category 1. Sources in Category 2 may present significant hazards which will require examination, and the Regulatory Authority needs to be aware of issues such as patient protection which have not been considered in this Categorization. Although the quantities of radioactive material may be lower for sources in Category 2, other source attributes, such as portability and accessibility will remain critical, including the potential loss of accountability and presence of reasonable options for the disposition of disused or spent sources.

Sources and devices in Category 3 will require less effort on the part of the Regulatory Authority. In many cases, safety and security during operations is a function of the device construction, and a detailed review of a particular application for use will not be needed. However, the Regulatory Authority will need to remain mindful of end of life issues where there may be the potential for a loss of regulatory control if accountability is not maintained.

Table 1.

Categorization of radiation sources: information concerning practices and radioactive materials.

Category 1

Practice or application	Radionuclide	Decay energy [keV] half-life	Typical activity	Dose rate at 1m[a,b,c] [mSv/h]	Time at 1m[a,b,c] to exceed 1mSv
Teletherapy	Co-60	γ (1173; 1333) β (max.: 318) $T_{1/2}$ = 5.3 y	50-1000 TBq	3.E+05	< 1 s
	Cs-137	γ (662) β (max.: 512) e (624) $T_{1/2}$ = 30 y	500 TBq	3.E+04	< 1 s
Blood irradiation	Cs-137	γ (662) β (max.: 512) e (624) $T_{1/2}$ = 30 y	2-100 TBq	6.E+03	< 1 s
Industrial Radiography	Ir-192	γ (317) β (max.: 675) e (303) $T_{1/2}$ = 74 d	0.1-5 TBq	4.E+02	9 s
	Co-60	γ (1173; 1333) β (max.: 318) $T_{1/2}$ = 5.3 y	0.1-5 TBq	1.E+03	3 s
	(Cs-137) (rare)	γ (662) β (max.: 512) e (624) $T_{1/2}$ = 30 y			
	(Tm-170) (rare)	γ (84) β (max.: 968) $T_{1/2}$ = 129 d			
Sterilization and food preservation (Irradiators)	Co-60	γ (1173; 1333) β (max.: 318) $T_{1/2}$ = 5.3 y	0.1 - 400 PBq	1.E+08	< 1 s
	Cs-137	γ (662) β (max.: 512) e (624) $T_{1/2}$ = 30 y	0.1 - 400 PBq	2.E+07	< 1 s
Other Irradiators	Co-60	γ (1173; 1333) β (max.: 318) $T_{1/2}$ = 5.3 y	1-1000 TBq	3.E+05	< 1 s
	(Cs-137) (rare)	γ (662) β (max.: 512) e (624) $T_{1/2}$ = 30 y			< 1 s

Category 2

Practice or application	Radionuclide	Decay energy [keV] half-life	Typical activity	Dose rate at 1m[a,b,c] [mSv/h]	Time at 1m[a,b,c] to exceed 1mSv
High Dose Rate Remote afterloading brachytherapy	Co-60	γ (1173; 1333) β (max.: 318) $T_{1/2}$ = 5.3 y	≈ 10 GBq	3.E+00	20 min
	Cs-137	γ (662) β (max.: 512) e (624) $T_{1/2}$ = 30 y	0.03-10 MBq	6.E-04	70 d
	Ir-192	γ (317) β (max.: 675) e (303) $T_{1/2}$ = 74 d	≈ 400 GBq	3.E+01	2 min
Low Dose Rate brachytherapy (manual or remote)	Cs-137	γ (662) β (max.: 512) e (624) $T_{1/2}$ = 30 y	50-500 MBq	3.E-02	30 h
	Ra-226	γ (186) α (4784) $T_{1/2}$ = 1600 y	30-300 MBq	2.E-04	200 d
	Co-60	γ (1173; 1333) β (max.: 318) $T_{1/2}$ = 5.3 y	50-500 MBq	1.E-01	8 h
	Sr-90	β (max.: 196) $T_{1/2}$ = 29 y	50-1500 MBq	0	N/A
	Pd-103	X (20) $T_{1/2}$ = 17 d	50-1500 MBq	0	N/A
Well logging	Cs-137	γ (662) β (max.: 512) e (624) $T_{1/2}$ = 30 y	1-100 GBq	6.E+00	10 s
	Am-241/Be	γ (60) α (5486) neutrons $T_{1/2}$ = 432.2 y	1-800 GBq	2.E+00	20 s
	(Cf-252)	α (6118) X (15) $T_{1/2}$ = 2.6 y	50 GBq	6.E-04	70 d
Level gauge Thickness gauge Conveyor gauge	Cs-137	γ (662) β (max.: 512) e (624) $T_{1/2}$ = 30 y	10 GBq-1TBq	6.0 E +01	1 min
	Co-60	γ (1173; 1333) β (max.: 318) $T_{1/2}$ = 5.3 y	1-10 GBq	3.E+00	20 min
	Am-241	γ (60) α (5486) $T_{1/2}$ = 432.2 y	10-40 GBq	1.E-02	3 d
Moisture/density detector (portable, mobile units)	Am-241/Be	γ (60) α (5486) neutrons $T_{1/2}$ = 432.2 y	0.1-2 GBq	6.E-03	7 d

Practice or application	Radionuclide	Decay energy [keV] half-life	Typical activity	Dose rate at 1m[a,b,c] [mSv/h]	Time at 1m[a,b,c] to exceed 1mSv
	Cs-137	γ (662) β (max.: 512) e (624) $T_{1/2}$ = 30 y	to 400 MBq	2.E-02	2 d
	Ra-226/Be	γ (60) α (5486) neutrons $T_{1/2}$ = 1600 y	~1500 MBq		
	(Cf-252)	α (6118) X (15) $T_{1/2}$ = 2.6 y	3GBq	6.E-04	70 d

Category 3

Practice or application	Radionuclide	Decay energy [keV] half-life	Typical activity	Dose rate at 1m[a,b,c] [mSv/h]	Time at 1m[a,b,c] to exceed 1mSv
Level gauge[d] Density gauge[d]	Cs-137	γ (662) β (max.: 512) e (624) $T_{1/2}$ = 30 y	0.1-20 GBq	1.E+00	50 min
	Co-60	γ (1173; 1333) β (max.: 318) $T_{1/2}$ = 5.3 y	0.1-1 GBq	3.E+00	20 min
Thickness gauge[d]	Kr-85	β (max.: 687) $T_{1/2}$ = 10.8 y	0.1-50 GBq	1.E-02	4 d
	Am-241	γ (60) α (5486) $T_{1/2}$ = 432.2 y	1-10 GBq	1.E-02	3 d
	Sr-90	β (max.: 546) $T_{1/2}$ = 29 y	0.1-4 GBq	0	
	Tl-204	γ (69) β (max.: 763) $T_{1/2}$ = 3.8 y	40 GBq	4.E-03	10 d

Notes:

[a] Gamma dose rates were calculated assuming total loss of shielding and upper value of the activity applies.

[b] Bremsstrahlung radiation was not taken into account.

[c] Times were calculated assuming total loss of shielding.

[d] Practices similar to Category 2; lower activity sources generally used.

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.

Status

The Secretariat, with the help of consultants, has 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:

(a) loss during use or (in the case of mobile sources) in transit,

(b) being abandoned or their control being relinquished,

(c) theft for scrap or illicit trafficking (particularly when sources are inadequately stored).

It was recognized that there may also be a “historical legacy” - 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:

(a) actions to bring sources that are in a vulnerable state (for example, in inadequate storage) under firm control,

(b) programmes for investigating sites where the presence of abandoned sources is suspected,

(c) detection systems at border crossings, scrap yards, and landfill sites or incinerators,

(d) intelligence gathering (for cases of illicit trafficking),

(e) 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 (IAEA-TECDOC) which will define a model national strategy and 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 is also preparing a leaflet containing guidance on the action which should be taken when sources are inadequately stored. The leaflet will be ready for distribution to States before the end of this year.

Various draft documents which touch on the question of national strategies for dealing with orphan sources - documents on regulatory infrastructure, emergency preparedness and response, and combating illicit trafficking in radioactive materials - will be reviewed in order 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.

Status

The Secretariat, with the help of consultants, 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 as defined in the *Categorization of Radiation Sources* contained in the Annex to Attachment 3 to this document. A group of consultants will meet before the end of this year in order to continue the work on the formulation of the criteria.

Action: to develop further national response capabilities for dealing with radiological emergencies.

Status

Technical documents and manuals

In November 1999, a Technical Committee convened by the Secretariat reviewed IAEA-TECDOC-953, "Methods for the development of emergency response preparedness for nuclear or radiological accidents", in the light of experience gained since its publication in 1997.[1] The Secretariat is preparing - for publication later this year - a revised edition which will cover also the detection and location of orphan sources and their subsequent management.

The Secretariat is finalizing a technical document on "Generic procedures for assessment and response during a radiological emergency". The 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 designed 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 later this year on the development of a practical emergency response manual designed to help medical doctors and paramedics deal with radiation injuries.

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[1] IAEA-TECDOC-953 was published in English, Russian and Spanish. Other documents published in recent years for the purpose of helping States to strengthen their nuclear or radiological emergency response capabilities include: IAEA-TECDOC-1092, "Generic procedures for monitoring in a nuclear or radiological emergency" (1999, currently being translated into Russian); Safety Reports Series No. 2, "Diagnosis and treatment of radiation injuries" (1998); and Safety Reports Series No. 4, "Planning the medical response to radiological accidents" (1998).

Training materials (see also Attachment 6)

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

In order 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 will be tested in Europe later this year and 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.

Status

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. For the purpose of considering how to strengthen the Agency's emergency response system and improve the operational arrangements described in the new edition of ENATOM, the Secretariat is convening in June 2001 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 in the near future.

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). Copies of the Plan are to be made available to all Member States of the Agency in due course.

In order 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 Secretariat is reviewing and, where necessary, updating its in-house procedures for the procurement of drugs and the provision of biodosimetry and radiometric services necessary in radiological emergencies, for the technical assessment of emergency situations and for the rapid deployment of emergency response teams.

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.

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.

Status

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*, which will be hosted by the Government of Argentina and take place 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 may 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.

The Announcement of the Conference, with a detailed description of its objectives and format, was sent to Member States early in May 2000. Copies of the Announcement will be made available to Member States' delegations on request.

Regional workshops

The Secretariat is organizing six regional workshops on the safety and security of radiation sources and radioactive materials. 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. They are being financed partly from an extrabudgetary contribution made by the United States of America.

The participants 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* contained in the Annex to Attachment 3 to this document.

The workshops are to be held between November 2000 and June 2001.

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

Status

A Technical Committee convened by the Secretariat 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 Convention on the Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and described in ENATOM. The Technical 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 Technical Committee considers that only sources belonging to the two most hazardous categories of the three-category *Categorization of Radiation Sources* need 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.

Status

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.

Note

The Secretariat collects information about radiological accidents and disseminates it to Member States using several mechanisms, of which RADEV is just one.

Some of the unusual radiation events covered by RADEV may well have been radiological emergencies calling for rapid information exchange or rapid assistance, pursuant to the Convention on the Early Notification of a Nuclear Accident or the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, through the arrangements described in ENATOM.

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 analysing 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 follow-up of accident victims will be handled separately in collaboration with WHO.

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.

Status

The Secretariat, using extrabudgetary funds, 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 in radiation protection and nuclear safety*"[1] and to develop, in a systematic way, syllabuses and training material for specific target groups and specific uses of radiation sources and radioactive materials.

Status

The Secretariat has, in the light of the Basic Safety Standards and of a number of other safety standards developed within the Agency framework, 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 under the symbol IAEA-SYL-01). 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

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[1] In 1992, in resolution GC(XXXVI)/RES/584, the General Conference stressed the special importance of the educational courses referred to in document GC(XXXVI)/1016 and urged the Secretariat "to arrange for such courses to be conducted in appropriate official languages of the Agency". In document GC(XXVI)/1016, which contained a proposal for education and training in radiation protection and nuclear safety, the Secretariat had stated that one of the targets for post-graduate educational courses would be young professionals needing to acquire a sound basis in radiation protection and nuclear safety in order to become trainers in their home countries and that the target audience for training courses would generally include people with broad expertise in radiation protection and nuclear safety who require specialized training in particular areas and professionals and technicians who need to master specific techniques or to upgrade specific skills. The Secretariat is of the view, reflected in document GC(XXXVI)/1016, that training should be specialized and, ideally, be provided only to persons who have attended a post-graduate educational course.

organized, mainly within the framework of the Model Projects 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.

The Secretariat has drafted 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 Basic Safety Standards. It has also drafted 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.[2]

Status

[2] The first **Action** under **Education and Training** was in the Action Plan as approved by the Board. This second **Action** has been added pursuant to paragraph 9 of General Conference resolution GC(43)/RES/13, in which the Conference requested the Secretariat "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 (to be made available 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.

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.

Status

The Secretariat convened 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 which took place on 6 to 10 March 2000. A first draft Code of Conduct was produced at the meeting, which was chaired by Mr. S. McIntosh of Australia and attended by representatives of 16 Member States (Argentina, Australia, Austria, Canada, Cuba, Egypt, Finland, France, Germany, Greece, India, the Republic of Korea, the Russian Federation, Slovakia, Sweden and the United States of America) and observers from the Commission of the European Communities (CEC), the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (NEA/OECD) and the Pan American Health Organization.

A second Open-ended Meeting of Technical and Legal Experts, chaired once more by Mr. S. McIntosh of Australia, took place from 10 to 14 July 2000. The report of the Chairman of the meeting is reproduced below:

1. *The second 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 took place from 10 to 14 July 2000 at the IAEA Headquarters in Vienna under the chairmanship of Mr. S. McIntosh (Australia). The meeting was attended by representatives from 15 Member States (Argentina, Australia, Canada, China, Finland, France, Germany, India, Japan, the Russian Federation, Saudi Arabia, Slovakia, Sweden, the United Kingdom and the United States of America) and observers from the CEC and NEA/OECD. The meeting was opened by Mr Z. Domaratzki, DDG-NS, followed by introductory remarks by Mr A. González, DIR-NSRW.*

2. *During the course of the discussions, a number of proposals were tabled and incorporated in the new draft text. These related in particular to considerations of safety and security at the end of use of a radioactive source, what 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. The Group noted that, according*

to the definition of "regulatory body", such a body need not necessarily possess the legal authority to grant authorizations.

3. *As to the scope, the Group agreed that the Code should apply to radioactive sources defined as "radioactive material that is permanently sealed in a capsule or closely bonded and in a solid form, excluding material within the nuclear fuel cycles of research and power reactors", including "radioactive material released if the source is leaking or broken". While recognising that radiation generators have caused a certain number of accidents, the Group also recognised that most of the accidents with serious consequences were caused by radioactive sources. It therefore felt that the Code should focus on radioactive sources.*

4. *The Group also discussed whether the Code should be addressed to States only or also to manufacturers, suppliers and users of radioactive sources. The Group felt that, 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.*

5. *A proposal was made that States should create comprehensive national registries for radioactive sources under their jurisdiction. However, for various reasons the Group agreed that such a proposal was not practicable at this time. Consequently, a further proposal that the Agency provide the platform for an international registry, at least initially for radioactive sources in Category 1 of the "Categorization of Radiation Sources" reproduced in the Annex to Attachment 3 to IAEA document GOV/2000/36-GC(44)/12, was also felt to be premature. The Group noted that there were other fora, including the Agency's policy-making organs, in which this issue could be further pursued.*

6. *As to the question of import and export of radioactive sources, the Group 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.*

7. *The final draft text of the Code of Conduct is enclosed with this report.*

8. *On procedure, the meeting noted that as part of the Agency's Action Plan, the "Categorization of Radiation Sources" will be submitted to the Board of Governors at the same time as the draft Code of Conduct. Any cross-reference in the Code had therefore been introduced in the draft ad referendum.*

9. Regarding the question as to whether unilateral declarations whereby States would undertake to take the necessary steps to implement the provisions of the Code should be submitted to the Director General, the meeting felt that the Code as such should be an incentive document which may or may not be complemented by binding legal undertakings. The Group 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. It was therefore not in the mandate of the Group to recommend policy or political actions to States. Rather, these decisions should be taken by the Agency's policy-making organs.

10. Finally, the Group, having fulfilled its mandate, recommended that the Chairman's report be transmitted together with the draft text of the Code of Conduct on the Safety and Security of Radioactive Sources to the Director General, with the request that the draft Code be submitted to the Board of Governors for consideration.

The Code of Conduct on the Safety and Security of Radioactive Sources is contained in the Annex to this Attachment.

Code of Conduct on the Safety and Security of Radioactive Sources

The IAEA's Member States

Noting that radiation sources are used throughout the world for a wide variety of beneficial purposes, e.g. in industry, medicine, research, agriculture and education,

Aware that their use involves risks due to radiation exposure,

Aware that these risks must be restricted and protected against through the application of appropriate radiation safety standards,

Aware that there have been a number of accidents with serious, even fatal, consequences during the use of radiation sources,

Recognizing that such accidents may have an adverse impact on individuals and on the environment,

Recognizing the importance of fostering a safety culture in all organizations and among all individuals engaged in the regulatory control or in the management of radiation sources,

Recognizing the need for effective and continuous regulatory control, both within States and in situations involving the transfer of radiation sources between States,

Noting that serious accidents have occurred during the use of radiation sources, in particular radioactive sources, as a result of ineffective, or lapses in the continuity of, regulatory control, or as a result of lapses in management control during extended periods of storage,

Recognizing that most of these accidents have been caused by the use of radioactive sources, including accidents involving orphan sources,

Recognizing that a number of States may lack appropriate infrastructure for the safe management of radioactive sources, and that consequently exporting States should take due care in authorizing exports,

Recognizing the need for technical facilities, including appropriate equipment and qualified staff, to ensure the safe and secure management of radioactive sources,

Noting that the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources contain recommendations for protection against exposure to ionizing radiation and for the safety and security of radioactive sources,

Recalling the IAEA's Safety Requirements document on Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety,

Taking account of the provisions of the Convention on Early Notification of a Nuclear Accident (1986) and of the provisions of the Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency (1986),

Taking account of the provisions of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (1997), in particular those provisions which relate to the transboundary movement of radioactive waste and to the possession, remanufacturing or disposal of disused sealed sources,

Recognizing the global role of the IAEA in the areas of nuclear and radiation safety and the safety of radioactive waste management and disposal, and

Taking account of the "Categorization of Radiation Sources" in the Annex to Attachment 3 to IAEA document GOV/2000/34/GC(44)/7,

DECIDE that the following Code of Conduct should serve as guidance to States for - *inter alia* - the development and harmonization of policies, laws and regulations on the safety and security of radioactive sources.

I. SCOPE AND OBJECTIVE

1. This Code applies to all radioactive sources that may pose a significant risk to health and the environment. In implementing this Code, States should give highest priority to those radioactive sources which pose the most significant risks, i.e. the radioactive sources belonging to Category 1 of the IAEA's "Categorization of Radiation Sources". However, in doing so, States should also devote appropriate attention to the regulation of radioactive sources other than those belonging to Category 1.

2. This Code does not apply to the control of nuclear materials as defined in the Convention on the Physical Protection of Nuclear Materials.

3. This Code also does not apply to radioactive sources within military or defence programmes. However, such sources should be managed in accordance with the principles of this Code.

4. The objective of this Code is to achieve and maintain a high level of safety and security of radioactive sources through the development, harmonization and enforcement of national policies, laws and regulations, and through the fostering of international co-operation. In particular, this Code addresses the establishment of an adequate system of regulatory control from the production of radioactive sources to their final disposal, and a system for the restoration of such control if it has been lost.

5. This Code relies on existing international standards relating to legal and governmental infrastructure for nuclear, radiation, waste and transport safety and to the control of radioactive sources. It is intended to complement existing international standards in these areas.

6. In implementing this Code, States should emphasize and reinforce to manufacturers, suppliers, users and those managing disused sources their responsibilities for the safety and security of radioactive sources.

II. DEFINITIONS

7. For the purposes of this Code:

"authorization" means a permission granted in a document by a regulatory body to a legal person who has submitted an application to manufacture, supply, receive, store, use, transfer, import, export, transport, maintain or dispose of radioactive sources. The authorization can take the form of a registration or a licence.

"disused source" means a radioactive source no longer intended to be used for its original purpose.

"management" means all activities, administrative and operational, that are involved in the manufacture, supply, receipt, storage, use, transfer, import, export, transport, maintenance or disposal of radioactive sources.

"orphan source" means a source which poses sufficient radiological hazard to warrant regulatory control but is not under regulatory control, either because it has never been under regulatory control, or because it has been abandoned, lost, misplaced, stolen or transferred without proper authorization.

"radiation source" means a radiation generator, or a radioactive source or other radioactive material outside the nuclear fuel cycles of research and power reactors.

"radioactive source" means radioactive material that is permanently sealed in a capsule or closely bonded and in a solid form, excluding material within the nuclear fuel cycles of research and power reactors. It also includes any radioactive material released if the source is leaking or broken.

"regulatory body" means any body or bodies on which a State has conferred legal authority to regulate any aspect of the safety and security of radioactive sources, including legal authority to grant authorizations.

"regulatory control" means any form of control applied to facilities or activities by a regulatory body for reasons related to radiation protection or to the safety and security of radioactive sources.

"safety" means measures intended to minimize the likelihood of accidents with radiation sources and, should such an accident occur, to mitigate its consequences.

"security" means measures to prevent unauthorized access to, and loss, theft and unauthorized transfer of, radioactive sources.

III BASIC PRINCIPLES

GENERAL

8. Every State should, in order to protect human health and the environment, take the appropriate steps necessary to ensure that the radioactive sources within its territory, or under its jurisdiction or control, are:
   (a) fit for purpose;
   (b) safely managed during their useful lives and at the end of their useful lives; and
   (c) not stored for extended periods of time in facilities not designed for the purpose of such storage.

9. Every State should establish an effective national legislative and regulatory system of control over the management of radioactive sources and over any other activity involving radioactive sources which entails a significant risk to individuals or the environment. Such a system should:
   (a) place the prime responsibility for the safe management of radioactive sources on the persons being granted the relevant authorizations;
   (b) minimize the likelihood of a loss of control;
   (c) provide for rapid response for the purpose of regaining control over sources that are no longer under control;
   (d) foster ongoing communication between the regulatory body and users; and
   (e) provide for its continual improvement.

10. Every State should ensure that appropriate facilities and services for radiation protection and safety are available to, and used by, the persons who are authorized to manage radioactive sources or undertake any other activity with radioactive sources within its territory. Such facilities and services should include those needed for:
   (a) searching for missing sources and securing found sources;
   (b) intervention in the event of an accident involving a radioactive source;
   (c) personal dosimetry and environmental monitoring; and
   (d) the calibration and intercomparison of radiation monitoring equipment.

11. Every State should ensure that adequate arrangements are in place for the appropriate training of the staff of its regulatory body, its customs officers, its police and the staff of other law enforcement agencies.

12. Every State should encourage bodies or persons likely to encounter orphan sources during the course of their operations to implement appropriate monitoring programmes to detect such sources.

LEGISLATION AND REGULATIONS

13. Every State should establish legislation and regulations that:

(a) prescribe and assign governmental responsibilities for the safety and security of radioactive sources;
(b) provide for the effective control of radioactive sources;
(c) specify the requirements for protection against exposure to ionizing radiation; and
(d) specify the requirements for the safety and security of radioactive sources.

14. Such legislation and regulations should include, in particular:
(a) the establishment of a regulatory body whose regulatory functions are effectively independent of other functions if that body is involved in both the management of radioactive sources and in their regulation. This body should have the powers listed in paragraphs 15 to 17;
(b) measures, commensurate with the risks, to protect individuals and the environment from the deleterious effects of radiation;
(c) administrative requirements relating to:
(i) the authorization of the management of radioactive sources; and
(ii) the notification to the regulatory body, as appropriate, by an authorized person of actions involved in the management of such sources and of any other activity in relation to such sources which may engender a significant risk to individuals or the environment;
(d) provisions for exemption, as appropriate, from these administrative requirements;
(e) managerial requirements, in particular relating to the establishment of adequate policies, procedures and measures for the control of radioactive sources;
(f) security measures to prevent, protect against, and ensure the timely detection of, the theft, loss or unauthorized use or removal of radioactive sources during all stages of management;
(g) requirements relating to the verification of safety, through: safety assessments; monitoring and verification of compliance; and the maintenance of appropriate records; and
(h) the imposition of appropriate penalties;

REGULATORY BODY

15. Every State should ensure that the regulatory body established by its legislation has the authority to:
(a) establish regulations and issue guidance relating to the safety and security of radioactive sources;
(b) require those who intend to use radioactive sources to seek an authorization , and to submit a safety assessment when one is deemed necessary in the light of the risks posed;
(c) obtain any relevant information from an applicant for an authorization;
(d) issue, amend, suspend or revoke, as necessary, authorizations for:
(i) the management of radioactive sources; and
(ii) any other activity involving such sources which may engender a risk to individuals or the environment;
(e) attach clear and unambiguous conditions to the authorizations issued by it, including conditions relating to:
(i) responsibilities;

(ii) minimum operator competencies;
(iii) minimum equipment performance criteria (including radioactive source requirements);
(iv) requirements for emergency procedures and communication links;
(v) work procedures to be followed;
(vi) maintenance of equipment and sources; and
(vii) the adequate management of disused sources, including, where applicable, agreements regarding the possible return of decayed/disused sources to a supplier;

(f) obtain any relevant and necessary information from the holder of an authorization;
(g) enter premises of authorized users to undertake inspections, according to established procedures, to verify compliance with regulatory requirements;
(h) enforce regulatory requirements;
(i) monitor, or request other authorized bodies to monitor, at appropriate checkpoints for the purpose of detecting orphan sources;
(j) ensure that corrective actions are taken when a radioactive source is in an unsafe condition;
(k) provide, on a case-by-case basis, to the holder of an authorization and the public any information that is deemed necessary in order to protect individuals and the environment;
(l) liaise and co-ordinate with other governmental bodies and relevant non-governmental bodies within the State, and also with international bodies and regulatory bodies in other States, in order to seek guidance, information and assistance relevant to the safe and secure management of radioactive sources; and
(m) establish criteria for intervention in emergency situations.

16. Every State should ensure that its regulatory body:
(a) is staffed by qualified personnel; and
(b) has the financial resources and the facilities and equipment necessary to undertake its functions in an effective manner.

17. Every State should ensure that its regulatory body:
(a) establishes procedures for dealing with applications for authorization;
(b) ensures that, before the receipt of a radioactive source is authorized:
(i) arrangements have been made for its safe management once it has become a disused source; and
(ii) financial provision has been made for its safe management once it has become a disused source.
(c) maintains appropriate records of holders of authorizations in respect of radioactive sources, with a clear indication of the type(s) of the radioactive sources that they are authorized to use, and appropriate records of the transfer and disposal of the radioactive sources on termination of the authorization;
(d) establishes systems for ensuring that, where practicable, both radioactive sources belonging to Categories 1 and 2 of the IAEA's "Categorization of Radiation Sources", and their containment, are marked with an appropriate sign to warn

members of the public of the radiation hazard, but where this is not practicable, at least the containment is so marked.

(e) establishes systems for ensuring that, where practicable, radioactive sources belonging to Categories 1 and 2 of the IAEA's "Categorization of Radiation Sources" are identifiable and traceable;
(f) ensures that inventory controls are conducted on a regular basis by the holders of authorizations;
(g) carries out both announced and unannounced inspections at a frequency determined by past performance and the risks presented by the radioactive source;
(h) takes enforcement actions, as appropriate, to ensure compliance with regulatory requirements;
(i) ensures that the regulatory principles and criteria remain adequate and valid and take into account, as applicable, operating experience and internationally endorsed standards and recommendations;
(j) requires the prompt reporting by authorized persons of loss of control over, and of incidents in connection with, radioactive sources;
(k) prescribes appropriate levels of training for manufacturers, suppliers and users of radioactive sources;
(l) requires authorized persons to prepare appropriate emergency plans;
(m) is prepared, or has established provisions, to recover orphan sources and to deal with radiological emergencies and has established appropriate response plans and measures;
(n) is prepared, in respect of any radioactive source whose export it has authorized, to provide, upon request, information relating to its safe management.

IMPORT AND EXPORT OF RADIOACTIVE SOURCES

18. Every State intending to import a radioactive source belonging to Categories 1 and 2 of the IAEA's "Categorization of Radiation Sources" should consent to its import only if the State has the technical and administrative capability needed to manage the source in a manner consistent with the provisions of this Code.

19. A State should allow for re-entry into its territory of disused radioactive sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused radioactive sources.

20. Any State which authorizes the export of a radioactive source should take appropriate steps to ensure that such export is undertaken in a manner consistent with existing international standards relating to the safe transport of radioactive materials.

ROLE OF THE IAEA

21. The IAEA should:

(a) continue to collect and disseminate information on laws, regulations and technical standards relating to the safe and secure management of radioactive sources, develop and establish relevant technical standards and provide for the application

of these standards at the request of any State, inter alia by advising and assisting on all aspects of the safe and secure management of radioactive sources; and

(b) in particular, implement the measures approved by its governing bodies, including pursuant to its Action Plan on the Safety of Radiation Sources and the Security of Radioactive Materials.

DISSEMINATION OF THE CODE

22. 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.