

**GENERAL PROBLEMS ASSOCIATED WITH THE CONTROL AND SAFE  
USE OF RADIATION SOURCES (199)****J.U. Ahmed****International Atomic Energy Agency  
P.O. Box 100, A-1400 Vienna, Austria****ABSTRACT**

There are problems at various levels in ensuring safety in the use of radiation sources. At the user level, the problems seem to derive from inadequate education and training and disregard for, and often violation of, radiation protection standards and procedures. At the national level, in many countries there is inadequate or no regulatory control, and there is a diversity of authorities responsible for the procurement, control and use of radiation sources. At the international level the situation is more complex; the different international organizations concerned operate in co-operation with different national authorities, and there is no standard international mechanism to ensure radiation safety in user countries. Often, foreign companies using industrial radiography import irradiation sources into a country without clearance from the national competent authority. At the level of manufacturer or supplier there is no international agreement defining the obligations, particularly with respect to the supply of sources or dealing with spent sources. A relatively new problem that warrants international action is the smuggling of radioactive material across international borders. An international convention on the control and safe use of radiation sources is essential to provide a universally harmonized mechanism for ensuring safety.

**1. INTRODUCTION**

Concern has been growing about the safety and control of radiation generating machines and radioactive sources in use in medicine, industry, agriculture, research and teaching after a number of serious radiation accidents in recent years. Fatal accidents with radiation sources occurred in Italy in 1975 [1], in Norway in 1982 [2], in Mexico in 1983 [3], in Brazil (Goiânia) in 1987 [4], in El Salvador in 1989 [5], in Israel in 1990 [6], in France in 1991 [7] and in Byelorussia in 1991 [8]. Many minor accidents led to radiation injuries; some are reported but many are not. According to Lushbaugh et al. [9], 296 accidents with sealed sources occurred up to 1988 in which 25,000 people were overexposed leading to 69 deaths. The majority of accidents occur owing to the malfunction of source manipulating devices, inadequate maintenance, human error or the violation of safety procedures.

## 2. NATURE OF THE PROBLEMS

### 2.1. Variety and number of sources

Radiation sources are mainly of three categories, namely radiation generators such as X-ray machines and electron accelerators, sealed radioisotope sources and unsealed radioisotope sources. Nearly one million diagnostic X-ray units are in use around the world. Therapeutic and radiographic X-ray machines are not as numerous as the diagnostic units. Most electron beam accelerators used in medicine operate at between 5 MeV and 25 MeV. Sealed radioisotope sources include teletherapy sources, brachytherapy sources, moisture gauges, industrial radiographic sources, industrial gauges, commercial product irradiators, and consumer products containing radioisotope sources. Unsealed radioisotope sources have a wide variety of types and strengths; these are not covered in this paper.

Some estimates of numbers of sources are given in Table 1. In addition, an estimate of the number of shipments of radioactive sources in 20 countries shows a total of well over 10 million per year. With increasing use of radiation sources the number of national and international shipments of radioactive material will continue to increase.

TABLE 1. SOME DATA ON RADIATION SOURCES USED WORLDWIDE

Source	Number	Average Source Strengths
Teletherapy sources	3000	Co-60 220 TBq Cs-137 40 TBq
Brachytherapy sources	about 120,000	20 MBq - 4 GBq
Radiography units	50000	Ir-192 4-11 TBq Co-60 1.5 TBq
Commercial product irradiators	about 180	Co-60 40,000 TBq Cs-137 400,000 TBq
Industrial gauges	500,000	---
Electron beam accelerators in medicine	over 600	Usual energy range - 5-25 MeV

### 2.2. Problems at the user level

Large radiation facilities have, in general, radiation protection specialists and organized radiation protection services; small facilities do not. Smaller users are specialists in their own fields but are not well trained in, and lack the qualification

and experience necessary to exercise sound judgement on, radiation protection. Owing to the lack of understanding of radiation protection on the part of the user in hospitals and private clinics, in particular, many people, either patients or accompanying persons, receive radiation exposures unnecessarily. In the accident [4] in Goiânia, Brazil, a radiotherapist abandoned a Cs-137 teletherapy source in old premises whence it was taken and broken up. The accident in Mexico [3] happened when a radiotherapist left his job and left a Co-60 teletherapy source in no one's care. Examples of such irresponsibility are many. In the industrial use of radiation sources, the companies in many cases employ unskilled workers who have little knowledge of radiation, its biological effects and radiation protection. Small users generally think or represent that they know about radiation protection; however, they frequently lack regard for safety. Human errors or violations of safety procedures by the users are often factors contributing to accidents.

### 2.3. Problems at the national level

At the national level sealed radiation sources are not generally procured through one single national authority. Countries which do not have national infrastructures for radiation protection lack the mechanisms to require licensing and registration of sources. Generally, medical and industrial irradiation sources are procured through the administrative channels of the Ministry of Health and the Ministry of Industry respectively. Some medical users import sources directly from the supplier or the manufacturer. Sources are procured through agricultural authorities and educational authorities for applications in their respective areas. There are also cases where foreign companies bring in industrial radiography sources directly to a country without permission.

National authorities in many developing countries, except the national atomic energy organization and, in some cases, health authorities, do not usually have radiation protection services, or any system of inspection and compliance assurance. The atomic energy organization may have no knowledge of many sources or their locations of use. This is mainly due to the lack of a national infrastructure for radiation protection.

The IAEA Radiation Protection Advisory Team (RAPAT) reviews carried out so far in more than 60 Member States have revealed that 38 Member States have no radiation protection legislation and 50 Member States do not have adequate radiation protection standards and/or infrastructures. Many problems and irregularities were identified, such as: source imported a long time ago but no documentation available; lack of regulations; sources not registered; users not licensed; no specified system to deal with damaged sources or storage or disposal of spent sources; no one responsible for decommissioning; no designated authority

to be informed in the event of an accident; many sources lost; many imported sources left uncontrolled in the country; sources delivered but not licensed; supplier companies defunct; the legal responsibility of the foreign operator to ensure safety measures not discharged; local radiation workers often without personal dosimeters and with inadequate training.

#### 2.4. Problems at the international level

The IAEA is concerned in one way or another with any radiation accident. Also, the IAEA is often contacted for assistance in the event of radiation incidents. In principle, the Agency, being the only international organization charged with a mandate relating to nuclear and radiation safety, should have a clear, definite and effective role to play in the area of safety and radiation protection in all areas of use of radiation sources. Unfortunately, in practice this is not the case, since the IAEA generally operates through the national atomic energy organizations in its Member States and not through other governmental bodies. The World Health Organization (WHO) operates through the Ministries of Health in its Member States, the International Labour Organization (ILO) through the Ministries of Industry, the Food and Agriculture Organization of the United Nations (FAO) through the Ministries of Agriculture and UNESCO through the Ministries of Education. But WHO, ILO, FAO and UNESCO only have limited programmes on radiation protection in their respective disciplines. Another aspect of the problem is the fact that there are many countries which are Member States of WHO, ILO, FAO and UNESCO but not of the IAEA. Therefore, although IAEA has been playing an important role in providing guidance on radiation protection (10), from the global perspective, it has achieved only a partial success.

The IAEA has been a significant procurer of industrial, medical and educational irradiation sources, about 550 since 1957, under Technical Co-operation assistance agreements with its Member States. During the past 12 years the Agency has supplied to developing Member States 38 industrial irradiators, 14 radiotherapy sources and 26 sealed sources for industrial applications. Until recently, the Agency supplied radiation sources to developing country Member States without ensuring first that such countries had adequate radiation protection infrastructures. This practice has now been stopped and no radiation source will be supplied to a country until it has established an adequate radiation protection infrastructure.

#### 2.5. Problems relating to the supply of sources

During production, the manufacturer looks into the radiation protection aspects of the design, manufacture, shielding and integrity of radiation sources. For shipments of radioactive packages, IAEA Regulations for the Safe Transport of

Radioactive Material generally apply. However, there are gaps in ensuring the safety of sources between the supplier and the user. The manufacturer and the supplier are in many cases not the same body. Sources are supplied by suppliers of scientific equipment, individuals or donor countries, institutions in developed countries donating used sources to developing countries, or by international organizations. Between many suppliers and individual users, regulatory requirements for safety are not met owing to the lack of a national regulatory infrastructure. An international mechanism is essential to prevent the supply of radiation sources to the user until appropriate regulatory control and operational radiation protection are ensured. Also, under the same mechanism a supplier should be required to obtain authorization from the user country or from the national competent authority either to supply radiation sources within the country or to export to other countries. Some countries have such regulatory requirements, but many do not.

## 2.6. Smuggling of radiation sources

Transboundary smuggling of radiation sources and radioactive materials has arisen as a problem recently, particularly in Europe. In a meeting held at the IAEA Headquarters recently, most of the 13 Republics of the former USSR that sent delegates to the meeting reported attempts to smuggle radioactive material to western Europe. Some sources being smuggled through international borders are intercepted and recovered but many pass undetected. This is a new problem of international dimension and requires international attention.

## 2.7. Problems with radiation sources no longer in use (spent sources)

The use of sealed radiation sources, particularly in medicine, dates back to the beginning of the century. With time, other uses of sealed sources were found *in industry, agriculture, research and teaching*. Many sources, for a variety of reasons, are no longer needed and the stock of spent sources continues to grow in every country. The number of spent radiation sources in developed countries is estimated to be more than 100,000 and in developing countries close to 30,000. In the absence of national regulations for storage or disposal, particularly in developing countries, the stock of spent sources is likely to pose problems of physical security, and the chances of such sources falling into unauthorized hands may be high. Sealed radiation sources are small and can be easily misplaced, lost or stolen, thus posing a threat to human health and the environment. One possibility may be to oblige the suppliers to take the spent sources back; however, no international mechanism has so far been developed for this. The IAEA has recently taken up an activity to develop guidance on how to manage and dispose of spent sources, but this falls short of offering a practical international system.

## 2.8. Insufficient authority given to radiation safety personnel

It is a common experience in almost all Member States that the radiation safety specialists occupy a low rung on the administrative ladder. At the facility level they may have direct access to the management, but at the national level they have little or no authority. Therefore, their voices are not heard with respect to regulations or practical safety. However, when an accident happens, governmental authorities demand a lot of them. Safety personnel should have more authority at the national level to help achieve effectiveness in the national control of radiation sources.

## 3. NEED FOR AN INTERNATIONAL CONVENTION

The problems with the use of radiation sources, both national and international, are diverse and quite severe. To resolve them is not a task of only one national organization or one international authority. The solutions should be sought through an international convention, bringing in all parties concerned to define the role and responsibility of each individual party. All countries should be involved because radiation sources are used in all countries. To ensure effective global controls it is also necessary to define the roles and obligations of the suppliers of sources. At the national level the commitments to the convention should be at a high level to prevent the effectiveness being jeopardized by competition between the various national authorities. At the international level all concerned organizations, whether within the UN system or not, should become party to the Convention.

### References

- [1 to 8] May be requested from Radiation Safety Section, IAEA, P.O. Box 100, A-1400 Vienna.
- [9] LUSHBAUGH, C.C., et al., in Radiological Accidents: A Historical Review of Sealed Sources Accidents (Proc. IAEA Conf. on Radiation Protection in Nuclear Energy, Sydney, 1988) (1988).
- [10] AHMED, J.U., The Role of the IAEA on the Control and Safe Use of Radiation Sources, Proc. of IRPA 8, 1992, Vol.II, pp. 1464-1467.  
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