Chapter 14 Risks from radiation sources

In normal everyday use, radiation sources and technologies are used by professionals in well managed, properly regulated institutions. As described previously, radiation sources can be generating devices, such as X ray machines or particle accelerators used in medicine. The sources can also be radioactive materials sealed in a secure capsule or housing. Some sources, particularly those used in nuclear medicine and research are radioactive materials in an unsealed form. Problems can arise if radiation sources are involved in accidents, and if they become damaged or lost.

Accidents involving radiation sources

Radiation sources are widely used in industry and accidents can occur either as a result of poor management or sometimes because of bad judgement.

A large number of accidents involving radiation sources and radioactive materials have been reported over the past half century. People have died from causes attributed to excessive radiation exposure, and many more have suffered serious, sometimes disabling injuries. In some cases, the associated environmental damage has been notable, and restoration financially costly. A common denominator of the major accidents is a breach of safety or security requirements. Another common thread is that for the most part they could have been prevented through the enforcement of international safety standards that were developed and issued for that purpose.

Blistering of the right hand following radiation injury

Between 1945 and 1999 there were some 140 serious reported accidents involving excessive radiation exposure in the nuclear industry, military facilities, hospitals, research facilities, and general industry. The most frequent occurrence (about 70 in total) is the mishandling or misappropriation of sealed sources used for radiography in industry and radiotherapy in hospitals. Some of the most serious health consequences have been caused by therapy sources being taken from discarded hospital equipment by people who did not appreciate the acute radiation hazard that could result. Unfortunately, there are also cases of unintentional overexposures of patients from radioactive sources in medicine, usually caused by human error or inappropriate calibration procedures.

The following table gives information on the most serious accidents that resulted in fatalities reported between 1987 and 2001.

Recent Fatal Radiation Accidents (1987–2001)[a]

Year	Location	Type of Source	Deaths caused by radiation exposure		
			Workers	Public	Patients
1987	Goiânа, Brazil	Removed teletherapy source		4	
1989	San Salvador, El Salvador	Industrial sterilizer	1		
1990	Zaragoza, Spain	Radiotherapy accelerator			several[b]
1990	Soreq, Israel	Industrial sterilizer	1		
1991	Nesvizh, Belarus	Industrial sterilizer	1		
1992	China	Lost cobalt-60 source		3	
1992	USA	Brachytherapy			1
1994	Tammiku, Estonia	Source removed from waste repository		1	
1996	San José, Costa Rica	Radiotherapy			several[b]
1997	Sarov, Russian Federation	Critical assembly	1		
1999	Tokaimura, Japan	Criticality accident	2		
2000	Thailand	Lost cobalt-60 source		3	
2000	Egypt	Lost and found iridium-192 source		2	
2001	Panama	Radiotherapy overexposures			several[b]

Notes:

[a] In nuclear facilities and non-nuclear industry, research and medicine

[b] The individuals affected in these cases were patients receiving radiotherapy for cancer, and therefore the number of deaths attributable to overexposure is not known.

The numbers of patients overexposed were 26 (Zaragoza), 115 (San José) and 28 (Panama).

In each case, overexposure is considered likely to have been a direct or major cause of several deaths.

Lost sources causing contamination incidents

Many sources are sealed devices, with the radioactive material firmly contained or bound within a suitable capsule or housing; others consist of radioactive materials in an unsealed form. Sealed radioactive sources should only present a risk of exposure to external radiation. However, damaged or leaking sealed sources, as well as unsealed radioactive materials, may lead to radioactive contamination of the environment and the intake of radioactive substances into the human body.

Melting of disused radioactive sources accidentally sent with scrap metal for recycling is of particular concern. The table below gives an assessment of the major contamination incidents that have involved sources appearing in the recycled metal industry.

Major contamination incidents involving lost sources

Type of source mislaid	*Number of reported incidents worldwide (1983–1998)*	*Recycled metal industry involved*
Cobalt-60	*15*	*Steel (14), Copper*
Caesium-137	*30*	*Steel (27), Aluminium (2), Lead*
Iridium-192	*1*	*Steel*
Radium-226	*3*	*Aluminium (2), Steel*
Thorium-232	*3*	*Aluminium (2), Steel*
Americium-241	*3*	*Aluminium, Copper, Gold*
Others	*4*	*Aluminium, Copper, Zinc, Lead*
Total	***59***	

Each of these incidents had a significant economic impact on the industry involved, and some also led to environmental and health consequences. In addition to those listed, there are many more cases of lost sources being discovered by radiation monitoring equipment installed by the metal recycling industry. The installation of radiation detectors at recycling facilities is becoming common practice in many countries, and, therefore, the number of serious contamination incidents is expected to decrease.

Radioactive Dispersal Devices

Although some of the events described above involved the theft of sources by people who didn't realize the risk, deliberate attempts to use radioactive sources as a terrorist weapon are extremely rare. Since the 11th September, 2001 terrorist attacks in the USA, there has been much speculation about the possibility of terrorists making a radioactive dispersal device or 'dirty bomb' using conventional explosives and a stolen radioactive source. Such a bomb could not cause a nuclear explosion, but could disperse radioactive material over an area up to a square kilometre or so. While this might, like the accidents described previously, cause a small number of local casualties, the overall radiation effects would be limited. The wider the material is dispersed, the more diluted it will be and the lower the doses are that people could receive. Nevertheless, severe social disruption could arise. The construction of such a device would be likely to entail dangerously high radiation doses to the terrorists, but would be possible if they were able to obtain a source and were not concerned for their own safety. This possibility reinforces the need for effective measures to ensure that radioactive sources are kept securely under control until they are disposed of permanently.