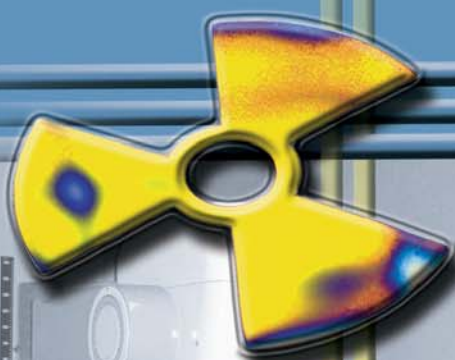




IAEA

International Atomic Energy Agency

Reducing Risks from Sources in Medical Uses



Sealed
Radioactive
Sources

Introduction

In November 2000, a worker set off a radiation detector on his way into work at a French nuclear power plant. Fearing that the worker might have somehow been contaminated at the plant, a thorough check for contamination was made. The results sparked concern not just in France, but also around the world. The worker himself was not contaminated, but parts of the metal bracelet of his watch were found to be radioactive. Further analysis revealed that the steel pins in the bracelet were contaminated with traces of cobalt-60, a radioactive form of cobalt.

The watches had been imported from Hong Kong, where they had been assembled. The source of the contamination was later traced to a small plant in China that had provided the steel for the bracelet pins. It is thought that a teletherapy head, a device used in radiation treatment of cancer patients, had been inadvertently melted down as scrap at this plant. In France, the watches were sold through a large multinational, department store, raising fears that the watches could also have been on sale in Europe, Asia, and South America. Fortunately, an investigation by nuclear regulatory authorities around the globe did not find any similar watches in distribution. But had one contaminated watch not been detected at a French nuclear plant, many people might have been exposed to low doses of radiation. The one hundred kilograms of steel found at the plant in China might never have been discovered and could have been used to make other consumer products.

Sealed radioactive sources are used widely in medicine, industry, and agriculture. When used as designed, these sources have far-reaching benefits. When these sources are lost or make their way into untrained hands, the consequences can be equally far-reaching, and unfortunately even deadly. How can loss, theft or accidents be

prevented? How can contaminated materials be detected before they make their way into consumer or other products?

In most countries, radioactive materials and activities that produce radiation are regulated. Those working with sealed radioactive sources are required not just to have proper authorization, but also the needed training and support to deal with unexpected circumstances that may arise when a source is used. Despite these measures, accidents continue to occur. Serious or life threatening injuries from overexposure to radiation have been reported to the International Atomic Energy Agency (IAEA).

Among its many activities to improve the safety of sealed sources, the IAEA has been investigating the root causes of major accidents since the 1980's and publishes findings so that others can learn from them. There are growing concerns today about the possibility that an insecurely stored source could be stolen and used as a radioactive dispersal device. To improve both safety and security, information needs to be in the hands of those whose actions and decisions can prevent a source from being lost in the first place.

It is hoped that this booklet will provide those using sources in medical settings with this information and, thereby, reduce accidents and injuries from and improve security of sealed radioactive sources.

Lessons to be learned

The following are but a few of the accidents that have occurred in the last 20 years, where lapses in good practice, human error, or lack of knowledge have resulted in serious injuries and deaths. A review of the root causes of these accidents reveals a worrying similarity.

Severe radiation accident in Turkey. In 1993 in Ankara, Turkey, three disused cobalt-60 teletherapy sources were packaged for re-export to the United States. The sources were not exported immediately, but were stored without the permission of the regulatory authority at the company's premises. Over time, two of these packages were taken to Istanbul and eventually transferred to empty premises that were not secure. In November 1998, these premises were sold, and the new owners sold the packages as scrap metal to two brothers. By December 1998, the brothers had taken the packages to the family home and over a period of a few days began dismantling the protective containers, until they and others became ill with nausea and vomiting. At some point, pieces of the dismantled containers and at least one unshielded source were apparently left in a residential area before being taken to a local scrapyard. By the time doctors suspected exposure to radiation, and not food poisoning, was the cause of the illnesses, a total of 18 persons were admitted to hospital. Ten of these persons had symptoms of severe radiation syndrome. Five of these had to be hospitalized for 45 days. Authorities recovered one source at the scrapyard before it was melted down. The second source, reported to be in one of the packages, has not been recovered to this day.

Inadequate security over the sources and inadequate periodic inventory checks of the waste packages were the main contributing factors that allowed the unauthorized sale to take place. Lack

Damaged teletherapy heads (IAEA).



of recognition of the trefoil symbol on the source by those trying to dismantle the source was also an important factor in the number of persons affected by this accident. Improper waste management of the sources once they become disused was the root cause of the problem.

Multiple deaths in Thailand. In February 2000, a serious accident in Samut Prakarn, Thailand resulted in death, injury, and widespread concern. A disused cobalt-60 teletherapy source was being stored, apparently without knowledge or permission of the regulatory authority, in insecure outdoor premises normally used for storing new cars. Two local scrap collectors allegedly bought some scrap including the source and took it home to dismantle and resell. They later took the partially dismantled teletherapy head to a junkyard where an employee cut open the protective shielding with an oxyacetylene torch. Those who had been nearby when the protective shielding was cut began to experience nausea and vomiting. Those who had touched some parts of the exposed metal began to suffer burn-like injuries. The symptoms worsened over a period of days. It was not until about 10 days later that some began to seek medical treatment for their symptoms. By the time medical authorities reported their suspicions about a radiation accident, approximately 17 days had passed. This accident resulted in radiation injuries to 10 people of whom three died within the first two months despite medical treatment. Approximately 1870 individuals living within 100 metres of the junkyard were exposed, with many seeking medical attention. The Ministry of Health is monitoring about 258 of these individuals who live within 50 metres of the junkyard for long term health effects from the accident.

Investigation revealed that the root cause of the accident was the failure of the party responsible for the disused source to keep it securely stored.

However, as in previous examples, had those who acquired the teletherapy head recognized the radiation symbol (trefoil), they might not have tried to dismantle it and would have not been exposed to radiation.

Common medical uses of sealed radioactive sources



The sealed sources used in medical applications are usually very powerful. Therefore, they have the potential to cause serious and life threatening injuries.

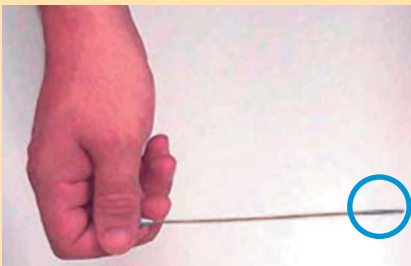
Sealed radioactive sources are used in several medical applications for diagnosis and treatment of diseases. One of the most common uses is teletherapy, which delivers precise doses of radiation to a well-defined area of the body. Teletherapy commonly uses cobalt-60 as the source of radiation, although some older equipment may use caesium-137. Teletherapy equipment can be used safely and effectively to kill tumours, but to do so, it must be properly installed, calibrated, and maintained and should only be used by skilled personnel under the supervision of a radiation oncologist. The sources

Teletherapy Unit — 500 TBq cobalt-60 (IAEA).



may also need to be changed regularly. A source change can **only** be done by a licensed source supplier. The preferred option to further manage disused sources is to return the source to the supplier. If this is not possible, disused sources should be transferred to an authorized waste management organization for storage and for disposal.

Another common medical use of sealed radioactive sources is brachytherapy. Unlike teletherapy, in brachytherapy the radioactive source is in direct contact with the patient, inserted into a tumour either directly by a surgical team or remotely using special equipment. In order to reduce exposure risks both to patients and the medical staff, remote loading is much more frequently used. In addition to routine measures to reduce exposure risks to both patients and healthcare workers, because brachytherapy sources are implanted, care must be taken to ensure that no source is left implanted following treatment. Depending on the manufacturers specifications, some brachytherapy sources need to be replaced every 10 to 15 years. This necessitates not just appropriate procedures for radiation protection during replacement and transfer, but also appropriate procedures and facilities to dispose of all disused brachytherapy sources permanently.



An example of brachytherapy is a radium applicator once used for insertion into patient's nasal passageways to shrink the lymphoid tissues. The small monel metal capsule on the right end of the applicator would contain approximately 1.8 GBq (50 millicuries) of radium-226.

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Preventing loss and theft of sources

While proper training and experience will reduce the risk of radiation exposure when sealed radioactive sources are used, the vast majority of serious accidents are due to a source that has been lost or stolen. Good operational practices and procedures can reduce such accidents by preventing a source from becoming lost or stolen in the first place.

- Maintain proper records of all radiation sources, including isotope, activity, manufacturer, and the name of person responsible.
- Establish an effective accounting system for all sources including: a periodic physical inventory of stock to confirm location of sources, a regular check of all sources stored in containers, and a movement log to track sources when taken out of storage, in use, or returned.
- Maintain and service equipment regularly as recommended by the manufacturer.
- Secure all sources to prevent theft.

Brachytherapy

- Keep a shielded container in the treatment area during use to house the source safely should it accidentally be removed from the patient.
- Use care when using a source in an applicator to ensure that it is securely closed or covered.
- Suture radioactive needles in the patient to prevent them working loose.
- Ensure that the number of sources removed from the patient equal the number inserted.
- Monitor for radiation with a dose rate survey meter after completion of therapy to ensure that no source remains in the patient, treatment area, or ward.
- If sources are unaccounted for, monitor dressing and excreta from patient for radioactive sources **before disposal**.
- If a source still cannot be accounted for, monitor all containers (soiled dressing bins, laundry baskets, etc.) coming from the treatment ward for radioactivity. If necessary, monitor likely routes from treatment room to laundry or waste collection areas or other likely areas for signs of radioactivity.
- Return sources to stores as soon as possible after use, using a shielded container for transport.

Emergency Planning

All users of sealed radioactive sources should have a contingency plan in place for emergencies, such as a damaged, lost, or stolen source. The plan should detail who is responsible, who must be contacted, and how to get outside assistance to deal with the emergency.

Waste Management

A disused sealed radioactive source is an accident waiting to happen, if it is not stored securely, conditioned, or disposed of properly. When a source no longer has a useful purpose, it should be disposed of permanently if feasible. Keeping old sources just in case (for such uses as back-up to a current source, etc.) is not a good practice. They often are forgotten, not given proper leakage tests, and may eventually be lost or stolen. Sources that are no longer in use should be transferred to the national radioactive waste processing facility (waste operator).

Interim storage may be acceptable: if the facility is secure to prevent loss or theft; the source is properly conditioned so as to improve its shielding and stability; and proper records and periodic physical check of the sources in interim storage are made. Secure interim storage may not be feasible in a hospital or other medical facility, however. Given the possibility for such a source to be stolen, good security must be assured.

When a source no longer has any use, the regulatory authority should be notified and arrangements made for its disposition, either by:

- return of the source to the manufacturer for disposal when feasible; or
- disposal of the source at a licensed waste disposal facility.

Where neither of these is possible:

The source should be conditioned and stored securely at an interim waste processing and storage facility that is licensed by the regulatory authority.

Even though the disused source is housed in a teletherapy head, it will require conditioning for safe management. It is recommended that disused teletherapy sources be returned to the manufacturer or sent to a licensed waste processing facility.

Records for all disused sources should indicate the manner in which they were managed. These records should be maintained as required by the responsible regulatory authority and according to the technical procedures of the waste operator.

In Conclusion

The most effective means to prevent accidents with sealed radioactive sources is to adopt work habits that reduce the likelihood of a source becoming lost or stolen. The onus is on those professionals using sources to take the necessary steps to protect the public, the environment, and themselves from the serious consequences of an accident, each and every time they work with a radioactive source. Sources no longer in use should be transferred to a waste operator as soon as possible.



Cover photo: Teletherapy machine in operation with a patient/
V. Friedrich, Radiation and Transport Safety Section (IAEA).

For more information about sealed radioactive sources or radiation in general, contact your local regulatory authority. Information is also available on the International Atomic Energy Agency's website <http://www.iaea.org>

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