Radioactive Scrap Metals

A Vital Environmental Issue for Metal Industry

- Metalworld Research Team

Introduction

What Are These Radioactive Scrap Metals?

Studies show that long-term exposure to low levels of radiation can be more hazardous than short term exposure to high levels, resulting in a six to eight times greater cancer risk. Think about the metal you come into contact with every day. Your bracelets, your silverware, the zipper on your crotch, the coins in your pocket, frying pans, belt buckles, that chair you're sitting on, the batteries that are in your car and motorbike, the batteries in your computer etc. Radioactive scrap metal can be defined as comprising "radioactively contaminated scrap metal, activated scrap metal and scrap metal with radioactive source(s) or substances contained within it. It may include both radioactive substances that are subject to regulatory control and radioactive substances that are outside regulatory control"(1). To understand in simple words Radioactive scrap metals are formed when radioactive material enters the metal recycling process known as the scrap metal trade. Due to unfortunate past events recoverers and recyclers of scrap metal including steel mills and foundries want to prevent the entry of any radioactive source which could lead to possible melting of such sources, decontamination and disposal work and costs, that has sometimes required the temporary shut down of the plant. They also want to avoid transfer of such radioactive products to their clients. Waste management sites also want to keep away radioactive material from coming in.

Two management alternatives for radioactive scrap metal were evaluated: (1) recycling and reuse, and (2) disposal and replacement. The human health risks, environmental impacts, and sociopolitical issues potentially associated with these alternatives were assessed in an international context. For each alternative, the health risks from workplace and transportation accidents are greater in magnitude than the risks from potential exposure to radioactive materials or chemicals. The nonradiological risks are at least twice as high for disposal and replacement as they are for recycling, with the result that recycling has lower health risks overall. Environmental impacts from disposal and replacement of scrap metals are likely to be orders of magnitude higher than those for recycling. This is true of effects on land, water, and air quality, as well as for mineral and energy resources. In addition to risks and costs, issues affecting the choice between radioactive scrap metal management alternatives include low-level waste disposal site availability, public acceptability of recycling, potential impacts on metal markets, impacts of radioactivity on sensitive industrial uses of metal, and international equity issues.

How Do These Radioactive Sources Come in Contact of Scrap Metal?

Sometimes radiation sources are disposed of improperly and end up in scrap metal yards. With the help of advanced technology, ways are made to locate misplaced radiation sources before they get into scrap metal yards and enter the nation's metal supply consumer products. Some sources of radioactive materials lack adequate control, sufficient accountability, and proper disposal processes. Many radioactive sources found by recoverers and recyclers originally come from nuclear installations (fission and activation products) as well as from industrial and research irradiator activities, teletherapy, industrial radiography, medical brachytherapy, humidity gauges and density gauges, industrial gamma gauges and various beta gauging, and well logging. One can also find pipes contaminated with uranium and thorium and from the potash industries. There can be other radioactive sources from these fields and elsewhere. Radioactive sources found in the recovering and recycling metals business usually have very long half-lives and energies.

The origin of such radioactive sources is very often unknown and there seems to have been a significant increase in the number of uncontrolled (orphan) radioactive sources in a number of countries. Until the 1950s, only radionuclides of natural origin, particularly radium-226, were generally available for sources. Since then, radionuclides produced artificially in nuclear facilities and accelerators have become widely available, including cobalt-60, strontium-90, caesium-137 and iridium-192. The IAEA has categorized radioactive sources, to identify those types that require particular attention for safety and security reasons. Most significant are certain industrial and medical radioactive sources - typically cobalt-60, caesium-137, strontium-90, and iridium-192 - that emit high levels of radiation. When safely used and regulated, the social and economic benefits from the many applications of radioactive sources are high, in the billions of dollars worldwide each year.

Found or abandoned sources are described as "orphan" when their identifying marks have been removed or damaged. Some industrial devices contain a small quantity of safely enclosed radioactive material called a "sealed "source. On the other hand, if this equipment is disposed of improperly or sent for recycling as scrap metal, the sealed source accidentally may be placed in the possession of someone who is not licensed to handle it. For instance, if a steel mill melts a sealed source containing radioactive material, it contaminates the metal, the processing equipment, and the facility. More importantly, the mill workers will be exposed to the radiation. So the government has become more concerned with this issue as increased radiation monitoring has uncovered a growing number of these orphan sources.

Orphan and Sealed Sources

Radioactive sources that are outside of regulatory control are called "orphan sources" for short. They may never have been subject to regulation, or they may have been regulated initially but then were abandoned, lost, misplaced, stolen, or removed without authorization. Some sources may not be formally "orphaned" but their control may be weak and therefore vulnerable to being mishandled or lost. Through its efforts to help countries improve their national infrastructures for radiation safety and security, the IAEA has found that more than 100 countries (not all of them IAEA Member States) may have inadequate control and monitoring programmes necessary to prevent or even detect the theft of radiation sources. Half of these countries with urgent needs - 52 in Africa, Asia, Latin America, and Europe - are making progress through an IAEA project to strengthen their capabilities to control and regulate radioactive sources.

Sealed radioactive sources are used widely in medicine, industry, and agriculture — by doctors to treat cancer, by radiographers to check welds in pipelines, or by specialists to irradiate food to prevent it from spoiling, for example. The radioactive substance within the source is sealed within a protective container. Radioactive substances emit energetic particles or waves. Professionals who work routinely with radioactive sources are able to do so safely because of their skill and training and because they are knowledgeable about the safety features and design of the equipment they are using. When these sources are lost or stolen, however, they can fall into the hands of persons who do not have such training and knowledge. In such circumstances, radioactive sources may be a serious risk to anyone who comes too close to them, touches them, or picks them up, particularly if they are damaged. Serious injuries from sealed radioactive sources have occurred in the past when a radioactive source is found and the person handling the source is not aware of the risk. For instance, In Thailand in February 2000, two scrap collectors obtained a radioactive source, and unaware of the risk, tried to take it apart. As a result, ten people were seriously injured, three of whom died. Many hundreds more living in the area of the scrap yard sought medical advice.

How Many Radioactive Sources Are There Worldwide?

Millions of radioactive sources have been distributed worldwide over the past 50 years, with hundreds of thousands currently being used, stored, and produced. Worldwide, the IAEA has reported on specific applications: more than 10,000 radiotherapy units for medical care are in use; about 12,000 industrial sources for radiography are supplied annually; and about 300 irradiator facilities containing radioactive sources for industrial applications are in operation.

When are radioactive sources hazardous?

In normal and regulated use, radioactive sources pose no undue radiological hazard to workers or the public.

Problems can arise if radiation sources are involved in accidents, and if they become damaged or lost. Some of these sources contain large amounts of radioactive material and have the potential to cause serious radiological harm if they were involved in accidents or used in malicious acts.

Identification of radioactive source

Radioactive sources can be detected and their movement monitored. The effective detection range depends on the amount and type of radiation emitted by the source and also on the possible presence of shielding materials that may reduce the amount of radiation that reaches the detector. There are certain ways to identify and localize a radioactive source (2). Many containers having a radioactive source can be identified visually because of their known shape, size, labels and writings. They can be as small as the tip of a match or needle or as large as paint can. High activity sources are inside a lead or other heavy material container, which acts as a protective shield. Heavy materials block radiation, making sealed radioactive source containers typically heavy.

Fortunately, the most intense and dangerous sources normally are the most susceptible to detection. Several types of advanced instruments already are in use for detecting radioactive materials. More advanced systems are under development that will be more sensitive, easier to use, or more capable of identifying exactly what kind of radioactive materials are present.

Advanced detectors currently in use include:

A)Portable Detectors : Instruments using an inorganic or a plastic scintillator as detector are being used and developed. They may include a multi-channel analyser for gamma spectroscopy to identify radioactive materials emitting gamma rays.

B) Fixed Detectors : These types of monitors are designed for border control points, airports, and other ports of entry. They typically include alarms and display instrumentation and are automated to enable screening of people, luggage, or vehicles. In addition to a capability to detect gamma radiation, many are equipped with neutron detectors that can help in detection of plutonium.

Certain detected radioactive sources can also be identified visually such as a one meter rod of radium previously used as an anti-electrostatic bar in lithography. Acquired experience and use of photographs can help in identifying radioactive sources with or without its shielding component. If the source and/or the detected radioactive gauge is carefully removed by vehicle unloading over a non porous surface, and the load searched for, under controlled conditions, it becomes easier to identify the source. The ideal way is certainly by means of a portable gamma spectrometer, especially if it has been programmed to analyze the emitted radiation and identify the corresponding radionuclides. The results of spectrometry, dose rate and accumulated dose over a given period of time can be displayed on the LCD screen and put in the memory for future retrieval on the display or sent to a PC.

The 6 photographs of the figure 1 shown below are one old teletherapy unit, a gauge, one portable and two mobile industrial radiography cameras, and transport containers, all of which might contain radioactive sources, when recovered and recycled.

Fig 1

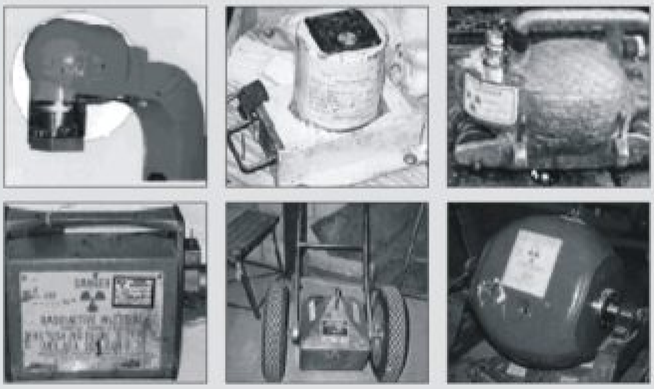

Fig 2

The two photographs in fig 2 represent a typical stationary radiation detection system and a gamma spectrometer to identify radioactive sources and do other functions needed. The last photograph of the figure shows the Exploranium GR-130 which can do the above functions and others at different locations and be stored and retrieved later on the meter or on a PC.

Concerning the quantity of radioactive material in MBq of an identified source, it can be obtained simply by combining the measured dose rate at one meter away from source, and the photonic specific emission rate as published for the identified radionuclide. If the source is inside a nuclear device, the results calculated will significantly underestimate the actual quantity in MBq because of shielding.

Orphaned Sources - Major Safety Concern

The risk of accidents is the other major concern, besides terrorism, that can derive from sources that are "orphaned". Orphaned sources include sources that were never subject to regulatory control; sources that were

subject to regulatory control but since have been abandoned, lost or misplaced; and sources that were stolen or removed without proper authorization. Exactly how many orphaned sources there are in the world is not known, but the numbers are thought to be in the thousands. Sealed sources or their containers can be attractive to scavengers for the scrap metal trade because they appear to be made of valuable metals and may not display a radiation warning label. Cases where unsuspecting people or even members of the public have tampered with sources have led to serious injury and in some cases death.

Some of the More Notable Such Accidents Include :

a) In China in 1992, a cobalt-60 source was lost and picked up by an unsuspecting individual. Three persons in the family died of resulting overexposure.

b) In Georgia in 1997, a group of border frontier guards became ill and showed signs of radiation-induced skin disease. Eleven servicemen had to be transferred to specialized hospitals in France and Germany. The cause of the exposures was found to be several abandoned caesium-37 and a cobalt-60 sources of varying activities, abandoned in a former military barracks that had been under the control of the former Soviet Union

c) In Istanbul, Turkey in 1998, two cobalt-60 sources in their shipping containers were sold as scrap metal and ten persons were inadvertently exposed to radiation and had to be treated for acute radiation syndrome

d) In the Goiania incident, authorities believe that scavengers dismantled a metal canister from a radiotherapy machine at an abandoned cancer clinic and left it in a junkyard. During the dismantling procedure the metal capsule that contained the caesium-137 source was ruptured. Over the next week, several hundred people in Goiania were exposed to the caesium-137, but did not know it. Some children and adults, thinking the caesium powder was "pretty," even rubbed it over their bodies. Others inadvertently ate food that had been contaminated with the radioactive powder. After one week, a public health worker correctly diagnosed radiation syndrome when a sufferer visited a clinic.

Measures to Detect Radioactive Sources

These accidents show that it is important to be aware of the potential hazards from radioactive materials and recognize materials that may be radioactive. Smaller companies and independent scrap dealers are particularly at risk, if they do not have proper detection systems and procedures in place to check the origin of the scrap and if their workers are not trained to recognize international symbols. Those working with scrap metal should be aware of the labeling used to indicate the presence of radiation.

a) Unusually heavy metal objects may contain radioactive sources

High activity sealed radioactive sources are usually in heavy containers because of the density of metals used to shield their radioactivity. Heavy metal containers (lead, tungsten or depleted uranium) are used to block the gamma rays. This shielding is used to protect those who work with sources and by-standers during transport.

b) Radioactive sources have labels

The "trefoil" is the official international radiation symbol used to label sources, containers, or devices. In addition to the trefoil symbol, the word "radioactive" may also appear. Some containers used for transporting sources will have other information on the amount of radioactivity or the type of protective container. Some sources, such as fine needles used for killing tumours, are too small to have any symbols. However, their containers will be labeled. The display of printed material (eg. posters) that shows typical devices containing the sealed sources at the premises will provide a constant reminder for the staff of their potential risk.

c) Monitoring incoming scrap for radioactivity

Several countries have set up monitoring equipment at ports of entry to detect undeclared radioactive materials before they enter the country. Many large scrap yards and foundries also use radiation detectors to check loads of incoming scrap for signs of radioactivity. Improved record keeping on the origins of scrap metal may also help reduce the risk of undetected radioactive materials.

d) Preventing radiation exposures, contamination, and economic loss

In addition to the exposure risks, melting down a radioactive source can contaminate equipment, requiring very costly clean-up, long-term waste management, and interruption of business. It is in the best interest of operators at foundries and steel factories to have procedures in place to detect radioactive material.

e) Procedures and instructions

If radioactive material is found or suspected, the staff needs to know what to do and who to contact. Operators should develop procedures to follow and make sure they are understood by workers. Emergency numbers for relevant agencies should be posted and updated regularly.

f) Training

All staff responsible for collecting, transporting and processing scrap metal should be provided with on-going training on the procedures in place to monitor for radiation and check for radioactive materials. Training should include how to recognize radiation symbols.

1 UNECE, 2006, Recommendations on Monitoring and Response Procedures for Radioactive Scrap Metal
2 IAEA : Methods to identify and locate spent radiation sources, TECDOC-804, 81 p., 1995, Vienna.