

# Measures to Prevent Radioactive Contamination in Metal Recycling Industries

- Radiological Safety Division  
Atomic Energy Regulatory Board

**A**<sup>ERB</sup> was constituted on November 15, 1983 by the President of India by exercising the powers conferred by the Atomic Energy Act to carry out certain regulatory and safety functions under the Act. The regulatory authority of AERB is derived from the rules and notifications promulgated under the Atomic Energy Act and the Environment (Protection) Act, 1986.

The mission of AERB is to ensure that the use of ionizing radiation and nuclear energy in India does not cause undue risk to health and the environment. For more information, please visit website- [www.aerb.gov.in](http://www.aerb.gov.in).

In the recent years there were a few cases of detection of low level radioactive contamination in steel/metal products in India and in several other countries as well. These incidents occurred due to melting of radioactively contaminated scrap (scrap containing orphan radioactive sources). It may be noted that radioactive sources are widely used for various medical and industrial applications. The reason behind the origin of orphan is because of poor management and/or lack of awareness about radiation/radioactive materials amongst the users. While the potential environmental and health risks of the incidents involving radioactively contaminated scrap metal are usually not very high due to the relatively low radiation levels involved, the economic and financial consequences of such incidents for the metal reprocessing industries are severe. Occurrence of such incidents can lead to a loss of trust in the recycled metal industry and the associated finished products since consumers do not wish to have unnecessary radiation emanating from their purchases.

## Preventive Measures

It is necessary to take preventive measures to avoid occurrence of such incidents. Monitoring at different levels of value addition of metal scrap and its appropriate management can prevent such incidents.

## Radiation Monitoring

Where there is an identified risk or doubt concerning the possible presence of radioactive material in scrap metal shipments, it should be checked for radiation using fixed or portable monitors.

All systems used for the monitoring of metal scrap for radioactivity rely on the detection of the gamma radiation that is emitted from the scrap. Although gamma radiation can penetrate metal, a proportion of the radiation is absorbed by the metal. The amount of absorption increases exponentially with the thickness of metal, so that for large



thicknesses of metal negligible amounts of radiation escape. When radioactive sources are in use they are often kept in heavy metal housings, which absorb much of the radiation and so make handling of the source safer. Because nearly all of the radiation is absorbed by the housing, and little radiation is emitted, detection of a source in a housing in the scrap is difficult. So a multilayer radiation monitoring system should be available. Such a multilayer monitoring system should include:

- Introduction of procedure that every importer of metal scrap should obtain a certificate from the exporting country that the scrap is free from radioactivity; (please refer to Director General of Foreign Trade Notification No.: DGFT PUBLIC NOTICE NO. 17/2009-14 dated 12/11/2009);

- Radiation monitoring by metal scrap dealer after the import and prior to melting the scrap;

- Radiation monitoring of output at mills like plates, billets, ingots etc.;

- Radiation monitoring at industries involved in value addition to products like plates, billets, ingots etc.;

- Radiation monitoring of by products like slag, off-gas dust etc.

- In the check list of Quality Assurance program prior to export/supply, include radiation contamination check on the final packaged material.

### Selection and Location of Radiation Monitors

For the facilities handling large (of the order of hundreds of tons per day) quantity of metal scrap, it may require both fixed type and portable radiation monitor. For the facilities handling small quantity (of the order of tens of tons per day) of metal scrap, it can be monitored with a portable radiation monitor.

#### Fixed Monitors

Fixed type monitors (portal) are used to monitor the container as a whole while passing around the monitor. This type of radiation monitor usually consists of large volume plastic scintillation detectors and is very sensitive to gamma radiation. For such kind of monitoring, the vehicle carrying metal scrap/semi-finished products/finished products need to pass near the monitor with a limited speed (normally less than 8 km/h). The most preferable location of a fixed type of radiation monitor is at the weigh bridge. In case of weigh bridge, audio and visual ports of the monitor can be kept in the operator room of weigh bridge. If weigh bridge is not available, it should be installed at the entrance of the industry.

#### Portable Monitors

These are hand held equipments. Such kind of monitors usually employ either a Geiger counter (gas filled counter) or a scintillation counter. Because of higher efficiency of scintillation counters, use of portable monitors employing scintillation counter is recommended. The probability of detection can be improved if the user moves the instrument closer to any radioactive material that is present. Also, an instrument is more likely to detect radiation when it is moved reasonably slowly over the area to be scanned. It is important that during scanning the instrument is maintained at a close distance to the surface (approximately 5 to 10 cm) without making contact. In addition, instruments are typically more sensitive if they are moved slowly over an area. However, there is a trade-off with the length of time that a survey might take. A reasonable guide would be to move the detector or its probe at about 20 cm.s<sup>-1</sup>. The nearer a monitor is to a radioactive source, the greater the radiation intensity and the easier it is to find the material.

#### Desirable Characteristics for A Portable Radiation Monitor

As per the experience gained, an instrument having the following characteristics may suffice:

- Should be capable of measuring background radiation levels.
- The minimum resolution should be 0.01  $\mu\text{Sv/h}$ .
- The time constant should be about 3 seconds (response time: it is the time taken by a radiation monitor to stabilize the meter reading)

#### Location of Use

Portable type monitors can be used:

- Monitoring the outside of a container as whole while entering the industry

- At the time of unloading the scrap

- At the time of filling the charge bucket

- At the time of rolling/casting

- In the laboratory while performing the elemental analysis

- Monitoring of slag and off-gas dust.

- At the time of containers leaving the industry with finished products

#### Response to the Alarms

In case the alarm is genuine, take the container to an unoccupied area and carry out further investigation by a portable radiation monitor. To localize the radioactive material, the user should follow the direction of increasing intensity (more frequent beeps) until the maximum level is found. A rapidly varying dose rate as the instrument is moved would be an indicator of an individual radiation source or partially shielded radiation. On the other hand, a small change in an elevated reading would indicate a larger volume of material such as uniformly contaminated material.

Once an alarm is confirmed as genuine alarm, cordon off the area around the container and ensure that the radiation level at cordon does not exceed 0.1 mR/h (1  $\mu\text{Sv/h}$ ). At the cordoned off area, it is required to display radiation caution symbol and a placard mentioning "RADIATION AREA-KEEP AWAY" at a prominent location. Also, physical security around the cordoned off area should be ensured. After the execution of above mentioned work, contact Head, Radiological Safety Division (RSD), Atomic Energy Regulatory Board (AERB) immediately.

## National/International Trade

As per International Atomic Energy Agency (IAEA), there should be no need for any further action (e.g. to reduce exposures) for materials containing radionuclides at activity concentrations below the values (see Table 1 & 2). In particular, national and international trade in commodities containing radionuclides with activity concentration below the values of activity concentration as provided in Table 1 & 2 should not be subject to regulatory control for the purposes of radiation protection. Till date there is no universal acceptance of these prescribed concentration values.

Currently some countries have prescribed clearance levels of activity concentration in commodities. **But, the manufacturers / suppliers should always keep in mind that even if a country has specified a clearance level, the buyer has all the right to deny the commodities containing contamination level above the natural background. Hence, before selling their products, the sellers should at first ascertain that up to what contamination level it is acceptable to the buyer.**

### Actions Initiated by AERB

There are various actions initiated by AERB to deal with the issue of radioactive contamination in recycling metal industry, which is mentioned below :

### Co-ordination with Other Ministries / Governmental Agencies

AERB is coordinating with various Ministries/Governmental agencies such as Director General of Foreign Trade (DGFT), Engineering Export Promotion Council (EEPC), Ministry of Steel, Indian Customs, National Institute of Secondary Steel Technology (NISST) etc. to prevent such incidents through organising awareness programme, etc.

### Co-ordination Various Associations

AERB is also coordinating with various associations like All India Induction Furnace Association (AIIFA), Metal Recycling Association of India (MRAI), Jamnagar Factory Owner's Association (JFOA) etc. to guide their members to start radiation monitoring of the scarp, semi-finished and finished products.

### Public Awareness Programmes with Respect to Steel Contamination

AERB has been conducting several awareness programmes on the topics like prevention and detection of contamination in recycling metal industry and response to incidents of contamination of metal products. So far, AERB has conducted 22 such programmes.

In addition to above Ministry of Shipping has started the process of installation of portal radiation monitors (gate monitors) at all the major sea ports.

### Radiation Units

The following units are frequently used in the metal recycling industry:

- Amount of Radioactivity Becquerel  
(Bq) – (1 Bq = one disintegration per second)  
Curie (Ci)- (1 Ci=3.7 x10<sup>10</sup> Bq)
- Ambient radiation levels  
Roentgen (R) per hour, rem per hour, Sievert (Sv) per hour
- Radiation dose  
Rad, rem, Gray (Gy), Sievert (Sv)



### ● Activity Concentration

Activity concentration levels are usually expressed in Bq/g. It can be noted that there is no established relation exists between concentration level and external radiation level.

#### Note :

For practical purposes (for gamma radiation with whole body exposure):

$$1 \text{ R} = 1 \text{ rem} = 0.01 \text{ Gy} = 0.01 \text{ Sv}$$

$$1 \text{ mR} = 1 \text{ mrem} = 0.01 \text{ mGy} = 0.01 \text{ mSv}$$

$$1 \mu\text{R} = 1 \mu\text{rem} = 0.01 \mu\text{Gy} = 0.01 \mu\text{Sv} = 10 \text{ nSv}$$

**TABLE 1 : VALUES OF ACTIVITY CONCENTRATION FOR RADIONUCLIDES OF ARTIFICIAL ORIGIN IN FOR SOME OF THE COMMONLY USED RADIOACTIVE MATERIALS**

RADIONUCLIDE	ACTIVITY CONCENTRATION (BQ/G)
Co-60	0.1
Cs-137	0.1
Ir-192	1.0
Am-241	0.1

**TABLE 2 : VALUES OF ACTIVITY CONCENTRATION FOR RADIONUCLIDES OF NATURAL ORIGIN**

Radionuclide	Activity Concentration (Bq/g)
<sup>40</sup> K	10
All Other Radionuclides of Natural Origin (Uranium, Thorium and their Daughter Products)	1

### Conclusion

Radioactive contamination is undesirable in metal/steel consumer products. Apart from radiological consequences, it can have significant economic impact on suppliers/exporters of steel products. Therefore, it is necessary that all stakeholders take appropriate measures to prevent such incidents. Radiation monitoring by various stakeholders can play a great role in preventing the incidences of metal contamination which in fact will help in protection of workers, public and environment, and to safeguard stakeholders from large economic loss.