Part 2a – Radioactive Scrap

INTRODUCTION

Metal recycling does not typically use radiation in its processes and, as a result, operators are not prepared or trained to deal with the problems that arise when radioactive materials enter a yard or are found in an incoming load.

As many yards do not have radiation monitors on their weighbridges, radioactive scrap passes through the yard and is not detected until a road vehicle or a railway wagon enters a steelworks where portal monitors are normally located. However, given the obvious shielding provided by scrap metals, the radioactive material may escape detection altogether.

The subsequent business disruption is usually out of proportion to the exposure risk, which is often very low. Nonetheless, high exposure incidents have occurred worldwide and the recycling industry needs to be equipped to avoid these. This document summarises the problem and describes the agreement which BMRA has negotiated with interested parties.

DEFINITIONS

Radioisotope - Elements have a number of different forms (or isotopes) depending on the number of neutrons in the nucleus. If the atom is unstable it emits energy in the form of ionising radiation and is described as a radioisotope.

Ionising radiations - This is a generic term that includes the different types of radiation. i.e. particulate radiations (alpha or beta), which are not very penetrating, or electromagnetic photon radiation (gamma or X-rays), which are extremely penetrating.

Activity - The strength of a radioactive substance, or activity, is described in becquerels (abbreviated Bq). 1 Bq is defined as one atomic disintegration per second. This is a tiny amount or radioactivity so most materials in industrial use are in the kBq, MBq or GBq activity range.

Specific activity - This is a measure of the concentration of radioactivity in a substance and is measured in becquerels per gram (Bq/g).

LSA scale - Low Specific Activity scale is the scale or sludge that accumulates over a period of time in pipework used in the oil/gas processing activities. The radiation comes from substances known as rare earths which are naturally occurring. As the name implies, the specific activity is very low.

NORM - Naturally occurring radioactive material (NORM) accounts for around 85% of our exposure to background radiation. The remaining 15% is from artificial, man-made sources of radiation (primarily medical exposures).

Dose rate - This is the rate at which a person's body will receive ionising radiation from a radioactive substance or X-ray machine. It is measured in microsieverts per hour (μSv/h), which directly describes the risk of exposure. Considering an electric fire, the further you stand from the fire, the less heat received. So it is with radiation dose rate.

USES OF RADIOACTIVE SUBSTANCES

There are many purposeful uses of radioactive sources in industrial process control, commercial products, research and teaching. This overview is useful in anticipating the likely radioactive sources or materials which could potentially enter members' yards.

Industrial gauges – These instruments are bolted to machines and are used to determine the thickness or density of a material being produced on a production line, e.g. strip rolling mill. The sealed source is housed within a shielded source container which should be clearly labelled (with the radiation trefoil) so not to mix up the source with the detector head.

Industrial radiography – This investigation technique uses radioisotopes of cobalt and iridium which emit highly penetrating gamma rays. The sources are of varying levels of activity, but all are capable of harm. They are contained in source containers (normally clearly identified) that have a cable attached for winding out the source.

Medical isotopes – Sources used for radiotherapy are of high strength but decay rapidly (i.e. short half-life) to a stable, non-radioactive isotope. However, this is now an old technology, having been replaced by the use of linear accelerators and, more recently, proton beam therapy.

Luminised dials – In the 40s and 50s it was very common for military and other dials to be coated with radium paint for illuminating the hands and digits. These are still around today, as museum or collection pieces, and appear in scrap metal from time-to-time. They normally emit sufficient gamma radiation to be detected on entering the yard.

LSA scale and NORM – as described above.

X-ray machines – These are powered up by an electrical supply. They are either diagnostic in nature, being used in universities, hospitals and dental practices, or industrial for taking X-rays of metal structures or welds. They only emit ionising radiations when the electric current is flowing. Without a power supply there is no possibility of generating X-rays.

RECOGNITION

X-ray machines and radioactive source containers come in a wide range of size and shape. It is therefore more important to look for the international symbol for ionising radiation which is the trefoil in a black triangle with a yellow background.

HAZARDS

The hazards and consequences of radioactive materials appearing in scrap metals can be very serious, resulting in:

- **Radiation risk to yard workers**
  Potentially high radiation exposures to those handling the offending metals at the processing yard and the steelworks.

- **Contamination risk**
  The potential for widespread contamination of workers, plant and surrounding areas resulting from a breach of source containment.

- **Radiation risk to the public**
  The public could be exposed to radioactivity incorporated into metal products distributed into international commerce.

- **Costs to the metals recycling and steel industries.**
  High clean-up costs and reduced profits for lost production.

RADIATION EXPOSURES

Everyone in the UK is permanently exposed to ionising radiation from natural sources (rocks, soil, cosmic rays from outer space). The exposure level averages 2,400 μSv per year. Add to this the 300 μSv per year we all receive from man-made radiation (largely medical) and our total annual dose is 2,700 μSv or around 7 μSv per day.

Radiation in the workplace is limited to 1,000 μSv per year as an occupational exposure. Note, however, that this is highly restrictive since we cannot say with any certainty that a given radiation dose will or will not result in cancer. We do know, however, that there is no evidence of cancer in humans below 100,000 μSv but the legislation takes the precautionary approach.

In the workplace a Controlled Area has to be designated around a gauge or a source store wherever the dose rate exceeds 7.5 μSv/h. Most source containers are so constructed that the dose rate at contact with them is no greater than 7.5 μSv/h. This means that even if the source container entering the yard is still loaded with a source there should be no danger provided it remains intact.

Serious problems arise if a sealed source is found to be physically damaged resulting in contamination of surrounding metals, i.e. the spread of radioactive material from the source which has lost containment. If this is confirmed then action has to be taken to limit the opportunity for airborne contamination which could be breathed in, and to wear correct PPE.

The majority of sources / items which may enter members' yards emit low levels of gamma radiation which typically represents a low exposure risk. A greater risk is associated with breathing in contaminated dust due to the presence of loose radioactive material or a damaged sealed source.

LEGISATION

The Environmental permitting (England & Wales) Regulations 2016 *as amended*

These regulations control the management of radioactive materials and waste on company premises so to protect the environment For the majority of industrial radioactive sources, the site operator is required to hold a permit for the keeping/use of materials and for the accumulation/disposal of radioactive waste. A number of sources of natural origin and low activity sealed sources are conditionally exempt from the permitting requirements.

In Scotland, the Environmental Authorisations (Scotland) Regulations 2018 prescribe very similar requirements.

The regulations are enforced by the EA, NRW and SEPA in England, Wales and Scotland respectively.

For those with installed weighbridge detectors in England and Wales, a permit is required to accumulate sources on site pending removal.
https://www.gov.uk/government/publications/part-rsr-b7-apply-to-keep-radioactive-material-and-accumulate-and-dispose-of-radioactive-waste-following-its-unintentional-receipt

The Ionising Radiations Regulations 2017 (IRR17)

These regulations, made under the enabling Health and Safety at Work Act 1974, control exposures of employees, contactors and visitors to sources of ionising radiation in the workplace. Whilst the regulatons prescribe annual dose limits, the over-riding control is for all exposures, no matter how small, to be kept *as low as reasonably practicable* (ALARP). Such dose reduction is achieved by a combination of physical protection measures, written procedures and training in best practice.

The regulations are enforced by the Health and Safety Executive (HSE) in England, Wales and Scotland.

The Carriage of Dangerous Goods Regulations 2009 (CDG09)

These regulations control the transport of radioactive (Class 7) material on GB public roads in order to protect the vehicle crew and the public from radiation exposures, both operationally and following a road traffic accident. There are obligations placed upon both the consignor and the carrier for ensuring safe carriage and responding to a radiation emergency.

The regulations are enforced by the Office for Nuclear Regulation in England, Wales and Scotland.

DETECTION

Many larger sites have now fitted portal gamma monitors to their weighbridges. The worst-case event would involve a high activity sealed source being exposed in a yard or entering a furnace in a steelworks. However, these sources are likely to be housed in heavy shield containers (i.e. shielding) making them difficult to detect. A detector alarm therefore simply signals the presence of the radiation but gives no clue as to the type and size of radioactive source present in the load.

The majority of past cases which have triggered the detection alarm have so far been due to LSA scale, depleted uranium, thoriated alloys or radium-luminised dials. It is rare for discrete sealed sources to enter the scrap chain.

INVESTIGATION

Where a weighbridge radiation detection system has been installed, the operator must have a procedure to follow should the alarm be triggered. On confirmation of the alarm, the load should be driven to a less busy part of the site for quarantine and investigation. The investigation requires careful tipping and surveying by trained staff with hand-held radiation monitors to investigate the load and identify the source.

Of crucial importance throughout is the requirement to assess the exposure risk by reference to the dose rate (in µSv/h) reported by a hand-held monitor. Should a dose rate of more than 7.5 µSv/h be measured then a barrier should be erected and professional help sought. This is the dose rate at which a Controlled Area has to be designated under the Regulations.

On no account should the driver be allowed to return the load to the roads with the source still present since this becomes a breach of transport regulations and may give rise to an unacceptable driver exposure.

However, if the driver refuses to stay and does drive off site, the relevant Environmental Regulator should be notified (EA/SEPA Tel: 0800 807060; NRW Tel: 0300 065 3000).

As with visible light, the exposure reduces very quickly with distance; in fact with the square of the distance, as the following example shows:

Distance (m)	Dose rate (µSv/h)
0.25	160
0.5	40
1	10
2	2.5
3	1.1
4	0.6
5	0.4

Note how steeply the dose rate increases close to the source.

In most cases it's reasonable to establish an exclusion area around the source or wagon at 1 µSv/h, in this case at 3m.

As illustrated above, distance is the most important means of protecting against radiation. If a trefoil is spotted then rope off the area to a minimum of 3m (10ft) and seek professional help.

Once the source of the radiation has been isolated and identified it should be placed in secure storage pending removal, either by a licensed contractor or direct to landfill depending on the nature of the source. The radiation protection adviser (RPA) will advise the best course of action.

The environment agency should be notified at this point with details of the source and the supplier so that they may trace the route of the material. The HSE do not need to be notified.

ACTIONS TO BE FOLLOWED

The steps to be taken are as follows:

1) The 'radioactive load' activates the weighbridge monitor alarm. The road vehicle is sent round for a second pass to confirm the reading. If no alarm the second time then pass through a third time. Two alarms from three passes signals a positive.
2) The vehicle is moved to a 'quiet corner' of the site for monitoring by a Radiation Protection Supervisor or an operator trained in using the hand-held monitor.
3) If the dose rate at the sides of the vehicle is 7.5 μSv/h or less then the investigation may continue. If greater, then the load should be quarantined awaiting an RPA to assist in the investigation.
4) The prime investigator should visually / verbally establish an exclusion zone approx. 5m around the load to restrict unauthorised close access.
5) Tip the load on the yard and spread out using a grab, systematically from one end of the pile to the other monitoring each section in turn.
6) If the dose rate reaches 7.5 μSv/h at any point, stop the investigation and call on RPA assistance. Mark the exclusion zone 5m around the pile using bunding tape.
8) On identification of the problem item remove it (wearing gloves) using a shovel to a clear space of the yard and record the dose rate at 30cm and at 10cm. Photograph the item. **NEVER directly handle a radioactive item irrespective of activity level.**
9) If you see or suspect flaking material, bag the item in a thick gauge poly bag and seal. The area around the item should be monitored for loose contamination.
10) Label the item as radioactive and the date received.
11) Secure the item in a lockable store or container away from general access. (All sites with a means to detect radiation should have a suitable store).
12) Record the following information: date received, description of item, any distinguishing marks, measured dose rate and a photograph of the item.
13) If required, the RPA will be able to assist in identification of the radionuclide and estimating the activity.
14) The subsequent disposal route for the radioactive item will be advised by the RPA.

In order to comply with a Standard Rules Permit (England) for unintentional receipt of radioactive materials and radioactive waste the following records should be maintained:

- The radionuclide present.
- The date on which accumulation began and the activity on that date.
- Its location on the premises.
- If it is removed from the premises, the date of removal, the activity on date of removal and the name and address of the person to whom it was transferred.
- The total activity and volume of radioactive waste present on the premises.