

# NORM and other radioactive sources found in scrap metal yards in Sweden

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**Abstract.** The Swedish steel and scrap metal recycling industry does not allow any radioactive material to enter the steel process flow; there is a “zero tolerance” policy. The industry has increased the control of scrap metal over the past two decades by installing portal monitors at both scrap metal yards and steelworks. In addition, some facilities have detecting equipment in crane grips and transportation units. There are also a number of hand-held instruments.

Radioactive material is found among the scrap metal where it is impossible to establish the owner. This paper will give examples of radioactive materials and sources detected and put aside at scrap metal yards in Sweden. In most cases the materials can be categorized as NORM, such as scale in pipes and different types of filters but also radioactive sources and pieces from instruments containing radium.

In the end, the scrap yards have no one to charge for the costs for the management of the scrap and formerly had the financial responsibility themselves. Today they can apply for money from the Swedish Radiation Safety Authority, SSM, to cover the costs for the management and disposal of the material. SSM receives special funding corresponding to EUR 100,000 per year from the Government to cover the costs for the management and disposal of non-nuclear waste from past practices and orphan sources. Another problem for the industry is the uncertainty whether the radioactive material will be accepted by Studsvik Nuclear AB, which is the only Swedish licensed company that manages radioactive waste. Studsvik Nuclear AB recently decided that it will no longer accept NORM due to uncertainties regarding its disposal. In some cases, NORM can be disposed of in landfills by specific clearance of the material.

**KEYWORDS:** *scrap metal, radioactive, NORM*

## INTRODUCTION

Sweden has so far only had a few incidents where radiation sources have been melted down together with scrap metal, none of which has led to any hazardous consequences for human health or the environment. The Swedish steel and scrap metal recycling industries do not allow any radioactive material to enter the steel process flow; there is a “zero tolerance” policy. The zero tolerance not only applies to the final products distributed on the market, but also to the by-products such as slag, dust, sludge, etc. Therefore, the scrap metal recycling industry represents a filter for radioactive material that for some reason is not under regulatory control. A description is provided below of the measures taken by the industry in order to guarantee that no radioactive material enters the steel process flow.

Steel mills and scrap metal suppliers cooperate with the aim of jointly securing that all radioactive material is detected before it enters any processing equipment in the material flow, such as shearers, shredders or smelting furnaces. This cooperation is administrated by JBFAB, or “Iron Mill Supplies”, a company owned by the major Swedish steel companies and acting as their purchasing agent for scrap on the Swedish market and in the Baltic region. The steel and scrap metal recycling industry has, as a result of a joint effort over the years, published The Swedish Scrap Book (Skrotboken 2000, 2005), which is regularly updated. The main purpose of the book is to achieve higher efficiency when recycling scrap metal by regulating specifications on purchasing and production of different qualities. The Scrap Book establishes that it is the responsibility of the scrap metal suppliers to deliver scrap metal free from radioactive material to the steel mills.

In JBFAB's scrap specifications it is clearly stated that shipments of scrap metal to the steel industry must be free from radioactive material whether it is imported or of Swedish origin. For imported scrap metal, the European Steel Scrap Specification applies: Shipments may not contain radioactive material in sealed containers even if no significant exterior radioactivity is detectable due to shielding or due to the position of the sealed source in the scrap delivery. The companies that import scrap metal are obliged to check the material before it leaves the country of origin.

In 1996, the former Swedish Radiation Protection Authority (SSI) issued guidelines on general rules when monitoring scrap metal. These guidelines were updated in 2010. In the Guide, SSM recommends that all scrap yards and steel mills with monitoring systems should have a documented action plan on how to monitor and manage contaminated material. The industry has to a large extent followed this advice; at several facilities, all radioactive sources found are separated from the flow and handled according to documented routines.

## **MONITORING**

The scrap metal industry has increased its control of scrap metal over the past two decades. The majority of the steel mills have portal monitors, as do many of the largest scrap metal yards. In total, the industry has approximately 40 portal monitors spread across the country. In addition, some yards have detecting equipment in crane grips and transportation units. There are also a number of hand-held instruments. Employees receive information and training on a regular basis with the goal of being able to handle the monitoring equipment and also of visually detecting radiation sources and radioactive material of different kinds. The final monitoring step of the steel process flow is when steel heats, slag and dust from the melt down furnaces are analysed for radioactive nuclides.

## **MANAGEMENT OF DETECTED RADIOACTIVE MATERIAL**

According to the Scrap Book, if a scrap yard or steel mill finds radioactive material in a shipment of scrap metal, the material can be sent back to where it came from and the owner has to pay a penalty fee. The owner can also choose to let the scrap yard/steel mill take care of the contaminated material. The owner then has to pay the costs for the management of the material in addition to the penalty fee. As long as the ownership is clear, there is no problem as to who is financially responsible for the contaminated material.

However, radioactive material is found among the scrap metal and whose ownership is impossible to establish. This is particularly common in the scrap metal recycling industry. Sometimes these shipments come from municipal recycling sites, where anyone can leave their waste without virtually any control at all. In the end, the scrap yards have no one to charge for the costs for the management of the radioactive material in the scrap metal. In these cases, the facilities can apply for money from SSM to cover the costs for the management and final disposal of the material. SSM receives special funding corresponding to EUR 100,000 per year from the Government to cover the costs for the management and final disposal of non-nuclear waste from past practices and orphan sources.

Most radioactive material found by the steel and scrap metal recycling industry is sent to Studsvik Nuclear AB, which is the only approved radioactive waste management facility in Sweden for handling radiation sources that need a licence. Studsvik Nuclear AB recently decided that it will no longer accept NORM due to uncertainties regarding its final disposal. Any NORM that is found by the steel and scrap metal recycling industry therefore has to be stored on site at the different facilities while awaiting a final waste management solution.

## DETECTED RADIOACTIVE MATERIAL

It is not mandatory for Swedish scrap metal suppliers to report incidents with contaminated scrap metal to the authorities. The main reason for reporting material or sources that have been detected is for applying for money to cover the cost for management and final disposal of sources. Table 1 shows examples of radioactive material that has been found in incoming scrap metal shipments at Swedish scrap metal yards.

**Table 1.** Some examples of the kinds of radioactive material that have been found in incoming scrap metal shipments at Swedish scrap yards.

Examples of reported objects	Nuclide
Scintillation counters	Ra-226
Thickness gauge	Am-241/Be
Laboratory balances	Ra-226
Rotors from helicopter	Cs-137, Th-232
Metal parts from a vehicle	Cs-137
Measuring instrument	Co-60
Luminescent switches	Ra-226
Motor parts from airplane	Th-232
Radium emanator	Ra-226
Airplane instrument panels	Ra-226
Luminescent paint	Ra-226
Smoke detectors	Am-241
Dewpoint measuring instrument	Am-241
Jet engine from airplane	Th-232

The reports received by the authorities over the years therefore do not reflect the reality. The trend during the past eight years or so is that fewer and fewer incidents are reported to the authorities. Since the scrap metal suppliers have invested in more detectors during the same period, the number of incidents probably has not decreased as indicated by the reporting. One of the more serious incidents at a scrap yard, from a radiation protection point of view, was when a thickness gauge (4.4 GBq Am-241/Be) was found in a container that passed a portal monitor at a car scrap yard. The gauge was intact and shielded and had been used for measuring asphalt during road construction. The gauge probably had been used and lost by a Swedish company, but it was not possible to establish its ownership. Most recently, in spring 2011, a level gauge (11.1 GBq Cs-137) was found at a scrap yard, intact and shielded. Again, it has not been possible to establish where the level gauge comes from, although originally it was manufactured in Norway and intended for use in the oil and gas industry.

## NORM

As Studsvik Nuclear AB only accepts radioactive material (including sources) for which the company can foresee a final disposal, certain types of waste will have to remain at the scrap metal yards, where they are stored until there is a solution for their final management. This is the case for NORM, which needs to be handled separately. In 2010 and 2011, SSM visited five scrap metal yards and one steel company that store NORM in order to learn more about the material and, in a long-term perspective, identify options for disposal of the material. Altogether, up to 70 samples have been taken and analysed at the laboratory at SSM. Depending on the site and type of material, the scrap metal that contains NORM is stored in containers or in scrap heaps at the scrap yards. One site has up to one hundred pieces

containing NORM, with several pieces of the same origin and type. The materials have been stored for many years, and new pieces are found regularly. There is a large variety of the material and the radioactive material itself is, in most cases, only a small fraction of the metal piece to which it is attached. NORM is usually in the form of scale in pipes and water filters.

The material was detected by portal monitors which have an alarm level just above the background level. When monitoring the material with hand-held instruments, the dose rate is sometimes only slightly above background due to low activity concentrations or very thin layers of deposits. The analyses of the material still show that the concentration in the material is increased.

Here are examples of material detected as radioactive in scrap yards. The weights of the pieces are estimations.



Filter cloth  
14 microSv/h, 130-180 Bq/g Ra-226  
Total weight: 20 kg/piece



Steel beams with rubber coating  
4 microSv/h, 50-70 Bq/g Ra-226 in the outer layer of the rubber  
Total weight: 200 kg, rubber 3 kg



Scale in water pipe from ice hockey rink  
0.4 microSv/h, ca 20 Bq/g Ra-226  
Total weight: 150 kg, scale 2 kg



Very thin scale in an industrial equipment detail  
1 microSv/h, 1000-1500 Bq/g Ra-226  
Total weight: 5 kg, scale 20 g



Water filter  
0.3 microSv/h, 2.2-3 Bq/g Ra-226  
Total weight: 30 kg, NORM 28 kg



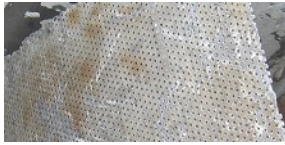
Metal plate, probably from radium emanator  
40 microSv/h, Ra-226  
Total weight: 30 g



Insulation  
0.2 microSv/h  
5-11 Bq/g Ra-226, 12 Bq/g Ra-228, 12.5 Bq/g Ra-224  
Weight: 20 kg



Loose scale in a pipe  
0.7 microSv/h  
6-8.5 Bq/g Ra-226  
Total weight: 60 kg, NORM 2 kg



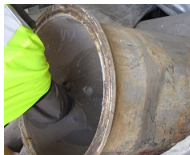
Perforated steel with scale (5mm thick)  
8 microSv/h  
35.4-41.1 Bq/g Ra-226  
Total weight: 10 kg, NORM 10 g



Scale  
0.5 microSv/h  
9.8-13.4 Bq/g Ra-226, 4 Bq/g Ra-228  
Total weight: 150 kg, scale 2 kg



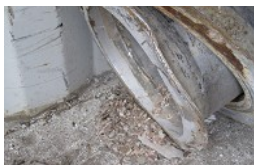
Heavy industrial equipment detail, scale inside  
0.8 microSv/h  
Ca 54 Bq/g Ra-226, ca 2 Bq/g Ra-228  
Total weight: 1.16 tonne, scale 1 kg



Thin scale firmly attached inside a pipe  
Ca 73 Bq/g Ra-226, ca 11.6 Bq/g Ra-228  
Total weight: 200 kg, scale 500 g



Perforated steel with pulp fibres and deposits firmly attached to the steel  
0.4 microSv/h  
Ca 32.8 Bq/g Ra-226, 8.1 Bq/g Ra-228  
Total weight: 300 kg, NORM 100 g



Loose scale  
0.35 microSv/h  
Ca 61 Bq/g Ra-226, 3.5 Bq/g Ra-228  
Total weight: 300 kg, scale 500 g

Several factors give rise to uncertainties in the analysis results. Taking samples of the material can be difficult as the radioactive material is often firmly attached to a metal surface. The amount of material that is possible to remove is sometimes very small. For water filters, the situation is somewhat different while it is necessary to take several samples from the filter as the activity might be unevenly distributed in the mass. The different natures of the samples may cause large uncertainties in the analysis results. Still, the results we have seen so far show an approximate activity concentration of mostly radium nuclides.

## **DISPOSAL OF NORM**

New regulations on NORM will come into force in 2011. These regulations will exempt NORM from regulatory control, given that the material is disposed of in a landfill. The maximum activity concentration in such NORM can be 10 Bq/g and nuclide, and the landfill needs to have a construction at least corresponding to a landfill for non-hazardous waste. Some of the NORM found in scrap metal yards can be disposed of in accordance with the new regulations. This is the case for most water treatment filters and some of the scale. Even some scale having an activity concentration above 10 Bq/g is likely to be deposited the same way following a decision on specific clearance of the material taken by SSM.

There are many types of scale and deposits. As observed, some scale can be easily removed from the pipe by just shaking the pipe; then the clean metal can enter the recycling process. Other types of scale and deposits are very firmly attached to the surface of the metal. The thickest scale observed so far in the scrap metal industry has a thickness of about 1 cm. Many deposits are only about 1 mm thick and are not possible to remove manually, and deposits may be found in metal filters from which the deposits are very difficult to remove. Since there is no specific industry in Sweden producing large amounts of NORM or scale, there are no established methods available for removing scale from pipes and metal pieces such as in the Norwegian oil industry. This would be necessary to enable the scrap metal industry to recycle the metal. Sometimes whole pipes have to be deposited in a landfill, but this may not always be an option if the landfill is licensed according to the environmental regulations and the licence may not allow depositing of metal. This can also be seen as a waste of valuable material that should be recycled.

The next issue to be solved is how scale with an activity concentration above 10 Bq/g should be disposed of. The options available will be studied in detail during 2012. A number of circumstances have been identified and these need to be taken into account; the amount of NORM with activity concentrations above 10 Bq/g is small. The material is sometimes firmly attached to metal and is difficult to remove and there is usually no owner of the material to be found. Today the scrap metal industry involuntarily stores this material since there is no disposal option available.

The process of finding ways to deal with radioactive scale in Sweden has so far only begun. In a short-term perspective, the analysis results will be used for decisions on how to manage each and every one of the scrap metal parts that have scale attached to them. In a long-term perspective, we will get an overview of different types of scale arising in Sweden and hopefully identify safe solutions for managing scale.

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