

## **Treatment of Contaminated Non-Iron Metals for Clearance - 15361**

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### **ABSTRACT**

Iron based metals and concrete make up most of the structures in a nuclear power plants and most other nuclear installations. During the last few decades, a lot of effort has been put into the treatment of steel in order to allow recycling of the metal and to reduce the volume for final disposal.

In addition to the iron based metals, there are also other metals in significant amounts that can be treated for recycling and waste minimisation. Aluminium, lead, titanium, brass and copper have all been treated by Studsvik in the metals treatment facility in Sweden over the years. Some of these metals like lead and aluminium causes certain concerns (for reasons not related to their radioactivity) if they were to be disposed as radioactive waste. Other as copper and titanium has a high economic value if recycled outside the nuclear industry.

Studsvik experience from treatment of non-iron metals is reported in this paper.

### **INTRODUCTION**

Contaminated non-iron metallic waste is generated within nuclear power plants, other nuclear facilities, and in other operations involving or generating radioactive isotopes.

Non-iron metals are usually not part of the primary systems of a nuclear power plant and therefore, these metals are not irradiated or heavily contaminated. They are however quite common further out in the water and steam systems such as in heat exchangers like the condenser. Aluminium is common in certain structures, as cladding on insulation of piping and in cables. Lead is used for shielding, copper as electric bus bars and in cables etc. The amount of non-iron metals is usually significantly less than the amount of steel but could still be fairly large in total, especially in decommissioning projects.

Independent of use within controlled areas the material must go through clearance before the metal can be recycled.

For release from regulatory control and recycling, melting and decontamination followed by clearance based on measurements on the metallic components as is are established methods.

Independent of method specific and reliable knowledge about the nuclide distribution in the material sent for treatment as well as further distribution during treatment is essential. A good understanding as well as reliable data is crucial in the clearance process but also when it comes to qualification of the waste for disposal. In a disposal perspective not only the radiological data

are of importance. For gas generating materials like aluminium the surface to mass ratio is of importance. Treatment by melting can be motivated just to reduce this ratio.

Since there is a variation in nuclide composition, how the radioactive particles are adhered to the surfaces, if surfaces are reachable for treatment with the discussed decontamination methods, if there is any penetration of activity etc. every batch of material is unique. Also the nuclide inventory could vary significantly between different batches due to the origin. All these parameters have to be evaluated in the optimization of the metal treatment. For some metals there is a potential choice between treatment with or without melting prior to clearance. For other materials like titanium there is no option for melting in the existing facilities due to the high melting point.

The Studsvik metals recycling facility has been in operation since 1987 for segmentation, decontamination, melting and clearance of metals. Thousands of tonnes of metallic low-level waste have been processed with the aim of clearance, including more than 1 700 tonnes of non-iron metals. The non-iron metals treated within the facility so far are aluminium, copper, lead, brass, and titanium.

## **DESCRIPTIONS**

The behaviour of different materials in the treatment process could differ significantly and must be considered while developing the material specific treatment operations. Lessons learned from the industry is that the proper selection of the decontamination method can be the differentiator between failure and success. As an example high force steel shot blasting on a soft metal could move the contamination from the surface into the material structure instead of removing it.

Also in respect to the nuclide distribution during the treatment, metallurgical understanding is vital. Some nuclides do, independent of the metal type, evaporate at the actual melting temperature of the metal and are transferred to the slag on top of the melting bath, captured in the dust filters or remains as gas also at low temperatures and will by then either be released to the atmosphere or do require some special off-gas treatment. For some nuclides it will differ due to temperature or type of metal.

A very nice metal for treat for clearance is lead as most nuclides contaminating the metal will spontaneously, or with some help, be separated from the metal. Some nuclides will however remain in the metal fully or partially.

On the other hand, special personnel safety arrangements are mandatory when handling lead due to the well-known health hazards of lead exposure. Studsvik has melted 500 tonnes of lead, and every metal ingot has so far met the clearance criteria directly after melting. Some typical treatment data is shown in Figures 1 – 3.

From Figure 1 it can be seen that after treatment only 3% of the measured activity is found in the metal lead ingots, while the remaining activity has been transferred to the secondary waste (such as dust and slag).



Fig. 1. Typical activity distribution when treating lead at Studsvik.

From Figure 2 it can be seen that the secondary waste is only 1% of the total weight which means that all the mass remains as metal and can be subject to recycling after conditional clearance. The effectiveness of the decontamination can also be seen from Figure 3, which shows the specific activity in the ingots and in the secondary waste. It differs with more than three orders of magnitude in specific activity.

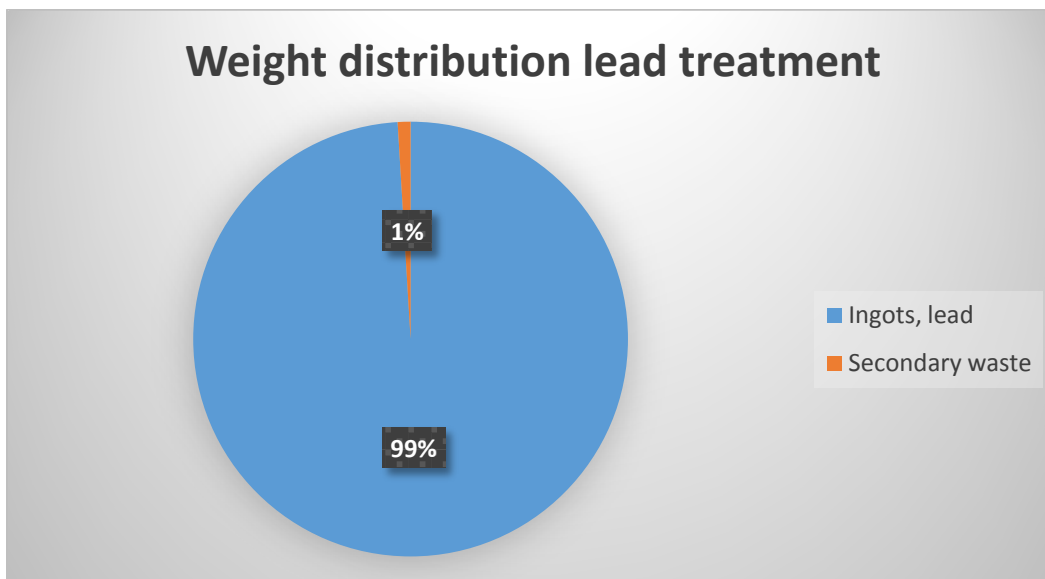


Fig. 2 Typical weight distribution when treating lead at Studsvik.

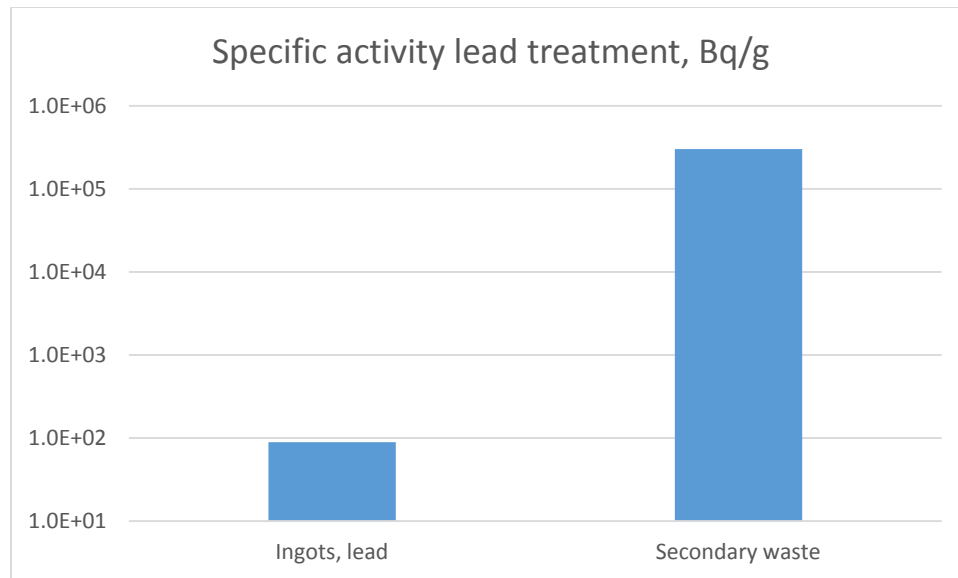


Fig. 3. Typical specific activity after treatment of lead at Studsvik.

Studsvik has treated about 300 tonnes contaminated copper from nuclear and non-nuclear facilities, and all copper ingots have been subject for conditional clearance after melting. The copper in cables has a significant value when recycled after clearance. Based on experience only the cable shielding is contaminated which means that the copper in cables from heavily contaminated areas could be subject to clearance if managed properly. By applying pre-treatment and by using a cable shredder of a suitable design, Studsvik has been able to successfully separate the contaminated shielding and the copper. All copper from cables has so far been subject to clearance.

Brass is a frequently used metal for heat exchanger tubes, inside valves etc. The experience from decontamination of brass is good. More than 100 tonnes of brass has been treated at Studsvik and almost 100% has been subject to clearance.

Titanium is mainly found in condensers at NPPs but could also occur in other heat exchangers. The contamination level at condenser tubes is usually relatively low. Since titanium is difficult to melt due to the high melting point, it is preferred that the material is measured for clearance as is after decontamination.

## DISCUSSION

The treatment of contaminated non-iron metals in Studsvik has in most cases been very successful with a very high degree of metal subject for clearance after treatment. The benefits are not only from a recycling perspective, but also from disposal perspective. Aluminium may cause problems due to the gas generation and disposal of lead is to be avoided to the extent possible due to the hazardous properties. Lead is also recycled on a commercial basis. Lead has a well-established recycling route and all lead from car batteries is recycled for production of new batteries. A win-win situation for all involved parties including the environment.

Copper, brass, aluminium and titanium are all attractive metals on the market and are recycled after clearance.

It must also be highlighted that certain hazards exist also in addition to what is highlighted about lead above. Other materials with significant hazards like magnesium and cadmium can be mixed up with the “normal” non-iron metals. By applying a defence in depth philosophy taking benefit of both the waste generators experience and the processors skills along with a stringent safety culture such risks can be minimised if not eliminated.

## **CONCLUSIONS**

Treatment of contaminated non-iron metals can be performed very efficiently, with a very high degree of recycling after treatment. For more than three decades, Studsvik and other companies have treated contaminated non-iron metals successfully and an extensive knowledge has been built up within the industry.

Recycling of non-iron metals is a good example of the implementation of the Waste Hierarchy and a contribution to a sustainable society.