

RECYCLING OF CONTAMINATED METALS FOR FREE RELEASE

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ABSTRACT

Since 1987, Studsvik has melted low-level scrap metal with the aim of safely determining the radioactive content of the metal after treatment as well as in order to recover the metal for reuse. The scrap metal which has been and is being treated mainly originates from nuclear installations. These installations mainly comprise nuclear power plants, nuclear fuel vendors and experimental facilities.

Since operations started, about 4,200 tonnes of scrap metal have been treated and about 2,100 tonnes of this amount have been given clearance for reuse.

Following clearance, the metals are remelted at steelworks or foundries operating outside the nuclear sector.

The facility where the treatment and melting of metals is carried out and procedures for clearance are described here. Furthermore, the problems which have been encountered in connection with the reuse of metals within the non-nuclear industries are presented.

BACKGROUND

In the mid-eighties, a large quantity of scrap metal was stored at Studsvik. The scrap metal originated from the R&D activities conducted at the company in the early sixties. The large quantity of metal, together with the supervisory authorities' requirements that as large an amount as possible should be recovered for clearance and reuse means that a thorough review of the treatment process and procedures was conducted. It was decided that melting would be the optimum treatment method.

After trial melting of low-level scrap metal, which was carried out at a conventional steelworks, an induction furnace was installed at Studsvik for the melting of steel scrap. The installation was located in an existing building which had been previously used for nuclear activities. The building also housed the facilities for pre-treatment, e.g. cutting of large components into segments, and the melting process.

A crucible furnace was subsequently added for melting aluminium, brass and copper as well as a new facility for the pre-treatment of the metal to be melted.

When operations started, no formal clearance limits had yet been established. The clearance guideline generally applied in Sweden was based on an activity level of 0.1 Bq/g (total activity). In the case of Studsvik's melting operations, a clearance level of a maximum of 1 Bq/g was obtained. This higher level was considered to be appropriate since the melted metal, in the form of ingots, was sent to steelworks where it was remelted. During remelting, the Studsvik ingots were mixed with other scrap metal originating from non-nuclear activities.

THE MELTING FACILITY

The melting facility consists of a reception area, two furnaces, filters and other auxiliary systems as well as areas for the storage of scrap metal to be melted.

A 3-tonne induction furnace with a melting capacity of about 1.5 tonnes per hour is used for the melting of steel. Non-ferritic metals are melted in a crucible furnace (about 600 kg aluminium per batch) with a capacity of about 250 kg (aluminium) per hour. Exhaust systems are connected to both furnaces and the gas is taken to a filter system for particle separation.

The reception area is also used for the pre-treatment of the metal to be melted. The pre-treatment process comprises inspection, sorting and segmentation. During the pre-treatment process control measurements of the radioactive content of the metal are continuously carried out.

OPERATION OF THE MELTING FACILITY

In general, delivered scrap metal is handled and treated in batches ensuring that the scrap from different owners/suppliers is not mixed together. This also means that secondary waste products, which are always treated as radioactive waste, in the form of slag and dust from the filter system can be returned to the original owner.

This procedure is required since the original ownership of the scrap metal is retained until the scrap, in the form of ingots, has been given clearance.

PRE-TREATMENT OF SCRAP METAL

The delivered scrap metal is segmented using thermal methods (oxygen/acetylene) and mechanical methods (cold) and equipment. During the segmentation and when this is not necessary, inspections and radiological control measurements of the scrap metal are carried out. The aim of the inspections is to prevent liquids or containers from being fed into the furnaces in connection with melting. The control measurements are conducted to verify that the material agrees with the melting specification.

The pre-treated metal is then stored on site until it can be melted.

MELTING

The metal is fed into the furnaces manually or using an overhead crane. After the furnace is filled, the slag is removed from the surface of the melt. Samples are then removed and analyzed to determine the remaining level of radioactivity in the ingots which are produced.

The induction process entails an automatic mixing and homogenization of the radioactive content of the melt while this process is achieved in the crucible furnace through the use of additives.

The melt is poured into moulds to produce ingots. Normally, 5 or 6 ingots weighing about 600 kg each, are produced from the steel melting process. Normally 4 ingots weighing about 150 kg each are produced through aluminium melting.

ANALYSIS OF SAMPLES

The samples, which are 50 mm in diameter and 30 mm high, are geometrically adapted to the calibration of the measurement equipment used in the analysis. All analyses are carried out in a specialist laboratory.

Only quantitative and qualitative gamma spectrometry analyses are carried out from scrap metal originating from nuclear power plants. When metal originates from other types of facilities or activities, and when required, alpha analyses are conducted.

The samples are stored until the ingots are given clearance.

HANDLING OF INGOTS

Ingots and samples for each batch are given a unique identification for further handling and followup. After the remaining radioactivity in the ingots is determined, it is decided whether the ingots can be given clearance immediately or whether and for how long they must be stored for decaying and subsequent clearance. The ingots are stored if clearance can be given within 20 years. In cases where ingots cannot be given clearance within 20 years, the ingots are returned to the owner.

RULES AND PROCEDURES FOR FREE RELEASE

Clearance can be given either on the basis of the Swedish Radiation Protection Institute's regulations or with special permission. In the case of clearance in accordance with regulations, the activity content (total activity) may not exceed 0.5 Bq/g of which no more than 0.1 Bq/g may consist of alpha-emitting nuclides. This clearance procedure results in the unrestricted reuse of the material.

Studsvik's procedure for clearance in the case of material with a radioactivity content of a maximum of 1 Bq/g (total activity) means, in cases where the activity content exceeds 0.5 Bq/g, that special permission must be granted by the regulatory authority.

WHY RECYCLING BY MELTING?

Based on the approach that an optimum management of the Earth's limited resources is necessary and that valuable material must be recycled as far as possible, melting of scrap metal is the safest way to determine the remaining radioactive content in the treated material. The reuse of metals also has environmental advantages compared with new production, since the consumption of electricity is lower.

ACCEPTANCE OF METALS RECOVERED FROM THE NUCLEAR INDUSTRY

In recent years, there has been resistance from the steel industry in connection with discussions concerning the reuse of metal scrap melted at Studsvik. In the steel industry, there is usually an understanding of the fact that the radiological risks associated with reusing this type of scrap metal are very low and much lower than other risks associated with the handling and use of scrap metal in general. However, there is concern for how third parties will react, i.e. those who will subsequently purchase and use products made from recycled metal. Unjustified anxiety and ignorance concerning radioactivity and radiological risks among the public may be the problem here. It is often the case that radioactivity related to the nuclear industry is not acceptable while naturally occurring radioactivity, e.g. in equipment from the oil industry, is acceptable.

SUMMARY

In just over 10 years, Studsvik has melted a total of about 4,200 tonnes of very low-level scrap metal generated by the nuclear industry. This has been conducted safely and reliably in compliance with the relevant regulations and conditions, avoiding the exposure of individuals to significant risks. Through the recycling of scrap metal as described above, the total risk is considerably lower than that incurred with new metal production, not to mention the added advantage of the environmental benefits of recycling.