Gained experience concerning the treatment of radioactive metal scrap from German nuclear power plants

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Introduction

Established in 1977, GNS Gesellschaft für Nuklear-Service mbH (GNS) has been tasked with the complete disposal of residual materials and waste from the German nuclear power plants of the four power supply companies in Germany. With more than 35 years of experience, it offers efficient solutions to meet the challenges of nuclear waste disposal, up to and including the decommissioning of nuclear facilities.

Along with the core competences in the area of cask development and manufacturing, the interim disposal of spent fuel rods, the operation of interim storage facilities, and the concept of the future final repository, another essential element of safe, sustainable disposal of radioactive waste by GNS is its radioactive waste treatment service. For the purposes of performing those tasks, GNS operates a number of different facilities and mobile devices which are able to treat radioactive wastes as required in order to render them suitable for a safe disposal in interim and final repository.

Motivation

In the course of decommissioning and dismantling nuclear plants, large quantities of radioactive contaminated and activated metals accumulate. For this material flow, the preferred approach in most cases is to make use of the release for further use. The melting process can be used to maximise the recovery of recyclable material while minimising at the same time the amount of radioactive waste generated. The recyclable material can be reused in the nuclear engineering area, e.g. in form of cask (MOSAIK® model) or shielding blocks. Alternatively it can also be reused in conventional areas.

If the radiological inventory makes it impossible, the waste will be disposed via a landfill site, or – as a last resort – treated as radioactive waste together with the process wastes, for the purposes for a safe disposal in interim and final repository. The rough basic process diagram is shown in Figure 1:

Figure 1: Process workflow for the disposal of metal scrap

From a technical standpoint, all metallic materials from a nuclear facility are more or less suitable for melting. The aspect of reuse as a primary objective must be taken into account, however; that objective is directly related to the existing activity inventory and the metallurgical composition of the material itself.

For optimal treatment results, it is advisable to establish a suitable method for determining the nuclide activity and a functional sorting process. This makes it possible to maximise the share of material suitable for recycling and release. On the opposite side, only a small part of radioactive waste will then be generated.

Transport

When shipping the metal scrap, along with the technical regulatory requirements and the export-specific legal regulations also the applicable cargo security guideline must be observed. The standard procedure by which GNS transports materials uses 20' IP-2 containers in the BOX or Open Hard Top variety. Depending on the degree of sorting, the metals are loaded as "loose bulk" in drums or transfer packages. An emphasis should be placed here on optimising the mass and volume of the loading configuration.

GNS has sent a total of 1.186 containers by means of 396 transports to three different melting facilities. A graphic representation of the container movements is displayed in Figure 2.

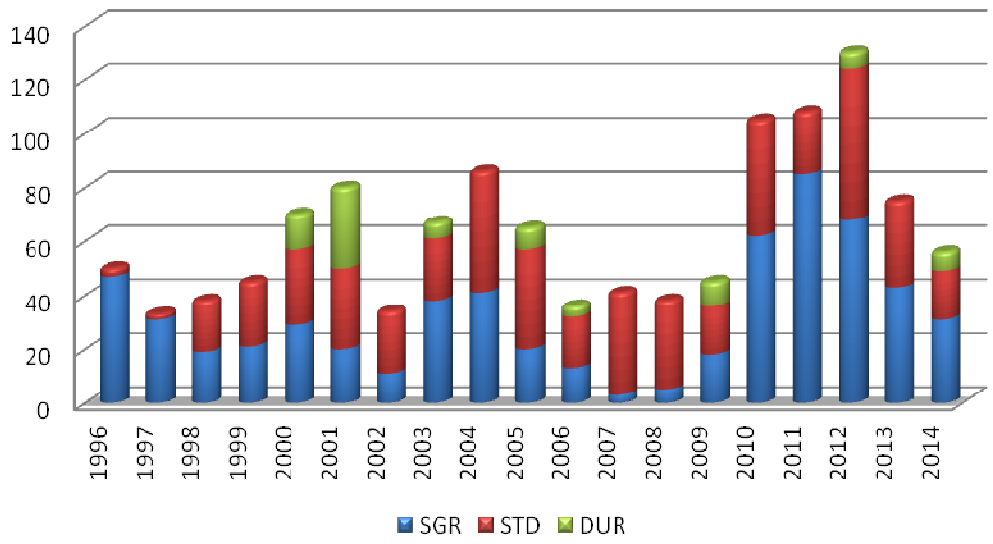

Figure 2: Number of 20' containers transported to different melting facilities

Within the framework of the transport, the ADR regulations requiring a classification according to the specific nuclide activity and according to the dose rate on the package. This process is carried out using the related UN numbers, whereby the main classes involved are those of the excepted packages (UN 2910) and as surface contaminated objects (SCO - UN 2913).

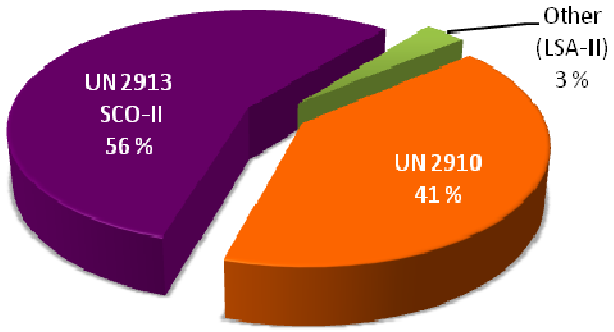

Figure 3: UN number distribution

Melting

If the material first undergoes pre-treatment at the point of origin, the requirements and necessity of additional procedures such as sorting, cutting and decontamination can be reduced accordingly. For that reason, particular emphasis should be placed on a targeted pre-treatment and original documentation at the point of origin, because this has a direct influence on the duration, cost and success of the external treatment process.

The melting process itself takes advantage of the following positive effects:

- Decontamination effect through possible separation of some of the radioactive contaminants from the material
- Reduction of the volume and mass of potentially radioactive waste
- Generation of inert, homogeneous, dry and inorganic products and process residues
- Simplified radiological and metallurgical characterisation of products and process residues for subsequent treatment and/or release
- Easier handling of products and waste after the process

Due to the effects mentioned here and given the primary objective of reusing the recyclable material, the German operators, experts and regulatory authorities consider the melting of scrap by GNS as an accepted method which has meanwhile become common practice. As a result, a total of 17.707 Mg of metal scrap (an average of 983 Mg/year) from an extremely wide range of nuclear facilities (dismantling and operation) and of extremely different quality levels has been processed by GNS over three different subcontracted melting facilities.

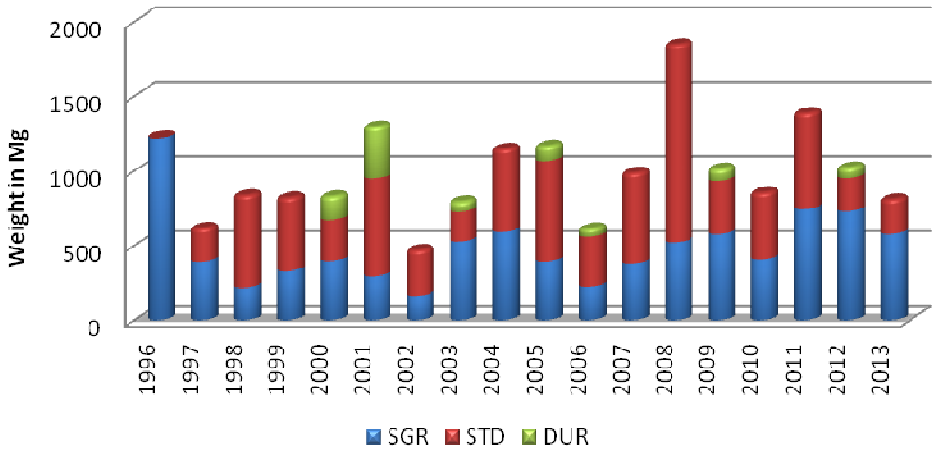

Figure 4: Overview of metal scrap processed

The resulting part of free releasable material is about 89% by mass (approx. 15.900 Mg), leaving only a total of 5% non-releasable material (approx. 830 Mg) and another 6% process residues (approx. 1.100 Mg), which represent together barely 11% of the remaining amount of radioactive waste.

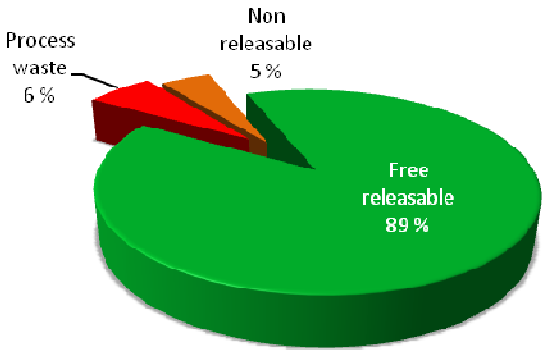

Figure 5: Ratio of free releasable to radioactive shares

Release

The recycling or release of the created process products (ingots) is regulated according to the valid permit of the melting operation in combination with the approved process of the nuclear facilities. All of these are based on the respective applicable legal regulations and ordinances and the settled limit values. The technical proof of the release itself will be practically done by radiological characterisation of samples by using a qualified measurement and calculation method.

According to the share of specific activity, in total approx. 16.000 Mg of releasable material is distributed among the individual release and recycling ways.

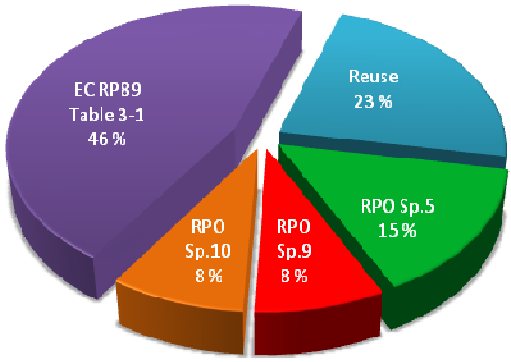

Figure 6: Percentage distribution of the different release and usage channels

Process residues

The occurred process residues consisting mainly from slag, filter dust, blasting and cutting residues and furnace lining, along with the ingots which are unsuitable for free release. In order to comply with the basic requirements applicable to radioactive waste, GNS further treats the process residues according to the final repository standards including packaging. This treatment process essentially includes drying, high-pressure compaction and packaging, and can further reduce the volume by as much as 2/3. The resulting waste packages holding sufficiently high quality in terms of the requirements for interim and final repository.

Conclusion

As a result of the gained experience over the course of many years in connection with the treatment of radioactive contaminated metal scrap, the radioactive waste management projects which GNS has carried out have earned it a high level of acceptance among the German operators, experts and regulatory authorities and have meanwhile become common practice.

The melting process is a proven means of maximising the recovery of recyclable material while minimising the radioactive waste which is generated. This conforms perfectly with the German Waste Management Act and is also beneficial in terms of interim storage capacity and the cost of future final repository.

With regard to the process waste, the GNS conditioning processes make it possible to safely produce waste packages according to high quality standards for secure interim and/or final future final repository.

All of the results demonstrate that the offered complete “care-free package” by GNS for the treatment of radioactive contaminated scrap via melting from the operation and dismantling of nuclear plants represents an efficient and future-oriented disposal channel,

….not only for German customers!

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