Some Impact of Melting Scrap for the Decommissioning of Nuclear Power Plant Stade

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Introduction

The German NPP Stade (PWR, 630 MW electric) was shut down in November 2003. After a transient phase the license for dismantling was granted in 2005. Until now, about 13,000 Mg have been dismantled in the controlled area. A share of about one third (4,200 Mg) was dedicated to be melted. The dismantling of NPP Stade is planned to be finished by the end of 2014.

The material dedicated to melting at SWT usually consists of surface contaminated low level metal scrap which in some cases has been pre-decontaminated by sand blasting prior to its shipment to the melting facility.

In general the molten scrap (ingots) is subject to clearance according the regulations given in RP 89.

In Germany, the GNS (Gesellschaft für Nuklear Service mbH) is in charge for the off-site waste management for German NPPs. GNS holds a license for the handling of radioactive waste. Among other things this license covers the treatment of secondary radioactive waste generated by melting and incineration. Therefore GNS is contractor to NPP Stade for melting of metallic low level waste and organizes all transports related to scrap and waste treatment at SWT. Studsvik Waste Technology (SWT) is an assigned subcontractor of GNS related to melting.

NPP Stade has the approval of the regulatory authority for the conditioning of radioactive residual materials and radioactive waste at SWT in Sweden. This permission includes the melting of metal scrap and the clearance for recycling (remelting) following the regulations according to RP 89 and transfer of ownership for molten material (ingots) which comply with the clearance values acc. to RP 89 and the German Radiation Protection Ordinance (StrlSchV). Remaining radioactive waste as well as secondary radioactive waste must be sent back to NPP Stade.

Both the license of GNS and the permission of NPP Stade are based on SWT’s permit for operation of the scrap melting facility.

The following chapters will describe the main criteria for deciding for this way of treatment and the reasons to melt or not to melt are discussed.

Main criteria to choose a certain option for treatment of contaminated material

Radioactive content of the waste

In general only material which will meet the clearance criteria after melting is sent to Studsvik. This condition is laid down in accordance with SWT’s acceptance criteria and SWT’s permit for operation of the scrap melting facility.

The clearance levels for recycling (remelting) according to RP 89 are about factor 10 higher than the levels for unrestricted clearance according to the German Radiation Protection Ordinance (StrlSchV)

Under certain conditions we are allowed to send scrap with higher level of Co-60 activity to Studsvik. In this case the scrap has to be decontaminated in Studsvik before melting. Finally the resulting ingots must also be acceptable for clearance. The decontamination residues are sent back to Germany together with all other secondary waste.

Other properties of the scrap

Once activity values allow a clearance of the material after melting, two other main properties of the metallic scrap has to be taken into consideration to find and decide for the optimal way:

- Material: In case of Studsvik facility, many kinds of metals are accepted as long as the amount of the batch is big enough to use the capacity of the oven. The scrap must be of pure metal or it must be easy to select the different kind of metals. Non-metallic content or coating is only allowed in restricted amounts. Any water is completely forbidden.
- Geometry: The geometry of the metal scrap must be acceptable and suitable for the oven. Especially cavities which may contain air must be excluded. Complex geometries are difficult to be measured for clearance and thus do not constitute an optimum for direct clearance. This leads in case of NPP Stade to the decision to prefer melting for small tubes and smaller parts with geometries which are not accessible for direct clearance measurements. Metallic parts and components with large surface and less mass are also preferred material for melting.

The geometry can be adapted by prior treatment which can be performed either at NPP Stade or at SWT facility. Therefore the properties of the scrap are evaluated in an overall cost optimization process together with the costs to fulfil the acceptances conditions of the melting facility.

Expected decontamination result of the desired treatment

One important criterion whether the scrap may be melted by the Studsvik melting facility is the remaining activity of the ingots. As a defined part of the activity will be separated to the slug or dust during the melting process, it is important to find out the remaining activity of the ingots. Therefore a simplified model for the separation is used. All Co-60 is assumed to remain in the ingots. All other nuclides are assumed to accumulate in the secondary waste. The resulted distribution for about 1,000 Mg ingots and 18 Mg dust and slag is shown in Figure 1 and 2.

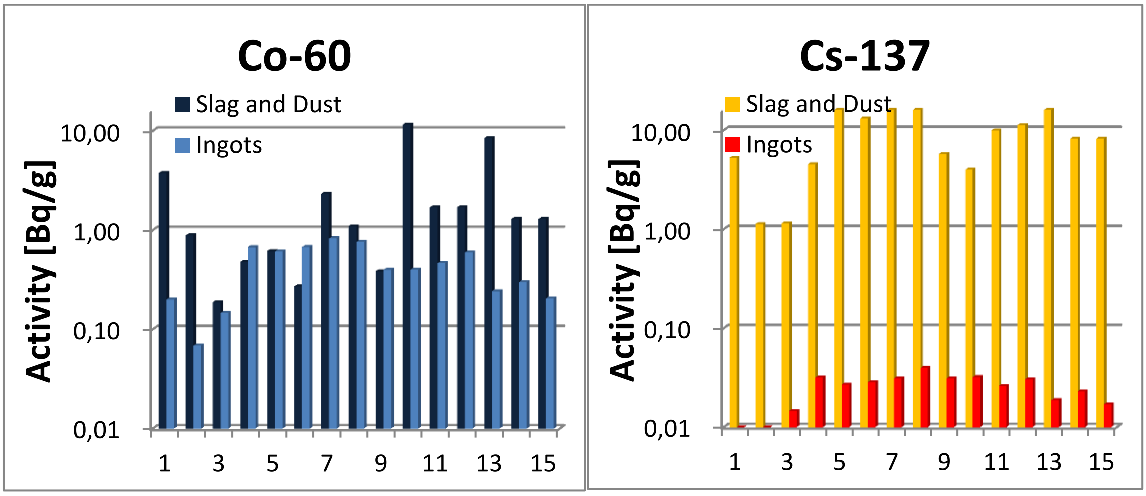

Figure 1 and 2: Specific activity in the ingots, the dust and slug after melting 1,000 Mg scrap

For ingots the amount of other nuclides than Co-60 and Cs-137 is negligible. Taking into account the amount of dust and slag is less than 2 % of the total mass, the simplified model is suitable for a first estimation of the remaining activity in the ingots.

Furthermore the figures 1 and 2 demonstrate that for the total 1,000 Mg of ingots the clearance level of the RP89 (1 Bq Co-60/g) has been achieved.

On the other hand, the simplified decontamination process of scrap and removal of all relevant nuclides beside Co-60 is an important advantage of the melting process. A second advantage is the easy way to determine the remaining activity in the ingots.

Acceptance criteria of the desired service facility

The most important points of the acceptance criteria have already been discussed above:

- Activity limits, for the SWT melting facility the resulting ingots must comply with the clearance levels according RP 89. Therefore radiological characteristics for the metal scrap are specified.
- Dimensions and geometries of the scrap are limited by the oven and due to safety aspects
- Only certain types of metal are accepted.

For facilities outside of Germany, the rules for cross-border transports of radioactive material as well as the export conditions have to be fulfilled in detail. Furthermore the requirements according to applicable law and license of the owner of the waste as well as export regulations for radioactive material must be respected.

As a consequence NPP Stade has to ask for different permissions and approvals which apply only to the requested service facility.

As NPP Stade cooperates also with other facilities a comparable set of permissions and approvals must be obtained for every single facility.

Availability of the desired service facility

The availability of a service facility may vary and change. Some reasons are

- No capacity for the special types of metal at a particular time
- The facility is temporarily closed down due to an incident
- Running out of one of the licenses
- Political influence or change of laws / regulations

In this case of non-availability, another service facility must be alternatively chosen or the scrap has to be treated on site at the NPP. Sometimes the scrap can be temporarily stored until the service facility is re-open or available for our scrap again.

Process reliability and stability

In order to fulfil all the mentioned conditions and licenses, a process has to be established. The quality is ensured by internal instructions and by different steps for quality assurance. The complexity of the process, the staff realising the process and more often the political acceptance of the authority has an important influence on the stability of the process.

Cost and efficiency of the process for the desired treatment option

The overall costs are influenced by all above mentioned criteria and factors. Not all parts of the costs can be calculated in advance and could change due to external impacts. These costs have to be estimated or are considered as a risk. In addition the influence on the general time schedule of the dismantling project must also be taken into account.

Long-term aspects (e.g. remaining waste amount, decay storage)

In Germany no final repository is available yet. All radioactive waste must be stored in intermediate storage and this increases additionally the costs for radioactive waste conditioning. Hence, to avoid the generation and to minimize the volume of radioactive waste is in general the most cost efficient way of waste treatment.

The melting of scrap reduces the amount of resulting radioactive waste. The secondary waste is chemical inert and main parts are quite compact. This facilitates the conditioning and preparation for the intermediate storage and the acceptance for final storage.

Another way to reduce the amount of radioactive waste could be decay storage connected with later clearance of this waste. For melted material with origin from countries outside Sweden a decay storage in Sweden is not accepted. If decay storage is applicable, other treatment options are preferred.

On-site or off-site treatment

Some of the mentioned criteria or facts generate the question, whether it would be more efficient to install a melting facility on-site at the dismantling project. For the realisation of such a on-site waste conditioning additional criteria has to be taken into account:

- Available space to perform the treatment on site
- Availability of the desired treatment before melting on site
- Knowhow and experience in melting of scraps
- Availability of the needed experts and staff members
- Influence on the time schedule due to the installation of the melting facility on site
- Surrounding licensing environment

- Security aspects
- Political aspects and acceptance

For large NPP components the question has to be asked vice versa. It may be a better option to send those components as they are to an external service facility and take advantage of the time the might be saved in the dismantling project schedule.

NPP Stade e.g. sent the steam generators (SG) as a whole to SWT. At SWT the SG (complete, primary and secondary system) were cut into parts suitable for melting. Before melting the material was separated to fractions suitable for clearance and radioactive waste. The melted radioactive waste as well as the secondary waste was sent back to NPP Stade and is now stored in our on-site intermediate storage building.

Summary

The presented criteria and facts give a quite complex view on relevant considerations to be taken in order to decide for a way of metallic scrap treatment. There is no option that represents the optimum for all NPP’s. Nevertheless, some general conditions can be identified:

- If the material is assumed to meet the criteria for unrestricted clearance and this can be proved with reasonable effort and in an economic way, the clearance will be performed on-site at the NPP. Non-metal material is also subject to conditional clearance (in Germany we have special clearance levels for disposal in landfills dumping or for incineration).
- If the clearance levels for unrestricted clearance are exceeded and the material is metallic scrap and the conditions of RP 89 will be fulfilled after melting, melting is the preferred option. Also for small tubes and scrap with complex geometries melting is often a preferred option (about 30 % of the dismantling masses is dedicated to melting),

As a large proportion of the dismantling masses is comprised of low contaminated metallic material the melting of radioactive scrap was one of the main economic aspects for decommissioning of NPP Stade.

The long lasting experience of NPP Stade regarding melting of metal scrap at SWT has shown that melting of materials outside the NPP is a cost efficient way of conditioning this kind of waste.