TREATMENT OF DISUSED RADIOACTIVE SOURCES IN LOWER SAXONY GERMANY FOR STORAGE AND DISPOSAL

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ABSTRACT

Spent and disused radioactive sources in the Federal Republic of Germany are collected for interim storage in the respective state collecting points (Landessammelstelle). As a disposal site the planned underground repository Grube Konrad is foreseen. The paper will describe the practice of the management of spent and disused radioactive sources in the state of Lower Saxony.

The paper will provide a list and a description of commonly-used radioactive sources in Lower Saxony. At the end of their useful life, the radioactive sources are recycled or treated for storage in the state collecting point of Lower Saxony. The various options used for treating the sources and the practice for the supervision by the authority will be described. The pre-treated sources will be super compacted or cemented in small containers with standardized dimensions and packed in drums together with super compacted low active dry waste.

The storage facility for sources and institutional waste in Lower Saxony will be presented in the paper. Possible methods for conditioning the stored drums for a final disposal will be discussed.

Institutional Waste in Germany

The radioactive waste disposal policy in Germany has been based on the decision that all types of radioactive waste are to be disposed of in deep geological formations. Near-surface disposal or shallow land burial is not practiced in Germany because of the high population density and climatic conditions; furthermore appropriate deep geological formations exist.

In performing its federal supervision, the BMU is supported by the Federal Office for Radiation Protection (Bundesamt für Strahlenschutz - BfS) in all matters concerning nuclear safety and radiation protection. The BfS is responsible for the construction and operation of nuclear waste repositories. The responsibility for the disposal of radioactive waste lies with the federal government, the BfS is the legally responsible authority. Therefore all methods for the treatment of radioactive waste and for the conditioning of waste packages for disposal have to be approved by the BfS. All other radioactive waste management steps, i.e. the treatment of operational waste or the spent fuel interim storage, are within the responsibility of the waste producers. The states have to construct and operate regional state collecting points for the interim storage of radioactive waste originating, in particular, from radioactive applications in industry, universities or medicine. The owners of this institutional waste have to deliver the waste to the state collecting facilities and they have to pay a fee. With this payment the ownership and the responsibility for the safe storage and the conditioning is transferred to the state.

Institutional Radioactive Waste in Lower Saxony

With an area of 47,618 km² (18,400 sq miles) and nearly eight million inhabitants, Lower Saxony (Niedersachsen) lies in north-western Germany and is second in area and fourth in population among the country's sixteen states (Bundeslaender).

Radioactive materials are used in Lower Saxony outside of the nuclear industry in research institutes, medical installations and in commercial business. There are approximately 400 users in research and medical institutes and 700 users in commercial businesses. In the commercial business area sealed sources are predominant compared with other radioactive materials. In the year 2001 ca 1400 sealed sources, used in Lower Saxony, were tested for tightness.

The activities of these sealed sources extend over a broad range. The maximum activity content of Co-60-sources is 400 TBq (11 kCi), Cs-137-sources have a maximum activity of 90 TBq (2,5 kCi). Most of the source activities are much lower. Figure 1 shows a percentage distribution of the main radionuclides in radioactive sources in use in Lower Saxony in 2001. Additionally, minor distribution sources contain radionuclides like Ba-133, C-14, Tl-204, Na-22, Fe-55, Ru-106, Gd-153, Ra-226/Be, Cf-252, Ge-83, Pu-238, Cd-109, I-129, Sm-151, Bi-207 and Pu-239.

In rare occasions orphan sources are found, these are often small sources for education purposes and old Ra-sources which were in use decades ago.

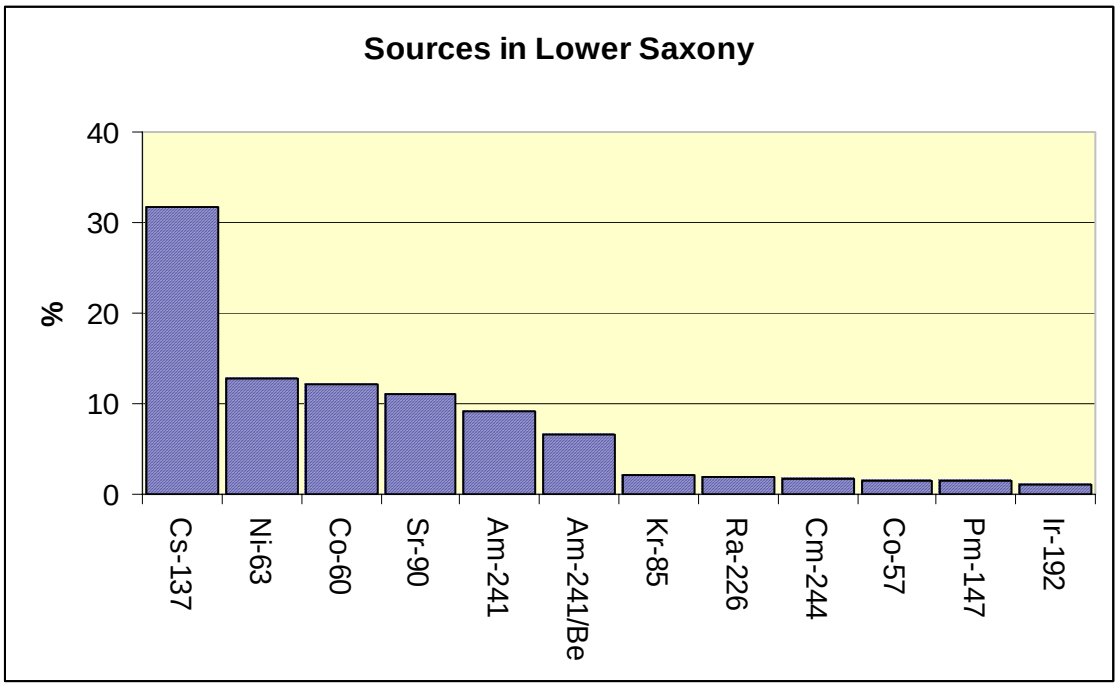

Fig. 1. Sources in Lower Saxony

The main purposes for the use of radioactive sources in Lower Saxony are listed in the table I.

Table I. Examples of Applications of Sources in Lower Saxony

Application	Radionuclide
Calibration facilities Sources as standards	Am-241, Sr-90, Cs-137, Tl-204, Ba-133, Ra-226, Na-22, Pb-210, Co-60
Thickness gauge, level gauge, density gauge	Cs-137, Co-60, Am-241, Sr-90, Kr-85, PM-147, C-14
Education, demonstration	Co-60, Kr-85, Na-22, Cs-137, Sr-90, Tl-204, Ra-226, Th-nat, U-nat
Smoke detector	Am-241, Ra-226
ECD	Ni-63
Brachytherapy, radiotherapy	Ra-226, Sr-90

Some of the radioactive materials from the above mentioned institutions are decayed after their use or they need a relatively short period of decay for clearance. Waste containing radionuclides

with longer life times is to be treated for interim storage and disposal after use. The owner of the radioactive waste transfers the waste to the state collecting facility for treatment and storage.

After the transfer of the waste and after the payment of the aforementioned fee to the state the owner is no longer responsible for the waste. The fee has to cover the costs for the treatment, storage and disposal of the waste. It is in the interest of the state of Lower Saxony to calculate this fee in a reasonable way. Necessary expenses for the treatment, the storage and the future disposal which are not covered by this fee are a burden for the taxpayer. Unnecessary amounts will obstruct the industry and the research in Lower Saxony, additionally a high fee will not improve the tendencies of the waste owners to deliver the used sources to the state collecting points. Therefore an inexpensive way for treating the waste is needed. The concept for the conditioning of the waste also has to take into consideration the volume of the waste packages to minimize the costs for disposal.

The treatment of the radioactive waste from facilities in Lower Saxony outside the nuclear industry is done by a service company, the Gesellschaft für Nuklear Service mbH (GNS). This company operates different installations for the treatment of radioactive waste in the research centre Jülich. Disused radioactive materials in Lower Saxony are stored in the storage facility in Leese, a village approximately 60 km (38 miles) north of Hannover. This facility can be used for the waste packages of the state collecting point. The Ministry for Environment in Lower Saxony (Niedersächsisches Umweltministerium – NUM) is responsible for the waste. Additionally radioactive waste packages can also be stored in interim storage facilities in Gorleben or in Jülich.

Fig. 2. Interim storage in the state collecting point, Leese

The waste packages have to be suitable for a long term interim storage, the treatment of the waste and the production of the packages have to be qualified for the interim storage in the mentioned facilities on behalf of the Ministry for Environment in Lower Saxony. Complementary the waste treatment has to be qualified for disposal due to the German radiation protection ordinance by the BfS. The evaluation of reports for the qualification of waste treatment processes for storage and disposal is done by experts of TÜV EnSys Hannover.

Requirements for Interim Storage

The treatment of sources as radioactive waste will be done in two steps. First the sources are treated for the interim storage. The second step will include the conditioning of the interim packages for final disposal. Therefore for the treatment of the sources for the interim storage the acceptance criteria for the disposal site Konrad have to be observed too. Different methods for the processing of the sources will be chosen in relation of activity limits. Sources with lower activity contents will be mixed with dry waste, supercompacted and packed into 200-l-drums (55 gallons). Sources with higher activities will be mixed with concrete in small barrels, suitable for packing in 200-l-drums. If necessary an additional shielding of concrete can be provided.

Waste packages for the interim storage in Leese have to keep the dose and contamination limits of the transport regulations and the mass limits according to the licensing of the drums. Additionally the drums have to be suitable for long term storage. Therefore the corrosion

protection of the coating will be assessed. Up to now three different types of drums are admitted for the storage in Leese.

Requirements for Disposal

200-l-drums are not permitted for disposal in the planned repository Grube Konrad in Germany. Therefore the conditioning for disposal will be done by packing these drums into rectangular containers with an approval by the Federal Office for Radiation Protection. For the institutional waste from the state collecting point the use of containers type IV (figure 3) is planned.

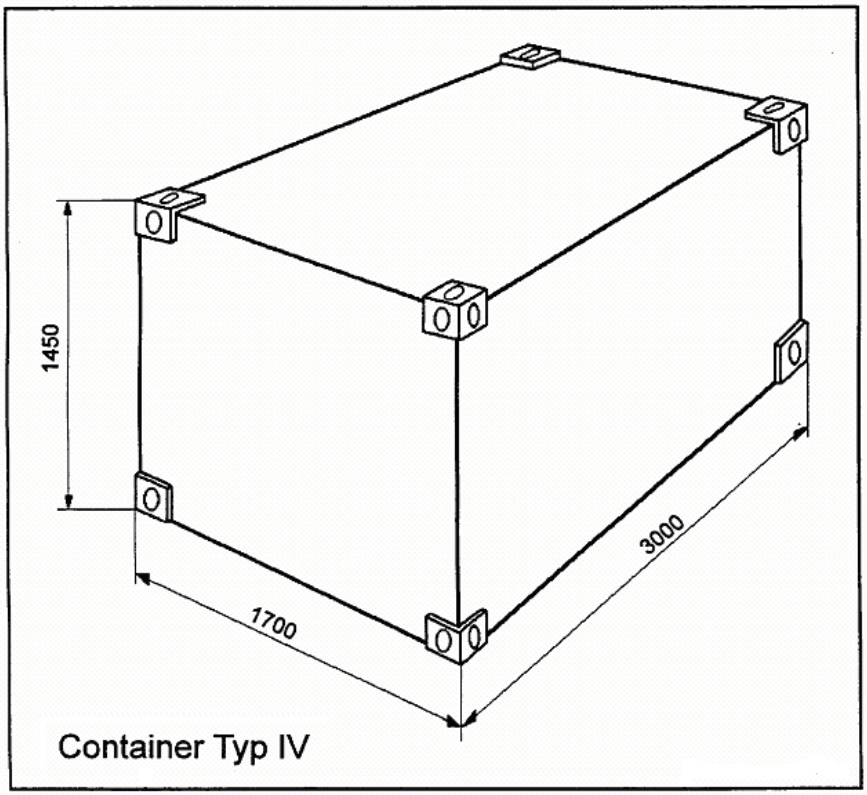

Fig. 3. Container for disposal in the planned repository Konrad

The container Typ IV is made from carbon steel with a protective coating inside and outside. The container has enough space for packing of up to 14 drums. As a result of incident analyses for the repository Konrad different activity levels according to the properties of the waste product and the waste container are admitted. It is possible to fill the container with 14 drums of compacted low active waste. For packing of waste with greater inventories the waste product quality has to be improved, e. g. by cementation. It is also possible to condition the waste packages with an inactive outer layer of concrete to achieve an accident proof package. This

accident proof package has space for only eight drums with a higher inventory of radionuclides. According to these kinds of waste treatment different activity inventories were calculated. The following table II shows examples for the acceptance criteria for the state collecting point depending on different treatments, the nuclide and the activity of the source.

An appropriate fee will be calculated for these standardized methods of treatment. It is also possible to accept and treat sources with higher inventories of radionuclides. In these cases a singular concept for treatment and a special fee have to be worked out.

Table II. Activity Limits for Different Sources and Different Treatments due to Disposal Acceptance Criteria

Nuclide	Max. activity / source	Treatment	Packing
Co-60	1,6E+10 Bq (0,43 Ci)	Supercompaction	14 drums / container
Sr-90	2,7 E+09 Bq (0,07 Ci)		
Am-241	2,3 E+09 Bq (0,06 Ci)		
Co-60	5,0 E+10 Bq (1,4 Ci)	Cementation	14 drums / container
Sr-90	8,6 E+09 Bq (0,2 Ci)		
Am-241	7,6 E+09 Bq (0,2 Ci)		
Co-60	5,0 E+11 Bq (13,5 Ci)	Cementation / Supercompaction	8 drums / container (accident proof)
Sr-90	8,6 E+10 Bq (2,3 Ci)		
Am-241	7,6 E+10 Bq (2,1 Ci)		

Treatment of Disused Sealed Sources

Disused radioactive sources are treated in relation to the nuclide and activity content (see table II). Sources with relatively low activity content are treated together with dry low active waste. They are filled together with the waste in 180-l-drums and super compacted. The resulting pellets show a good volume reduction and sufficient waste properties to fulfil requirements for interim storage and disposal. The super compactor produces pellets suitable for packing in 200-l-drums, as shown in the picture of the interim storage facility in Leese (figure 2).

Waste and sources with higher activity content have to be treated in a different way to realize a better waste product quality for compliance with the acceptance criteria of the repository Grube Konrad. The used sources have to be embedded in concrete. To facilitate this in an easy and inexpensive way small drums made from carbon steel are used for the fixation of the sources. These drums have similar dimensions as the pellets with super compacted waste so they can be packed in ordinary 200-l-drums. Figure 4 shows the testing of the treatment by cementation of

inactive dummies. One can see the small drum filled half with a layer of concrete and some dummy sources. Behind the drum an ordinary 200-l-drum for packing of the cemented sources and of super compacted waste is shown.

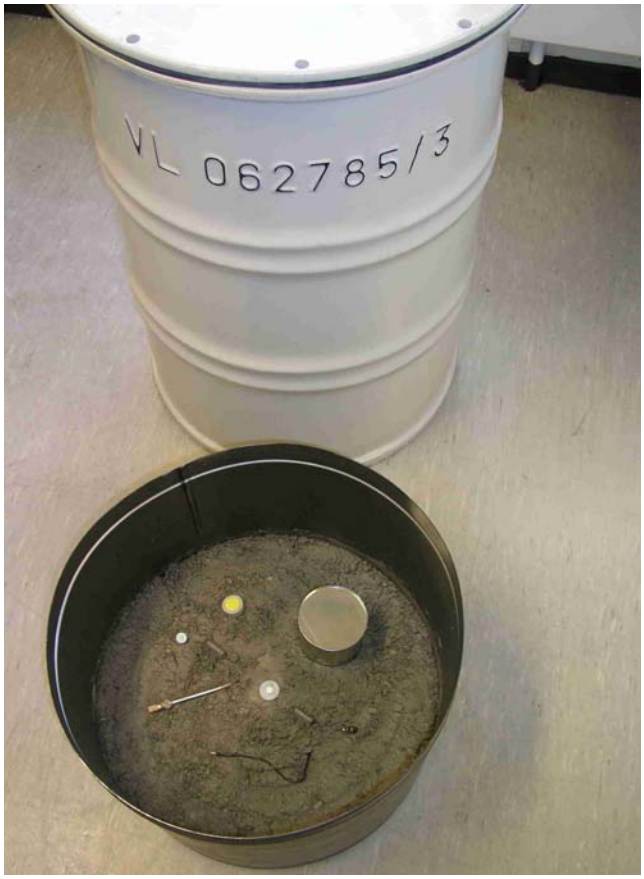

Fig. 4. Cementation of dummy sources

The 200-l-drums are used for the interim storage. The conditioning of these drums for the final disposal will be done immediately before the disposal by packing the drums into rectangular containers.

Quality Assurance of Waste Packages with Radioactive Sources

The service company GNS illustrates the characterization and treatment of the waste and the used sources in a process sequence plan. This qualification plan describes each planned waste treatment step and defines the tasks and the responsibilities of the different parties. It is submitted to the federal authority, the Federal Office for Radiation Protection (BfS) and to the state authority, the Ministry for Environment in Lower Saxony. Additionally the TÜV EnSys

Hannoverexperts perform an assessment on behalf of the federal authority to verify the suitability of the waste products and waste packages for disposal in the planned repository Grube Konrad. The qualification plan is assessed by experts from TÜV EnSys Hannover on behalf of the state authority in relation of the requirements for long term storage in the facility of the state collecting point in Leese. Both authorities approve the process sequence plan.

The treatment of the waste will be performed in separate campaigns. After the GNS has received enough waste and sources for performing a campaign, the documentation of these materials, together with some details concerning the planned treatment (compaction or cementation), is sent to TUV EnSys Hannover.

The treatment of the sources according to the approved qualification plan is verified by independent experts in the treatment facility of the GNS.

The properties of the treated sources and low active dry waste are documented. The documentation will be checked by the TÜV EnSys Hannover experts. After verification of compliance of the waste properties with the requirements for long term storage in the interim storage facility in Leese and the acceptance criteria for disposal in the planned repository Grube Konrad approval is given by the named authorities.

CONCLUSIONS

The legal frame for the management of radioactive waste not coming from the nuclear industry in Germany is summarized. The situation in Lower Saxony, one of the states in Germany, concerning the uprising of disused spent radioactive sources was analysed. For the treatment of radioactive sources methods had to be developed which are not expensive and which will lead to packages suitable for a safe long term interim storage and a later disposal in the planned German repository Grube Konrad. In relation to the activity content the sources will be super compacted or cemented. The container for the interim storage will be a standard 200-l-drum. For later disposal the use of rectangular containers is planned.