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Challenges in Compliance with the Waste Acceptance Requirements for the KONRAD Mine – 10046-rev

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ABSTRACT

This contribution to the group of “LLW, ILW, MW, NORM and TENORM Posters“ describes the challenges arising with the quality control required for the disposal of radioactive waste in the German repository KONRAD [1]. The licence for operating the KONRAD repository had initially been contested by opponents of disposal, but final court decision of 26 March 2007 established that the repository in the former iron ore mine KONRAD may be operated for the disposal of low- and intermediate-level radioactive waste from 2013. Preparations are currently being made in Germany for the delivery of waste packages to the KONRAD repository.

The demonstration of the suitability of the KONRAD mine as a repository proved particularly difficult with respect to legacy waste, for example, in the case of poor documentation of this legacy waste. The declaration of the radionuclides contained in that waste generally no longer fulfils the standards now required. Furthermore, it proved difficult to verify the assignment of the waste products created in the past to the waste product groups (WPGs) defined for KONRAD [2]. Another problem associated with the quality control of the legacy waste is the requirement that waste packages should be delivered to the KONRAD [2] repository in a depressurized state. In order to fulfil this requirement, it must be ensured that there is little or no gas formation (e.g. due to the decomposition or fermentation of organic matter). Conditioned waste has already been cemented into the packages for disposal so that it is very difficult to provide sufficient proof that this requirement has been complied with.

Beginning in the 90s, radioactive waste was already conditioned in accordance with the draft KONRAD waste acceptance requirements published in 1990. A large volume of the waste produced at that time was packed into containers that were manufactured considering the 1990 requirements. However, the fulfilment of the KONRAD waste acceptance requirements has to be demonstrated prior to emplacement.

Finally, the declaration of substances of relevance for legislation relating to water [3] is a topic of current interest. This requirement must be fulfilled for both newly conditioned waste and also for legacy waste.



Fig. 3: Gamma scanner



Fig. 4: Tomograph

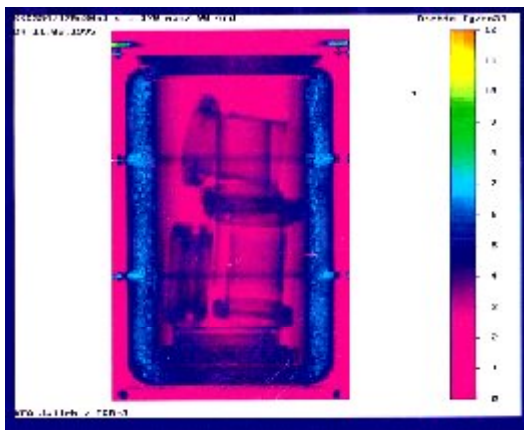


Fig. 5: Tomogram

VERIFICATION OF WASTE PRODUCT QUALITY

The KONRAD waste acceptance requirements [2] classify the radioactive waste into so-called waste product groups (WPGs). 6 waste product groups with individual requirements are defined:

- WPG 01 (e.g. bitumen and plastic products),
- WPG 02 (e.g. solids),
- WPG 03 (e.g. metallic solids),
- WPG 04 (e.g. compacted pellets),
- WPG 05 (e.g. cemented waste),
- WPG 06 (e.g. concentrates).

However, certain requirements for the waste product group have to be fulfilled in assigning the waste to one of the WPGs. For example, in order to be classified in waste product group 1 the waste must fulfil the basic requirements in accordance with the KONRAD waste acceptance requirements [2]. The waste must be in a solid form. It must not be decomposing or fermenting.

In the same way, except for reasonable and unavoidable residual amounts, the waste products

- must not contain liquids nor gases in ampoules, bottles or any other containers,
- must not contain freely moving liquids nor must it be possible for any such liquids or gases to be released under the usual storage and handling conditions,
- must not contain any self-igniting or explosive substances.

In most cases this can be verified by the documented conditioning or by the conditioning process.

However, it is frequently a problem to assign legacy waste products that have already been created to higher waste product groups in accordance with KONRAD requirements.

Example of verifying the waste product group

For example, in order to assign waste into WPG 04 (compacted pellets), it is not sufficient to verify that the waste has been supercompacted. Further information such as compacting pressure (> 30 MPa) or information on the compaction cassettes is necessary. The compaction cassette must therefore have a minimum wall thickness of 0.75 millimetres and must not display any distinct cracks or chips (mass fraction of “non-metallic” constituents max. 1 %). The activity adhering to the outside of the pellet must not exceed 1 % of the activity of the pellet. It turns out to be meaningful to pack legacy pellets into (qualified) drums thus ensuring that there are no distinct cracks or chips and that there is no release of activity. This waste is assigned to waste product group 02. This thus complies with the protective aim of waste product group 04. This procedure enables the higher activity limits of waste product group 04 to be exploited. The disadvantage is that the waste containers cannot be so densely loaded.

If the waste were not packed in drums considerably more supercompacted waste could be loaded into a waste package. Verification of cracking and adhering activity is, however, also difficult for newly generated supercompacted waste (Figure 6). Although verification can be performed by a visual inspection and wipe test during conditioning this procedure is time-consuming and, due to the additional wipe tests, means that the operating staff are exposed to increased radiation exposure.



Fig. 6: Pressing in the supercompaction facility

Alternative verification by the use of polyurethane coating

An alternative to verification is coating the supercompacted waste with pyrolysing polyurethane (Figure 7). This procedure is used for compacted pellets containing aluminium and has been evaluated positively in an expert review. However, since the coating is very expensive this procedure has only been used for waste in cases where it was appropriate for other reasons (e.g. for hygroscopic waste).



Fig. 7: Pellet coated with polyurethane

The problem of demonstrating the suitability of waste for disposal in the KONRAD repository has been demonstrated by the example of supercompacted waste. The verification of legacy waste products has also proved difficult for other waste product groups, e.g., in the case of cemented waste of waste product group 05. The compressive strength required for the cemented waste product of 10 N/mm² can be relatively easily determined by measurements at the cemented surface. In contrast, the uniform incorporation of the radioactive waste in the cement matrix is very difficult to verify. A permitted possibility to demonstrate the homogeneity are dose rate measurements [1], that are used regularly for this purpose. The values measured as the waste package should be as homogeneous as possible.

DELIVERY IN A DEPRESSURIZED STATE

Another problem arising with the quality control of the legacy waste is the requirement that waste packages should be delivered to the KONRAD repository [2] in a depressurized state. In order to fulfil this requirement, depressurizing must be performed (e.g., by using special filters) or it must be ensured that there is little or no gas formation (e.g., due to the decomposition or fermentation of organic matter). This can be verified relatively simply for newly produced packages or when loading KONRAD containers with waste products. However, already conditioned waste is also present in cylindrical concrete shieldings (serving as a licensed waste package for the repository), which was cemented without depressurization measures (Figure 8). For this waste it is very difficult to provide sufficient proof that this requirement has been complied with. On the basis of analogous considerations of the same type of waste that has not yet been cemented, it is possible to perform calculations of pressure build-up in the cemented waste. However, due to the large number of factors involved in the calculation, this is very difficult and cannot be successfully performed in every case.

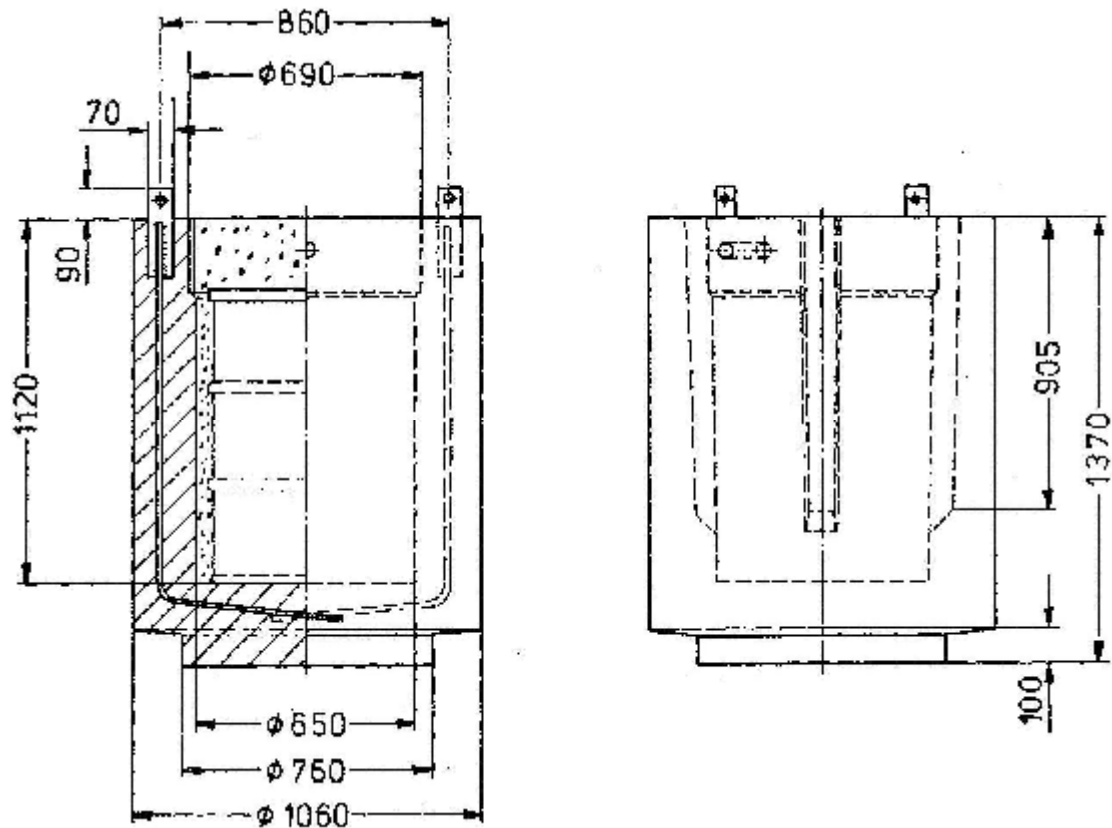


Fig. 8: Waste product cemented in lost concrete shielding without pressure relief

Packages which cannot be verified must be re-conditioned in a laborious process.

CONTAINER LICENSING

The problems of verifying waste packages that have already been conditioned also continue with respect to the containers used. Beginning in the 90s, radioactive waste was already conditioned in accordance with the draft KONRAD waste acceptance requirements published in 1990. A large volume of the waste produced at that time was packed into waste containers that were manufactured considering the 1990 requirements. However, the fulfilment of the KONRAD waste acceptance requirements has to be demonstrated prior to emplacement. Even the quality-assurance measures and the documentation of container fabrication represent a problem for the requalification of legacy containers already in use. After a device for securing the lid failed to withstand the load in a drop test for verifying a repository container the design of this device was modified. For containers fabricated before the lid design was modified a suitable replacement must be developed for the device securing the lid so that these containers can comply with requirements. The different lid designs are shown in Figures 9, 9a and 10.

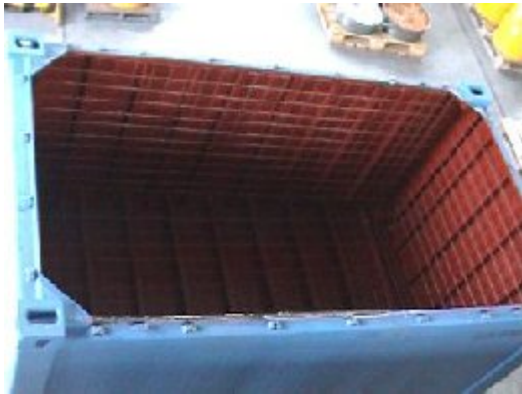


Fig. 9-9a: Old design of KONRAD container (lid not screwed on)



Fig. 10: New design of KONRAD container (lid screwed on)

Verification of the materials used to fabricate these containers must also be provided. Without such verification the containers cannot be emplaced in the repository. The contents must then be reloaded into licensed containers. At the moment, alternative measures are being developed for the devices securing the lid since for reasons of radiation protection it is not desirable to reload the waste.

SUBSTANCES RELEVANT TO WATER LEGISLATION

Finally, consideration should be given to a topic of current interest – the declaration of “substances of relevance with respect to water legislation”. This requirement must be fulfilled for both newly conditioned waste and also for legacy waste. Figure 11 shows an excerpt from the list of description and declaration thresholds for substances in accordance with List 1 of the Appendix to the Groundwater Directive [3].

| Stoff | Beschreibungsschwellenwert | | Deklarationsschwellenwert | |
|---------------------------------------|----------------------------|-----------|---------------------------|-----------|
| | Neuabfall | Altabfall | Neuabfall | Altabfall |
| Nr. 1 der Liste I | | | | |
| Halogenierte Naphthaline | 0,1 | 0,5 | 0,1 | 0,5 |
| Halogenierte Phenole | 0,1 | 0,5 | 0,1 | 0,5 |
| Biphenyle | 0,01 | 0,05 | 0,01 | 0,05 |
| Hexachlorbenzol | 0,01 | 0,05 | 0,01 | 0,05 |
| γ Hexachlorcyclohexan (Lindan) | 0,1 | 0,5 | 0,1 | 0,5 |
| Nr. 2 der Liste I | | | | |
| Phosphorsäureester | 1 | 5 | 1 | 5 |
| Tributylphosphat | 1 | 5 | 1 | 5 |
| Dibutylphosphat | 1 | 5 | 5 | 5 |
| Hexamethylphosphorsäuretriamid | 1 | 5 | 5 | 5 |
| Nr. 4 der Liste I | | | | |
| Na-Ethylendiamintetraessigsäure | 0,1 | 0,5 | 0,1 | 0,5 |
| Ethylendiamintetraessigsäure | 0,3 | 1,5 | 0,3 | 1,5 |
| Na-Nitilotriessigsäure | 1 | 5 | 1 | 5 |
| Gold | 1 | 5 | 2 | 25 |
| Caesium | 1 | 5 | 5 | 5 |
| Lithium | 1 | 5 | 1 | 5 |
| Platin | 1 | — | — | — |
| Rubidium | 1 | 5 | 5 | 5 |
| Strontium | 1 | 5 | 25 | 25 |
| Nr. 5 der Liste I | | | | |
| Quecksilber | 1 | — | 1 | 5 |

Fig. 11: List of description and declaration thresholds [3]

Since a draft of the requirements to be fulfilled has only been available since October 2009 it is difficult to comment finally on the verification demanded. It does, however, seem apparent that in this case as well it will be more difficult to provide verification for waste packages that have already been produced than for those yet to be fabricated. As in the preparation of documentation described above, the main problem here will probably also be the quality of the legacy documentation.

In accordance with the KONRAD Water Law Permit (appendix 4 to the KONRAD license), no analysis of the waste product itself for verifying the substances of relevance for water legislation is required. Verification will have to be provided by plausibility checks and analogous considerations.

CONCLUSION

The fulfilment of the KONRAD waste acceptance requirements is a challenge for a part of the legacy wastes.

However, today much more stringent requirements have to be met for waste packages to be emplaced in KONRAD. Nevertheless, these requirements allow several possibilities in order to be fulfilled.

REFERENCES

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