Implementation of Control Measures for Radioactive Waste Packages with Respect to the Materials Composition - 12365

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ABSTRACT

In addition to the radiological characterization and control measures the materials composition has to be described and respective control measures need to be implemented.

The approach to verify the materials composition depends on the status of the waste:
- During conditioning of raw waste the control of the materials composition has to be taken into account.
- For already conditioned waste a retrospective qualification of the process might be possible.
- If retrospective process qualification is not possible, legacy waste can be qualified by spot checking according to the materials composition requirements

The integration of the control of the material composition in the quality control system for radioactive waste is discussed and examples of control measures are given.

INTRODUCTION

On May 22nd 2002 the license for the Konrad repository for the disposal of radioactive waste with negligible heat generation was issued. In addition to the radiological limits the license also limits the inventory of 94 non-radioactive substances relevant for ground water protection. To ensure the compliance with these limits a methodology to describe and control the materials composition of radioactive waste packages was developed [1].

With the approval of the methodology by the competent authority with respect to the water law (Lower Saxony Water Management, Coastal Protection and Nature Conservation Agency, NLWKN) on March 15th 2011 revised waste acceptance requirements for the Konrad repository containing requirements on the description and declaration of non-radioactive constituents were put into force [2].

The Federal Office for Radiation Protection (BfS) provides a material-list and a packaging-list as the central tools for the description, declaration and control of the materials composition of radioactive waste packages [3].

MATERIAL-LIST

The material-list contains the 94 substances limited in the license, basic materials that might appear in radioactive waste packages and material-vectors that describe common waste streams. Every entry of the material-list includes the following information:

Name	Description	Relevant for control measures
Unique code	Unique code for the data set entry. This code has to be used for the description of the material composition by the waste producer	
Formula, name, material number	This information gives further notations for the material such as chemical formulas, trade names, material numbers or codes from national or international standards	
Approval status	Indicator for the status of the approval procedure. Approved data set entries are marked with “g”, and only these entries may be applied for further use	
Auxiliary parameters	Characteristic quantity for the assignment for a material to a waste component, e. g. pH value, solid fraction of liquid concentrates etc.	X
Validity range	Potential restrictions for the use of the data set entry	X
Composition	Fractions of materials, of which the respective material consists. All materials of this vector must be part of the materials list	
Description threshold value	Fraction of the material in the waste, from which the respective material has to be considered in the material description of the waste	
Declaration threshold value	Fraction of the material in the waste, above which the respective material is considered to be harmful to the near surface groundwater. The declaration threshold values are computed on the base of solubility and other specific material properties. A value of 101 % is assigned to materials not harmful to the near surface groundwater	
Recording threshold value	Below the recording threshold value a waste is regarded as free of the respective material	
Frequency of occurrence	Fraction of a waste package or a group of waste packages in which the respective material may occur	
Control measures	Control measures necessary to verify the material composition	X
Solubility	Solubility of the material in pure water at 20 ºC	

PACKAGING-LIST

The packaging-list contains all relevant information on containers for the disposal in the Konrad repository (both inner and outer containers) with their composition. For every listed container the following information is included:

- unique code
- description of the container
- tare mass
- drawing number
- qualification number
- material composition

CONTROL MEASURES

With respect to control of the materials composition radioactive waste can be divided into three categories:

1. Unconditioned radioactive waste:
   The treatment and packaging has to be performed according to a qualified process. The materials composition has to be taken into account during **process qualification**.

2. Conditioned waste products being qualified with respect to the radiological requirements:
   In the past, processes for the conditioning of radioactive waste were qualified according to the radiological requirements without taking into account the materials composition. The control measures were aimed at the radiological relevant properties of the waste products. Even though the materials composition was not taken into account during process qualification and accompanying control it might be possible to utilize the performed control measures for the qualification of the materials composition. For this purpose a **retrospective process qualification** with respect to the materials composition has to be carried out.

3. Legacy waste that has been conditioned without process qualification:
   Legacy waste being conditioned without process qualification and lacking dedicated independent control measures need to be qualified by **spot checking** according to the radiological and the materials composition requirements.

Process Qualification

For the treatment and packaging of radioactive waste qualified processes are mandatory according to § 74 (2) of the radiation protection ordinance [4]. The control of the materials composition has to be considered within the process qualification. Possible control measures are defined as part of the entry in the materials list and approved by NLWKN as the competent authority with respect to the water law. Specific control measures have to be implemented as part of the qualified process based on the respective entries in the materials list. These control measures are subject to inspections by independent experts during conditioning.

Retrospective Process Qualification

Since about 30 years qualified processes are applied during the conditioning of radioactive waste. Requirements on the control of the materials composition were implemented very recently. Therefore reasonable amounts of radioactive waste were conditioned and qualified with respect to the radiological requirements, but not to the materials composition.

For already conditioned radioactive waste products the materials composition has to be verified. For waste products being conditioned by qualified processes with respect to the radiological requirements it might be possible to retrospectively qualify the conditioning process and the

products with respect to their non radioactive constituents. It has to be assessed whether the control measures together with the inspections already carried out are sufficient compared to the control requirements as defined in the materials list.

Spot Checking

For legacy waste that was conditioned without process qualification and where retrospective process qualification is not possible spot checking is the only option for the qualification of the radiological properties and the materials composition. According to the requirements on radiological control measures [5] between 0.5 % and 12 % of the waste products have to be checked. It is expected that the amount and scope of the radiological control measures is sufficient to verify the materials composition [6].

EXAMPLES FOR CONTROL MEASURES

Example 1: Process qualification

Evaporator concentrates are a common liquid waste stream from the operation of nuclear power plants. To be disposed of in the Konrad repository solidification is required. With respect to volume optimization drying is the preferred treatment.

For reliable operation of the drying process routine analyses are performed. A typical set of parameters to be determined is:

- solid content
- dry residue
- density
- pH value
- organic fraction
- boron content

Even though these parameters do not provide enough detail on the materials composition, they can represent auxiliary parameters to demonstrate an unchanged composition of the liquid raw waste. Together with the origin of the evaporator concentrate (e. g. from the operation of a pressurized water reactor) and specified drying conditions the dried product can be assigned to a specific entry of the materials list.

A promising approach with respect to the control of the materials composition could be to create an entry in the materials list with the following basic content:

Field	**Content**
Formula, name, material number	Dried evaporator concentrates from the operation of a pressurized water reactor
Auxiliary parameters	- solid content - dry residue - density - pH value - organic fraction - boron content

Field	Content
Validity range	Not for other dried liquid waste
Control measures	The auxiliary parameters have to be determined as part of the qualified process and need to be in the specified range. Independent control is required during sampling of the liquid concentrate (once per batch) and during weighing of the dried product (once per campaign)

During process qualification it has to be checked, that the raw waste is actually liquid evaporator concentrate from the operation of a pressurized water reactor and that the required sampling, analyses and weighing steps together with the independent control measures are part of the process control quality plan.

There are no additional steps arising from the control of the materials composition and the required amount of independent control measures is the same or less as the radiological control measures.

Example 2: Retrospective process qualification

Concrete rubble from demolition of a storage room for ion exchange resins was characterized and packaged in 200 l-drums by a qualified process. The weight of the concrete rubble was documented for each drum. Independent control measures by experts on behalf of the competent supervisory authority were performed for verification. The materials composition was not taken into account during process qualification, conditioning and control.

For disposal in the Konrad repository the waste drums need to be packaged in standardized containers and the materials composition has to be described. The packaging of the drums in containers and the backfilling of the voids with sand is described in a process control quality plan.

Prior to packaging the description of the materials composition has to be approved. The conditioning process for packaging the concrete rubble in the 200 l-drums was assessed retrospectively with respect to the requirements on the materials composition. The independent control measures performed could be accepted with respect to the protection objective of the water law. No additional control measures on the waste drums and their content were considered to be necessary.

During packaging of the drums in containers the only control measures with respect to the materials composition are the identification of the drums and the weighing of the backfill material.

Example 3: Spot checking

Before process qualification became mandatory in 2001 [4] it was possible to condition radioactive waste without independent control measures. Such waste has to undergo spot checking to verify the radiological and material properties.

According to the requirements on radiological spot checking [5] between 0.5 % and 12 % of an

inspection lot has to be checked. This includes checking the amount of free liquids, gases or self igniting materials. This means that in such cases some drums need to be opened already to demonstrate the fulfillment of the radiological requirements. While opening the drums it can also be checked that the description of the materials composition is correct. Therefore no additional drums have to be examined to verify the materials composition.

CONCLUSIONS

With the materials-list and the packaging-list the Federal Office for Radiation Protection (BfS) provides an appropriate tool to describe the materials composition of radioactive waste packages. The control measures with respect to the materials composition integrate well in the established quality control framework for radioactive waste. The system is flexible enough to deal with waste products of different qualities: raw waste, qualified conditioned waste or legacy waste. Control measures to verify the materials composition can be accomplished with minimal radiation exposure and without undue burden on the waste producers and conditioniers.

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