Description of Non-radioactive Substances in Radioactive Wastes - 10406

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ABSTRACT

The license of the German Konrad repository includes additional requirements on water law aspects. Due to those requirements the non-radioactive waste package constituents have to be monitored and balanced. This paper outlines the practical use of the system introduced to cover the water law requirements. The focus is especially on the use of the official list of substances for the description of the waste packages.

INTRODUCTION

As part of the license of the German Konrad repository, supplement four gives licensing requirements in respect of laws pertaining water quality. The licensee, the Federal Office for Radiation Protection, is liable to monitor and balance the types and amount of non-radioactive waste package constituents. Therefore, the licensee provides lists of substances and casks to be used for the description of those substances by the waste generators.

Any waste generator has to request the affiliation of additional waste streams not yet included in the list of substances. The request must give a description of the waste composition. This paper gives an example for such a request, including data collection and compilation for evaporator concentrates originating from the Greifswald nuclear power plant (NPP).

DATA ACQUISITION AT NPP GREIFSWALD

At Greifswald NPP different methods for the description of the chemical waste composition are used. The choice of a method depends on the waste type and the distribution of non-radioactive substances as part of the waste.

Methods used so far are:

1. Description of substances in each singular cask

In that case the material description is based on an excerpt from the official list of substances published by the Federal Office of Radiation Protection. The list is part of the waste documentation system ReVK and includes only those substances being contained in the waste and, additionally, some compounds frequently being part of the waste and still to be added to the official list of substances.

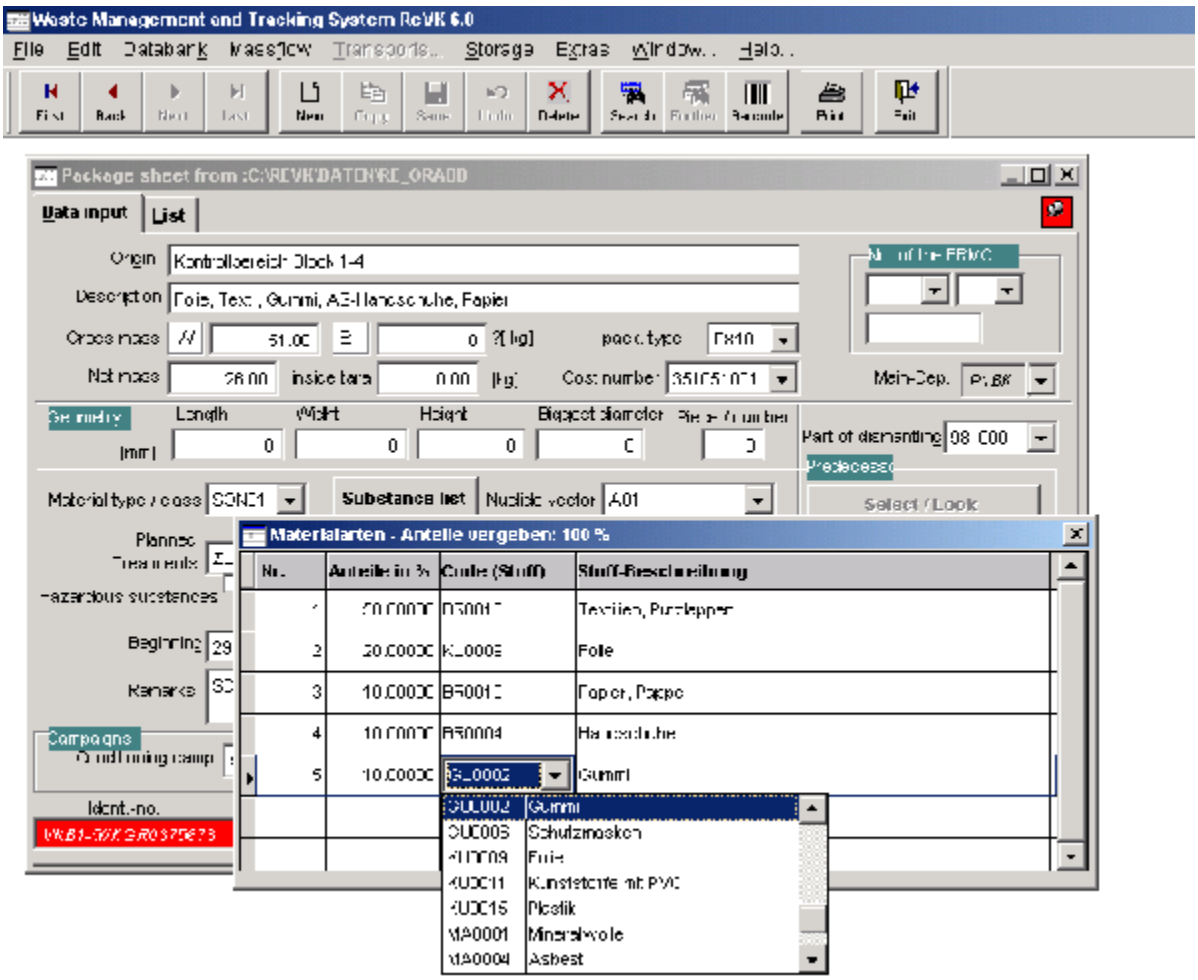


Fig. 1: Input mask for description of non-radioactive waste package constituents.

This method is applied for small batches of special composition.

2. Batches of waste packages with similar composition of a few substances

In this case an example is given by big amounts of steam generator needle tubes arising from decommissioning of the Greifswald NPP. The total mass of this waste stream is about 1300 Mg. To describe the composition of this waste, the official list of substances is used. During the data collection for this list, NPP Greifswald reported the steel grades primarily used. In case of the above mentioned tubes the composition is completely described with 100 % of the correct steel grade as there are no other substances included.

3. Uniform median composition for large waste batches

This method is mainly used for mixed waste. It is planned to request the affiliation of an entry in the official list of substances for this special waste type. Thus, at the moment, data on the composition of this waste stream is collected. The data collection will then be used as statistical base for a representative composition of this type of waste. Beside the quantifiable data actually collected, the qualitative data already recorded from the start of decommissioning will be included in the description.

4. Uniform distribution of substances in different waste batches

The requirements are given regarding ion exchanger resins as well as evaporator concentrates both being subject of the following explanations. Both waste streams will be subject of a request for affiliation in the official list of substances.

SETTING UP OF SOLID EVAPORATOR CONCENTRATES

During operation, post-operation, decommissioning and disposal of the plant, radioactive waste water from the different control areas is produced in various compositions. The waste water is collected in drainage pits. Based on its origin and composition the waste water is chemically processed. Subsequent to that conditioned waste water is concentrated in an evaporator. The still liquid concentrates are then solidified using a rotary thin-film evaporator.

The use of the rotary thin-film evaporator is exclusively dedicated to the production of disposable salt cubes from liquid evaporator concentrates

The rotary thin-film evaporator consists of a double-wall cylindric tank which is fed with a defined amount of the liquid concentrate from the top. Evaporation is driven by heat introduced in the gap between the two walls of the tank. Thus the water is nearly completely removed from the liquid.
Wiper blades made of metal scrub the solidified concentrate from the inner wall of the tank. The blades are placed on a spindle in the middle of the tank and cover the complete height of the evaporator. By this adhesion and encrustation are inhibited.

All components not to be evaporated build thus a paste-like waste elutriated in 200 l drums through the feeder at the bootom of the evaporator. The components of this waste product are dominated by potassic and sodium salts of boracid acid.

By natural cooling the paste becomes solid.

Parameters	
<u>Turnover</u>	
Liquid concentrate (input)	250 - 450 kg/h
Solid concentrate (output)	50 - 90 kg/h
<u>Heating steam</u>	
Pressure	0,4 - 1 MPa
Temperature	143 - 179°C
Nominal output	5,5 KW

Fig. 2 Feeder and transport system of rotary thin-film evaporator

All evaporator concentrates currently in stock at the Greifswald storage facility has been produced in this way between 1998 and 2009.

In total, 2321 drums with a total net mass of 433 Mg are stored. These waste packages are going to be packed in steel containers with concrete liners, eight drums per container. Figure 3 shows the yearly turnout of evaporator concentrate drums.

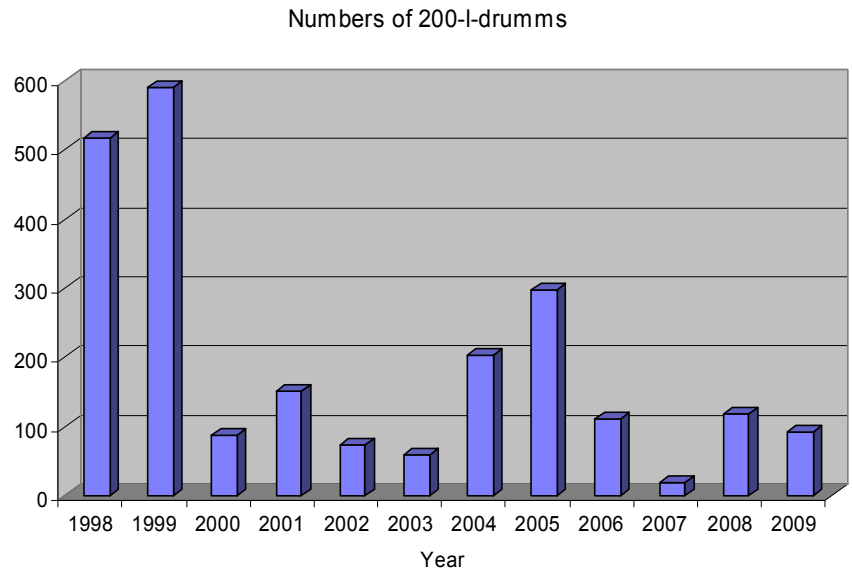


Fig. 3 Yearly turnout of evaporator concentrates drums at Greifswald NPP

According to scheduling the rotary thin-film evaporator will be operated until the end of 2010. Another 100 drums of 200 l volume will presumably be produced in this period of time.

The idea is to define one request for a waste composition for all solid evaporator concentrates output in the interim storage at Greifswald at the moment and all still to be produced until the end of 2010.

DETERMINATION OF CHEMICAL COMPOSITION OF EVAPORATOR BOTTOM

Analytic data being available has been used to define the chemical composition as proposed in the preliminary Konrad waste acceptance requirements. No additional analysis has been conducted. The data covers liquid and solid concentrates from 1997 to 2009.

The data available originates from analysis being part of the preparation of conditioning campaigns, accompanying waste package quality assurance or for the dimensioning of a new evaporator. Thus, the scope of parameters is varying.

An important and main constituent of evaporator concentrates is boric acid. The crystallization mechanism of boric acid and the associated salts results in a concentrate suitable to gain a solid salt cube at the end of the process.

Other constituents are sodium, potassium, oxalic acid, phosphate, nitrate and chloride.

Table I. Average Composition of Dried Evaporator concentrates

Compound/Element	Average percentage %	Main agents of constituent
Boric acid	51,63	Borates
Sodium	11,50	Sodium nitrate, sodium borate, sodium phosphate
Nitrate	12,00	Sodium nitrate, potassium nitrate

Phosphate	1,90	Iron phosphate, sodium phosphate
Potassium	3,10	Salts, mainly sodium oxalate and iron oxalate
Chloride	1,00	Sodium chloride, potassium chloride
Oxalic acid	0,54	Potassium phosphate, potassium borate, potassium chromate
Ferrite	0,32	Iron phosphate, iron oxide, iron oxalate
Chrome	0,08	Chrome oxalate, potassium chromate
Nickel	0,05	Nickel oxalate
Calcium	0,60	Calcium phosphate, calcium borate, calcium chloride
Magnesium	0,08	Magnesium chloride
Copper	0,04	Copper oxalate
Zinc	0,04	Zinc oxalate
TOC	1,60	Tensides from washing agents, oxalates
Ammonia	0,02	Ammonium chloride, ammonium nitrate
Nitrite	0,02	Sodium nitrite, potassium nitrite
Undissolved solids	6,50	Mineral wool, cellulose, cloth fibres, ceramic, silicates and others
Residual moisture	9,90	

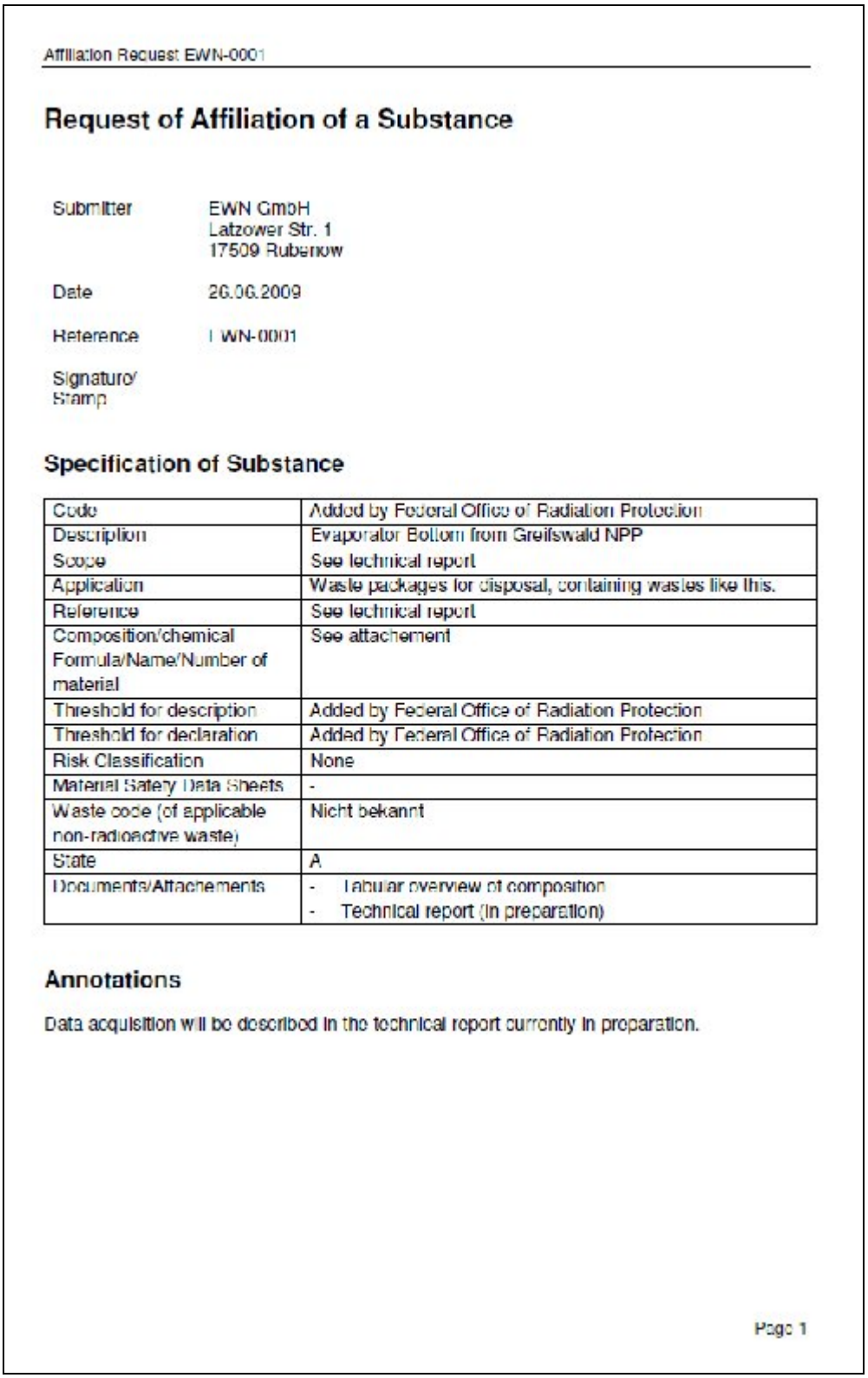
Based on this data the affiliation of evaporator concentrates from Greifswald NPP will be requested from the Federal Office of Radiation Protection as follows.

REQUEST PROCEDURE FOR THE AFFILIATION OF COMPOUNDS IN THE LIST OF SUBSTANCES

The request for affiliation of evaporator concentrates from Greifswald NPP into the official list of substances comprises information and data of different kind.

Beside common general information like name of the submitter, date of request and so on, the compound or substance (in this case evaporator concentrates) has to be described. The focus of this description is on known risks for the water quality coming from the described substance. The second main information is the description of the kind of waste covered by this request. The composition of the waste stream is given and the generation of the composition data is illustrated. The period of time of sampling, the number of samples and the kind of analytics are to be specified.

Figure 4 gives the first page of the example request for the affiliation of evaporator bottom. The second page consists of a table, given in table II.



Affiliation Request EWN-0001

Request of Affiliation of a Substance

Submitter: EWN GmbH
Latzower Str. 1
17509 Rubenow

Date: 26.06.2009

Reference: EWN-0001

Signature/
Stamp

Specification of Substance

Code	Added by Federal Office of Radiation Protection
Description Scope	Evaporator Bottom from Greifswald NPP See technical report
Application	Waste packages for disposal, containing wastes like this.
Reference	See technical report
Composition/chemical Formula/Name/Number of material	See attachement
Threshold for description	Added by Federal Office of Radiation Protection
Threshold for declaration	Added by Federal Office of Radiation Protection
Risk Classification	None
Material Safety Data Sheets	-
Waste code (of applicable non-radioactive waste)	Nicht bekannt
State	A
Documents/Attachements	- Tabular overview of composition - Technical report (in preparation)

Annotations

Data acquisition will be described in the technical report currently in preparation.

Page 1

Fig. 4: First page of request for affiliation of evaporator bottom

Table II. Table of ingredients, part of page 2 of the request

Code of waste	Code of constituent	Name	Median-/Expectation-value [%]	Lower Limit [%]	Upper Limit [%]
	ABK041	Boric acid	51,63	36,14	67,12
	AAE009	Sodium	11,50	8,05	14,95
	ABK017	Nitrate	12,00	6,00	18,00
	ABK090	Phosphate	1,00	0,70	1,30
	ABK066	Iron phosphate	0,90	0,72	1,08
	ABK089	Oxalic acid	0,54	0,38	0,70
	ABK061	Chloride	1,00	0,80	1,20
	AAE006	Potassium	3,10	2,17	4,03
	AAC004	Chromate (VI)	0,04	0,03	0,05
	AAC003	Chrome (III)	0,04	0,03	0,05
	AAC007	Nickel	0,05	0,04	0,06
	AAE003	Calcium	0,60	0,42	0,78
	AAE008	Magnesium	0,08	0,02	0,14
	AAC005	Copper	0,04	0,01	0,07
	AAC008	Zinc	0,04	0,03	0,05
	ABK123	Tenside (unspecific)	1,60	1,28	1,92
	ABK045	NH_3	0,02	0,02	0,02
	ABK018	Nitrite	0,02	0,02	0,02
	ABK179	SiO_2	6,50	1,95	11,05

Based on the information about the composition of the waste and water relevant risks of constituents, bandwidths for the fraction of each constituent are supposed. The bandwidths have to be observed for applying the entry in the official list of substances for the description of a waste package. As long as the actual fraction of a constituent is in the scope of the bandwidth, waste quality control will accept the description using this entry.

Available protocols of analysis are attached to the request. In other cases, where no analytical data is available, plausibility is used to deduct the composition of a waste stream. The aim is a coherent and comprehensible description of the composition of a waste. The fractions given in the description are to be reproducible for the competent water authority in order to approve the request.

In the actual example the deduction of the composition data might include the following information:

1. For each constituent a bandwidth has been determined. For this scope for each fraction the entry in the official list of substances is valid. The width of this band depends on the risk coming from the respective constituent.
2. Boric acid is meant as delegate for all not exactly identified borates.

3. Sodium is found as sodium nitrate, sodium borate and sodium phosphate. As sodium borate is not yet part of the official list of substances and both of the other compounds are dissociating, sodium is included as ion.
4. The nitrates found are sodium and potassium nitrate. Both are dissociating and thus the group entry for nitrate is used.
5. The main agents of phosphate are iron and sodium phosphate. As iron phosphate has a more restrictive threshold, the total phosphate amount is split based on the iron contingent into one part of phosphate using the group entry and iron phosphate.
6. Oxalic acid is found in salts, mainly sodium and iron oxalate. As oxalic acid and sodium oxalate are treated the same way in the official list of substances and as the detailed distribution on the agents is not known, oxalic acid is used to describe all of the oxalates.
7. Chloride is found in sodium and potassium chloride. Both are dissociating. Thus, chloride is used in the ionic form to describe the constituent.
8. Potassium is found in potassium borate, chromate and phosphate. None of these is found in the official list of substances. Also the distribution on the different agents is not known. Thus the ionic form is used to describe all potassium compounds.
9. Iron is found in iron phosphate, oxide and oxalate. Conservatively the iron fraction is described with the most restrictive entry of those, iron phosphate (see also phosphate).

This list has to be completed for every constituent of the composition. Additionally the request includes the original data from all analysis (Table I) and the technical report as an attachment. Thus the data generation should be easily understood.

The request is verified by the Federal Office of Radiation Protection. The thresholds for description and declaration are calculated for the new substance or material to be added to the official list of substances. The Federal Office of Radiation Protection assigns a unique code for the additional substance, too.

Thus the complete request, including the added parameters processed by the Federal Office of Radiation Protection as mentioned above, is forwarded to the competent water authority for approval. In case of approval the entry in the official list of substances is marked. It can be used by any other waste producer for the description of waste packages from now on as long as the respective waste composition fits into the scope of the bandwidths.

USE OF THE NEW ENTRY IN THE OFFICIAL LIST OF SUBSTANCES FOR THE DESCRIPTION OF WASTE PACKAGES

For the description of non-radioactive materials a waste package consists of, a special form was prepared, as shown in the picture below. This data sheet is part of the documentation of radioactive waste to be disposed of in the Konrad repository.

According to the present example, the waste package documented consists of:

- Dried, solid evaporator concentrates as described above
- Eight 200 l drums (inner containers), filled with the evaporator bottom
- Concrete for casting of the drums inside the waste container
- Steel container with concrete liner (waste container)

Table III. Form for description of non-radioactive composition of waste packages

44	**Composition [kg]: lists of substances and casks**		
	Waste product		
	Description	**Code (list of substances)**	**Mass**
	Solid evaporator concentrates	AED001	1634,5 kg
	concrete (casting)	AB_004	3500 kg
	Inner and outer containers		
	Description	**Code (list of casks)**	**Mass**
	Steel container with concrete inliner	CS04002	9100 kg
	8 x 200-l-drums	FS20002	328 kg
45	**Total mass of waste package**		14,5626 Mg
46	**Waste package quality assurance completed**		yes/no
47	**Acceptance of waste package by BfS**		yes/no
48	**Date of Acceptance**		
49	**Place/Date and signature of radiation protection department (waste owner)**		

The first part of the data sheet gives a description of all relevant substances. In this example the ingredients are concrete and the dried evaporator concentrates from the above given request, with the code AED001 assigned by the Federal Office of Radiation Protection.

In the middle of the data sheet the used containers are listed. For each waste container an entry in the official list of casks is to be added. The entries in the list of waste containers give a detailed description of the type and mass of the used materials.

Thus after the affiliation of a typical waste stream like evaporation bottom, the description of the waste package needs only four entries to cover all non-radioactive substances included in waste form and containers. The documentation of the data relevant to cover the aspects of water law is thus remarkably simplified.