

## **Documentation of Radioactive Waste Packages for Disposal in the Konrad Repository – 16253**

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### **ABSTRACT**

For the Konrad repository, the plan approval procedure has been completed in 2002. In 2007 all complaints filed against the repository were dismissed, so that there is a legal and unappealable license decision available. The waste acceptance requirements were revised taking into account additional requirements from the plan approval decision. Today, there are already several hundred waste packages produced that meet all requirements for final disposal in Konrad.

The acquisition, verification and quality assurance of the data relevant for disposal is performed in parallel to the waste treatment and packaging. This constitutes the development of database applications, on the one hand to capture and handle specific data for the waste packages to another to manage the disposal procedures.

The development of a database application for recording disposal-relevant data of waste packages has already been completed with regard to the radiological requirements. Additional aspects based on the requirements of the plan approval decision, e.g. water law relevant aspects, have to be taken into account. Thus, an upgrade relating to the recording of groundwater debilitating substances will be carried out in a second step, which is expected to be completed in 2016. In parallel, the development of a database application is carried out to coordinate the waste package deliveries to the repository and to document their disposal.

### **INTRODUCTION**

The plan approval decision for the former iron ore mine Konrad near Salzgitter as a repository for low and intermediate level radioactive waste was issued in 2002 [1]. With the decision of the Federal Administrative Court on April 3, 2007 the license is unappealable. In 1995, the Federal Office for Radiation Protection (BfS) published the waste acceptance requirements for the emplacement of radioactive waste in the Konrad repository [2]. These requirements were complemented by additional requirements in the plan approval decision [1]. The combined waste acceptance requirements were published in 2010 [3] and revised in 2014 [4].

Prior to disposal, radioactive waste packages have to be checked and the fulfillment of the waste acceptance requirements has to be demonstrated [5, 6]. A database application [7] has been developed to record the waste specific data.

## WASTE PACKAGE DATA SET

The waste acceptance requirements [2, 3, 4] stipulate the required data to demonstrate the fulfillment of the waste acceptance requirements, for the planning of the emplacement in the Konrad repository and to balance the emplaced radioactive and non-radioactive inventory. So far, only the radiological requirements were taken into account during the construction of the database. TABLES I, II and III show the required data set mapping the specifications for waste data sheets in [2, 3, 4].

Whereas the data corresponding to TABLE I has to be provided by the waste generator together with the waste package documentation. The data in TABLE II and TABLE III is added by the Federal Office for Radiation Protection (BfS) during the quality control of waste packages and their emplacement in the repository. In this context, measured values for dose rates or surface contaminations are listed in TABLE III that are gained during the waste package inspections as well as by calculative verifications for declared summation values or guaranteed values (for normal operation, cf. TABLE I Consecutive No. 40 to 46).

TABLE I. Waste Package Dataset

Consecutive No.		Consecutive No.	
Waste unit:			
1	Waste package documentation-No.	2	Waste data sheet-No.
3	Waste package-No.	4	Container-Identification-No.
5	BfS-Campaign	6	NPP-Campaign
7	Process control quality plan (pcqp)	8	Date of the pcqp
9	Copy of pcqp ("Stempeloriginal")	10	Date of copy of pcqp
11	Waste generator	12	Conditioner
13	Conditioning-Process (Abbr.)	14	Date of conditioning
15	Process qualification	16	Waste type (Raw waste) (Abbr.)
17	Fixation material	18	Waste product (Abbr.)
19	Container type	20	Permit-No. of construction test
21	Inner container	22	Inside coating

Consecutive No.		Consecutive No.	
23	Annual release factor of the waste package	24	Water content resp. residual moisture (wt.%)
25	Combustible waste (melting point < 300°C) %	26	Compaction pressure [MPa]
27	Compressive strength [N/mm <sup>2</sup> ]	28	Waste form group
29	Waste container class	30	Mass of the waste package [Mg]
31	Concentration of fissile material [g/0,1 m <sup>3</sup> ]	32	Total-alpha [Bq/package]
33	Total beta/gamma [Bq/Package]	34	Reference date for activity values
35	Activity values are (one of: measured / calculated)	36	Code of radionuclide spectrum
37	Calculation method	38	Enrichment U-233 [%]
39	Enrichment U-235 [%]	40	Exceeding of the guaranteed value for normal operation, H-3
41	Exceeding of the guaranteed value for normal operation, C-14	42	Exceeding of the guaranteed value for normal operation, Kr-85
43	Exceeding of the guaranteed value for normal operation, Ra-226	44	Exceeding of the guaranteed value for normal operation, I-129
45	Exceeding of the guaranteed value for normal operation, further alpha emitters (including Pu-241)	46	Exceeding of the guaranteed value for normal operation, Further beta-/gamma emitters (without Pu-241)
47	Factor F	48	Ss (Summation value assumed incidents)
49	Sw (Summation value heat)	50	Sk (Summation value criticality safety)
51	Dose rate at surface [mSv/h]	52	Dose rate in 1m distance [mSv/h]
53	Dose rate in 2m distance [mSv/h]	54	Neutron part of the dose rate in 1m distance [mSv/h]
55	Neutron part of the dose rate in 1m distance [mSv/h]	56	Date of measurement of the dose rate
57	Limit of the surface contamination is fulfilled, alpha emitters	58	Limit of the surface contamination is fulfilled, beta- / electron capture emitters
59	Limit of the surface contamination is fulfilled, further radionuclides	60	Date of the contamination control
61	Remarks		

Activity values of nuclides and nuclide groups:											
62	Ac-227	63	Ac-228	64	Total alpha	65	Ag-108m	66	Am-241	67	Am-242m
68	Am-243	69	Ar-39	70	Be-10	71	Total bg	72	Ca-41	73	Cd-113m
74	Cf-249	75	Cf-251	76	Cl-36	77	Cm-243	78	Cm-244	79	Cm-245
80	Cm-246	81	Cm-247	82	Cm-248	83	Co-60	84	Cs-137	85	C-14
86	Eu-152	87	Fe-55	88	H-3	89	I-125	90	I-129	91	Kr-85
92	Na-22	93	Nb-94	94	Ni-63	95	Np-237	96	Pa-231	97	Pb-210
98	Pu-238	99	Pu-239	100	Pu-241	101	Pu-244	102	Ra-224	103	Ra-226
104	Ra-228	105	Rb-87	106	Se-79	107	Sn-126	108	Sr-90	109	Th-228
110	Th-230	111	Th-232	112	U-232	113	U-233	114	U-234	115	U-235
116	U-236	117	U-238	118	Y-90						

TABLE II. Approval

Consecutive No.		Consecutive No.	
Waste unit:			
119	Date of approval	120	Approval BfS
121	Approved by	122	Waste acceptance requirements
123	Product control passed		

TABLE III. Disposal-Data

Consecutive No.		Consecutive No.	
Waste unit:			
140	Exceeding of the guaranteed value for normal operation, H-3	141	Exceeding of the guaranteed value for normal operation, I-129
142	Exceeding of the guaranteed value for normal operation, C-14	143	Exceeding of the guaranteed value for normal operation, Ra-226

Consecutive No.		Consecutive No.	
144	Exceeding of the guaranteed value for normal operation, Kr-85	145	Exceeding of the guaranteed value for normal operation, further alpha emitters
146	Exceeding of the guaranteed value for normal operation, further beta-/gamma emitters	147	Date of assessment
148	Signature repository	149	Ss (Summation value assumed incidents)
150	Sw (Summation value heat)	151	Sk (Summation value criticality safety)
152	Mass of transport unit	153	Dose rate in 1m distance [mSv/h]
154	Dose rate in 2m distance [mSv/h]	155	Neutron part of the dose rate in 1m distance [mSv/h]
156	Neutron part of the dose rate in 2m distance [mSv/h]	157	Surface contamination alpha emitters
158	Surface contamination beta-/gamma emitters	159	Surface contamination further radionuclides
160	Approval for emplacement	161	Date of control
162	Signature radiation protection	163	Date of entry in buffer hall
164	Position in buffer hall	165	Date of removal from buffer hall
166	Buffer hall signature	167	Date of disposal
168	Disposal - emplacement field	169	Disposal - emplacement chamber
170	Disposal - emplacement row	171	Disposal: Signature
172	Disposal: Notification to waste generator	173	Repository: date of notification
174	Repository remarks		

## IMPORT OF WASTE PACKAGE DATA

A predefined input mask in the program module "Data Import" is used for the import of relevant waste package data according to TABLE I. The waste generators have to provide the relevant data sets (see TABLE I) in electronic form for each waste package to be disposed in the Konrad repository. Additionally, there is the possibility for a manual input of data. For this purpose, two common text file formats CSV (Character-Separated Values) and XML (eXtensible Markup Language) are implemented and supported by the database application. The import format and import file may be selected as shown in Fig. 1. As mentioned above, the data in TABLE II and TABLE III is added by the Federal Office for Radiation Protection (BfS) during waste package quality control and emplacement.

During the import process, the data consistency is checked against the waste acceptance requirements [2, 3, 4] and safety values mainly based on the data provided in program module "Basic Charts". The charts in this module contain categorized specifications derived from the waste acceptance requirements and define possible data entries for relevant data fields according to TABLE I, e.g. mandatory radionuclides (have to be declared), all other relevant radionuclides, repository container types et cetera. Only if the consistency check is completed without any errors the entered or imported data set can be transferred to the database ("Master Data"). Otherwise the program module "Data Import" provides the possibility for necessary corrections in the data set and a repetition of the consistency check.

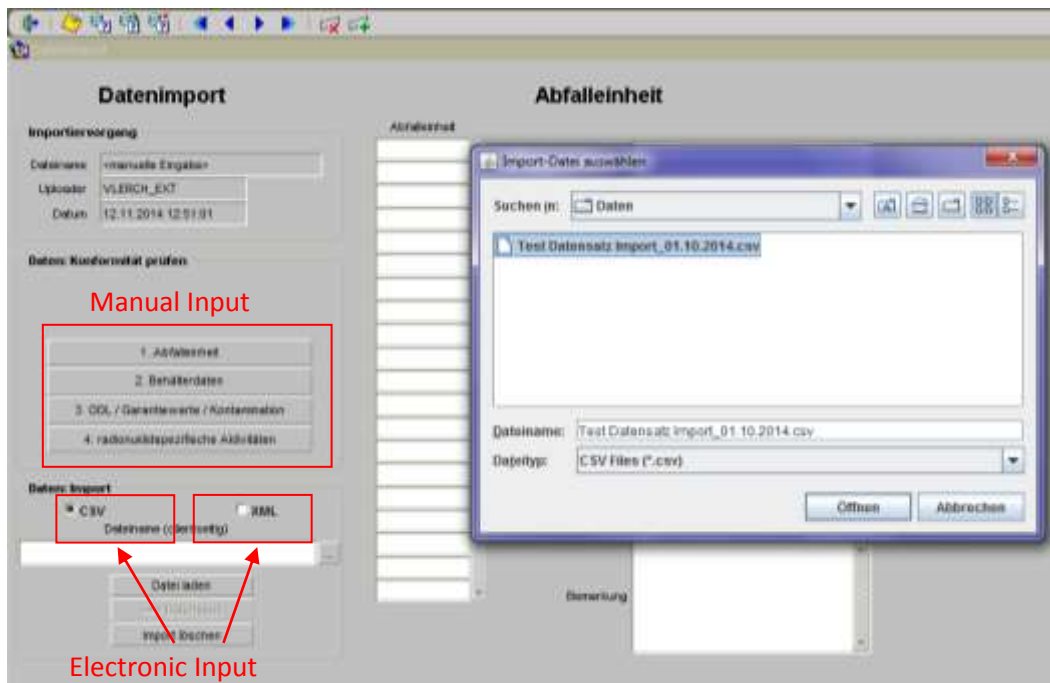


Fig. 1. Program Module "Data Import" – here: Selection of Import File

Furthermore, the program module "Basic Charts" contains an activity log called "Watson" for logging all relevant data entries and data changes in the modules "Data Import", "Master Data" as well as "Basic Charts". A picture of the program module "Basic Charts" can be found in Fig. 2.

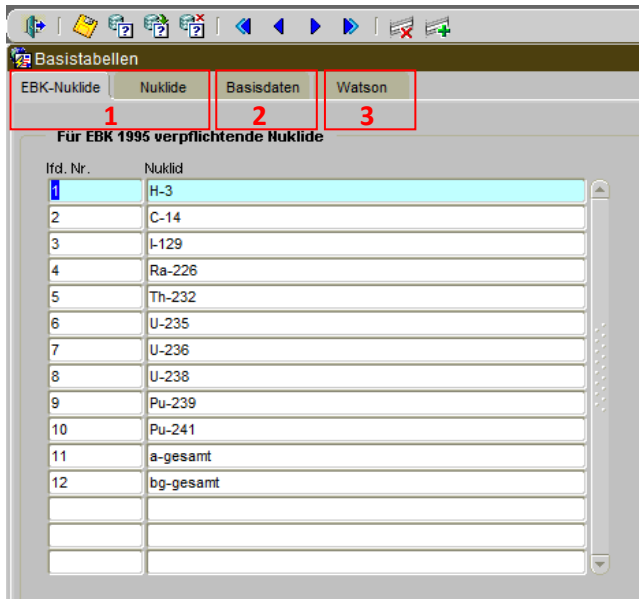


Fig. 2. Program Module "Basic Charts" –  
1) Radionuclide Charts (mandatory radionuclides and other relevant radionuclides [2, 3, 4]),  
2) Basic Data,  
3) Activity Log

## DISPLAY OF MASTER DATA

The waste package data stored in the database can be displayed in two different display modes: "Master Data Overview" (Fig. ) and "Master Data Detail" (Fig. ). Both modes provide the possibility for presenting a clearly arranged compilation of data either for all waste packages or for user defined search results. Whereas "Master Data Overview" grants access to the information corresponding to TABLE I, "Master Data Detail" is designated for presenting the whole dataset according to TABLE I to TABLE III.

The "Master Data Overview" mode is intended for a quick presentation of the waste package data. After selecting the destined waste package ID the information corresponding to TABLE I is displayed on the screen. The basic campaign and conditioning data is displayed on the left upper side together with the ID of the waste package. The radionuclide data is found on the right side, whereas the remaining waste package data is positioned on the bottom of the screen. The data fields that do not fit the screen can be displayed by use of scroll bars. A picture of the program module can be found in Fig. 3.

Abfallseinheit	Abfallgeb. Dok. Nr.	Abfallidentif. Nr.	Abfallgebäude Nr.	Behälter-Ident-Nr.	BfS-Kampagne	HAkt	AktivEM [Bq]
500235	GNS		500235	00436		g-gesamt	6.4E+05
500999	GNS		500235	00436		Ag-108m	5.1E+06
						Ag-110m	6.0E+05
						Am-241	2.2E+05
						Am-242m	2.2E+03
						Am-243	1.5E+03
						Ba-133	2.2E+01
						Bg-gesamt	5.0E+09
						Ca-41	6.2E+01
						Cd-113m	2.6E+02
						Cl-36	4.3E+04
						Cm-242	1.0E+03
						Cm-243	1.2E+03
						Cm-244	1.2E+05
						Cm-245	1.8E+01
						Cm-246	6.0E+06
						Co-58	1.3E+06
						Co-60	1.7E+09
						Cs-134	2.4E+06
						Cs-135	1.5E+02
						Cs-137	3.6E+07
						C-14	3.7E+07
						Eu-152	4.2E+02
						Eu-154	6.3E+05
						Eu-155	3.0E+05
						Fe-55	6.8E+06

Behältertyp	Dauartzulassung	Innenbehälter	Innenauskleidung	Durchlässigkeitsfaktor	Restfeuchte [g]
Container Typ V	BfS/EWB/01/2005	ja	-	ohne spezifizierte Dichtl.	≈ 1

Konz. spaltl. St. [g/l m³]	Ges. Alpha [Bq/Obj]	Ges. Beta [Bq/Obj]	Bezugsdatum	Messmethode	Code d. Radionuklidspalt
3.00E-04	6.4E+05	5.0E+09	01.09.2013	gemessen	

Fig. 3. Program Module "Master Data Overview"

Abfallseinheit: 500235

Abfallidentif. Nr.: 500235 | Abfallgebäude Nr.: 500235 | Behälter-Ident-Nr.: EB5000436

BfS-Kampagne: 235 / 0202 | KKW-Kampagne: 0000000000

Abfallplan: | Stempelgröße: |

Abfaller: | Kond.-Verf.: 017 | Datum: 21.11.2009 | Abfallart (Rohstoff): AA

Verf.-Qualifikator: keine | Abfallprodukt: F

Flussungshilf: | Bemerkung: |

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Behälterdaten	Radionuklidspez. Aktivitäten	Garantiewerte / OGL / Kontamination	Freigabe	BfS-Daten	Endlager-Daten
Behältertyp: Container Typ V	Zeugnis-Nr. der Dauartzulassung: BfS/EWB/01/2005	Jährlicher Durchlässigkeitsfaktor des Abfallgebüdes: ohne spezifizierte Dichtl.	Freigabe:	BfS-Daten:	Endlager-Daten:
Innenbehälter:	Innenauskleidung:	Pressdruck [MPa]: 36	Abfallproduktgruppe: 01	Masse Abf. [Mg]: 7.363	Masse Abfallgeb. [Mg]: 10.360
Wassergehalt bzw. Restfeuchte [Ma %]: ≈ 1	Brennbare Abf. Smp. < 300°C %: ≈	Druckfestigkeit [N/mm²]:	Masse ges. [Mg]:		
Abfallbehälterklasse: nicht stofffest					

Fig. 4. Program Module "Master Data Detail" with categories:  
 1) basic conditioning data, 2) container data, 3) radionuclide data,  
 4) guaranteed values/local dose rates/radioactive contamination and  
 5) data corresponding waste package quality control and emplacement



More detailed information corresponding to TABLE I to III can be accessed by the "Master Data Detail" display mode. In this mode, the whole waste package dataset is shown in clearly arranged categories. Beginning with the basic campaign and conditioning data on the upper right side (cf. Fig. 4 frame 1, TABLE I Consecutive No. 1 – 17). The waste container data can be found in the first flag in the lower part (cf. Fig. 4 frame 2, TABLE I Consecutive No. 19 – 30). The second flag contains information concerning the radionuclide data and the fissile material content (cf. Fig. 4 frame 3, TABLE I Consecutive No. 31 – 37 and 36 subsequent). The data regarding guaranteed values, local dose rates and radioactive contamination can be found in the third flag (cf. Fig. 4 frame 4, TABLE I Consecutive No. 40 – 60). The last three flags contain data corresponding to TABLE II to III, which is added during quality control of the waste packages and their emplacement in the repository (cf. Fig. 4 frame 5).

## REPORTS

The database application provides basic possibilities for data analysis and necessary data reports. It is possible to get reports on all qualified waste packages for specific deliverers and for a defined time range as well as on all waste packages logged in the database (cf. Fig. 5 frame 1). Furthermore, reports on partially qualified waste packages can be generated. These datasets lack information stipulated by the waste acceptance requirements and have to be updated prior to emplacement, e.g. datasets for waste containers without type testing approval marks (cf. Fig. 5 frame 2). The queries in frame 3 and 4 in Fig. 5 enable the generation of cumulative values out of the data pool concerning the radionuclide inventory or waste volume. These requests are necessary for surveys regarding the maximum waste volume as well as the maximum radionuclide inventory for the Konrad Repository defined by the plan approval procedure. For more detailed or further search requests 2nd party tools have to be used.

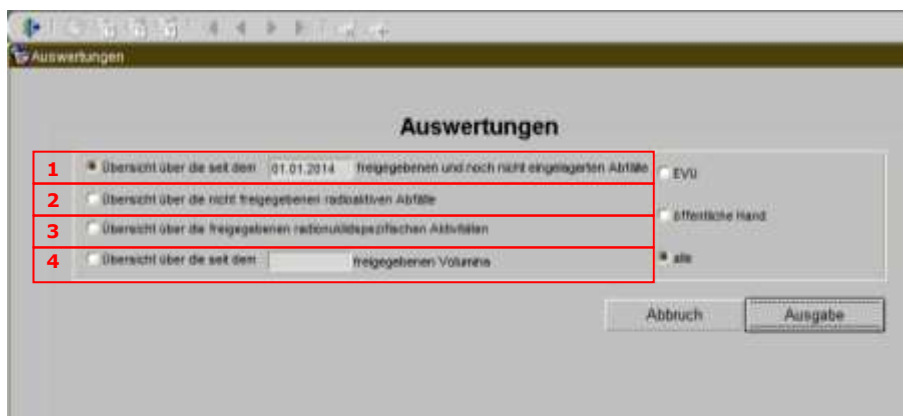


Fig. 5. Program Module "Data Analysis" with search requests:  
1) for waste packages approved since a specific date,  
2) for partially qualified waste packages,  
3) for approved radionuclide inventories,  
4) for approved waste volume

## OUTLOOK

The development of a database application for recording disposal-relevant waste package data has already been completed regarding the radiological requirements [2, 3, 4]. With this database, a suitable tool is available to record and manage the waste package data with respect to disposal.

An upgrade of the database application is necessary due to the revised waste acceptance requirements [3],[4]. The most important changes are additional requirements concerning the material composition of the waste packages. Thus, additional data on the inventory of non-radioactive compounds in the radioactive waste packages has to be recorded. In this context, new algorithms for customized queries and mass balance studies corresponding to the plan approval decision have to be implemented. Furthermore, waste products i.e. waste packages that are not yet packed in licensed waste containers will be taken into account in the next version of the database. The improvements described above will cause relevant changes in the database structure, import interface and predefined queries. The completion of the database including all upgrades described above is expected at the end of 2016.

In parallel to the database application described in this article, the development of a database application is taking place for the coordination of waste package deliveries to the repository and the documentation of their disposal. Thus, an appropriate interface for the data transfer to this second database will be implemented.

## REFERENCES

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