

WAK

**Wiederaufarbeitungsanlage Karlsruhe
Rückbau- und Entsorgungs- GmbH**

**Radionuclide Relationships (vectors) for
Clearance of Materials**

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- Clearance Procedure in Germany (Overview)
- Clearance Procedure at WAK II / FZK
- Calculation of the Nuclide vector
- Consequences for Clearance Measurements

Legislation, Article § 29, clearance

The licensee... may only use, exploit, dispose of ... radioactive substances and movable items ... that are activated or contaminated ... as non-radioactive substances, ... if the competent authority has granted clearance ...

Article 44 (3) remains unaffected

The authority shall grant clearance on request, if an effective dose of 10 $\mu\text{Sv/a}$ only may occur for an individual person of the population. This is fulfilled when the values of Annex III, Tab. 1 for the respective material, together with the disposal path given there and the requirements of Annex IV of the Radiation Protection Ordinance, are observed ...

Art. 29 Clearance, Annex IV, Clearance Requirements

Part A General

The averaging surface to be used for the measurements to determine the surface activity may be up to 1000 cm².

The averaging mass to determine the specific activity must not significantly exceed 300 kg.

In case of several radionuclides, the summation formula must be applied, the total must not exceed the value of 1.

Radionuclides do not have to be considered when the partial sum of their proportions is smaller than 10%.

Art. 29 clearance, Annex IV, clearance Requirements

Part B Unrestricted Clearance

No need to specify further use, application, utilization... or the final whereabouts...

Part C Clearance for disposal

... requires... disposal on a dump or in a incineration plant. Utilization outside of these facilities is not permitted.

Part D Clearance of buildings

In principle, clearance measurements shall be carried out on a standing structure. The averaging surface may be up to 1 m². After the clearance of the building for demolition, the rubble arising does not need to be clearanced separately.

Clearance Procedure established at WAK / FZK

- With a general clearance license the license holder was given the unrestricted clearance for defined, recurrent material flows.
- For unrestricted clearance, the clearance limits given in the **RPO Annex III, Tab. 1, column 4 and/or column 5 or column 6**, have to be respected.
- The requirements made in the **RPO Annex IV, Part A, No. 1 and B**, shall be valid.
- Averaging values deviating from those given in the **RPO Annex IV**, shall require approval in each individual case.

Radiation Protection Instruction

The clearance procedure is subject to a internal **radiation protection instruction** and an **instruction for clearance measurement processes**. Major parts of the radiation protection instruction are:

- Scope of validity
- Procedure
- Clearance process, material flows
- Accounting and information obligations

Scope of Validity

- Radiation protection areas of the license holder
- Radioactive substances (items, buildings, ground surfaces, plants, plant components, etc.), if these are **contaminated** or **activated** from handling under a license and shall not be transferred to third parties as radioactive substances
- Not applicable to substances, items according to Art. 44 (3) RPO.
- Not applicable to radioactive substances transported according to ADR/RID.

Procedure

- The delivering organization unit (Radiation Protection Officer) has to register the **radioactive substances for clearance** purposes by the Safety Department (S)
- RP Officer for clearance specifies the type and scope of **preliminary studies.**
- Measurements are carried out according to a generally authorized procedure “**Measurement Instruction for Radiation Protection Control for the clearance According to Art. 29, RPO.**”

Procedure (cntd)

- Safety Department checks the measurement results of the preliminary study.
If they are **above the detection limit according to DIN 25482** for the measurement method chosen, Art. 29 RPO shall apply.
- Material or substances from controlled areas, where unsealed radioactive substances are handled, shall always be subject to Art. 29 RPO.
- Safety Department specifies the **clearance measurement procedure** to be used as well as the **type and scope** of the clearance measurements.

Procedure (cntd)

- **Information of the independent expert (TÜV)** about upcoming clearance measurements, about 10% of the clearance measurements of the operator are controlled by the expert.
- **Check of agreement** according to Art. 29 (3), RPO, by the Radiation Protection Officer, assuring that the expert does not find any deviations either from the clearance values nor from the procedure applied.

Standardized Procedure for Unrestricted Clearance

- **Metal scrap**
- **Non-metals**
- **Concrete**
- **Shredded electric cables**
- **Rubble**
- **Excavated earth**
- **Burnable wastes**
- **Bulk materials and liquids**
- **Mixture of the above material flows**

Clearance Pathways and Averaging Values

Unrestricted Clearance

	Solid substances with solid surface	Liquid substances, bulk materials	Rubble/ excavated soil > 1000 Mg/a	Ground surfaces Soil, land	Buildings for further use
Annex III, Tab. 1	Columns 5 and 4	Column 5	Column 6	Column 7	Column 8
Averaging mass	< 300 kg	< 300 kg	< 1000 kg		
Averaging surface	< 1000 cm ²			< 100 m ²	< 1 m ²

Clearance of buildings for demolition

	*) Buildings for demolition
Annex III, Tab. 1	Column 10
Averaging mass	
Averaging surface	< 1 m ² **)

*) The rubble arising from demolition is not subject to any separate clearance, it may be disposed of unrestrictedly

**) with the approval of the authority, also higher values are possible.

For mass and surface related activities, the summation formula shall apply, radionuclides, the total partial proportions of which do not exceed 10%, and daughter nuclides in the equilibrium state do not need to be considered.

Number of Nuclide Relationships (Vectors)

- no general recommendation
- Depends on
 - types of materials (concrete, metal, isolation wool)
 - origin (building, room, system, component)
 - usage of material
 - type and origin of contamination (liquids, dust)
- Nuclides are relevant, which have a high contribution to occasional dose (our experience)

Number of Nuclide vectors as low as possible

Aspects for number of nuclide vectors

- Decommissioning steps
 - changes by systems decommissioned
 - primary/secondary systems
 - Decontamination after steps
- Objective of nuclide vector
 - waste declaration or clearance
 - before/after decontamination
- state of operation / decommissioning

Example for Creating a nuclide vector

	H-3	Fe-55	Co-60	Ni-63	Sr-90	Cs-137	Pu-238	Pu-239/240	Pu-241	Am-241	
	H-3	Fe-55	Co-60	Ni-63	Sr-90	Cs-137	Pu-238	Pu-239/240	Pu-241	Am-241	
	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]
MS 304411/3	4,26	0,36	0,732	17,8	0,01	0,241	0,001	0,005	0,224	0,0172	23,6502
MS 309288/X	1,15	0,21	0,022	1,6	0,04	0,204	0,001	0,002	0,138	0,0157	3,3827
VL 050515/8	2,31	0,22	0,346	1,2	0,83	0,268	0,001	0,001	0,138	0,0127	5,3267

	H-3	Fe-55	Co-60	Ni-63	Sr-90	Cs-137	Pu-238	Pu-239/240	Pu-241	Am-241	
MS 304411/3	18,0%	1,5%	3,1%	75,3%	0,0%	1,0%	0,0%	0,0%	0,9%	0,1%	100,0%
MS 309288/X	34,0%	6,2%	0,7%	47,3%	1,2%	6,0%	0,0%	0,1%	4,1%	0,5%	100,0%
VL 050515/8	43,4%	4,1%	6,5%	22,5%	15,6%	5,0%	0,0%	0,0%	2,6%	0,2%	100,0%
MW (NV)	31,8%	4,0%	3,4%	48,4%	5,6%	4,0%	0,0%	0,0%	2,5%	0,3%	100,0%

clearance limit	H-3	Fe-55	Co-60	Ni-63	Sr-90	Cs-137	Pu-238	Pu-239/240	Pu-241	Am-241	
Anl. III Tab. 1 Sp. 9	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	
	1000	10000	4	3000	2	10	1	1	100	1	

	H-3	Fe-55	Co-60	Ni-63	Sr-90	Cs-137	Pu-238	Pu-239/240	Pu-241	Am-241	
weighted	0,00032	0,00000	0,00853	0,00016	0,02801	0,00403	0,00018	0,00033	0,00025	0,00258	0,04440
normalized	0,7%	0,0%	19,2%	0,4%	63,1%	9,1%	0,4%	0,7%	0,6%	5,8%	100,0%

NV for clearance meas. fac.			21,0%		69,0%	9,9%					100,0%
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	H-3	Fe-55	Co-60	Ni-63	Sr-90	Cs-137	Pu-238	Pu-239/240	Pu-241	Am-241	
derived limits			[Bq/g]		[Bq/g]	[Bq/g]					
			0,84		1,38	0,99					

Consequences for clearance measurements

- Nuclide vector related to batch, room etc.
- Individual settings for measurement devices
- and for measurement campaigns
- Documentation
- nuclide specific activity

**Thank you
for your attention**