



## Clearance of waste in KCD (Nuclear Powerplant Doel)

Topical training day 11/09/2015

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GDF SUEZ is now ENGIE  
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- Questions (and, hopefully, answers)

# Legislative basis

## Legislative basis

### ▪ Royal Decree ARBIS 20 July 2001:

- Artikel 18: Vergunningen voor verwijdering, recyclage of hergebruik van vaste en vloeibare radioactieve afvalstoffen
- Artikel 35: Opvangen, behandelen en verwijderen van vaste afvalstoffen
- Bijlage IB: Vaste radioactieve afvalstoffen: voorwaarden en niveaus voor vrijgave

→ **Summary**: Clearance if the material in question does not lead to:

- Exposure of any member of the general public in the order of 10  $\mu$ Sv or more
- A collective dose exceeding around 1 manSv
- Criteria can be considered to be met if clearance levels in annex 1B of ARBIS are adhered to
- These specific activities are based on the RP 122 part I (no surface contamination levels)

Remark: Solid waste only. Art. 18 (ARBIS) defines a specific procedure for liquid waste.

## Legislative basis

- **FANC-decision:** 02/04/13 Vaststelling vrijgaveniveau voor Ba-133ter  
→ **Summary:** clearance level for Ba-133 added to Bijlage IB (ARBIS)
- **FANC-decision:** 30/04/10 Richtlijnen meetprocedures en meettechnieken vrijgaveniveaus  
→ **Summary:** further details how a clearance procedure should be composed
- **FANC-letter:** “Vragen naar aanleiding van FANC Besluit van 30 april 2010 over vrijgave van vaste radio-actieve afvalstoffen”, letter dated 29.10.2010  
→ **Summary:**
  - Limits for surface contamination (1 Bq/cm<sup>2</sup> beta en 0.1 Bq/cm<sup>2</sup> alfa)
  - Definition of reference area for surface contamination (300 cm<sup>2</sup>)
  - Definition of minimum mass for clearance (3 kg)

# Clearance procedures KCD

# Clearance procedures KCD

- Structure of KCD clearance procedures:

<b>PREV/59 – Beheer vrijgave afval &amp; materiaal uit WZ</b> <i>General principles of clearance in KCD</i>	
<b>Overzicht van de vrijgavecriteria</b> <i>Overview of clearance limits and alarm settings of clearance devices</i>	
<b>Werkwijze voor vrijgave van afval uit warme zone</b> <i>Details the proces of waste clearance.</i>	<b>Werkwijze voor vrijgave van materiaal uit warme zone</b> <i>Details the proces of clearance of equipment (not detailed in ARBIS)</i>
<b>Isotopenvector KCD dienstjaar 20XX – 20XX</b> <i>Year specific calculation of isotopic vector for clearance measurements, and calculation of device specific yield</i>	
<b>Richtlijnen voor het uitvoeren van beta-gamma en alfa laagactiviteitsmetingen voor oppervlakte besmetting en vrijgavecriteria</b> <i>Calculation of device specific MDA and measurement time</i>	

# Clearance of waste at KCD

## Clearance of waste at KCD

- Focus for today's presentation: **clearance of (solid) waste**
- KCD distinguishes between:
  - **Geometry FMP/CPO/RTM610/RTM661:** waste that is small enough to fit in these measurement devices (usually bigger waste is shredded)
  - **Bigger (non-shreddable) waste:** bigger waste that can not be shredded to pieces small enough to fit the previous category → usually handled via Specific Clearance File
  - **Bulk:** waste with homogenous distribution of activity (e.g. active charbon)
  - **TL-lamps:** KCD uses the UNIMAT device for clearance measurements of these lamps
  - **Specific Clearance File:** specific method for each case and subject to approval by BelV
- Focus for today's presentation: **Geometrie FMP/CPO/RTM610/RTM661**

This is the largest category of waste.

*INFO: FMP (58x58x55 cm<sup>3</sup>), CPO (25x35x36 cm<sup>3</sup>), RTM610 (50x60x50 cm<sup>3</sup>), RTM661 (60x60x85 cm<sup>3</sup>)*

**VRIJGAVE VAN AFVAL:****Geometrie FMP/CPO/RTM610/RTM661****Clearance of waste at KCD: overview**

Oriënterende meting	Meting	100% depistage (2-3 m <sup>2</sup> )	
	Toestel	FMP (γ) of CPO (γ)	RTM610/661 (γ)
	Type	Afnembare besmetting	
	Limiet	< 100 Bq Co-60 eq.	< 100 Bq iso. vector
Controlemeting	Meting	Wrijfmonsters op representatieve plaatsen	
	Toestel	LB124 (β/γ)	γ-totaal op basis van γ-spectrum (γ)
	Type	Afnembare besmetting	
	Limiet	< 0,4 Bq/cm <sup>2</sup> iso. vector	< 0,4 Bq/cm <sup>2</sup>
Vorbereidende meting	Meting	Oppervlakte meting	
	Toestel	LB124 (β/γ)	
	Type	Vaste besmetting	
	Limiet	< 1 Bq/cm <sup>2</sup> iso. vector	
1ste vrijgave	Meting	Meting stuk	
	Toestel	FMP/CPO (γ)	RTM610/661 (γ)
	Type	Massieke vrijgave	
	Limiet	< 100 Bq Co-60 eq.	< 0,1 Bq/g iso. vector, min. 100 Bq - max. 1000 Bq
2de vrijgave	Meting	200l vat	
	Toestel	Q2 (spectrum - γ)	
	Type	Massieke vrijgave	
	Limiet	ARBIS limieten per isotoop	



## Clearance of waste at KCD

### **GENERAL CONDITIONS:**

- Excluded from the clearance process:
  - Activated materials
  - Waste suspected of being contaminated with  $\alpha$ -emitting isotopes
  - Certain materials (e.g. wood)
  
- All waste destined for clearance must be clean:
  - No dust
  - No oil
  - No grease
  - No oxidation
  - ...

# Clearance of waste at KCD

## ▪ ORIENTATION MEASUREMENT:

- Measurement: 100 % dépistage of the waste object
- Type of measurement: non-fixed contamination
- Measurement details: 2 – 3 m<sup>2</sup> wiped per dépistage

### Old (but still in operation):

- Measurement device: FMP (γ) or CPO (γ)
- Limit: < 100 Bq Co-60 eq.

### New:

- Measurement device: RTM610/661 (γ)
- Limit: < 100 Bq isotopic vector

+	-
100% of surface checked	Indication only (Ex.: wipe yield = estimation, ...)
Measurement removes residual contamination	

# Clearance of waste at KCD

- **ORIENTATION MEASUREMENT**

## 1) Dépistage



## 2) CPO



## / FMP



## / RTM610/661



# Clearance of waste at KCD

- **VERIFICATION MEASUREMENT:**

- Measurement: wipe test(s)
- Type of measurement: non-fixed contamination
- Measurement details: 300 cm<sup>2</sup> wiped per wipe test

**Actual:**

- Measurement device: LB124 ( $\beta/\gamma$ ) ( $\alpha$  too, but not subject to clearance)
- Limit: < 0,4 Bq/cm<sup>2</sup> isotopic vector

**Optional:**

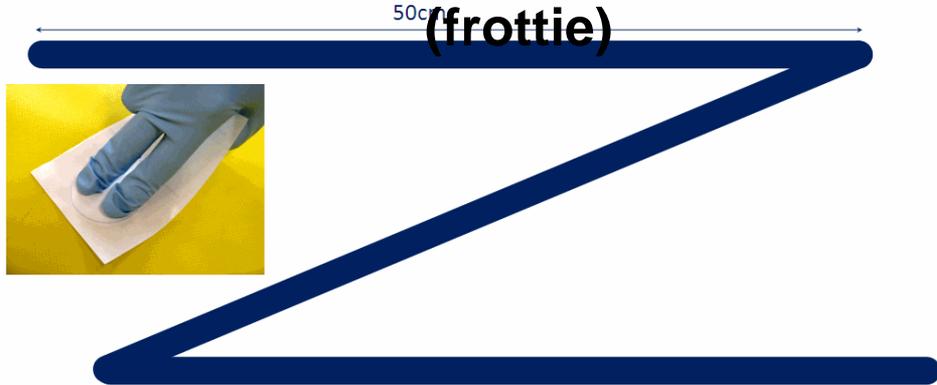
- Measurement device: Spectrum analyser ( $\gamma$ )
- Limit: < 0,4 Bq/cm<sup>2</sup>  $\gamma$ -total (based on  $\gamma$ -spectrum)

+	-
Measurement result in Bq/cm <sup>2</sup> (Wiped surface and wipe yield known)	Sample

# Clearance of waste at KCD

- **VERIFICATION MEASUREMENT:**

## 1) Wipe test (frottie)



## 2) LB124



## Clearance of waste at KCD

### ▪ PREPARATORY MEASUREMENT:

- Measurement: “contact” measurement
- Type of measurement: fixed and non-fixed contamination
- Measurement details: 170 cm<sup>2</sup> detector area (max 300 cm<sup>2</sup>)

### **Actual:**

- Measurement device: LB124 ( $\beta/\gamma$ ) ( $\alpha$  too, but not subject to clearance)
- Limit: < 1 Bq/cm<sup>2</sup> isotopic vector

+	-
100% of surface checked	
Fixed and non-fixed contamination	
Detection of “hot particle” contamination	

## Clearance of waste at KCD

- **PREPARATORY MEASUREMENT:**

### 1) LB124



# Clearance of waste at KCD

## ■ 1<sup>st</sup> CLEARANCE MEASUREMENT:

- Measurement: measurement of piece (waste)
- Type of measurement: specific clearance (Bq/g) (+ weight measurement)
- Measurement details:
  - minimum weight of 1 kg (3 kg according to FANC-letter)
  - Co-60 limit (0,1 Bq/g) used: < 1 kg → 100 Bq limit
  - Max. considered weight 10 kg → 1000 Bq maximum activity
  - Co-60 limit (0,1 Bq/g) used in combination with isotopic vector: more conservative than actual OCL (Operation Clearance Level) calculation

### Old (but still in operation):

- Measurement device: FMP (γ) or CPO (γ)
- Limit: < 100 Bq Co-60 eq.

### New:

- Measurement device: RTM610/661 (γ)
- Limit: < 0,1 Bq/g isotopic vector

+	-
Measurement per piece	1 kg minimum weight
10 kg maximum weight	Isotopic vector usage (instead of an actual spectrum)

# Clearance of waste at KCD

- 1<sup>st</sup> CLEARANCE MEASUREMENT:

1) CPO



/ FMP



/ RTM610/661



## Clearance of waste at KCD

### ■ 2<sup>2d</sup> CLEARANCE MEASUREMENT:

- Measurement: measurement of 200L drum (waste)
- Type of measurement: specific clearance (Bq/g) (+ weight measurement)
- Measurement details:  $\gamma$ -spectrum

#### Device:

- Measurement device: Canberra Q2 ( $\gamma$ )
- Limit: isotope specific limits in Bq/g as per ARBIS addendum IB

+	-
Actual gammaspectrum (measurement per isotope & comparison to legal limit for each isotope)	Measurement per drum

# Clearance of waste at KCD

- **2<sup>nd</sup> CLEARANCE MEASUREMENT:**

## 1) Q2





## Clearance of waste at KCD

***And finally clearance of the waste... or not***

(waste drums remain at the disposal of BelV for 2 weeks to allow for spot checks)

# Detailed look at the Q2

## Detailed look at the Q2

### ■ What:

- $\gamma$ -spectrum analyzer for 200L drums
- 3 HPGe detectors (liquid nitrogen cooling)
- Rotating drum table
- 1000s count time
- Sum-spectrum calculated and used
- Genie 2k software for spectrum analysis
- Automatic comparison of MDA / measurement value to isotope specific limits

### ■ Quality assurance (every night):

- Background check (nearby sources, detector contamination)
- Detector & sum-spectrum : test drum with 3 Eu-152 sources
  - Peak activity, peak position, channel position, FWHM
- Background measurement (for background compensation)
- Failed QA check: all measured drums after the last succesful QA check are measured again.



## Detailed look at the Q2

- **Results of Q2 measurement:**

- Header with general info (contents of drum, weight of drum, geometry, detector live time...)
- Peak analysis report (peak position, peak area, FWHM, ...)
- NID/MDA report:
  - Total activity
  - Concentration in Bq/g per isotope

Nuclide	Total Activity (Bq )	%Error	Concentration (Bq /g)
BE-7	< 1.7435E+03 +/-	2.6%	< 9.6862E-02
NA-22	< 1.2771E+02 +/-	1.7%	< 7.0951E-03
K-40	< 1.8421E+03 +/-	3.9%	< 1.0234E-01
CA-47	< 1.5301E+02 +/-	12.3%	< 8.5003E-03
CR-51	< 1.9983E+03 +/-	2.1%	< 1.1101E-01
MN-54	< 2.2613E+02 +/-	1.4%	< 1.2563E-02
CO-56	< 1.9442E+02 +/-	1.4%	< 1.0801E-02
CO-57	< 3.1081E+02 +/-	3.0%	< 1.7267E-02
CO-58	5.4151E+02 +/-	13.6%	3.0084E-02
FE-59	< 2.8652E+02 +/-	2.9%	< 1.5918E-02
CO-60	2.2352E+03 +/-	4.0%	1.2418E-01

## Detailed look at the Q2

- **Results of Q2 measurement:**

- Clearance report (Genie script):
  - Automatic comparison of measurement/MDA to nuclide specific limits (ARBIS IB)
- “VN” = clearance level = ARBIS IB limit
  - “<” if C is lower than VN, or if the nuclide was not found
- “MDA” = detection limit in Bq/g
  - “<” if C is lower than MDA, or if the nuclide was not found
- “C/VN” = concentration divided by clearance level, sum at the bottom of the column
- “C/VN>=MDA” = see above, but with added condition C > MDA

Nuclide	Totale act. (Bq )	C (Bq /g)	VN (Bq /g)	MDA (Bq /g)	C/VN	C/VN >= MDA
BE-7		<	1.00E+01	<	9.69E-02	
NA-22		<	1.00E-01	<	7.10E-03	
K-40		<	0.00E+00	<	1.02E-01	
CA-47		<	1.00E+00	<	8.50E-03	
CR-51		<	1.00E+01	<	1.11E-01	
MN-54		<	1.00E-01	<	1.26E-02	
CO-56		<	1.00E-01	<	1.08E-02	
CO-57		<	1.00E+00	<	1.73E-02	
CO-58	5.42E+02	3.01E-02	<	1.08E-02	3.01E-01	3.01E-01
FE-59		<	1.00E-01	<	1.59E-02	
CO-60	2.24E+03	1.24E-01	1.00E-01	1.04E-02	1.24E+00	1.24E+00
ZN-65						



## Detailed look at the Q2

- **Results of Q2 measurement:**

- Sum of “C/VN” and “C/VN $\geq$ MDA” is calculated at the bottom of each column
- Sum  $< 1 \rightarrow$  OK for clearance
- Sum  $\geq 1 \rightarrow$  NOK for clearance
  
- Manual final approval by RP.

## Detailed look at the Q2

### ▪ Other uses of Q2: nuclide vector

- Every 2 year a vector is determined based on Q2 measurements of the previous 2 year
- This is the “fingerprint” of our installation
- Non  $\gamma$ -emitting isotopes are factored in:
  - Relative abundance to  $\gamma$ -emitter used to calculate
- A vector is determined for each unit
- The most conservative vector is used for actual clearance

### For each clearance device:

- The new yield based on the new nuclide vector is calculated
- The new yield is programmed into the device.
- The minimum measurement time and or MDA are calculated (and adjusted if necessary)

## Detailed look at the Q2

- Other uses of Q2:  
nuclide vector  
(2015-2016 vector)

ISOTOOP	D12 (%)	D3 (%)	D4 (%)	WAB (%)	SITE (%)	SITETOT. (%)	C <sub>i,L</sub> in Bq/gr	γ in MeV/des	β in MeV/des	α in MeV/des
Ag-110m	0,0687	0,9700	0,4454	0,0684	0,2585	0,2493	0,1	2,74	0,0713	-
Be-7	0	0	0,3502	0	0	0,0422	10	0,0494	3,90E-08	-
C-14	1,4914	2,2256	2,2425	1,6882	1,9686	1,7685	10	-	0,0495	-
Co-56	0,0566	0,1039	0	5,0140	0,5410	0,8044	0,1	3,61	0,00335	-
Co-58	0,8443	0	0,6817	0	0	0,4806	0,1	0,975	0,0341	-
Co-60	45,1300	67,3465	67,8568	51,0863	59,5692	53,5154	0,1	2,5	0,0958	-
Cs-134	0,0181	0	0	0,8522	0,2803	0,1676	0,1	1,55	0,162	-
Cs-137+	18,2956	4,1145	2,4691	14,7618	9,6929	12,9150	1	0,568	0,231	-
H-3	2,4232	0,6320	0,8107	0,1065	1,1484	1,5067	100	-	0,00568	-
I-131	0	0	0,0964	0	0	0,0116	1	0,38	0,192	-
La-140	0	0	0	6,6824	0,1491	0,9322	0,1	2,32	0,533	-
Nb-94	0,0082	0,0122	0,0123	0,0092	0,0108	0,0097	0,1	1,57	0,147	-
Nb-95	0,4826	0,8732	0	0,1308	0,0615	0,3578	1	0,766	0,0444	-
Ni-63	13,5390	20,2039	20,3570	15,3259	17,8707	16,0546	100	-	0,0171	-
Pu-239	1,26E-04	2,84E-05	1,71E-05	1,02E-04	6,70E-05	8,93E-05	0,1	0,000796	0,00488	5,23
Pu-240	1,26E-04	2,84E-05	1,71E-05	1,02E-04	6,70E-05	8,93E-05	0,1	0,00173	0,00833	5,24
Sb-125+	0,0845	0	0	3,5853	2,1859	0,8640	1	0,44	0,126	-
Sr-89	9,0893	2,3705	3,0411	0,3995	4,3074	5,6516	10	0,000136	0,583	-
Sr-90+	3,4992	0,6590	1,4248	0,2892	1,6974	2,2010	1	1,69E-06	1,13	-
Zn-65	4,8480	0	0,2121	0	0,2581	2,3530	1	0,584	0,0045	-
Zr-95+	0,1210	0,4887	0	0	0	0,1146	0,1	0,739	0,116	-
<b>total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>				

De SITE- vector is afkomstig van vaten die samengesteld zijn uit voorwerpen van alle entiteiten.



## Questions?