
5th International Seminar on RADIOACTIVE WASTE PRODUCTS

October 27th to 31st, 2008

Würzburg (D)

W. Kunz & M. Lochny, GNS:

Repatriation of Reprocessing Waste
from La Hague (F) and Sellafield (UK)
to Germany

Radioactive Waste to be Returned

- **Waste Products to be returned from La Hague**
 - a) CSD-V Vitrified HLW: fission products, fines
 - b) CSD-C Compacted MLW: H&E, technological waste
 - c) CSD-B Vitrified MLW: effluents, sludges
- **Waste Products to be returned from Sellafield**
 - a) Vitrified HLW: fission products

All Waste Products are conditioned in cylindrical stainless steel canisters which are known in Germany as
“Glaskokille”

Standard Containers

Model of a CSD-V,

Canisters with same weight and dimensions:

- CSD-B, La Hague
- VR, Sellafield
- VEK, Karlsruhe

$\varnothing = 430 \text{ mm}$
 $h = 1335 \text{ mm}$
 $V = 150 \text{ l} / 180 \text{ l}$
 $m_{\text{vitr}} = 500 \text{ kg}$
 $m_{\text{comp}} = 700 \text{ kg}$

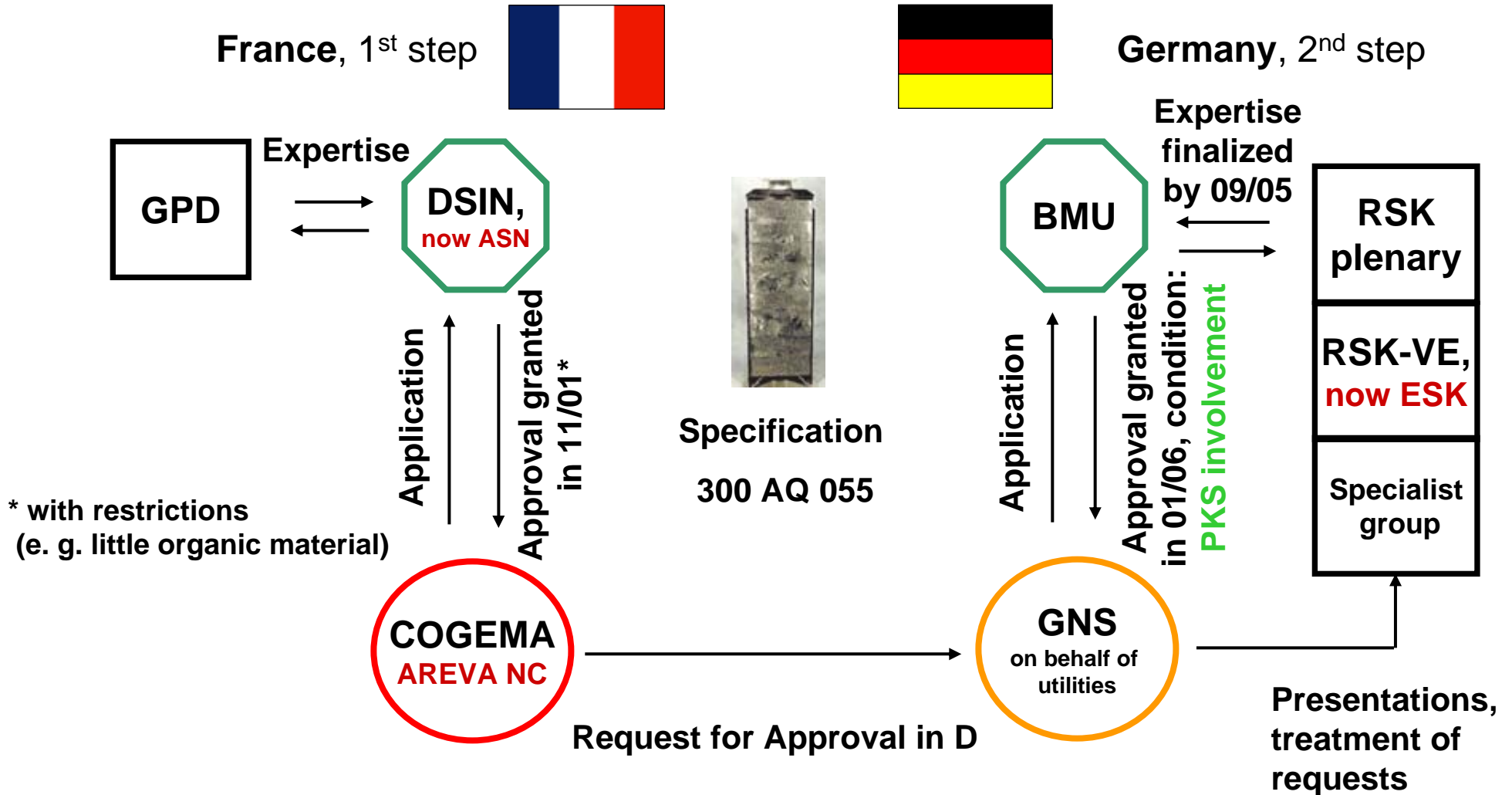


Model of a CSD-C

Facts on Contractual Issues

- The major reprocessing contracts (GUs / COGEMA and BNFL) have been signed between 1977 and 1990; reprocessing was an obligation due to §9a AtG
- By intergovernmental exchange of notes (F/D, UK/D) Germany has acknowledged the obligation / support of waste repatriation; the return of equivalents is feasible
- The BMU has approved the Waste Product Specifications as a pre-condition for the return (CSD-B not yet)
- In 2005 the last fuel has been delivered to F and UK
- In 2007 the last fuel out of 5310 t had been reprocessed at La Hague (now AREVA NC La Hague Plant)
- At Sellafield site the reprocessing of foreign fuel has restarted (after THORP shut down in 4/2005), recently interrupted again

Approval of Waste Specifications, Example: CSD-C



Status of CSD-V (Glass Canisters) Return

Canisters stored in TBL-G

- First shipment to Gorleben: May 1996
- Last shipment to Gorleben: November 2006
- Today: 2100 canisters in 75 flasks (70 % of return project),
- 74 CASTOR[®] HAW 20/28 CG thereof
- Total activity (April 2008): 22 500 PBq (610 Mio. Ci)
- Total heat load : 2.5 MW (0.9 to 1.5 kW/canister)
- Total Cm-244 inventory: 52 kg
- Total mass of cast iron: see next page

Repatriation of CSD-V



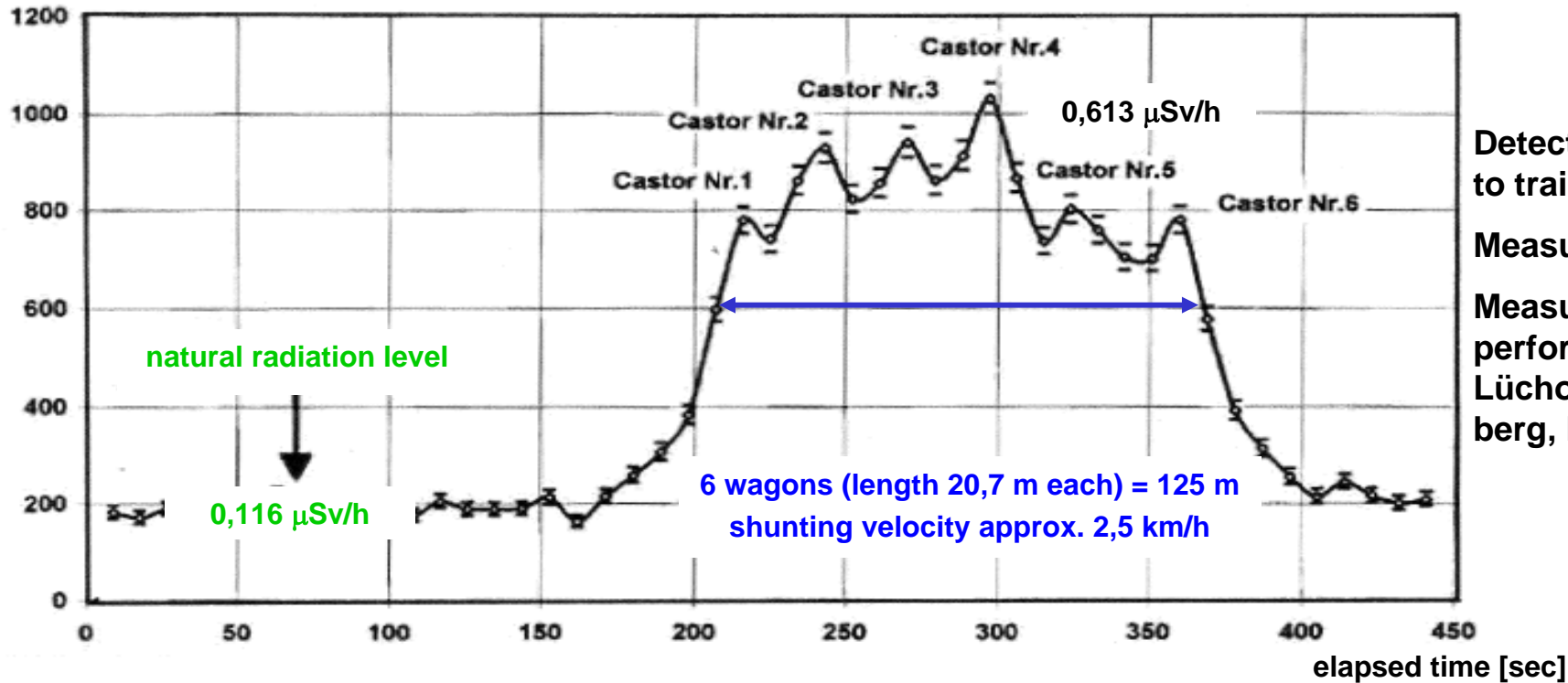
75 CASTOR[®] HAW 20/28 CG flasks \triangleq 7500 t \triangleq 1 Eiffel tower

Repatriation of CSD-V



SH07 approaching TBL-G

γ Measurements near Dannenberg Terminal



Detector distance to train: 24 m,
Measuring time: 9s
Measurements performed by BI Lüchow / Dannenberg, March 2001

Current flask No.		1	2	3	4	5	6
HAW 28/20 CG SN		04	05	06	07	08	09
VG No.		04	09	08	07	05	06
Eu-154	[PBq]	1,8	2,2	2,2	2,5	1,7	1,9
Ce-144	[TBq]	0,1	7,0	6,0	25,0	0,4	0,6
A, total (29.3.01)	[PBq]	286	313	327	340	288	290
γ surface dose rate	[µSv/h]	52	66	71	75	52	55
normalized dose rate		1,00	1,27	1,37	1,44	1,00	1,06
normalized γ peak height		1,00	1,24	1,25	1,41	1,03	1,00

Actual and Future Operations

- ✚ Total number of canister: 3016, total number of flasks: 108
- ✚ New flask generation (TN85 and CASTOR® HAW28M) for the last 33 consignments
- ✚ Extended Inventory: $Q \leq 2$ kW and $Cm-244 \leq 90$ g per canister
- ✚ Until now: $Q \leq 1.6$ kW; $Cm-244$: \emptyset 34 g , max. 60 g; ≤ 90 g in central position
- ✚ 11 TN 85 flasks are ready for shipment at La Hague (VG 76 to 86)
- ✚ Dispatch at Valognes rail terminal is ongoing
- ✚ Loading operation for SH11 will commence in summer 2009 at La Hague
- ✚ In future mainly CASTOR® HAW28M flasks will be used
- ✚ Last shipment: most likely in 2011

Repatriation of CSD-V



Lock 600, NPH,
La Hague



Cold trials of TN 85 flask



Terminal Dannenberg

AMEC, La Hague

Repatriation of CSD-V



Cold trials in Gorleben



Basket for 28 Canisters




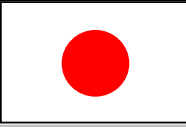

CASTOR[®] HAW28M

Decay of Inventory of Canister 12464C / VG 77

Nuclide 12464C	A _{max} [TBq] *	t _{1/2} (SF) [a]	gamma energy [MeV]	Nov. 2005 production		Nov. 2007 loading		Nov. 2008 shipment	
				[TBq] *	[W]	[TBq] *	[W]	[TBq] *	[W]
Sr-90	4600	28,6	only beta	3490	617	3330	588	3250	575
Ru-106	via SK	1	1,046 (31%)	884	115	226	30	114	15
Cs-134	via SK	2,1	0,796 (85%)	1270	347	650	177	460	127
Cs-137	6600	30,2	0,662 (90%)	5540	706	5290	675	5170	670
Ce-144	via SK	0,8	0,696 (1%)	1090	118	184	20	75	8
Eu-154	via SK	8,8	1,274 (36%)	191	46	163	39	151	36
Am-241	via SK	432 (2,3E14)		601	69	600	69	598	68
Cm-244	90	18,1 (1,3E07)		77	218	71	202	67	194
Total heat release [W]					2276		1830		1710

*) respectively [g] for Am and Cm

CSD-V Repatriation into the Customers' Countries

					
	Germany	Switzerland	Japan	Belgium	The Netherlands
CSD-V					
to be returned:	3016	430	1310	391	280
- flasks:	108	16	55	14	10
already returned:	2100	224	1310	391	140
- flasks:	75	8	55	14	5
Interim Storage Facility					
Operator:	GNS mbH	Zwilag GmbH	JNFL	Belgoprocess	Covra
Name:	TBL-G	ZIWLAG		Bldg. 136	HABOG
Location:	Gorleben	Würenlingen	Rokkasho Mura	Dessel/Mol	Borselle
Type:	flask	flask	vault	vault	vault
Shipments					
flask type (mainly):	CASTOR [®] HAW	CA HAW / TN81	TN20/28VT	TN28VT	TN28VT
canister per flask:	28	28	20 und 28	28	28
flasks per shipment:	12	1 bis 2	max. 8	1	1
means of transport:	rail	rail	ship	rail	rail
remaining road transport:	18 km	2 km	10 km	10 km	none
last shipment (flasks):	Nov. 2006 (12)	Sep. 2006 (1)	Feb. 2007 (6)	Apr. 2007 (1)	Sept 2007 (1)
project time schedule:	1996 -2011	2001 -2010	1995 -2007	2000 - 2007	2004 - 2011

CSD-C (high pressure compacted H&E + TW)

■ Preliminary Number

Grand total approx. 5300 CSD-C, official status 31.12.2007
H&E part: 0.75 CSD-C / t HM, TW part: to be defined

■ Return Program

Storage in flasks: GNS storage facility TBL Ahaus, from 2012 onwards
Flask: TGC-36 with 36 CSD-Cs each: Expected Total < 150

■ Approval of Specification by BMU

Granted January 16, 2006 (H&E and TW with little organic material, without MOX, M5 and high burn-up); extension to be applied for soon.

■ Process Qualification

Positive official notification by BfS (10.12.2007); the conditions set by the expert, PKS, have to be worked off. On site inspections required.

Repatriation of CSD-C

Flask Development TGC36

- ✚ Transport/Storage Flask TGC36, for 36 CSD-Cs, Manufacturer: Consortium AGC
- ✚ Interim storage in TBL-A, direct rail link
- ✚ 1:1 body of a drop test flask (forged steel) has been recently produced by *Forgemasters* in Sheffield/UK



Repatriation of CSD-C



Machined forged steel body,
initial weight 180 t

TGC36

Technical Data:

Loading capacity: 36 CSD-Cs

Pay load: 27 Mg

Total mass: approx. 116 Mg *)

Length of Flask: 4493 mm

Flask diameter: 416 mm



*) Transport
configuration

CSD-B (Medium Active Glass Product)

Before waste water from reprocessing operations can be discharged to the sea it needs to be purified and decontaminated.

Two methods have been applied:

Precipitation (basic method): settlement of sludge and decantation of the purified water. The sludges are embedded via an extruder in a **bitumen** matrix forming a type of asphalt which is drained into a 200 l drum.

Evaporation (advanced method): The remaining sludges consist of nitrates which can be converted into oxides by calcination and melt down with a glass matrix forming as waste **glass product** which is drained into a 180 l standard canister → CSD-B.

The foreign customers have to take back a defined and by Bureau Veritas verified amount of activity expressed in a residue unit called **URBE**).

In 2005 AREVA NC made a commercial offer to the German customers to settle all the URBE accounts only by the return of CSD-Bs. The German utilities agreed.

→ **No Bitumen Product has to be returned to Germany**

Advantage of CSD-B

Reduction of waste packages:

Bitumen: max. 15000 drums (old specification, approved by BMU)
target: 6000 (respectively 1200 GC VII container)

CSD-B: max. 600 (contractual maximum value)
min. 125 (planned guaranteed value of specification)

Stable Product:

Borosilicate glass like HLW, low leaching rates

Inflammable (safety case difficult for storage of bitumen)

Standardization:

Use of standardized equipment for transport, storage and final disposal

Use of transport/storage flask types to be developed for HLW or CSD-C without modification, easy adaptation of licenses

The design of a rectangular shaped cast iron container (GC VII) as type B(U) and KONRAD container type II was very ambitious

Repatriation of CSD-B

Return of CSD-B

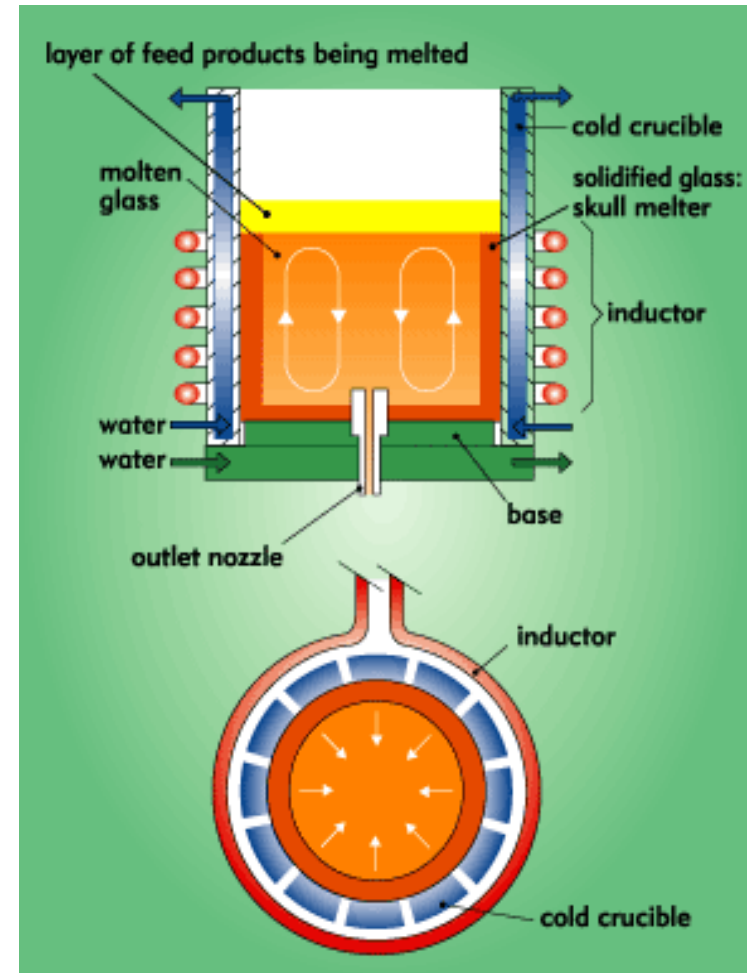
Start of repatriation: 2015 (contractual)

Shipments (with up to 12 flasks): probably only 1 (approx. 30 for all other types of waste if consolidated transports are required further on)

Interim Storage: TBL-Ahaus or -Gorleben (not yet decided), no shortage in capacity either

Specification: BMU Approval and Process qualification from 2010 onwards

Vitrification: AREVA NC has started to modify one line of the R7 vitrification plant in order to implement the CCM (Cold Crucible Melter) process designed by CEA



Cold Crucible Melter

Source: http://www.cea.fr/gb/publications/clefs46/pagesg/clefs46_47.html

Repatriation of VR from UK

**Only one type of residue has to be repatriated to Germany:
HAW Vitrified Residue (VR) containers**

○ **Vitrified Residue Return Programme**

- Approx. 570 VR containers (incl. 4.8 % additional amount for substitution of all other types of waste and residues)
- first loading scheduled in 2013, first transport in 2014 (Status May 2008)
- shipments probably in batches of up to 6 CASTOR® HAW28M flasks

○ **Status and way forward**

- Completion of destorage facility REF, active commissioning in progress
- Negotiation of destorage agreements between International Nuclear Services Ltd (INS) and Utilities ongoing
- Delivery of the first CASTOR® HAW28M to Sellafield for cold trials in 2009
- Concept of “Advance Allocation” or “Virtual Reprocessing” approved by the British Government. Fixing of the number of containers to be returned on that basis possible.

Thank you
for your attention



**Bisons grassing in front of Ahaus
Storage Facility**



**1:1 CSD-C model at Ahaus
Information Center**