Occupational Exposure in Radioactive Waste Management in Germany

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Content

- Results of the study from 1992 to 1995
- Results of the current investigation for nuclear power plants
- Comparison of results of both studies
- Results for medicine, research, and industry
- Summary

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Subject of the study from 1992 to 1995

- Waste stream specific holistic evaluation of the collective dose in the field of non-heat-generating radioactive waste management
- Data evaluation of TÜV Nord at waste producers, conditioning companies, research centers, interim storage facilities, and the ERAM repository
- Inquired were the collective dose and corresponding amount of waste for individual campaigns for the following waste steams:

Nuclear field

- Mixed waste, combustible and compactable
- Concentrates
- Filter materials
- Core components
- Scrap

"Non-nuclear" field

- Medicine
- Research
- Sources

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Results of the study from 1992 to 1995

- The collective dose for the sorting of mixed waste depended on the local conditions (➔ sorting tables!)
- External conditioning did not imply an increase in collective dose, compared with conditioning on site
  (super-compaction of mixed waste, drying of concentrates)
- Interim storage and disposal only provided a negligible contribution to the collective dose
- BWR produced clearly more waste, the dose being nearly twice as high as that of a PWR
  (Reason: disassembling of fuel channels on site)

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Mixed waste, combustible

Period	**2002-2006**		**1992-1995**
	PWR	BWR	BWR/PWR
Annual amount	13 Mg	21 Mg	25 Mg
Sorting in NPP (depending on local conditions)	0.4 - 3.5 mSv/a	0.4 - 5.7 mSv/a	0.4 - 8 mSv/a
Incineration (Studsvik)	0.5 mSv/a	0.8 mSv/a	1.2 mSv/a
Super-compaction	0.1 mSv/a	0.2 mSv/a	0.5 mSv/a
Interim storage / follow-up qualification	0.05 mSv/a	0.05 mSv/a	0.02 mSv/a
Disposal	–	–	0.01 mSv/a
Sum	**1.0 - 4.1 mSv/a**	**1.4 - 6.7 mSv/a**	**2 - 10 mSv/a**

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Super-compaction			mSv/a
Interim storage / follow-up qualification			mSv/a
Disposal	–	–	0.01 mSv/a
Sum	**1.0 - 4.1 mSv/a**	**1.4 - 6.7 mSv/a**	**2 - 10 mSv/a**

- Now: reactor-specific investigation
- BWR usually produces more waste than PWR (larger controlled area)
- Waste arisings lower as compared to the earlier study

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Incineration (Stu			a
Super-compacti			a
Interim storage / follow-up qualifi			a
Disposal	–	–	0.01 mSv/a
Sum	**1.0 - 4.1 mSv/a**	**1.4 - 6.7 mSv/a**	**2 - 10 mSv/a**

- Sorting mainly contributes to the sum of the collective dose
- Optimization potentials identified
  - use of special sorting tables with lead-glass shielding
  - shielded area for the storage of waste

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Disposal			
Sum	**1.0 - 4.1 mSv/a**	**1.4 - 6.7 mSv/a**	**2 - 10 mSv/a**

- Decrease of the collective dose for the external conditioning

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Disposal	–	–	0.01 mSv/a
Sum	**1.0 - 4.1 mSv/a**	**1.4 - 6.7 mSv/a**	**2 - 10 mSv/a**

- Increase of the collective dose for interim storage
- Probably caused by increasing follow-up qualification measures due to long periods of interim storage

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Super-compaction	0.1 mSv/a	0.2 mSv/a	0.5 mSv/a
Interim storage / follow-up qualification			
Disposal	–	–	0.01 mSv/a
Sum	**1.0 - 4.1 mSv/a**	**1.4 - 6.7 mSv/a**	**2 - 10 mSv/a**

- Overall decrease of the collective dose corresponding with a decrease of waste arisings

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Mixed waste, compactable

Period	2002-2006	1992-1995
PWR und BWR		
Annual amount	25 Mg	25 Mg
Sorting in NPP (depending		Sv/a
Compacti		Sv/a
Interim storage / follow up qualification		Sv/a
Disposal	–	0.07 mSv/a
Sum	**3.6 - 10 mSv/a**	**5.5 – 13 mSv/a**

- Mainly the same applies as to “mixed waste, combustible“
- Due to the loss of mass associated with incineration the amount-specific collective dose is higher for compaction without incineration

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Filter materials (resins)

Period	2002-2006	1992-1995
PWR		
Annual amount	approx. 1 m^3	approx. 2 m^3
Dry pumping an dewatering with mobile devices in NPP	1.1 - 2 mSv/a	< 1 mSv/a
Interim storage (1 cast-iron container per year)	0.04 mSv/a	0.05 mSv/a
Sum	**1.1 - 2 mSv/a**	**1 mSv/a**
BWR		
Annual amount	approx. 22 m^3	approx. 24 m^3
Dry pumping an dewatering with mobile devices in NPP	3.5 - 7.5 mSv/a	7.2 mSv/a
Interim storage (8 cast-iron containers per year)	0.3 mSv/a	0.05 mSv/a
Sum	**3.8 - 7.8 mSv/a**	**7.25 mSv/a**

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Sum	**1.1 - 2 mSv/a**	**1 mSv/a**
BWR		
Annual am		24 m^3
Dry pumpir with mobile		mSv/a
Interim storage (8 cast-iron containers per year)	0.3 mSv/a	0.05 mSv/a
Sum	**3.8 - 7.8 mSv/a**	**7.25 mSv/a**

- Resins from PWR plants are partially conditioned together with evaporator concentrates
- Overall increase of the collective dose, reason unknown

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PWR		
Annual am		3
Dry pumpi with mobile		a
Interim sto		a
Sum	**1.1 - 2 mSv/a**	**1 mSv/a**
BWR		
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Interim storage (8 cast-iron containers per year)	0.3 mSv/a	0.05 mSv/a
Sum	**3.8 - 7.8 mSv/a**	**7.25 mSv/a**

- Almost no change of waste arisings for BWR
- Almost no change of collective dose
  - Optimization of the loading concept
  - Increasing efforts to proof the absence of contamination

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Concentrates
(including powder and bead resins)

Period	2002-2006	1992-1995
PWR		
Annual amount	17 m^3	25 m^3
Drying (a) wit (b) wit		v/a
Interim storage (cast-iron container) in NPP	0.9 mSv/a	0.1 mSv/a
Disposal		0.012 mSv/a
Sum	**2.5 - 5 mSv/a**	**2.6 mSv/a**

- Current investigation only for PWR
- No changes for BWR and only negligible collective doses (conditioning is usually remote-controlled)

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Concentrates
(including powder and bead resins)

Period	2002-2006	1992-1995
PWR		
Annual amount	17 m^3	25 m^3
Drying (a) with mobile devices in NPP (b) with stationary devices in NPP	**4 mSv/a** **1.5 mSv/a**	**2.5 mSv/a**
Interim s		mSv/a
Disposal		mSv/a
Sum		**mSv/a**

- Differential investigation for mobile/stationary devices
  Result: Higher collective doses for mobile devices
- Conditioning is usually remote-controlled for PWR as well
- Conclusion: Set-up and dismantling of mobile devices is disadvantageous from the radiation protection point of view

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Concentrates
(including powder and bead resins)

Period	2002-2006	1992-1995
PWR		
Annual amount		m^3
Drying (a) with mobile devices in NP (b) with stationary devices in NPP		v/a
Interim storage (cast-iron container) in NPP	**0.9 mSv/a**	**0.1 mSv/a**
Disposal		0.012 mSv/a
Sum	**2.5 - 5 mSv/a**	**2.6 mSv/a**

- Increase of collective dose for interim storage
- This includes collective dose values for follow-up qualification

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Core components

Period	2002-2006	1992-1995
PWR and BWR		
Annual amount	1 to 2 cast-iron containers/year	
Direct packing into cast-iron containers in the fuel pool	approx. 1.8 mSv/a	1.5 mSv/a
Interim storage	0.06 mSv/a	0.05 mSv/a
Sum	**1.9 mSv/a**	**1.6 mSv/a**
For BWR additionally		
Dissecting of fuel channels, packing into cast-iron containers	dropped	20 mSv/a
Sum	**–**	**21.6 mSv/a**

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Sum	1.9 mSv/a	1.6 mSv/a
For PWR additionally:		
Dissecting of fuel ch… packing into cast-iro…		20 mSv/a
Sum	–	**21.6 mSv/a**

- Almost no change in collective dose for PWR
- The same applies to the waste arisings

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Core components

Period	2002-2006	1992-1995
PWR and BWR		
Annual amount	1 to 2 cast-iron containers/year	
Direct packing int the fuel pool		Sv/a
Interim storage		Sv/a
Sum		**Sv/a**
For BWR additionally		
Dissecting of fuel channels, packing into cast-iron containers	**dropped**	20 mSv/a
Sum	**–**	**21.6 mSv/a**

- Dissecting an packing of fuel channels is substituted by
  - the transport of fuel elements with channels to the reprocessing plant or
  - the direct packing into transport and storage casks

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Scrap

Period	2002-2006	1992-1995
PWR and BWR		
Annual amount	6 Mg	47 Mg
Dissecting, sorting, followed by super-compaction and packing or utilization	0.1 mSv/a	0.5 - 1.9 mSv/a

- The waste arisings as well as the collective dose is drastically reduced

Reasons:

- Increasing decontamination efforts
- Increase of clearance (after amendment of RPO in 2001)

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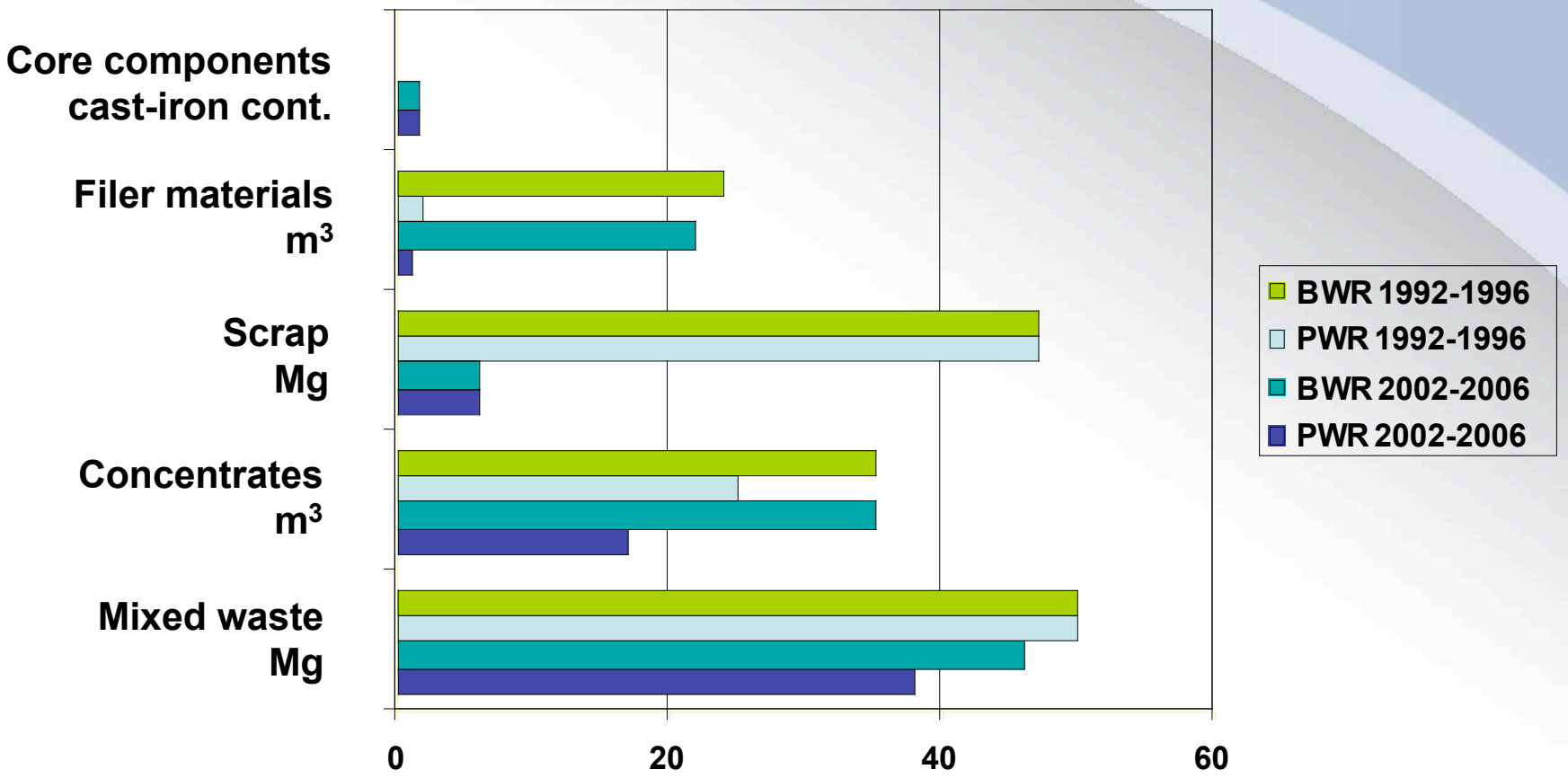
Annuals waste arisings in a typical NPP



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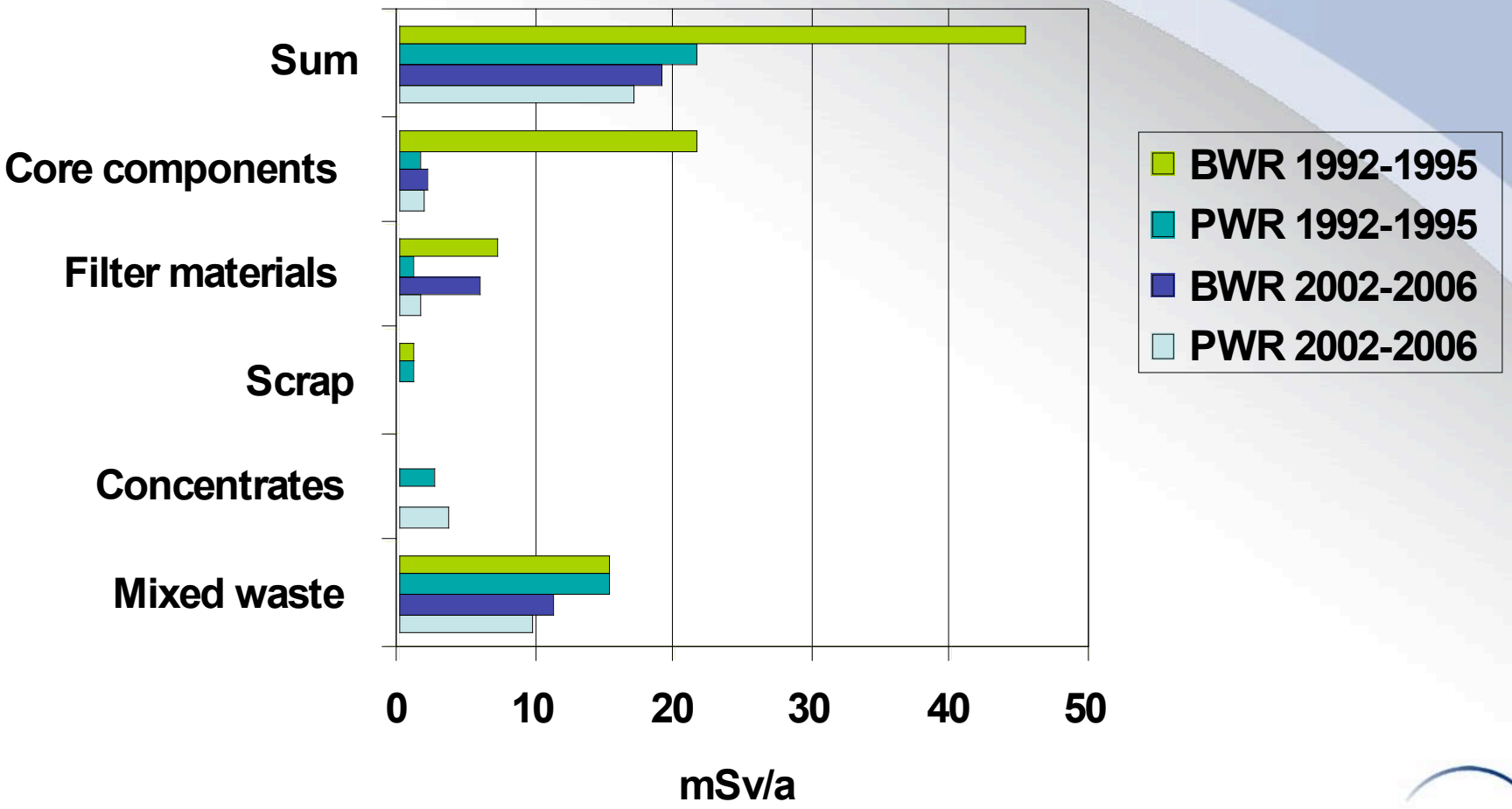
Annual collective dose for the handling of NPP waste



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Comparison of results of both studies

- The collective dose for waste management has clearly been reduced.
  (Main reason: Dropping of dissection of fuel channels from BWR)
- The collective dose for the handling of mixed waste has decreased.
  The values for other waste steams are practically unchanged.
- Regarding the collective dose, there are no more differences between the two reactor types. (in earlier study much higher dose for BWR)
- There are differences in the handling of concentrates (PWR) and
  Filter materials (BWR). They compensate each other.
- Optimization potentials still exist for the sorting of mixed waste.
  (The majority of plants is already equipped with special sorting devices)
- For the conditioning of evaporator concentrates with mobile devices a higher collective dose arises as compared to stationary devices.

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Collective doses for waste management (2002 – 2006)

Results of this study :

- NPP: ~ 20 mSv/a per plant → **~ 0.4 Sv/a** (for 19 NPPs)
- Medicine, research, industry: **~ 0.3 Sv/a**
- Sum: **~ 0.7 Sv/a**

Results of the Radiation Protection Register of BfS:

- Total occupational exposure: **~ 44 Sv/a**
- from NPP: **~ 20 Sv/a**
- in the field of waste management **~ 0.8 Sv/a**

Non-official dosimeters

Official dosimeters

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Summary

- Collected data are difficult to compare with the values from the Radiation Protection Register. (official and non-official doses)
- Differences may also arise from the assignment of doses to different fields of workings. (especially Radiation Protection Register)
- The occupational exposure has generally decreased as compared to the earlier study. (especially due to the dropping of fuel channel dissecting)
- Waste management still contributes less than 2 % to the overall occupational exposure in Germany.
- The collective dose value of 25 mSv according to IWRS II Directive for special planning is usually not reached within a waste campaign.

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Acknowledgement

We express our thanks to all operators of nuclear facilities, research institutions and companies who provided us with data for this investigation.

Thank you for your attention!

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