Treatment of Operational Radioactive Wastes from the Mühleberg Nuclear Power Plant and Future Changes Following the Start of Operation of the Centralised Interim Storage Facility (ZWILAG) in Würenlingen

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For operational wastes arising regularly at Mühleberg Nuclear Power Plant (KKM), management pathways leading to conditioning into a disposable form have been defined; specifications already exist for these pathways. While the most significant wastes in terms of volume and activity, namely ion-exchange resins and activated reactor internals respectively, are conditioned into a disposable form (cemented into 200-l drums) at the KKM site, conditioning of contaminated mixed wastes from the controlled zone is carried out at external locations. With the exception of high-pressure compactable wastes, which have been conditioned at the Leibstadt NPP site since 1988, conditioning of mixed wastes is carried out at the Paul Scherrer Institute (PSI). These wastes are then transported back to KKM as packages suitable for emplacement in a repository. In the future, the treatment and conditioning of radioactive waste will be performed centrally at the intermediate storage facility Zwischenlager Würenlingen AG (ZWILAG). The wastes currently conditioned in external facilities will also be conditioned and stored - until final disposal - at ZWILAG.

1. Introduction

Various radioactive wastes arise from the operation of the Mühleberg nuclear power plant (KKM) with 355 MW electrical power, which began commercial power production in 1972. Depending on their radiological and physical composition, these wastes required to be handled and conditioned using appropriate methods. For wastes which have already arisen, and those still being generated, methods have been developed and introduced for on-site or off-site treatment. The aim is to convert the raw wastes into a form which is suitable for disposal and easy to transport and handle.

One important boundary condition attached to converting radioactive wastes into a form suitable for disposal is that there should be optimum utilisation of volume, while at the same time fulfilling requirements in terms of waste package properties. Although conditioning methods and management pathways have already been defined for the wastes arising from KKM, there will, in the future, be a significant change in the treatment of mixed wastes. This will be due mainly to the start of operation of the centralised interim storage facility (ZWILAG) in Würenlingen, which will take over the processing of these wastes. The availability of the new waste treatment facilities at ZWILAG will require KKM to undertake a new division of the mixed wastes and to modify its sorting criteria.

2. Operational Sources of Radioactive Wastes

Figure 1 shows the annual arisings of operational radioactive wastes from KKM. All waste quantities are converted into solidified, disposable waste volumes and are classified according to surface dose rate and waste source. A total of around 31 m^3 of waste arises per year, corresponding to approximately 145 200-l drums. Compared to the figures published in 1996 [1], the annual volume has decreased by around 50 drums, or approximately 10 m^3.

Resins used for cleaning the steam circuit represent by far the largest waste stream, with around 55% of the total volume. Around 31% of the total are conventional mixed wastes (combustible, compactable, neither combustible nor compactable), 6% are activated reactor wastes and the remaining 8% are slurries and filter cartridges. From the radiological point of view approximately ¼ of the annually finally conditioned drums have a dose-rate less than 1mSv/h and approximately ¾ have some tens of mSv/h. These cause no handling problems using standard equipment available in the nuclear industry. Less than half a percent of the drums have a very high dose-rate (over 1Sv/h) and require special measures.

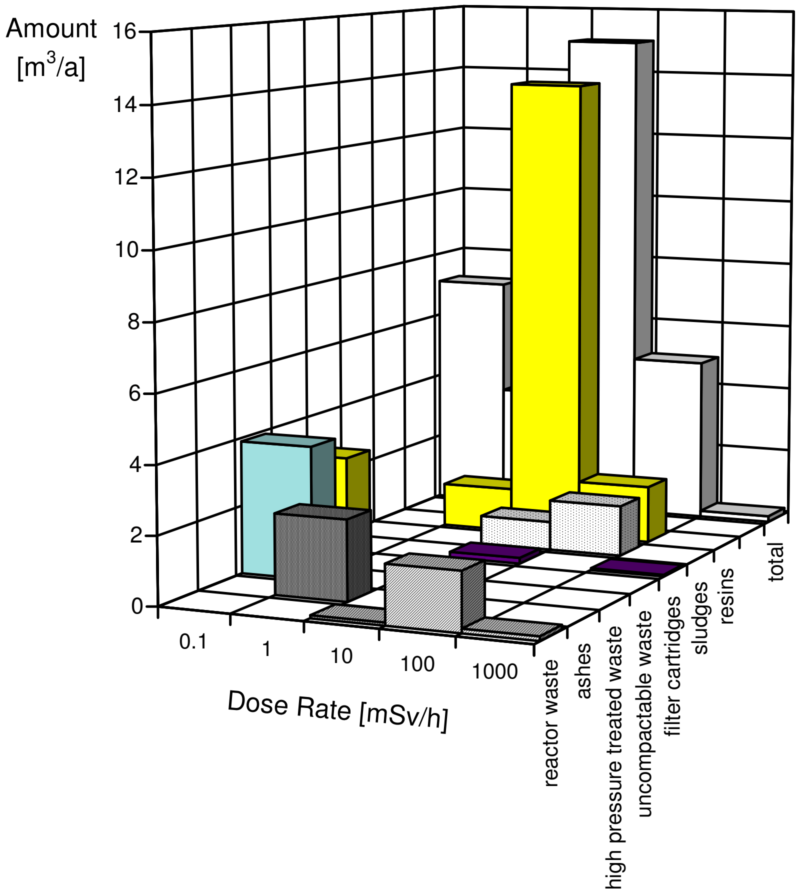

Figure 1 Classification (in terms of volume) of finally conditioned operational wastes arising annually in KKM; for the surface dose rate of the individual waste a logarithmic scale is used.

While Figure 1 shows only a rough division based on the key properties of surface dose rate, volume and origin, operational aspects of waste handling (waste management) require more detailed analysis of the place of origin and physical composition of the wastes. This information is also relevant with a view to categorisation and allocation of conditioned wastes in a repository.

In order to optimise waste management procedures at KKM, all wastes which have arisen in the past, and those which will arise (or potentially arise) in the future, are documented and allocated to a waste sort, depending in each case on the conditioning procedure to be applied. The waste sorts are defined in the Swiss model inventory of radioactive wastes [2]. Table 1 provides a general overview of raw waste arisings and possible pathways leading to conditioned and disposable waste. Using this overview, it is easy to check whether a management pathway is available for a waste arising for the first time, or whether special measures have to be taken. For example, when considering the introduction of new decontamination methods, the treatment of the associated secondary waste and the potential to integrate it into already existing waste streams may have a marked influence on the decision finally reached.

Table 1 Waste types arising from operational sources at KKM and their allocation to waste sorts depending on conditioning procedures. The procedures are marked with arrows, with existing branches shown as filled circles and future ones as open circles. BA-1 Resins; BA-2 Sludges; BA-3 Filter cartridges; BA-5 Solid Waste; BA-6 Ashes; RA Waste from reactor pressure vessel.

Waste sort conditioned	Waste type 'Stored rawwaste '	Description of waste type resp. waste sort (only for BA-5 and BA-6)
BA-1a	H-P1	Powdered resins from KRA and drainage of apparatus and buildings
BA-1b	H-P2	Powdered resins from cleaning reactor water and fuel element storage pool
BA-1c	H-KU	Bead resins from mixed bed filters in waste water
BA-2a	R-WS	Laundry sludges
BA-2b	R-SL	Sump and other sludges
BA-2c	R-GP	Decontamination Beads
	R-QS	Silica sand
	R-AK	Used oil / Cold cleaning
BA-3a	F-FW	Filter cartridges from precoat filters in water circuits
BA-3b	F-FB	Filter cartridges from underwater filters (Balduf filter)
BA-3c	F-SG	Filter cartridges from underwater cleaning systems
BA-3d	F-SC	Filter cartridges from underwater shearing assembly
	F-CF	Control rod drive assembly filters
	A-LF	Ventilation filters
	A-VF	Pre-filters
	A-AF	Absolute-filters
	M-MA	Mixed waste, unsorted
	M-MB	Mixed waste, combustible
	M-MS	Mixed waste, slaggable (ZWILAG)
	M-MP	Mixed waste, compactable
	M-NN	Mixed waste, not compactable, combustible or slaggable
	M-VA	Incineration residues
	M-RP	Samples
	M-SO	Other solid wastes
	G-SB	Stones, concrete
	G-BF	Coatings, paint
	E-IS	Insulation material
	E-AS	Asbestos
	E-ME	Metal
	E-NM	Non-metal
	K-KG	Components, equipment
	K-TK	Parts of components / equipment
	K-TL	Parts of components, loose
BA-5a		Solid wastes, not compactable, combustible or slaggable
BA-5b		High-pressure compacted wastes
BA-6a		Ash
BA-6b		Filter cartridges from furnace off-gas cleaning
BA-6c		Slaggable waste (ZWILAG)
RA-1	C-CR	Control rods
RA-2	C-NQ	Neutron sources
RA-4	C-VB	Poison curtains
RA-6	C-BK	Fuel channels
RA-7a	C-LA	Instrument lances, activated components
RA-7b	C-LS	Instrument lances, slightly activated components
RA-8a	C-KT	Small parts from reactor pressure vessel
RA-8b	C-SO	Other parts from reactor pressure vessel

3. Treatment of Resins and Sludges

The entire water treatment process in KKM is done using ion-exchange resins, which accounts for the relatively large volumes of this waste type (see Fig. 1). By optimising resin management, but particularly also by exchanging brass condenser pipes for titanium ones and by renewing the filters in the condensate clean-up system, it was possible to reduce the annual arisings of resin from an average of 6.5 t to less than 4 t (dry weight).

Solidification of significant volumes of resin only began in 1995. For the operating cycles from 1972 to 1995, around 150 t (dry weight) of spent resins in 3'000 200-l-drums were held in the interim storage facility. Conditioning of these old resins and of resins and slurries arising in ongoing operations is carried out using a solidification plant installed in the existing waste treatment building.

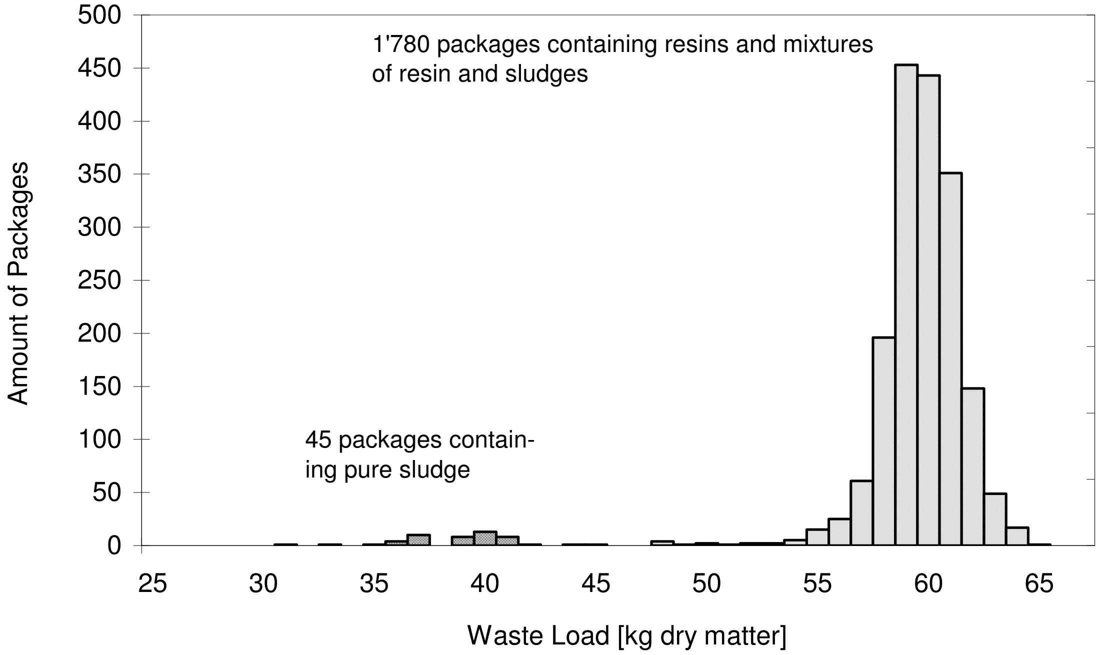

Figure 2 Loading of the waste packages produced using the CVRS solidification plant up to the end of 2000

The procedure comprises treatment of the raw wastes, thermal conditioning of the resins and volume-optimised immobilisation in cement. The loading achieved using this method is 300 kg dry substance per m^3 waste matrix for resins and 200 kg dry substance per m^3 waste matrix for slurries. A total of around 35 t of resin were processed in the year 2000, producing 588 waste packages. The solidification plant was presented in detail earlier [3]. Figure 2 shows the status of the conditioning activities carried out up to the end of 2000.

4. Handling and Separating of Solid Wastes from the Controlled Zone

Inspection, maintenance and conversion work in the controlled zone, and the waste treatment process itself, give rise to a range of mixed waste arise which require to be sorted before further processing. The first step is always to separate out the inactive fraction for conventional disposal. The remaining radioactive components are then sorted into combustible, compactable and neither combustible nor compactable fractions. Where possible, composite materials are size reduced into the different fractions (e.g. absolute filters into inactive, combustible and compactable components). Table 2 shows an overview of the volumes of these wastes which have arisen since 1992; it can be seen from this that the volumes vary depending on the work carried out in a particular operating year. Taken overall, however, it can be estimated that around 9 t of combustible waste, 4 t of compactable waste and around

Table 2 Mixed wastes from the controlled zone arising between 1991 and 2000

Waste fraction		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
combustible	[t]	8.7	10.0	7.6	7.1	6.7	7.5	10.2[1]	10.0[1]	8.7[1]	7.7
compactable	[t]	4.7	6.9	4.6	3.6	2.9	2.9	5.2[2]	5.8[2]	4.1[2]	4.4
neither combustible nore compactable											
Paint etc.	[t]	0.7		0.2	0.4	0.6	0.2	0.1		0.2	
Building debris	[t]	2.9	0.8	2.8[3]	2.8[3]	0.7	0.6	1.0	2.5	1.0	2.2
Metals	[t]	1.5		1.0	1.4	0.7	0.2	0.2		3.3[4]	16.9[4]
Total	[t]	**18.5**	**17.7**	**16.2**	**15.3**	**11.6**	**11.4**	**16.7**	**18.3**	**17.3**	**31.2**

[1]1997: renewal of filters; 1998 and 1999 exchange of condenser A and B; [2]spent resin drums dismantled; [3]installation of solidification plant in treatment building; [4]decontamination material from decontamination of condenser.

2 t of waste which is neither combustible nor compactable arise from operation. An inactive fraction of around 5 t per year is disposed of using conventional methods following clearance by the authorities.

4.1 Sorting out the Inactive Fraction and Decontamination of Components

As part of the process of sorting mixed waste into the fractions combustible, compactable and neither combustible nor compactable, inactive substances are first separated out and disposed of using conventional methods. This has the effect of reducing the waste volume and cutting down processing costs, which are significantly higher compared to the costs involved in separating the waste. The volume of inactive waste depends on what special retrofitting work or campaigns are carried out; these are associated with an increase in material production but it can be said roughly that, on average, per operating year around 5 - 6 t of mixed waste is sorted and disposed of as inactive material (see Tab. 3). This inactive waste is made up of material which is around 60% combustible, 25% compactable and 15% neither combustible nor compactable, leading overall to a saving of around 200,000 Fr. in operating costs.

Table 3 Inactive and decontaminated wastes arising at KKM between 1991 and 2000

Year	sorted (mixed wastes)	Dismantled and decontaminated (exchanged components)	
1991	5.2 t		
1992	5.0 t	7 t	Insulation material
		6 t	Iron / steel
1993	5.4 t	22 t	Steel
1994	8.5 t	24.3 t	Steel
		1.8 t	Cables
		40 t	Concrete
1995	4.2 t	10.4 t	Steel
		38 t	Turbine oil
		40 m^3	Insulation material
1996	5.5 t	5.2 t	Old drums
		2.0 t	Crane parts
		0.9 t	Rock wool
		1.8 t	Sheet metal
		3.0 t	Iron / Steel
		9.3 t	Preheaters
1997	5.0 t	23 t	Preheaters
		4.5 t	Core drilling
1998	5.4 t	21 t	Preheaters
		2.7 t	KRA-filters, etc.
		8 t	Wood
		2 t	Insulation material
1999	8.1 t	155.2 t	Steel, brass and packaging
2000	8.4 t	90.1 t	Brass
		41.6 t	Steel and other metals
		6.3 t	Corrundum

Dismantling and decontamination of components and other materials means that a further very significant volume of material can be treated in such a way that inactive management becomes possible. For example, for the brass pipes from the condensers commercial reuse and reintroduction into the system as valuable materials is possible to some extent.

In the case of decontamination procedures in particular, it has to be checked very carefully that the methods used do not produce secondary wastes which are significantly more problematic in terms of their conditioning and suitability for disposal, and whether such potential disadvantages are justified by the reduction in waste volumes.

4.2 Combustible Mixed Wastes

Typical combustible mixed wastes arising at KKM include, in order of decreasing volume, plastic sheeting, cellulose, cloth (overalls, overshoes, etc.), wood, paper/pulp (packing material, filter paper from mask filters and absolute filters), zone shoes and fibres and lint from the laundry centrifuge. In addition to this there are small amounts of concentrated citric acid from decontamination of components, cloths from waste oil filtering and nylon of filter cartridges from condensate decontamination which can also be incinerated. As wood is used to fire up the incineration plant, contaminated wood is delivering separately packed.

The combustible waste is broken up in such a way that it can be filled into plastic sacks with a capacity of approximately 35 l. The aim when filling the sacks is to achieve loose loading of a readily combustible mixture of the different waste types.

The guidelines for packaging of combustible wastes are based on the experience of the operating personnel of the incineration plant at the Paul Scherrer Institute (PSI), where combustible radioactive wastes presently arising in Switzerland are incinerated. Because of the design of the furnace, not all wastes which consist in principle of combustible material can be accepted. Some wastes which could give off harmful emissions on burning or those which would impair the operation of the furnace are allocated to different waste streams (e.g. high-pressure compactable waste; the materials in italics in Tab. 4 are basically combustible).

For transport to the incineration plant, the plastic sacks, each with around 2 - 3 kg of waste, are loaded into 200-l drums. On average, such a drum holds 17 kg of waste. As the processing steps are basically carried out by hand, radiological boundary conditions have to be observed in addition to requirements such as good combustibility. Without taking any possible hot spots into consideration, the surface dose rate of the filled drums should not exceed 2 mSv/h where possible. If the surface dose rate is more than 0.5 mSv/h, then the container requires to be marked with a white adhesive strip. The locations of hot spots, which significantly exceed the background surface dose, should be marked with a red sticker at least 5 cm in diameter. Hot spots may not exceed a value of 5 mSv/h.

Ash produced from incineration is solidified at PSI in accordance with plant-specific specifications and is transported back to KKM together with the ceramic filter cartridges (also cemented) which arise as secondary waste during incineration. On average, around 10 conditioned (to disposable) waste packages containing ash and filter cartridges are accepted back at KKM per operating year; these originate from approximately 9 t of raw wastes. As of the end of 2000, 176 waste packages, which arose between 1984 and 2000, were being stored in KKM's interim storage facility.

4.3 High-Pressure Compactable Mixed Wastes

Since 1988, mixed wastes have also been separated into a high-pressure compactable fraction, compacted and cemented into 200-l drums. Similarly to the requirements for combustible wastes, the compactable wastes have to be sorted in such a way that a good volume reduction is achieved during processing (see Tab. 4). There are also restrictions on the dose rate of the waste pieces. Pieces with a high dose rate (small parts with max. 50 mSv/h) are positioned centrally in the compaction drums in such a way that the surrounding material acts as a shield. To eliminate problems in handling and transporting the filled compaction drums, the measured dose rate at the drum surface should not exceed 2 mSv/h. No filled compaction drums is permitted to have a local dose rate greater 10 mSv/h.

High-pressure compacting campaigns have been carried out since 1988 using a rented 2'000 t compressor. These campaigns involve all the Swiss waste producers and are carried out at a central location. The pellets produced by compaction are loaded into 200-l drums and the voids filled with cement mortar. Once the mortar has hardened, the packages are transported back to the relevant producer.

The third and, up till now, last campaign was carried out in 1995. Today, more than 400 filled containers ready for compaction are being held at KKM (see Tab. 4).

Table 4 Content (material vector) of compaction drums filled between May 1995 and the end of 2000. For comparison purposes, the material vector based on the analysis of high-ressure compactable materials arising up to 1994 and declared in the type specification is shown with its Band with. The good agreement with the specified values indicates, that the material vector for high-pressure compactable wastes from KKM is very constant.

Material	Volume [kg]	Distributed over packages [no]	Proportion [%]	Proportion specified in 1994 [%]	specified Band width [%]
Aluminium	247	103	1.0	1.0	0 - 6
Asbestos	47	10	0.2	0.2	0 - 3
Seals	606	58	2.4	2.5	0 - 18
Iron / steel	8614	403	34.6	40.0	0 - 83
Felt	317	99	1.3	1.5	0 - 10
Glass & glass fibre	695	121	2.8	1.6	0 - 10
Glass- & rockwool	1645	181	6.6	7.2	0 - 30
Rubber	*1630*	139	6.6	4.1	0 - 26
Cables	421	53	1.7	2.5	0 - 18
Adhesiv tape	*3075*	304	12.4	11.9	0 - 49
Halogen free plastic	*2538*	254	10.2	5.2	0 - 25
PVC	*666*	84	2.7	3.8	0 - 18
Vacuum sacks	2389	311	9.6	7.5	0 - 24
Protective clothing,	*1984*	195	8.0	10.1	0 - 40
Miscellaneous	-		-	10.0	0 - 20
Total	24'874	411	100	100	
Average per compaction container	60.52				

The naming of the materials in the case of compactable wastes came about historically and has been maintained as it is familiar to the sorters. To provide information on the materials in the conditioned waste packages, the materials are changed using a conversion matrix into the nomenclature required for evaluation of material properties. By mixing wastes with different degrees of compactability, KKM can achieve a compaction of 1200 to 3400 kg/m^3, with an average of 2000 kg/m^3. This is equivalent to a waste loading of approximately 230 kg of contaminated or slightly activated radioactive substances per solidified waste package or 3.8 highpressured pellets per drum.

4.4 Non-Compactable Wastes

After the inactive wastes have been sorted out and the combustible and compactable wastes have been packaged, what remains is waste consisting mainly of larger metal pieces which cannot be decontaminated, remnants from work on concrete structures and coatings, all of which arise during repair work. These wastes are either mixed with cement mortar (homogeneous waste product) or are cemented into 200-l drums (quasi-homogeneous waste product). This work is also carried out at PSI.

5. Other Solid and Liquid Wastes

Other wastes such as acid baths from decontamination, residues from the laundry centrifuge or contaminated oils are not suitable for direct cementation. This category also includes materials which generally arise as a result of one-of special actions and cannot be allocated to any of the existing waste streams (e.g. abrasive substances used to decontaminate condenser pipes).

If these wastes are handled appropriately, it is possible in most cases to convert them into a form which will allow them to be allocated to an existing management pathway. For example, residues from the centrifuge of the active laundry are dried and the resulting product is packaged for incineration. Contaminated oils are filtered through several layers of old zone overalls; the activity is retained by the cloth layers (combustible) and the filtered oil is then inactive. Citric acid from wet decontamination is distilled and the remaining viscous residue is dried and also incinerated. The procedures discussed here are naturally only appropriate for small waste volumes (several hundred kg per year).

One waste which represents a special case in terms of its management is the 10 t of stainless steel granulate from condenser pipe decontamination. Because the steel is mixed with brass, direct cementation is impossible (reaction of the zinc component in an alkaline medium with release of hydrogen). The waste (in 8 kg portions) is presently stored in 19 200-l drums. As soon as the incineration and melting facility at ZWILAG becomes operational, the waste will be taken there to be melted down (see also section 7).

6. Reactor Wastes

Wastes from the reactor pressure vessel include e.g. used fuel channels and control rods, incore instrumentation assemblies, filter cartridges, small parts and bolts from the shroud. These wastes are activated and contaminated materials with such a high dose rate that handling is possible only with lead or steel shielding or underwater in the fuel element storage pool.

As part of three conditioning campaigns, the wastes - with the exception of the control rods - are size reduced (where possible and necessary), packed into baskets and cemented into 200-l drums. A major part of the equipment used for handling the wastes is the joint property of the Leibstadt and Mühleberg power plants. The underwater shearing assembly for cutting the fuel channels was rented from the Gundremmingen power plant and operated by the company Noell-KRC (Würzburg). These components, and the procedure for cutting the fuel channels, have already been described previously [4]. A special sawing technique has been developed and optimised for the bolts from the shroud (see [5]). The experience gained in the campaigns to date has also been published ([5], [6]) and only the most important information is summarised here in Table 5.

Table 5 Data on the waste packages from the three conditioning campaigns for reactor wastes and filter cartridges

	Fuel channels			Filter candles	Detector assemblies	Small items from RPV	Shroud head bolts
Campaign	1991	1992	1998	1998	1998	1998	1998
Raw waste, total proc-	102	299	232	200	415 m	640 kg	52 St
Raw waste per package (average value)	4.86t	5.64	5.95	20	138 m	213 kg	4 St
Number of packages	21	53	39	10	3	3	13
Total weight per package	599	622	630	481	662	671	907
γ-surface dose rate							
average	570	820	660	690	39	960	5
maximum	640	915	1'400	3'300	230	1'900	9

7. Implications for Waste Treatment of the Start of Operation of ZWILAG

The Zwischenlager AG Würenlingen (ZWILAG) is a joint stock company of the Swiss nuclear power plant operators. Its aim is to construct and operate centralised management facilities for radioactive wastes. All categories of radioactive residues of Swiss origin can be stored at ZWILAG in the future. For the conditioning of low- and intermediate-level waste, ZWILAG has facilities for sorting, decontamination, dismantling and cementing; it also has an incineration and melting plant which can process both combustible and meltable wastes [7], [8].

For the conditioning of operational waste from KKM, in the future ZWILAG will take over all work previously carried out by PSI. This will consist mainly of conditioning of the regular arisings of mixed wastes from the controlled zone described in section 4. In addition to this, wastes for which internal conditioning is not appropriate will also be handled by ZWILAG (e.g. 13 t of recirculation loops exchanged in 1986, asbestos insulation material, decontamination waste such as decontamination beads, etc.). The difference from current practice is that, following conditioning, the wastes will remain at ZWILAG and will no longer be returned to the waste producer, who remains the owner of the wastes.

The greatest changes from the viewpoint of waste sorting will be brought about by the operation of the incineration and melting plant. This is because the material vector of combustible waste in the future will contain not only substances which are forbidden for the PSI plant on grounds of harmful emissions but also up to 20 kg of non-combustible materials. The result will be that the wastes destined today for high-pressure compaction will probably disappear.

The acceptance criteria for ZWILAG's incineration and melting plant include a wide mixture of materials covering all wastes arising today. For handling reasons, the only restrictions relate to the weight of the package and the total activity. The containers which presently hold around 17 kg of waste can be filled in future with up to 200 kg of combustible wastes. The streamlined regulations will mean a considerable reduction in the effort involved in sorting and documentation of wastes and in the number of external transport activities.

To fill containers with 200 kg of combustible waste it is necessary to extend the present sorting plant to include a drum press. In the case of KKM, an existing press which has not been used will be modified and upgraded to give a pressing power of 30 t to compress the waste. However, it is expected that, even making use of the allowed 20 kg of high-density non-combustible waste, it will only be possible to load the drums with a maximum of 100 to 150 kg of waste. Although the increased weight of the resulting drums makes them more difficult to handle, the advantages of the new packaging method outweigh any disadvantages. The storage requirements will be reduced and the number of external transports will drop from the current 10 to 15 per year to 2 to 3.

Because compacting the combustible waste results in a product which cannot be handled without diffi-

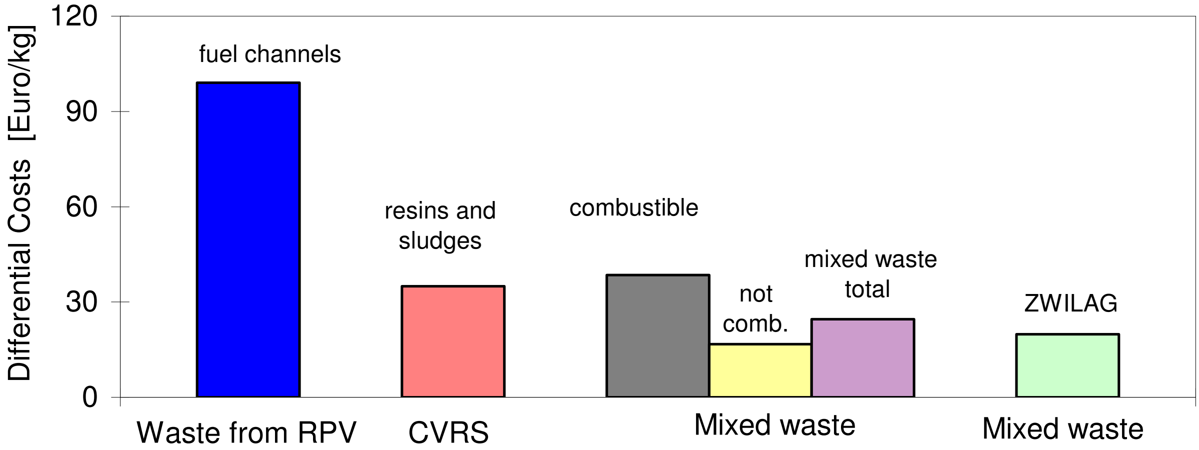

Figure 3 Specific differential costs for conditioning radioactive wastes from KKM. "Cement Volume Reduction & Solidification" (CVRS), procedure for solidification of resins and slurries.

culty by PSI, and given that processing of the existing half-finished products together with combustible waste in ZWILAG is not economical, changing the waste preparation procedures should be postponed until it is clear at what point in time the incineration and melting plant at ZWILAG will commence operation. Repackaging wastes which are already in an acceptable form for ZWILAG to allow them to be processed at PSI would be very difficult because compaction has already been carried out.

In order to compare the costs presently involved in waste treatment with the future prices of processing by ZWILAG, it is necessary to consider the differential costs. These are understood to include processing costs without taking into account the cost of writing off the necessary infrastructure. Figure 3 shows the specific differential costs per kg of processed waste for some types of operational waste. For the conditioning of 1 kg of mixed wastes from the controlled zone, the differential costs without final disposal and associated transport are around € 25 (see Fig. 3 'total mixed waste'). According to current estimates, the corresponding costs of future conditioning at ZWILAG will be around 20% lower (cf. Fig. 3).

The start of operations at ZWILAG, particularly of the storage facilities and the incineration and melting plant, will streamline the conditioning of mixed wastes from the controlled zone. Because a radioactive waste repository will not become available in Switzerland on the medium term, the new storage capacity will have the effect of relieving the situation in the storage facilities at the individual power plants. Based on current rates, the costs of waste processing will be somewhat lower and the effort involved in packaging the wastes will be less.

Changing tried-and-tested methods is always associated with an increased effort on the short term. Added to this is the uncertainty regarding the right moment to implement these changes (see [9]). Despite these uncertainties in planning, it is expected that the start of operation of the ZWILAG facilities will have a positive impact on waste management procedures in KKM on the medium term.

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