OPERATING EXPERIENCE WITH THE LLW-SCRAPPING FACILITY AT KFK

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ABSTRACT

The volume of slightly contaminated plant equipment such as piping, components, fittings, tanks, valves etc. increases proportionally to the growing number of on-line nuclear power plants, other nuclear facilities and their increased operating lifetime. This contaminated equipment mainly originates from retrofitting actions. Parallely, the nuclear power plants of the first generation are about to be decommissioned, producing also larger quantities of slightly contaminated component parts.

Ultimate storage capacity is not available in the Federal Republic of Germany at the moment and the costs for ultimate storage seem to be very high in the future. Intermediate storage costs in engineered storage facilities are reasonably high as well.

That is why priority is given to all measures which aim at volume reduction. This applies both to ultimate storage as well as to intermediate storage. It is therefore indispensable to develop and apply new methods and techniques to reduce the volume of the waste material to be stored.

There are two ways to reach this goal:

- Dismantling of the components and subsequent decontamination below the specified limit value which allows their reuse (unrestricted release)
- Volume reduction by crushing and high pressure compaction

The LLW-scrapping facility at the Karlsruhe Nuclear Research Center (KfK), operated by Transnuklear (TN) and Kraftanlagen Heidelberg (KAH) in a joint venture is described. The experience gained in the start-up phase and the first months of operation are reported. The results allow to evaluate the advantages of the above mentioned two ways of volume reduction in both countries, the Federal Republic of Germany and the United States.

1. INTRODUCTION

Since about 1980 there has been a steadily increasing accumulation of contaminated metallic material such as components, fittings, pipes or parts of these items as well as all kinds of construction elements used in nuclear facilities.

The reason for this is

- In a growing number of nuclear power plants, repair or replacement work with resulting exchange of components becomes necessary.
- New results and experience in the area of material strength and corrosion in compliance with administrative regulations, have led to retro-fitting work in conjunction with demounting large quantities of contaminated material.
- A number of experimental and demonstration power plants will be decommissioned in the next few years. Here again, large quantities of contaminated material will have to be removed.

Both, the necessity of intermediate storage as well as the future, volume-specific costs of ultimate storage recommend volume reduction of such radioactive wastes by decontamination and unrestricted release or by compaction.

2. DECONTAMINATION AND HIGH PRESSURE COMPACTION

Each one of the two applicable methods of volume reduction - decontamination and high pressure compaction - have to be taken into account when dealing with contaminated materials (see fig. 1).

Decontamination

A large portion of the produced waste material is only slightly contaminated; another portion is considerably contaminated, but is nevertheless worth to be decontaminated due to its operating history, geometry, value of material, etc.

For an important portion a decontamination is not recommended under economical aspects. In some cases, decontamination is technically feasible, however, the required work and expenses would be excessively high. It may also imply that measuring expenditures are unreasonably high or that tracing of residual contamination is just impossible.

High pressure compaction (h.p.c)

Therefore this metallic material must be handled the other way - h.p.c. - to be reduced in volume. Beside metallic components, a considerable amount of other contaminated material is produced during repair and replacement work and decommissioning of nuclear facilities.

For mixed or non-metallic materials - insulation material, cables, PVC-foil, rubble etc. again the only economic method of volume reduction is h.p.c.

3. LLW-SCRAPPING FACILITY AT THE KFK

Facilities and cooperation

Large modern radioactive material treatment facilities using the most recently developed technologies in the FRG are available in the Karlsruhe Nuclear Research Centre (KfK).

Treatment in such a facility offers various advantages to the owner/operator of a nuclear power plant, such as:

- normal plant operation is not obstructed by treatment in a central facility
- large quantities of contaminated material from various power plants can be handled most economically in a central facility
- a central facility permits to realize optimum safety conditions
- some of the methods applied in a central facility cannot be used on site.

Within the frame of a cooperation contract, KfK GmbH carries out all the decontamination work on the above mentioned material, whereas a TN/KAH joint venture operates the LLW-srapping facility.

LLW-scrapping facility - dismantling

The main part of this scrapping facility is a 12 x 8 x 7 mα-tight caisson provided with an 8 m material lock. The plant is designed for conditioning of equipment up to a total weight of 100 Mg and max. lengths of up to 18 m. Material that has to be crushed is transferred into, unwrapped and dismantled in the caisson (see fig. 2).

Large components are first cut into suitable pieces by means of

- remote controlled plasma arc cutting devices (up to 110 mm material thickness)
- oxyarc electrode cutting devices (up to 60 mm material thickness)
- conventional cutting tools

The crude pieces then are

either sent to the nearby decontamination facility for decontamination and unrestricted release
or are subsequently crushed with a

- hydraulic shear (length of cut 760 mm, cutting force 7 kN)
- hacksaw (length of cut 550 mm)
- hydraulic prepress for bulky material (press force 2000 kN)

LLW-scrapping facility - compaction

The so treated material is packed into simple 180 l-cans. The cans are sealed with a lid and sent to the 4-column h.p.c. Compaction of the cans with a press force of 15.000 kN yields pellets with 530 mm in diameter and different heights. On request pellets with other diameters can be produced by exchanging the press mould and main cylinder. Pellets are collected in a buffer storage with 41 storage places. The height of all pellets is registered on a computer, then composed to give an optimum column and then filled into a 200 l-drum through a double lid lock.

On request pellets are cemented inside the 200 l-drums. Cement filling station, pellet buffer storage and high pressure compaction operate automatically and are computer-controlled. Various data such as size of compacted cans, weight and dose rates are used to ensure optimum drum filling.

Operation of the compactor and dismantling work in the caisson are controlled by TV-cameras or through lead glas windows, respectively. Dose rate and contamination of outgoing drums are monitored and plotted for each drum together with other relevant data for intermediate and final storage.

4. OPERATION EXPERIENCE

Operation mode

Construction of the LLW-scrapping facility by Nukem started in autumn 1982. Meanwhile the function tests and start-up are completed. Since the start-up of active operation in November 1983 different types of material have been treated.

Up to now, most of the incoming material was packed in 20'-ISO-containers. Containers were coupled to the lock, thus extending the controlled area. The content was put on a trolley and transferred into the caisson. Here a staff of 2-3 men in protective clothes were responsible for the further treatment.

In case of 180 l cans already prefilled with e.g. steel scrap, rubble, insulation material, glass wool, glass, ceramic pieces, wrapping material, HEPA-filter, cable, turnings, pipes, masks etc. the cans passed the caisson and were sent directly to the h.p.c.

Depending on kind and amount of material, cans with an original diameter of 520 mm and a height of 830 mm were compacted with a surface pressure of 6.9 kN/cm² to give pellets with 530 mm in diameter and different heights. As the material is compacted together with the can - resulting in an encapsulated pellet - expanding of material was neglectable, with one exception (rubber masks).

Volume reduction factors of performed operations

1. 24 m³ steel scrap, filled in 134 cans of 180 l each, were pressed to yield 31 drums of 200 l with pellets, finally solidified with cement. The volume reduction factor, based on raw material and pellets was 4.3, taking into account the packing in 200 l drums the volume reduction factor was 3.9. More detailed volume reduction factors for mixed waste, rubble, steel scrap and pre-pressed steel scrap as well as the corresponding specific gravities are presented in fig. 3.

2. Pre-compaction work with the 2.000 kN pre-press was performed with insulation material and α-contaminated filters.

   E.g. 70 m³ contaminated insulation material resulted in 12.4 m³ tablets, then being pressed with h.p.c. and filled into 23 drums of 200 l (4,6 m³). The overall volume reduction factor was 15.2. The total operation time of the LLW-scrapping facility from the receipt of containers, prepressing, feeding the tablets into 180 l-drums,h.p.c. up to filling the pellets into 200 l-drums was 20 hours.

3. Nearly the same overall volume reduction factor (17.5) was reached when treating 28 m³ α-contaminated filter material. On an average, half a m³ material was prepressed so that two tablets fit in one 180 l can. After h.p.c. the final waste was fixed with cement in 8 drums of 200 l.

4. Optimum volume reduction factors were reached for contaminated ventilation ducts. Shearing and precompacting with the 2.000 kN prepress and final compaction of tablets with the 15.000 kN h.p.c. resulted in an overall volume reduction factor of 55.

5. Combined dismantling, and h.p.c. work e.g. was performed with tubes of 300-650 mm in diameter and up to 20 mm wall thickness. Due to the infiltrated contamination and complicated geometric structure, the material was not recommended for decontamination and unrestricted release.

   By means of plasma arc cutting, pipes were easily cut into pieces fitting into the 180 l-press cans. After h.p.c. of those cans the resulting pellets were filled into 200 l-drums giving a surface dose rate of 0,2 Sv/h. Considering the raw material and final drums the overall volume reduction factor was 2.7.

Besides h.p.c. of prefilled 180 l press-cans, compaction of contaminated iron grids and insulation material, two heat exchangers from FR 2 are presently being dismantled and conditioned.

5. ECONOMICS

Basic figures

Evaluating decontamination of radioactive material for unrestricted release and h.p.c - including intermediate and ultimate storage - it is assumed:

- intermediate / ultimate storage
  - specific costs for intermediate storage in the FRG depend on the material itself and layout of storage halls leading to 3,700 - 7,500 DM/m³ on an average 5,000 DM/m³ must be assumed
  - final disposal costs in the FRG are in the range of 10,000 DM/m³
  - costs for intermediate and ultimate storage are risk factors because of undefined storage conditions and licensing requirements
  - costs for intermediate and ultimate storage force to reduce volume during conditioning and to use volume saving disposal containers
- decontamination and unrestricted release
  - for the economic evaluation it is assumed that 20 % of contaminated metallic components cannot be decontaminated due to unreasonably high measuring expenditures, infiltrated contamination or complex geometric structure. This waste material shall undergo treatment using volume reduction techniques
  - conditioning in a central facility, where all modern techniques for decontamination are available
- scrapping and h.p.c.
  - 200 l-drum concept with (conservatively) 500 kg per drum
  - conditioning in a central facility, where all modern equipment for crushing and dismantling are available.

Cost comparison

The distribution of costs for the operation steps in table 1 shows the following results:

- decontamination and unrestricted release is given preference to scrapping and h.p.c. even in case of equal costs, considering the risks of uncertain cost development for intermediate and ultimate storage in the FRG
- conditioning in a central facility means that the treatment of radioactive material is done outside the nuclear power plant site. In case of decontamination up to 66 %, in case of scrapping and h.p.c. up to 48 % of the work is done off-site. In both cases, the nuclear power station avoids:
  - interruption of operation
  - licensing problems
  - dose commitment
  - additional secondary waste

- In case of lower costs for intermediate and ultimate storage as in the case in the US, h.p.c. results to be more economic than decontamination and unrestricted release.
  As an example the cost break-down for the different steps: decontamination, unrestricted release and scrapping, h.p.c. is shown in table 1 for the FRG and for the US.

6. RESUME

By means of compacting, a significant reduction of the waste volume intended for ultimate storage can be achieved. The expected high costs for storage of waste can be reduced and the limited space for ultimate storage can be saved.
Both, decontamination for unrestricted release and volume reduction of the remaining waste, particularly by high pressure compaction, are successfully demonstrated and are of specific use to ease waste management and to reduce operating costs in nuclear facilities.

TABLE 1

DISTRIBUTION OF COSTS FOR DIFFERENT OPERATION STEPS

	operation step	decontamination and unrestricted release		scrapping and high pressure compaction	
		FRG	US	FRG	US
1	intermediate and ultimate storage	5	1	23	6
2	dismounting on site	23	23	23	23
3	scrapping, compaction cementation	9	9	48	48
4	decontamination final cutting monitoring	57	57	-	-
5	transporting	6	6	6	6
6	sum (%)	100	96	100	83

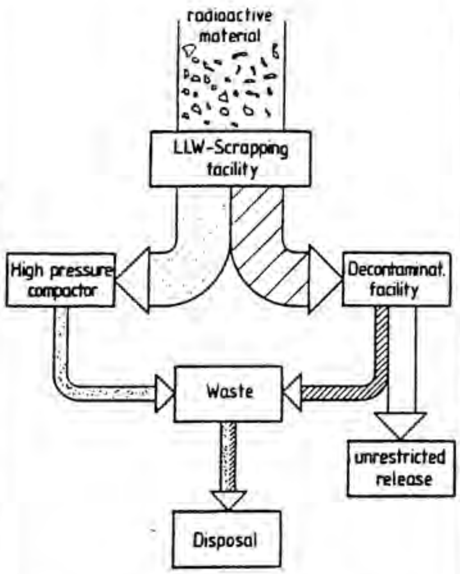

Fig.1 Decontamination and high pressure compaction.

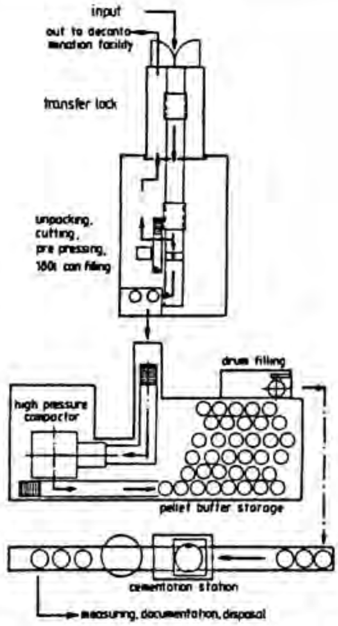

Fig.2 Sequence of operations in LLW-scrapping facility

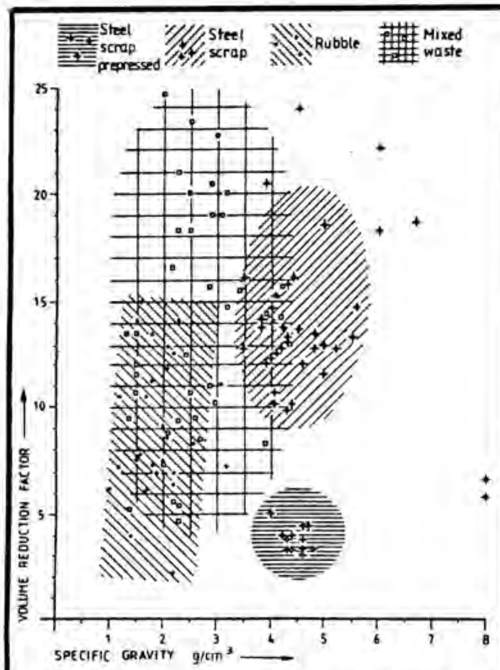

Fig.3 Volume reduction by high pressure compacting