

HIGH COST SAVINGS DUE TO THE SEPARATION OF CLEAN FROM CONTAMINATED CONCRETE AND CABLES

by

Dr. Lutz Bergemann, Nuclear Power Station Gundremmingen, Germany
Stefan Rosenberger, NUKEM Nuclear Technologies, Columbia, SC USA

ABSTRACT

The nuclear power station KRB A (**K**ernkraftwerk **R**WE - **B**ayernwerk, unit A) was the first commercial reactor - a Boiling Water reactor - in Germany. This station started operation in 1966 and was shut down 1977. The decision to decommission the reactor was made in 1980 and work started in 1983.

Since that time, there has been extensive experience in minimizing the amount of radioactive waste by (1) utilizing decontamination techniques and (2) measuring for the unrestricted release of very low contaminated materials to the environment. In Germany, waste minimization was necessary since there is no final disposal for radioactive waste (the only disposal site was in the former GDR and after reunification, the site was closed in 1998 based on a decision of the court of the state Sachsen-Anhalt).

One of the waste minimization techniques is the shredding and unrestricted release of concrete and cables. Shredding is a proven, efficient method of separating and segregating contaminated waste elements from non-contaminated elements.

In the case of concrete, the most activity - nearly 70% - is concentrated in approximately 5% of the filterdust. The unrestricted release of the concrete results in its use as street construction material or it may be disposed in a sanitary landfill. In Germany, the costs for shredding and unrestricted release of the concrete (including the costs of equipment and personnel) are less than 5% of the costs for the final storage as radwaste.

The unrestricted release of cable is complicated due to the ratio cable surface to mass and thus, surface contamination surveys are inadequate. By shredding the cable, the insulation and copper are separated completely; all contamination is concentrated in the granulated insulation. Subsequently, a mass-specific measurement of the copper is very simple and typically, 74% of the total mass of initial cable is released for unrestricted use. The costs of shredding and measuring for unrestricted release are about 10% of the costs of final storage as radwaste.

INTRODUCTION

Gundremmingen is a nuclear power plant (NPP) with three boiling water reactors on site. Two operational modern units of the Siemens KWU BWR-type 72 generate 1344 MWe each and have been operational since 1984. Also, The Gundremmingen site houses one older unit – KRB A, a GE-plant – that had generated 250 MWe and started operation in 1966. KRB A was the first commercial reactor in Germany and after 11 years of operation, was shut down as result of an accident in 1977.

The owners decided to decommission the plant because the costs of the retrofitting of KRB A were expected to be too expensive. The decommissioning activities started in 1983 and are now in the final stages. Decisions on which technologies to use were driven by the overall goal to minimize the costs of the plant dismantling /1/. Numerous investigations were made to consistently use the safest and most economic dismantling techniques; techniques were selected based on the ability to reduce radiation exposure to the workers, and reduce the generation of contaminated waste. This emphasis on waste

WM '00 Conference, February 27 – March 2, 2000, Tucson, AZ

reduction gained significant importance after the 1998 closing of the only operational German final repository at Morsleben. The existing German intermediate storage facilities and their capacities are limited and therefore, the operating NPPs prefer to store waste on site.

During the past 17 years of decommissioning activities, numerous technologies have been developed and demonstrated. Following is a discussion of two of these technologies – the shredding and unrestricted release of contaminated concrete and cables. These technologies were deployed at KRB-A have resulted in significant cost savings and waste volume reductions. With increasing disposal costs, these and other disposal volume reducing technologies will become even more significant.

DISMANTLING OF CONCRETE STRUCTURES AND RECYCLING OF CABLES

Decommissioning of nuclear power plants includes the removal of not only process systems like pipes, pumps, valves etc., but also the removal of large quantities of contaminated concrete. Structures such as walls, foundations for pumps, shielding, and other concrete structures (e.g., structures that must be removed for access to dismantle process components) will generate the first concrete waste, long before the building structures are removed. The concrete rubble contains pieces of various sizes and irregular geometries and thus, such pieces prevent a reasonable standard surface contamination measurement (counting time becomes too long to account for the irregular geometries). Total γ -measurement is not possible due to the missing calibration parameters.

Similar problems must be resolved for the contamination measurement of electrical cables. The measurements must address the extremely large surface areas. This issue is especially pertinent to the measurement of thin cables like electronic and telephone cables.

Faced with these issues, KRB-A resolved the problem by conducting assessments of the volumetric properties of the concrete and cable wastes. Using a shredder the concrete rubble is size reduced to small pieces of a few centimeters in diameter. This granulates – filled into 200-l drums – can be measured with a reasonable effort. In addition to size reducing cable scrap with a shredder, KRB has maximized the cost-effectiveness of volume reduction by separating non-contaminated copper from the insulation.

REUSE OF CONTAMINATED MATERIAL

Article § 9a of the German Atomic Law demands the “Reuse of radiocontaminated material and removal of radiocontaminated waste.”

Operators of nuclear power plants are required either

- to reuse all removed/ dismantled radiocontaminated materials and components without any harm to human beings or the environment,
- Or to dispose of contaminated materials as nuclear waste if such a reuse is technically or economically not possible/ feasible.

Therefore, close attention is given to the reuse and recycling of any materials, especially since no final repository site is currently operational in Germany.

Due to the legislative rules, the classification and removal of wastes as non-radiocontaminated material from KRB-A can be achieved in two ways:

- a) Decontamination of the surface contamination to less than 0.5 Bq/cm² or to a mass-specific activity of less than 0.1 Bq/g. Measurement and verification by the regulatory authority leads to the free release for unrestricted reuse without any conditions.
- b) Melting of metal scrap with an activity of more than 0.1 Bq/g but less than 1 Bq/g and restricted (controlled) reuse of such metal in the nuclear industry (e.g., as shield blocks or containers) /2/. This approach provides a very important alternative if decontamination, measurement and release are not possible (or economically feasible). Melting is commonly used for pipes with thin walls and components with complicated geometries (e.g., valves and pipes with a diameter of less than 200 mm).

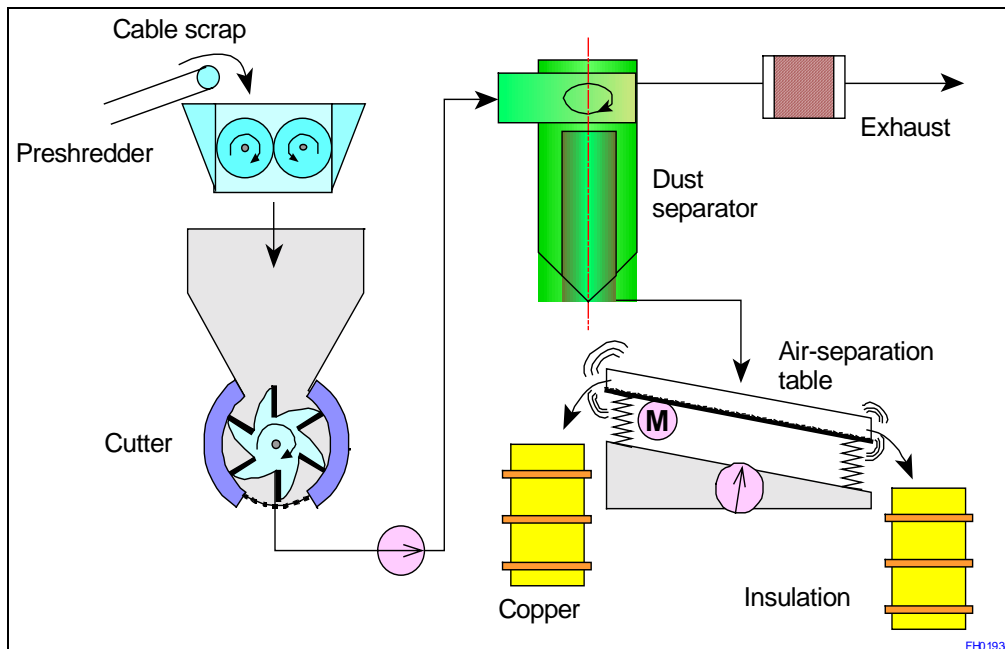
Recycling of Cables

Revisions, maintenance and decommissioning of nuclear power plants generate substantial quantities of cable scrap. These cables are often contaminated and if possible, they must be decontaminated and measured for free release. A common practice in the non-nuclear industry is the separation of copper and insulation for copper recycling purposes. This separation and recycling approach was adapted by KRB and built into a process design that meets the demands of a nuclear processing application.

At KRB, the task was to separate simultaneously the contaminated (insulation) from the non-contaminated (copper) material. Such an approach would reduce the project costs since no further handling of the material would be necessary /3/. KRB has achieved this goal of unrestricted release for most of the cable via the following technique.

All cables were cut into approximately 1m pieces during the dismantling activities and stored in a collection box. Subsequently, these cable pieces were wiped to remove loose contamination. Finally, the cable pieces were processed using a newly developed process, the “cable stripper”. A simplified flow diagram is shown below (Fig. 1)

Figure I: Principle of the Cable Stripper



The cable stripper consists of a conveyor to load the cable scrap, a pre-shredder, and a shredder with several blades that will cut the cables into 3 to 5 mm small nodules. These nodules are transported to a vibrating separation device that separates the insulation material from the copper. Both waste streams are separately collected in standard 200-l drums

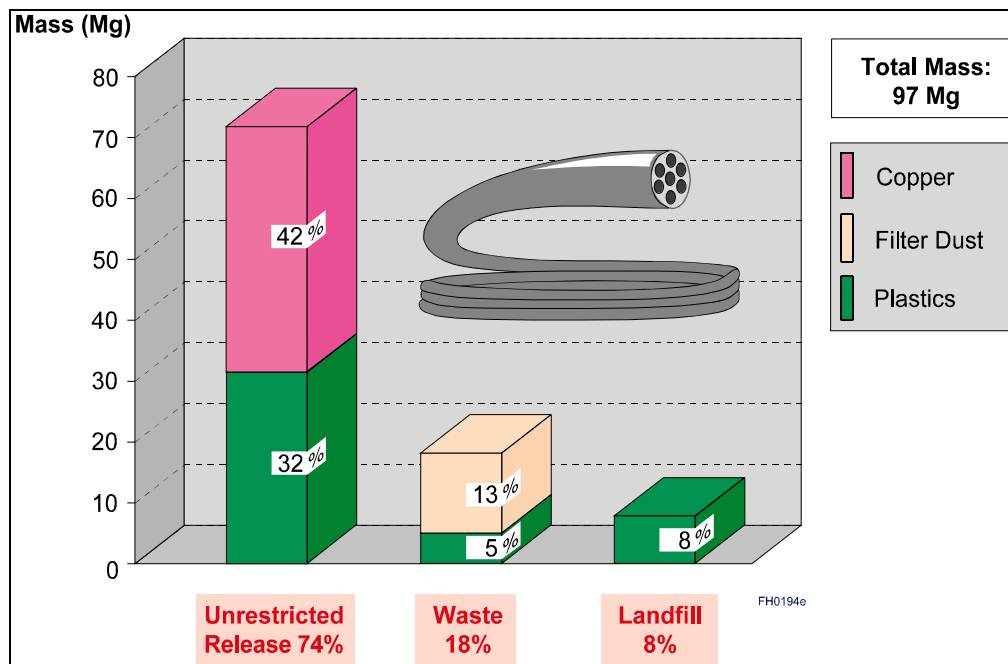
As a result of the cable stripper process, 100% copper and about 65% of the insulation processed was not contaminated in accordance with the German standards, and was free for reuse without any limitations (see Fig 2). A total of 74% of the initial cable scrap was subsequently free released. A total of 8% of the insulation was disposed at a regular landfill utilizing unrestricted release limits.

Only 18% of the scrap cables processed (insulation and dust) had to be treated as contaminated waste and will remain for final storage.

The copper with a high purity was recycled and sold to a melter of electrolytic copper. The revenue from such sale contributes to the reduction of dismantling costs.

The Cable Stripper process and approach was developed by KRB-A in collaboration with the commercial industry and currently, has a patent pending.

Figure II: Results of the Cable Stripper



Concrete recycling

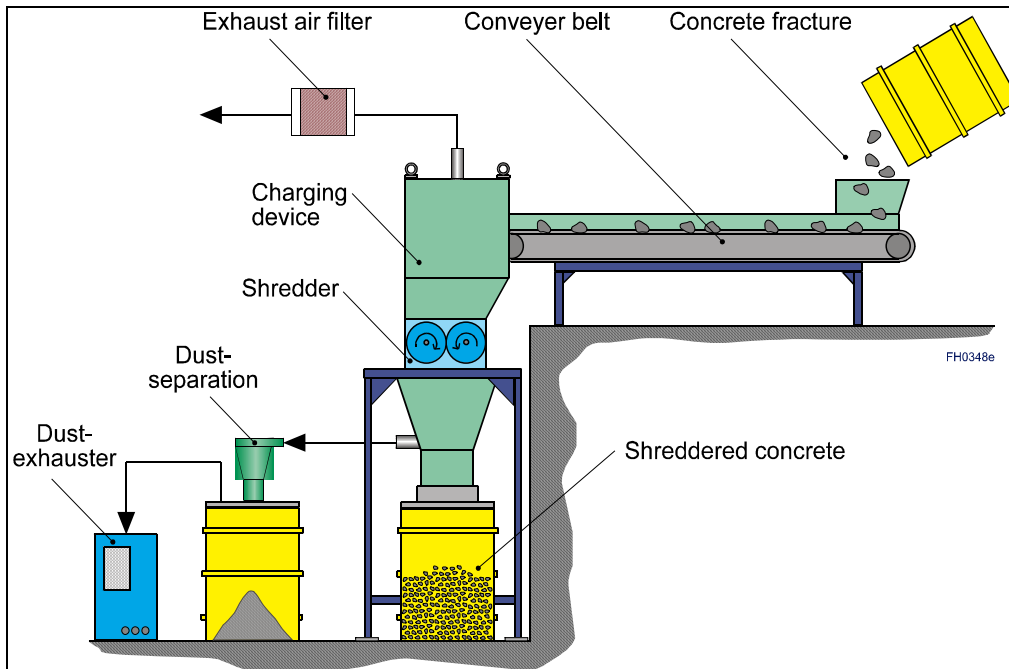
Concrete must be size reduced in order to assess and measure it with total-gamma-measuring equipment. A concrete shredder that breaks rubble with a contamination level of up to 30 Bq/g into smaller pieces serves such a purpose. Fig. 3 shows the principle for such a device.

The rubble is filled into the machine via a conveyor. Other materials that might be trapped such as iron scrap (e.g., armor irons or anchor bolts) can be detected and removed. Two rollers with “breaking teeth” size reduce the pieces to the level as necessary for measurement. The dust generated in that process is

separated and collected in standard 200-l drums. The granulated concrete with diameters up to several centimeters is collected separately in other 200-l drums. Subsequently, the free release measurement is performed.

Pre-tests have demonstrated that the largest amount of the activity is associated with the dust. Generally, the concrete granulate was clean for unrestricted release. Using the allowable higher release limit of more than 1 Bq/g, it is possible to deposit such concrete granulates directly in a regular landfill.

Figure III: Concrete crushing



FREE RELEASE MEASUREMENTS

For the release of large quantities of very low contaminated materials for unrestricted reuse, it is necessary to have developed suitable, simple and time saving measuring equipment and procedures.

At Gundremmingen KRB uses two approaches for

1. Materials with exactly defined surfaces
2. Materials with no defined surfaces

For all materials with an exactly defined surface, KRB performs a 100% measurement of the surface using commercial gas-filled large surface detectors. The measurements are transferred directly to an electronic database and are evaluated in nearly real-time. With a special program /4/ developed by KRB-A, the plant can achieve measuring times of about 5 sec with a lower detection limit of 0.1 Bq/cm² for Co-60.

For materials with no defined surface (e.g., such as crushed concrete/cable where surface measurements are not feasible), KRB uses total-gamma equipment with liquid scintillation, or nuclide-specific measurement with pure germanium counters.

WM '00 Conference, February 27 – March 2, 2000, Tucson, AZ

The following limits must be observed in Germany /2/:

Table I: Activity Limits in Germany

Nuclide	Unrestricted release [Bq/g]	restricted release [Bq/g]
Co-60	< 0.1	< 4
Cs-137	< 0.5	< 10

The higher value of the restricted release allows for use in road construction or deposition in a landfill without any surveillance.

The following table shows the masses and their percent distribution for the waste stream and contamination limits.

Table II: Masses and their Percentile Distribution

	unrestricted release		restricted release		contaminated waste	
	[Mg]	[%]	[Mg]	[%]	[Mg]	[%]
Cables: Copper	40.5	42%	0.0	-	0.0	-
Cables: Insulation	31.2	32%	8.0	8%	5.4	6%
Cables: Filterdust	0.0	-	0.0	-	12.2	13%
Concrete rubble	89.9	56%	47.5	30%	21.5	13%
Concrete dust	0.0	-	0.0	-	1.2	1%

For the cables, only 19% of the initial total 97 Mg of material are contaminated waste to be stored in a final storage; for concrete, only 14% of rad waste results from the initial total 160 Mg of material.

Table 3 describes the percent distribution based on activity of each waste stream.

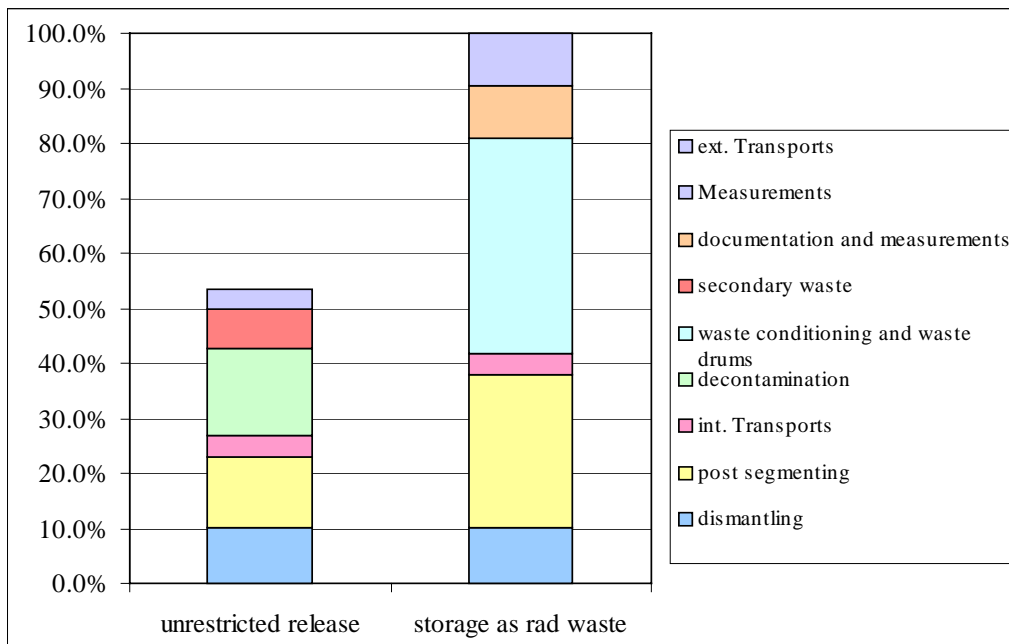
Table III: Activities and their Percentile Distribution

	Unrestricted release		restricted release		contaminated waste	
	[Bq]	[%]	[Bq]	[%]	[Bq]	[%]
Cables: Copper	1.4E+07	5.0%	0.0	-	0.0	-
Cables: Insulation	1.1E+07	3.9%	6.1E+07	22.1%	5.8E+07	21.2%
Cables: Filterdust	0.0	-	0.0	-	1.3E+08	47.9%
Concrete rubble	3.1E+07	2.5%	1.8E+08	14.7%	1.6E+08	13.3%
Concrete dust	0.0	-	0.0	-	8.5E+07	69.4%

In comparing table 2 and table 3, it is clear that this method of processing both materials is a type of decontamination. For cables, the filterdust is 13% of the mass and contains 48% of the activity. For concrete, only 5% of the mass contain 69% of the activity.

Fig. 4 shows the relative distribution of the cost for the two paths:

Figure IV: Cost Comparison



WM '00 Conference, February 27 – March 2, 2000, Tucson, AZ

The figure above clearly demonstrates that the free release measurements result in approximately half of the costs as compared to disposal. Thus, free release is the better option for saving costs and for saving space in the intermediate storage facility.

All measurement results are verified by random check by German authorities. If the measuring methods and the lower detection limit can be verified and demonstrated, the authorities will issue a permit for the free release of the materials.

CONCLUSION

The experiences gained during the decommissioning of KRB-A demonstrate that volume reduction and cost-saving dismantling technologies are possible and available. They can be readily applied

- within reasonable economic conditions
- with negligible release of radioactivity to the environment
- with minimized amounts of secondary waste

The successful deployments of the treatment processes for concrete and cables as shown above have demonstrated new ways for more economic decommissioning projects; these technologies not only address environmental concerns, but also result in substantial cost savings.

REFERENCES

- /1/ W. Stang, A. Fischer
Großtechnische Anwendung von optimierten Trenn-, Dekontaminations- und Säurebehandlungsverfahren
EUR 14402 (DE), 1993.
- /2/ SSK-Recommendation
Freigabe von Materialien, Gebäuden und Bodenflächen mit geringfügiger Restaktivität aus anzeige- und genehmigungspflichtigen Umgang
Bundesanzeiger 50, 193 vom 15.10.98
- /3/ N. Eickelpasch, W. Stang, H. Steiner:
Waste Minimization and Scrap Recycling during Decommissioning Work of the KRB Nuclear Power Plant, Unit A
Spectrum '92, Boise (Idaho), August 1992.
- /4/ L. Bergemann
Measuring methods for the free release of steel and other material from nuclear power plant as non-radiocontaminated material
Waste Management, 92; Tucson, (Arizona), May 1992.