DECONTAMINATION OF METALLIC WASTE FROM NUCLEAR FACILITIES FOR UNRESTRICTED RELEASE

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ABSTRACT

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

That is why highest priority is given to all measures which aim at a volume reduction. This applies both to ultimate storage as well as to an interim period until a final storage facility is available. It is therefore indispensable to develop new methods and techniques to reduce the volume of the waste material to be stored.

There are two ways to reach this goal:

- Volume reduction by crushing and subsequent compacting (for intermediate and ultimate storage)
- Dismantling of the components and subsequent decontamination below the specified limit value which allows their reuse (unrestricted release).

For more than 20 years, decontamination of contaminated equipment has been ensured by the Decontamination Division (HDB) of the Karlsruhe Nuclear Research Center Ltd (KfK). As KfK-licensee, Kraftanlagen Heidelberg is able to make use of the experience gained in close cooperation with KfK GmbH in the field of decontamination for unrestricted release of component parts originating from retrofitting and decommissioning.
The KfK Ltd decontamination and LLSW-scrapping facilities are described and examples for already performed works are given later on.

PRESENT SITUATION CONCERNING THE DISPOSAL OF WASTE MATERIAL ORIGINATING FROM RETROFITTING AND DECOMMISSIONING OF NUCLEAR POWER STATIONS IN THE FEDERAL REPUBLIC OF GERMANY

Nuclear Power Stations in the FRG

15 nuclear power plants of a total capacity of 10,358 MW are presently on-line including also plants which are shut down at the present for retrofitting. Another 10 nuclear power stations with a total capacity of 11,217 MW are under construction and are supposed to go on-stream by 1989. 4 nuclear power plants of the first generation and an experimental reactor were already shut-down. These facilities are scheduled for future total removal, with some of them passing first a certain time under safe enclosure

Type and quantity of waste material originating from retrofitting and decommissioning

Since 1980, 4 BWR nuclear power stations have been shut-down in compliance with administrative regulations and have been subject to comprehensive retrofitting actions during which approx. 700 Mg waste equipment were produced.

Furthermore, minor modifications and maintenance actions are frequently required during normal plant operation. The total quantity of contaminated material from on-line nuclear power stations in the FRG amounts to annually 500 Mg to 1,000 Mg.

The inventory of contaminated metallic components of a 1,200 MWe power reactor totals to approx. 7,000 Mg. The waste inventory of the 4 shut-down reactors is approx. 1,200 Mg per reactor, however varying considerably according to the respective reactor design. The shut-down experimental reactor will supply another 100 Mg of contaminated material. This means that by the year 2000 the contaminated equipment will total approx. 20,000 Mg, not to forget the additional operational waste produced in nuclear facilities and other radioactive waste produced for example in hospitals.

The contaminated equipment essentially consists of:

- piping
- heat exchangers
- tanks
- pumps
- valves
- ventilation ducts
- support structures

including also reactor pressure vessel internals, turbine parts, electric motors and the like.

Development of methods to reduce the volume of radioactive waste for intermediate and ultimate storage

With regard to the high costs required for intermediate storage and ulterior final storage a reduction of the waste volume is imperative.

There are two applicable methods of volume reduction:

- Volume reduction by crushing and compacting
- Decontamination of the equipment to values below the admissible residual contamination. This means that the equipment is fit for unrestricted release and permits recycling of the respective material.

Depending on actual requirements, we apply both methods, i.e. compacting of parts which are not recommended for decontamination as well as decontamination of parts for unrestricted release.

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

Only a rather small portion is not worth being decontaminated. This means that under economical aspects a decontamination is not recommended. In such 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.

Basic legal provisions

The Radiation Protection Regulations of the Federal Republic of Germany strictly prohibits the conventional disposal of parts (waste) originating from qualified facilities (e.g. nuclear power plants as defined in Art. 7 and/or 9 of the Atomic Law). Radioactive waste disposal shall be ensured as follows:
Crushing, volume reduction, fixing, intermediate storage.
However, with a permit as defined in Art. 3 of the Radiation Protection Regulation, conventional disposal of slightly contaminated waste is admissible when keeping below the admissible limit value for residual contamination. The owner/operator of the respective nuclear facility shall submit the application for this permit to the competent authority, where the permit is issued together with eventually required directions for measuring, documentation, mass limitation etc.

The admissible limit values presently valid for surface contamination, total activity and specific activity are indicated on Table I.

For tools and equipment, for example, which were used in a nuclear power plant for repair work (but were not installed in or supplied to a nuclear facility under a license according to Art. 7 of the Atomic Law) the values specified in line 2 of Table I are valid.

The limit values for parts which were installed in a nuclear facility covered by a license according to Art. 7 of the Atomic Law, but which were demounted for being repaired outside the controlled area and intended for ulterior reinstallation, are indicated in line 3 of Table I.

COOPERATION BETWEEN KFK LTD AND KAH

Large modern radioactive waste treatment facilities using the most recently developed technologies in the Federal Republic of Germany are available in the Karlsruhe Nuclear Research Center. Kraftanlagen Heidelberg in its capacity as licensee of the Research Center, is entitled to use all available methods and facilities.

The available facilities are used in Joint Venture with Transnuklear GmbH, Hanau (TN) which is also a KfK licensee.

Waste conditioning in a central facility as for example in the Karlsruhe Nuclear Research Center, offers various advantages to the owner/operator of a nuclear power plant, such as:

- normal plant operation is not obstructed by these conditioning actions
- conditioning of large quantities of waste from various power plants can most economically be handled 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 this cooperation, KfK GmbH carries out all decontamination work whereas the KAH/TN Joint Venture performs dismantling, crushing and scrapping.

TABLE I

LIMIT VALUES FOR SURFACE CONTAMINATION, TOTAL ACTIVITY AND SPECIFIC ACTIVITY

Origin of the parts and their respective application	Surface contamination α -emitters* (Bq/cm²)	Surface contamination other radionuclides (Bq/cm²)	Specific activity** (Bq/g)	Total activity** (Bq)	Remarks
Parts demounted from qualified facilities according to Art. 7 of the Atomic Law, which shall be decontaminated for unrestricted release	3.7 E-02	3.7 E-01	3.7		
Parts which are not covered by a license according to Art. 7 of the Atomic Law, e.g. tools, devices and equipment used for repair work	3.7 E-02	3.7 E-01			
Parts which are covered by a license according to Art. 7 of the Atomic Law, but which are demounted for repair outside the controlled area and intended for ulterior reinstallation.	3.7 E-02	3.7 E-01	-	3.7 E 05	no permit required for further handling
	3.7 E-02	3.7 E-01	7.3 E 01	3.7 E 04	no registration or permit required for further handling.

* for α -emitters of a release limit of 3.7 E-03

** in this case related to Co 60

PLANTS AND METHODS

Decontamination plant

The decontamination plant essentially consists of three plant sections:

1. One for the decontamination of beta-contaminated parts, being designed as a big hall of 50 x 20 m floor space. This hall houses two caissons of 10 x 5 m and 5 x 3 m. Entering of the caissons is made through a protective suit lock; all work in the caissons is carried out in ventilated protective suits. In the bigger one of the two caissons, parts up to a length of 9 m can be conditioned.

2. One for the decontamination of alpha-contaminated parts. This section is a L-shaped room which is provided with a stainless steel caisson. Ventilated protective suits are also obligatory in this section. As far as ventilation is concerned, this plant section is completely separated from the other sections.

3. Beta-contaminated small parts of dimensions of 80 x 80 x 80 cm, at maximum, undergo treatment in a glove box line which is installed in a separate room.

LLSW-scrapping facility

Tha main part of this plant is a 12 x 8 x 7 m caisson provided with an 8 m material lock. This plant is designed for conditioning of equipment of a total weight of 100 Mg and max. lengths of up to 18 m.

A compacting press of a capacity of 15,000 kN, a drum and compacted waste conveyor system, compacted waste storage, drum handling and cementing equipment are installed in the basement. The compacting press is computer-controlled, with various data such as size of compacted waste, weight and activity being used to ensure optimum drum filling. Equipment which is not recommended for decontamination is dismantled in the large caisson, then filled into 180-l-drums and directly transferred to the compacting press. The compacted material is then filled into 200-l-drums and cemented, if required, with the filling operation being computer-controlled.

Decontamination methods and dismantling techniques

We apply all available and approved decontamination methods. A selection of suitable decontamination methods is made on the basis of comprehensive information on origin and operating history of the respective equipment, material, type and extent of contamination as well as on the geometry of the respective part.

The most frequently applied methods, specific examples of application are given in the next chapter, are:

- steam jet blasting, with decontamination additives, if required,
- HP water jet blasting with pressure up to 250 bar, in particular cases even up to 600 bar,
- treatment of stainless steel parts with stainless steel pickling paste
- dipping in acids of different composition, depending on the respective material
- removal of rust and scale with special remover pastes,
- removal of varnish coats with paint remover pastes,
- treatment of enamelled components with organic solvents
- manual treatment with brushes and various abrasive cleansers.

In addition, the following methods are applied in special cases:

- electro-polishing
- sand blasting
- wet sand blasting
- rinsing of the parts in the APAC process and the like.

For crushing and preliminary compacting of large components the following mechanical and thermal methods are available:

- sawing
- grinding
- milling
- cutting
- autogenous cutting
- plasma cutting
- oxygen lance cutting
- preliminary compacting

EXAMPLES OF PERFORMED OPERATIONS

After the KAH/TN Joint Venture offered in 1980 for the first time the decontamination of equipment with the aim to permit unrestricted release and thus to reduce the waste volume to be stored, we have been entrusted, in the meantime, with various interesting orders, some of them being already carried out.

However, this was only possible after innumerable talks with ministries, licensing authorities and experts in order to get their approval for our proposed concept. For example an application for decontamination of parts for unrestricted release originating from retrofitting work carried out in 1981 at Würgassen nuclear power plant received approval only by the end of 1981. In the meantime, unrestricted release of equipment of another three nuclear power plants received approval.

A few examples of decontamination operations carried out in Joint Venture are specified below:

- Decontamination of a steam drier of Würgassen nuclear power plant (of a total weight of 45 Mg).

The steam drier was dismantled in the power station prior to its transfer to the place of decontamination. Decontamination work is still under way. In doing so, the activated bottom part of the component must be cut off, with that part being then crushed and filled in drums.

- Decontamination of a 45 Mg fuel element storage rack originating from Unterweser nuclear power plant.
  In this case, too, decontamination is still going on, with approx. 4 Mg being already decontaminated for unrestricted release.
  These two decontamination orders are carried out in the Juelich Nuclear Research Center.

- Decontamination of approx. 800 Mg of waste material produced during retrofitting of Würgassen nuclear power plant. The 800 Mg of waste material consist of

  -- piping and valves of the feedwater system;
  -- piping and valves of the live steam system;
  -- condensor tubes made of brass;
  -- support structures, pipe hangers etc;
  -- and also ventilation ducts, turbine housing parts and piping of other systems.

- Decontamination work on feedwater piping and support structures is already under way. Approximately 20 Mg of material have been decontaminated so far for unrestricted release.

- Decontamination of three pressure tanks of 80 Mg, each, and a pressurizer relief tank of Neckarwestheim nuclear power plant. The work covered by this order was carried out within the agreed time, with the defined objective being fully reached. As soon as our Customer receives approval for unrestricted release, the respective tanks will undergo normal scrapping.