DECOMMISSIONING OF NUCLEAR FACILITIES IN GERMANY

RADIATION EXPOSURE CAUSED BY THE UNHARMFUL REUSE OF RADIOACTIVE RESIDUAL MATERIALS

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ABSTRACT

The decommissioning of nuclear facilities causes the release of radioactive material. The radiation exposure of the public was calculated and contamination limits for the unharmful reuse of residual material were derived.

INTRODUCTION

As a consequence of the strong requirements of the German Atomic Energy Act radioactive residual material or dismantled radioactive components from nuclear facilities must be reused in an unharmful way.

As an independent expert organisation TÜV Bayern checked how these requirements had been met in the nuclear licensing procedure for the NPP

- Kahl (25 MW_e, BWR),
- Niederaichbach (100 MW_e D_2O-moderated, CO_2-cooled),
- Gundremmingen (250 MW_e, BWR).

LIMITS FOR UNHARMFUL REUSE

After 2 years of reactor-operating time the NPP Niederaichbach was shut down in 1974. It was the first nuclear facility in Germany which was applied for decommissioning. Therefore TÜV Bayern get most experience in the valuation of the radioactive material of this plant.

Especially for concrete, steel and some other materials (e. g. insulation material) the radiation exposure of the public was calculated by using appropriate exposition scenarios. Contamination limits for the unharmful reuse were derived. These limits depend on the nuclide mixture as well as the procedure for the clearance measurements.

The nuclide mixture depends on the material. In the activated steel there is mainly Fe 55, Co 60, and Ni 63, in the activated concrete there is mainly Ba 133, Co 60, Eu 152, and H 3.

At the time TÜV Bayern carried out the assessment on

the decommissioning of the NPP Niederaichbach no regulations for the release of radioactive material for unharmful reuse did exist. TÜV Bayern proposed such regulations by calculating the radiation exposure of the public. The radiation exposure caused by the release of radioactive material should be small compared with the range of the variation of the natural radiation.

As a result of our assessment of the release of former contaminated material it was not allowed to exceed the following two limits:

- mass specific activity,
  (10^{-5} times the allowances per gramm as specified in the German Radiological Protection Ordinance (GRPO), e. g. for 100% Co 60 it would be 0.37 Bq/g),

- surface contamination,
  (0.37 Bq/cm^2, required by the German Radiological Protection Ordinance)

The first limit restricts the amount of activity released and should be measured in an easy way (e. g. gamma-spectroscopy) using a reference nuclide composition. The second limit is a requirement of the GRPO and is to prove for every material released from the controlled area. For more than one radionuclide or a mixture of radionuclides of known composition the allowance shall be determined as the sum of the nuclide portions. In the licence for the decommissioning of the NPP Niederaichbach a nuclide mixture for the release of radioactive material was determined by the licensing authority. These nuclides are H 3, Mn 54, Fe 55, Co 58, Co 60, Ni 59, Ni 63, Nb 94, Cs 134, Ba 133, Eu 152, and Eu 154. For the mass specific activity of the NPP Niederaichbach you get the following condition:

$$\sum_{i=1}^{m} \frac{A_i}{F_i} + \sum_{j=1}^{n} \frac{B_j}{F_j} < 10^{-5}/g$$

A_i : measured specific activity of the nuclide i
B_j : detection limit of the nuclide j
$F_{i,j}$: allowance of the nuclide i,j according to the GRPO
m : number of nuclides with measureable activity
n : number of nuclides with detection limit

The amount of radioactivity of some nuclides, e. g. Fe 55, Ni 59, and Ni 63, was measured separately in laboratory because they are emitting no gamma-rays. Because of the low amount of these nuclides in the material the radioactivity was not measureable. According to the licence it was necessary for these nuclides to use the detection limits

when proving that the clearence levels are met. The sum of the measured activity and the detection limits for all layed down nuclides shall not exceed the mass specific clearance level. Up to now a mass of about 740 Mg was released with a mean radioactivity of about 0.2 Bq/g. Considering the amount of the activity due to detection limits, one gets about 0.2 Bq/g. So the real activity of the material is only a part of it and will be significantly lower than 0.1 Bq/g.

With the materials and activities released up to now the theoretical exposition scenarios have been checked. It turned out that the actual radiation exposure of individuals of the public is significantly lower than the values calculated for the licensing procedure.

In 1987 the National Commission of Radiological Protection (SSK) made a recommendation for the unharmful reuse of radioactive steel released by a NPP. In this recommendation a value of 0.1 Bq/g for the mass specific activity should be adequate for an unrestricted release.

Because of the conservative procedures for the release of radioactive material one can state that the successing recommendation of the SSK is met in practice at NPP Niederaichbach.