POLICY AND CRITERIA FOR THE RECYCLE AND REUSE OF VERY LOW LEVEL CONTAMINATED MATERIALS FROM MAINTENANCE REFURBISHMENT AND DECOMMISSIONING OF NUCLEAR FACILITIES IN THE FEDERAL REPUBLIC OF GERMANY

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1. INTRODUCTION

In the course of maintenance, refurbishment and decommissioning of nuclear facilities large amounts of materials with very low level specific or surface activities arise, which may be handled either as conventional waste, reused and recycled conventionally or treated as radioactive waste. In any case it is necessary to define criteria which allow to discriminate between the two main options. When establishing such criteria one should start at the basic radiation protection criteria given by ICRP 26.

2. JUSTIFICATION AND APPLICATION OF THE ALARA-PRINCIPLE

It has been estimated that in the OECD-countries the equivalent of two hundred 1000 MW(e) nuclear power plants will be definitely shut down in the period from 1996 to 2010. Studies have shown, that e.g. the total quantity of steel in a large PWR is approximately 10,000 tonns, of which half has a potential for recycling with currently available techniques. (1) That means that recycle and reuse of very low level contaminated or activated steel scrap from decommissioned NPP's offer the potential for extending the life time of valuable natural reserves and is of particular interest for materials which are in short supply in the world and for materials whose extraction from the earth crust is difficult and expensive. In addition an economic benefit from recycling might arise from the recovered value of the recycled material and the savings to be made in costs of conditioning, packaging, storage, transport and especially the disposal of large volumes of very low level radioactive material as radioactive waste.

On the other hand however it must be seen that the release of large amounts of very low level radioactive materials for unrestricted recycle or reuse will cause the exposure of many people to ionising radiation even if only with very low doses. In order to minimize this exposure in the Federal Republic of Germany the first option for recycle and reuse of very low level active materials, especially steel scrap is to restrict the recycle and reuse to the nuclear field as far as possible. How this is already practiced will be described in chapter 4.

3. ESTABLISHMENT OF ACTIVITY LIMITS FOR UNRESTRICTED RELEASE

There seems to be already international agreement that the annual effective dose equivalent to the most exposed individuals caused by the unrestricted release of materials from decommissioned nuclear facilities should not exceed the order of magnitude of 10 µSv.The IAEA e.g. requested that a source or practice can be exempted from notification, registration and licensing provided that:

(1) The annual effective dose equivalent to individuals of the critical group at no time exceeds 10 µSv, and the annual dose equivalent to skin does not exceed 500 µSv; and
(2) The collective effective dose equivalent commitment from the exempted source or practice is of the order of 1 manSv or less. (2)

There arises the question whether the requirement "at no time exceeds 10 µSv" is not to strict. In order to demonstrate that release limits given as specific activity and surface contamination are in compliance with the dose limits, it is necessary to use exposure scenarios by which the exposure of individuals can be derived from the release of material of given mass and activity. Numerous studies exist in this field. (3, 4, 5, 6, 7) One of the common results is that in most cases the external irradiation by gamma-emitting radionuclides dominates the doses to people exposed to these materials.

But all scenarios which might be established can never be conservative enough that it could not be possible to describe one which is still more conservative.Therefore it seemed desirable however, to have a method available to assess the actual doses to individuals of the general public. Based on this information, one could derive release criteria.The release of radioactive metals from the controlled area for unrestricted use and the processes of recycling have basically a stochastic character. The pathways of these materials cannot be predicted deterministically and the quantities which are relevant for the radiological assessment are fluctuating. Consequently a stochastic simulation of the complete process of scrap release, scrap processing, steelmaking, product manufacture and the use of products including exposure scenario on each of these stages presents an adequate approach. Such a probabilistic model has been developed (8),some of the important input parameters of which are listed in Tab. I.

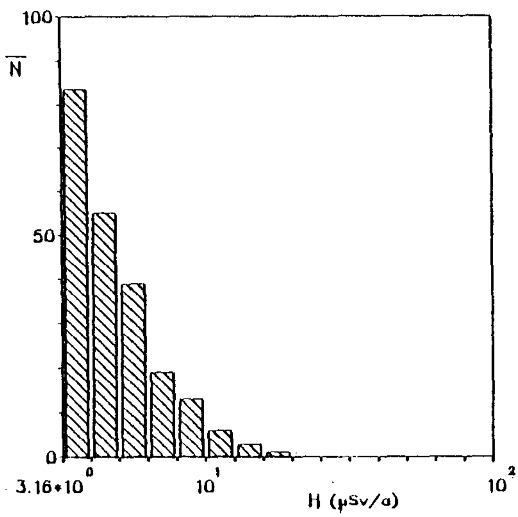
Tab. I: Basic parameters for the stochastic simulation of scenarios

Amount of scrap released	1000 t
Contamination release level	0.37 Bq/cm²
Release level for "specific total activity" ((surface + bulk activity)/mass))	1 Bq/g
Average fraction of activated scrap	0.1

Note: Only external gamma-exposure taken into account.

The result of each simulation is a distribution of individual doses. Fig. 1 shows the average dose distribution received by multiple repetition of the simulation. The distribution of the maximum doses received after 200 fold repetition of the simulation process is given in Fig. 2. One sees that the requirement of the IAEA that 10 µSv/a is never exceeded is not fullfilled but that the number of cases were this figure is exceeded is rather limited and the maximum doses remain within one magnitude of order above 10 µSv/a.

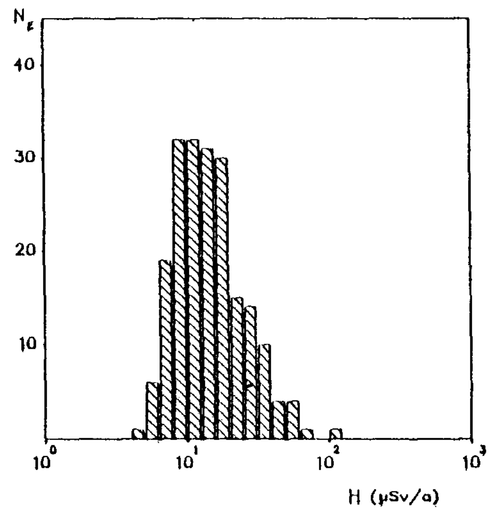
Fig. 1 Distribution of individual doses. $\overline{N}$: Average number of persons who received doses in a certain range.



$\overline{N}_0$ = 210 (3.16 µSv/a ≤ H ≤ 10 µSv/a)

$\overline{N}_1$ = 10 (H ≥ 10 µSv/a)

Fig. 2 Distribution of maximum individual doses. N_E: Number of events with the maximum dose in a certain range.



These results were used in order to support the establishment of the following release criteria in the Federal Republic of Germany. They are to be applied for the time beeing for steel scrap coming from NPP only:

a) Unrestricted release: Completely unrestricted release is possible if the specific overall activity is not higher than 0.1 Bq/g and the surface contamination does not exceed 0.37 Bq/cm² for beta-gamma-emitters and 0.037 Bq/cm² for alpha-emitters. All single items have to comply with these limits. The surface contamination may be averaged over 100 cm².

b) Release for general melting: The release of scrap material for general melting in a normal steel furnace together with other inactive scrap is possible if the specific overall activity of each single item is not higher than 1 Bq/g and at the same time the surface activity conditions as for unrestricted release are complied with. The producer of the scrap just has to demonstrate that the scrap material he is going to release is really going into a furnace. The owner of the furnace does not need any licence for handling this material.

c) Controlled recycling: If the specific overall activity of 1 Bq/g is exceeded or it is not possible to measure this because the scrap items are of to complicated geometrical shape or are to small a controlled melting is possible under a special licence according to the German Radiation Protection Ordinance. The only condition is that if the product material is going to be released unrestrictedly the specific activity must not exceed 0.1 Bq/g. In any case the resulting specific activity of the material must not exceed 1 Bq/g. The competent authority can allow that this material is used outside controlled areas if it can be foreseen that nowbody receives an enhanced exposure by this.

In all three kinds of release for any single case a licence by the competent authority is necessary.

4. RECYCLING WITHIN THE NUCLEAR FIELD

As mentioned above, the basic requirement for recycling of scrap is to do this within the nuclear field. This is practiced in Germany by several producers and the Siempelkamp Giesserei GmbH and Co. (9) They started with this idea already in 1981 and up to now about 1000 t of metallic waste were melted and recycled. The way to melt is in short:

- cutting the material and filling into 200 l-drums;
- charging the material into the furnace by using a special developed charging device;
- melting in an induction furnace under low pressure by tight enclosure of the melting bath;
- keeping low pressure by a filter system, which filters all evading radioactive aerosoles coming from the melt.

To be able to melt in this special manner several licenses had to be achieved by the German authorities, who restricted the activity of the contaminated scrap to be melted to not more than 74 Bq/g. All the material being melted is used to produce components for nuclear facilities like waste and transport containers, shielding plates, crane testweights etc.

REFERENCES: Information through the authors.