V/4
THE RADIOLOGICAL SITUATION WITH RESPECT TO *NORM* AND ITS REGULATION IN GERMANY

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1. Introduction

Nearly all materials contain certain amounts of "natural" radionuclides from the decay chains of U238, U235, Th232 as well as the natural radionuclide K40. In several industrial branches materials with enhanced levels of natural radioactivity (NORM, naturally occurring radioactive material) are handled, processed, transported or stored in large amounts, the radio activity itself being of no importance to the industrial process at all. However, the radionu clide contents may lead to radiological consequences for the workers or for the general public. Moreover, in some processing steps the radionuclides are concentrated thus also increasing the radiological importance of the resulting products or waste materials.

This paper deals with those radiological consequences and addresses the question how NORM could be handled from a regulatory point of view in Germany. This is of particular interest as the regulatory aspect has become important in the course of transforming the European Union Basic Safety Standards [1] into national legislation.

2. Practices Involving NORM Material and Radiological Consequences

Several human activities involve the use of large amounts of materials containing non negligible quantities of natural radionuclides. Although these radionuclides are present in virtually all materials we deal with every day, large material quantities and high specific ac tivities can make certain kinds of materials radiologically relevant. If in addition there are certain exposure situations at workplaces where people come into close and prolonged contact with those materials or will inhale dusts generated from it, the resulting dose commitment may be relevant to involve the regulatory authorities. Special consideration has to be given to radon and its decay products.

To investigate the radiological consequences of NORM has been the aim of the German Commission on Radiation Protection (SSK, Strahlenschutzkommission) for several years [2]. In addition, the competent ministries of the German Federal States as well as the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety have commis sioned several studies dealing with the whole situation in Germany as well as with special aspects [3], [4], [5]. The situation in the European Union has been investigated in [6] and [7].

In the following the results of [3] are briefly summarised to give an overview of the situation in Germany.

The aim of the research project [3] has been to estimate the overall radiological consequences of use of NORM in Germany. First steps therefore have been to gather data on the various material cycles, exposure conditions, number of people involved etc. From these data simple stochastic radiological models have been derived for each category of workplaces trying to estimate the distribution of the number of exposed people as a function of dose commitment. From these dose distributions it is not only possible to assess whether or not certain dose levels (e.g. 1 mSv/a) can be exceeded but also with which probability.

The basis of these stochastic models is the knowledge of value distributions for the relevant parameters. In the calculations no fixed values for those parameters are used but the parameters can vary according to predetermined value distributions that describe the reality as closely as possible. The dose distributions are obtained from averaging a large number of single Monte Carlo calculations.

Such a stochastic approach can only be used to investigate the (radiological) consequences of the current situation. It cannot be used to calculate any kind of numerical exemption levels for which deterministic models would have to be used. The great advantages of the stochastic approach are, however, that it provides a much more concise picture than deterministic calculations, that it incorporates realistic and conservative assumptions simultaneously with different probabilities, and that decisions are not based on conservative but on realistic evaluations.

As an example, the results of the radiological assessment of sandblasting are briefly addressed below. Like the other types of workplaces and industries referred to above, an assessment has been made how many people will carry out sandblasting in Germany and what their average exposure conditions are (exposure time, dust, inhalation rate, protective measures, specific activity of the abrasive material etc.). The calculations with the simple stochastic model de rived for sandblasting show the following dose distribution (number of people exposed as a function of the dose range). It can be seen that sandblasting will most probably not lead to doses above 1 mSv/a in Germany (i.e. for working conditions and material applied here). This result is in very good agreement with the investigations of the SSK [2].

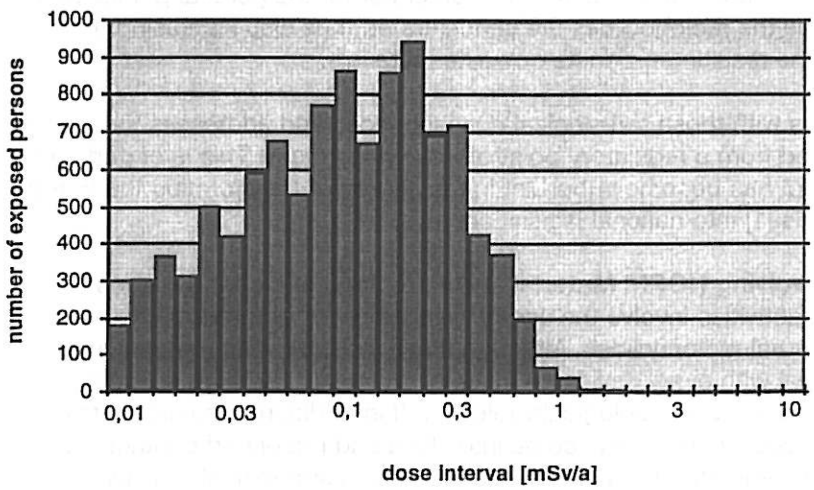

Figure 1: Radiological assessment for sandblasting in Germany: number of people exposed as a function of the dose range

The assessment in [3] has been performed using probabilistic approaches applying realistic scenarios. It shows that for the majority of people working in industries where materials with enhanced levels of natural radioactivity are involved the annual dose will remain below 1 mSv. This mainly applies to workplaces in open pits, on waste rock heaps and landfills, ore processing, transport, sand blasting, use of zirconium sands in foundries, use of fertilisers, as well as for use of slag in road and building construction. There are, however, workplaces where a dose level of 1 mSv/a will be exceeded with a substantial probability. This mainly applies to workplaces in underground mines or caves and in water treatment facilities as well as to workplaces where materials containing thorium (mainly welding electrodes) are used. In many cases inhalation of radon and its decay products is the most relevant pathway.

Comparing these results with the studies performed on behalf of the European Commission applying to all countries of the European Union, some differences can be identified, mainly for welding electrodes and use of special minerals. This can usually be attributed to differ ences in the materials used and is not a feature of the radiological modelling.

3. The Current Regulatory Situation in the EU

In the past, the radiological implications of NORM have to a great extent simply been ignored and therefore evaluations of such problems which could have been used to develop solutions were not carried out for many years. The necessity to implement the new EURATOM Basic Safety Standards [1] in national legislation, however, has fostered both investigations and solutions.

The EURATOM Basic Safety Standards (BSS) [1] address NORM in Title VII which is entitled "Significant Increase in Exposure due to Natural Radiation Sources". According to Articles 40, these regulations shall "apply to work activities not covered by Article 2(1) within which the presence of natural radiation sources leads to a significant increase in the exposure of workers or of members of the public", i.e. those work activities, which are not already regulated because of the involvement of artificial sources. It is left to the discretion of the Member States to identify which natural radiation sources need attention and have to be sub ject to control. The Member States further have to set up appropriate means for monitoring exposure and have to ensure application of radiation protection measures as indicated in Article 41 of the BSS. From this it can be concluded that the upper dose level for members of the public of 1 mSv/a according to Article 13 BSS would also be applicable to NORM.

The BSS, however, do not provide further quantitative guidance on NORM, they do not contain numerical exemption levels. However, investigations on behalf of the European Commission have been carried out [6] that clearly indicate that no uniform and commonly applicable numerical exemption levels valid for all kinds of workplaces and materials could be estab lished. Numerical exemption levels would only make sense if they were available for each type of workplace or industry or for each product or waste category. This is a major difference between NORM and artificial sources for which generally applicable, nuclide specific exemp tion levels are provided in Table A of Annex I of the BSS.

4. Implications for the German Regulatory Situation

Germany has chosen the following dose levels with respect to NORM:

- If the annual dose for a worker dealing with NORM (or, likewise, for other persons of the general public) arising from a certain practice will remain below 1 mSv/a, no actions need to be taken at all; in particular, there is no need for applying the scheme of reporting and authorisation.

- If the annual dose will be in the range between 1 and 6 mSv/a, it is generally considered adequate to apply conventional measures for good health and safety practices, thereby minimising exposures. Health and safety practices may e.g. comprise additional ventilation at work places where high radon levels persist (water supply stations, underground workplaces etc.), or it may be considered to gradually change the material composition of products to reduce the nuclide content. Case-by-case investigations and decisions will usually be required.

- If the annual dose will be above 6 mSv/a, it is usually necessary to introduce an appropriate radiation protection system. Also in this case, case-by-case investigations and decisions may help to reduce the exposure.

Until now, no final decision has been reached in Germany how to transform those dose levels into numerical criteria for NORM in the legislation. There are, however, three basic options which are briefly addressed together with their respective implications:

1. Prescription of a dose level which should not be exceeded for workers and members of the public when working with or coming into contact with NORM as well as products or waste arising from NORM.

2. Establishment of a dose level as in 1, but additionally establishment of reference levels (in terms of specific activities in the material) for all those types of workplaces and industries for which this dose level could possibly be exceeded, using a set of values for each type of workplace or industry.

3. Establishment of a dose level as in 1, but additionally establishment of a single set of reference levels (in terms of specific activities in the material) that apply simultaneously to all those types of workplaces and industries for which this dose level could possibly be exceeded.

Each of these options which would all be compatible to the BSS clearly has advantages and disadvantages some of which shall be discussed now. It is clear that option 1 leaves the most room for individual solutions and case-by-case decisions and might probably be the most flexible option. However, it also opens the door for differing application in the various German Federal States (as has been experienced e.g. with clearance of radioactive materials from nuclear installations) because it leaves all to the authorities and their experts.

A more binding approach is provided by option 2 which would leave less flexibility for each Federal State (or each authority) but which would require a detailed investigation of each workplace and material category which would yet have to be performed. The results of [6] would probably not be directly applicable in Germany as has been shown in [3] because of differences in material streams. However, the complexity of the reference levels derived in [6] indicates that option 2 would probably require a large number of value sets making the application complicated. Probably this would require a solution on a sub-legal level.

Although option 3 would be both unambiguous and simple in its structure, it is most likely that a single set of values would not be appropriate to cover all types of workplaces, industries, products and wastes simultaneously. This has become evident from investigations like [6] and [7], but also from [2] and [3]. A single set of values would either unnecessarily restrict some workplaces and industries or open the possibility that the dose criterion is exceeded. The first possibility might occur when very restrictive reference levels are chosen at the lower end of the possible range of values in order to ensure that the dose criterion is complied with in any case. The second possibility might occur when liberal reference levels are chosen at the upper end of the range of values in order to avoid unnecessary regulation of some types of industry.

A further distinction could be made for options 2 and 3 whether exceeding the reference levels should automatically lead to application of the scheme of reporting and authorisation or whether this should only lead to a case-by-case evaluation by the competent authorities. It is apparent that the former would be a more binding solution while the latter would maintain greater flexibility but would also increase the overall number of evaluations and case-by-case investigations.

5. Conclusion

Like all other Member States of the EURATOM Treaty, Germany has to find the best alternative for NORM when transforming the BSS into national legislation. At the moment it is still open which option might be used but it seems that the option to include only the dose level in the Radiation Protection Ordinance and to issue separate regulations on a lower level might be the best solution regarding flexibility, simplicity of use and possibility for later amendment.

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