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EXEMPTION LEVELS FOR DREDGED MATERIALS

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1. Introduction

Large amounts of dredged material come from waterways and harbours each year and have to be relocated or disposed of on land. When this material is to be dumped at sea in international waters, it falls under the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (LC) [1] which regulates sea dumping of hazardous materials. Among other prescriptions, this Convention prohibits dumping of materials in which the radionuclide content exceeds prescribed exemption levels which have yet to be developed. The Contracting Parties to the LC agreed that these exemption levels need to be derived and they have asked the IAEA to take on the task of developing appropriate exemption levels.

2. The London Convention

Through the years, the LC has changed considerably with respect to the dumping of radioactive material at sea. At the beginning dumping of low and intermediate level waste was permitted (and practised) at special dumping sites, and the IAEA had issued numerical guidance on levels of radioactivity contents suitable for dumping [2], [3]. In more recent years, dumping of radioactive waste and other material containing radioactivity (both high and low level) has been abolished entirely. According to the 1993 amendment of the LC [4], it is only permitted to dump the following categories of material (provided that they are not to be considered radioactive):

- dredged material;
- sewage sludge;
- fish waste or organic material resulting from industrial fish processing operations;
- vessels and platforms or other man-made structures at sea (with some restrictions);
- uncontaminated inert geological materials the chemical constituents of which are unlikely to be released into the marine environment;
- uncontaminated organic material of natural origin.

Those material categories are listed in greater detail in Annex I of the LC. The 1996 Protocol [5] has left this structure more or less unchanged. However, there still remains the problem of how to define "non-radioactive material" in order to distinguish it from the radioactive material that can no longer be dumped. This is addressed in more detail in section 4.

While the LC in its current version has been incorporated into German legislation, Germany has already issued a law to transform also the 1996 Protocol [6], [7]. This law proscribes all materials from dumping with the only exceptions of dredged material and urns containing the ash of human bodies. It must, however, be added that in Germany dumping of dredged material is usually done in coastal waters where the LC does not apply and only rarely in international waters which are covered by this convention.

3. Origins of Radioactivity in Dredged Material

Before addressing the question how to distinguish between "radioactive" and "non-radioactive", it shall be briefly outlined where radioactivity in dredged material can originate from. Dredged material has been chosen as an example because it is the only material in Germany out of the materials listed above that may still be dumped.

Dredged material in general consists of bottom sediment of waterways, harbours or other waters. It therefore contains the naturally occurring radionuclides of the U 238, Th 232 and U 235 decay chains as well as K 40. However, anthropogenic nuclides are also found in sediments, originating e.g. from the global fallout or the Chernobyl reactor accident, but also from many other controlled

In the case of the LC this means that the continuation of dumping of e.g. dredged material only relies on expert opinion stating that any radiological consequences will most probably remain below the de minimis dose criterion, but it does not rely on hard scientific evidence that this is really the case. So the answer to the first question simply should be yes.

With regard to the second question of how these numerical criteria might look like it must be stated that in general such values can only be derived from radiological analyses where a link between the mass specific activity in the material in question and the possible radiological consequences (i.e. the individual doses and eventually the collective dose) is established by scenarios and pathway analyses. Attempts to create a generically applicable set of values have been made by the IAEA in order to provide the guidance asked for by the Contracting Parties of the LC but have recently been abandoned. In general, such an approach requires a simple model for the dispersion of the radionuclides in the ocean, a model for the aquatic food chain and some exposure scenarios to man, including assumptions on food uptake, all of which have been applied many times by various authors and need only be combined properly. From such a model numerical exemption levels can be calculated.

Such a set of numerical exemption levels should, however, not exceed the exemption values laid down in the Basic Safety Standards (BSS) of the IAEA [11] which are identical to those laid down in the EURATOM Basic Safety Standards (BSS) [12]. The reason is that any material that exceeds those exemption levels as laid down in the BSS is to be regarded as radioactive. On the other hand, the exemption levels of the BSS cannot simply be used for the purposes of the LC. If it were intended to do so it would still be necessary to perform a radiological analysis as outlined above because the exemption levels of the BSS are only valid for "moderate material quantities", i.e. several Mg, and because they are based on scenarios which do not take account of marine pathways.

It is, of course, also possible to use a different approach and to investigate what radiological consequences the dumping of a certain kind of material would have. If it can be demonstrated that radiological consequences would in any case remain below the limiting dose criterion, there would be no need to introduce numerical exemption criteria but instead it would be possible to exempt dumping of this material in general (provided, of course, that dumping of this material is not forbidden by the LC). However, such an approach is only possible on a scale where the properties of the material in question are well known which makes this a viable option probably only on a national scale. Because in Germany the sediments in waterways are so well characterised (2) such an approach has been chosen for dredged material in Germany which is outlined in section 5.

5. German Approach for Dredged Material

In Germany it has recently become necessary in the course of transforming the 1996 Protocol to the LC into national legislation to decide whether dredged material could be exempted, i.e. whether it can be regarded as "non-radioactive" for the purposes of the national legislation regulating dumping at sea. As currently there are no quantitative guidance available from IAEA for this matter, the following general approach was devised:

1. In a first step, the typical and maximum activity contents of bottom sediments of waterways and harbours in Germany as well as the total annual amount of dredged material has been compiled.

2. Dumping of dredged material ist not simply a relocation process because dredging and especially dumping mobilises the radionuclides and leads to dispersion of particles. Therefore some assumptions on the release mechanisms of radionuclides from dumped dredged material have been made on the basis of currently applied procedures for dredging and dumping.

3. A simple model for the radionuclide dispersion in marine waters has been used which is based on IAEA recommendations [13]. By choosing a model that applies to coastal waters, the total model becomes more conservative. This model includes transfer of radionuclides to fish and crustaceae as well as migration of nuclides to beach sediments. The geometry is depicted in figure 1.

non-natural sources where radionuclides are used or produced, like nuclear installations, industry, medicine, research etc.

Radionuclides from these controlled sources are released into rivers or streams, where they are dispersed and transported by the flow, but gradually sink to the ground and attach to the bottom sediment. It depends to a great extent on the element and the chemical composition in which it is present how soluble the nuclides are and how tight they are bound to the grains of the sediment. Radionuclides that are widely dispersed on land or in other waters are gradually collected by runoff, discharges of sewers and other mechanisms and may also be transported to the sediment of larger waterways.

Compared to their concentrations in which the radionuclides are present in the water, their concentrations in sediments (and thus their mass specific activities) are drastically enhanced. Concentration processes of this kind are only rarely taken into account when radiological assessments of discharges are performed.

In Germany, like in any other country, the environmental radioactivity is continuously monitored. Results are published by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety annually [8]. Sediments in German rivers show activities for Co 60 up to ca. 10 Bq/kg, for Cs 137 up to ca. 100 Bq/kg, for K 40 between 300 and 700 Bq/kg, for U 238 and for Th 232 several 10 up to a few 100 Bq/g (all values related to dry mass). The Cs 137 concentration which is mainly caused by the Chernobyl accident shows a pronounced local variation and decreases continuously. It is much higher in lakes where there is a less pronounced exchange of water.

4. Numerical Exemption Levels in the London and Other Conventions

As already indicated, the LC proscribes radioactive material from dumping. regardless whether they are or are not included in the list of substances for which dumping is still applicable. Annex 1 of the 1996 Protocol to the LC [5] states: "Materials ... containing levels of radioactivity greater than de minimis (exempt) concentrations as defined by the IAEA and adopted by the Contracting Parties, shall not be considered eligible for dumping."

It is very important in this regard that neither the LC [1] nor the 1996 Protocol [5] contain any numerical exemption levels which define which kind of material is to be regarded as radioactive in terms of the Convention and which can be considered non-radioactive. Contracting Parties of the LC have asked the IAEA to provide guidance on appropriate exemption levels that are in accordance with the de minimis concept of the IAEA [9], i.e. where the radiological consequences would not exceed the range of trivial individual effective dose which is specified in [9] as the range of 10 to 100 μSv per year. IAEA is presently developing guidance, but it has already become clear that this guidance will not provide numeric exemption levels but discuss the problem on a qualitative level.

This leads to two essential questions:

1. Is it really necessary to use numerical exemption criteria that define a border between "radioactive" and "non-radioactive" in a quantitative way for the scope of the LC (or any other convention like e.g. the Basel Convention [10])

2. How can numerical exemption criteria be derived, and which levels are appropriate?

In order to answer the first question, one has to look at the possible consequences if no such numerical criteria were available. Virtually all material contain radioactivity, and for some cases like dredged material, but also e.g. sewage sludges there may even be processes that lead to a concentration of radionuclides. It is therefore clear that no material can be addressed as non-radioactive from a strictly physical point of view. However, it has never been the intention of conventions like the LC to apply such a strict criterion (which would render them useless) but to apply more specific criteria so that the term "non-radioactive" implicitly means "non-radioactive in the scope of the convention". However, as long as no numerical criteria are available, it simply cannot be decided whether a material really is "non-radioactive in the scope of the convention".

4. Radiological scenarios have been developed for exposure situations of the crew on the ship by which the material is transported to the dumping site (external irradiation, dust inhalation) and for other members of the general public that consume seafood (ingestion of fish and crustaceae) and spend time on beaches (external irradiation).

5. Doses have been calculated for dumping of a very large quantity of dredged material (10^6 Mg/a) and high activity concentrations of the various nuclides in question. Both quantity and activity concentration exceed the real values making the model conservative.

The result of the dose calculations show that even under conservative assumptions no member of the general population will receive doses exceeding 10 µSv/a. On the contrary, it is very likely that the doses will be lower by several order of magnitude. The most important pathway might be external irradiation from the nuclides Co 60 and Cs 137.

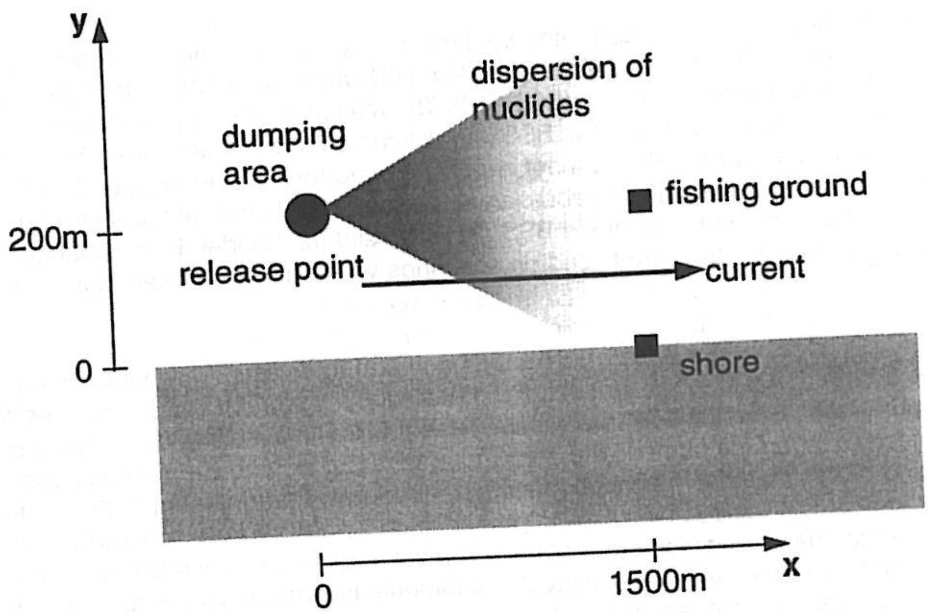

Figure 1: Schematic overview of the assumptions for dose calculations

In total, the assessment clearly demonstrates that the current radionuclide content of dumped dredged material from German waterways will only lead to negligible doses. This also applies to the natural radionuclides.

6. Conclusion

The London Convention requires some criterion by which "radioactive" and "non-radioactive" material can be distinguished in the scope of the convention. It has been shown that those criteria can be derived from a conventional radiological analysis that is based on specific data for the properties and quantities of the material in question as well as on dose calculation with appropriately chosen scenarios. For Germany this approach has been used to investigate the radiological consequences of dumping of dredged material that may be contaminated with radionuclides from excluded, exempted, or cleared practices or sources. It became clear that radiological consequences would in any case comply with the de minimis concept of IAEA.

While it may be argued that such an approach may be of limited success it is clearly a viable option on a national scale. A similar approach can be applied for other international conventions where a distinction between "radioactive" and "non-radioactive" material has to be made.

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