

ANNEX 9

2015 GUIDELINES FOR THE APPLICATION OF THE DE MINIMIS CONCEPT UNDER THE LONDON CONVENTION AND PROTOCOL

(Based on 2015 IAEA-TECDOC 1759 (the recently updated 2003 IAEA- TECDOC 1375))

1. INTRODUCTION

1.1 The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 and 1996 Protocol Thereto (the London Convention 1972 and London Protocol 1996) prohibits the disposal of radioactive wastes and other radioactive matter at sea. However, all materials, including natural and inert materials, contain radionuclides of natural origin and are frequently contaminated with artificial radionuclides from such anthropogenic sources as fallout due to past atmospheric nuclear testing, nuclear accidents and authorized discharges from nuclear and radioactive installations. Therefore, the Contracting Parties to the London Convention 1972 and London Protocol 1996 recognized the need to develop definitions and guidelines whereby candidate materials (those wastes or other matter not otherwise prohibited from disposal at sea in accordance with Annex I to the Convention) containing *de minimis* levels of radionuclides could be disposed of pursuant to the provisions of this Convention and Protocol.

1.2 The concept of *de minimis* for radioactive substances was initially discussed in 1976 at the First Consultative Meeting of Contracting Parties to the London Convention 1972. Since that time, the International Atomic Energy Agency (IAEA) has prepared several reports on the subject, all of which reflect contemporary development of the concept at the time of publication. Parallel to progress in the field of radiation protection, there have been developments in the framework of the Convention itself. In 1993, the Annexes I and II to the London Convention 1972 were amended to prohibit the dumping at sea of radioactive wastes or other radioactive matter. At the Nineteenth Consultative Meeting in 1997, Contracting Parties agreed to request the IAEA to develop further the concept of *de minimis* and, in particular, to "provide guidance for making judgements on whether materials planned to be dumped could be exempted from radiological control or whether a specific assessment was needed" (LC 19/10, paragraph 6.31). This paragraph continues: "The IAEA would then further be requested to provide guidance to national authorities responsible for conducting specific assessments."

1.3 In 1998, the IAEA presented its advice on *de minimis* in a draft document (LC 20/7) to the Twentieth Consultative Meeting of Contracting Parties. The Consultative Meeting requested the IAEA to revise this document based on comments made by Contracting Parties. The Consultative Meeting agreed that in further developing the concept of *de minimis*, the following issues should be considered in detail (LC 20/14, paragraph 7.9):

- .1 to ensure that the *de minimis* concept applies only to those wastes or other matter not otherwise prohibited from disposal under the Convention;
- .2 the protection of the marine environment including human health, flora and fauna of the marine environment as well as legitimate uses of the sea; and
- .3 the need for practical and uniform guidance to national authorities responsible for authorizing sea disposal activities."

1.4 The revised text of the IAEA report has been distributed as IAEA-TECDOC-1068 entitled: *Application of Radiological Exclusion and Exemption Principles to Sea Disposal* [1]. The Contracting Parties accepted these principles and criteria and interpreted them further in the *Guidelines on the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter* (the LC and LP Guidelines) [2]. At that time, the Contracting Parties asked the IAEA to prepare additional guidance on conducting specific assessments to determine whether candidate materials for disposal at sea contained *de minimis* levels of radioactivity.

1.5 The IAEA prepared this additional guidance and published it in 2003 in the IAEA-TECDOC-1375, *Determining the suitability of materials for disposal at sea under the London Convention 1972: A radiological assessment procedure* [3], which includes advice on performing specific radiological assessments of candidate material. The procedure within IAEA TECDOC 1375 was based on principles and criteria for protection of humans only, assuming that the protection of humans implies a certain level of protection to all other living species in the environment. Subsequently, the Contracting Parties to the London Convention and Protocol requested the IAEA to provide a method for assessing more explicitly the radiological impact to flora and fauna from the effects of ionizing radiation, so that the protection of the environment could be adequately addressed.

1.6 In 2003 the Consultative Meeting of the LC and LP urged the IAEA to continue its work on the development on a mechanism for determining the level of environmental protection from ionizing radiation, so the protection of flora and fauna could be adequately addressed in this step.

1.7 In 2013, the IAEA presented for consideration of the Contracting Parties to the London Convention and London Protocol, a new procedure which incorporates IAEA TECDOC 1375 to assess doses to workers and members of the public and adds a similar approach for assessing doses to marine flora and fauna, based in the updated IAEA Safety Standards for protection of people and the environment [4, 5] and the recent recommendations by the International Radiological Protection Commission (ICRP) on protection of humans and the environment [6, 7]. The proposal by IAEA was approved during the XX? Consultative Meeting of the Contracting Parties to the London Convention and London Protocol in October 2013.

1.8 Consequently, the IAEA prepared and published in 2015 the report entitled *Determining the suitability of materials for disposal at sea under the London Convention 1972 and London Protocol 1996: A Radiological Assessment Procedure, Edition 2015* [8] (IAEA-TECDOC-1759) which incorporates and replaces IAEA-TECDOC-1375 and is expected to be used mainly by national regulatory authorities responsible for authorizing disposal at sea of candidate materials as well as those companies and individuals applying to obtain permission from such authorities to dispose of these materials at sea. It is also intended to provide guidance to national radiological protection authorities which might become involved in determining whether candidate materials can be designated as *de minimis* for the purpose of the London Convention and Protocol.

1.9 The following text provides specific guidance¹ regarding the definition and application of the *de minimis* concept only to candidate materials. This guidance reproduces relevant sections of the work of the International Atomic Energy Agency (IAEA) to develop a concept of *de minimis* for the purposes of the London Convention 1972, set forth in IAEA-TECDOC-1068 (1999) and the subsequent IAEA-TECDOC-1375 (2003) and IAEA-TECDOC-1759 (2015).

¹ This guidance is meant specifically for implementation of the *de minimis* aspects of Annex I to the London Convention 1972, and may have to be adapted for implementing the 1996 Protocol to the London Convention 1972 upon its entry into force.

2 THE IAEA ADVICE ON 'DE MINIMIS' (EXEMPTION⁵) CRITERIA FOR CANDIDATE MATERIALS FOR SEA DUMPING UNDER THE LONDON CONVENTION"

2.1 In IAEA-TECDOC-1068, page 10, the first paragraph under this heading deals with the criteria for exemption without further consideration as follows:

"Materials eligible for consideration for dumping at sea under the London Convention that can be assigned as 'de minimis' (exempt⁵) without further consideration from the perspective of their radionuclide content are therefore those containing only:

- (1) natural radionuclides in environmental and raw materials, unless there is concern on the part of the national regulatory authority that the radiation field would be substantially modified;*
- (2) radionuclides in materials derived from activities involving some modification of the natural radionuclide composition that has been considered by the national regulatory authority, and deemed not to warrant radiological control, having taken proper account of the marine environmental and other conditions relevant to the disposal, re-use and relocation of such materials;*
- (3) widely-distributed radionuclides resulting from global fallout from nuclear weapons tests, satellite burnup in the stratosphere, and accidents, that have led to widespread dispersion of radionuclides that are deemed by the national regulatory authority not to warrant intervention; and*
- (4) radionuclides arising from sources and practices that have been exempted or cleared nationally from radiological control, pursuant to the application of the international criteria for exemption and clearance, where proper account has been taken of the marine environmental and other conditions relevant to potential disposal, re-use and relocation of such materials."*

Footnote 5 of IAEA-TECDOC-1068 reads as follows:

"The term 'exemption for the purposes of the London Convention' is taken to mean 'de minimis', that is, it includes both the radiological concepts of exclusion and exemption."

2.2 The concluding text of the final section of IAEA-TECDOC-1068 deals with materials that cannot be exempted without further consideration for the purposes of the London Convention 1972 (note that footnote 5 of IAEA-TECDOC-1068 applies equally here also). This text reads as follows:

"Candidate materials that cannot be exempted⁵ without further consideration may then be subjected to a specific assessment to determine if they still qualify as exempt⁵ for the purposes of the London Convention. Such specific assessments would need to be carried out by national regulatory authorities using the radiological criteria for exemption set out in Section 3 (of IAEA-TECDOC-1068). It should be noted in this context that assessments are required for proposed dumping activities in relation to other characteristics and properties of candidate materials than radioactivity pursuant to the provisions of Article IV and Annex III of the Convention. The specific assessment required to consider further exemption⁵ of materials for determining if they can be treated as "non-radioactive", would include an evaluation of the radiological implications for human health and the environment (see Section 3 of IAEA-TECDOC-1068).

In cases where candidate materials are either contaminated by, or derived from, authorized or unauthorized releases, each situation would have to be reviewed in its specific context. The need for intervention may also be a relevant consideration in certain cases."

3 RADIOLOGICAL PROTECTION OF HUMANS AND DE MINIMIS CONCEPT

3.1 The concept of *de minimis* was first developed by the IAEA following a request by the Contracting Parties to the London Convention to provide guidance on how to determine whether candidate materials could be regarded as "non-radioactive" and may be disposed at sea [1]. The term *de minimis* subsumes the consideration of two distinct concepts used in radiological protection: "exclusion" and "exemption" [5, 9, 10]. Exclusion applies to radiation exposures that are unamenable to control using regulation irrespective of the magnitude of the dose [5, 9, 10]; exemption, on the other hand, applies to sources or practices that need not be subject to some or all aspects of regulatory control on the basis that the exposure and the potential exposure are too small to warrant regulatory control or that this is the optimum option for protection irrespective of the actual level of the doses or risks [5, 9, 10].

3.2 The principles and criteria for exemption were originally described in [9] and updated in [5]. The main concepts and criteria for exemption expressed in [9] remain valid and are the basis of the past and present IAEA advice to LC and LP. These are that:

- (a) the radiation risks to individuals caused by the exempted practice or source be sufficiently low as to be of no regulatory concern;
- (b) the collective radiological impact of the exempted practice or source be sufficiently low as not to warrant regulatory control under the prevailing circumstances;
- (c) the exempted practices and sources be inherently safe, with no appreciable likelihood of scenarios that could lead to a failure to meet the criteria in (a) and (b).

4 THE CONCEPT OF DE MINIMIS EXTENDED TO INCORPORATE PROTECTION OF FLORA AND FAUNA

4.1 The concept of exclusion, which was described in IAEA-TECDOC-1068 [1] and used previously in IAEA-TECDOC-1375 [3] based only on humans protection, can be applied in equal measure to flora and fauna. This means that, exposures considered unamenable to control from the perspective of human protection will generally be considered unamenable to control for flora and fauna.

4.2 In other situations, when for the purpose of LC and LP the concept of exemption can be applied to humans, the IAEA advises that it will be necessary to perform an assessment of the radiological impact to flora and fauna. This assessment should, similarly to the case of humans, demonstrate the triviality of the radiological concern respect to populations of marine flora and fauna. In this regard, the IAEA guidance proposes a method for estimating radiation exposures of marine flora and fauna, with similar cautious assumptions than those applied to assess radiation exposures of humans, and radiological criteria to be used as a reference (the criteria for flora and fauna is presented and discussed in more details in [8]).

5 MEANING AND IMPLICATIONS OF THE IAEA ADVICE

5.1 The IAEA advice presented in this guidelines may require some clarification for an audience unfamiliar with the terminology used in the field of radiological protection. Such explanation is provided here as a basis for developing appropriate definitions and guidelines under the London Convention 1972. It should be noted that all reference to the "national regulatory authority" in the IAEA's advice refers to the national radiation protection authority.

5.2 All materials contain natural radionuclides. Sometimes human activities can result in changes to their concentrations, thus potentially increasing radiation doses. If this occurs, an activity could be subjected to radiological control. Previous human activities, particularly nuclear weapons testing in the atmosphere, have also introduced new radionuclides to the environment and slightly enhanced the overall concentrations of radionuclides.

5.3 The IAEA advice provides for two distinct categories in relation to the *de minimis* question:

- first, cases in which the radionuclide constituents of a candidate material fall within the provisions of section 2.1 above and can be automatically (i.e. without further consideration) defined as *de minimis* under the London Convention 1972; and
- second, cases in which a specific assessment is required to determine whether the candidate materials are *de minimis* or not (see section 2.2 above).

6 AUTOMATIC EXEMPTION CRITERIA

6.1 The paragraph of the IAEA advice quoted in section 2.1 above deals with materials eligible for dumping at sea under the London Convention 1972 and London Protocol 1996 without further consideration from the perspective of radiological protection. The provisions of this paragraph correspond to "automatic" or "default" assignment of *de minimis*, that is exempted from any concerns regarding the radioactive content of the candidate materials (i.e. materials eligible for dumping at sea) from the perspective of radiological protection. The following subparagraphs need to be considered before this assignment can be made. Each of the subparagraphs specifies classes of constituent radionuclides that according to the IAEA advice can be considered as *de minimis* for the purposes of the London Convention 1972 and London Protocol 1996.

- .1 Subparagraph 2.1 (1) specifies that natural radionuclides in naturally-occurring materials are *de minimis* unless the national radiation protection authority has registered concern, from radiological perspectives, about the radiation field being substantially increased. In most cases, movement of such materials from one location in the marine environment to another presents relatively minor modification of the prevailing radiation fields in both the original and destination (dump) site. Thus, such cases are not regarded as of concern. The kind of natural materials over which such concerns might be registered by the national radiation protection authority could include the deliberate relocation of natural materials that are naturally enriched in naturally-occurring radionuclides (e.g. monazite sands) to an environment in which the natural radiation field is low. Unless such concerns have been raised, natural radionuclides in unmodified natural environmental materials can be assigned as *de minimis* and automatically exempted without further consideration or assessment. In instances in which concerns had been expressed by the national radiation protection authority, a specific assessment would be required to determine their suitability for *de minimis* assignment.

- .2 Subparagraph 2.1 (2) deals with natural radionuclides associated with materials derived from human activities that have resulted in some redistribution of natural radionuclides such that the concentrations in otherwise natural materials may have been changed. For some countries such activities could include application to soil of phosphate fertilizer. For other countries, such activities could include the processing of minerals, e.g. fertilizer production from phosphate-rich geological materials. In this case the distribution of natural radionuclides (e.g. phosphorus-31, uranium and thorium decay radionuclides) is altered in the process. It should be noted that some countries regard processing of such materials as a regulated practice, not one from which the exposures are excluded. Wastes from the process may be discharged into the aquatic environment and incorporated into sediments that may need to be dredged. The national regulatory authority may have evaluated this practice and made a judgement regarding its inclusion or exclusion from regulatory control. If a decision on the exclusion of exposures associated with the practice has been made based on evaluations of the entire practice taking into account marine pathways of exposure, the decision translates into automatic exemption for the purposes of the London Convention 1972. No further account would then need to be taken of the radioactive constituents or radiological effects of materials derived from or affected by that practice. If such is not the case, a specific assessment would be needed to determine if the candidate material could be assigned as *de minimis* or not.
- .3 Subparagraph 2.1 (3) deals predominantly with artificial radionuclides stemming from nuclear weapons testing in the atmosphere, from satellite radiothermal power unit burnup in the stratosphere and nuclear accidents. Atmospheric fallout is a collective term but primarily comprises radionuclides, particularly fission products, from nuclear weapons tests that were conducted in the atmosphere in the period 1945–1981. These have been augmented by specific radionuclides such as plutonium-238 from thermonuclear generators that have burnt up during re-entry to the atmosphere and the more widely-dispersed radionuclides (i.e. radionuclides distributed globally rather than locally or regionally) from nuclear accidents. Global fallout results in the contamination of soils and sediments throughout the surface of the Earth. The relocation of aquatic sediments contaminated by global fallout over relatively small distances, as is effected by dredging and dumping activities, for example, neither significantly alters the distribution of such radionuclides nor significantly changes their environmental concentrations. In cases where contamination by radionuclides from such sources has been judged by the national radiation protection authority not to warrant intervention to reduce associated human exposures, the materials so contaminated can be assigned as *de minimis* and exempted without further consideration or assessment. In other circumstances a specific assessment would be needed to determine if the candidate material could be assigned as *de minimis* or not.
- .4 Subparagraph 2.1 (4) deals with radionuclides derived from sources and practices that have been exempted or cleared from radiological control by the national radiation protection authority, consistent with applicable international criteria. If the national radiation protection authority has exempted a practice, or cleared from radiological control a previously regulated practice, based on an assessment of the practice and any disposal, reuse and relocation of materials from the practice, including taking account

of marine environmental exposure pathways, the radionuclides derived from that practice can be assigned as *de minimis* and automatically exempted from radiological concerns without further consideration. In instances in which these conditions are not fulfilled, a specific assessment would be needed to determine if the candidate materials could be assigned as *de minimis* or not.

6.2 Assignment of materials as *de minimis* based on the above criteria merely relieves the permitting authority of any requirement to further consider the radioactive properties of such materials and the radiological consequences of their disposal. The other characteristics and properties of candidate materials still remain to be assessed in the context of the suitability of the candidate materials for disposal at sea under the London Convention 1972 through application of the provisions of Article IV and Annexes I and III of the Convention and their suitability for disposal at sea through application of the *Guidelines for the Assessment of Wastes or Other Matter, that May be Considered for Dumping*.

7 SPECIFIC ASSESSMENTS

7.1 The two paragraphs of the IAEA advice quoted in section 2.2 above deal with the situation that applies if the assignment of *de minimis* cannot be made automatically (i.e. without further consideration). The first paragraph defines the nature of a "specific assessment" that would be required to be undertaken by the national regulatory authority using the international radiological criteria for exemption as quoted in section 2.3 above and other considerations relating to the radiological implications for the environment.

7.2 The second paragraph quoted in section 2.2 above deals specifically with contamination of candidate materials by authorized discharges or unauthorized releases of radionuclides to the environment. Authorized discharges are those from regulated practices such as nuclear power reactor operations and nuclear fuel reprocessing. Unauthorized releases are either illicit or unintentional. In such cases, a specific assessment using relevant international radiological criteria for exemption would also be needed regarding the suitability of the material for assignment as *de minimis*.

7.3 Again, as in the case of *de minimis* assignment without further consideration (see paragraph 6.2 above), irrespective of any determination that a candidate material is *de minimis* from the perspective of its radionuclide content or radioactive properties, that material would still be subject to the provisions of the London Convention 1972, in particular, Article IV and Annexes I and III and its suitability for disposal at sea would require to be assessed through the application of the *Guidelines for the Assessment of Wastes or Other Matter, that May be Considered for Dumping*.

8 EVALUATION PROCEDURE FOR DEFINING *DE MINIMIS*

8.1 This section describes the application of the IAEA *de minimis* definition when assessing candidate materials under the London Convention 1972. The intent is to assess candidate materials to determine if they contain *de minimis* levels of radioactivity or if a specific assessment is required.² This evaluation procedure is intended to be implemented through judgements based on available information regarding the provenance of candidate materials and sediments in the receiving marine environment, specifically at the dump-site. The questions posed at each of the first five steps are designed to be answered without the

² The text in this evaluation procedure refers to the national radiation protection authority and the national permitting authority. It is recognized that these authorities could be the same agency in some countries, could be called by other titles, or could encompass more than two agencies.

need for direct measurements of radionuclides in either the candidate material or the marine environment. Indeed, had such a requirement been a prerequisite to the first five steps of this procedure, it would run entirely counter to the intent and interpretation of *de minimis*.

8.2 In cases when there is insufficient existing information on which to base such judgements a specific assessment would be required.

9 STEPWISE EVALUATION PROCEDURE

STEP 1: CANDIDATE MATERIALS

Decision Criteria: Candidate materials are those wastes or other matter not otherwise prohibited from disposal by Annex I of the London Convention 1972.

- 1 Are the proposed materials eligible for dumping under the provisions of the London Convention 1972 and London Protocol 1996?
- 2 If **NO**, the material is not allowed to be dumped and no further consideration is warranted.
- 3 If **YES**, go to Step 2.

STEP 2: INITIAL SCREEN FOR SOURCES OF CONTAMINATION

Decision Criteria: Virtually all candidate materials are likely to have some level of radioactivity due to natural radionuclides at background levels and artificial radionuclides derived from global fallout. Global atmospheric fallout is a collective term but primarily comprises radionuclides, particularly fission products, from nuclear weapons tests that were conducted in the atmosphere in the period 1945–1981. These have been augmented by specific radionuclides such as plutonium-238 from thermonuclear generators that have burnt up during re-entry into the atmosphere. If candidate materials for dumping at sea contain only such natural radionuclides at locally prevailing background levels in the vicinity of the proposed dump-site and artificial radionuclides from global fallout, they can be immediately assigned as *de minimis*.

If the result of the initial screen leads to a conclusion that there is no reason to believe that the candidate material is a modified natural material or contaminated from other sources, the material is considered *de minimis*, unless there is concern on the part of the regulatory authority that the radiation field in the vicinity of the dump-site would be substantially modified: (this latter situation is dealt with at Step 4 of this procedure).

- 1 Is there reason to believe that the candidate material contains anything other than unmodified natural radionuclides at background comparable with that in the receiving environment and artificial radionuclides derived from global fallout?
- 2 If **NO**, the materials are *de minimis*.
- 3 If **YES**, go to Step 3.

STEP 3: ASSESSMENT OF ADDITIONAL CAUSES/SOURCES

Decision Criteria: If there are additional radionuclides in the candidate material, it is important to discriminate between the causes/sources of the presence of these additional radionuclides. Increases in the presence of radionuclides at the dump-site could result from two causes: (1) differences in the concentrations of natural radionuclides in the candidate material and in sediments at the dump-site, and; (2) human activities that increase the concentrations of natural radionuclides in candidate materials. The permitting authority should address both possibilities before determining if levels of radioactivity in the materials are *de minimis*. The first of these causes is addressed in Step 4 of this procedure. The second is considered in Step 5.

This Step is intended to determine the nature of causes/sources responsible for any additional radioactivity in the candidate material.

- 1 What are the likely additional causes/sources contributing to the radioactivity in the materials?
- 2 If only unmodified natural causes/sources, go to Step 4.
- 3 If only anthropogenic causes/sources, go to Step 5.
- 4 If both anthropogenic and natural causes/sources, go to Step 5

STEP 4: NATURAL CAUSES/SOURCES

Decision Criteria: Candidate materials of natural origin unmodified by human activities are *de minimis*, unless the national permitting authority is concerned that the radioactivity would be substantially increased at the dump-site as a result of the dumping action.

This Step addresses the issue of whether the radiation field at the dump-site will be substantially altered by dumping of a candidate material containing natural radionuclides at unusual concentrations as a result of natural processes.

Information pertinent to this determination would include any assessment conducted by the national radiation protection authority.

- 1 If the material were to be dumped, would it substantially increase radioactivity at the dump-site?
- 2 If **NO**, the materials are *de minimis*.
- 3 If **YES**, go to Step 6.

STEP 5: ANTHROPOGENIC CAUSES/SOURCES³

Decision Criteria: For candidate materials containing artificial radionuclides (other than from global fallout that is referred to in Step 2) and/or altered natural radionuclides stemming from human activities, the national permitting authority should consider previous decisions and action taken by the national radiation protection authority. The national permitting authority should assess whether the human activity contributing to the radioactivity in the candidate material is from an activity that has been exempted or cleared or one from which radiation exposures have been excluded by the national radiation protection authority based upon international radiological criteria. The pertinent question in such cases is whether the decisions on exclusion, exemption, or clearance were made considering marine environmental pathways of exposure to humans and to marine flora and fauna and whether these are suitable to an assessment of the proposed dumping operation. If this is the case, the materials are *de minimis*.

- 1 Were the likely anthropogenic causes/sources part of exempted or cleared practices or excluded exposures?
- 2 If **NO**, go to Step 6.
- 3 If **YES**, were the marine environmental exposure pathways to humans and to marine flora and fauna considered by the national radiation protection authority and are these suitable to an assessment of the proposed dumping operation?
 - 3.1 If **YES**, the materials are *de minimis*.
 - 3.2 If **NO**, go to Step 6.

STEP 6: SPECIFIC ASSESSMENT

Materials not determined to be *de minimis* through the evaluation in Steps 1–5 above could also be determined to be *de minimis* by the application of a specific assessment. The foregoing Steps of this evaluation procedure lead to initial perspectives on the nature and requirements of a specific assessment as follows.

A specific assessment should provide an evaluation of the potential adverse impacts to the marine environment including effects upon human health and to marine flora and fauna, and to other legitimate uses of the sea. The nature and extent of the specific assessment should be determined in accordance with existing knowledge of the sources and likely extent of any radioactive contamination of the candidate material. For example, candidate dredged material containing only minor amounts of radionuclides may not need to be subjected to an unnecessarily detailed or unnecessarily complex assessment process. International radiological exemption criteria based on the protection of human health should be used for part of this assessment as well as the international radiological criteria for the protection of flora and fauna, permitting authorities should use appropriate scientific information and a precautionary approach (as provided for in resolution LDC.44(14)) in conducting assessments of the potential impacts on the marine environment.

³ Step 5 was modified by the IAEA in the TECDOC 1759 to include an assessment to flora and fauna.

Guidance for the conduct of specific assessments, including for the radiological impact to humans and marine flora and fauna, has been developed by the IAEA in IAEA-TECDOC-1759, entitled *Determining the Suitability of Materials for Disposal at Sea Under the London Convention 1972 and London Protocol 1996: A Radiological Assessment Procedure, Edition 2015*.

There are various reasons for which a candidate material may require a specific assessment as a result of reaching Step 6 of the Stepwise Evaluation Procedure. These reasons, not necessarily in the order of radiological significance, are as follows:

- When the national permitting authority is concerned that the radioactivity would be substantially increased at the disposal site as a result of the disposal of candidate materials of natural origin (unmodified by human activities);
- When the likely anthropogenic causes/sources of artificial radionuclides and/or altered natural radionuclides in the candidate material were not part of exempted or cleared practices or associated with activities for which exposures are excluded⁴;
- When, despite the likely anthropogenic causes/sources of artificial radionuclides and/or altered natural radionuclides in the candidate material being part of exempted or cleared practices or excluded exposures, marine environmental exposure pathways to humans and those relevant for marine flora and fauna were either:
 - Not considered by the national radiation protection authority;
 - Were considered, but not in a manner appropriate to disposal at sea of the material.

The purpose of a specific assessment is to determine if candidate materials can be designated to be *de minimis* within the meaning described to it by the LC and LP and discussed in TECDOC 1759. The nature and extent of a specific assessment should be determined in accordance with existing knowledge of the origin of the candidate material, the relevant sources of radionuclide contamination and the radionuclide content of the material. Consequently, candidate materials comprising sediments containing only relatively minor amounts of artificial radionuclides may not need to be subjected to an unnecessarily detailed or complex assessment process.

10 APPLICATION OF THE WASTE ASSESSMENT GUIDANCE

10.1 Candidate materials that are determined to be *de minimis* through the evaluation in Steps 1-6 above must then be evaluated through application of the generic *Guidelines for the assessment of wastes or other matter that may be considered for dumping*, and/or the waste-specific guidance developed thereunder. No further evaluation of the radionuclide content of the candidate materials that are *de minimis* is needed.

10.2 The present guidelines have been developed on the basis of existing scientific knowledge of the radiation protection considerations and on a knowledge of current technology. Scientific work and technical development is, however, proceeding and consequently these guidelines should be kept under review as the results of further research and investigation become available.

⁴ Includes radionuclides derived from authorized discharges.

11 THE SPECIFIC ASSESSMENT PROCESS

11.1 This section describes a process for carrying out a specific assessment to determine whether a candidate material can be treated as *de minimis*, under the LC and LP (Step 6 of the Stepwise Evaluation Procedure, as defined above).

11.2 The method proposed by the IAEA for the LC and LP is based on the assessment of individual and collective dose to humans (workers and members of the public) and dose rates to marine flora and fauna. This proposal provides an assessment method which, despite being of a generic nature, introduces cautions assumptions regarding, the dispersion of radionuclides in the ocean, the inclusion of comprehensive radiation exposure pathways and the consideration of the habit data.

11.3 The specific assessment is designed to estimate radiation doses that could be received by human beings and marine flora and fauna exposed directly and indirectly to the radioactivity in the candidate material to be disposed at sea.

11.4 The schematic diagram given in figure 1 below outlines the process for performing a specific radiological impact assessment for human and marine flora and fauna including the verification of the level of their protection, in other words, to decide if dumping of candidate material is permitted within the provisions of the LC and LP. As indicated in the figure, different types of assessment are included in this process: first within a "screening stage" and, as a second option, a more "detailed stage" for both humans and marine biota (flora and fauna).

11.5 The screening stage, (section 5.3), is based on the use of cautious estimated screening coefficients, expressed in terms of dose/dose rates per unit activity concentration in the candidate material. These screening coefficients were calculated by IAEA and are provided and discussed in IAEA-TECDOC-1759.

11.6 The assessment in the detailed stage (section 5.4) requires that additional information be collected and input from relevant specialists obtained. Guidance for carrying out a more detailed assessment for humans and marine flora and fauna, including the selection of associated parameter values and the models for dose estimation, is described in the in IAEA-TECDOC-1759.

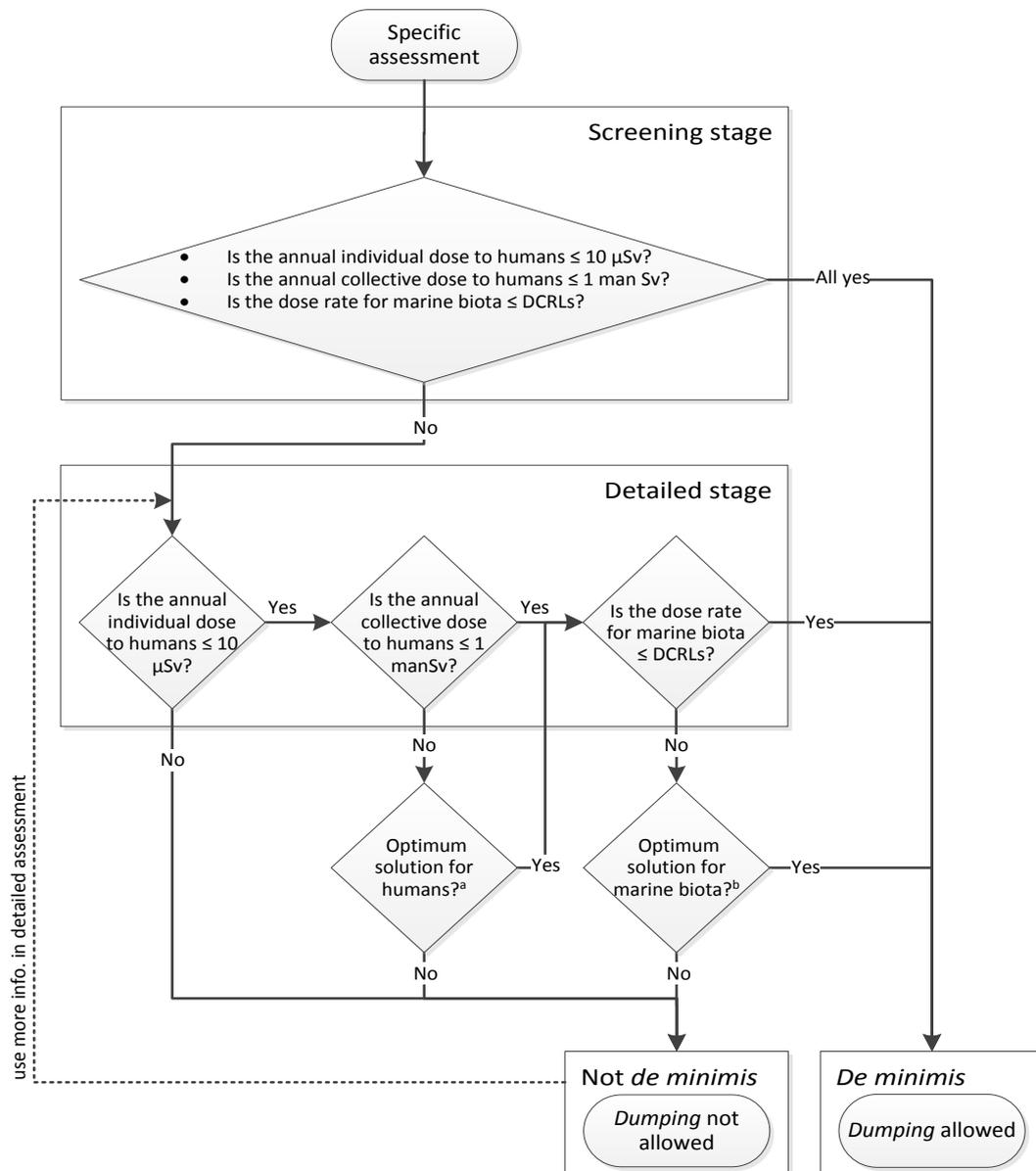


Figure 1: Procedure for performing the specific assessment⁵.

The radiological criteria used for humans (10 μSv and 1 man Sv) and marine biota (DCRLs) within the Screening Stage and the Detailed Stage are discussed in IAEA-TECDOC 1759. These criteria are not defined as "limits" but as references to make informed decisions with respect to the level of radiological protection of the humans and the marine flora and fauna.

^a Here, an "optimum solution" would be that determining what level of radiological protection makes exposures and the probability and magnitude of potential exposures "as low as reasonably achievable, economic and social factors being taken into account" (ALARA), as recommended by the ICRP [11] and adopted in IAEA safety standards [5, 9].

^b Here, an "optimum solution" would consider additional factors such as the nature of the exposure situation, the size of the potentially affected area, the duration of the contamination, the type of managerial interest, the actual flora and fauna present (including the number of individuals), and the presence of other environmental stressors in the same area.

12 REFERENCE CRITERIA FOR HUMANS

12.1 A specific assessment for the protection of human health should include estimates of individual doses and collective doses⁶ to reference persons for comparison with the radiological criteria for exemption set out in IAEA-TECDOC-1068 [1]. The relevant criteria can be summarized as follows:

12.2 A specific assessment for the protection of human health should include estimates of individual doses and collective doses⁷ to reference persons for comparison with the radiological criteria for exemption set out in IAEA-TECDOC-1068 [1]. The relevant criteria can be summarized as follows:

12.3 A practice, or source within a practice, may be exempted without further consideration provided that the following radiological criteria are met in all feasible situations:

- (i) the effective dose⁸ expected to be incurred by any individual⁹ due to the exempted practice or source is of the order of 10 μ Sv or less in a year;
- (ii) either the collective effective dose¹⁰ committed by one year of performance of the practice is not more than about 1 man Sv or an assessment for the optimization of protection shows that exemption is the optimum option."

12.4 The criteria defined in (i) and (ii) for the protection of humans are not intended to constitute "limits" but numerical guidance to define protection measures commensurate with the significance of the radiological risk.

12.5 The reference criteria for humans, for the specific assessment in the Stepwise Evaluation Procedure for the purpose of the LC and LP, is presented in table 1 below.

⁵ It should be noted that the reference criteria for humans are not defined as absolute, or "limits". Criteria for exemptions are (IAEA TECDOC-1759 section 5.2.1):

- (i) the effective dose expected to be incurred by any individual due to the exempted practice or source is of the order of 10 μ Sv or less in a year;
- (ii) either the collective effective dose committed by one year of performance of the practice is not more than about 1 man Sv or an assessment for the optimization of protection shows that exemption is the optimum option.

⁶ When referring to humans and if not otherwise specified, the term "dose" is used in this report to indicate the sum of the committed effective dose from intakes (ingestion or inhalation) and the effective dose for external exposure as defined in the current BSS [5].

⁷ When referring to humans and if not otherwise specified, the term "dose" is used in this report to indicate the sum of the committed effective dose from intakes (ingestion or inhalation) and the effective dose for external exposure as defined in the current BSS [5].

⁸ Effective dose is defined as a summation of the tissue equivalent doses, each multiplied by the appropriate tissue weighting factor. The unit of effective dose is the sievert (Sv) [10]. The effective dose is clearly dedicated to the consideration of exposures to humans, since it aims at the quantification of human stochastic effects and risks.

⁹ The dose criterion of 10 μ Sv in one year should be applied to a hypothetical individual receiving a dose that is representative of the doses to the more highly exposed individuals in the population. In the framework of the LC and LP the criterion is applied to the most exposed workers (crew) and members of the public.

¹⁰ Collective effective dose is the total effective dose to a population. The unit of collective effective dose is the man-sievert (man Sv) [10].

13 REFERENCE CRITERIA FOR FLORA AND FAUNA

13.1 ICRP defined a set of reference animals and plants (the RAPs) for the purpose to assess the radiological impact to flora and fauna [7]. Radiological criteria for reference animals and plants was introduced by ICRP as "derived consideration reference levels" (DCRLs) that are intended to guide and optimize environmental protection measures. DCRLs are not dose limits. ICRP defines DCRLs as dose rates for chronic exposures derived for the set of RAPs that serve as markers at which one should pause in order for the known radiation effects data to be considered alongside other relevant factors when considering managerial options. [7]. The DCRLs are grouped in bands corresponding to different RAPs and considering a range of possible effects at the level of individuals which may have impact at the level of populations.

13.2 A specific assessment for the protection of marine flora and fauna should include estimates of radiation exposures to a set of RAPs more highly exposed and to compare the results with the corresponding reference criteria. For the marine environment and under the exposure situations related to the framework of the LC and LP, the IAEA indicates that the relevant ICRP RAPs for the purpose of the LC and LP are a marine fish, a marine crustacean and a type of seaweed, with the corresponding reference criteria.

13.3 As mentioned before, these bands are not intended to be "dose limits" but indicators of the need to consider additional factors in any decision making regarding environmental protection. Examples of these factors are: the nature or the exposure situation, the size of the area where dose rates are assessed to occur, the fraction of the population of biota exposed, the time period, the managerial interest, other forms of coexisting environmental stress, the degree of precaution [7].

13.4 In principle, the IAEA indicates that, for the purpose of the LC and LP, the lower end of the DCRL bands should be used as the appropriate reference criteria for protection of the different flora and fauna. If the resulting dose rates fall within the bands, consideration should be given as to whether all reasonable actions have been taken under the prevailing conditions and considering, for example, the factors mentioned in the previous paragraph. Options resulting in doses above the upper boundary of the relevant DCRL band imply a stronger need to consider further protection efforts.

13.5 It should be noted that DRCLs used for the purpose of the LC and LP are not defined in any international standard as "exemption criteria for protection of flora and fauna". However, when small fractions of populations of flora and fauna are exposed at low increments of radiation levels resulting in dose rates below DCRLs – a situation that is typical for the exposure scenarios prevalent within activities related to LC and LP – it can be concluded that impacts at the level of populations of marine flora and fauna are trivial and of no radiological concern.

13.6 The reference criteria for marine flora and fauna, for the specific assessment in the Stepwise Evaluation Procedure for the purpose of the LC and LP, is presented in table 1 below.

Table 1: Reference criteria for humans and flora and fauna¹¹ for the specific assessment in the Stepwise Evaluation procedure for the purpose of the LC and LP

Subject of exposure	Reference criteria
Crew/public, individual dose	10 µSv in a year
Crew/public, collective dose	1 man Sv in a year
Marine fish, dose rate	40–400 µGy/h
Marine crustacean, dose rate	400–4000 µGy/h
Seaweed, dose rate	40–400 µGy/h

14 SCREENING STAGE OF THE SPECIFIC ASSESSMENT

14.1 This section describes a generic method for assessing whether a candidate material can be regarded as *de minimis* in relation with the specific assessment in the Stepwise Evaluation Procedure for the LC and LP (see box 1 in section 4 and figure 1 in this section). The method developed by IAEA uses tabulated coefficients for dose per unit activity concentration. This tabulated coefficients, which have been derived on the basis of cautious models, parameters and assumptions, are presented in TECDOC 1759.

14.2 The coefficients included in IAEA-TECDOC-1759 (named as "screening coefficients") allow, for the case of humans, the estimation of individual and collective doses in a year and, for the case of marine flora and fauna, the estimation of the dose rates. For the case of humans, two groups of individuals who could receive doses from the material disposed of are included in the screening procedure. The first group consists of members of the crews working on the ships that transport the material to the disposal site. The second group consists of members of the public who may be exposed to the radionuclides from the material after it has been disposed of. For the case of flora and fauna, three marine reference species are used to estimate the impact on flora and fauna: marine fish, marine crustaceans and seaweeds [7].

14.3 The doses to humans/dose rates to flora and fauna should be calculated multiplying the screening coefficients provided in table 2 in IAEA-TECDOC-1759 [8] by the actual activity concentrations of radionuclides and the mass of the candidate material divided by the reference mass used to derive the tables. The activity concentrations of the radionuclides in a candidate material should be representative of the material in question and provide appropriate averaging over volume and time. The mass of the candidate material should be that planned to be dumped in a one year period in a single location.

14.4 More details on the development and use of the tables for this screening stage are presented in IAEA-TECDOC-1759 [8] including an example calculation.

15 CONSIDERATIONS RELATED TO THE SPECIFIC ASSESSMENT

15.1 In carrying out the specific assessment it is important to take into account the following considerations:

- The assessment presented in IAEA-TECDOC-1759 includes a graded approach: a screening stage and a detailed stage. Competent authority for radiation protection could provide advice on whether both of these stages are required and what data are needed to perform a specific assessment and what radionuclides are relevant;

¹¹ In order to derivate screening coefficients the criteria for flora and fauna are presented in µGy/h units, to be consistent with the units used for human individual dose (µSv). However, the ICRP indicates that the criteria for flora and fauna protection should be expressed in µGy/day because of the lifecycles of reference plants and animals [7].

- A relevant national competent authority could identify some situation related to some particular marine flora or fauna needing special considerations different from those of a more generic character as presented in IAEA-TECDOC-1759. The existence of, for example, endangered species, special protected areas or very sensitive ecological niches could necessitate a less generic assessment which considers not only the radiological perspective;
- The calculation presented in IAEA-TECDOC-1759 should be performed using the activity concentrations of radionuclides present in the candidate material, irrespective of their origin (e.g. natural or artificial). When an increased level of natural radionuclides in the candidate materials could be due to an industrial process, the national authority for radiation protection should provide advise on the activity concentrations to be used for the assessment;
- The approach used to assess the level of protection of humans and the marine environment in IAEA-TECDOC-1759 is basically of a generic nature. However, the IAEA considers that this approach can be valid in most of the exposure scenarios related to marine dumping activities which follow the general guidelines [2] of the LC and LP, due to the cautious assumptions used to calculate the environmental activity concentrations and to estimate the doses to reference humans and reference marine flora and fauna.
- The use of the radiological reference criteria for humans and flora and fauna within LC and LP procedures to define candidate materials as *de minimis* as described in IAEA TECDOC 1759 is very cautious. For instance, the criteria is respectively much lower than typical doses to humans due to the natural background of radiation and in the order of dose rates due to natural background of radiation for flora and fauna. Annex III in IAEA TECDOC 1759 [8] illustrates the radiological significance of the criteria advised by the IAEA comparing doses to humans and dose rates to marine flora and fauna resulting from the natural radiation background.

16 DATA COLLECTION REQUIREMENTS

16.1 Information necessary for the Stepwise Evaluation Procedure includes estimates of the quantity of the candidate material to be disposed of, its origin and the activity concentrations of the constituent radionuclides. Knowledge of the origin of the material can be useful in determining which radionuclides are likely to be present. Radionuclide sources could include, but are not limited to, nuclear medicine facilities, nuclear power plants, nuclear processing facilities, relevant mining activities and fossil fuelled power plants. Mining activities could include the mining and processing of phosphate, tin, niobium, thorium, titanium, natural gas, uranium and precious metals. For additional information regarding the identification of potential causes or sources of radionuclides see Tables V-2 and V-3 in Annex V in IAEA-TECDOC-1759 [8].

16.2 When in the screening stage (see figure 1) estimates of the activity concentrations of the radionuclides in the candidate material are required. It is not expected that it will be necessary to carry out new measurements on a routine basis for the screening process, as sufficient information should be already available. Due account should be taken of the reasons for the material failing the Stepwise Evaluation Procedure, the origin and form of the candidate material, the constituent radionuclides and their sources. Only information relevant to determining whether the material can be treated as *de minimis* under the LC and LP should be considered.

16.3 When in the detailed stage (see figure 1), the same additional information necessary to estimate with more realism the environmental activity concentrations in order to estimate doses to humans (for example, the actual water depth and flow) is likely to be required to calculate exposures to marine flora and fauna, due to the fact that the procedure to estimate concentrations in the marine environment is based on the same models and data. This report provides generic parameters and data which can be used by default to perform a detailed assessment; however site specific data could be used instead of generic data in the detailed stage.

16.4 IAEA-TECDOC-1759 [8] provides detailed information on models, data and assumptions used for the derivation of the screening coefficients for workers, public and flora and fauna. This detailed information can be also used as guidance when more detailed assessment is deemed necessary by a national authority.

References

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Annex I to the London Convention 1972, as amended in 1993

- 1 Organohalogen compounds.
- 2 Mercury and mercury compounds.
- 3 Cadmium and cadmium compounds.
- 4 Persistent plastics and other persistent synthetic materials, for example, netting and ropes, which may float or may remain in suspension in the sea in such a manner as to interfere materially with fishing, navigation or other legitimate uses of the sea.
- 5 Crude oil and its wastes, refined petroleum products, petroleum, distillate residues, and any mixtures containing any of these, taken on board for the purpose of dumping.
- 6 Radioactive wastes or other radioactive matter.
- 7 Materials in whatever form (e.g. solids, liquids, semi-liquids, gases or in a living state) produced for biological and chemical warfare.
- 8 With the exception of paragraph 6 above, the preceding paragraphs of this Annex do not apply to substances which are rapidly rendered harmless by physical, chemical or biological processes in the sea provided they do not:
 - (i) make edible marine organisms unpalatable, or
 - (ii) endanger human health or that of domestic animals.

The consultative procedure provided for under article XIV should be followed by a Party if there is doubt about the harmlessness of the substance.

9 Except for industrial waste as defined in paragraph 11 below, this Annex does not apply to wastes or other materials (e.g. sewage sludge and dredged material) containing the matters referred to in paragraphs 1–5 above as trace contaminants. Such wastes shall be subject to the provisions of Annexes II and III as appropriate.

Paragraph 6 does not apply to wastes or other materials (e.g. sewage sludge and dredged material) containing *de minimis* (exempt) levels of radioactivity as defined by the IAEA and adopted by the Contracting Parties. Unless otherwise prohibited by Annex I, such wastes shall be subject to the provisions of Annexes II and III as appropriate.

- 10 (a) Incineration at sea of industrial waste, as defined in paragraph 11 below, and sewage sludge is prohibited.
- (b) The incineration at sea of any other wastes or other matter requires the issue of a special permit.
- (c) In the issue of special permits for incineration at sea Contracting Parties shall apply regulations as are developed under this Convention.
- (d) For the purpose of this Annex:
 - (i) "Marine incineration facility" means a vessel, platform, or other man-made structure operating for the purpose of incineration at sea.

- (ii) "Incineration at sea" means the deliberate combustion of wastes or other matter on marine incineration facilities for the purpose of their thermal destruction. Activities incidental to the normal operation of vessels, platforms or other man-made structures are excluded from the scope of this definition.

11 Industrial waste as from 1 January 1996.

For the purposes of this Annex:

"Industrial waste" means waste materials generated by manufacturing or processing operations and does not apply to:

- (a) dredged material;
- (b) sewage sludge;
- (c) fish waste, or organic materials resulting from industrial fish processing operations;
- (d) vessels and platforms or other man-made structures at sea, provided that material capable of creating floating debris or otherwise contributing to pollution of the marine environment has been removed to the maximum extent;
- (e) uncontaminated inert geological materials the chemical constituents of which are unlikely to be released into the marine environment;
- (f) uncontaminated organic materials of natural origin.

Dumping of wastes and other matter specified in subparagraphs (a)–(f) above shall be subject to all other provisions of Annex I, and to the provisions of Annexes II and III.

This paragraph shall not apply to the radioactive wastes or any other radioactive matter referred to in paragraph 6 of this Annex.

12 Within 25 years from the date on which the amendment to paragraph 6 enters into force and at each 25 year interval thereafter, the Contracting Parties shall complete a scientific study relating to all radioactive wastes and other radioactive matter other than high level wastes or matter, taking into account such other factors as the Contracting Parties consider appropriate, and shall review the position of such substances on Annex I in accordance with the procedures set forth in article XV.
