

International Atomic Energy Agency

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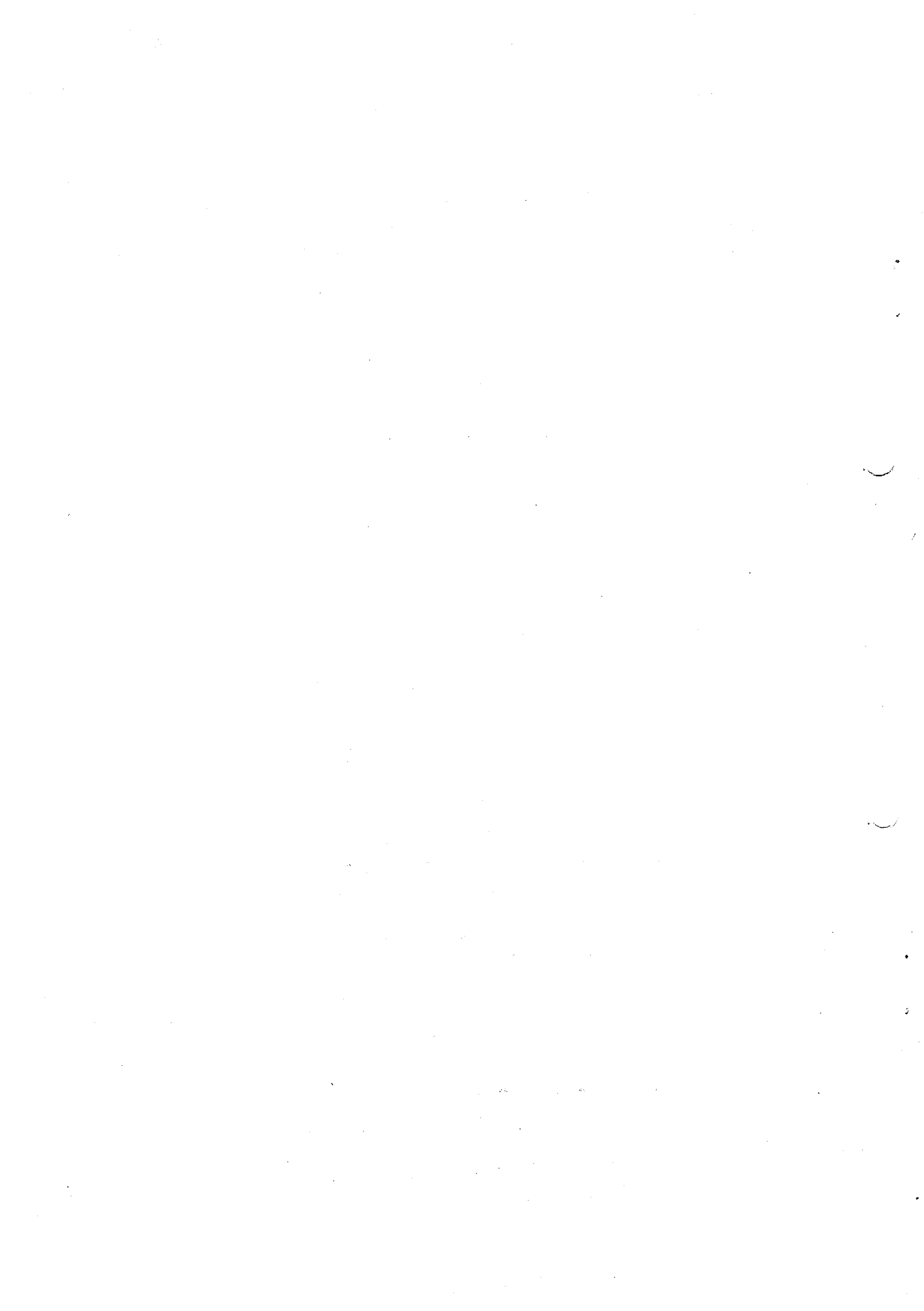
### CONVENTION ON THE PREVENTION OF MARINE POLLUTION BY DUMPING OF WASTES AND OTHER MATTER

#### The Definition Required by Annex I, paragraph 6 to the Convention and the Recommendations Required by Annex II, Section D

1. Paragraph 6 of Annex I to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter<sup>[1]</sup> provides for the Agency to define high-level radioactive wastes or other high-level radioactive matter as unsuitable for dumping at sea, and section D of Annex II provides for the Agency to make recommendations which the Contracting Parties to the Convention should take fully into account in issuing permits for the dumping at sea of radioactive wastes or other radioactive matter "not included in Annex I".
2. On 13 September 1974 the Board of Governors took steps to enable the Agency to discharge the responsibilities thus entrusted to it by authorizing the Director General:
  - (a) To transmit the Provisional Definition and Recommendations which are reproduced in this document to the Government of the United Kingdom of Great Britain and Northern Ireland, which is performing secretariat duties under the Convention pursuant to Article XIV, 3 thereof; and
  - (b) To inform that Government that the Provisional Definition and Recommendations, which should not be construed as encouraging in any way the dumping at sea of radioactive wastes and other radioactive matter, would be subject to periodic review and revision by the Agency, the first of such reviews being scheduled for early 1975.
3. Pursuant to that authorization, the Director General made the necessary communications to the Government of the United Kingdom on 6 December 1974.

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[1] Reproduced in document INFCIRC/205.



CONVENTION ON THE PREVENTION OF MARINE POLLUTION  
BY DUMPING OF WASTES AND OTHER MATTER

Provisional Definition and Recommendations Concerning Radioactive Wastes  
and Other Radioactive Matter Referred to in  
Annexes I and II to the Convention

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## DEFINITION AND RECOMMENDATIONS

The Definition and Recommendations set forth in this Document should not be interpreted as precluding the adoption of more restrictive requirements by any party to the Convention or national competent authority, pursuant to Articles IV, 3 and VI, 3 of the Convention. Nothing in this Document shall be construed as encouraging the dumping of radioactive waste or other radioactive matter.

## A. DEFINITION

A. 1. Definition of High-Level Radioactive Wastes or Other High-Level Radioactive Matter Unsuitable for Dumping at Sea

A. 1. 1. For the purposes of Annex I to the Convention, high-level radioactive wastes or other high-level radioactive matter unsuitable for dumping at sea means any waste or other matter with a concentration in curies per unit gross mass (in tonnes) exceeding:

- (a)  $10^3$  Ci/t for  $\alpha$ -active waste of half life greater than 50 years. (In the case of  $^{226}\text{Ra}$ , not more than 100 Ci/yr may be dumped at any one site);
- (b)  $10^3$  Ci/t for  $\beta/\gamma$ -active waste (excluding tritium) but the limit for  $^{90}\text{Sr}$  plus  $^{137}\text{Cs}$  is  $10^2$  Ci/t; and
- (c)  $10^6$  Ci/t for tritium.

The Definition is based on an assumed upper limit to the dumping rate of 100 000 t per year at any one site. The above activity concentrations shall be averaged over a gross mass not exceeding 100 tonnes.

A. 1. 2. The Definition must not be taken to imply that material falling outside the Definition is thereby deemed to be suitable for dumping.

A. 1. 3. Materials of activity concentrations less than those in the above Definition shall not be dumped except in accordance with the provisions of the Convention, in particular Annexes II and III thereto, and the Recommendations set out in this Document.

## B. THE RECOMMENDED BASIS FOR ISSUING SPECIAL PERMITS FOR RADIOACTIVE MATERIALS LISTED IN ANNEX II TO THE CONVENTION

B. 1. Environmental Evaluation of Specific Dumping Applications

B. 1. 1. The appropriate national authorities shall not grant a special permit for dumping of radioactive waste unless a detailed environmental and ecological assessment gives a reasonable assurance that such dumping can be accomplished in accordance with the objectives and provisions of the Convention and the Recommendations set out in this Document.

B. 1. 2. The environmental assessment shall include, in addition to the factors specified in Annex III to the Convention, consideration of:

- (1) The justification for the proposed dumping, when weighed against land-based alternatives, including the respective population dose commitments;
- (2) The total alpha, beta and gamma activities and the activity of any individual nuclide of special significance for the assessment;
- (3) Those factors likely to affect significantly the movement of radioactive materials from the dumping site to the human environment, including the nature of the sea-bed and the physical processes of mixing and transport in the sea at the particular site;

- (4) Dose commitments to individual members of the public and to the population via critical and other appropriate pathways;
- (5) The risk to marine ecosystems resulting from the release of radioactivity from dumped packages;
- (6) The degree to which it is practical to attempt to reduce dose commitments, either for normal dumping or in case of accidents, by techniques such as having the radioactive material in a relatively insoluble form or within a relatively insoluble matrix, by designing the containment to retain for a period of time radioactive material when it is on the sea-bed, or by selecting an area with characteristics that will facilitate the retention of the radioactive material in the vicinity of the dumping site;
- (7) Operational methods to be used, including arrangements for dealing with accidents and emergencies and methods of verifying their correct execution.

B. 1. 3. The IAEA is of the opinion that it is necessary that the reports to be submitted, pursuant to Article VI. 4 of the Convention, to the Organization to be designated thereunder include this environmental assessment in relation to an individual application for a special permit for dumping.

B. 2. Monitoring and Assessment

B. 2. 1. In the context of dumping carried out in accordance with the Convention, the following requirements shall be met:

- (1) Determination by measurement or estimation of the nature and quantities of radioactive waste or other radioactive material to be dumped; and
- (2) Monitoring, to the extent feasible and meaningful, of the condition of the seas with respect to dumped radioactive wastes in the vicinity of the dumping site, taking into full account the relevant guidance as provided for in the IAEA Safety Series No. 5 [1] and the ICRP Publication 7 [2].

B. 3. Environmental Evaluation of Total Dumping

B. 3. 1. In addition to the environmental assessment in relation to an individual application for a special permit for dumping, the appropriate national authorities shall take the following factors into account in determining whether each proposed dumping operation is acceptable:

- (1) Periodic reviews of the total dumping which has been carried out under permits issued by them;
- (2) Dumping which has been reported pursuant to the Convention as having been carried out by other States; and
- (3) Prospective dumping which may reasonably be expected.

This evaluation will be facilitated through the establishment of regional agreements and other appropriate forms of international co-operation.

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[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Series No. 5, "Radioactive Waste Disposal into the Sea", Vienna, 1961, STI/PUB/14.

[2] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, "Principles of Environmental Monitoring related to the Handling of Radioactive Materials", A Report by Committee 4, ICRP Publication 7, 1965.

C. THE RECOMMENDED DETAILED BASIS FOR OPERATIONAL CONTROL OF DUMPING OF WASTE

C.1. General Requirements Governing Operational Control of Dumping of Waste

C.1.1. Pending the formulation of appropriate recommendations by the IAEA, the Recommendations set out in this Document shall not be taken as applicable to the dumping of liquid or unpackaged radioactive waste into the deep sea or the dumping of any radioactive waste into surface and shallow waters.

C.1.2. In order to make an assessment of safe levels for the Definition, a model was developed based on an assumed dumping rate of 100 000 tonnes/yr at any site. This assumed rate of dumping should not be interpreted as implying that such a rate will be reached or as encouraging such a rate. The IAEA considers that present rates of dumping will not be unduly increased in the near future. It would be prudent for the appropriate national authorities to authorize dumping at the lowest rate which is reasonably practicable, having regard to the development of applications of nuclear energy.

C.1.3. The dumping operation must be subject to strict control. A number of factors have to be taken into consideration. They concern, in particular, the conditioning and packaging of the waste in order to ensure safe transport and handling, and minimization of the risk of accidental recovery of containers after disposal. This is covered by operational measures dealing with the choice of a suitable dumping site, the design and construction of waste containers, the choice of an appropriate ship able to dispose of the waste at the given dumping site, provisions for radiation protection of the crew, and an adequate supervision of the dumping operations by competent escorting officers. All these operational requirements shall, therefore, be included in the special permits issued by the appropriate national authorities in accordance with the Convention.

C.2. Requirements for Selection of a Dumping Site

C.2.1. In addition to the factors specified in Annex III to the Convention, the following requirements shall be met by the appropriate national authorities in the selection of a site for the dumping of packaged waste:

- (1) The chance of recovering the waste by processes such as trawling shall be minimized;
- (2) The area shall have a depth of at least 2000 metres and be well clear of the continental shelf;
- (3) The area must be free from known undersea cables currently in use;
- (4) Areas where it is known that sea-bed resources will be developed shall be avoided;
- (5) The number of dumping sites shall be strictly limited; and
- (6) The area must be suitable for the convenient conduct of the dumping operation and so far as possible shall be chosen to avoid the risk of collision with other traffic during manoeuvring and undue navigational difficulties. The area chosen should preferably be one covered by electronic navigational aids.

C.2.2. The dumping site shall be defined by precise co-ordinates. In order to ensure a reasonable operational flexibility, it should have an area of about  $10^4$  square kilometres.

C. 3. Special Requirements for Packages for Dumping

C. 3. 1. General

C. 3. 1. 1. In addition to the provisions of Article IV of the Convention, the following requirements for conditioning, handling, transport and immersion shall be met:

C. 3. 2. Conditioning of Waste.

C. 3. 2. 1. Waste in the package shall be either solid, solidified or absorbed in a solid substrate.

C. 3. 2. 2. Waste in liquid form shall be excluded; small quantities of liquids such as tritiated water may, however, be absorbed on a material of good absorption capacity. Containers of such absorbed liquids shall be mounted within a second enclosure of an appropriate design.

C. 3. 3. Handling and Transport

C. 3. 3. 1. The relevant provisions of the IAEA Transport Regulations [3] shall be complied with, together with any applicable national and international transport regulations for dangerous goods. In particular, the packages shall be designed to ensure adequate containment of the waste during handling and transport until the end of the dumping operations.

C. 3. 4. Immersion

C. 3. 4. 1. The packages shall be designed to ensure that the contents are retained within them during descent to the sea-bed. To achieve this, the following requirements shall be met:

- (1) The package shall have an overall specific gravity of not less than 1.2 to ensure sinking to the sea-bed to a depth greater than 2000 metres;
- (2) The design shall be such that any inner container will remain on the sea-bed;
- (3) The container shall be made sufficiently strong or pliable to remain intact and retain its contents under the pressure encountered during descent to the sea-bed, or be equipped with a pressure equalization system which relieves the stress on the container; and
- (4) Buoyant material shall be excluded unless it is treated or packaged so as either to preclude the return of such material to surface waters or to ensure that, on its return, it will not constitute a radiation hazard nor interfere materially with fishing, navigation or other legitimate uses of the sea.

C. 4. Approval of the Ship and its Equipment

C. 4. 1. Certain special requirements are necessary for ships engaged in the dumping of packaged radioactive wastes. These requirements are set out below:

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[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Series No. 6, "Regulations for the Safe Transport of Radioactive Materials - 1973 Revised Edition", Vienna, 1973, STI/PUB/323; and INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Series No. 37, "Advisory Material for the Application of the IAEA Transport Regulations", Vienna, 1973, STI/PUB/324.



- (1) The ship shall be capable of safely carrying the approved [4] consignment to the designated dumping site;
- (2) The ship shall be provided with the appropriate navigational and communication equipment;
- (3) An adequate supply of dunnage and equipment shall be provided to ensure that the containers can be suitably stowed;
- (4) The ship shall be provided with suitable handling gear;
- (5) Provision for hosing and pumping out the holds and bilges shall be available; and
- (6) The ship shall be available for inspection by the appropriate national authorities before an approved dumping operation is carried out and thereafter as necessary.

C. 5. Escorting Officers

C. 5.1. General

C. 5.1.1. The dumping operations shall be supervised by approved escorting officers, whose duties and responsibilities, powers and qualifications are separately specified in sections C. 5.2.1, C. 5.3.1 and C. 5.4.1 below.

C. 5.2. Duties and Responsibilities

C. 5.2.1. The escorting officer shall have the following duties and responsibilities:

- (1) He must ensure that he is provided with a certified copy of the special permit with respect to each dumping operation. He must ensure that he is provided in advance with sufficient information about all containers and their contents to enable him to act appropriately in an emergency;
- (2) Before loading, he must be satisfied that all containers are:
  - (a) Of an approved type and on visual inspection appear sound and not to be leaking;
  - (b) Correctly identified and marked with the gross weight to show a specific gravity not less than 1.2; and
  - (c) Within the radiation and contamination limits laid down by the appropriate national authorities;
- (3) The escorting officer shall provide the master of the ship with a loading sheet showing weights and volumes to be dumped;
- (4) In conjunction with the master, the escorting officer shall ensure that the cargo is safely stowed. The consignment must be stowed and segregated to ensure that the levels of radiation measured at living quarters and regularly occupied working spaces do not expose the crew to doses exceeding those specified by the appropriate national authorities;

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[4] Throughout sections C. 4, C. 5 and C. 6 the term 'approved' means approved by the appropriate national authorities within the meaning of the Convention.

- (5) He is responsible for the radiological safety of all personnel engaged in the operation. For this purpose, he shall carry an adequate supply of individual dosimeters, protective clothing, monitoring and decontaminating equipment. He shall monitor the crew and provide protective clothing whenever necessary;
- (6) The daily rate of dumping and the working hours must be agreed upon between the escorting officer and the master. Before dumping commences, the escorting officer must obtain from the master an assurance that the ship is at the approved dumping site and make arrangements for hourly fixes of the ship's position during dumping. He must also witness the dumping of all containers to satisfy himself that the drums and their contents sink;
- (7) He must monitor for radioactive contamination occurring on the ship and arrange for decontamination of the affected areas as necessary. Subject to his ultimate responsibility for the safety of the ship, the master must comply with any directions given by the escorting officer in this connection; and
- (8) When the dumping operation is completed and after completion of any necessary decontamination, the escorting officer must provide the master with a Clearance Certificate of an approved type. He must also prepare, for the appropriate national authorities, a Certificate of Disposal confirming that the recorded cargo has been dumped at the designated site, with details of how the ship's position was fixed. This shall be accompanied by a certified copy of the ship's log for the duration of the voyage, including details of hourly fixes of the ship's position during the dumping period.

#### C. 5.3. Powers

C. 5.3.1. Without prejudice to the master's overall responsibility for the safety and control of the ship and the crew:

- (1) The escorting officer must be empowered to refuse the loading or dumping of any container which, in his opinion, does not conform with the standards of packaging or have the documentation required by the special permit;
- (2) He must be empowered to stop the dumping operation at any time if, in his judgement, the requirements for the operation cannot be met or the safety of the operation cannot be guaranteed;
- (3) He must be empowered to prescribe, through the ship's officers or port officials, any protective measures which in his opinion are necessary for the radiological safety of the personnel engaged in the operation; and
- (4) Subject to the requirements of the appropriate national authorities, he must be empowered to require that the ship or any part of it may not be used for other cargoes except in accordance with the terms of a Contamination Clearance Certificate.

#### C. 5.4. Qualifications

C. 5.4.1. To fulfil these responsibilities and to exercise these powers, the escorting officer:

- (1) Must be adequately trained in the basic principles of radiation protection and must know how to use monitoring equipment and interpret the readings;
- (2) Must be fully conversant with the design and construction of all approved types of container and, if possible, should have practical experience of the problems involved in handling them;
- (3) Should have supervisory and organizing experience.

C. 6. Record Keeping

C. 6. 1. Approved records of the nature and quantities of all matters permitted to be dumped, and the location, time and method of dumping shall be kept and reported to the Organization to be designated under the Convention and to other parties as appropriate, in accordance with Article VI, 1(c) and 4 of the Convention.

C. 7. International Co-operation and Observation

C. 7. 1. Dumping should preferably be carried out within the framework of regional co-operation agreements as provided for by Article VIII of the Convention.

C. 7. 2. International co-operation in the selection of dumping sites should be encouraged.

C. 7. 3. In order to further the objectives and provisions of the Convention, the IAEA is of the opinion that the parties to the Convention, the Organization to be designated thereunder and the appropriate national authorities should provide for international observation of loading and disposal at sea of radioactive waste or other radioactive matter to satisfy themselves that these operations are carried out in accordance with the Convention and with the Definition and Recommendations set out in this Document.



## ANNEX

## I. INTRODUCTION

1.1. The Convention of 1972

1.1.1. The Convention, drawn up at the Inter-Governmental Conference on the Dumping of Wastes at Sea, held in London from 30 October to 10 November 1972, was opened for signature by any State at London, Mexico City, Moscow and Washington from 29 December 1972 until 31 December 1973 and thereafter for accession by any State. It provides for control of "any deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea" and any deliberate disposal of such vessels, aircraft, etc. themselves. The prevention of marine pollution emanating from the normal operations of vessels, aircraft, etc. or directly arising from the exploration and exploitation of sea-bed mineral resources is excluded from the scope of the Convention (Article III.1).

1.1.2. With respect to radioactive materials, the Convention entrusts the IAEA with specific responsibilities in the following provisions pursuant to Article IV:

(1) In Annex I on materials prohibited from dumping, item 6 states:

"High-level radio-active wastes or other high-level radio-active matter, defined on public health, biological or other grounds, by the competent international body in this field, at present the International Atomic Energy Agency, as unsuitable for dumping at sea".

(2) In Annex II on materials requiring special care in dumping procedures, item D states:

"Radio-active wastes or other radio-active matter not included in Annex I. In the issue of permits for the dumping of this matter, the Contracting Parties should take full account of the recommendations of the competent international body in this field, at present the International Atomic Energy Agency".

1.1.3. Article IV.1 of the Convention makes a distinction between materials that may be dumped after the issue of a general permit and those that may be dumped only after the issue of a special permit. Annex II puts "radio-active wastes or other radio-active matter" into the class requiring special permits, without, however, defining such radioactive wastes or matter.

1.1.4. Article IV.3 of the Convention provides that no provision thereof is to be interpreted as preventing a party from prohibiting, insofar as that party is concerned, the dumping of wastes or other matter not listed in Annex I. Further, the content of the Annexes to the Convention will be kept under review by consultative meetings of the parties, which will be convened not less frequently than once every two years, or by special meetings which may be convened at any time on the request of two-thirds of the parties, pursuant to Article XIV.3(a), 4(a) and 4(b) of the Convention. Amendments to the Annexes, which will be based on scientific and technical considerations, are subject to a simplified procedure as compared with amendments to the basic provisions of the Convention (Article XV.2).

1.1.5. Further, Article IV.2 of the Convention provides that all the factors specified in Annex III thereto should be given careful consideration prior to the issue of any permit, including prior studies of the characteristics of the dumping sites as set forth in Sections B and C of that Annex.

1.2. Purpose of this Annex

1.2.1. This Annex provides background material pertinent to the specific responsibilities entrusted to the IAEA under the Convention, namely to define "high-level radio-active wastes or other high-level radio-active matter . . . . unsuitable for dumping at sea" and to ensure that any dumping of radioactive matter into the sea involves no unacceptable degree of hazard to man and his environment. It provides information on the way the IAEA arrived at the Definition and outlines the thinking behind the Recommendations which are set out rather formally and without elaboration in the Definition and Recommendations.

II. BACKGROUND INFORMATION

2.1. Radiation Protection Principles to be applied to Waste Management

2.1.1. The rapid development and increasing use of nuclear energy for peaceful purposes and the expanding application of radioisotopes in various fields of science, medicine and technology are unavoidably associated with the production of growing amounts of radioactive wastes. The basic principle to be applied in the management of radioactive wastes is to protect man and other sensitive elements of the biosphere from undue exposure to ionizing radiation emanating from these wastes.

2.1.2. In selecting an appropriate waste management system it should be verified that natural resources are protected and that any reduction of amenities is acceptably low. Man is dependent upon the land and the sea, and both must be protected.

2.1.3. A balance has to be achieved between the need to find suitable storage or disposal methods, the radiation protection of workers and members of the public, and the overall cost involved. The justification for dumping radioactive wastes must be viewed in this light.

2.1.4. The most recent applicable ICRP recommendations should be used as a guide in this area.

2.2. Sources of Radioactivity in the Sea

2.2.1. Radioactive wastes may enter the sea through one of the following major routes, by:

- (1) Direct dumping of the wastes into the seas and oceans;
- (2) Discharge to river systems;
- (3) Discharge to tidal estuaries;
- (4) Discharge to coastal waters;
- (5) Discharge from nuclear-powered ships; and
- (6) Deposition from the atmosphere.

2.2.2. Some solid wastes have been dumped in packaged form in the depths of the sea. This form of disposal has so far been limited to materials with low radioactive content.

2.2.3. Unlike many of the stresses presently confronting man, radiation and radioactivity have always been a part of man's environment. Studies by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) show that the present doses to humans of naturally occurring radiation lie generally in the range of 100 mrem/yr to 300 mrem/yr with doses in a few areas exceeding 1000 mrem/yr. The main contributions

to this exposure are radioactive materials in the earth's crust, cosmic radiation, and natural radioactivity in the human body (mainly  $^{40}\text{K}$ ).

2.2.4. The marine environment contains a wide range of natural radionuclides, mainly  $^{40}\text{K}$ ,  $^{87}\text{Rb}$ , members of the uranium and thorium series, and  $^{14}\text{C}$  and  $^3\text{H}$ . The total activity in all of the sea (mainly  $^{40}\text{K}$ ) amounts to rather more than 300 Ci/km<sup>3</sup> or nearly 500 000 MCi in total. Radium alone accounts for more than 1000 MCi. The doses to marine organisms are usually of the order of 10 mrad/yr to 100 mrad/yr.

2.2.5. Though the total naturally occurring radioactive content of the sea is very large, this does not provide a sure basis for determining what quantities of radioactivity may be added in local areas without leading to unacceptable additional exposures to man or the marine environment. Though such additions may be relatively small in quantity, the hazards associated with localized releases of wastes must be assessed and considerable care exercised, as contemplated by the Convention, in disposing of any radioactive wastes into the marine environment.

2.2.6. Man has been dealing with radioactive materials in artificially concentrated or artificially produced forms for nearly three-quarters of a century and has been generating electrical power from nuclear fission for over a decade. Man has also released radioactive material as the result of several series of nuclear explosions.

2.2.7. These operations have all resulted in some radionuclides being released into the environment, including the sea. Apart from short-lived materials close to the scene of nuclear explosions, the quantities released to the sea so far amount to some hundreds of megacuries from explosions and a few megacuries from nuclear operations. To date, civilian nuclear power programmes have accounted for only a small fraction of these latter releases. These quantities amount to less than one thousandth ( $10^{-3}$ ) of the natural activity in the sea. This fraction gives an indication of the relative magnitudes, but no such simple comparison of activities can indicate the relative biological importance of the different materials. Radionuclides have very widely ranging toxicities, and their significance in a given environment depends not only on this fact but also on their distribution and on the uses made of that environment.

### 2.3. Basis of the Definition (High-Level Radioactive Wastes or Other High-Level Radioactive Matter Unsuitable for Dumping at Sea)

2.3.1. The Definition identifies material the radioactive content of which is at such a level that the parties to the Convention would wish to prevent any participating State from issuing a special permit even after a detailed appraisal of the safety of the proposed operation, and even for the sector of the marine environment having the largest capacity, i. e. the deep sea with depth greater than 2000 metres. The Definition also covers those wastes which have been generally recognized by the appropriate national authorities as being unsuitable for dumping, for example the "first cycle wastes" from nuclear fuel reprocessing, irradiated fuel and irradiated fuel cladding. The Definition must not be so permissive that regular and repeated operations somewhat below the defined levels would endanger man or his environment, even though each individual operation had been conducted with appropriate care. The Definition has, therefore, been based on the concept of the limiting capacity of the deep sea with depth greater than 2000 metres, which capacity is based on the annual input of radioactivity which will result in individual dose commitments via the critical pathways equal to the dose limits for individual members of the public recommended by the International Commission of Radiological Protection (ICRP). The numbers predicted by the model have been reduced to allow for uncertainties, for multiple releases and for other sources of exposure, and to take account of population dose commitment.

2.3.2. The limiting capacity of the environment in relation to dumping into the North East Atlantic has recently been reassessed by the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development, based on the results of a United Kingdom evaluation (NRPB-R 14) [1]. The findings of these assessments have been used as a starting point in arriving at the Definition.

2.3.3. For material released from containers on the bed of the North East Atlantic the activity dumped annually that would cause doses in the exposed critical group to approach ICRP dose limits is of the order of:

- (a)  $10^{10}$  Ci/yr for  $\alpha$ -active waste (based on  $^{239}\text{Pu}$ );
- (b)  $10^6$  Ci/yr for  $\alpha$ -active waste (based on  $^{226}\text{Ra}$ );
- (c)  $10^{11}$  Ci/yr for  $\beta/\gamma$ -active waste (excluding tritium);
- (d)  $10^{12}$  Ci/yr for aged mixed fission products (not exceeding 15%  $^{90}\text{Sr}$  plus  $^{137}\text{Cs}$ );
- (e)  $10^{15}$  Ci/yr for tritium.

These figures assume no other substantial releases in the North Atlantic. They contain a safety factor, up to about  $10^4$ , because of the conservative nature of the assessment.

2.3.4. The grouping of waste categories in paragraph 2.3.3 is taken from the United Kingdom evaluation referred to in paragraph 2.3.2 above and can be simplified. In particular it is not essential, for the purposes of the Document, to regard aged mixed fission products and all other  $\beta/\gamma$  wastes as separate categories. There is merit, however, in treating  $^{90}\text{Sr}$  and  $^{137}\text{Cs}$  as being within a separate category because the calculated limiting capacities of the deep sea for these two nuclides differ only by a factor of three and are about two orders of magnitude less than the limiting capacities for the other radionuclides likely to be present to a significant extent in wastes. The limiting capacity for  $^{137}\text{Cs}$  as an individual radionuclide is calculated to be  $10^{11}$  Ci/yr. The corresponding figure for  $^{90}\text{Sr}$  is higher and it is therefore safe to set the limiting capacity for both these nuclides together as  $10^{11}$  Ci/yr. For all other  $\beta$  or  $\beta/\gamma$  emitting radionuclides which may be present in significant quantities in waste, the limiting environmental capacity is at least  $10^{13}$  Ci/yr. As a starting point for the derivation of the levels of the Definition, the list of waste categories and limiting environmental capacities in paragraph 2.3.3 may therefore be modified as follows:

- (a)  $10^{10}$  Ci/yr for  $\alpha$ -active waste (based on  $^{239}\text{Pu}$ );
- (b)  $10^6$  Ci/yr for  $\alpha$ -active waste (based on  $^{226}\text{Ra}$ );
- (c)  $10^{11}$  Ci/yr for  $^{90}\text{Sr}$  plus  $^{137}\text{Cs}$  wastes;
- (d)  $10^{13}$  Ci/yr for  $\beta/\gamma$  wastes (excluding tritium);
- (e)  $10^{15}$  Ci/yr for tritium wastes.

[1] WEBB, G. A. M. and MORLEY, F., "A Model for the Evaluation of the Deep Ocean Disposal of Radioactive Waste", National Radiological Protection Board Report NRPB-R 14, Harwell, UK (June 1973).



There are some individual short-lived  $\alpha$ -emitting radionuclides for which the calculated limiting capacity is very much greater than the number given in item (a) above and, for the purpose of the Definition, it is sufficient to restrict consideration to  $\alpha$ -emitting radionuclides with half-lives greater than 50 years.

2.3.5. The definition of prohibited waste should be set lower than these limits so that it can be applied to individual operations without the need for considering the addition of the effects from several operations. One hundredth of the calculated limits is regarded as adequate to take account of multiple dumping in any one area. These numbers relate to disposals in the North East Atlantic; other areas will have somewhat different characteristics, some of which may be more favourable, but, on the other hand, some may be less favourable. For this reason the numbers have been reduced by a further factor of 100 to give:

- (a)  $10^6$  Ci/yr for  $\alpha$ -active waste of half-life exceeding 50 years (based on  $^{239}\text{Pu}$ );
- (b)  $10^2$  Ci/yr for  $\alpha$ -active waste of half-life exceeding 50 years (based on  $^{226}\text{Ra}$ );
- (c)  $10^7$  Ci/yr for  $^{90}\text{Sr}$  plus  $^{137}\text{Cs}$  wastes;
- (d)  $10^9$  Ci/yr for  $\beta/\gamma$ -active wastes (excluding  $^{90}\text{Sr}$ ,  $^{137}\text{Cs}$  and tritium);
- (e)  $10^{11}$  Ci/yr for tritium.

2.3.6. In practice, it is expected that areas selected for dumping will be specially chosen as having favourable characteristics. This fact, together with the deliberate introduction of a safety factor of  $10^4$  over and above the estimated safety factor of the original assessment, making a total safety factor that may be as high as  $10^8$ , ensures that man and his environment will be protected if wastes of higher total activity than this are prohibited from dumping, and if other wastes are disposed of at sea only in accordance with special permits issued by the appropriate national authorities after proper assessment of the possible environmental impact. If the above annual disposal limits per dumping site are not exceeded, there will be no large-scale effects on biological organisms. Any adverse effects would only be evident in a few individual organisms in the vicinity of the dumping site.

2.3.7. To meet the objectives of the Convention it is necessary to express the Definition in terms of activity per unit mass (in tonnes). It is considered that over the next decade or so the total mass dumped at any one site will not exceed 100 000 tonnes per year. Using this assumed maximum dumping rate the limiting concentrations derived from the above annual figures are:

- (a) 10 Ci/t for  $\alpha$ -active waste of half-life greater than 50 years (excluding  $^{226}\text{Ra}$ );
- (b)  $10^{-3}$  Ci/t for  $^{226}\text{Ra}$ ;
- (c)  $10^2$  Ci/t for  $^{90}\text{Sr}$  plus  $^{137}\text{Cs}$ ;
- (d)  $10^4$  Ci/t for  $\beta/\gamma$  wastes (excluding  $^{90}\text{Sr}$ ,  $^{137}\text{Cs}$  and tritium);
- (e)  $10^6$  Ci/t for tritium.

2.3.8. As a result of the successive application of safety factors and the use of a mass dumping rate never likely to be approached with  $^{226}\text{Ra}$  wastes, the concentration for  $^{226}\text{Ra}$  expressed in Ci/t has come out at about one tenth of the value for solid natural radioactive substances specified in the IAEA's Safety Series No. 9 [2] for exemption from the requirements for notification, registration or licensing by national competent authorities. In the absence of information that could provide a basis for estimation of possible future requirements for the dumping of  $^{226}\text{Ra}$ , the limit in curies of an annual dumping rate at any one site has been proposed.

2.3.9. In the interest of further simplification, and having regard to possible applications for special permits to dump wastes contaminated by aged mixed fission products which will contain  $^{90}\text{Sr}$  and  $^{137}\text{Cs}$ , the following list is considered to be a sufficient system of limits:

- (a)  $10\text{ Ci/t}$  for  $\alpha$ -active waste of half-life greater than 50 years. (In the case of  $^{226}\text{Ra}$ , not more than  $100\text{ Ci/yr}$  may be dumped at any one site);
- (b)  $10^3\text{ Ci/t}$  for  $\beta/\gamma$  waste (excluding tritium) but the limit for  $^{90}\text{Sr}$  plus  $^{137}\text{Cs}$  is  $10^2\text{ Ci/t}$ ;
- (c)  $10^6\text{ Ci/t}$  for tritium.

2.3.10. The use of these concentration limits would cause the annual limits stated above to be approached only if the rate of dumping at any one site approached 100 000 tonnes per year and if all this material had an activity concentration close to the concentration limits. The annual dumping rate at each site will be reviewed by the organization to be designated under the Convention and by the IAEA. The appropriateness of the Definition in the light of actual dumping rates will be kept under review by the IAEA.

2.3.11. For operational purposes it is necessary to average the limiting values over a substantial mass of waste. It is recommended that the limiting concentration in the Definition be taken to be the average over a mass not exceeding 100 tonnes. Expressing the Definition as an activity concentration averaged over a small fraction of the assumed annual dumping rate should result in keeping the total activity dumped annually below the derived annual limits.

2.3.12. The Definition must not be taken to imply that material in which the concentration of radioactivity is below that specified in the Definition is thereby deemed to be suitable for dumping. No radioactive material may be dumped except in accordance with the provisions of the Convention, in particular Annexes II and III thereto, and with the Recommendations set out in this Document.

2.3.13. It should be noted that no material is totally devoid of radioactivity. However, it is clearly not the intention of the Convention that every material should be treated as a potential radioactive pollutant and the competent authorities of parties to the Convention will wish to define some "de minimis" level of specific activity below which a material will not be regarded as "radioactive" for the purposes of the Convention. No such numbers are suggested at this time and some flexibility of interpretation is therefore left to the appropriate national authorities. Although not derived for the purpose of dumping, some guidance may be found in the levels set forth for exemption of radioactive materials from regulatory control in various international and national standards and regulations; such levels are generally within an order of magnitude of  $10^{-3}\text{ Ci/t}$ .

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[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Series No. 9, "Basic Safety Standards for Radiation Protection - 1967 Edition", Vienna 1967, STI/PUB/147.

#### 2.4. Environmental Evaluation of Specific Dumping Applications

2.4.1. The appropriate national authorities may grant a special permit for dumping of radioactive waste only after a detailed environmental and ecological assessment gives a reasonable assurance that such dumping can be accomplished in accordance with the objectives and provisions of the Convention.

2.4.2. At the levels of radioactive materials which may be dumped under the terms of the Definition, the present state of knowledge, cautiously interpreted, should provide a satisfactory basis for environmental assessments. There is a substantial body of relevant scientific literature, including publications of the IAEA (e.g. the Safety Series, the Technical Reports Series, and the Symposium Proceedings), ICRP and UNSCEAR. In carrying out these environmental assessments it should not be necessary for the appropriate national authorities to require that detailed field and experimental studies be undertaken in every case.

#### 2.5. Monitoring and Assessment

2.5.1. Article VI, 1(c) and (d) of the Convention requires that the appropriate national authorities:

- (1) Keep records of the nature and quantities of all matter permitted to be dumped and the location, time and method of dumping; and
- (2) Monitor individually, or in collaboration with other parties and competent international organizations, the condition of the seas for the purposes of the Convention.

2.5.2. As detailed in the relevant guidance provided by the IAEA publications (particularly IAEA Safety Series No. 5) [3] and ICRP Publication 7 [4], the general objectives of environmental monitoring programmes are as follows:

- (1) The assessment of actual or potential exposure of man and other sensitive elements of the biosphere, or estimation of upper limits of such exposure; these assessments or estimations may be needed in relation to regulatory functions;
- (2) Scientific investigations;
- (3) Improved public understanding.

In the context of dumping carried out in accordance with the Convention and the Recommendations set out in the Document, it is unlikely that exposure assessment objectives could be entirely fulfilled by direct environmental monitoring. The use of other less direct methods could provide more precise estimates.

#### 2.6. Environmental Evaluation of Total Dumping

2.6.1. In addition to evaluating individual applications for permits for dumping, the appropriate national authorities should make periodic reviews of the total dumping which

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Series No. 5, "Radioactive Waste Disposal into the Sea", Vienna, 1961, STI/PUB/14.

[4] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, "Principles of Environmental Monitoring related to the Handling of Radioactive Materials", A Report by Committee 4, ICRP Publication 7, 1965.

has been carried out under permits issued by them. They should also consider the dumping which has been carried out by other States. Further they should consider prospective dumping which may reasonably be expected. It is desirable that a comparable international review also be carried out. Such reviews, after considering the past and prospective quantities dumped, their locations, the significant operating experience as reported by escorting officers, and the findings of pertinent oceanographic and ecological research, could lead the IAEA to update these recommendations.

2.6.2. In addition to these reviews the parties to the Convention are required by Article VI,4 to report in detail to the Organization to be designated under the Convention the special permits issued and the nature and quantities of all matter permitted to be dumped, together with the location, time and method of dumping. National records are expected to contain all the information necessary for such reporting as well as for the establishment of an international register. The environmental assessment is considered a necessary part of this information.

## 2.7. General Principles Governing Operational Control of Dumping of Waste

2.7.1. Provisions to be considered in establishing criteria for the issue of permits for dumping are set out in Annex III to the Convention. The general principles for control of dumping of radioactive waste are provided for in the IAEA's Safety Series No. 5 [3]. At present, dumping almost always takes place in the deep sea in packages with the waste either solid, solidified or absorbed in a solid substrate. The dumping of radioactive waste into surface and shallow waters from vessels, aircraft, platforms, etc. may also be envisaged under the Convention; this could involve higher exposure to man than dumping into the deep sea. However, such dumping is expected to be rare in practice and, pending the development of data concerning the nature, extent, and potential effects of such operations, the IAEA has not yet formulated any specific recommendations for the operational conduct of such disposal. In the opinion of the IAEA, solid or packaged radioactive wastes should not be dumped into shallow waters because of the risk of accidental recovery of the material. The Recommendations are, therefore, limited to deep sea dumping. Dumping, including that of unpackaged or liquid waste into surface and shallow waters, must be considered on a case-by-case basis and authorized only after an appropriate environmental evaluation and in accordance with the provisions of the Convention.

2.7.2. In addition to the movement of the radioactivity through ecosystems, other factors have to be taken into consideration in assessing the acceptability of a proposed dumping operation. They concern, in particular, the conditioning of the waste in order to ensure safe transport and handling, and the risk of an accidental recovery of containers after dumping. This is covered by operational measures dealing with the design and construction of waste containers, the choice of a suitable dumping site, the choice of an appropriate ship able to dispose of the waste in the given dumping site, provisions for radiation protection of the crew, and an adequate supervision of the dumping operations by competent escorting officers. All these operational measures should, therefore, be included in the special permits issued by the appropriate national authorities in accordance with the Convention.

## 2.8. Factors Affecting Choice of a Dumping Site

2.8.1. In the selection of marine areas to be utilized as dumping sites for packaged wastes, consideration must be given primarily to the factors affecting the safety of man and his environment, and secondarily to economic considerations.

2.8.2. In general, the first step in an evaluation will involve the selection from a number of possible sites of those apparently most suited for safe disposal of packaged wastes. Among the factors which must be considered in such a site selection are:

- (1) The probability of accidental recovery of packaged or solid waste by man. A site would not be suitable for packaged or solid waste disposal unless it were highly improbable that accidental recovery would occur; the selection of shallow waters for dumping is therefore considered to be unacceptable;
- (2) The possible utilization of the sea-bed site by man directly in the harvest of marine products, or indirectly in the use made of the area by organisms which are harvested by man for food in adjacent areas;
- (3) The nature of bottom sediments with respect to the uptake of the activity from the water and impact damage to packages;
- (4) Transport by deep-sea currents from the dumping site, with particular concern for the shoreward-directed flow;
- (5) Rate of turbulent diffusion in the waters over the dumping site;
- (6) Rate of exchange of waters of the particular marine sub-division containing the dumping site with other sub-divisions of the marine environment.

2.8.3. It is evident that dumping sites must be selected in areas not used for bottom trawling or other types of bottom fishing, and which are unsuited for future utilization. This requirement is best satisfied by selection of sites in water having depths of 2000 metres or more. Areas crossed by submarine cables in current use are likewise undesirable. Dumping sites located in the deep sea should be in areas where there is a low rate of exchange of the deep waters with the surface layers and with the waters of any adjacent continental shelf. Thus, submarine canyons located on the edge of the continental shelf are generally less suited for dumping sites than the deep waters in the true ocean basins, since the deep waters of the canyons more readily exchange with the waters of the continental shelf.

2.8.4. The importance of the sea and sea-bed for resource development in the future can hardly be seen in accurate perspective today. They are likely however to be used on an increasing scale to obtain the mineral and food resources needed by mankind. Before selecting a dumping site, studies should therefore be carried out to assess possible future resource development in the area concerned. The conduct of such studies could well be co-ordinated by an appropriate international organization. It would also seem desirable to agree internationally to approved dumping sites. Concern about the future exploitation of the sea would also make it prudent to keep the total number of dumping sites as limited as practicable.

## 2.9. Special Requirements for Packages for Dumping

### 2.9.1. General

2.9.1.1. It is essential that packages of radioactive matter permitted to be dumped under the provisions of the Convention meet certain minimal requirements to ensure that the packages may be handled and transported safely and that upon immersion the waste materials reach the sea-bed without being released.

2.9.1.2. When dealing with radioactive waste of the levels that may be permitted to be dumped, the protection of man and the marine environment does not depend upon the long-term integrity of the packaging. However, packages so designed that their contents are retained during descent to the sea-bed will generally remain intact for a period of time after they have reached the bottom. The packages will, however, eventually release some or all of their radioactive contents. When considering whether to issue a special permit for a specific site, the appropriate national authorities should ensure that the concentration of radioactivity in the vicinity of the package does not present any unacceptable risk to man or the marine ecosystem.

2.9.1.3. To meet essential packaging requirements, the considerations set forth in paragraphs 2.9.2 to 2.9.8.2 below apply.

2.9.2. Conditioning

2.9.2.1. The radioactive waste within the packages should be in a form which, even in the case of containers which may be damaged or corroded, will as far as possible prevent a release and subsequent spreading of the radioactive material; this is particularly important to ensure safe handling and transport. Therefore, it is essential that the radioactive waste permitted to be dumped be in a form either solid, solidified or absorbed on a solid. The waste may be incorporated into a solid packaged matrix such as cement, concrete or bitumen, forming a single block (monolithic design of the package) or packaged separately and assembled in a concrete vessel or a metal drum (multistage design of the overall package). Liquid wastes should, at least at present, be excluded. However, small quantities of liquids such as tritiated water may be absorbed on a material of good absorption capacity and then dumped as packages containing solid substrate.

2.9.3. Transport

2.9.3.1. The transport of radioactive waste should be in accordance with the IAEA Transport Regulations [5] and any other applicable international and national transport regulations, in particular when the radioactive waste has other hazardous characteristics such as explosiveness, inflammability, pyrophoricity, chemical toxicity and corrosiveness. The IAEA Transport Regulations include provisions for special arrangements when the package design or shipment conditions do not comply in all respects with the standard requirements. This system of special arrangements is the one most likely to be used for dealing with the transport of waste for dumping.

2.9.4. Packaging Materials

2.9.4.1. It can be expected that packages containing radioactive waste will be made of dense material, and that they will be made strong enough for safe handling. For the purpose of dumping, it may be desirable to have the additional quality of some resistance to attack by sea-water.

2.9.4.2. Steel drums are frequently used for forming concrete containers, and both the concrete and the steel can be regarded as protective. It is desirable that concrete used in packaging be of good quality and of low porosity if it is intended to resist breakage on impact with the sea-bed and to withstand the destructive action of sea-water. It should not be regarded merely as weighting material. When concrete alone is used, the thickness of the concrete between the waste and the outer surface should be sufficient to prevent rupture of the package on impact if this is required. Other suitable material can be used to provide the needed weight.

2.9.4.3. Baled radioactive waste which is not provided with a containment system should not be dumped.

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[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Series No. 6, "Regulations for the Safe Transport of Radioactive Materials - 1973 Revised Edition", Vienna, 1973, STI/PUB/323; and INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Series No. 37, "Advisory Material for the Application of the IAEA Transport Regulations", Vienna, 1973, STI/PUB/324.

#### 2.9.5. Specific Gravity

2.9.5.1. All packaged wastes disposed of into the sea must be sufficiently dense to sink immediately. This condition should not be difficult to meet since the specific gravity of sea-water at sea level does not exceed about 1.03. However, precautions must be taken to see that the contents of a broken package will not rise to the surface. It is expected that light materials, such as cloth and paper, would be incorporated into concrete within the outer protective containment system, and the overall specific gravity of all packages disposed of in deep waters would not be less than 1.2. Packages and their contents should be sufficiently dense to ensure that they are not readily moved along the sea-bed by currents. Should inner containers be incorporated into the principal container, the design must be such that they will remain on the sea-bed.

#### 2.9.6. Voids

2.9.6.1. If a package containing voids or compressible materials is dumped in deep water, it will collapse due to the hydrostatic pressure unless there is provision for equalizing the pressure between interior and exterior, or the container is made sufficiently strong or pliable to retain its contents under the pressure encountered during descent to the sea-bed.

#### 2.9.7. Strength against Impact

2.9.7.1. Packaged wastes will suffer impact at the surface of the sea, and again when they hit the bottom. Designers should take this into account.

#### 2.9.8. Contents

2.9.8.1. Material in the package should comply with the relevant criteria and conditions set forth in the Annexes to the Convention.

2.9.8.2. The package should exclude buoyant material, unless it is treated or packaged so as either to preclude the return of such material to surface waters or to ensure that, on its return, it will not constitute a radiation hazard nor interfere materially with fishing, navigation or other legitimate uses of the sea. Among the materials which might thus be disposed of, polyethylene is one of the few which are permanently buoyant and which thus present a special risk of return to the surface, especially when used in the form of closed bottles. The presence of polyethylene in containers for dumping would be acceptable only in the following cases:

- (a) When thin polyethylene sheeting is used to protect the inside surface of the containers against corrosion;
- (b) When the material is processed, for example by shredding, granulating, or cutting into small fragments; and
- (c) Where it can be guaranteed that the specific gravity of an inner polyethylene container and its contents is not less than 1.2, provided the contents have been solidified by an acceptable method (e.g. with cement).

#### 2.10. International Co-operation and Observation

2.10.1. The IAEA welcomes the undertaking provided for by Article VIII of the Convention with respect to the conclusion of regional agreements for the prevention of pollution, especially by dumping. This seems particularly necessary in considering environmental monitoring and the need for the appropriate national authorities to be aware of the sites used and the quantities disposed of in the dumping carried out by other States, as discussed in paragraph 2.6.1 above.

2.10.2. International co-operation in the selection of dumping sites and international observation of the dumping have been suggested. International observation is considered desirable to establish to the satisfaction of all parties concerned that dumping involving radioactive materials is carried out in accordance with the requirements of the Convention and the Definition and Recommendations of the IAEA.