

Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF)

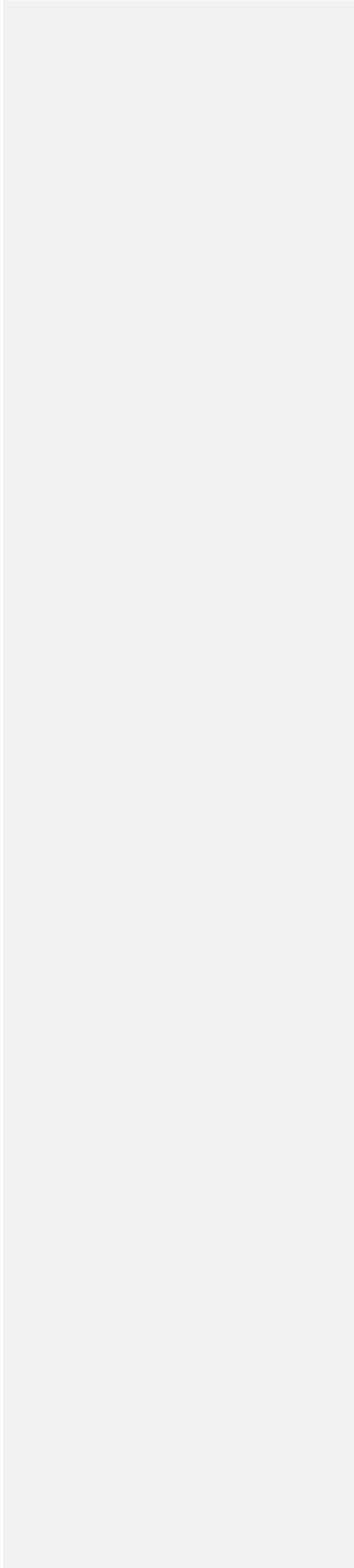
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Abbreviations and acronyms

CAS	Chemical abstract service
OECD	Organisation for Economic Co-operation and Development
OEWG	Open-Ended Working Group
PFC	Perfluorinated compounds
PFOS	Perfluorooctane sulfonic acid
PFOSF	Perfluorooctanesulphonyl fluoride
POPs	Persistent organic pollutants
UNIDO	United Nations Industrial Development Organization
UNEP	United Nations Environment Programme

Units of measurement

I. Introduction

A. Scope

1. The present technical guidelines provide guidance for the environmentally sound management (ESM) of wastes consisting of, containing or contaminated with perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF) pursuant to decisions IV/17, V/26, VI/23, VII/13, VIII/16, IX/16 and X/9 of the Conference of the Parties to the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and Their Disposal; decisions OEWG-I/4, OEWG-II/10, OEWG-III/8, OEWG-IV/11, OEWG-V/12, OEWG-VI/5, OEWG-VII/8 and OEWG-VIII/[...] of the Open-ended Working Group of the Basel Convention; resolution 5 of the Conference of Plenipotentiaries to the Stockholm Convention on Persistent Organic Pollutants (POPs); decisions INC-6/5 and INC-7/6 of the Stockholm Convention Intergovernmental Negotiating Committee for an International Legally Binding Instrument for Implementing International Action on Certain Persistent Organic Pollutants and decisions SC-1/21, SC-2/6, SC-3/7 and SC-4/17 of the Conference of the Parties to the Stockholm Convention.

2. Along with PFOS, its salts and PFOSF these guidelines address PFOS related substances. For the purpose of this document, the term "PFOS related substances" refers to any substance that contains the PFOS carbon chain and moiety (defined as C₈F₁₇SO₂) that can degrade to PFOS in the environment (also known as precursors). PFOS related substances can be polymers in which PFOS is only a fraction of the polymer or final product. Topics addressed in these guidelines include waste management, treatment and disposal.

3. The present document should be used in conjunction with the document entitled "General technical guidelines for environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants" ("the general technical guidelines") (UNEP, 2006d). That document provides more information on the nature and occurrence of wastes consisting of, containing or contaminated with PFOS, its salts and PFOSF for purposes of their identification and management.

Comment [JC1]: We believe PFOS related substances should also be included in the scope of the guidelines as they can degrade to PFOS in the environment. Waste containing PFOS related substances would be captured by the hazardous characteristic H13 "Capable, by any means, after disposal, of yielding another material, e.g., leachate, which possesses any of the characteristics listed above".

B. Description, production, use and wastes

(1) Description

4. PFOS, its salts and PFOSF belong to a group of chemicals called perfluorinated compounds (PFCs). PFOS (CAS no. 1763-23-1) is a fully fluorinated anionic substance. Fluorinated chemicals such as PFOS contain carbons that are completely saturated by fluorine. It is the strength of the C-F bonds that contributes to the extreme stability and unique properties of PFCs.

5. While PFOS can exist in anionic, acid and salt forms, the PFOS anion is the most common form at pH values in the environment and in the human body (Environment Canada, 2006a). The basic structure of the PFOS anion is shown in Figure 1 below and has the molecular formula C₈F₁₇SO₂.

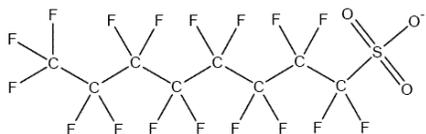


Figure 1: The structural formula of Perfluorooctane Sulfonate (PFOS) shown as its anion structure

Comment [JC2]: Advice required from SIWG members:

Question: Should a separate description for PFOSF and PFOS salts be also included?

Comment [JC3]: Advice required from SIWG members:

Question: Should a table be included to see all PFOS use and waste generated?

6. PFOS is persistent and has bioaccumulation and biomagnifying properties. PFOS substances do not follow the classic pattern of other persistent organic pollutants (POPs) by partitioning into fatty tissues but rather binds to proteins in the blood (Stockholm, 2007), and liver of living organisms (Luebker et al., 2002).

(2) Production

7. There are no known natural sources of PFOS and its presence in the environment is due solely to anthropogenic activity (Key et al. 1997). PFOSF is the starting material for the production of PFOS and PFOS related substances (Stockholm, 2007). PFOS can be produced commercially from PFOSF by electrochemical fluorination. PFOS can also be formed by environmental microbial degradation or by metabolism in larger organisms from PFOS-related substances.

8. The company 3M was the world's largest producer of PFOSF, starting in 1949 (Paul et al. 2009) until the company's phase out of all PFOS-related products in 2003. Although there was PFOS production in Asia (Lim et al., 2011) and in some developed countries between 2003 and 2008, in general there was a significant drop in PFOS use and production after 2002 largely due to strict legislation in developed countries (UNIDO 2009).

9. PFOS, its salts¹ and PFOSF are listed on the Stockholm Convention Annex B and Parties to this Convention shall restrict its production and use except if Parties have notified the Secretariat to produce/or use them according to a specific exemption or acceptable purpose. As these have been claimed by Parties, PFOS is still produced and used in several countries (Stockholm 2012b).

(3) Use

10. PFOS and its related substances exhibit unique properties such as thermal and acid resistance and are both hydro- and lipophobic (water and fat repelling). For this reason, they have been used in a wide range of application in consumer products and industrial processes such as polymers, surfactants, lubricants, pesticides, textiles coating, nonstick coatings, stain repellent, food packaging, firefighting foams and more.

11. In 2000, about 2160 metric tons, corresponding to 48% of total PFOS production, were used for soil, oil and water resistance on apparel and leather, fabric/upholstery and carpets. About 1490 metric tons (33% of the total) were produced for paper protection and About 891 metric tons (18% of the total) were produced for industrial applications such as mining and oil well surfactants, acid mist suppressants for metal plating and electronic etching baths, photolithography, electronic chemicals, photographic film etc (OECD 2002).

12. Information on present use of PFOS, its salts, and PFOSF can be found in the PFOS register at <http://chm.pops.int/Implementation/Exemptions/AcceptablePurposesPFOSandPFOSF/tabid/794/Default.aspx> and <http://chm.pops.int/Implementation/Exemptions/SpecificExemptions/tabid/790/Default.aspx>

(4) Wastes

13. Wastes consisting of, containing or contaminated with PFOS and its related substances, are found in a number of physical forms including:

- (a) Solid obsolete stockpiles of PFOS (used in pesticide), its salts and PFOSF in original packages which are no longer usable because their shelf life has been exceeded or the packaging has deteriorated;
- (b) Contaminated soil, sediment and sludge;
- (c) Contaminated waste water from industrial and municipal process;

¹ For example: potassium perfluorooctane sulfonate (CAS No: 2795-39-3); lithium perfluorooctane sulfonate (CAS No: 29457- 72-5); ammonium perfluorooctane sulfonate (CAS No: 29081-56-9); diethanolammonium perfluorooctane sulfonate (CAS No: 70225-14-8); tetraethylammonium perfluorooctane sulfonate (CAS No: 56773-42-3); didecyldimethylammonium perfluorooctane sulfonate (CAS No: 251099-16-8)

- (d) Landfill leachate;
 - (e) Contaminated solid waste (food packaging materials, paper, textile, leather, rubber, and carpets);
 - (f) Liquid industrial and household cleaning products;
 - (g) Liquid fluid (aviation hydraulic fluids);
 - (h) Fire suppression equipment; and
14. Waste consisting of, containing or contaminated with PFOS and its related substances may contain variable concentrations of PFOS and its related substances depending on the initial amount used in the products, articles or industrial process and their bioaccumulation and biomagnifying properties.

II. Relevant provisions of the Basel and Stockholm Conventions

A. Basel Convention

15. Article 1 (“Scope of the Convention”) defines the waste types subject to the Basel Convention. Subparagraph 1 (a) of that Article sets forth a two-step process for determining whether a “waste” is a “hazardous waste” subject to the Convention: first, the waste must belong to any category contained in Annex I to the Convention (“Categories of Wastes to be Controlled”), and second, the waste must possess at least one of the characteristics listed in Annex III to the Convention (“List of Hazardous Characteristics”).

16. Annex I lists some of the wastes which may consist of, contain or be contaminated with PFOS, its salts or PFOF. These include:

- Y4 Waste from the production, formulation and use of biocides and phytopharmaceuticals
- Y16 Wastes from production, formulation and use of photographic chemicals and processing materials
- Y17 Wastes from surface treatment of metals and plastics
- Y18 Residues arising from industrial waste disposal operations
- Y45 Organohalogen compounds other than substances referred to in this Annex (e.g. Y39, Y41, Y42, Y43, Y44)

17. Annex I wastes are presumed to exhibit an Annex III hazardous characteristic such as H6.1 “Poisonous (Acute)”, H11 “Toxic (Delayed or Chronic)”, H12 “Ecotoxic” or H13 unless, through “national tests”, they can be shown not to exhibit the characteristics. National tests may be useful for a particular hazard characteristic listed in Annex III until such time as the hazardous characteristic is fully defined. Guidance papers for Annex III hazardous characteristics H11, H12 and H13 “Leachate” were adopted on an interim basis during the sixth and seventh meeting of the Conference of the Parties to the Basel Convention.

18. List A of Annex VIII describes wastes that are “characterized as hazardous under Article 1 paragraph 1 (a) of this Convention” although “Designation of a waste on Annex VIII does not preclude the use of Annex III (hazard characteristics) to demonstrate that a waste is not hazardous.” (Annex I, paragraph (b)). List B of Annex IX lists wastes that “will not be wastes covered by Article 1, paragraph 1 (a), of this Convention unless they contain Annex I material to an extent causing them to exhibit an Annex III characteristic”.

19. List A of Annex VIII includes a number of wastes or waste categories which have the potential to contain or be contaminated with PFOS, its salts or PFOF, including:

- A1120 Waste sludges, excluding anode slimes, from electrolyte purification systems in copper electrorefining and electrowinning operations.

Comment [JC4]: Advice required from SIWG members.

Should a link to section III A low POP content be made here.

A4030 Wastes from the production, formulation and use of biocides and phytopharmaceuticals, including waste pesticides and herbicides, which are off-specification, outdated² or unfit for their original intended use.

Comment [JC5]: For use as a pesticides

A4060 Waste oils/water, hydrocarbons/water mixtures, emulsions.

Comment [JC6]: For use in the oils and gas sectors

A4130 Waste packages and containers containing Annex I substances in concentrations sufficient to exhibit Annex III hazard characteristics.

Comment [JC7]: For use as a pesticides

A4140 Waste consisting of or containing off specification or outdated chemicals corresponding to Annex I categories and exhibiting Annex III hazard characteristics.

Comment [JC8]: For use as a pesticides

20. For more information, see section II.A of the general technical guidelines.

B. Stockholm Convention

21. The present document covers intentionally produced PFOS, its salts and PFOSF whose production and use are to be restricted in accordance with articles 3 and Annex B, Part III of the Stockholm Convention.

22. Annex B, Part III³ ("Perfluorooctane sulfonic acid, its salts, and perfluorooctane sulfonyl fluoride") outlines specific requirements for PFOS, as follows:

1. The production and use of perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF) shall be eliminated by all Parties except as provided in Part I of this Annex for Parties that have notified the Secretariat of their intention to produce and/or use them for acceptable purposes. A Register of Acceptable Purposes is hereby established and shall be available to the public. The Secretariat shall maintain the Register of Acceptable Purposes. In the event that a Party not listed in the Register determines that it requires the use of PFOS, its salts or PFOSF for the acceptable purposes listed in Part I of this Annex it shall notify the Secretariat as soon as possible in order to have its name added forthwith to the Register.
2. Parties that produce and/or use these chemicals shall take into account, as appropriate, guidance such as that given in the relevant parts of the general guidance on best available techniques and best environmental practices given in Part V of Annex C of the Convention.
3. Every four years, each Party that uses and/or produces these chemicals shall report on progress made to eliminate PFOS, its salts and PFOSF and submit information on such progress to the Conference of the Parties pursuant to and in the process of reporting under Article 15 of the Convention.
4. With the goal of reducing and ultimately eliminating the production and/or use of these chemicals, the Conference of the Parties shall encourage:
 - (a) Each Party using these chemicals to take action to phase out uses when suitable alternative substances or methods are available;
 - (b) Each Party using and/or producing these chemicals to develop and implement an action plan as part of the implementation plan specified in Article 7 of the Convention;
 - (c) The Parties, within their capabilities, to promote research on and development of safe alternative chemical and non-chemical products and processes, methods and strategies for Parties using these chemicals, relevant to the conditions of those Parties. Factors to be promoted when considering

² "Outdated" means unused within the period recommended by the manufacturer.

³ <http://chm.pops.int/Convention/ConventionText/tabid/2232/Default.aspx>.

alternatives or combinations of alternatives shall include the human health risks and environmental implications of such alternatives.

5. The Conference of the Parties shall evaluate the continued need for these chemicals for the various acceptable purposes and specific exemptions on the basis of available scientific, technical, environmental and economic information, including:
 - (a) Information provided in the reports described in paragraph 3;
 - (b) Information on the production and use of these chemicals;
 - (c) Information on the availability, suitability and implementation of alternatives to these chemicals;
 - (d) Information on progress in building the capacity of countries to transfer safely to reliance on such alternatives.
6. The evaluation referred to in the preceding paragraph shall take place no later than in 2015 and every four years thereafter, in conjunction with a regular meeting of the Conference of the Parties.
7. Due to the complexity of the use and the many sectors of society involved in the use of these chemicals, there might be other uses of these chemicals of which countries are not presently aware. Parties which become aware of other uses are encouraged to inform the Secretariat as soon as possible.
8. A Party may, at any time, withdraw its name from the Register of acceptable purposes upon written notification to the Secretariat. The withdrawal shall take effect on the date specified in the notification.
9. The provisions of note (iii) of Part I of Annex B shall not apply to these chemicals.

23. For further information, see section II.B of the general technical guidelines.

III. Issues under the Stockholm Convention to be addressed cooperatively with the Basel Convention

A. Low POP content

B. Levels of destruction and irreversible transformation

24. For the provisional definition of levels of destruction and irreversible transformation, see section III.B of the general technical guidelines.

Methods which constitute environmentally sound disposal

25. See section G of chapter IV below and section IV.G of the general technical guidelines.

IV. Guidance on environmentally sound management (ESM)

A. General considerations: Basel and Stockholm Conventions and Organisation for Economic Co-operation and Development

1. Basel Convention

26. One of the principal vehicles for the promotion of ESM is the preparation and dissemination of technical guidelines such as the present document and the general technical guidelines. For further information see subsection IV.A.1 of the general technical guidelines.

Comment [JC9]:
Development in progress.

Advice required from SIWG members on proposed scientific information that would lead to the determination of the low POP content.

27. Parties planning or reviewing a national ESM programme should consult, inter alia, the Basel Convention document entitled "*Preparation of a National Environmentally Sound Management Plan for PCBs and Other POPs Wastes under the Basel Convention*, vols. A, B and C" (UNEP, 2003a).

Comment [JC10]: Consider an update with recent information.

2. Stockholm Convention

28. The term "environmentally sound management" is not defined in the Stockholm Convention. Environmentally sound methods for disposal of wastes consisting of, containing or contaminated with PFOS, its salts or PFOS-F are to be determined by the Conference of the Parties in cooperation with the appropriate bodies of the Basel Convention.

29. Parties should consult *Guidance for developing a National Implementation Plan for the Stockholm Convention* (UNEP, 2005b).

Comment [JC11]: Consider an update with recent information.

3. Organisation for Economic Co-operation and Development

30. For information regarding the Organisation for Economic Co-operation and Development and ESM, see subsection IV.A.3 of the general technical guidelines.

B. Legislative and regulatory framework

31. Parties to the Basel and Stockholm conventions should examine national controls, standards and procedures to ensure that they are in keeping with the conventions and their obligations under them, including those which pertain to ESM of wastes consisting of, containing, or contaminated with PFOS.

32. Elements of a regulatory framework applicable to PFOS could also include the following:

Environmental protection legislation establishing a regulatory regime, setting release limits and establishing environmental quality criteria;

Prohibitions on the manufacture, sale, import and export (for use) of PFOS;

Phase-out dates for PFOS that remain in service, inventory, or storage;

Transportation requirements for hazardous materials and waste;

Specifications for containers, equipment, bulk containers and storage sites;

Specification of acceptable analytical and sampling methods for PFOS;

Requirements for waste management disposal facilities;

A general requirement for public notification and review of proposed government regulations, policy, certificates of approval, licences, inventory information and national releases/emissions data;

Requirements for identification and remediation of contaminated sites;

Requirements for health and safety of workers;

Other potential legislative controls, as for waste prevention and minimization, inventory development and emergency response.

33. A link should be established in legislation between the phase-out dates for production and use of PFOS (including in products and articles) and the disposal of the PFOS once they have become waste. The legislation should include a time limit for disposal of wastes consisting of, containing, or contaminated with PFOS so as to prevent the creation of stockpiles which have no clear phase-out dates.

34. For further information, see section IV.B of the general technical guidelines.

C. Waste prevention and minimization

35. Both the Basel and Stockholm Conventions advocate waste prevention and minimization. PFOS are restricted under the Stockholm Convention to a limited number of acceptable purposes as provided in Part I of Annex B to the Convention.
36. Quantities of waste containing PFOS should be minimized through isolation and source separation to prevent mixing, and contamination of other waste streams. For example,
37. Mixing of wastes with a PFOS content above a defined low POP content with another material solely for the purpose of generating a mixture with a POP content below the defined low POP content is not environmentally sound. Nevertheless, mixing of materials before waste treatment may be necessary in order to optimize treatment efficiencies.
38. For further information, see paragraph 6 and section IV.C of the general technical guidelines.

Comment [JC12]:
Development in progress.

Identification and inventories

1. Identification

39. For information, see subsection IV.D.1 of the general technical guidelines.
40. PFOS and its related substances can be **found** :
- When used in a pesticide:

- (a) In residues from pesticides production and at sites where they were produced and formulated; and
- (b) In storage facilities.

When used as an industrial chemical

In industrial wastewater and sludge from electronic, semi conductor, photographic, metal plating, mining, impregnating and coating of textile-paper-packaging and medical device manufacturing industries;

In recycling facilities of carpets, papers and aviation hydraulic fluids; and

Oil and gas production sites.

When used in consumer articles

- (a) In municipal wastewater
- (b) In municipal sludge
- (c) In dumpsites leachate and in contaminated surface and groundwaters
- (d) In landfill leachate

41. **Current uses** of PFOS-related substances have also been confirmed in the following sectors: photographic industry, photolithography and semiconductor; hydraulic fluids; and metal plating.

42. It should be noted that even experienced technical persons may not be able to determine the nature of an effluent, substance, container or piece of equipment by its appearance or markings. Consequently, the information on production, use and waste types provided in section B of chapter I of the present document may be found useful in identifying PFOS.

Comment [JC13]: Advice required from SIWG members.

We would like to develop a table with typical ranges of concentrations of PFOS in the different waste stream listed.

Comment [JC14]: All of these will need to be confirmed with references.

Comment [JC15]: Need to further look into the plastic and rubber industries.

Comment [JC16]: Need to be further developed and confirmed with references

2. Inventories

43. For information, see subsection IV.D.1 of the general technical guidelines.

E. Sampling, analysis and monitoring

Comment [JC17]:
Development in progress.

44. For general information, see section IV.E of the general technical guidelines.

1. Sampling

45. For information on sampling, see subsection IV.E.1 of the general technical guidelines.

2. Analysis

46. For information on analysis, see subsection IV.E.2 of the general technical guidelines.

47.

3. Monitoring

48. Monitoring programmes should be implemented for facilities managing wastes consisting of, containing or contaminated with PFOS, its salts and PFOSF. For further information, see subsection IV.E.3 of the general technical guidelines.

F. Handling, collection, packaging, labelling, transportation and storage

49. For general information on handling, collection, packaging, labelling, transportation and storage, see the first two paragraphs of section F of the general technical guidelines.

1. Handling

50. Recommended procedures towards handling PFOS include:

For lead and spill detection:

- (i) Shut off source of spill if possible to do so without hazard;
- (ii) Contain the spill by diking;
- (iii) Absorb spillage with clay, sawdust, or other absorbent material;
 - (iv) Place all spilled material, contaminated dirt, and other contaminated materials in approved drums for disposal.
- (b) For waste disposal:
 - (i) Always dispose or according to local/national regulations.
- (c) For handling and special equipment:
 - (i) Do not get PFOS-containing products in eyes, on skin or clothing;
 - (ii) Do not take it internally;
 - (iii) Do not breathe vapours;
 - (iv) Keep away from heat, sparks, and open flames.

51. For further information, see subsection IV.F.2 of the general technical guidelines.

2. Collection

52. Collection arrangements and collection depots for wastes consisting of, containing or contaminated with PFOS and its related substance should be separate from those for all other wastes.

53. It is imperative that collections depots do not become long-term storage facilities for wastes consisting of, containing or contaminated with PFOS and its related substances. The risk of environmental and human health impairment is higher for large amounts of wastes, even if properly stored, than for small quantities scattered over a large area.

54. For further information, see subsection IV.F.2 of the general technical guidelines.

3. Packaging

55. Wastes consisting of, containing or contaminated with PFOS and its related substances should be properly packaged before storage or transport:

- (a) Liquid wastes should be placed in double-bung steel drums or other approved containers;
- (b) Regulations governing transport often specify containers of a certain quality (e.g., 16-gauge steel coated inside with epoxy resin/polymer); consequently, containers used for storage should meet transport requirements given that they may be transported in the future;
- (c) Large, drained equipment may be stored as is or may be placed inside a large container (overpack drum) or heavy plastic wrap if leakage is a concern;
- (d) Small pieces of equipment, whether drained or not, should be placed in drums with an absorbent material. Numerous small pieces of equipment may be placed in the same drum so long as an adequate amount of absorbent material is present in the drum. Loose absorbents may be purchased from safety suppliers. Sawdust or peat moss may also be used;
- (e) Drums and equipment may be placed on pallets for movement by forklift truck and for storage. Drums and equipment should be strapped to the pallets before they are moved.

56. For further information, see subsection IV.F.2 of the general technical guidelines.

4. Labelling

57. All containers containing PFOS and its related substances should be clearly labelled with both a hazard-warning label and a label which gives the details of the container and a serial number. The details should include the contents of the container (exact counts of equipment of volume and weight), the type of waste, the name of the site from which it originated so as to allow traceability, the date of repackaging and the name and telephone number of the responsible person during the repackaging operation.

58. For further information, see subsection IV.F.4 of the general technical guidelines.

5. Transportation

59. For information, see subsection IV.F.5 of the general technical guidelines.

6. Storage

60. For further information, see subsection IV.F.6 of the general technical guidelines.

G. Environmentally sound disposal

1. Pre-treatment

60. For further information, see subsection IV.G.1 of the general technical guidelines

2. Destruction and irreversible transformation methods

61. For further information, see subsection IV.G.2 of the general technical guidelines

3. Other disposal methods when neither destruction nor irreversible transformation is the environmentally preferable option

62. For further information, see subsection IV.G.3 of the general technical guidelines

4. Other disposal methods when the POP content is low

63. For further information, see subsection IV.G.4 of the general technical guidelines

H. Remediation of contaminated sites

64. For further information, see subsection IV.H of the general technical guidelines

I. Health and safety

65. For further information, see subsection IV.I of the general technical guidelines

1. Higher-risk situations

66. For further information, see subsection IV.I.1 of the general technical guidelines

2. Lower-risk situations

67. For further information, see subsection IV.I.2 of the general technical guidelines

J. Emergency response

Comment [JC18]:
Development in progress.

K. Public participation

Comment [JC19]:
Development in progress.

ANNEX I

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