



**United Nations
Environment
Programme**



Distr.
GENERAL

UNEP/CHW.6/...
22 August 2002

ORIGINAL: ENGLISH

CONFERENCE OF THE PARTIES TO THE BASEL
CONVENTION ON THE CONTROL OF
TRANSBOUNDARY MOVEMENTS OF
HAZARDOUS WASTES AND
THEIR DISPOSAL

Sixth meeting
Geneva, 9-13 December 2002

Item ... of the provisional agenda[□]

TECHNICAL GUIDELINES
ON THE ENVIRONMENTALLY SOUND MANAGEMENT
OF BIOMEDICAL AND HEALTHCARE WASTES

Note by the secretariat

I. BACKGROUND

1. Refer to decision V/26 on the Work Programme of the Technical Working Group.

II. IMPLEMENTATION

2. At its seventeenth session in October 2000, the Technical Working Group adopted the technical guidelines on the environmentally sound management of biomedical and healthcare wastes. The meeting agreed that the technical guidelines should be published and made available to Parties and others in need of such guidance until their final adoption by the Conference of the Parties and expressed its appreciation to Germany for taking the lead in the preparation of these guidelines.
3. The Technical Working Group noted that different concepts and approaches are used for the definition of biomedical and healthcare wastes among countries and at the international level, especially in the case of infectious wastes. For the purpose of informing users of the technical guidelines on the different concepts and approaches that exist at the international level, the secretariat has prepared an accompanying note that is contained in Annex I to the present note.

[□] UNEP/CHW.6/1

4. The technical guidelines as adopted by the Technical Working Group are contained in Annex II to the present note.
5. At its first meeting in May 2002, the Working Group on Implementation approved the decision of the Technical Working Group to adopt these technical guidelines for transmissions to the sixth meeting of the Conference of the Parties.

III. PROPOSED ACTION

6. At its sixth meeting, the Conference may wish to consider adopting a decision along the following lines:

The Conference,

Welcoming the adoption of the technical guidelines on the environmentally sound management of biomedical and healthcare wastes,

Noting with appreciation the leading role played by Germany with support from Parties and others in the preparation of the technical guidelines,

Also noting the different concepts and approaches used at the international level concerning the definition and classification of biomedical and healthcare wastes, especially in the case of infectious wastes,

1. Adopts the technical guidelines on the environmentally sound management of biomedical and healthcare wastes as contained in document UNEP/CHW.6/...;
2. Invite Parties and others to use the technical guidelines and to report to the Conference of the Parties at its next meeting, through the secretariat, on their experience and any difficulties or obstacles encountered in their application with a view to improving the technical guidelines as necessary and required;
3. Requests the secretariat to continue its cooperation with the World Health Organization and the United Nations Committee of Experts on the Transport of Dangerous Goods on matters concerning or related to the environmentally sound management of biomedical and healthcare wastes.

Annex I

Note by the secretariat

I. PURPOSE AND SCOPE OF THE TECHNICAL GUIDELINES

1. A primary purpose of the technical guidelines is to assist countries to improve, as necessary, the management of the biomedical and healthcare wastes. As it is a normal procedure in the context of the Basel Convention, the technical guidelines once adopted by the Conference of the Parties could, later on, be revisited to up-date or consolidate them. In this context, it is important to note that the disposal options proposed in the technical guidelines address the current priority needs of, in particular, developing countries. For this reason, the Technical Working Group, at its seventeenth session in October 2000, recommended that the technical guidelines be published and made available to Parties and others in need of such guidance pending their final adoption by the sixth meeting of the Conference of the Parties

2. The Technical Working Group, while preparing the technical guidelines, ensured that the Guidelines assist in reducing the impacts on health and the environment of biomedical and healthcare wastes, taking into account varying degree of infrastructural development and capacity among countries. Hence, focus has been given on developing guidance concerning:

- (a) A strict definition and classification of the relevant waste streams;
- (b) The segregation at source of the wastes;
- (c) The access to the best available information for the identification of the wastes.

The technical guidelines provide guidance on how to move towards state-of-the-art management of biomedical and healthcare wastes as a complement to those options considered necessary and suitable today taking into account the level of know-how, capacity and costs.

3. The Technical Working Group has also recognized the difficulties, from a waste management point of view, to apply a definition for the criteria of infectiousness that is applicable worldwide.

II. ISSUE OF INFECTIOUS WASTES

4. Concerning the definition and classification of biomedical and healthcare wastes, different concepts and approaches are used internationally, especially in the case of infectious wastes. The World Health Organization (WHO) follows the “Universal Precautions” concept which describes a set of measures formulated to prevent the transmission of communicable diseases. The technical guidelines adopted by the Technical Working Group in October 2000 point to a narrower definition of infectious wastes, focusing on pragmatic and cost-effective waste management options. Definitions and criteria for the determination of infectious substances represent an area where international harmonization is of relevance and cooperation with WHO and the United Nations Committee of Experts on the Transport of Dangerous Goods is important.

5. Consequently, the users of the technical guidelines should review how these guidelines are implemented at the national level with a view to identifying how to improve them and the difficulties and obstacles to their effective application. For ease of reference, information provided by WHO on “Universal Precautions for Prevention of Transmission of HIV and other Bloodborne Infections” is contained in the appendix to the present note.

Appendix

Universal precautions for prevention of transmission of HIV and other bloodborne infections

"Universal precautions," as defined by CDC, are a set of precautions designed to prevent transmission of human immunodeficiency virus (HIV), hepatitis B virus (HBV), and other bloodborne pathogens when providing first aid or health care. Under universal precautions, blood and certain body fluids of all patients are considered potentially infectious for HIV, HBV and other bloodborne pathogens.

Universal precautions took the place of and eliminated the need for the isolation category "Blood and Body Fluid Precautions" in the 1983 CDC Guidelines for Isolation Precautions in Hospitals. However, implementing universal precautions does not eliminate the need for other isolation precautions, such as droplet precautions for influenza, airborne isolation for pulmonary tuberculosis, or contact isolation for methicillin-resistant *Staphylococcus aureus*.

Universal precautions differ from the system of Body Substance Isolation (BSI) used in some institutions. For information about BSI, refer to the following articles:

1. Lynch P, et al. Rethinking the role of isolation precautions in the prevention of nosocomial infections. *Annals of Internal Medicine* 1987;107:243-246.
2. Lynch P, et al. Implementing and evaluating a system of generic infection precautions: Body substance isolation. *American Journal of Infection Control* 1990;18:1-12.

In 1996, CDC published new guidelines (standard precautions) for isolation precautions in hospitals. Standard precautions synthesize the major features of BSI and universal precautions to prevent transmission of a variety of organisms. Standard precautions were developed for use in hospitals and may not necessarily be indicated in other settings where universal precautions are used, such as child care settings and schools.

Universal precautions apply to blood, other body fluids containing visible blood, semen, and vaginal secretions. Universal precautions also apply to tissues and to the following fluids: cerebrospinal, synovial, pleural, peritoneal, pericardial, and amniotic fluids. Universal precautions do not apply to feces, nasal secretions, sputum, sweat, tears, urine, and vomitus unless they contain visible blood. Universal precautions do not apply to saliva except when visibly contaminated with blood or in the dental setting where blood contamination of saliva is predictable.

Universal precautions involve the use of protective barriers such as gloves, gowns, aprons, masks, or protective eyewear, which can reduce the risk of exposure of the health care worker's skin or mucous membranes to potentially infective materials. In addition, under universal precautions, it is recommended that all health care workers take precautions to prevent injuries caused by needles, scalpels, and other sharp instruments or devices.

Pregnant health care workers are not known to be at greater risk of contracting HIV infection than are health care workers who are not pregnant; however, if a health care worker develops HIV infection during pregnancy, the infant is at risk of infection resulting from perinatal transmission. Because of this risk, pregnant health care workers should be especially familiar with, and strictly adhere to, precautions to minimize the risk of HIV transmission.

WRITTEN GUIDELINES: UNIVERSAL PRECAUTIONS

Universal precautions are discussed in the following documents:

1. [CDC. Recommendations for prevention of HIV transmission in health-care settings.](#) *MMWR* 1987;36(suppl no. 2S).

2. [CDC. Update: Universal precautions for prevention of transmission of human immunodeficiency virus, hepatitis B virus, and other bloodborne pathogens in health-care settings.](#) MMWR 1988;37:377-388.
3. [CDC. Guidelines for prevention of transmission of human immunodeficiency virus and hepatitis B virus to health-care and public-safety workers.](#) MMWR 1989;38(S-6):1-36.

These three documents may be obtained by calling the AIDS Hotline at 1-800-342-2437 or the National AIDS Information Clearinghouse at 1-800-458-5231.

In addition, the Occupational Safety and Health Administration (OSHA) has published a standard on "bloodborne pathogens." For information about this document, call 202-219-7157.

For information on infection control in dental practice, call 1-800-458-5231 to obtain "The Infection Control File." For further questions on dental practice, call the Division of Oral Health, CDC, telephone 770-488-3034.

GLOVING, GOWNING, MASKING, AND OTHER PROTECTIVE BARRIERS AS PART OF UNIVERSAL PRECAUTIONS

All health care workers should routinely use appropriate barrier precautions to prevent skin and mucous membrane exposure during contact with any patient's blood or body fluids that require universal precautions.

Recommendations for the use of gloves are presented in detail in the Morbidity and Mortality Weekly Report dated June 24, 1988, which is available by calling the National AIDS Information Hotline at 1-800-342-2437 or the National AIDS Information Clearinghouse at 1-800-458-5231.

Gloves should be worn:

- for touching blood and body fluids requiring universal precautions, mucous membranes, or nonintact skin of all patients, and
- for handling items or surfaces soiled with blood or body fluids to which universal precautions apply.

Gloves should be changed after contact with each patient. Hands and other skin surfaces should be washed immediately or as soon as patient safety permits if contaminated with blood or body fluids requiring universal precautions. Hands should be washed immediately after gloves are removed. Gloves should reduce the incidence of blood contamination of hands during phlebotomy, but they cannot prevent penetrating injuries caused by needles or other sharp instruments. Institutions that judge routine gloving for all phlebotomies is not necessary should periodically reevaluate their policy. Gloves should always be available to health care workers who wish to use them for phlebotomy. In addition, the following general guidelines apply:

1. Use gloves for performing phlebotomy when the health care worker has cuts, scratches, or other breaks in his/her skin.
2. Use gloves in situations where the health care worker judges that hand contamination with blood may occur, e.g., when performing phlebotomy on an uncooperative patient.
3. Use gloves for performing finger and/or heel sticks on infants and children.
4. Use gloves when persons are receiving training in phlebotomy.

The Center for Devices and Radiological Health, Food and Drug Administration (FDA), has responsibility for regulating the medical glove industry. For more information about selection of gloves, call FDA at 301-443-8913.

Masks and protective eyewear or face shields should be worn by health care workers to prevent exposure of mucous membranes of the mouth, nose, and eyes during procedures that are likely to generate droplets of blood or body fluids requiring universal precautions. Gowns or aprons should be worn during procedures that are likely to generate splashes of blood or body fluids requiring universal precautions.

All health care workers should take precautions to prevent injuries caused by needles, scalpels, and other sharp instruments or devices during procedures; when cleaning used instruments; during disposal of used needles; and when handling sharp instruments after procedures. To prevent needlestick injuries, needles should not be recapped by hand, purposely bent or broken by hand, removed from disposable syringes, or otherwise manipulated by hand. After they are used, disposable syringes and needles, scalpel blades, and other sharp items should be placed in puncture-resistant containers for disposal. The puncture-resistant containers should be located as close as practical to the use area. All reusable needles should be placed in a puncture-resistant container for transport to the reprocessing area.

General infection control practices should further minimize the already minute risk for salivary transmission of HIV. These infection control practices include the use of gloves for digital examination of mucous membranes and endotracheal suctioning, handwashing after exposure to saliva, and minimizing the need for emergency mouth-to-mouth resuscitation by making mouthpieces and other ventilation devices available for use in areas where the need for resuscitation is predictable.

Although universal precautions do not apply to human breast milk, gloves may be worn by health care workers in situations where exposures to breast milk might be frequent, e.g., in breast milk banking.

Division of Healthcare Quality Promotion
National Center for Infectious Diseases
Centers for Disease Control and Prevention
Atlanta, GA
URL: <http://www.cdc.gov/ncidod/hip/blood/universa.htm>

Requested amendments to the draft
 "Technical Guideline on the Environmentally Sound Management
 of Biomedical and Healthcare Waste (Y1; Y3)",
 Basel Convention, dated January 2001

The document should comply with the basic principles for preventing transmission of bloodborne disease described as "Universal Precautions".

According to "Universal Precautions", wastes contaminated by blood, blood products, and certain body fluids (cerebrospinal, synovial, pleural, peritoneal, pericardial, and amniotic fluids) should be classified as one single category, whether or not the patient/ sample/ waste has been previously tested or diagnosed. All reference to classification of wastes according to whether patients/samples/wastes "known or clinically assessed" to have the potential of transmitting infectious agents should be removed. Universal Precautions should be systematically adopted to prevent unprotected contact when handling such wastes.

In particular, the following modifications are requested:

- Modify this section in page 9, section 3/13 to include all wastes contaminated with blood, blood products, and certain body fluids (cerebrospinal, synovial, pleural, peritoneal, pericardial, and amniotic fluids). This waste category does not necessarily have to be labelled as "infectious health-care waste"
- Page 10, last paragraph, 2nd sentence: Sharps should include all "sharps or pointed parts able to cause an injury or invasion of the skin barrier in the human body" that have been contaminated with blood, blood products, and certain body fluids (cerebrospinal, synovial, pleural, peritoneal, pericardial, and amniotic fluids), and not only those from infected patients with hazardous communicable diseases.
- Page 17, section 6/33: C a) Delete "from infected patients with hazardous communicable diseases..." until the end of the paragraph
- Page 19, 1st and 3rd paragraph: delete the two sections "Notice"
- Page 21, section 39: Modify footnote a) by deleting "from infected patients with hazardous communicable disease" Until the end of the paragraph.

Moreover, the following addition is recommended:

"Universal Precautions" involve the use of protective barriers such as gloves, gowns, aprons, masks, or protective eyewear, which can reduce the risk of exposure of the healthcare worker's skin or mucous membranes to potentially infective materials. In addition, under "Universal Precautions", it is recommended that all healthcare workers take precautions to prevent injuries caused by needles, scalpels, and other sharp instruments or devices.

Annex II

Technical guidelines on the environmentally sound management
of biomedical and health-care waste (Y1; Y3)

Foreword

1. A series of national guidelines from developed and developing countries, in particular a comprehensive World Health Organization (WHO) publication which covers a very wide spectrum, and a paper prepared by the European Committee for Standardization (CEN), the form the basis for these guidelines.
2. Both the publication and the paper include two fundamentally different concepts concerning the definition and classification of biomedical and health-care waste, especially for infectious waste. One proposal among others made by WHO prefers a wide definition and classification of infectious which in principle covers all waste contaminated with blood and other body fluids and thus excludes all - even theoretical - pathways for infectious diseases (the precautionary principle). For the following laid-down and described routes for the disposal of the waste, more pragmatic and cost-effective solutions (e.g. disposal together with household waste) are suggested, meaning however that the desired high-safety aspects can not be ensured for the whole disposal process.
3. These guidelines do not follow the approach of a wide definition. They follow an approach aimed at reducing hazardous and problematic waste streams to a minimum by means of highly qualified staff, strict definition and classification of the waste stream, and segregation at the source of the waste with the best information for identification of the waste.
4. Specialized waste disposal techniques are needed only for this reduced amount of waste. However, they still cover the main sources of the hazardous waste. This will lead to well-organized disposal of biomedical and health-care waste with justifiable costs.
5. Because of the different levels of waste management infrastructure, capacity and capability among Parties, suitable and feasible solutions are required. In that spirit, the technical guidelines describe the manner in which to move towards state-of-the-art management of biomedical and health-care wastes while at the same time identifying other kinds of suitable possibilities.
6. The major points of these guidelines are the practical aspects of waste management pertaining to the handling and environmentally sound management of biomedical and health-care wastes. Other aspects were dealt with only as deemed necessary.
7. These technical guidelines should be considered together with other technical guidelines adopted by the Conference of the Parties to the Basel Convention and governing the environmentally sound recovery and disposal of wastes, in particular the Technical Guidelines for Incineration on Land (D 10) and on Specially Engineered Landfill (D 5). In addition, special attention should be paid to the legal frameworks and the responsibilities of the relevant competent authorities.
8. Because of the fact that radioactive wastes which are not covered by the Basel Convention are found, for example, in the medical sector, it was necessary that some fundamental instructions be made regarding the handling of such wastes. Many of the radionuclides used in nuclear medicine and biological research have short half-lives, and therefore radioactive decay causes the radioactive hazard of the waste to fall below clearance levels in a relatively short period of time. At this stage, the waste is subject to the Basel Convention.
9. The management of radioactive waste is subject to national or international regulations, that is, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Comprehensive guidance on all aspects of the safety of radioactive waste management is provided in the Safety Standards Series of the International Atomic Energy Agency

UNEP/CHW.6/...

(IAEA). Reference is made in chapter 4.7 below to several IAEA publications that are relevant in the context of these guidelines.

Contents

	<u>Page</u>
1	5
2	6
3	7
3.1	7
3.2	7
3.3	7
3.4	8
3.5	8
3.6	8
4	9
4.1	9
4.2	9
4.3	10
4.4	12
4.5	12
4.6	12
4.7	12
5	13
6	14
6.1	15
7	22
7.1	23
7.1.1	23
7.1.2	24
7.1.3	24
7.2	24
7.3	26
7.4	27
7.4.1	28
7.4.2	29
7.5	29
7.6	29
7.6.1	30
7.6.1.1	31
7.6.1.2	32
7.6.1.3	32
7.6.1.4	33
7.6.1.5	33
7.6.1.6	36
7.7	39
7.7.1	39
7.7.1.1	39
7.7.1.2	40
7.7.2	41
7.7.2.1	41
7.7.2.2	42

	<u>Page</u>	
7.7.2.3	Reporting accidents and incidents	43
8	Waste management auditing	43
9	Capacity-building	44
9.1	Education and training of personnel of health-care establishments	45
9.1.1	Responsibility for training	46
9.1.2	The training package	46
9.1.3	Selection of participants	46
9.1.4	Training recommendations	46
9.1.4.1	Training recommendations for personnel providing health care	46
9.1.4.2	Training recommendations for waste-handling staff	47
9.1.4.3	Training of health-care waste management operators	47
9.1.4.4	Training for members of staff who transport waste	47
9.1.4.5	Training of incinerator operators	48
9.1.4.6	Training of operators of specially engineered landfill sites	48

Annex

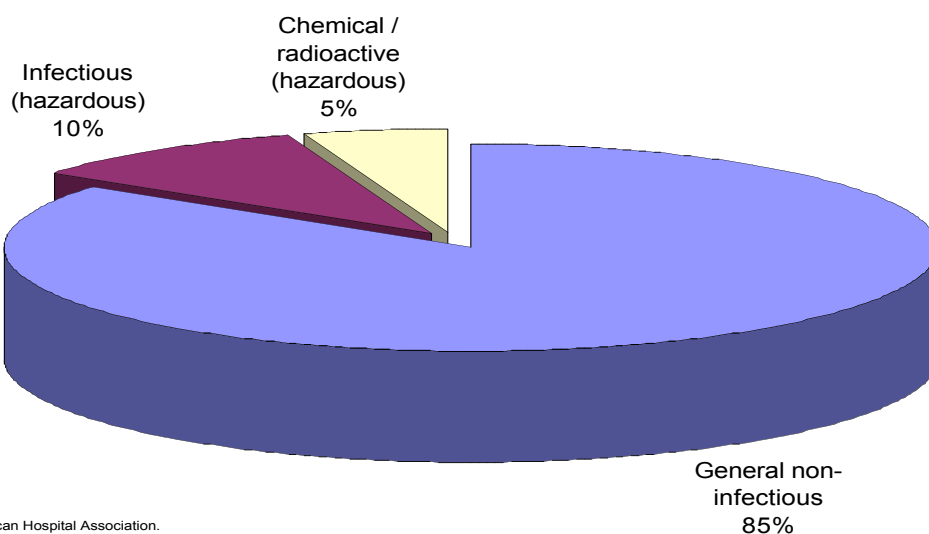
Annex I	Bibliography	49
Annex II	Glossary/terminology	51
Annex III	Examples of specific waste reduction, reuse and recycling activities	53
Annex IV	Validation of waste disinfection processes (April 1993)	55
Annex V	Emission standards for waste incinerators (in mg/m ³ at 11 % O ₂ dry) set by the European Union	61

I. Introduction

1. The disposal of wastes originating from health-care establishments (public and private) can have an effect on human health and well-being, the environment (air, water, soil, animals, plants, landscape) and issues relating to public security and order.
2. Nevertheless, experience has proven that wastes originating from health-care establishments, when properly managed, generally pose no greater risks than that of properly treated municipal or industrial wastes. This also pertains to the disposal of biomedical and health-care wastes, in contrast to occasional public perception.
3. The guidelines provide information for the proper treatment of wastes from health-care establishments (public and private). The information provided takes due consideration of the waste management requirements of disposal and recovery measures as well as hygiene requirements. In addition to ecological aspects, the information and recommendations should be economically feasible and easy to undertake. It and also makes allowances for technical progress.
 1. It has become apparent that the introduction of improved solutions for the segregation of waste within health-care facilities can result in reduced amounts of waste requiring special treatment and therefore in reduced waste treatment costs. In addition, new technologies have become available to treat and disinfect biomedical and health-care wastes so that they can be disposed of finally with low risk by landfilling.

2. In many countries, landfill has been and continues to be the predominant method for direct disposal of wastes - most frequently without pre-treatment. This practice causes considerable concern.
3. The safe management of biomedical and health-care waste is essential for community and environmental health. It is also important that the standards for the protection of the environment and human health are uniform across all health-care establishments, irrespective of technologies used for treatment and disposal. This in turn ensures a more viable and efficient industry. However, it should be noted that in many countries, the national authorities, in addition to industry, are an active participant in health-care, either providing services or paying for them. In addition, the lack of resources or of experience in developing standards may be significant factors affecting the capacity to treat biomedical and health-care wastes.
4. To manage biomedical and health-care waste effectively, the following should be taken into consideration:
 - (a) Generation and minimization;
 - (b) Separation and segregation of sources;
 - (c) Identification and classification;
 - (d) Handling and storage;
 - (e) Packaging and labelling;
 - (f) Transportation inside and outside health-care establishments;
 - (g) Treatment;
 - (h) Disposal of residues (including emissions);
 - (i) Occupational health and safety; public and environmental health;
 - (j) Stakeholder and community awareness and education;
 - (k) Research into and development of improved technologies and environmentally friendly practices.
5. These guidelines attempt to address all of these issues and provide support for the achievement of improved environmental performance in managing biomedical and health-care waste. To be successful, waste management strategies should always take account of, and interact with, the process that generated the wastes in the first place.

Figure 1
Waste from clinics and hospitals



Source: American Hospital Association.

6. Observations at several health-care establishments in the world indicate that the average biomedical and health-care waste stream contains less than 10 per cent of materials that could be considered "potentially infectious". If properly segregated, the content of infectious waste can be reduced to 1-5 per cent of the waste generated in health-care establishments.

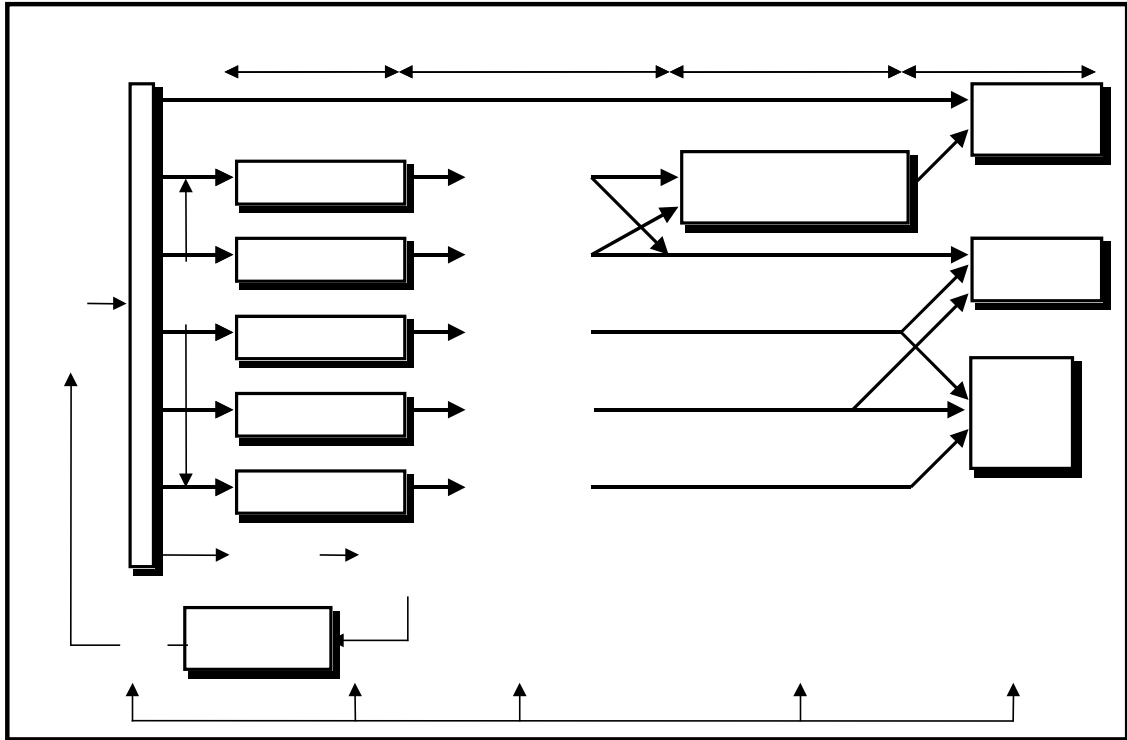
7. Biomedical and health-care waste is a term for all waste generated in health-care establishments. Biomedical and health-care waste can briefly be described as waste from medical or other related practices. In reality, only a small proportion of this waste causes a higher risk of transmitting infectious diseases than normal household or municipal waste. These guidelines deal with all biomedical and health-care waste, but focus on the segregation and treatment of hazardous biomedical and health-care waste.

8. Concern regarding the safe management and disposal of biomedical and health-care waste has resulted from the perceived or real risk of potential transmission of infectious diseases through accidental injury or contact with infected body fluids. The disposal of sharps (needles, scalpels etc.) has attracted particular interest because of the small number of occupationally acquired hepatitis and HIV human immunodeficiency virus (HIV) infections suffered by health-care workers attributed to sharps injuries. The majority of sharps injuries, however, do not result in infection. It is therefore "good practice" in waste management to reduce the risk of injuries. Figure 2 describes some possible action points to establish "good practice" in waste management.

Figure 2

Biomedical and health-care waste strategy

INFECTIOUS INFECTIOUS SHARPS BIOLOGICAL ANATOMICAL BIOLOGICAL ANATOMICAL DRUGS SR



9. To get a better understanding of the waste management practice of health-care facilities, there is a need to have a common and internationally accepted definition for the waste generated in those facilities.

10. The general definitions below are set forth by these guidelines:

3.1. Health care

11. Medical activities such as diagnosis, monitoring, treatment, prevention of disease or alleviation of handicap in humans or animals, including related research, performed under the supervision of a medical practitioner or veterinary surgeon or another person authorized by virtue of his or her professional qualifications.

3.2. Biomedical and health-care waste

12. The solid or liquid waste arising from health care (including collected gaseous waste).

3.3. Hazardous health-care waste

13. This includes:

- (a) Infectious health-care waste;
- (b) Chemical, toxic or pharmaceutical waste, including cytotoxic drugs (antineoplastics)
- (c) Sharps (e.g. needles, scalpels);
- (d) Radioactive waste;

- (e) Other hazardous waste.¹

3.4. Infectious health-care waste

14. All biomedical and health-care waste known or clinically assessed by a medical practitioner or veterinary surgeon to have the potential of transmitting infectious agents to humans or animals. The interpretation of the definition of infectious health-care waste varies according to national circumstances, policies and regulations. International organizations – WHO,² the United Nations,³ etc. have specific interpretations of the definition. Infectiousness is one of the hazardous characteristics listed in annex III to the Basel Convention and defined under class H6.2⁴.

15. For the purpose of these guidelines, infectious health-care wastes are:

(a) Discarded materials or equipment contaminated with blood and its derivatives, other body fluids or excreta from infected patients with hazardous communicable diseases (specified in section 6.1, subsection B.5 below). Contaminated waste from patients known to have blood-borne infections undergoing haemodialysis (e.g. dialysis equipment such as tubing and filters, disposable sheets, linen, aprons, gloves or laboratory coats contaminated with blood);

(b) Laboratory waste (cultures and stocks with any viable biological agents artificially cultivated to significantly elevated numbers, including dishes and devices used to transfer, inoculate and mix cultures of infectious agents and infected animals from laboratories).

16. Wherever appropriate and applicable, waste from basic and fundamental biomedical and other research shall be managed according to the principles set forth for health-care waste.

3.5. Biological health-care waste

17. All body parts and other anatomical waste including blood and biological fluids and pathological waste that are recognizable by the public or the health-care staff and that demand, for ethical reasons, special disposal requirements.

3.6. Sharps

18. All biomedical and health-care waste with sharps or pointed parts able to cause an injury or an invasion of the skin barrier in the human body. Sharps from infected patients with hazardous communicable diseases (specified in section 6.1, subsection B.5 below), isolated wards or other

¹ For further information the WHO handbook Safe Management of Wastes from Health-care Activities is recommended. See also paragraph 39 below.

² A. Prüss, E. Girault and P. Rushbrook, eds., Safe Management of Wastes from Health-care Activities” (Geneva, WHO, 1999).

³ Recommendations on the Transport of Dangerous Goods by Road, Eleventh revised edition (United Nations publication, Sales No. E. 99. VIII.1.

⁴ Further elaboration of the characteristics is the subject of working papers under discussion by the Convention’s Technical Working Group.

pointed parts contaminated with the above-mentioned laboratory waste must be categorized as infectious waste.

4.1 Types of hazards

19. As mentioned in section 1, biomedical and health-care waste includes a large component of non-risk waste and a smaller proportion of risk waste. Non-risk waste is similar to municipal waste and does not create more health or other hazards than mismanaged municipal waste. If the risk waste is not properly segregated from other waste fractions (e.g. mixture of biological and pathological waste with sharps and body fluids), the whole mixture has to be handled as infectious waste. In this section, potential hazards related to exposure to biomedical and health-care waste will be addressed.
20. Exposure to hazardous or potentially hazardous biomedical and health-care waste can induce disease or injury. The hazardous nature of biomedical and health-care waste may be due to the following or a mixture of the following properties:
- (a) It contains infectious agents, including contaminated sharps;
 - (b) It is cytotoxic or genotoxic;
 - (c) It contains toxic or hazardous chemicals or pharmaceuticals;
 - (d) It is radioactive;
 - (e) It contains sharps.
21. For the purposes of these guidelines, infectious substances are those substances known or reasonably expected to contain pathogens. Pathogens are defined as micro-organisms (including bacteria, viruses, rickettsia, parasites, fungi) or recombinant micro-organisms (hybrid or mutant) that are known or reasonably expected to cause infectious disease with a high risk for animals or humans. Note that not all pathogenic micro-organisms can be transmitted by waste as a pathway.

4.2 Persons at risk

22. All persons exposed to hazardous biomedical and health-care waste are potentially at risk of contamination through accidental exposure. This includes people within health-care establishments or any other source of biomedical and health-care waste, and people inside and outside these sources who either handle these wastes or are exposed to them, for example as a consequence of careless management. The main groups at risk are the following:
- (a) Doctors, nurses, ambulance staff and hospital sweepers;
 - (b) Patients in health-care establishments or under home care;
 - (c) Workers in support services to health-care establishments, such as laundries, waste handling and transportation, waste disposal facilities including incinerators and other persons separating and recovering materials from waste;

(d) Inappropriate or inadvertent end-users such as scavengers and customers in secondary markets for reuse (i.e. households, local medical clinics, etc.).

23. Owing to the extension of drug abuse and of home care including home dialysis, the hazards associated with scattered small sources of biomedical and health-care waste should not be overlooked.

4.3 Hazards from infectious waste

24. Infectious waste may contain a great variety of pathogenic micro-organisms, but not all can be transmitted to humans and animals by contact with waste.
25. The pathogens contained in the waste may infect the human body through the following pathways: absorption through a crack or cut in the skin (injection), absorption through the mucous membranes, and rarely by inhalation and ingestion.
26. Concentrated cultures of pathogens and contaminated sharps (in particular syringe needles) are probably the waste items that create the most acute human health hazards.

Table 1

Classification of risks and suggested remedies

Risk attached to:	ACTUAL RISKS								PERCEIVED RISKS	
	INFECTION						TOXIC		EMOTIONAL	
	Pricking, cutting		Inhalation, ingestion		Existing wounds		Contact, ingestion, inhalation		Sensibility, ethical position	
	Scale	Reduce by	Scale	Reduce by	Scale	Reduce by	Scale	Reduce by	Scale	Reduce by
A. Within health-care areas										
Category of person										
Patient	-	I	±	P, I	+	P, I	+	P, I	+	I
Health-care personnel	+	P, I	+	P, I	+	P, I	+	P, I	±	I
Logistic personnel	+	P, I	+	P, I	+	P, I	+	P, I	+	I
Other personnel	0		-	P, I	0		0		+	I
Visitors and service contractors	0		-	I	0		0		+	I
B. Outside health-care areas										
Category of person										
Transport personnel	+	P, I	±	P, I	±	P, I	+	P, I	+	I
Treatment personnel	+	P, I	±	P, I	±	P, I	+	P, I	+	I
Members of the public	0		0		0		0		+	I

Key to column symbols:

Scale of risk: 0 is trivial risk; - is low risk; ± is average risk; + is high risk

Means of reducing risk: P is by prevention, i.e. good practice (segregation etc.), indirect means (sterilization of waste etc.) and training (on hygiene and safety).

I is by information (communicating hygiene rules, public information, effective training).

4.4. Hazards from sharps

27. Sharps may not only cause cuts and punctures but also infect the wounds by agents which previously contaminated the sharps. Owing to this double risk of injury and disease transmission, sharps are considered problematic. The main diseases of concern are infections which may be transmitted by subcutaneous introduction of the agent - for example, viral blood infections.
28. Syringe needles are of particular concern because they constitute an important part of the sharps and are often contaminated with the blood of patients.

4.5 Hazards from chemical and pharmaceutical waste

29. Many chemicals and pharmaceuticals which are used in health-care establishments are hazardous chemicals (e.g. toxic, corrosive, flammable, reactive, explosive, shock-sensitive, cytotoxic or genotoxic). Fractions of these will be found in biomedical and health-care waste after their use or when they are no longer required.
30. They may have toxic effects, either through acute or chronic exposure, and injuries, including burns. Intoxications can result from absorption of the chemicals/pharmaceuticals through the skin or the mucous membranes and from inhalation or ingestion. Injuries can be provoked by contact of flammable, corrosive or reactive chemicals with the skin, the eyes or the mucous membrane of the lung (e.g. formaldehyde and other volatile chemicals). The most common injuries are burns.
31. Mercury is another hazardous product common within hospitals owing to its prevalent use in literally hundreds of different devices. It is most concentrated in diagnostic devices such as thermometers, blood pressure gauges and, oesophageal dilators, Miller Abbott/Cantor tubes. It is also found in other sources such as fluorescent light tubes and batteries.
32. Disinfectants constitute a particularly important group of hazardous chemicals, as they are used in large quantities and are often corrosive. It should also be noted that reactive chemicals may form highly toxic secondary compounds. Chemical residues discharged into the sewage system may have toxic effects on the operation of biological sewage treatment plants or on the natural ecosystems of receiving waters. Pharmaceutical residues may have the same effects, as they may include antibiotics and other drugs, heavy metals such as mercury, phenols and derivatives and other disinfectants and antiseptics.

4.5 Hazards from cytotoxic waste

33. The severity of health hazards for health-care workers handling cytotoxic waste arises from the combined effect of the substance toxicity and of the magnitude of exposure that may occur during waste handling or disposal. Exposure to cytotoxic substances in health care may also occur during preparation for treatment. The main pathways of exposure are inhalation of dust or aerosols, skin absorption and ingestion of food accidentally in contact with cytotoxic (antineoplastic) drugs, chemicals or waste, or from contact with the secretions of chemotherapy patients.

4.7 Hazards from radioactive waste

34. Radioactive materials are unique in that they cause harm through both external radiation (by approaching them or handling them) and through their intake into the body. The degree of harm depends on the amount of radioactive material present or taken into the body and on the type of material. Exposure to radiation from high-activity sources, such as those used in

radiotherapy, can cause severe injuries, ranging from superficial burns to early fatalities. Radioactive waste arising from nuclear medicine is much lower in activity than the sources referred to above and is unlikely to cause such harm, but exposure to all levels of radiation is considered to be associated with some risk of carcinogenesis, however small.

35. There are well-established procedures for minimizing the hazards arising from work with radioactive materials, and these are normally implemented in hospitals and laboratories where such materials are used. Similarly, the arrangements for safe radioactive waste storage and disposal are well established. There should be a person or persons appointed in the organization with responsibility for ensuring that radiation protection is observed and that radioactive waste is properly and safely managed. International recommendations on the safe management of radioactive wastes are established by IAEA and are applicable to their control in health care.⁵

36. These guidelines shall be applicable for the generation of biomedical and health-care wastes from health-care establishments. Health-care establishments shall specifically include the following:
 - (a) Large sources:
 - (i) University hospitals and clinics;
 - (ii) Maternity hospitals and clinics;
 - (iii) General hospitals.

 - (b) Medium sources:
 - (i) Medical centres;
 - (ii) Out-patient clinics
 - (iii) Mortuary/autopsy centres;
 - (iv) Farm and equine centres;
 - (v) Hospices;
 - (vi) Abortion clinics
 - (vii) Medical laboratories
 - (viii) Medical research facilities;
 - (ix) Animal hospitals;
 - (x) Blood banks and transfusion centres;
 - (xi) Emergency services.

⁵ Management of radioactive wastes produced by users of radioactive materials, Safety Series No.70, IAEA, Vienna (1985).

Handling, treatment, conditioning and storage of biological radioactive wastes, IAEA-TECDOC-775 (1994).

Management of small quantities of radioactive waste, IAEA-TECDOC-1041 (1998).

- (c) Small sources:
 - (i) General medical practitioners;
 - (ii) Convalescent homes;
 - (iii) Nursing and remedial homes;
 - (iv) Medical consulting rooms;
 - (v) Dental practitioners;
 - (vi) Animal boarding and hunt kennels;
 - (vii) Tattooists;
 - (viii) Acupuncturists;
 - (ix) Veterinary practitioners;
 - (x) Pharmacies;
 - (xi) Cosmetic piercers;
 - (xii) Zoos, safari parks, etc.

37. The following classification of biomedical and health-care waste is based on the major classification in annexes I, II, VIII and IX of the Basel Convention but specified for practical use in the health-care sector. Biomedical and health-care waste is therefore classified in the following groups:

- A Health-care wastes with the same composition as household and municipal waste
 - A1 Normal household and municipal waste
- B Biomedical and health-care waste requiring special attention
 - B1 Human anatomical waste (tissues, organs, body parts, blood and blood bags)
 - B2 Waste sharps (needles, syringes, scalpels, slides, ampoules, etc.)
 - B3 Pharmaceutical waste (e.g. expired medicines)
 - B4 Cytotoxic pharmaceutical wastes
 - B5 Blood and body fluid waste (materials contaminated with blood or other body fluids, soiled cotton from non-infected patients)
Wastes which only require special measures to prevent the risk of infection during their management.

C Infectious wastes

For the purpose of these guidelines, infectious health-care wastes⁶ are:

- (a) Discarded materials or equipment contaminated with blood and its derivatives, other body fluids or excreta from infected patients with hazardous communicable diseases (specified in section 6.1, subsection B.5 below). Contaminated waste from patients known to have blood-borne infections undergoing haemodialysis (e.g. dialysis equipment such as tubing and filters, disposable sheets, linen, aprons, gloves or laboratory coats contaminated with blood);
- (b) Laboratory waste (cultures and stocks with any viable biological agents artificially cultivated to significantly elevated numbers, including dishes and devices used to transfer, inoculate and mix cultures of infectious agents and infected animals from laboratories).

D Other hazardous wastes¹.

Not exclusive to the medical health-care sector, e.g. solvents, chemicals, batteries, fixer solutions, etc.

E Radioactive waste from health care.

6.1 Fact sheets

B1: Human anatomical waste

Description

Non-infectious human body parts, organs and tissues and blood bags.

Examples of such wastes

Tissue waste, removed organs, amputated body parts, placentas, etc.

Waste management guidance

It is primarily for ethical reasons that special requirements must be placed on the management of waste human body parts, organs and tissue. The waste must be collected in appropriate containers or bags as soon as possible and at the place where it is generated. The waste must be kept in tight receptacles (e.g. in the wooden coffins commonly used in pathology) and under cooled conditions when stored temporarily for a prolonged period of time, or else be handed over to a waste management facility within a reasonable period. Intermediate storage takes place at a location which is accessible only to trained personnel. Normally, the waste must always be

⁶ The interpretation of the definition of infectious health-care waste varies with national circumstances, policies and regulations; international organizations have specific interpretations of the definition (see notes 2 and 3 above). Infectiousness is one of the hazardous characteristics listed in annex III to the Basel Convention and defined under class H6.2. Further elaboration of the characteristics is the subject of working papers under discussion by the Conventions' Technical Working Group.

incinerated completely, in an appropriate facility. Household waste incineration plants are, as a rule, not suitable for the incineration of amputated body parts, removed organs and placentas (cases of exceptions, such as separate storage and direct feeding, have to be clarified with the responsible authorities and the management of the incineration plant). In exceptional cases crematoria can be used for the incineration (disposal) of amputated body parts.

Exemptions and special provisions

Where only small quantities of these wastes are generated (e.g. in medical practices), they can be collected in appropriate containers (e.g. "hard box") and managed jointly with municipal waste at a volume of up to 1 litre per waste bag. The management of animal waste body parts, organs and tissues is subject to the provisions of relevant special legislation.

B2: Waste posing the risk of injury (sharps)

Description

Sharps are all objects and materials which are closely linked with health-care activities and pose a potential risk of injury and/or infection.

Examples of such wastes

Needles, drain tubes, syringes with the attached needle, butterfly needles, spikes, broken glassware, ampoules, pipettes, scalpel blades, lancets, vials without content, etc.

Waste management guidance

Wastes posing the risk of injury require measures to be taken to prevent injury and infection during the handling of these wastes within and outside of health-care establishments. These wastes have to be collected and managed separately from other waste. The collection containers must be puncture-resistant and leak-tight. Storage of these wastes takes place at a location which is accessible only to trained personnel.

Note: Sharps from infected patients, isolated wards, infected patients undergoing haemodialysis or other pointed parts contaminated with laboratory waste must be categorized as infectious waste.

Exemptions and special provisions

Syringes and needles should not be reused.

Note: Some countries treat all sharps as infectious waste.

B3: Pharmaceutical waste

Description

Pharmaceutical wastes are pharmaceuticals which have become unusable for the following reasons:

- Exceeded expiration date;
- Expiration date exceeded after the packaging or the ready-to-use preparation prepared by the user has been opened;
- Cannot be used for other reasons (e.g. call-back campaign).

Examples of such wastes

The term "pharmaceuticals" embraces a multitude of active ingredients and types of preparations. The spectrum ranges from teas through heavy-metal-containing disinfectants to highly specific medicines containing a large variety of different hazardous or non-hazardous substances. Waste management may therefore be based on a differentiated approach; for example, pharmaceutical waste could be divided into three classes and its management carried out in a class-specific manner as follows:

- Pharmaceutical wastes: Class 1

Pharmaceuticals such as camomile tea and cough syrup which pose no hazard during collection, intermediate storage and waste management.

Class 1 pharmaceutical wastes are not considered hazardous wastes. They are managed jointly with municipal waste.

- Pharmaceutical wastes: Class 2

Pharmaceuticals which pose a potential hazard when used improperly by unauthorized persons.

Class 2 pharmaceutical wastes are considered to be hazardous wastes. Their management takes place in an appropriate waste disposal facility.

- Pharmaceutical wastes: Class 3

Heavy-metal-containing and unidentifiable pharmaceuticals, heavy-metal-containing disinfectants, which, owing to their composition, require special management. Class 3 pharmaceutical wastes are considered to be hazardous wastes. Their management takes place in an appropriate waste disposal facility. However, owing to the fact that medicines are not normally labelled in accordance with their hazardous characteristics, the sorting of medicines into different classes, in particular classes 2 and 3, may often be too difficult in practice. Countries may therefore decide to consider all or a major part of medicines as hazardous waste or waste requiring special consideration.

Waste management guidance

Waste prevention: To reduce the generation of pharmaceutical waste, stocks of pharmaceuticals should be inspected periodically and checked for their durability (expiration date).

Recovery by specialized facilities: Possibilities for returning old pharmaceuticals to the producer or handing them over to a special collection system (e.g. pharmacies) for possible subsequent use could be explored. Such a return of pharmaceuticals in their original packaging prior to or within a reasonable period after the expiration date is possible if it is ensured that the producer or collector examines possibilities for subsequent use of the pharmaceuticals and that pharmaceuticals which are no longer usable are disposed of in an environmentally sound manner.

Pharmaceutical wastes which are considered to be hazardous wastes have to be collected separately in appropriate containers. Intermediate storage takes place at a location which is accessible only to trained personnel. This should be done in a manner to avoid misuse.

Exemptions and special provisions

Cytotoxic pharmaceutical waste: See Group B4: Cytotoxic pharmaceutical wastes.

B4: Cytotoxic pharmaceutical wastes

Description

Cytotoxic (antineoplastic) pharmaceutical wastes are wastes which can arise from use (administration to patients) and manufacture and preparation of pharmaceuticals with a cytotoxic (antineoplastic) effect. These chemical substances can be subdivided into six main groups: alkylated substances, antimetabolites, antibiotics, plant alkaloids, hormones and others. A potential health risk to persons who handle cytotoxic pharmaceuticals results above all from the mutagenic, carcinogenic and teratogenic properties of these substances. Consequently, these wastes pose a hazard, and the measures to be taken must also include those required by occupational health and safety provisions.

Examples of such wastes

Specific lists of pharmaceuticals which contain cytotoxic substances are available. Discernible liquid residues of cytotoxic concentrates, post-expiration-date cytotoxic pharmaceuticals and materials proven to be visibly contaminated by cytotoxic pharmaceuticals must be disposed of as cytotoxic pharmaceutical waste.

Waste management guidance

The risks posed by cytotoxic pharmaceuticals are primarily of relevance for persons who come into contact with them during preparation and during or after their use. It has long been common practice in hospitals to see to it that the number of persons who come into contact with these products is small. Specific guidance

on this is available. These wastes usually arise at central locations, i.e. in pharmacies and laboratories and they are also often found at places where the ready-to-use cytotoxic solutions are prepared. Intermediate storage of these wastes takes place under controlled and locked conditions.

The precautions taken during the use of cytotoxic pharmaceuticals must also be applied on their journey outside the respective establishment, as releases of these products can have adverse environmental impacts. The management of these wastes, in covered and impermeable containers, must therefore be strictly controlled. Solid containers must be used for collection. The use of coded containers is recommended. For reasons of occupational safety, cytotoxic pharmaceutical wastes must be collected separately from pharmaceutical waste and disposed of in a hazardous waste incineration plant.

Exceptions and special provisions

None.

B5: Wastes with blood and body fluid

Description

These are wastes from health-care establishments not categorized as infectious wastes which are contaminated with human or animal blood, secretions and excretions. It is reasonable to assume that these wastes might be slightly contaminated with pathogens (in nearly the same way as household waste).

Examples of such wastes

Dressing material, swabs, syringes without the attached needle, infusion equipment without spikes, bandages, etc.

Waste management guidance

Special requirements must be imposed on the management of these wastes from the viewpoint of infection prevention inside the health-care establishments. Double bags or containers made of strong and leak-proof material are used for the collection of these wastes within health-care establishments.

Proper management of these wastes is by incineration in a household waste incineration plant but they can also be disposed of together with household waste on a controlled landfill site. It should be noted that some countries prohibit the landfilling of waste with blood and body fluids.

Exemptions and special provisions

This mixture of wastes should not be recycled.

Description

Special requirements regarding the collection and management of infectious wastes must be imposed whenever waste is known or, on the basis of medical experience, expected to be contaminated by causative agents of the diseases listed below and when this contamination gives cause for concern that the disease might spread. The list comprises diseases which make particular demands on infection prevention when the following factors are taken into account:

- The associated risk of infection (contagiousness, infection dose, epidemic potential);
- The viability of the pathogen (infection capacity/infectiousness);
- The route of transmission;
- The extent and nature of the potential contamination;
- The quantity of contaminated waste;
- The severity and treatability of the disease that might be caused.

The wastes belonging to this group may occur in the context of diagnosis and treatment of patients suffering from the following diseases (relevant pathogen-containing excretions are given in brackets):

Acquired immunodeficiency syndrome (AIDS)* (blood)
Viral hepatitis* (blood, faeces)
Creutzfeld-Jacob disease (CJD), transmissible spongiform encephalopathy (TSE)* (tissue, cerebrospinal fluid)
Cholera[#] (faeces, vomit)
Typhoid fever/paratyphoid fever[#] (faeces, urine, bile)
Enteritis, dysentery, enterohaemorrhagic Escherichia coli (EHEC)-induced haemolytic uraemic syndrome (HUS)[#] (faeces)
Active tuberculosis (respiratory tract secretions, urine, faeces)
Meningitis/encephalitis (respiratory tract secretions, cerebrospinal fluid)
Brucellosis (blood)
Diphtheria (respiratory tract secretions, secretions from infected wounds)
Leprosy (secretion from nose/infected wounds)
Anthrax (respiratory tract secretions, secretion from infected wounds)

⁷ For the purpose of these guidelines, infectious health-care wastes are:

- (a) Discarded materials or equipment contaminated with blood and its derivatives, other body fluids or excreta from infected patients with hazardous communicable diseases. Contaminated waste from patients known to have blood-borne infections undergoing haemodialysis (e.g. dialysis equipment such as tubing and filters, disposable sheets, linen, aprons, gloves or laboratory coats contaminated with blood).
- (b) Laboratory waste (cultures and stocks with any viable biological agents artificially cultivated to significantly elevated numbers, including dishes and devices used to transfer, inoculate and mix cultures of infectious agents and infected animals from laboratories).

The interpretation of the definition of infectious health-care waste varies with national circumstances, policies and regulations; other international organizations have specific interpretations of the definition (see notes 2 and 3 above). Infectiousness is one of the hazard characteristics listed in annex III to the Basel Convention and defined under class H 6.2. Further elaboration of the characteristics is the subject of working papers under discussion by the Conventions Technical Working Group.

Plague (respiratory tract secretions, secretion from infected wounds)
Poliomyelitis (respiratory tract secretions, faeces)
Q fever (respiratory tract secretions, blood, dust)
Glanders (respiratory tract secretions, secretion from infected wounds)
Rabies (respiratory tract secretions)
Tularaemia (pus)
Virus-induced haemorrhagic fever, including hantavirus-induced renal (HFRS) and pulmonary (HPS) syndromes (blood, respiratory tract secretions, secretion from infected wounds, urine)

Waste of this kind is typically generated in the following places: isolation wards of hospitals; dialysis wards or centres caring for patients infected with hepatitis viruses (yellow dialysis); pathology departments; operating theatres; and medical practices and laboratories which mainly treat patients suffering from the diseases specified above.

The relevant wastes are wastes contaminated with pathogen-containing blood, excretions or secretions (see list) or containers containing blood in liquid form.

Examples

The infections marked with (*) are usually transmitted through inoculation. Therefore, the wastes of relevance here are not taken to include dry contaminated waste from sporadic patients suffering from diseases in question (AIDS, viral hepatitis, CJD), such as contaminated swabs (e.g. from taking of blood samples), cotton plugs used in dental practices, etc. However, they do include blood-filled vessels and waste drenched with blood or secretions from surgeries performed on infected patients, used dialysis systems from yellow dialysis as well as wastes drenched with blood/secretions from medical practices and laboratories mainly treating patients who have contracted the diseases in question.

The infections marked with (#) are transmitted via faeces and oral ingestion of contaminated material. Relevant bodily discharges may be fed to the waste-water stream in observance of hygienic requirements. Management under conditions that would result from categorization as infectious waste must be considered only when the waste is heavily contaminated with excretions from diagnosed patients.

Infectious wastes in any case include the following:

(a) All microbiological cultures generated, for example, in institutes working in the fields of hygiene, microbiology and virology as well as in medical laboratories, medical practices and similar establishments and in which a multiplication of pathogens of any kind has occurred;

(b) Experimental animals as well as litter and animal faeces from animal test laboratories, if transmission of the above-mentioned diseases is to be expected.

Waste management guidance

Infectious wastes must be collected in tear-resistant and leakproof containers and transported to a central storage facility/delivery point in carefully sealed condition and without any transfer into other containers or sorting (containers marked with the "biohazard" symbol). They must be collected and transported in a way that precludes direct contact, and they may not be transferred into other containers at the central storage facility or during delivery. They must be stored in such a way that gas formation in the collection containers is avoided. To this end, efforts must be made to ensure that storage periods are as short as possible depending on climatic conditions (e.g. storage at temperatures below +15°C for not more than one week or at a temperature of 3°C to 8°C for a longer storage period).

Infectious waste must either be incinerated (approved incineration plant) or be disinfected prior to final disposal using a recognized method, preferably treatment with saturated live steam. Disinfected wastes may be disposed of in the same way as domestic waste. The disinfection plants must be operated under the operating parameters prescribed for waste disinfection, and this mode of operation must be documented. The use of a mobile disinfection plant to treat infectious waste is permissible only if the waste disposer furnishes proof that the plant has been checked by the competent authority or an approved institution for its functional and operational reliability on a regular basis.

The efficiency of the vapour disinfection plant must be verified by a recognized institution when the plant is first put into operation and at regular intervals thereafter (e.g. twice a year), using appropriate microbiological indicators (see annex IV).

Exceptions and special provisions

Body fluids and excreta of infected patients with hazardous communicable diseases can be discharged to the sewerage system if there is a strict separation between the waste and drinking water installations and the sewerage system is connected to a waste-water plant. In other cases, the body fluids and excreta have to be disinfected before being discharged to the sewerage system. Exceptionally for developing countries, infectious waste can be disposed of by using a special area in a controlled landfill if there is no risk of contamination of ground or drinking water and the infectious waste is directly covered with earth or other material.

E: Radioactive waste

Description

Material contaminated with a radioisotope which arises from the medical or research use of radionuclides. It is produced, for example, during nuclear medicine, radio immunoassay and bacteriological procedures, and may be in a solid, liquid or gaseous form.

Examples of such wastes

Radioactive waste includes solid, liquid and gaseous waste contaminated with radionuclides generated from in vitro analysis of body tissue and fluid, in vivo body organ imaging and tumour localization, and investigative and therapeutic procedures. Radioactive health-care waste usually contains radionuclides of short half-lives like ^{32}P (\square , 14.3 days half-life), ^{57}Co (\square , 271 days half-life) or $^{99}\text{Tc}^{\text{m}}$ (\square , 14.3 days half-life) which lose their activity relatively quickly. Certain therapeutic procedures require the use

of radionuclides with longer half-lives like ^{60}Co (□, 5.3 years half-life), ^{137}Cs (□, 30 years half-life) or ^{226}Ra (□, 1600 years half-life), which are usually conditioned as pins, pills or needles and may be reused on other patients after sterilization.

Waste management guidance

Where activity limits for immediate or simple disposal methods cannot be met (clearance levels), health-care establishments should segregate radioactive waste and store it during the required period to reduce the activity level. If the activity concentration is below these clearance levels, the material may be disposed of by normal methods. Guidelines on clearance levels have been provided by IAEA.⁸ Since the half-life of most radioactive materials used in hospitals is in the range of hours or days, storage for a period of one or two months can be followed by disposal to the ordinary waste system with appropriate monitoring. Decayed non-infectious radioactive waste is placed inside black plastic bags if they are intended for landfilling. Decayed but infectious radioactive wastes are placed in yellow plastic bags in preparation for disinfection. They should not be used as landfill prior to disinfection.

All radioactive waste designated for storage to allow decay should be kept in suitable containers which prevent dispersion of the content. A plastic bag in a large can or drum is an appropriate container. Containers used for the storage of radioactive waste should be clearly labelled to show the activity of the radionuclide on a given date and the period of storage required. These containers should be stored in a specifically marked area in a lead-shielded storage room for radioactive substances or for radioactive waste. The storage record should be endorsed specifically to indicate which items are "radioactive waste". Containers of radioactive waste should be marked "RADIOACTIVE WASTE" and should carry the radiation symbol.

High-level and usually long-half-life radionuclides used in health-care activities are used for therapeutic purposes, conditioned as sealed sources, in the format of pills, seeds, ribbons, tubes or needles. These sealed sources are recovered after use, washed, disinfected and stored under lead-shielding for reuse on other patients. These items may, however, become waste if their conditioning is damaged, if they have lost too much of their activity, or if they are no longer required. Spent radionuclide generators also become waste. In countries without a nuclear industry equipped to dispose of high-level radioactive waste, hospitals should package these items appropriately or place them inside the same boxes in which they were originally supplied, and send them back to their original supplier for reprocessing, eventual recycling or safe final disposal. In countries with the appropriate nuclear industry, hospitals may alternatively send non-recyclable high-level waste to the national radioactive waste disposal agency, which will take care of them. These items are usually valuable, and, in most cases, it is possible to reprocess them for recycling.

Exceptions and special provisions

Any health-care establishment using radioactive substances should

⁸ Clearance of materials resulting from the use of radionuclides in medicine, industry and research, IAEA-TECDOC-100 (1989).

hire a specialized radiation officer who, among other duties, will monitor the management and disposal of radioactive waste and the storage of radioactive items.

38. It is generally recognized that waste management plans provide the best mechanism for improvement of environmental performance in waste management. A waste management plan can help generators to conserve resources and minimize waste through improved purchasing and reuse practices and through cost-effective, environmentally sound source separation, segregation, collection, transport, treatment and disposal of all waste streams generated within their facilities.
39. It is recommended that the plan be in the form of an environmental management system based on the ISO 14001 series of environmental management standards. This systems approach helps to ensure that auditable, verifiable documentation is available to demonstrate that operations are taking place as required. Such a system will also assist with the provision of quality data and information on which a state-of-the-environment report can be prepared. A prerequisite for developing or updating such a plan is adequate characterization and analysis of the existing waste stream and a detailed assessment of existing waste management practices. This process is commonly referred to as a waste audit.

7.1 Avoidance/prevention

40. According to the principles of the Basel Convention, each Party shall take the appropriate measures to ensure that the generation of hazardous wastes and other wastes within it is reduced to a minimum and that adequate disposal facilities for the environmentally sound management of hazardous wastes and other wastes are available.
41. For the various health-care establishments, waste management in observance of the waste avoidance and recovery obligation presupposes a system that is practice-oriented, clearly structured and manageable with clearly defined logistics. This can be achieved only if everyone who works in the health services sector gives increased thought to this issue and takes action to ensure that the volume and hazardousness of wastes are minimized.
42. The increasing relevance of the waste management problem demands an ecologically oriented reorganization. This should start with procurement, by giving preference to environmentally sounder products and replacing harmful or disposable products with reusable or alternative products, if these meet the relevant requirements in terms of hygiene and patient safety.
43. A noticeable reduction in waste volume can be achieved only if disposable products already in use are scrutinized as to their necessity. In principle, disposables such as disposable cutlery, disposable linen (including covering sheets), disposable instruments and equipment (scissors, scalpels, forceps) and disposable containers (kidney dishes, infusion bottles) should be replaced by reusable products and long-lived alternatives. For examples of specific reuse, waste reduction and waste recycling activities, see annex III and the literature mentioned in the bibliography.

7.1.1 Packaging

44. An issue closely related to the procurement of products is their packaging. It is possible to reduce the amount of waste generated noticeably if attention is paid in the selection of products to the associated amount of packaging. The latter should not exceed the minimum necessary to meet transportation, storage, hygiene and sterility requirements. Before orders are placed, the material input for the product and the packaging as well as the resulting input required for waste management should be taken into account.
45. The input required for the management of packaging waste can be reduced when:
- (a) Preference is given to products involving small amounts of packaging;
 - (b) Preference is given to product packaging which can be refilled, reused or otherwise used as a supply or disposal receptacle within or outside the facility at which the product is used;
 - (c) Preference is given to demand-oriented package sizes;
 - (d) The manufacturer or supplier of the product is required, when placing the order, to take back the associated transport packaging and containers.
46. Where it cannot be avoided, packaging should be collected separately and fed to an appropriate recovery process. Appropriate recovery is common for cardboard, paper, glass and metals. Plastics can best be recovered if they are collected as type-specific fractions.

7.1.2 Kitchen and canteen waste

47. Kitchen and canteen waste can be utilized as feed substitute if it is disinfected in a manner that is appropriate for such use or if such use conforms with the conditions imposed by the authorities.

7.1.3 Laboratory waste and chemical residues

48. An effort should be made to establish which hazardous products and substances in the health-care industry can be avoided completely. Chemical residues can be reduced by adapting laboratory apparatus to the "state of the art" and performing laboratory tests and analyses if they meet medical needs. In the procurement of laboratory devices, attention should be paid to the aspect of relative chemical consumption.
49. The use of mercury contained in hospital diagnosis devices such as blood pressure gauges and thermometers has been targeted for elimination and future avoidance in many countries. Elemental mercury is toxic and such uses present hazards during use and at end-of-life. Mercury can neither be safely landfilled nor incinerated. Fortunately, safer alternatives now exist for each of these mercury-containing products. Thus the problem is best avoided in the first instance through procurement policies.
50. With regard to laboratory chemicals, a priority task is to find out whether the use of chlorinated hydrocarbons as solvents is unavoidable. The aim should be to replace such laboratory procedures. Laboratory chemicals and solvents should be collected and recovered, if the cost of recovery entailed is reasonable in comparison with that of other forms of waste management. The best possibilities for solvent recovery exist in pathology, histology and anatomy because relatively large amounts of fat and blood-contaminated solvents (xylene, toluene and others) arise in these sectors.

7.2 Segregation, collection, labelling and handling of biomedical and health-care waste

51. Segregation is the key to effective biomedical and health-care waste management. It ensures that the correct disposal routes are taken, personnel safety is maintained, environmental harm is minimized and recycling consumes the least resources. Biomedical and health-care waste should be segregated and collected in accordance with the specific treatment or disposal requirements.
52. Segregation should be carried out under the supervision of the waste producer and as close as possible to the point of generation. Segregation must therefore take place at source, that is, in the ward, at the bedside, in the theatre, in the laboratory, in the delivery room, etc., and must be carried out by the person generating the waste, for example the nurse, the doctor or the specialist, in order to secure the waste immediately and to avoid dangerous secondary sorting. It should be undertaken on the basis of the types of waste listed in the definition for biomedical and health-care waste.
53. Each health-care institution should prepare and follow a waste plan. Correct and efficient segregation will be achieved only through rigorous training and education of employees, supervisors and managers, and policies should take this into account.
54. The same segregation system should be uniformly applied throughout the whole country. The segregation must be applied from the point of generation throughout the entire waste stream to the point of final disposal, whether or not it is on-site. All storage and transportation methods must also follow this segregation system.
55. Segregated wastes of different categories need to be collected in identifiable containers. Every room, such as wards, laboratories and operating theatres, should have containers/bags for the types of wastes that are generated in that room. The waste segregation and identification instructions should be placed at each waste collection point to ensure proper procedure. Waste containers made of non-halogenated leakproof combustible materials should always be given preference. Plastic bags for storing the waste may be suspended inside a frame or placed inside a sturdy container. A lid should be provided to cover the opening of the bag. Sharps must always be collected in puncture-proof containers (not made of glass) to avoid injuries to and infection of the workers handling them.
56. Clinical and sanitary personnel should ensure that the waste bags are removed and sealed when they are not more than three-quarters full. The preferred method of sealing involves a plastic sealing tag of the self-locking type; bags should never be closed by stapling. Each bag should be labelled with the point of generation (ward and hospital) and content.
57. A common system of labelling and coding of packaging should be developed for biomedical and health-care waste. A possible way of identifying biomedical and health-care waste categories is by sorting the waste into colour-coded bags or containers. As an example, a WHO-recommended colour coding is given in table 2. The use of internationally recognized symbols and signs is of very basic importance and is essential for the safety of handling and disposal of waste. It is recommended that the colour coding, the symbols and signs should be part of the waste management instructions and should be made known, e. g. by a poster on the wall at the waste collection points.

Type of waste	Colour of container and markings*	Type of container
Highly infectious waste	Yellow, marked "HIGHLY INFECTIOUS"	Strong, leakproof plastic bag, or container capable of being autoclaved

Other infectious waste, pathological and anatomic waste	Yellow	Plastic bag or containers
Sharps	Yellow, marked "SHARPS"	Puncture-proof containers
Chemical and pharmaceutical waste	Brown	Plastic bag or container
Radioactive waste**	-	Lead box, labelled with the radioactive symbol
General health-care waste	Black	Plastic bags

* Proposed colour coding and marking system; the use of other colour coding in a country is possible.

** Generated only in major hospitals.

58. Certain recommendations should be followed by the ancillary workers in charge of waste collection. They include:

(a) Waste should be collected daily from the wards, or as frequently as required, and transported to the central storage place;

(b) No bags should be removed without labelling indicating the point of generation (hospital and ward) and content;

(c) The workers should immediately replace the bags or containers with new ones of the same type.

59. Empty collection bags or containers should be readily available at the point of waste generation.

7.3 In-house transport and storage

60. It is important to ensure that waste does not accumulate at the point of generation. A routine for the collection of waste should be established in the waste management plan. Wastes should be moved through the facility in such a manner as to prevent unnecessary exposure to staff and others. Handling and transportation of waste containers should be minimized to reduce the likelihood of exposure to the waste. Specific routes should be planned through the facility to minimize the passage of loaded carts through patient care and other clean areas.

61. Carts used for moving biomedical and health-care waste through the health-care facility should be designed to prevent spills, and should be made of materials able to withstand exposure to common cleaning agents. They should have the following attributes:

(a) Easy loading and deloading;

(b) No sharp edges which could damage waste bags or containers during loading and deloading;

(c) Easy to clean.

62. All seals should be in place when movement of the bag has been completed. The carts should be cleaned regularly to prevent odour and as soon as possible if the waste material leaks or spills in the carts. The biohazard symbol should be clearly displayed on carts for the transport of infectious waste. These carts must be thoroughly cleaned before any maintenance work is

performed on them. The facility's infection control committee, biosafety officer or other appointed person should be consulted about the frequency of cleaning and the type of cleaning agent to be used.

63. After biomedical and health-care waste has been collected and moved from the point of generation, it must be held in storage areas to await disposal. These storage areas - either a separate area, room or building - should be dimensioned according to the quantities of waste generated and the frequency of collection. These areas must be totally enclosed and separate from supply rooms or food preparation areas. Recommendations for properties and equipment of the storage facilities are listed in box 1.
64. Storage areas must be identified as containing infectious waste, with the biohazard symbol clearly displayed. It is unacceptable for materials other than waste to be placed in the same storage area as infectious waste. Floors, walls and ceilings of storage areas must be thoroughly cleaned in accordance with the established procedures of the facility. These procedures should be prepared in consultation with the facility's infection control committee, biosafety officer or other appointed person.

Properties and equipment

- Impermeable hard-standing base with good drainage, easy to clean and disinfect and equipped with water supply;
- Readily accessible to staff in charge of handling the waste;
- Fitted with a lock, to prevent access by unauthorized persons;
- Easily accessible to collection vehicles (carts);
- Inaccessible to animals, insects and birds;
- Good lighting and ventilation;
- Not situated in the proximity of fresh food stores or food preparation areas;
- Situated close to the supply of cleaning equipment, protective clothing and waste bags or containers.

65. Unless a cooled storage room is available the proposed storage periods recommended by WHO between the generation and treatment of biomedical and health-care waste are the following:

Temperate climate: maximum 72 hours in winter
 maximum 48 hours in summer

Warm climate: maximum 48 hours during the cool season
 maximum 24 hours during the hot season

66. Anatomical waste should be stored at a temperature of 3° C to 8° C. All infectious waste must be refrigerated at a temperature of 3° C to 8° C if stored for more than a week. Health-care facilities should determine the maximum storage time of refrigerated or frozen biomedical and health-care waste based in the light of their storage capacity, rate of waste generation and any applicable local regulatory requirements.
67. Facilities refrigerating or freezing stored waste should use a lockable, closed storage facility or a lockable domestic-type freezer unit. Either type must be used only for storing anatomical and infectious waste, must display the biohazard symbol visibly and must be identified as containing infectious waste. Note that glass or plastic items containing infectious agents may fracture at lower temperatures.
68. The compacting of untreated infectious waste or waste with a high content of blood or other body fluids destined for off-site disposal (for which there is a risk of spilling) is not permitted.

Cytotoxic waste should be stored in a specific place, separate from the storage room devoted to other biomedical and health-care waste.

69. Depending on the local legislation, radioactive waste should be stored in containers preventing dispersion, behind lead shielding. Waste designated for storage to allow decay should be labelled with the type of radionuclide, date and required storage details.

7.4 Special requirements for packaging and labelling for off-site transport

70. Risks may occur during the storage, handling, transportation and disposal of the infectious waste. For this reason, biomedical and health-care waste generators are responsible for safe packaging, adequate labelling and authorization of the destination of the waste to be transported off-site. Hazardous biomedical and health-care waste should be packaged and labelled to comply with national regulations regarding the transport of hazardous wastes (dangerous goods), and with international agreements if they are shipped abroad for treatment. Where there are no such national regulations, the responsible authorities may refer to the "Recommendations on the Transport of Dangerous Goods" published by the United Nations, and specifically section 2.6.3 on infectious substances.

71. The control strategy for hazardous biomedical and health-care waste shall have the following components:

(a) A consignment note should accompany the waste from production to final disposal; after the journey, the transporter should complete the part of the consignment note especially reserved for him and return it to the generator;

(b) The transporting organization should be registered with, or known to, the waste regulation authority;

(c) Handling and disposal facilities should hold a permit issued by a waste regulation authority, allowing the facilities to handle and dispose of hazardous biomedical and health-care waste.

72. The consignment note should be designed taking into account the waste control system in operation in the State concerned and also taking into account the forms issued in pursuance of the Basel Convention.⁹ Anyone involved in biomedical and health-care waste generation, handling or disposal should be subject to a general "duty of care", i.e. ensure that documentation and transmission of waste comply with the national regulations.

7.4.1 Packaging requirements

73. In general, the waste should be packaged in resistant and sealed bags or containers to prevent spilling during handling and transportation. The bags or containers should be resistant to their content (puncture-proof for sharps, resistance to aggressive chemicals) and to normal conditions of handling and transportation such as vibration and changes in temperature, humidity or pressure (resulting from altitude, for example). In the United Nations Recommendations on the Transport of Dangerous Goods, "infectious substances" are defined (section 2.6.3.1.1) as those substances known or reasonably expected to contain pathogens. Pathogens are defined as micro-organisms (including bacteria, viruses, rickettsiae, parasites, fungi) or recombinant micro-organisms (hybrid or mutant) that are known or reasonably expected to cause infectious disease in animals or humans.

⁹ Instruction manual, Basel Convention Series/SBC No: 98/003.

74. Substances are not subject to the requirements of this section of the United Nations Recommendations if they are unlikely to cause human or animal disease. Most of the infectious wastes from health-care establishments are wastes derived from the medical treatment of animals or humans or from bio-research. These wastes are mostly transported under UN No. 3291 in the Dangerous Goods List attached to the Recommendations. Waste from infectious substances which can be specified (e.g. laboratory waste) shall be assigned to UN Nos. 2814 or 2900. Decontaminated wastes which previously contained infectious substances are considered non-dangerous unless the criteria of another class are met.

75. According to the packing instructions for infectious substances set out in the United Nations Recommendations, the packaging should include the following essential elements:

- (a) An inner packaging comprising:
- seal, a
- between
- receptacles are
- so as to
- (i) Watertight primary receptacle of metal or plastics with leakproof seal (e.g. a heat skirted stopper or a metal crimp seal);
- (ii) A watertight secondary packaging;
- (iii) Absorbent material in sufficient quantity to absorb the entire contents placed the primary receptacle and the secondary packaging; if several primary receptacles are placed in a single secondary packaging, they shall be individually wrapped so as to prevent contact between them;
- (b) An outer packaging of adequate strength for its capacity, mass and intended use, and with a minimum external dimension of 100 mm.

7.4.2 Labelling

76. All waste bags or containers should be identified by labels containing basic information on producer and content. This information may be directly written on the bag or container or by pre-printed labels. According to the United Nations Recommendations, the following indications should appear on the label:

- The United Nations substance class, e.g. class 6, division 6.2, UN No. 3291 for infectious waste;
- The United Nations label for class 6, division 6.2;
- The proper shipping name;
- The total quantity of waste covered by the description (by mass or volume);
- The packaging should be appropriately marked with the month and the last two digits of the year of manufacture;
- The country authorizing the allocation of the mark, indicated by the distinguishing sign for motor vehicles in international traffic.

7.5 Recycling/recovery

77. Recovery and recycling constitute one step in a systematic priority approach for environmentally sound waste management. Waste segregation at source is the basic requirement for cost-effective normal recycling operations on the non-hazardous component of biomedical and health-care waste. Some examples for the recycling of non-hazardous waste components are given in annex III.

78. Opportunities for chemical waste recycling can be described as follows:

- (a) Unused or waste chemicals in quantity can often be returned to the supplier for reprocessing;
- (b) Larger health-care facilities should establish internal reuse of chemicals;
- (c) Certain material such as mercury from broken thermometers, unused batteries containing mercury, cadmium, nickel and lead-acid and halogenated or non-halogenated solvents should be given to specialized recyclers.

7.6 Disposal operation/technologies, accreditation and environmental impacts

79. Biomedical and health-care waste should, if required, be inactivated or rendered safe before final disposal or discharge. The decision to treat biomedical and health-care waste and the choice of treatment method should be determined in accordance with the following considerations:
- (a) The type and nature of the waste material;
 - (b) The hazard and viability of the organisms in the waste;
 - (c) The efficiency of the treatment method;
 - (d) The operating conditions of the treatment method.

Table 3

Examples of waste treatment methods related to the type of waste

Type of waste Treatment	Gas	Liquid	Solid
Thermal	Possible	Recommended	Recommended
Chemical	Appropriate	Appropriate	<u>a/</u>
Irradiation	<u>B/</u>	<u>b/</u>	<u>b/</u>
Incineration	Appropriate	<u>c/</u>	Recommended
Filtration	Recommended	Possible	Not applicable

a/ Not possible for mixed wastes.

b/ Only for small amounts of waste.

c/ Recommended if the calorific value is high enough to reach a sufficiently high temperature.

80. The treatment method should be amenable to validation and independent of any packaging, and should be monitored. Monitoring can involve sampling and analysis or testing of the effluent for hazardous organisms or the use of suitable physical engineering or other process controls to demonstrate effective operation within the prescribed operating criteria.
81. Treatment of the waste should be validated with regard to the inactivation of the organisms and of any residual contamination of the packaging or containers. The process should not significantly increase the risk of exposure of laboratory staff or other waste handlers to the hazard itself or to other risks from the concomitant hazardous agents, equipment and substances

which are employed in the treatment. Outlines of the main advantages and drawbacks of the treatment and disposal options addressed in these guidelines are shown in table 4.

7.6.1 Methods of treatment or disposal

82. The validated chemical and physical methods for the treatment or inactivation of waste include: steam sterilization, chemical disinfection/sterilization, dry heat sterilization and other methods.
83. The relative effectiveness of these and other treatment methods depends on a number of factors including the volume, concentration, type and hazard caused by the organisms and the physiological state, the diffusion resistance of the material to be disinfected and the operating parameters and conditions of the treatment method. In general, steam sterilization should preferably be used in the treatment of infectious waste. Thermal methods are generally easier to validate and monitor than chemical treatment and are less damaging to the environment. An example for validation of waste-disinfecting processes is given in annex IV.
84. Methods other than steam sterilization should be selected only if this is impracticable or inappropriate. For example, effluent from veterinary research, contaminated laboratory equipment, fixtures and furniture which cannot readily be removed may be effectively treated using a gaseous fumigant such as formaldehyde. These methods of treatment can be used alone or in combination, depending on the risk assessment requirements and/or discharge consent standards, to enable the waste to be inactivated and safely discharged.

Treatment/disposal methods	Advantages	Drawbacks
Pyrolytic incineration/two-stage incineration with efficient gas cleaning	Very high disinfection efficiency; adequate for all infectious waste and most pharmaceutical and chemical waste.	Incineration temperature above 800°C, destruction of cytotoxics; relatively high costs of investment and operation. Care has to be taken on the management of the incineration residues (e.g. bottom ashes, fly ashes) because they can exhibit hazard characteristics.
Single chamber incineration with dust reduction	Good disinfection efficiency; Drastic reduction of the weight and volume of waste; the residues may be disposed of in a landfill; no need for highly qualified operators; relatively low investment and operation costs.	Generation of significant emissions of atmospheric pollutants and periodic slag and soot removal; with temperature below 800°C, inefficient in destruction of thermally resistant chemicals and drugs such as cytotoxics.
Drum or brick incinerator	Reduction of the weight and volume of the waste; the residues may be disposed of in a landfill; no need for highly qualified operators; very low investment and operating costs.	Only 99 per cent destruction of micro-organisms; no complete destruction of many chemicals and pharmaceuticals; massive emission of black smoke, fly ash and toxic flue gas. Exception only for disposal of infectious waste under certain circumstances outside urban areas (e.g., no other treatment method available during an emergency situation like acute outbreak of communicable diseases).

Chemical disinfection	Efficient disinfection under good operating conditions with special waste; costly if the chemical disinfectants are expensive.	Requirement of highly qualified technicians for operation of the process; use of hazardous substances which require comprehensive safety measures; inadequate for pharmaceutical, chemical and most types of infectious waste (mixed solid waste).
Autoclave wet-thermal treatment	Environmentally sound; relatively low investment and operation costs. Good for infectious and microbiological wastes.	Shredders are subjected to many breakdowns and bad functioning; operation requires qualified technicians; inadequate for pharmaceutical and chemical waste or waste which is not easily penetrable by steam; without shredding or other methods of destruction although inadequate for anatomic waste.
Microwave irradiation	Good disinfection efficiency under appropriate operational conditions; environmentally sound.	High investment and operation costs; potential operation and maintenance problems; only for wet infectious waste or for infectious waste with a high water content.
Encapsulation (e.g. with concrete or gypsum)	Simple and safe; low costs.	Only for sharps.
Special engineered landfill	Safe if access is restricted and where natural infiltration is limited	Safe if access to site is limited and there is no risk of water contamination

85. Steam sterilizing or autoclaving is the exposure of waste to saturated steam under pressure in a pressure vessel or autoclave. Autoclaves should meet the requirements of internationally agreed standards. Autoclavable waste containers should be of a design and material which allows steam to penetrate the load. They should have sufficient stability and resistance to the maximum operating temperature and pressure.
86. In addition to any devices such as gauges or indicators which measure and record the basic operating criteria (e. g. temperature, vacuum, pressure), a biological or chemical indicator should be placed in the waste load for validation to indicate that the necessary sterilization conditions have been achieved. The operational parameters, e. g. time, pressure and temperature, should be maintained and checked during the sterilization cycle.
87. While the temperature and time depend upon the total volume of the material to be treated, the number and type of organisms and their resistance against steam, it is necessary first to remove all the air from the autoclave, the waste and the waste containers to ensure that the required sterilization temperature will be maintained. In the case of closed containers included in waste material, the validation (with biological indicators) should take place within the material being sterilized. Sterilization should commence only when the air has been removed from the autoclave and the operating temperature has been reached.
88. The potential of complete air removal is affected by factors such as the type of waste, the amount of waste, the packaging, the water content of the waste and the form and material of

the container. The whole treatment process, including loading, the load, the suitability of the packaging or the container, air removal and filtration of the removing gas and liquid effluent discharge should be validated.

89. A record should be retained of all monitoring, maintenance and performance tests carried out on the autoclave together with a logbook or similar record of all routine disposals including the temperature charts and details of the load. When appropriate, air removed from the autoclave should be discharged into the environment after passing through a microbiologically validated filter.
90. Details of sterilization procedures, including the operational parameters and conditions, should be written down as a standard operating procedure document or operating manual which is to be used by all waste handlers. The document should be kept under review. A suitable biological indicator for steam sterilization is the spores of *Bacillus stearothermophilus*. Autoclaving may not change the visible appearance of the waste and it may be necessary to distinguish treated from untreated waste by careful removal or obliteration of biohazard warning labels from treated containers or by labelling such containers as "autoclaved" or "sterilized".
91. Alternatively, chemical indicators may be added to the load to indicate that the load has been autoclaved. Aesthetic concerns may require that the autoclaved waste is further treated to render it acceptable for final disposal, e.g. if the waste contains human or animal material or tissue. Autoclaving may not remove or reduce the non-biological hazards arising from the presence of chemical or physical agents or other materials in the waste.
92. Dry heat sterilization is the exposure of the waste to heat at a temperature and for a time sufficient to ensure sterilization of the entire waste load. The sterilization process should be monitored by the addition of a suitable indicator or measuring device to the waste load, and where appropriate by monitoring the organism(s) present in the waste. The sterilizing unit or equipment should incorporate a suitable thermal cut-out device which is independent of the device used for indicating or monitoring.
93. This method involves the exposure of waste to chemical agents which possess antimicrobial activity. General disinfectants may not inactivate organisms such as spores, some fungi and viruses and should not be used as the principal treatment methods unless thermal procedures are inappropriate because of the nature of waste or contaminated material. Thermal sterilization should be given preference over chemical disinfection for reasons of efficiency and environmental considerations.
94. The choice of an appropriate chemical agent and conditions of use should be determined by the risk assessment, taking into account the identity of the organism(s) to be treated, the nature of the waste and the presence of organic, protein or particulate matter, and the nature of the surfaces, items or equipment which will be exposed to the chemical disinfectant.
95. Chemical agents should be used at the manufacturers' recommended concentrations and exposure times according to the requirements and conditions of use. The chemical agent selected should be compatible with other substances or material that may be present in the waste load so that its efficiency is not reduced, and also to ensure that toxic or hazardous products are not thereby formed or released. The efficiency of any chemical agent against a particular organism or type of organism may be confirmed by reference and adherence to manufacturers' data and instructions. Ethylene oxide, formaldehyde (alone or with low-temperature steam) and certain other agents may be used as gaseous fumigants, particularly for equipment and items that should

be treated in situ. This method can also be used for the disinfection of body fluids and excreta before being released to the sewer system if no thermal treatment is available.

96. The options available for the treatment/disposal of waste and waste effluent which cannot be recycled or reused are incineration and landfill.
97. Other waste treatment methods are available but are not yet validated for general use and have only limited application. These include irradiation (e. g. with microwave, gamma and ultraviolet radiation) and other treatment methods (e. g. encapsulation and filtration). If such methods are used, validation and monitoring procedures should be performed.
98. The selection of an appropriate option should be based on a number of considerations, including:
 - (a) The nature of the waste and its intrinsic hazard;
 - (b) Whether the waste has been inactivated by a reliable and validated method;
 - (c) The aesthetic acceptability of the discharged waste;
 - (d) The potential deleterious effect of the discharged waste on the environment;
 - (e) The ease and reliability of the disposal method;
 - (f) The disposal and other costs;
 - (g) The general occupational hazards and risks to waste producers, handlers and operators;
 - (h) The overall impact of the disposal or discharge plant or equipment on the local and general environment.
99. Incineration can be used as one important method for the treatment and decontamination of biomedical and health-care waste. Oxidation at high temperature converts the organic compounds into their gaseous oxides, mainly carbon dioxide and water. Inorganic components are mineralized and converted into ash, unless they pass into the flue gas.
100. Depending on the type of incinerator, the following objectives can be achieved:
 - (a) Destruction of pathogens;
 - (b) Reduction of the hazard and pollution potentials as far as possible;
 - (c) Reduction of volume and quantity;
 - (d) Conversion of remaining residues into a form which is utilizable or suitable for landfill;
 - (e) Use of the released heat.
101. For reasons of emission control and operational safety and reliability, it is desirable to incinerate the biomedical and health-care waste from as many hospitals as possible in one central unit. In specific cases, even smaller separate incinerators may be justified. With a view to minimizing the environmental impact of incineration plants, emissions in the air, water and soil shall be reduced by the use of effective and advanced incineration and emission control

techniques under technically and economically viable conditions, taking into account the location of the plant.

102. Much experience in the application of techniques for the reduction of polluting emissions from incineration plants has been acquired over a period of more than 10 years. As an example of high standards, the emission limit values for waste incineration in the European Union published at the end of 2000 are shown in table 7 in annex V. Apart from these polluting emissions, all incinerators will produce varying amounts of residues, e.g. bottom ashes or fly ash and particulates captured by pollution control devices. Where they exhibit hazard characteristics, they will probably need to be handled as additional hazardous wastes with appropriate environmentally sound disposal methods.
103. Incineration leads to a significant reduction of the volume and quantity of the treated waste. Waste which has not been previously treated to inactivate it or to render it safe should be incinerated in a plant suitably designed and operated for the destruction of biomedical and health-care waste or other hazardous waste. If biomedical and health-care waste can be incinerated only in inadequate conditions (low temperature, inadequate emission control system), waste fractions like cytotoxic drugs, chemicals, halogenated materials or waste with a high content of heavy metals (batteries, broken mercury thermometers, etc.) should not be consigned to such an incinerator.
104. Biomedical and hazardous (infectious) health-care waste which has not been inactivated or treated should be conveyed or transported to the incinerator in suitable containers in accordance with the United Nations Recommendations on the Transport of Dangerous Goods where appropriate.

Testing and validation of waste treatment methods

105. The selected treatment option is required to inactivate or render safe the hazardous component of the waste as identified in the risk assessment. It should be possible to validate the treatment method to verify that the number of viable organisms in any waste or effluent is within acceptable discharge levels or that the organism has been destroyed.
106. Any treatment process for infectious waste has to be controlled for its efficiency. Where the waste treatment method is one that conforms to an appropriate international or national standard, its validation will be dependent on strict adherence to specified procedures, including any operational sampling, monitoring and performance tests undertaken to confirm that the treatment process proceeds as intended. These should be carried out in the prescribed manner and at the required time intervals, and a record of the relevant measurements and test parameters should be kept. Validation of any waste treatment process may also involve periodic checking by verification tests for the presence of viable organism(s) in the waste. Appropriate statistical methods can be used to make inferences from these tests to overcome difficulties in verifying that the treated waste or effluent contains no viable organisms.
107. Where a range of wastes originating from different sources and displaying other characteristics is encountered, the treatment method should be validated for operational effectiveness under "worst case" load conditions. The operational conditions and parameters necessary to inactivate the "worst case" load should be used as the basis to define the normal operational procedures for mixed wastes. Tests carried out to check the concentration of viable organisms in the treated waste may be either growth-related or non-growth-related.
108. The method chosen will depend on the composition of the waste. For example, direct methods (see annex IV) may be appropriate for testing waste streams with a low concentration

of viable micro-organisms, and indirect methods (see annex IV) where the concentration is high.

Testing of treated waste and waste effluent

109. The efficiency of the treatment method can be checked by assaying the waste before and after treatment for the presence of viable organisms. Samples of the treated waste to be assayed should be taken from different parts of the load for examination under aseptic conditions.
110. Effluent from waste treatment processes which is discharged directly to air or the sewer system should be periodically tested as required by the relevant national or local consent authorities or to ensure that the numbers of organisms are within permitted levels and there is no significant environmental risk.
111. The test methods and procedures used to assay treated wastes for the presence of viable organisms should be undertaken in accordance with international or national standards. Details of viability testing methods are available in standard reference texts (see annex IV). Testing of waste discharge and effluent from treatment plants or equipment may be carried out continuously or at periodic or irregular intervals, e.g., as random quality control checks. Tests should be carried out at frequent intervals if there is a likelihood of plant malfunction which would release untreated waste to the environment, or if the plant is operating at or very near to capacity. In cases where biological indicators are less resistant than the organism that is being handled, the organism itself should be used as the test model.

Calibration of measuring and monitoring devices and equipment

112. All devices and equipment used to measure or monitor the performance of the treatment process or any discharges or emissions from any process should be calibrated. This can be done using an appropriate international or national standard test or by a method which employs an independent or reference test device or probe which is calibrated against a national standard.
113. Micro-organisms are classified with respect to human health and harm to the environment in accordance with national or international classification schemes. A documented risk assessment should be made for hazardous waste handling activities and treatment processes taking account of the classification of the micro-organisms that are involved. The assessment should be reviewed and revised, if necessary, at the different stages of process design and implementation, if significant changes in the process are proposed, and at periodic intervals.
114. In the case of activities involving exposure to several categories of micro-organisms which may be present in the waste, the health and environmental hazards presented by each micro-organism should be taken into consideration while preparing the assessment.
115. To date, there is no adequate risk assessment of the use of landfills for untreated biomedical and health-care waste which may contain infectious organisms and hazardous chemicals. Best practice would require that any landfill used for biomedical and health-care wastes be engineered and secured (specially engineered landfill).
116. There are ongoing health and safety issues (and hence legal implications) associated with disposal of untreated biomedical and health-care wastes. With the availability of suitable landfill sites being reduced, the physical problem of disposing of large volumes of waste must be considered.

117. Disposing of infectious wastes into a landfill greatly increases the risks to human health and the environment of exposure to infection from this source. If the waste is disturbed by any means, or not properly covered, further risks will arise. It is therefore not good practice to dispose of infectious waste directly into a landfill. To guard against these risks, where landfill is the only available option, infectious wastes should be treated in order to destroy/remove their infectivity, preferably at the site of generation of the waste. This can be done by using known effective techniques such as autoclaving, microwave treatment, dry heat sterilization or chemical disinfection.
118. The following is a description of the features of a "specially engineered landfill"¹⁰ which are necessary for the safe and environmentally acceptable disposal of biomedical and health-care wastes:
- (a) Impermeable clay and/or synthetic liner to minimize groundwater pollution;
 - (b) Collection, treatment and environmentally acceptable disposal of leachate;
 - (c) Monitoring systems for groundwater surrounding the site to check integrity of leachate contamination protection;
 - (d) Daily and final covers to restrict the potential for disease vectors, reduce odours and reduce water infiltration;
 - (e) Monitoring for gas migration in the unsaturated zone surrounding the site, together with control measures if necessary.
119. It is generally accepted that untreated biomedical and infectious health-care waste disposal into landfills is not "best practice". Where health-care wastes are disposed of at a specially engineered landfill site, the following should apply:
- (a) Biomedical and infectious health-care wastes should be deposited at the lowest edge of the working face of the landfill or in an excavation;
 - (b) An operator or representative should supervise immediate cover with solid waste or cover soil to a depth of at least 1 metre;
 - (c) Any compacting should be only on the cover material;
 - (d) Biomedical and health-care disposal areas should be at least 3 metres from the proposed edge of the landfill;
 - (e) No access of unauthorized persons to the site of the landfill;
 - (f) Any biomedical and health-care waste should be at least 2 metres below the final surface of the landfill i.e. not in the final lift.
120. In accordance with national regulations and policies, landfilling may be prohibited in some countries.
121. The following biomedical and hazardous health-care wastes are generally considered unsuitable for disposal at a landfill site:

¹⁰ For further information see "Technical Guidelines on Specifically Engineered Landfill (D5), Basel Convention Series/SBC No: 97/004 Geneva, January 1997.

- (a) Identifiable body tissue;
- (b) Cytotoxic wastes;
- (c) Pharmaceutical, laboratory or domestic chemicals;
- (d) Radioactive wastes;
- (i) Infectious wastes.

122. Landfill is recognized as the terminal site for all wastes including ash from incineration and residues from other processes. Some residues of the treatment process residues may contain chemicals that could interact with other materials in a landfill. Consideration needs to be given to the stability and nature of such process residues and any potential impacts prior to disposal into a landfill. Some of the treatment processes may also contribute excess water to the landfill. Resultant leachate considerations require that engineered landfills should be used to ensure maximum environmental protection.

123. The application of treatment and disposal methods to biomedical and hazardous health-care waste categories is shown in table 5. It provides a broad overview of suitable treatment and disposal methods for the different health-care waste categories.

Method	Pyrolytic incineration/two-stage incineration (with after burning zone, e.g. rotary kiln)	Single-chamber incineration or municipal waste incineration	Chemical disinfection	Autoclave wet-thermal treatment	Microwave irradiation	Encapsulation (e.g. with concrete, gypsum, etc. - only minimal programmes)	Specially engineered landfill <u>a/</u>	Discharge to sewer systems	Other method
Waste types									
Infectious waste	Yes	Yes (special requirements, like direct feeding)	Small quantities	Yes	Yes (wet waste)	No	Yes <u>b/</u>	<u>c/</u> - only urine and faeces	
Anatomic	Yes	Yes <u>b/</u>	No	<u>c/</u>	<u>c/</u>	No	Yes <u>b/</u>	No	
Sharps	Yes	Yes <u>b/</u>	Yes	Yes	No	Yes	Yes <u>b/</u>	No	
Pharmaceutical waste	Small quantities or at high temperature >850 °C	Yes <u>b/</u>	No	No	No	Yes	Small quantities	No	Return expired drugs to supplier
Cytotoxic waste	At high temperature >850 °C	No	No	No	No	No	In exceptional cases if special requirements like fixation are met	No	Return expired drugs to supplier
Chemical waste	Small quantities	<u>c/</u>	No	No	No	No	In exceptional cases if special requirements like fixation are met	Yes <u>b/</u> - only small quantities of liquid disinfections	Return unused chemicals to supplier
Radioactive waste <u>d/</u>	Low-level infectious waste	Low-level infectious waste	No	No	No	No	No	Low-level liquid waste	Decay by storage

a/ In accordance with national regulations and policies, landfilling may be prohibited in some countries.

b/ Not the preferred method.

c/ Uncertainty still prevails as to the unsuitability of the disposal operation. There could be cases where the disposal option could be used, provided a number of safeguards are in place.

d/ Only if the clearance levels set by IAEA are met.

Note: Entries in bold indicate preferred methods.

7.7 Responsibility (including emergency response and contingency plan)

7.7.1 Assignment of responsibilities

124. The proper management of biomedical and health-care waste is largely dependent on good administration and organization. These should be supported by adequate legislation and financing as well as active participation of trained and informed staff.
125. The head of the hospital should establish a waste management team to develop a waste management plan. The head of the establishment should formally appoint the members of the waste management team in writing, informing each of them of their duties and responsibilities as outlined below.
126. In institutions where no direct patient care service is available, such as medical research institutions, the head of the establishment should use his discretion to appoint members of the waste management team. Depending on the availability of relevant staff, the post of waste management officer may be assigned to the hospital engineer, the hospital manager, or any other appropriate staff member, at the discretion of the head of the hospital.
127. The head of the health-care establishment is responsible for the following tasks:
- (a) Formation of a waste management team to formulate a written waste management plan for the hospital; within this plan, the duties and responsibilities of all members of staff, both clinical and non-clinical, shall be clearly defined in respect of the handling of health-care waste. A clear line of accountability shall be indicated in both the clinical and non-clinical management structures;
 - (b) Designation of the waste management officer (WMO) to supervise and coordinate the waste management plan; such an appointment shall not relieve him of his overall responsibilities in ensuring that biomedical and health-care and other waste are disposed of in accordance with the national guidelines;
 - (c) Keeping the management plan up to date;
 - (d) Allocation of sufficient financial and manpower resources to ensure efficient operation of the plan – for example, he has to ensure that adequate manpower is assigned to the WMO to ensure efficient operation of the waste management plan;
 - (e) Ensuring that monitoring procedures are incorporated to assess the efficiency and effectiveness of the disposal system and to effect the continuous improvement and updating of the system where appropriate;
 - (f) Appointing a successor immediately in the event of personnel leaving key positions in the waste management team, or assigning temporary responsibility until a successor is appointed;
 - (g) Ensuring adequate training for key staff members; he shall designate staff responsible for coordinating and implementing training courses;
 - (h) Ensuring adequate emergency response planning.

128. The WMO is responsible for the day-to-day operation and monitoring of the waste management system. He shall have direct access to all members of hospital staff to facilitate his control function. The WMO will be directly responsible to the head of the hospital. He shall liaise with the infection control officer, the pharmaceutical officer and the radiation protection officer to familiarize himself with the correct procedures for handling and disposing of pathological, pharmaceutical, chemical and radiological wastes.
129. Concerning waste collection, the WMO should undertake the following tasks:
- (a) Controlling internal collection of waste containers and their transport to the central waste storage facility of the hospital, on a day-to-day basis;
 - (b) Ensuring the supply of items required for waste collection and handling; he should liaise with the supplies department to ensure that an appropriate and acceptable range of health-care waste bags and containers, protective clothing and collection trolleys are available at all times;
 - (c) Ensuring that hospital attendants and ancillary staff immediately replace used bags and containers with the correct new bag or container as appropriate;
 - (d) Directly supervising hospital attendants and ancillary workers assigned to collect and transport health-care waste.
130. Concerning waste storage, the WMO should:
- (a) Ensure the correct use of the central storage facility for health-care waste at the health-care establishment, which shall be fenced with a lock on the entrance; hospital attendants and ancillary staff should always have immediate access to the storage area;
 - (b) Prevent unsupervised dumping of waste containers on the hospital grounds, even for short periods of time.
131. To supervise evacuation or disposal of the waste, the WMO should:
- (a) Coordinate and monitor all waste disposal operations;
 - (b) Monitor methods of transportation of wastes on-site and off-site and ensure that wastes collected from the hospital are transported by an appropriate vehicle to the designated incinerator;
 - (c) Ensure that waste is not stored on the hospital grounds for periods longer than specified in the guidelines and that the required frequency of collection is maintained; he should therefore liaise with the transport organization, which may be the local authority or a private contractor.
132. For staff training and information, the WMO should:
- (a) Liaise with the matron and the hospital supervisor to ensure that the nursing staff and medical assistants are familiar with their responsibilities for segregation and storage of waste and of the limited responsibilities of hospital attendants and ancillary staff in the handling and transport of sealed waste bags and containers;
 - (b) Liaise with departmental heads to ensure that all doctors and other qualified clinical staff are aware of their responsibilities regarding segregation and storage of waste and of the limited responsibilities of hospital attendants and ancillary staff in the handling and transport of sealed bags and containers;

(c) Ensure that hospital attendants and ancillary staff are not involved in waste segregation and that they handle only waste bags and containers sealed in the correct manner.

133. For incident management and control, the WMO should:

(a) Ensure that emergency procedures are available and in place at all times and that personnel are aware of the appropriate action to be taken;

(b) Investigate or review incidents reported during the handling of health-care waste.

7.7.2 Emergency response

134. For health-care establishments, spills of infectious or other hazardous material or waste are probably the most common emergencies related to hazardous material. Basically, the same response procedures are applied, regardless of whether the spills are from material or waste. The response to emergencies should ensure the following:

(a) The waste management plan should be respected;

(b) Contaminated areas should be cleared and, if necessary, disinfected;

(c) The exposure of workers should be limited as much as possible during the operation;

(d) The impact on the environment should be limited to the extent possible.

135. The staff should be well prepared for emergency response, and the required equipment should be easily available at all points in time and within reasonable distance to ensure that an adequate response can be made safely and routinely. The procedures for the different types of emergencies should be written down. For dangerous spills, clean-up should be carried out by designated, specifically trained personnel.

136. A response programme should be established for immediate reaction to injuries or exposure to a hazardous substance. All staff handling biomedical and health-care waste should be trained in dealing with injuries. Such a programme should include the following elements:

(a) Immediate first aid measures, such as cleansing of wounds and skin and splashing of eyes;

(b) Immediate reporting to a responsible designated person;

(c) Retention, if possible, of the item and details of its source for identification of possible infection;

(d) Additional medical care from an accident, emergency or occupational health department as soon as possible;

(e) Medical surveillance;

(f) Blood or other tests if indicated;

(g) Recording of the incident;

(h) Investigation, determination and implementation of remedial action.

137. Spills usually require only clean-up of the contaminated area. In spills of infectious agents, it is important to determine the type of infectious agent, as some may require immediate evacuation of the area, whereas others require fewer precautions. The more hazardous spills usually occur in laboratories rather than in health-care departments.
138. Spill-cleaning procedures should specify safe handling operations and appropriate protective clothing. An example of such a procedure is provided in box 2. Appropriate equipment for collecting the waste and placing it in new containers, and for disinfection, should be provided. Table 6 provides an example of the required items.

Box 2

Example of general procedure for spill-cleaning

- (a) Evacuate the contaminated area;
- (b) Eye and skin decontamination (disinfection) of exposed personnel should take place immediately;
- (c) Inform the designated person (usually the waste management officer);
- (d) Determine the nature of the spill;
- (e) Evacuate all the people not involved in cleaning up if agent is particularly hazardous;
- (f) Provide first aid and medical care to injured persons (see response to injuries);
- (g) Secure the area to prevent additional exposure of persons;
- (h) Provide adequate clothing to personnel involved in cleaning up;
- (i) Limit the spread of the spill;
- (j) Neutralize or disinfect the spill or contaminated material if indicated;
- (k) Collect the spill and the contaminated material;
Sharps should never be picked up by hand, but with tools, e.g. pans or brushes. Spilled material and contaminated items used for cleaning should be placed into the appropriate bags or containers;
- (l) Decontaminate or disinfect the area, and absorb;
- (m) Rinse the area, and absorb;
- (n) Decontaminate or disinfect the used tools;
- (o) Take off protective clothing and decontaminate or disinfect it if necessary;
- (p) Seek medical care if exposure to hazardous material has occurred during the operation.

Source: WHO.

Table 6

Example of a list of items for spillage-cleaning

Action	Tools or items
Approaching the spillage	Protective equipment
Containing the spillage	Absorbent material (e.g. absorbent paper, towels, gauze pads)
Neutralizing or disinfecting the spillage (if necessary)	For infectious material: disinfectant <u>a/</u>
	For acids: sodium or calcium carbonate or other base
	For cytotoxic material: special chemical degradation substances
	For bases: citric acid powder or other acid
Collecting the spillage	For liquids: absorbent paper, gauze pads, wood shavings, calcium bentonite, diatomaceous earth
	For solids: forceps, broom, dust pan or shovel
Containment for disposal	Mercury: mercury sponge or vacuum pump
	Plastic bag (red, yellow or brown, as appropriate), sharps container
Decontamination or disinfection of the area	For infectious material: disinfectants <u>a/</u>
	For hazardous chemicals: suitable solvent or water

Source: WHO.

a/ Such as bleaching powder, which is a mixture of calcium hydroxide, calcium chloride and sodium hypochlorite, used in the powder form or in solution of varying dilutions (1:1 to 1:100), depending on the nature of the spilled material.

139. All waste management staff should be trained in emergency response and made aware of the correct procedure for prompt reporting of accidents and incidents. Accidents or incidents, including near-misses, spillages, damaged containers, inappropriate segregation or any incidents involving sharps should be reported by the WMO if waste is involved, or otherwise to another designated person. The report should include:

- (a) The nature of the accident or incident;
- (b) Where and when it occurred;
- (c) Which staff were directly involved;
- (d) Other relevant circumstances.

140. The incident should be investigated by the responsible officer (WMO in cases of waste) to establish its causes and if possible action taken to prevent recurrence. Records should be kept.

141. The purpose of a waste audit is to help a hospital to determine which initiatives will be most beneficial. It does this by developing a detailed picture of the current status of waste generation and disposal for the hospital. It then identifies potential areas for improvement and develops action plans for each area. The ultimate impact of environmental action is judged in terms of a positive impact on the environment and cost savings for the institution.
142. There are three major steps involved in the waste audit. They include information gathering, waste stream analysis and the development of action plans. First, a waste audit must collect information on the following:
- (a) The total volume of each type of waste generated by the entire hospital;
 - (b) The volume of each type of waste generated by each specific area in the hospital;
 - (c) The current costs associated with the disposal of each type of waste;
 - (d) The waste management initiatives currently in place. Typically, these include reuse, reduction, recycling and recovery programmes.
143. Much of the information can be found in purchase records and requisitions, estimates made by the facility, and a search of the literature, and from interviews with staff concerning their experience in handling waste in the facility.
144. The next step in the waste audit is to proceed with the sorting and weighing of the components of the waste stream or to conduct a waste stream analysis. This second task will be referred to as the comprehensive study of general waste. This task is usually accomplished by personnel from the housekeeping staff over a period of two weeks. For safety reasons, no types of waste that could threaten the staff in any way are sorted - that is, biomedical waste, sharps, chemicals and so on are weighed only.
145. The third stage of a waste audit is to develop action plans for reuse, reduction, recycling and recovery initiatives. This involves analysing the data collected and, in the first part of the audit, identifying potential areas of opportunity. Each of these areas is then investigated to identify potential benefits associated with realistic initiatives.
146. For each area where benefits can be achieved, an action plan is developed to implement the initiative. The plan identifies where existing systems and work habits can be modified and where new systems could be introduced to achieve the desired results. While the action plan covers the entire hospital, the recommendations for action may focus on specific areas within the hospital where the most benefit can be gained.
147. Hospital managers or personnel making decisions need specific information about which types of waste are being generated, the volumes of these wastes and the locations of their generation. This information allows initiatives to be targeted to the specific hospital locations and/or types of waste for which the most significant benefits can be obtained. For example, waste recycling is most effective when the segregation of recyclables from non-recyclables occurs at the point where the waste is generated. By the time waste has reached the disposal hopper or compactor, it is too late to consider waste reduction, reuse or recycling options. Knowing the specific locations where most of the recyclable waste is generated permits assessment of the recycling opportunity and the development of appropriate plans.
148. The objectives of a comprehensive capacity-building strategy could include the following:
- (a) To provide a basic legal, technical and logistical framework;

- (b) To introduce options for the sound management of biomedical and health-care wastes;
- (c) To develop a logical framework for the completion of national biomedical and health-care waste profiles and the preparation of national health-care waste plans.

149. The elements of a comprehensive capacity-building programme are:

- (a) Establishment of a national committee for the environmentally sound management of biomedical and health-care wastes;
- (b) Completion of national (local) health-care waste profiles;
- (c) Development of a national (local) health-care waste management programme, including a technical and financial plan;
- (d) Preparation of national regulations on the environmentally sound management of biomedical and health-care wastes;
- (d) Undertaking of training programmes for health-care personnel, waste disposers, enforcement institutions, etc., including development of decision-supportive tools for policy makers and waste handlers.

9.1 Education and training of personnel of health-care establishments

150. A biomedical and health-care waste management policy is not effective unless it is applied daily by all involved staff in a consistent and accurate way. Training employees in implementing the policy is a critical step for a successful biomedical and health-care waste management programme. The overall aim of the training is to develop in the participants awareness of health, safety and environmental protection issues relating to biomedical and health-care waste and how these can affect them in their daily work. It should highlight the responsibilities and role of the employees in the overall management programme. Health and safety at the workplace and environmental awareness are the responsibility of everyone.
151. All hospital personnel, including senior medical doctors, should be educated with a view to convincing them of the importance of the comprehensive health-care waste management policy of the hospital and of its value for the health and safety of everyone. This is the best way to obtain their collaboration in the implementation of this policy.
152. Training activities should be designed for and targeted at four main categories of personnel: managers and regulatory staff, e.g. safety advisers; medical doctors; nurses and assistant nurses; and hospital cleaners, waste handlers and drivers.
153. Medical doctors may be educated through high-level workshops chaired by the head of the hospital, while general hospital staff may be educated through formal seminars. The training of waste managers and/or regulators does not usually take place in the hospitals but in public health schools or university departments of hospital engineering.
154. Education programmes should include: information on each aspect of the health-care waste policy and its justification; informing each hospital staff member of his or her responsibilities and role in implementing this policy; and technical instructions on the application of the practices relevant to the target group.
155. As the best way of learning is probably through practice, hands-on training in small groups should be considered where relevant. Testing the participants at the end of the course, by simple true/false or multiple-choice questions, often provides an incentive for learning and gives

the course organizers an idea of the actual knowledge acquired by the participants. The more detailed course contents are presented below.

156. The instructors should have experience in teaching and training, be familiar with the hazards and practices of biomedical and health-care waste management and, ideally, have experience in waste handling.
157. Periodic repetition of courses will refresh the acquired knowledge, provide orientation for new employees and for existing employees with new responsibilities, and provide continuous updating on policy changes. Follow-up training will provide data about the retention of information and the need for refresher courses.

9.1.1 Responsibility for training

158. The head of the health-care establishment should appoint a responsible person such as the infection control officer, the doctor for hygiene or the WMO for all training related to segregation, collection, storage and disposal of health-care waste. He should ensure that staff at all levels are aware of the hospital waste management plan and policy and of their responsibilities and obligations within the framework of this plan and policy. A record of all training sessions should be kept. The content of the training programmes should be periodically reviewed and updated where necessary. For smaller sources of biomedical and health-care waste, a central training function could be established at the regional health authority.

9.1.2 The training package

159. A training package could be developed by the national government agency responsible for the disposal of biomedical and health-care wastes. Training packages are also being developed by WHO, international agencies and development agencies.
160. The training package on biomedical and health-care waste should be suitable for various types of health-care establishment, including government hospitals, teaching hospitals, dental hospitals, polyclinics, health centres, health-care research institutions, clinical laboratories and other establishments where health-care wastes are generated. Such a training package would also be useful for educational establishments and the sectors providing services for biomedical and health-care waste disposal. The package should contain numerous illustrations, such as drawings, figures, photographs, slides or overhead transparencies.

9.1.3 Selection of participants

161. The ideal number of participants for a training course is 20 to 30 because larger groups may render discussions and exercises difficult. Training courses should be organized and targeted for all personnel categories. The discussions may, however, be easier if the group is composed of personnel from various disciplines (e.g. supervisors, medical and nursing staff, laboratory staff, engineers, ancillary staff) or if the group is laced with one or two medical assistants and nurses.
162. It may be beneficial to include senior administration staff and heads of department in certain training groups to demonstrate their commitment to the policy to other staff members and to show that the policy is the responsibility of all personnel of health-care establishments. Line managers may find it worthwhile to run the training sessions themselves, with their own personnel attending.

9.1.4 Training recommendations

163. As mentioned above, the content of the training course should provide an overview of the waste management policy and its inherent rationale and provide information on relevant practices for the targeted group. For example, personnel providing health-care will mainly be informed that with respect to waste segregation practices:
- (a) Care should be taken while removing needles from syringes during operations which require this;
 - (b) In no event should the staff correct segregation mistakes by removing items from a bag or container once disposed of, or by placing a bag into a bag of another colour;
 - (c) Hazardous and general waste should not be mixed. However, where this has occurred, the mixture should be treated as health-care risk waste;
 - (d) Nursing and clinical staff should ensure that adequate numbers of bag holders and health-care waste containers are provided for the collection and on-site storage of medical waste in the wards, clinics, operating theatres and other sources of waste generation. These on-site receptacles should be located close to the source of waste generation.
164. Upon completion of the training course, the members of staff should be aware of their responsibilities.
165. Relevant training chapters may constitute a basis for the training course. Topics covered may include the waste management policy, health hazards, on-site transportation, storage, safety practices and emergency response. The attention of members of staff who routinely handle biomedical and health-care waste may decrease with time, which will increase the risk of injury. Periodic training is therefore recommended.
166. The minimal training requirements for waste management operators should include the following:
- (a) Information on the risks associated with the handling of biomedical and health-care waste;
 - (b) Training on the procedures for dealing with spillages and accidents;
 - (c) Instructions on the use of protective clothing.
167. The training needs will depend on the type of operations the staff perform. Depending on the duties, training on specific areas (e.g. operation of incinerators, waste transportation) will be required.
168. The health-care establishment may either transport the waste itself or contract an authorized waste transporter. Drivers and waste handlers should be specifically trained and be aware of the nature and risks of the waste being transported. In particular, transport staff should be trained in the following issues, and be able to carry out the procedures and respect the instructions without any help from others:
- (a) Correct procedures for handling, loading and unloading waste bags and containers;
 - (b) Procedures for dealing with spillages or accidents; for these procedures, written instructions should be available in the vehicle;

- (c) Protective clothing and footwear should be worn at all times.
169. The vehicles dedicated to waste collection should at all times carry a supply of plastic bags, protective clothing, cleaning tools and disinfectants to clean and disinfect any spillage which may occur during loading, transport or unloading. Documentation and recording of health-care waste, e.g. by using a consignment note system, are necessary because they make it possible to trace the waste from the point of collection to the final disposal facility. The head of the health-care establishment should liaise with the transport contractor to ensure that the waste collection crew is well trained. Untrained personnel should never be allowed to handle biomedical and hazardous health-care waste.
170. Operation of incinerators requires qualified incinerator operators. It should be remembered that the availability of such operators in certain regions should be verified before purchasing high-technology incinerators. If qualified operators are not available, health-care establishments should either resort to alternative health-care waste disinfection technologies or contract the incineration out through a regional facility.
171. Incinerator operators should have received at least secondary technical education. They should be specifically trained in the following subjects:
- (a) Overall functioning of the incineration facility, including heat recovery and flue-gas cleaning technologies, if they exist;
 - (b) Health, safety and environmental implications of their operations;
 - (c) Technical procedures for the operation of the plant;
 - (d) Emergency response, e.g. in case of equipment failures, alarms;
 - (e) Maintenance of the plant;
 - (f) Surveillance of ash quality and emissions according to the specifications.
172. The training of landfill operators is important for limiting subsequent risks presented by buried biomedical and health-care waste, both in relation to preventing scavenging and to protecting the quality of water. Operators should be trained in the following areas:
- (a) Health risks related to biomedical and hazardous health-care waste;
 - (b) Hazards related to sorting of this type of waste, which should in no event be practised by the landfill operators or other people;
 - (c) Handling of biomedical and health-care waste by drivers or site operators, which should be limited to a minimum;
 - (d) Use of protective equipment and personal hygiene;
 - (e) Application of safe procedures to dispose the wastes into a landfill;
 - (f) Procedures for emergency response.

Annex I

Bibliography

Prüss, A., Townsend, W. K. Teacher's Guide - Management of Wastes from Health-care Activities, WHO/EOS/98.6, World Health Organization, Geneva, 1998

Safe Management of Wastes from Health-care Activities, edited by A. Prüss, E. Giroult, P. Rushbrook, World Health Organization, Geneva, 1999

Hospital Waste Audit Manual - First Steps toward Waste Reduction, Reuse, Recovery and Recycling, Office of Waste Management, Environment Canada, ISBN 0-919100-89-9, CHA Press, Ottawa, Ontario, 1993

Guidelines for the Management of Biomedical Waste in Canada; Prepared by the Canadian Standards Association; CCME EPC-WM-42E; February 1992

Analysis of Priority Waste Streams - Health-care Waste Commission of the European Communities; Directorate - General Environment, Nuclear Safety and Civil Protection, Rue de la Loi 200, B 1049 Bruxelles

Rot, A., Management of Infectious Health Care Waste - Book 1, Guide, ISWA General Secretariat, Bremerholm, DK-1069 Copenhagen K, Denmark

Instructions concerning the Avoidance and Disposal of Waste Generated by Public and Private Health Service Institutions, published by the Federal States Working Party on Waste [LAGA], (Merkblatt über die Vermeidung und die Entsorgung von Abfällen aus öffentlichen und privaten Einrichtungen des Gesundheitswesens, Hrsg. Länderarbeitsgemeinschaft Abfall [LAGA]), Federal Health Gazette (Bundesgesundheitsblatt) 1992, 35, p 30-38, Germany,

Hospital Wastes, Paravesh Newsletter, Vol. 4 (IV), March 1998, Central Pollution Board India, ISSN: 0971-6025

Recommendations on the Transport of Dangerous Goods by Road, Eleventh revised edition (United Nations publication, Sales No. E. 99. VIII.1).

Guidelines for Hospital Waste Management in Pakistan, Environmental Health Unit, Islamabad, January 1998, Ministry of Health Pakistan

Managing Medical Waste in Developing Countries, edited by Dr. Adrian Coad, WHO/PEP/RVD/94.1

Directive of the European Parliament and of the Council on the Incineration of Waste (2000/76/EC), Official Journal No L 332/91 of 28. December 2000

ISO 9000-1, Quality management and quality assurance standards - Part 1: Guidelines for selection and use

ISO 9000-2, Quality management and quality assurance standards -

Part 2: Generic guidelines for the application of ISO 9001, ISO 9002 and ISO 9003

ISO 9000-4, Quality management and quality assurance standards; part 4: guide to dependability programme management

ISO 14001, Environmental management systems - Specification with guidance for use

McRae, Glenn, Hollie Shaner R.N.: Guidebook for Hospital Waste Reduction Planning and Program Implementation, American Hospital Association, 1996

Leach Bisson, Connie, Glenn McRae, and Hollie Shaner, R.N., An Ounce of Prevention: Waste Reduction Strategies for Health-care Facilities, (American Hospital Association, 1993).

Annex II

Glossary/terminology

Activity	Disintegration of an amount of a radionuclide in a particular energy state at a given time per time interval at a given moment.
Air pollution	The presence of a material or substance in the air which may be harmful to either the natural or human environment, which includes any material present in sufficient concentrations for a sufficient time, and under certain circumstances, to interfere significantly with the comfort, health or welfare of persons or with the full use and enjoyment of property.
Air quality standards	The level of pollutants that cannot by law be exceeded during a specified time in a defined area.
Biomedical and health-care waste	Solid or liquid waste arising from health-care (medical) activities such as diagnosis, monitoring, treatment, prevention of disease or alleviation of handicap in humans or animals, including related research, performed under the supervision of a medical practitioner or veterinary surgeon or another person authorized by virtue of his professional qualifications.
Bottom ash	The non-airborne combustion residue from burning fuel and other materials in an incinerator. The material falls to the bottom of the incinerator and is removed mechanically.
Capacity	The quantity of solid waste that can be processed in a given time under certain specified conditions, usually expressed in terms of mass per 24 hours.
Chemical waste	Wastes generated from the use of chemicals in medical, veterinary and laboratory procedures, during sterilization processes and research.
Collection	The act of removing accumulated containerized solid waste from the generating source. Private collection of solid and liquid waste by individuals or companies from residential, commercial, health facility or industrial premises; the arrangements for the service are made directly between the owner or occupier of the premises and the collector.
Cytotoxic waste	Material which is visibly contaminated with a cytotoxic drug during the preparation, transport or administration of cytotoxic therapy.
Decontamination	The process of reducing or eliminating the presence of harmful substances such as infectious agents so as to reduce the likelihood of disease transmission from those substances.

Disinfection	Process of reducing the viability of micro-organisms by various physical and chemical methods.
Emergency	A situation created by an accidental release or spill of hazardous chemicals or infectious material which poses a threat to the safety of workers, residents, the environment or property.
Exposure	The amount of radiation or pollutant present in a particular environment (i.e. human, natural) which represents a potential health threat to the living organisms in that environment.
Fly ash	The finely divided particles of ash entrained in the flue gases arising from combustion. The particles of ash may contain incompletely burned material. The particles are frequently glassy spheres but may also be crystalline or even fibrous in structure.
Health-care waste	See biomedical and health-care waste.
Human tissue	The tissue, organs, limbs, blood, and other body fluids that are removed during surgery and autopsy.
Incineration	The controlled burning of solid, liquid or gaseous combustible wastes to produce gases and residues containing little or no combustible material.
Irradiation	Exposure to radiation of wavelengths shorter than those of visible light (gamma, x-ray or ultraviolet) for medical purposes, the destruction of bacteria in milk or other foodstuffs or initiation of polymerization of monomers or vulcanization of rubber.
Liquid wastes	Any waste material that is determined to contain "free liquids" - liquids which readily separate from the solid portion of waste under ambient temperature and pressure.
Monitoring	Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, animals and other living things.
Off-site facility	A clinical and related waste treatment, storage or disposal facility that is located away from the generating site.
On-site facility	A clinical and related waste treatment, storage or disposal facility that is located on the generating site.
Pharmaceutical waste	Wastes from the production, preparation and use of pharmaceutical products.
Pyrolysis	The decomposition of organic material by heat in the absence of or with a limited supply of oxygen
Radioactive waste	Material contaminated with a radioisotope which arises from the medical or research use of radionuclides. It is produced, for example, during nuclear medicine, radio immunoassay and bacteriological procedures, and may be in a solid, liquid or gaseous form.

Residual wastes Those materials (solid or liquid) which still require disposal after the completion of a treatment or resource recovery activity, e.g., slag and liquid effluents following a pyrolysis operation and the discards from front-end separation systems.

Sanitation The control of all the factors in the physical environment that exercise or can exercise a deleterious effect on human physical development, health, and survival.

Sharps All objects and materials which are closely linked with health-care activities and pose a potential risk of injury and/or infection.

Sterilization A process used to reach a state free of viable micro-organisms. Note that in a sterilization process, the nature of microbiological death or reduction is described by an experimental function. Therefore, the number of micro-organisms that survive a sterilization process can be expressed in terms of probability. While the probability may be reduced to a very low number, it can never be reduced to zero.

Waste minimization The application of activities such as waste reduction, reuse and recycling to minimize the amount of waste that requires disposal.

Waste segregation The process of keeping source-separated wastes apart during handling, accumulation (interim storage), storage and transport to assist resource recovery and to ensure that appropriate designated treatment and/or disposal methods are utilized. Waste segregation should be practised by both generators and waste-handling companies for efficient waste management.

Annex III

Examples of specific waste reduction, reuse and recycling activities

Purchasing practices

- Purchase recycled content material where appropriate (e.g. office paper, envelopes, toilet tissue, paper towels) and look for environmental labels. Work with purchasing committees to determine which products may be suitable
- Work with suppliers to have oversized packaging materials returned or recycled
- Use building construction products with recycled content materials (e.g. drywall, asphalt)
- Use environmentally responsible vehicles and maintenance products (e.g. propane as fuels, re-refined oils, retreated tyres, recycled antifreeze).

Reduction

- Use two-sided photocopying
- Use electronic mail (i.e. personal computers or phone messages)
- Buy in bulk (e.g. food and drink containers in the cafeteria and soaps and detergents in housekeeping)
- Avoid products with excess packaging and work with suppliers to reduce it
- Reroute publications such as magazines, newspapers and journals
- Circulate memos or documents
- Use bulletin boards for posting announcements
- Single-space texts
- Use two-way envelopes for billing
- Make sure staff understand how to use equipment to reduce wastage
- Use the reduction feature on your copier to fit more than one paper per page
- Use permanent tape dispensers, not disposable ones
- Use refillable pens instead of disposable ones
- Purchase durable equipment, furnishings and supplies
- Install energy-efficient appliances (e.g. lighting)
- Use water-saving devices
- Turn off lights and office equipment when not in use
- Use incinerators that meet the new discharge guidelines and have an energy recovery system
- Use computer fax software to send facsimiles without making hard copies
- Use non-solvent liquid scintillation cocktails in laboratories
- Use less hazardous radioactive materials where appropriate
- Develop microtesting procedures to reduce chemical usage
- Make sure biomedical waste is properly segregated from general waste to reduce disposal costs and increase materials for recycling
- Explore opportunities to reduce formalin usage in sample analysis by replacing with cold, physiological saline solutions where appropriate
- Replace formalin solutions with commercially available, less toxic cleaning solutions in dialysis machines.

Recycling

- Newspapers and telephone books can be given to farmers or charitable organizations as bedding
- Give used towels and rags to rag recyclers
- Use plain-paper fax machines; the paper is recyclable and the messages will not fade
- Recycle the following items in "blue box" programmes, where available: glass bottles from juice bottles or baby formula; juice and food material containers; newspapers; and plastic containers (e.g. polyethylene containers or other types where appropriate)
- Recycle cardboard with a commercial recycler or through your supplier
- Recycle pallets with a commercial recycler or through your supplier

- Include pick-up of containers as part of the supplier's role in your contracts
- Work with suppliers to help them design workable packages that are recyclable
- Send unwanted old equipment, furniture or medical supplies overseas
- Pool local businesses that recycle material and contract for the services of the same recycler to reduce pick-up costs
- When purchasing products, ensure that all packages can be returned to the supplier or recycled at your facility
- Use a distribution network to recycle materials back to a central location for better marketing of material
- Explore waste-recycling options for food waste either as human food, as animal feed - either directly or through a commercial processor – or as composting or for vermiculture, and use compost at your facility in landscaping
- Contract a shredding company that recycles your shredded paper
- Involve ambulatory patients in waste minimization programmes (e.g. psychiatric and geriatric patients in composting projects)
- For large waste generators, explore processing equipment such as balers or compactors for recyclable materials
- Locate markets for recyclable materials which are generated in sufficient quantities, such as office paper, cardboard, plastics, solvents (xylenes, toluenes, CFCs), oils (vegetable and hydraulic) and construction and demolition materials such as drywalls, asphalt, concrete, wood
- Install silver recovery units for photo processing waste waters
- Evaluate opportunities for anaesthetic gas recycling.

Reuse

- Donate used publications to doctors' surgeries, nursing homes or the local library.
- Reuse worn cloth nappies and towels as rags.
- Reuse scrap paper for notepads and draft copies.
- Reuse old envelopes by applying labels (with non-solvent glues) on top of old addresses.
- Use reusable nappies, incontinence pads and underpads where appropriate.
- Use reusable urine trays.
- Use reusable drapes and gowns where appropriate.

Annex IV

Validation of waste disinfecting processes (April 1993)

Directive issued by the Bundesgesundheitsamt (German Federal Health Office) and the Deutsche Gesellschaft für Krankenhaushygiene (German Society for Hospital Hygiene)^{a/}

1. Application

This Directive relates to the validation of processes to disinfect waste belonging to the so-called C category, for which, according to Section 10a of the German Epidemics Control Act, disinfection is mandatory.

The "Instructions concerning the Avoidance and Disposal of Waste Generated by Public and Private Health Service Institutions" published by the Federal States Working Group on Waste (LAGA) in a special issue of the Bundesgesundheitsblatt (Federal Health Gazette 1992; 35: 30 - 38) contain the following comment:

"Waste belonging to this category may conceivably originate in isolation wards, pathology departments, blood banks, surgeries, and veterinary practices or clinics as well as elsewhere. This category comprises waste material produced in consequence of the treatment of patients suffering from certain infectious diseases, which is contaminated by pathogen-bearing secretions or excretions; packaging material does not normally belong to this category. It does include, however, microbiological cultures prepared by university departments of hygiene, microbiology or virology, medical laboratories, and surgeries working in the fields described above."

What action is to be undertaken in each instance should be decided in consultation with the hospital epidemiologist in charge, making due allowance for local conditions.

For special types of waste not covered by Sections 4.3 to 4.4 as well as for specialized processes and containers, dedicated test conditions will have to be developed which reflect the peculiarities of the process and/or the type of waste concerned.

2. General requirements

Only thermal processes are suitable for the disinfection of waste conforming to the definition in Section 10a of the Federal Epidemics Control Act (so-called category C waste). Processes in which the medium is saturated steam^{b/} and in which air is evacuated mechanically should be given preference. Chemical waste disinfection processes are unsafe and cause unnecessary environmental pollution.

^{a/} Reprint with the kind permission of Carl Heymanns Verlag KG, Köln, Bundesgesundheitsblatt 1993: 36 (4): 158 - 160. mhp-Verlag GmbH assumes full responsibility for the English translation.

^{b/} Currently, the scientific data available about waste disinfection processes not involving saturated steam are not adequate to permit the formulation of test standards.

In judging disinfection processes, it should be remembered that one of the fundamental principles of epidemics control is that the spread of pathogens must be prevented and/or contamination restricted to the original contaminated objects. Consequently, the following requirements shall apply:

- Process parameters shall be maintained on all interior and exterior surfaces of the waste material, and, if necessary, everywhere inside the waste material (in the case of so-called wet waste, for instance). Process parameters shall be designed to cover grades A, B, and C (cf. the list of disinfectants and disinfection processes reviewed and approved by the Bundesgesundheitsamt and/or Section 5 of this Directive)
- Before the process of disinfection begins, the waste material to be disinfected shall not be repacked, sorted, or pre-treated in any other way. Shredding ^{□/}as well as the opening of containers before disinfection is admissible, provided that this is done within a closed system and that the said system is disinfected immediately after the process of shredding and/or opening in accordance with the provisions of this Directive, and that any spread of pathogens is precluded
- Hermetically sealed containers may only be intermingled with the product if they contain either water or some aqueous solution
- Equalization and cooling times shall be adjusted in relation to the nature of the waste material being treated, paying particular

^{□/} In the context of processes involving shredding, the requirements of this Directive shall be applied mutatis mutandis; in particular, disinfection shall take place under saturated-steam conditions; i.e. with both temperature and pressure conforming to the saturated-steam curve.

The following points should be observed:

With regard to section 4.1 and 6.1

Pressure as well as temperatures at critical locations within the product shall be monitored. Temperature fluctuations within the product and the pressure curve over time shall be measured and recorded. Sanitizers shall be equipped with outlet nozzles for the purpose.

With regard to section 4.3

Depending on the intensity of the shredding process, the hose pipe in the test carrier may be shortened. A test carrier shall be added to the product after shredding.

With regard to section 7.1

The intensity of shredding shall be determined during homologation.

Shredders shall be designed to ensure that access for repair and other purposes is possible only after the completion of the disinfection cycle. For this reason, the homologation test shall include an investigation of a shredder malfunction in the form of a disinfection test of the input section inclusive of shredder. In this test, lumens conforming to DIN 58948, Part 13, shall be used together with biological indicators conforming to DIN 58949, Part 4, Item 6. The test carrier shall be packaged without extra padding on a vapour-permeable wrapper such as, for instance, a transparent sterilization package conforming to DIN 58953, Part 4 and deposited in front of the homologation test which may be used at the end of each operating cycle to disinfect all parts of the apparatus that might have been contaminated. As a rule, it will be perfectly adequate to document such disinfection by conducting measurements of the physical process parameters in certain critical locations within the system. In cases of doubt, biological indicators conforming to DIN 58948, Part 4, Item 6 may be placed, for instance, in receptacles, i.e. tubeless test carriers, conforming to DIN 58948, Part 13.

With regards to Section 7.3

Routine tests shall comprise a review of other disinfection process used to disinfect the system at the end of each operating cycle with the aid of physical parameter measurements.

attention to the proportion of compact components and liquids. As a general rule, exposure periods shall be calculated so as to allow for isolated quantities of liquid amounting to 500 ml. The maximum quantity of liquid in each container shall be determined experimentally in the course of homologation testing

- The packaging of the waste material shall be designed to accommodate the disinfection process. Waste material containers shall be designed to permit the passage of air and steam during the process of disinfection or, alternatively, to open or destruct automatically during the phase of air evacuation to ensure proper disinfection afterwards
- There shall be no hazard of pathogens or infections being spread by the disinfection system either in operation or during maintenance and repair. Depending on the process involved, it may be necessary to install suitable systems for treating the exhaust air and waste water
- At the end of the disinfection and/or operating cycle ^{d/} not only shall the product itself be disinfected but also each and every part of the apparatus that has been in contact with the contaminated product. The same shall be assured in the event of malfunction.

3. Test versions

3.1 Homologation tests

The purpose of homologation is to determine what operating data are to be used in the operation of a specific type of disinfection apparatus. At the same time, it serves to determine exactly what products may be disinfected by the process in question, what loading and/or packaging regulations should be followed, and where critical levels for measurements to be carried out in the future lie. Another purpose of homologation testing is to check conformance with general requirements (see section 2 of this Directive) particularly with regard to malfunctions and the innocuousness of waste water and exhaust air. Homologation tests shall be performed exclusively on application by the manufacturers. Only after the completion of such a test can an application be made for inclusion in the Bundesgesundheitsamt list in accordance with Section 10c of the Federal Epidemics Control Act.

3.2 Commissioning tests

The inspection and testing of sanitizers on site serves the purpose of demonstrating that a particular unit is capable of conforming to the relevant general requirements, provided there is no deviation from the operating instructions. The operating data determined in the course of homologation testing shall be applied to the operation of the unit on site, which necessitates proper loading and a proper supply of expendables. This test may be commissioned by either the manufacturers or the suppliers of the unit.

^{d/} In non-stationary systems, the end of an operating cycle may be equivalent to the changeover to another source of waste. To cover this contingency as well as any malfunctions, an automatic disinfection cycle shall be provided.

3.3 Periodic performance tests ^{e/}

Periodic performance tests shall be conducted on site at intervals of no more than six months. Their purpose is to demonstrate that the disinfection performance of the sanitizer is good and that it causes no infection hazard, provided there is no deviation from the operating instructions and a proper supply of expendables is at hand.

3.4 Unscheduled tests

Unscheduled tests shall be conducted whenever there has been a change in the type, quantity, or packaging of the waste material being treated, whenever there is cause to suspect that the efficiency of the sanitizer has been impaired, or whenever repairs have been effected by which the said efficiency might have been impaired.

4 Test loading

4.1 General

Test loads shall comprise a variety of material, the composition of which should reflect that of the waste material actually being treated. The test should provide for treating one full load of both porous and liquid products (see section 4.1 and 4.4 of this Directive). In the test, only those containers which will later on hold the contaminated product shall be used.

Measuring implements, i.e. thermoelements and biological indicators, shall be distributed at critical points throughout the product in a representative manner. To facilitate the retrieval of the biological indicators after the test, their locations shall be marked. In processes in which containers are automatically destructed at the start of the air evacuation cycle, the critical points are at the centre of the test batch. In containers fitted with apertures such as, for instance, vents or filters in the cover, the critical zone as a rule is somewhere near the bottom of the container.

The vents or filters of waste material containers shall be function-tested under conditions simulating use by, for instance, filling them with shallow dishes containing nutrient substances.

4.2 Porous products

Containers shall be filled with horizontal layers of cellulose arranged as uniformly as possible, the objective being to avoid cavities. The biological indicators shall conform to DIN 58949, Part 4, Item 6.

4.3 Lumens

To simulate hollow objects that are open at one or two ends, test carriers that conform to DIN 58948, Part 13, shall be used together with biological indicators conforming to DIN 58949, Part 4, Item 6. Test carriers shall be packed in the requisite containers and placed in the disinfection chamber without any additional

^{e/} Each sanitizer shall be equipped with a comprehensive set of control and monitoring instruments and equipment to ensure the safety of the process. Routing test intervals shall be laid down in the homologation test report. In this context, it is of importance to note that the information leaflet published by LAGA calls for inspecting waste disinfection systems at three-month intervals.

padding.

4.4 Liquid products

Liquids shall be simulated by plastic bottles filled with 0.5 l of water. Thermoelements shall be inserted in the liquid to monitor its temperature. As an additional measure, biological indicators may be used. They should be designed and placed to ensure that meaningful data about conformance with the process parameters can be obtained. Regulations covering them are currently under preparation.

5. Biological indicators

The biological indicators used shall conform to DIN 58949, Part 4, Item 6. This standard also covers the packaging, storage and resistance testing of these bioindicators. As an additional measure, the homologation test shall involve at least a quantitative test for germs surviving on the biological indicators. This, in turn, necessitates a quantitative resistance test of these bioindicators by the standard process (saturated steam, 100 °C, 15 min). Germ count reductions shall be recorded.

This quantitative evaluation affords more insight into the safety margin of a process.

6. Physical process parameter measurements ^{f/}

6.1 Temperature

The thermoelements used shall be fitted with wires equipped with sturdy, heat-resistant insulation sheathing. Thermoelements shall be placed at all critical points within a test batch, one extra thermoelement being placed at the most unfavourable location within the disinfection chamber but outside the product proper. There shall be facilities for automatic test data recording. Temperature data shall be precise to within ± 1 K (calibration in accordance with DIN 58946, Part 3, Item 6.2.2).

It is recommended to use thermoelements equipped with sensors made of either copper/copper-nickel or nickel-chromium-nickel having a maximum diameter of 1 mm inclusive of insulation. The recorder used should be a temperature-compensated dotted-line recorder with a minimum of six input ports and a range of between 20 and 150°C (equivalent to 0 to 100 %), a usable width of 100 mm, a dot interval length of 1 s whenever possible (maximum 2.5 s), and a paper feed rate of 240 ,mm/h minimum.

6.2 Pressure

Pressure shall be measured by means of an absolute-pressure gauge with an indication or, if possible, recording imprecision of no more than ± 6 mbar. This pressure gauge shall be adequately protected by overtemperature and overpressure protection devices.

7. Scope of test

^{f/} Whenever necessary, due allowance should be made for the results of CEN TC 102 (requirements as per EN 285).

7.1 Homologation tests

Biological indicators shall be exposed within the empty disinfection chamber. Temperature distribution shall be recorded and documented.

Processes shall be tested both under partial and under full load (cf. DIN 58949, Part 3) inclusive of all the loads specified in section 4. In those processes where it appears fundamentally likely that difficulties might arise in treating batches mainly consisting of porous or liquid products, the test should include batches consisting exclusively of products defined in Section 4.2 and/or Section 4.4. As a minimum, batches consisting of single containers completely filled with porous or liquid product shall be tested.

The test batches described in Sections 4.2 and 4.2 may be omitted in the testing or processes designed for liquids only.

Biological indicators shall be used to determine the limits or process efficiency. Containers filled with porous product shall be fitted with no less than 10 bioindicators preferably placed in critical locations. The container, in turn, shall itself be placed in a critical location within the disinfection chamber. In "lumen" and "liquid" test batches, at least five of the test carriers used shall be equipped with biological indicators. As a rule, in quantitative tests, three biological indicators suffice.

Tests shall be repeated at least twice. Tests of processes not belonging to the fractional-vacuum category described in DIN 58949, Part 1, shall be repeated four times.

Homologation test records shall show what exposure time, i.e. the inactivation time plus a fixed safety margin, has been determined experimentally. Furthermore, such reports shall contain descriptions of critical locations and critical batches.

7.2 Commissioning tests

As a minimum, one test involving a test batch of lumens shall be conducted. The test shall involve at least five test carriers fitted with bioindicators. The batch in the disinfection chamber shall be one of the critical batches, identified in the homologation test or, alternatively, a full load.

Furthermore, these tests shall involve measurements of all physical parameters. In processes designed for liquids only, the test batch shall conform to Section 4.4.

7.3 Periodic performance tests

Tests involving biological indicators shall be conducted as described in Section 7.2. In addition, the physical parameters of a process should be measured once a year.

7.4 Unscheduled tests

To be conducted as described in Section 7.2.

8. Test records

As a minimum, test records shall show the following:

- The sanitizer's make, type designation and factory number;
- The type of test conducted;
- A description of the procedure involved;
- The type and weight of the load together with a description of the containers used;
- The location of the biological indicators and thermoelements (if any) within the sanitizer;
- Process parameter measurements, if applicable (local curves and histograms);
- The results of the microbiological test inclusive of the biological indicator resistance test. Reports shall show the makes of biological indicators used as well as their batch numbers, expiration dates and, if necessary, package types.

Annex V

**Emission standards for waste incinerators (in mg/m³ at 11 % O₂ dry)
set by the European Union**

Pollutant	EC Directive on the Incineration of Waste		
	Daily average limit	A – half-hour average limit 100 % <u>a/</u>	B – half-hour average limit 97 % <u>a/</u>
HCl	10	60	10
HF	1	4	2
SO ₂	50	200	50
No _x	200	400	200
CO	50	100	50
Organic substances	10	20	10
Dust	10	30	10
Heavy metals	Average emission limit over respective sampling time		
	[- 8 h]		
<input type="checkbox"/> Cd and Tl	0,05		
<input type="checkbox"/> Hg	0,05		
<input type="checkbox"/> As, Sb, Cr, V, Sn, Pb, Co, Ni, Cu, Mn	0,5		
	[6 - 8 h]		
Dioxins and furans (as toxic equivalent values)	0,1 x 10 ⁻⁶ TE <u>b/</u>		

a/ Either none of the half-hourly average values exceeds any of the emission limit values set out in column A or, where relevant, 97 per cent of the half-hourly average values over the year do not exceed any of the emission limit values set out in column B.

b/ = 0,1 ng TE/m₃.

K0113022e.doc