On behalf of:

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for the Environment, Nature Conservation,
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Umwelt Bundesamt

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Improvement of Handling Medical Waste in Healthcare Facilities in two Pilot Regions of the Russian Federation

COMPENDIUM

- Planning and Operation Guideline -

Healthcare Waste Management

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List of Abbreviations

CoP	Code of Practice
HCF	Healthcare Facilities
HCW	Healthcare Waste
HCWM	Healthcare Waste Management
HWO	Healthcare Waste Officer
IEC	Information, Education, Communication
MSDS	Material Safety Data Sheets
NAP	National Action Plan
NGO	Non-governmental Organization
NHWMP	National Healthcare Waste Management Plan
PAM	Physical Assets Management
PE	Poly Ethylene
PI	Process Instructions
PP	Poly Propylene
PPE	Personal Protection Equipment
PPP	Public Private Partnership
PVC	Poly-Vinyl-Chloride
SOP	Standard Operating Procedure
SSI	Small Scale Incinerator
SWOT	Strengths, Weaknesses, Opportunities and Threats analysis
WHO	World Health Organization
WMT	Healthcare Waste Management Team (or committee)

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1 Introduction & structure of the HCW compendium

The improper disposal of waste originating from healthcare institutions can have a negative effect on the health and the well being of health staff, patients, visitors and the general public. The environment might also be adversely affected by the indiscriminate disposal of hazardous Healthcare Waste (HCW). Risk should be therefore minimized to a minimum in order to create a safe working and living environment.

The Healthcare Waste Compendium is a set of information and process instructions in order to provide a standardized and practical guideline how to manage and handle this waste in healthcare facilities.

For every different waste stream, particular risk and safety instructions for safe and environmental sound processing are outlined. The complete logistic chain from segregation, collecting, transporting and storage - up to the treatment and disposal - is considered. The operational staff must be aware on the risks arising from the handling of different waste streams and should gain the knowledge how to handle the waste properly.

The HCW Compendium summarizes the general principles for the management of risk and non-hazardous HCW and provides only basic information on the treatment of the different kind of waste. Detailed information on the treatment of the different kind of waste can be found in the local regulations or can be obtained from the WHO (www.healthcarewaste.org).

The HCW Compendium outlines the different types of waste categories and provides process instructions for the specific waste classes. Furthermore, it includes information about the set up of a HCW Management Plan, the role of a Healthcare Waste Officer (HWO) in a hospital and emergency procedures for incidents and accidents.

The process instructions are following strictly the logical logistic chain. Environmental health and occupational safety measures are included. The process instructions can be used as an addendum to the internal policy for Healthcare Waste Management (HCWM). In the last chapter of the compendium, coaching and training contents for capacity building among healthcare staff and waste handling personnel can be found. A sample job description for the position of a HWO (Healthcare Waste Officer) is lined out.

A complete and updated version of the full Compendium should be found in the HCWM office and should be available to the director, all senior management, nursing, medical and cleaning staff and should be accessible to all staff via their superiors.

The HCW Compendium is not intended to replace any national or international laws, regulation or guidelines on HCW. On the contrary it is intended as a tool to help to implement management systems to fulfil these laws and by-laws.

2 Healthcare waste management

2.1 Definition of terms

2.1.1 Waste

Waste means any substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law

Waste includes product left over at the end of a process or action and is a resource out of place.

2.1.2 Healthcare waste

Healthcare waste includes all the waste (solid, liquid or gaseous) generated by healthcare facilities, research facilities, and laboratories. In addition, it includes the waste originating from "minor" or "scattered" sources, such as that produced in the course of health care undertaken in the home (dialysis, insulin injections, etc.).

2.1.3 Non-hazardous healthcare waste

Waste can be considered as non-hazardous waste if the risks created by this kind of waste are similar to municipal (or household) waste. It can be considered if it does not contain products or potential properties that are known to have either a reactive or toxic or pathogen effect, either to humans or the environment.

Non-hazardous waste is generated in healthcare facilities during the administrative and housekeeping functions of the hospital and includes waste from food preparation, from cleaning and sweeping, from repair and replacement, from clerical and office services. It includes packaging, cardboard, damaged containers, discarded flowers, bags, tins, wrappings and other non-contaminated plastics. Segregation of materials that can be reused or recycled will greatly reduce the impact burden of the general waste stream and may be an interesting source of income.

According to the policy paper of the WHO on healthcare waste[1], about 75% of the healthcare waste can be classified as non-hazardous waste, and about 25% must be classified as hazardous waste. This includes infectious waste (about 20%) sharps waste (1%), pathological waste (1%), chemical or pharmaceutical waste (3%), and radioactive and cytotoxic waste (less than 1%).

2.1.4 Hazardous healthcare waste

Hazardous or risk waste is waste containing substances or compounds which are directly harmful or indirectly harmful to environment and health by interacting with other substances. Waste can be considered as hazardous if it is:

- Explosive
- Oxidizing
- High flammable
- Flammable
- Irritant
- Harmful
- Toxic

[1] World Health Organization - Safe healthcare waste management – Policy paper 2004

- Infectious
- Teratogenic
- Mutagenic
- Carcinogenic
- Ecotoxic
- Corrosive
- Radioactive

2.1.5 Healthcare waste management

Waste management is involved with all efforts to eliminate or minimize wastes including:

- Identification of wastes and the sources of generation,
- Selecting and implementing of the most appropriate techniques:
    - with respect to the economic point of view,
    - with respect to environmental reasons in the frame of the hierarchy of WM practices,
    - through process optimization or redesign in developing cleaner process.

The main objective of waste management is the cost effective handling, minimization, treatment and disposal of waste under the key constraint of legislation and its enforcement.

Healthcare facilities have a duty of care for patients and for the public health. This includes that they also have a particular responsibility for healthcare waste management as they are the producer and owner of this waste. Any failure in classification, collection, storage, treatment and disposal processes will create potential risks to health and environment.

2.2 Classification system - WHO

2.2.1 Infectious waste

Infectious waste_is suspected to contain pathogens (bacteria, viruses, parasites or fungi's) in sufficient concentration or quantity to cause disease in susceptible host. Infectious waste must be considered as hazardous waste and forms the largest component of hazardous healthcare waste.

This category includes:

- Waste contaminated with blood or other body fluids,
- Cultures and stocks of infectious agents from laboratories,
- Waste from surgery and autopsies of infectious patients,
- Waste from infectious patients in isolation wards
- Waste that was in contact whit infectious patients undergoing haemodialysis,
- Infected animals from laboratories,
- Materials that have been in contact with infected patients or animals.

Examples are:

- Free-flowing blood, blood components,
- Tissues, and materials or equipment that have been in contact with blood or other body fluids,

- Excreta, dressings from infected or surgical wounds, clothes heavily soiled with human blood or other body fluids,
- Dialysis equipment such as tubing and filters, disposable towels, gowns, aprons, gloves, and laboratory coats,
- Food residues from infectious patients.

Cultures and stocks of highly infectious agents, waste from autopsies, animal bodies, and other waste items that have been in contact, inoculated or infected with such agents are highly infectious waste.

2.2.2 Sharps

Sharps are items that could cause cuts or punctual wounds and can break through skin barrier of the human body, whether or not they are infected. This waste category must be considered as highly hazardous waste.

Examples are:

- Needles,
- Scalpels and other blades,
- Knifes and saws,
- Infusions sets,
- Broken glass,
- Nails.

2.2.3 Pathological waste

Pathological waste consists of tissues, body parts, organs, human fetuses, animal carcasses, blood, and body fluids.

2.2.4 Pharmaceutical waste including cytotoxic waste

Pharmaceutical waste includes expired, unused, split, and contaminated pharmaceutical products, drugs, vaccines, and sera that are not longer required and need to be disposed of appropriately. The category also includes discarded items used in the handling of pharmaceuticals, such as bottles or boxes with residues, gloves, masks, connecting tubing, and drug vials.

Cytotoxic waste represents a subcategory of pharmaceutical waste. Genotoxic drugs, the main substance in this waste category, have the ability to kill or stop the growth of certain living cells and are used in chemotherapy (treatment) of cancer. Genotoxic drugs are used in specialized departments such as oncology and radiotherapy units. Genotoxic waste may have mutagenic, teratogenic, or carcinogenic properties. Genotoxic waste must be considered as highly hazardous waste and need special attention inside a hospital and after disposal.

Examples are:

- Contaminated materials from drug preparation such as syringes, needles, packaging,
- Outdated drugs, leftover solutions, drugs returned from the wards,
- Urine, faeces, and vomit from patients, which may contain potentially hazardous amounts of the administered cytostatic drugs or of their metabolites and which should be considered genotoxic for at least 48 hours and sometimes up to 1 week after drug administration.

2.2.5 Chemical waste

Chemical waste consists of discarded solid, liquid, and gaseous chemicals. It is hazardous, if it has at least one of the following properties:

- Toxic,
- Corrosive (e.g. acids of pH < 2 and bases of pH > 12),
- Flammable,
- Reactive (explosive, water-reactive, shock-sensitive),

Examples are:

- Laboratory reagents,
- Film developer and fixing bath,
- Disinfections which are expired or no longer needed,
- Solvents.

Wastes with high heavy metal content represent a subcategory of hazardous chemical waste, and are usually highly toxic.

Examples are:

- Broken thermometers (mercury),
- Blood pressure gauges (mercury),
- Batteries (cadmium).

2.2.6 Radioactive waste

All waste containing radioactive substances. Radioactive waste includes solid, liquid, and gaseous materials contaminated with radionuclides. It is produced in procedures such as in-vitro analysis of body tissues and fluids, in-vivo organ imaging and tumor localization and various therapeutic practices. Radioactive waste must de considered as highly hazardous waste.

Examples are:

- Unused liquids from radiotherapy or laboratory research
- Contaminated glassware,
- Urine or excreta from patients treated or tested with unsealed radio nuclides,
- Sealed sources.

2.3 General healthcare waste management strategies

2.3.1 General waste management principles

Independent of size, waste amount, hazards, etc., every natural or juristically body which is generating waste is committed to manage the generated waste in a responsible way under consideration of hygienically, ecological, economical and safety aspects. One of the main keys for an effective waste management and for waste minimization is a strict segregation of waste into different waste streams as otherwise the entire waste mixture (e.g. mixed infectious and household like waste) must be handled as hazardous infectious waste, resulting in extremely high treatment costs.

The expenditure for waste management should stand in proportion to the quantity and quality of the produced waste. Out of this it occurs that small, specialized hospitals, producing small

amounts of highly hazardous waste may have higher expenditures and must take more efforts as a large health facility, producing large amounts of non-hazardous HCW.

General principles to be followed for the Healthcare Waste Management are:

The **"Duty of Care"** principle – it stipulates that any person handling or managing hazardous substances or related equipment is ethically responsible for using the utmost care in that task.

The **"Proximity"** principle – it recommends that treatment and disposal of waste should take place at the closest possible location to its source in order to minimize risks linked to the transport of waste.

The **"Precautionary"** principle – it governs health and safety protection. When the magnitude of a particular risk is uncertain, it should be assumed that this risk is significant, and measures to protect health and safety should be designed accordingly.

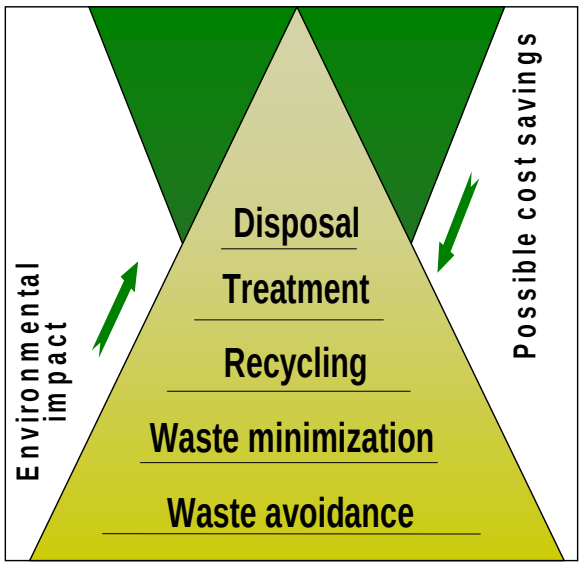
The **"Polluter Pays"** principle – it implies that all producers of waste are responsible for the safe and environmentally sound disposal of the waste they produce.

2.3.2 Pollution prevention strategy

The management and treatment of HCW, especially hazardous HCW, is cost intensive and often not carried out because of missing budgets. The cheapest and best way of waste management is the prevention of the waste generation. Waste which is not produced cannot result in any risks or harm. Pollution Prevention therefore starts at the point of purchase of medical goods – one example is the purchasing of goods with long expiry dates, usage of PVC free devices or the purchasing of goods requiring less packaging material.

The next strategy is the minimization of to be generated waste, to minimize by this the treatment and other combined costs. Re-engineered working processes will result in less waste quantities and can be found to be more efficient. An improved clinical workflow management considers environmental aspects and should include reuse practices as long as these are not contrary to hygiene requirements.

Figure 1: Pollution prevention strategy



An issue closely related to the procurement of products is the packaging of them. It is possible to noticeably reduce the amount of waste generated if attention is paid in the selection of products to the least amount of packaging.

Where waste cannot be avoided or minimized, as third strategy the recycling of e.g. packaging materials should be implemented which can also create a certain income for the hospital. Kitchen and canteen waste as another example can be utilised/sold as feed substitute to farmers, if it is disinfected in a manner, which is appropriate for such use. The last two waste management strategies (treatment and disposal of the waste) should only be chosen, if the other three strategies are not possible.

2.4 Risks associated with healthcare waste

2.4.1 Risks from hazardous HCW to humans

Risks associated with hazardous HCW can be found during all stages of its segregation, collection, storage, transport, treatment and disposal. The highest risk of infections is existent for medical staff in the healthcare facility and to waste management workers during the transport and the treatment of this waste.

Two types of risk are associated with healthcare waste. The first and most obvious is the risk to the health of humans as a result of infection or injury, mainly to those healthcare workers and others who are directly involved in handling of the waste materials. The second risk is the risk to the environment, which, in turn, presents a risk to the public health of a wider sector of the population.

All persons exposed to hazardous HCW are potentially at risk of contamination through accidental exposure. The main groups at risk and most likely to have an accident are:

- Nurses, and assistant nurses,
- Doctors,
- Laboratory staff,
- Logistic staff, attendances, cleaners and janitors,
- Mortuary workers,
- Patients,
- Municipal waste workers,
- Management staff of a hospital,
- The public.

People who are repeatedly moving bags from one receptacle to another may become complacent with this routine activity. Risk of injury is therefore increased for those staff handling waste in large quantities. Incorrectly segregated hazardous health care waste that is put into the general waste stream will be taken to the landfill site. Scavengers or municipal waste workers at the landfill site are then exposed to healthcare risk waste. Waste collection contractors or service providers and treatment plant operators are also vulnerable to accidental exposure.

For the public health, three potential ways of exposure to risks can be identified

Chronic exposure: People come in permanent contact with small amount of hazardous materials like germs, chemicals, etc. Samples are permanent germ burdens in the near of waste storage places, landfills, hospitals, etc.

Direct, acute exposure: The public is exposed for a shorter period to large amounts of germs or toxic substances. Samples are unauthorized disposal, inadequate landfills, bad interim storage places, loss of waste during external waste transport, etc.

Indirect, acute exposure: The public is exposed to amounts of germs through vectors such as rodents or other vermin. Samples are interim storage places, landfills, etc. vermin, rodents, cats, dogs, birds, etc. having access to waste.

Hospitals are today considered as a risky environment. Next to the risk of air-borne transmission of diseases, a special risk on blood-borne diseases is existent for hospital staff during the handling of sharp items. Consequently, healthcare workers are at risk of infection with blood-borne viruses including human immunodeficiency virus (HIV), hepatitis B (HBV) and hepatitis C (HCV). Occupational exposure to blood can result from percutaneous injury. The most common form of occupational exposure to blood and the one most likely to result in infection is a needle-stick injury.

Hazards from sharp items (sharps)

Sharps may not only cause cuts and punctures, but also infect the wounds by agents that previously contaminated the sharps. Due to this double risk of injury and disease transmission, sharps are considered as a high risk. The main diseases of concern are infections that may be transmitted by subcutaneous introduction of the agent, e.g. viral blood infections.

According to the WHO[2], among the 35 million health workers worldwide, about 3 million (8,5%) receive percutaneous exposures to bloodborne pathogens each year. The risk of infection following a needle-stick injury with needle from an infected source patient is ~ 0.3% for HIV, 3% for hepatitis C and 6-30% for hepatitis B.

A special problem is the so-called "re-capping" of sharp items. Re-capping means to put the protection cap of a needle back on the needle after usage and is considered as one of the main reasons for needle stick accidents. According to interviewed nurses, reasons for the carrying out of re-capping are mainly missing opportunities for a proper waste disposal (e.g. missing safety boxes, needle cutters, etc.).

Hazards from infectious waste

Infectious waste may contain a great variety of pathogenic micro-organisms, which may infect the human body through one of the following pathways:

- Absorption through a crack or cut in the skin (injection),
- Absorption through the mucous membranes,
- Rarely by inhalation and ingestion.

In the following table, sample of pathogens which can be potentially transmitted via contaminated waste can be found.

Table 1: Infection ways and infections

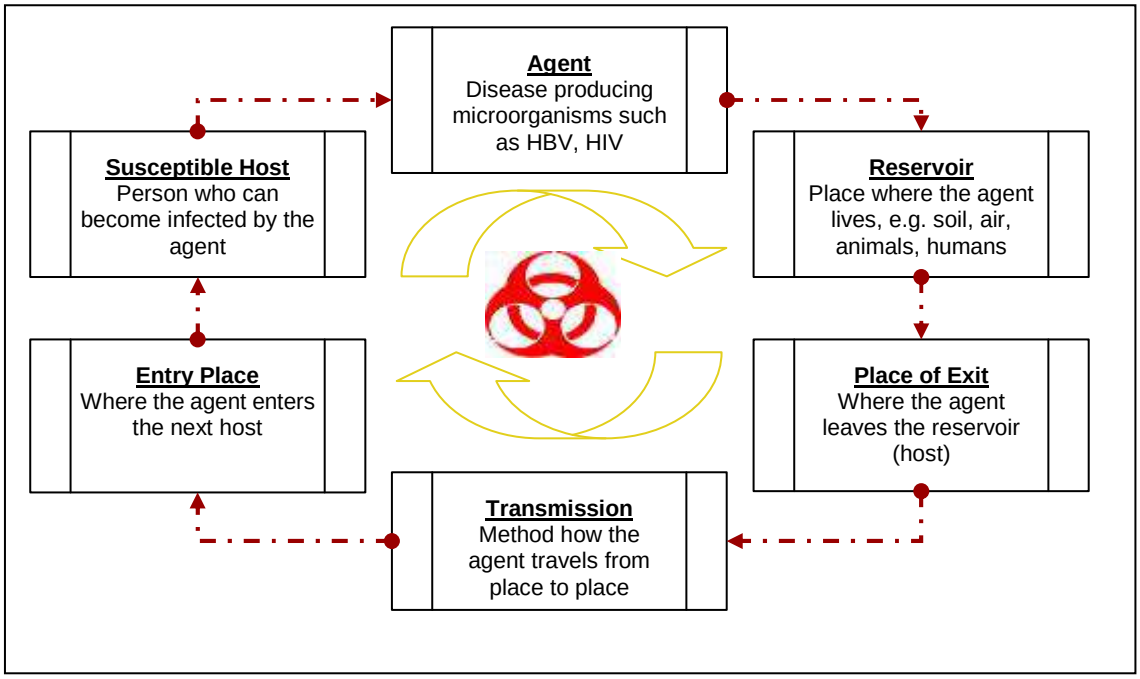
Body fluids	Bacteria / Virus	Types of infection
Blood	Straphylococcus (sp)	Septicaemia
	Human immunodeficiency virus (HIV)	Acquired immunodeficiency syndrome (AIDS)
	Straphylococcus aureus, Enterobacter,	Bacteraemia
	Candida albicans	Candidaemia
	Hepatitis B and C viruses	Viral hepatitis B and C
	Junin, Lassa, Ebola and Marburg	Haemorrhagic fevers
Faeces and/or vomit	Salmonella, Shigella sp, Vibro cholerae helminths	Gastroenteric infections
	Hepatitis A virus (faeces only)	Viral hepatitis A
Saliva	Mycobacterius tuberculosis, measles virus, streptococcus pneumoniae; Streptococcus sp.	Respiratory infections
Pus	Septicaemia	Skin infections

Incorrect management of infectious waste may lead to nosocomial infections. Nosocomial infections, or hospital acquired infections, are defined as infections that are not present in a human at the time of entry in to the hospital but develop during the work or stay in the hospital or can be later linked with the stay or work in the hospital.

[2] World Health Organization - Aide Memoire - For a strategy to protect health workers from infection with bloodborne viruses

Task of a good waste management will be to avoid the transmission of pathogen agent.

Figure 2: The communicable diseases transmission cycle



Hazards from chemical and pharmaceutical waste

Many chemicals and pharmaceuticals that are used in healthcare establishments contain toxic, corrosive, flammable, reactive, explosive, shock sensitive, cyto- or genotoxic properties. They may cause toxic effects, either by acute or by chronic exposure, and injuries, including burns. Intoxications can result from absorption of the chemicals/pharmaceuticals through the skin, the mucous membranes, from inhalation or ingestion.

Injuries can be provoked by contact of flammable, corrosive or re-active 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.

Some examples for hazardous substances and their effects in health care facilities are:

- **Mercury** constitutes another hazardous issue within hospitals due to its prevalent use literally hundreds of different devices most concentrated in diagnostic devices such as thermometers, blood pressure meters, oesophageal dilators, Miller Abbott/Cantor tubes. It is also found in more mercury sources such as fluorescent light tubes and batteries.
- **Disinfectants** constitute a particularly important group, as they are used in large quantities and are often corrosive. It should also be noted that reactive chemicals may form secondary compounds of high toxicity.
- **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.

Hazards from cytotoxic waste

The severity of health hazards for health care workers handling cytotoxic waste is the combined effect of the substance toxicity and of the magnitude of exposure, which may occur during waste handling or disposal. Exposure to cytotoxic substances in healthcare 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 chemotherapy patient's secretions.

Hazards from radioactive waste

Radioactive waste is depending on its elementary structure cell-toxic and mutagen. The radiation is penetrating the skin and organs and effect body cells. In most cases, healthcare facilities work with radioactive substances with a short half-life time, which radiates and deactivate within some hours, days or weeks. Radioactive waste has to be handled very careful and only by well trained persons.

2.4.2 Risks from hazardous HCW to the environment

Hazardous HCW has the potential to cause damage to most aspects of the environment, especially to land, water, air and to wildlife. Thoughtless or unnecessary disposal may also cause an unnecessary waste of natural resources. The pollution of water and air may have serious repercussion, in turn, for public health. Water resources may become contaminated by certain hazardous materials contained in clinical wastes. They may contain heavy metals, largely mercury from thermometers and silver from the processing of X-ray films.

Both these metals are toxic, especially the former. Certain pharmaceuticals, if deposited without treatment, may also cause toxic agents to leach into water supplies. In addition, the leachate generated by the biological degradation of clinical wastes, like that from Municipal Solid Waste (MSW), has the potential to cause water contamination, by reason of its high Biochemical Oxygen Demand (BOD) and toxic components.

The risk of air pollution from healthcare waste arises largely from the fact that most infectious waste is incinerated or burnt in order to eliminate or reduce infection. If incineration is carried out in suitable, modern treatment plants which are operated according to instructions, the incineration will only causes a negligible amount of air pollution.

However most incinerators today are of a small-scale type, are not operated and maintained in a proper way and do not contain flue gas treatment systems. This incinerator or burners have a potential to pollute the environment in several ways:

Particles: Inefficient combustion, for example when temperatures are too low or when waste is loaded in too large a quantity, will cause noxious black smoke.

Acid gases: The presence of significant quantities of PVC plastic in the waste, together with certain pharmaceuticals, can produce acid gases, notably HCl and SO_2.

- **Dioxins:** During combustion with low temperature halogen ingredients (F, Cl, Br, I etc.) in the waste are able to be transformed in e.g. hydrochloride (HCl). This causes a risk of forming dioxins, which are extremely toxic substances, even in small concentrations.
- **Heavy metals:** Volatile heavy metals, notably mercury, can be emitted from hospital incinerators.

The environmental risks described above all present risks to human health. They equally present risks to wildlife and biodiversity and many species are appreciably more sensitive to certain types of pollution than humans.

In addition to the issues which present risk to health and life, there is also the issue of the conservation of natural resources. Many materials in hazardous HCW have the potential for recovery and reuse. Those with the greatest value are organic solvents (recovery by distillation), mercury used in thermometers and the silver used for X-ray films (fixing bath). Non-hazardous items as paper and cardboard, glass and plastics may also be recovered for recycling if a market for these items is existent.

3 Legislation

The work of a Healthcare Waste Officer is strongly affected by different types of national regulations. Decision makers and legislators should consider relevant international laws and regulations. These are the basis for legislation improvements in several countries.

3.1 International regulations and conventions

3.1.1 The Basel Convention

The Basel Convention is signed by more than 100 countries and concerns the transboundary movements of hazardous waste and is by this also applicable to hazardous healthcare waste. Countries that signed this convention accepted the principle that the only legitimate transboundary shipments of hazardous waste are exports from countries without facilities, or expertise to dispose safely of certain wastes to countries which have both - facilities and expertise.

Based on the Basel Convention, technical guidelines are issued which should be a help to install on the international scale state of the art waste management systems in different branches. For the healthcare sector, this is the:

Technical Guideline on the Environmentally Sound Management of Biomedical and Healthcare Waste (Y1;Y3).

Unlike the precautionary principle of the World Health Organisation (WHO), the technical guideline follows an approach to reduce hazardous waste and by this the combined costs to a minimum by:

- High qualification of staff,
- Strict definition and classification of the waste streams,
- Segregation at the source with the best information for identification of the waste.

Target of a waste management should be to reduce and minimise hazardous waste as much as possible.

3.1.2 Model Regulations on the Transport of Dangerous Goods

These Recommendations have been developed in the light of technical progress, the advent of new substances and materials, the exigencies of modern transport systems and, above all, the requirement to ensure the safety of people, property and the environment. They are addressed to governments and international organizations concerned with the regulation of the transport of dangerous goods. They do not apply to the bulk transport of dangerous goods in sea-going or inland navigation bulk carriers or tank-vessels, which is subject to special international or national regulations.

The Model Regulations aim at presenting a basic scheme of provisions that will allow uniform development of national and international regulations governing the various modes of transport; yet they remain flexible enough to accommodate any special requirements that might have to be met.

Although only a recommendation, the Model Regulations have been drafted in the mandatory sense (i.e., the word "shall" is employed throughout the text rather than "should") in order to facilitate direct use of the Model Regulations as a basis for national and international transport regulations.

The regulation covers principles of classification and definition of classes, listing of the principal dangerous goods, general packing requirements, testing procedures, marking, labelling or

placarding, and transport documents. There are, in addition, special requirements related to particular classes of goods. With this document, carriers, consignors and inspecting authorities benefit from simplified transport, handling and control and from a reduction in time-consuming formalities.

Based on the UN Recommendations on the Transport of Dangerous Goods the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) was developed. In comparison to the UN Recommendations it also contains much more detailed provisions as regards:

- the types of packaging which may be used,
- the consignment procedures,
- transport equipment (vehicle to be used, vehicle construction and equipment),
- transport operation (training of drivers, supervision, emergency procedures, loading and unloading, placarding of vehicles).

There are at present 42 contracting parties to ADR.

3.2 Situation in CIS countries

3.2.1 General healthcare waste management situation

General waste

Due to the small amount of disposables used in healthcare facilities and the poor segregation rate, the amount of general waste generated during healthcare activities is low. The waste is often dumped in waste pits (especially in rural areas) or picked up by transport companies and dumped on unsecured landfills. The waste collected in pits is frequently burned.

Infectious waste including sharp items from curative activities

A common practice in CIS-Countries is the internal disinfection of infectious waste including sharp waste which is not generated within the immunization activities. For this the waste is soaked in a 0.5 % chloride solution.

The effectiveness of a disinfectant depends not only on the properties of the micro-organisms against which it is used, but also upon factors in the environment in which it is used. Factors that may affect the action of chemical disinfectants include the following:

- Concentration of the chemical in the disinfectant solution;
- Temperature;
- PH 6-8;
- Relative humidity of the environment;
- Duration of contact.

For safe disinfection the infectious waste has to get in optimum contact with the chloride solution. Especially in the case of hollow material like intravenous lines it may not be sufficient to soak the waste in the solution because it is likely that not all parts inside the tube are wetted by the disinfection solution.

After internal disinfection, the waste is disposed of or incinerated. Beside small scale incinerators and open burning, self-invented incinerators developed from metallic drums and pipes are used to combust the waste on the hospital compound. The generation of dioxins and furans in present of chloride and low combustion temperature is very likely and has high potential to harm humans and environment. Advanced environmentally friendly and safe treatment capacities are missing or not sufficient.

Separated sharp items are commonly collected in used plastic bottles and afterwards encapsulated and disposed of on a landfill or waste pit on the facility compound (rural area).

Waste from immunization activities (Sharp waste)

Sharp waste, which is generated during immunization activities, is handled distinct from other hazardous waste. First of all this waste is not disinfected by chloride solution but disposed off without any further handling in sharp boxes. The sharp boxes are made of cardboard and are mostly delivered together with vaccines and are incinerated (together with infectious waste).

In order to meet the requirements of *Global Alliance for Vaccination and Immunization* (GAVI) specific guidelines at country level for the destruction of the syringes in the framework of the *Expended programme on immunization* (EPI) have been developed. These guidelines include: 1) a specific procedure for collecting syringes directly into safety boxes without removing or recapping needles, 2) the incineration of the syringes (plus needles) in the HCF (either in rural or in urban areas) at special chosen places and the bury of the remnants in special refuse pits. In some countries the installation of small scale incinerators in central and urban hospitals was foreseen.

Pharmaceutical and chemical waste

A waste disposal system for chemical and pharmaceutical waste from healthcare facilities is often missing. Liquid chemical waste is disposed of via the sewage system.

Highly infectious waste

Following international recommendations, cultures and stocks from research and medical analyses laboratories are sterilized in autoclaves and incinerated afterwards.

Pathological waste

In case of Islamic countries, the pathological waste is often taken by relatives and buried in specific places. In major cities the pathological waste is picked up by a licensed company and centrally buried.

3.2.2 Legal framework and classification system

Almost all CIS countries have signed and ratified the Basel convention and most of the environmental authorities have developed or revised laws and technical guidelines for solid wastes management. Often no general waste management plans exist at regional or district levels. However in some countries, such as Kyrgyzstan, national healthcare waste management strategies and policies were developed and the implementation has been started on a pilot scale.

The lack of policy at central level has a direct consequence at regional and district levels. There is poor coordination between the HCF for the management of their HCW although some are extremely close from each other in a same district/city. Regional/district management plans are often missing to homogenize and co-ordinate the management of the HCW in each region/district.

Responsibilities are not clear defined, job descriptions often not available and training on HCWM is not conducted frequently. It is therefore hard to settle down a monitoring system to control the waste management procedures that might be defined in each HCF.

As the classification system in CIS countries is mainly based on the legislation of the former Soviet Union, healthcare waste is not classified according WHO recommendations. Following table shows exemplary the healthcare waste classification system of Azerbaijan and Uzbekistan.

Table 2: Classification system Uzbekistan and Azerbaijan

Non- hazardous waste	Waste not contaminated with biological fluids of patients, infectious diseases patients, including non-toxic wastes, Food wastes of all health facilities, except infectious diseases hospitals (including skin and STI diseases hospitals), TB clinics, Furniture, broken diagnostic equipment, which don't contain toxic elements,

	Non-contaminated paper, construction wastes etc.
Hazardous waste	Potentially contaminated wastes. Materials and instruments contaminated with excretions, including blood, patients' fluids, Pathologic wastes (patients' tissues, organs etc.), All waste from infectious diseases unit of hospitals (including food wastes), Waste of biological labs, working with micro-organisms, Bio-waste of animal research laboratories.
Highly hazardous waste	Materials, which were in contact with patients having very dangerous infections, Waste of laboratories, working with high-risk micro-organisms, Waste from physiatrics and micrological hospitals, Waste of patients having anaerobic infections.
Waste, similar to industrial waste	Expired medicine, wastes of medication and diagnostic materials. Disinfectants, Cytostatics and other chemicals, Equipment and instruments containing mercury
Radioactive waste	All radioactive waste.

4 Healthcare waste logistic system

The logistic system for healthcare waste management is the back-bone of a HCW management system. The HCW logistic includes the main working and management steps: identification, segregation, collection, storage and treatment/disposal.

4.1 The key for waste management - Segregation

4.1.1 Segregation at the place of origin – The background idea

Segregation means the separation of the entire waste generated in a hospital in defined, different waste groups according to the specific treatment and disposal requirements. Only a segregation system can ensure that the waste will be treated according to the hazards of the waste, that the correct disposal routes are taken, and that the correct transportation equipment will be used.

Occupational safety can only be maintained if the risks from the materials are defined, identifiable and the resulting counter measures are taken. By this, the risk of injury and incidents can be minimized in a cost effective waste.

Recycling can be only carried out if recyclable materials are separated from the hazardous waste (contaminated materials are excluded from any recycling activity and must be treated as mixed hazardous waste). To guarantee a high quality of the recycling materials it must be collected in a sort pure way. Mixed waste will decrease the possible income.

The separate handling, treatment, and disposal of different kind of hazardous and non-hazardous waste in different ways will reduce dramatically costs. Only the different kind of hazardous waste will be treated and disposed in a costly way instead of the entire waste stream in a hospital.

Segregation is the key to any effective waste management!

Without effective segregation system, the complete waste stream must be considered as hazardous!

4.1.2 The principles of segregation

The correct segregation is the clear responsibility of every waste generator, independent of the organisational position of the generator ("duty of care" principle).

In case of doubts regarding the waste group, the "precautionary" principle must be followed, that means if a classification of the waste unclear or not recognizable, the waste must be classified in the highest to be expected risk group.

The segregation should be carried out by the producer and close as possible to the place of generation, that means segregation must take place at source, e.g. on the ward, at the bedside, operation theatre, laboratory, etc. and must be carried out by the person generating the waste e.g. nurse, physician ("proximity principle"). The segregation must be applied from the point of generation, during collection, transport, storage and final disposal.

Every place of generation should have the necessary equipment for the types of wastes that are generated at that place like bags, bag holder, container, etc.

Segregation and identification instructions should be placed at each waste collection point.

Segregated waste should not be mixed during transport and storage.

If hazardous and non hazardous wastes are mixed, the entire mixture must be considered and treated as hazardous waste.

Correct segregation will only be achieved through a rigorous training of all hospital staff and waste generators inside the hospital (this includes patients and visitors).

The segregation should be carried out first under the "polluter pay" principle and second under the "precautionary" principle. This means the generator must segregate as good as possible and shall only in unclear situation follow the precautionary principle.

4.1.3 The planning of segregation – General aspects

For the planning of the segregation, some necessary information and facts must be investigated, to ensure a proper waste management in the healthcare facilities:

- Which kinds of waste are generated in each department (because different departments are generating different kinds of waste) - to find out which kinds of bags/containers must be used for the segregation (depending on the waste hazard, treatment, and disposal).
- Where are the different kinds of waste generated? Who generates the different kinds of waste? - to fix the segregation points as near as possible to the point of generation.
- How much of wastes are generated? – for the calculation of the needed size and quantity of bags and container to ensure a proper supply of bags/containers.
- Are peak times of generation existing? - to ensure the supply of bags and container during the peak times.

The quality of the segregation system will depend on the quality of the segregation concept and quality of the implementation of the concept!

4.1.4 Colour coding of the segregated waste

Colour coding means to combine different waste groups with "similar" hazards in one main group and to identify this main group in a fast and easy way by a fixed colour.

The different waste groups have different colours for the containers and bags for the identification according to the hazards and applied throughout the complete disposal chain (segregation, collection, storage, transport, disposal):

- Warning colours for hazardous waste (Red, yellow, orange)
- Positive colours for recycling (Blue, green, etc.)
- Neutral colours for normal waste (Black, etc.)

The colour coding makes the process understandable even for low-skilled workers with language and read problems.

4.1.5 Packaging of segregated waste

Different kinds of waste need a different packaging due to the different risks created by the waste. The chemical characteristic of the waste must be obtained! Some chemicals may can solute plastic bags and must be collected in metal containers or glass bottles. For the packaging of infectious waste, plastic bags should be used in a good quality and from strong material. For bags, closable bag holder or bins with a lid are recommended. The containers for hazardous waste should be puncture proof and sealable. For the identification of the risks, the United Nations packaging symbols should be used.

4.2 The labelling of the segregated waste

The labelling of the waste is absolutely necessary, for the identifying, monitoring, controlling, and record keeping of the different waste groups along the entire waste stream. At least all types of hazardous waste should be labelled with the basic information on their content and on the waste producer. The labels should be clearly, legibly and durably marked with at least the following information:

- Name of the producer, if applicable department,
- Waste classification, date of production,
- Special remarks,
- Waste volume-waste destination.

Table 3: Overview – Colour code, packaging and labelling

Non-hazardous or general waste		
Specification	Healthcare waste with similar composition to household and municipal waste	
Colour code	**Black**	
Packaging	Black PP or PE plastic bags of good quality and sufficient capacity.	
Symbol / marking	Household like waste: None	
	Recyclables: The international recycling sign should be placed on the bins/bags. Wording: "Non-contaminated XXX (kind of waste), to be recycled" is recommended.	
Labelling	During normal operation not necessary, only during times of research (e.g. waste audits: name of the producer, department, etc.)	

Infectious waste		
Specification	Healthcare waste contaminated with pathogens which are known or clinically assessed to have the potential of transmitting infectious diseases to humans or animals.	
Colour code	**Yellow**	
Packaging	Strong plastic bags of good quality and sufficient capacity. Should be placed in a container, such as a pedal bin, or suspended from a bag holder with a lid. If the waste is incinerated, the use of PVC bags should be prohibited.	
Symbol / marking	International bio-hazard symbol in black wording: "Infectious Waste"	
Labelling	• Name of the generator (department, ward) • Waste class, date of generation • Special remarks • Waste volume and waste destination • General remarks	

Sharps		
Specification	All sharp items, whether contaminated with infectious material or not.	
Colour Code	**Yellow**	
Packaging:	Watertight, puncture proofed, sealable and strong cardboard or plastic containers. A sharps container should, once assembled, have a lid which cannot be removed, have a handle (not part of the closure device) and a lid so designed as to enable items to be dropped in by one hand. Should be resistant to penetration and leakage.	
Symbol / marking	International biohazard symbol in black wording: "Infectious Waste" and "Sharps"	
Labelling	• The container should bear a horizontal line together with the words `WARNING - DO NOT FILL ABOVE THE LINE'. • Name of the generator (department, ward) • Waste class, date of generation, volume and waste destination	

Pathological waste	
Specification	Anatomical, pathological waste as body parts.
Colour code	**Yellow**
Packaging	Water tight and sealable strong plastic bags, containers or other collection items
Symbol / marking	None, Recommended wording: "Pathological waste - Handle with care"
Labelling	• General remarks

Other hazardous waste	
Hazardous pharmaceutical waste including cytotoxic waste	
Specification	Hazardous pharmaceutical waste
Colour code	**Brown**
Packaging	To be packed in specific cardboard boxes, containers or other safe packaging, depending on the specific characteristics and hazards.
Symbol / marking	Depend on the type of the waste, such as: toxic, noxious, corrosive, oxides, flammable, mixed hazards, environmental polluting materials etc. The wording: "Danger! Hazardous pharmaceutical waste" For cytotoxic waste: Cell in telo-phase and wording: "Cytotoxic waste"
Labelling	• General remarks

Radioactive waste	
Specification	Waste with radio-nuclides whose ionizing radiation has genotoxic effects e.g. Tc-99m, Cr-51, Ga – 67, I-125, I-131, In-111, P-32, Rb-86, RD – 222, S-35
Packaging	Approved container

Symbol / marking	International radiation symbol and wording: "Caution! Radioactive Waste"	
Labelling	• General remarks • Kind of radionuclide • Radiation on given date (start storage time) • Period of storage time required • Further safety remarks (e.g.: Danger! Contains Bio-hazardous materials)	

Hazardous chemical waste	
Specification	Chemical waste: Formaldehyde, oxide ethylene, X-Ray fixing and developing solutions, solvents, chemical mixtures.
Colour code	**Brown**
Packaging	Sealable, robust containers, appropriately for their content and for normal conditions of handling and transportation. Different types of hazardous waste should not be mixed to eliminate undesirable reactions.
Symbol / marking	Depend on the type of the waste, such as: oxides, corrosive, mixed hazards, environmental polluting materials etc.
Labelling	• General remarks • Special remarks

4.3 HCW segregation points

"Segregation point" is the generic term for any fixed place in a health facility where the first level separation of waste in different waste streams is regularly carried out and where the waste is put into its packaging for collection. As there are different waste streams existent in health facilities, segregation points consist out of receptacles for one or several different kind of waste. Normally, each room in a hospital has at least one segregation point. Typical waste streams for which segregation points are regularly set up include:

- Non-hazardous waste (municipal or household like waste),
- Recyclables (paper/cardboard, glass, plastic),
- Infectious waste and sharps,
- Pharmaceuticals (minor points).

Segregation points for other waste streams (as for chemical waste, radioactive waste, etc.) will only be set up in areas where this kind of waste is expected to be generated. Segregation points normally consist out of:

- Waste bins or bag-holders,
- Packing material for the waste (e.g. sharp box or plastic liner),
- Necessary IEC material to inform the waste generator what kind of waste shall be collected at the point (e.g. poster or labels on bins).

A sample of a basic segregation point is shown in the following picture.

Figure 3: Sample for a simple HCW segregation point

4.3.1 Planning of segregation points

To enable a systematic segregation and collection of HCW, it is highly recommended to carry out a segregation point planning. For this, the to be managed health facility shall be divided in different, logical areas (e.g. in departments, buildings, wards, etc.) which consist out of several rooms. Each room of a specific area will be analysed for:

- Kind of waste which will be generated in the room,
- Expected amount of waste to be generated per day,
- Frequency of the waste collection,
- Needed segregation equipment,
- Possible location for the containers, bins, bags.

The analysis is carried out for all rooms of the area. Based on this analysis, the kind and the quantity of segregation points can be estimated per room and for the entire area. By this, the total needed equipment (kind and size of bins) can be identified. For each area, a segregation plan shall be developed which contains the exact location and the numbers of to be set up segregation points in the different rooms as well as the list of equipment needed. For the equipment planning and the later on management of the equipment it is strongly recommended to introduce a PAM (Physical Asset Management) system.

Points to be observed during the planning phase of segregation points are:

- Segregation should be carried out as close as possible to the place of waste generation (proximity principle)
- Segregation points shall be easy accessible for the waste generator
- The place of segregation for non-hazardous and hazardous waste should be separated.
- Segregation points for hazardous waste must be out of reach of patients, visitors and strangers and should be only accessible to trained staff.
- Hazardous waste segregation points should be clearly marked and equipped with easy to understand instructions.

4.4 HCW collection & transportation system

Different kinds of strategies are available for the collection and transportation of HCW, depending on the quantity and quality of the waste. The collection systems can be divided in:

- **Regular collection** systems (for biological active waste and waste generated in large quantities): Depending on a fixed collection schedule, waste is regularly collected and transported to the interim storage.
- **On demand** (for waste generated in small quantities or for waste with special hazards). Waste will be only picked up and transported to the interim storage after official request.

Transportation systems can be divided in:

- **Direct transportation system:** direct transportation of the waste from the segregation point to the central interim storage place.
- **Indirect transportation:** two-step transportation system. First step: transport of waste from the segregation point to the de-central collection point (by the staff of the respective ward); second step: pick up of the waste from the de-central collection and transport to the interim storage (by logistic staff).

Under consideration of hygiene, ease and economical aspects, following systems are recommended for different waste streams:

Non-hazardous:	Regular collection, direct transportation for small hospitals, indirect transportation for larger hospitals.
Recyclables:	Regular collection, direct transportation for small hospitals, indirect transportation for larger hospitals.
Infectious waste:	Regular collection, direct transportation if no dirty rooms are available, indirect transportation if dirty rooms are available (recommended).
Sharps:	N.a. as collected together with infectious waste
Highly inf. waste:	N.a. as collected together with infectious waste after disinfection
Pharmaceuticals:	Direct transportation, on demand (Note: normally carried out by staff of the respective department)
Chemical waste:	Indirect transportation (usage of de-central collection points in laboratory, pathology or radiology department), on demand
Radioactive waste:	Direct transportation, on demand

Note: The final decision what kind of logistic system will be the most appropriate one must depend on the specific local situation and available equipment.

4.4.1 Planning of the HCW collection & transportation system

Based on the segregation point planning and on the chosen logistic system, the planning for the different collection & transportation systems has to be carried out. The planning should include:

- Location planning
- Necessary equipment planning
- Tour-planning for regular collection

Planning of de-central collection points

The idea of de-central collections points is to collect small waste bags from the different segregation points of a ward to a central point where the waste is put into a larger receptacle which can be picked up from the logistic service. This will minimize the entering of hygienically critical areas by potentially contaminated persons (as the logistic staff) and will allow an easier, flexible and efficient transportation of larger amount of waste to the central interim storage place.

The location of de-central collection points depends on the kind of waste. While for non-hazardous waste and recyclables free accessible places outside of buildings can be chosen, for hazardous waste lockable rooms (e.g. soiled utility or dirty room for infectious waste) or cabinets (e.g. for chemical waste) are necessary to avoid the access of unauthorized persons. All places must be easily to be reached for the ward cleaner or janitor.

If for non-hazardous waste the set up of de-central collection in public accessible areas is planned, it is recommended to lock the used containers and wheelie-bins to avoid theft and to ensure that containers are located at fixed places.

Equipment planning for de-central collection points

For the de-central collection points, certain equipment will be necessary. The needed equipment will include mainly transportation container, wheelie-bins and may lockers as de-central collection points for chemical waste. Pictures of sample equipment can be found (collection container for infectious waste, bin for non-hazardous waste, special locker as de-central collection place for chemical waste) in the following figure.

Figure 4: Sample of transport container/storage for de-central collection points

As one of the main reasons for the set up of de-central collection is the reduction of transport, the available total volume of the containers for the different container should correspond with the maximum daily waste volume generation of the respective area (ward, department).

Planning of the waste collection route & frequency

Waste collection has generally to be carried out from “clean-to-dirty”. Starting from hygienically sensible areas (as e.g. ICU, OT) a fixed route has to be planed until the interim storage area. The frequency of the collection must be carefully planed to ensure that there are no overstuffed waste containers at any time. Biological active waste (non-hazardous HCW, infectious waste) must be collected at least daily, better after each shift. The routing plan is depending on:

- Waste volume and number of bags,
- Waste type,
- Capacity of the ward storage area,
- Capacity of the transporting vehicle,
- Transport distances and transport times between the collection points.

The logistic staff should be provided with a hospital site layout which clearly marks the start and end point of the different collection routes for the different kind of waste. If bottlenecks for waste transportation exist as e.g. elevators in multi-story buildings, fixed transport times for the different waste routes should be provided and indicated in the map.

Planning of transport equipment

Waste, and especially hazardous waste, shall never be transported by hand. During transport, special risks are existent. To minimize this risk, waste normally has packed in a so called "transport packing". As example, infectious waste bags will be placed in a transport container or chemical waste in a special transport box. In the next illustration, samples of this means of transport can be found.

Left to right: Wheelie-bin for non-hazardous waste, trolley for transport of waste bins, transport box for infectious waste.

Figure 5: Different means of transport for HCW

The means of transport for waste should not be used for any other purpose. Trolleys and carts used for the movement of waste within premises should be designed and constructed so that bags cannot fall off and leakages from bags are contained. The transport containers and trolleys should be easy to load and unload.

The surfaces of the conveyance should be smooth and impermeable, coves and sharp edges should be avoided and they must easily to be cleaned and drained and allow waste to be handled without difficulty. The material of the cart must be able to withstand common cleaning and disinfections agents. If possible, international hazard symbols should be clearly displayed on the carts. The use of closed trolleys with lid is recommended.

In hospitals using de-central collection points, always a sufficient amount of spare transport bins must be available (>5 bins) to allow the exchange of bins. Always at least one spare trolley and cart must be available for the case of break downs and maintenance.

4.4.2 Implementation and operation of the collections system

For regular collection systems, a work schedule for the logistic staff has to be developed, based on the "3W":

- Who has to collect the waste?
- Where has the waste to be collected?
- When has the waste to be collected?

For the on-demand collection, a waste disposal request form has to be developed and must be distributed to the waste generators. Depending on the information flow of the respective

hospital, a system for sending the request to the department responsible for waste collection has to be set up (e.g. usage of a central compartment).

Closing and handling of bin liners

Proper closing of bin liners is of special relevance as good closing minimizes the risk of spillages. As during the closing germs may be set free, special care must be taken. Working instructions for closing bin liners (bags) should include:

- The worker must know the procedures for the case of accidental spillage and how to report accidents and incidents,
- Wear appropriate PPE (gloves, overall, etc.),
- Ensure that the bag is labelled,
- Bin liners must be properly sealed at all times by tying the bags,
- When the bin liners are 2/3's full, pull the two ends of the bin liner together. Hold the opening away from the face, gather the ends together and tie them,
- For bin liners inside the stands (bag-holders):
    - Drop the bag down and pull it to one side. Securely close the bin liner as above and lift out of the stand.
- For bin liners inside the nursing trolley and wall mounted baskets:
    - Pull the ends of the basket together to release the bin liner. Securely close the plastic bin liner as above and lift out of the basket.
- Put collected bags gently on each other in the collection vehicle or container.
- Handle bags by the neck only, do not throw and do not push bags down!
- The emptied bins must be immediately equipped with new bin liners.

Transportation of waste

Waste bags shall never be transported loose by hand as it will increase the risk of accidents and spillages. The bags have either to be packed in a transportation container or in a dedicated waste trolley. If no means of transport are available, waste bags have to be transported together with the waste bin to the central interim storage place. After emptying the bin, it must be cleaned and disinfected (for infectious waste) prior the bin is transported back to the ward.

If de-central collection points are used, an "exchange" logistic is recommended. Full waste transport bins and wheelie-bins shall be exchanged against clean and empty once. The full bins will be transported to the interim storage place where they will be emptied and cleaned.

Cleaning & maintenance

The vehicles and transporting containers used for the transportation of waste should be cleaned and disinfected daily after usage. Depending on the transported waste the used logistic equipment should be cleaned (non-hazardous waste) or appropriate disinfected (infectious waste). Mechanical cleaning combined with soaps and detergents, which act as solubility promoting agents, should be obligate. Cleaning and disinfection has to be carried out in a standardized manner or by automated means that will guarantee an adequate level of cleanliness. The set up of a SOP for the cleaning is recommended. For the preventive maintenance of the equipment a schedule should be set up (see section maintenance).

Logistic staff affairs

Logistic staff ordered to transport non-hazardous and hazardous waste must be special trained for this task and must be well aware what to do in case of emergencies as spillages. For safety reason, vaccination against tetanus and Hepatitis A+B is recommended. A record system to document training and vaccination of staff is recommended.

4.5 HCW interim storage system

Until the waste will be transferred for treatment or will be picked up for disposal, the waste has to be temporary stored in an interim storage place. For different kind of waste streams, different kind of interim storage places are required. Typically needed storage places are:

- Storage place for non-hazardous waste (municipal waste),
- Storage place for recyclables,
- Storage place for infectious waste and anatomical waste,
- Storage place for chemical and pharmaceutical waste,
- Storage place for radioactive waste.

4.5.1 Planning of the HCW interim storage system

All storage places must have an impermeable, hard standing base and must be easily to be cleansed. They should be located out of reach of visitors and patients and away from hygienically critical areas and the kitchen. Storage places should be connected to the sewage system, to the water supply and to the electricity system. They should be easily accessible for collection vehicles (carts) and inaccessible for rodents, birds and insects. Good lighting and ventilation is recommended. The storage places should be equipped with the necessary safety equipment and fire extinguisher. For the disposal, the storage places must be easy to reach for the trucks of the disposal companies.

Storage places should have a sufficient capacity to bridge over times in which no disposal or waste treatment service are offered, e.g. due to break downs, strikes, etc. For hazardous waste generated only in small quantities, the possibility must be existent to pile them up until a sufficient amount of waste is collected for economical disposal or treatment. In close proximity to the storage areas there should be a hut or cabin for the storeman, with access restricted to them alone, containing cleaning equipment, washing facilities and protective clothing stored in lockers. The basic cleaning equipment should include disinfectant, granular absorbent or sand in plastic bags, which can be used in the event of liquid spillage.

Interim storage place for non-hazardous waste

The non-hazardous waste storage should have a sufficient capacity to receive the maximum amount of waste of at least four days. As non risk waste is often collected in thin liners or without liners at all, leakages must be expected and a good drainage or leakage proof collection will be of importance. Pictures of sample storage place can be found in the following showing (from left to right): Simple, concrete made storage place, waste skip, waste compactor. Alternatively, the waste could be also collected in large waste containers (e.g. 1.1 m^3 container) until emptying by the municipal services.

Figure 6: Non-hazardous HCW storage places

Interim storage place for recyclables

The requirements for this storage places are in principle the same as for non-hazardous waste with the exemption that the waste should be stored in lockable areas to prevent theft. For each type of recyclable a separate storage place should be available. Pictures of samples can be found below showing: plastic waste stored in woven bags, waste building with three compartments for glass, paper, plastic; 1.1 m^3 container for glass. Alternatively, recyclable could be also stored in skips or in waste compactors (paper, cardboard).

Figure 7: Storages for waste for recycling



Interim storage place for infectious waste and pathological waste

The requirements for this storage place are higher as hazardous waste is stored. Infectious waste and pathological waste are considered as biological active waste, gas formation during the storage must be expected. To minimize the gas formation and the growing of pathogens, the storage places should be air-conditioned or refrigerated.

The storage place must be identifiable as infectious waste area by using the biohazard symbol. Floor and walls should be tiled to allow easy disinfection. If existent, the storage room should be connected to the special sewage system for infectious hospital waste waster. The following pictures shows (from left to right): advanced infectious waste storage place, isolated door of storage, plastic curtains to avoid loos of cold.

Figure 8: Different storage places for infectious waste



Interim storage place for hazardous chemical and pharmaceutical waste

When planning storages places for hazardous, chemical waste, especially the characteristics of the different chemicals to be stored and later to be disposed of must be considered (inflammable, corrosive, explosive, etc.). The storage place should be an enclosed area and separated from other waste storage areas. The existing hazards should be displayed by using signs. When storing liquid chemicals, the storage should be equipped with a liquid and chemical proof sump. If no sump is existent, catch-containers to collect leaked liquids shall be placed under the storage containers. Spillage kits, PPE and first aid equipment (eye-shower, etc.) should be available. The storage area itself should be subdivided in different sections for different hazards and should have good lightening and very good ventilation. In the following, sample hazardous storages for different kind of hazardous, chemical waste are shown.

Figure 9: Samples of storage places for chemical waste

Note: If explosive or highly inflammable materials shall be stored, it must be obeyed that the area and the used equipment is explosion proofed!

Interim (decay) storage for radioactive waste

The target of decay storages for radioactive waste differs from other waste storages as the main target will be to store the waste until the radioactivity is decayed and the waste can be safely disposed of (minimum storage time of 10 half-life-times of the radioisotopes). The storage places must be equipped with sufficient shielding material, either in the walls, or as movable shielding material. The storage must be clearly marked with "RADIOACTIVE WASTE" and the international hazard label should be placed on the door.

The storage place should be constructed in a manner that renders it flameproof and should have such surfaces on floors, benches and walls which allow proper decontamination. It is recommended that it should be fitted with an air extraction system and air monitoring should be performed. The following pictures show the storages of different kind of radioactive waste in the storage place.

Figure 10: Samples of the storage of radioactive waste

Note: Decay storages for radioactive waste must be planned under strict observance of national regulations and guidelines!

4.5.2 Operation of waste storage places

Storage places shall be generally managed only by special trained persons who will be also responsible to document incoming and outgoing waste streams and will inform the responsible person if maximum storage quantities are reached. At the storage sites, necessary safety equipment as spillage kits and PPE shall be available and the availability of this shall be checked regularly. For further information on this, please see the safety and emergency section.

All incoming and outgoing hazardous waste shall be documented. If hazardous waste is handed over to a third party for treatment and disposal, a waste transfer note (manifest or consignment note) shall be filled up It is recommended that for each waste stream a yearly waste balance sheet is created (comparison incoming and outgoing waste).

Storage places need maintenance. Of special relevance is the periodically cleaning of the places and the regular inspection of the safety equipment. The set up of a maintenance schedule is

recommended. In the case of spillages, set up SOP has to be followed. The spillage has to be cleaned up following the specific instructions, has to be documented and reported to the responsible waste officer.

The hospital should organize an emergency coordinator or designee on-site or on-call, 24 hours a day.

Recommendations for different waste storage places

Recommendations for non-hazardous waste

Municipal waste will be received in larger quantities and must be removed periodically by an external disposal company. After each pick-up of the waste, the storage area shall be cleaned.

Weighing and detailed documentation of the waste will be only necessary during times of waste audits; however the pick-up of waste should be documented. The storage area can be accessible for the logistic staff. To minimize storage volume, the waste might be compacted. To avoid odour, the maximum storage time should not exceed, if possible, two days during hot days and three days during warm days.

Waste for recycling should undergo a second sorting prior to storage to ensure a high material quality. It is recommended to separate the materials to be recycled into: PVC, PP, PE, PET, Aluminium (cans), cardboard and paper and glass. The waste shall be stored in the later used transport packing (e.g. woven plastic bags for plastic materials) or shall be bundled or baled (for paper and cardboard). To optimize storage and later on transport logistic, the materials should be compacted as good as possible.

Recommendations for infectious waste

The compacting of infectious waste to minimize volume for storage is under no circumstances permitted as pathogens may be set free. The recommended storage times for infectious waste are:

- Max. storage time in a normal room: Summer 24 hours, winter 48 hours
- Max. storage time air-conditioned room (15 °C): 48 – 72 hours
- Max. storage time refrigerated room (3 - 8 °C): 3 – 7 days

Anatomical waste should generally be stored at a temperature of 3-8°C (morgue) or should be stored for not longer than 24 hours.

For cleaning and disinfection requirements of the storage place, a schedule should be set up in cooperation with the infectious control department or the responsible hygienist.

Recommendations for chemical/pharmaceutical hazardous waste

Based on the planned storage strategy, the different chemical waste streams with same hazard characteristics will be stored together like e.g. inflammable solvents, water pollutant chemicals, halogen chemicals, etc. When storing chemical waste together, the possible risk of reactions between different charges has to be observed. The storage management of pharmaceutical waste shall be carried out in close cooperation with the pharmacy.

When storing liquid chemicals, a basin shall be placed under the storage container to collect possible leakages. The usage of appropriate PPE will be of importance and the correct usage has to be checked. The responsible storeman should be specially trained on the storage of hazardous chemical waste and in the usages of spill kits and safety equipment.

Recommendations for radioactive waste

The storage of radioactive waste needs special attention and a careful store management to ensure that the waste is decayed prior to final treatment or disposal.

For this, isotopes with different half-live times have to be stored in separate containers. All decay waste pails must have a plastic inner liner. Under no circumstances are solids to be placed in unlined waste pails. Infectious bags may only be used if the waste also contains infectious components.

A "For Radioactive Decay" label should be affixed to the exterior surface of the decay can. When the pail is full, it must be sealed and stored. In a log-book and additional on the label, the start date of decay must be mentioned. Allow the necessary time for decay. Once the contents have decayed, it is the responsibility of the storage keeper to retrieve the pail from the decay facility. Deface all radioactive labelling on any items to be disposed. Remove both symbols and written warnings. The bag can then be removed from the can and can be disposed as regular waste, unless other waste components prohibit disposal to landfill (e.g. chemical).

Documentation of the operation of storage places

Next to the already mentioned documentation, following additional documentation is recommended and should be considered for implementation:

- Written spill contingency plan,
- Weekly store inspection protocol,
- Protocols for using, repairing, or replacing emergency equipment,
- Collection of relevant Material Safety Data Sheets (MSDS),
- Training system and documentation,
- Name,
- Job description,
- Training required and certificate.

4.6 The waste yard / function area

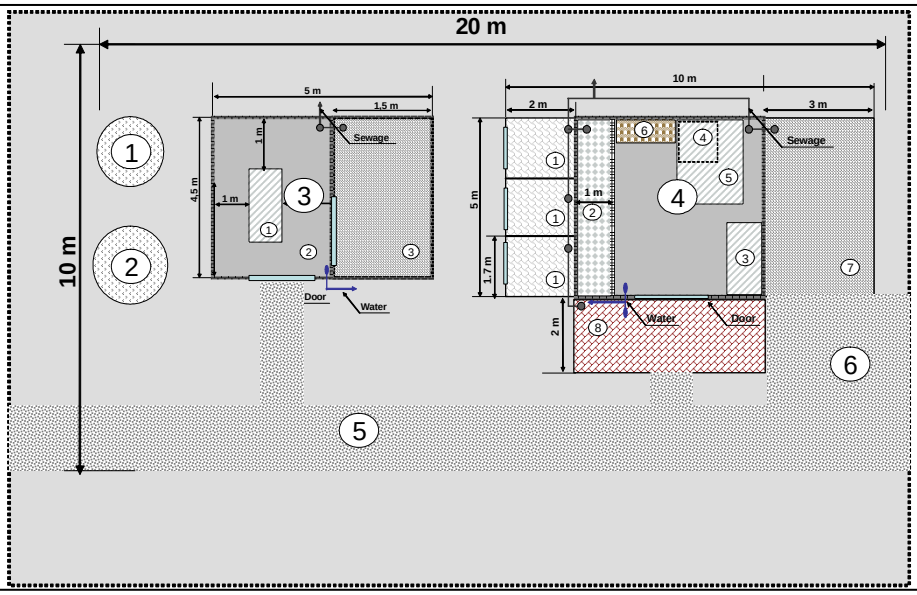
If new HCW management systems are developed and if new infrastructure is planned to be set us, it is recommended to concentrate this at an out of logistical and hygienic aspects suitable place. A “waste yard” is the place where all the relevant waste management activities are bundled. Typical tasks to be carried out at and by a waste yard are:

- Interim storage and transfer place (interface) for domestic waste,
- Post-sorting and storage place for valuable materials (waste for recycling),
- Storage and treatment place for infectious healthcare waste,
- Interim storage of hazardous chemical waste,
- Maintenance (cleaning) and repair place for waste logistic equipment,
- Storage place for logistic equipment (bins, bags, containers, etc.),
- Place for documentation and record keeping of the waste streams,
- Disposal pits for incinerator ash and pathological waste.

To concentrate certain tasks, the set up of multi-functional buildings (waste function buildings) is recommended. In the following, a lay out with the fixed assets of a waste yard is displayed.

Figure 11: Sample waste function area for a district hospital

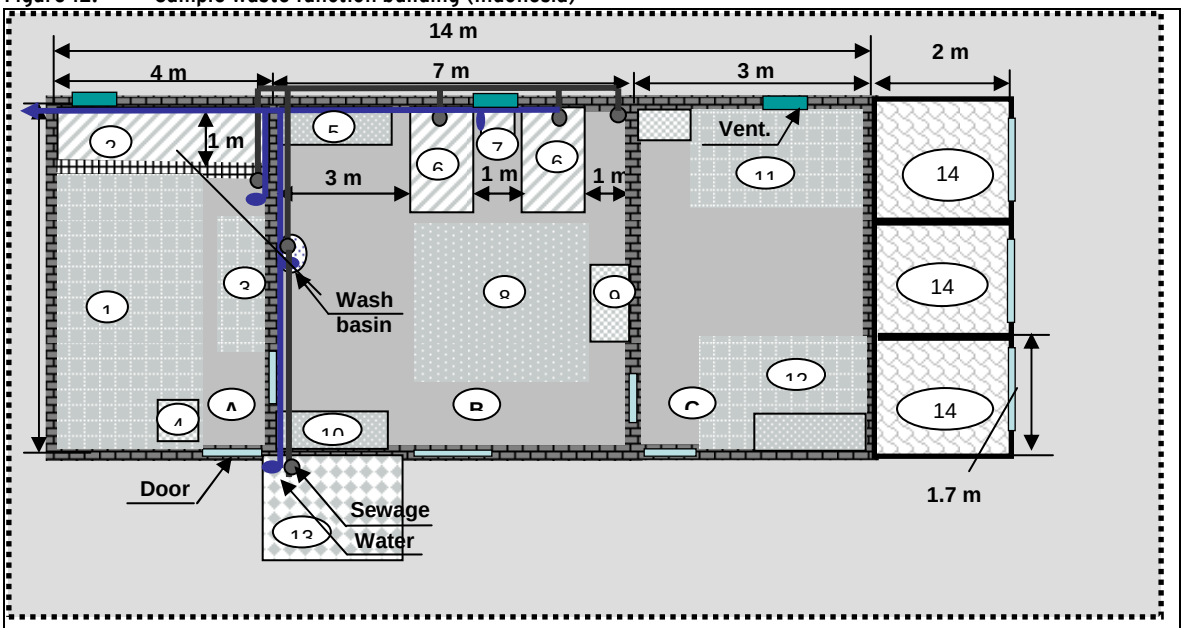
1. Ash pit
2. Placenta pit
3. Incinerator
4. Waste function building
5. Simple road
6. Turning area for trucks



The waste function buildings normally act as interim storage place for different waste streams, as place for carrying out maintenance activities and as the place for the administrative waste management activities. In the following, as sample layout of a waste yard with waste function building can be found. In the sample building concentrated tasks are:

- Reception and interim storage for infectious and chemical waste,
- Treatment place (autoclave) for infectious healthcare waste,
- Post-sorting and storage place for plastic, paper/cardboard and glass,
- Administrative work - documentation and record keeping,
- Maintenance and storage of logistic equipment,
- Cleaning areas for waste bins and logistic equipment.

Figure 12: Sample waste function building (Indonesia)



Legend:

1	Area for infectious waste	8	Working area – Waste treatment
2	Area for liquid hazardous waste	9	Container for treated waste
3	Area for solid hazardous waste	10	Shelf with supplies
4	Weighing scale	11	Administrative area
5	Utilities for autoclave	12	Maintenance area
6	2 x Autoclave system	13	Washing place for bins, container
7	Water treatment system	14	Storage for valuable waste

5 Healthcare waste treatment & disposal

Different kinds of waste streams need different kinds of waste treatment. Until today, no treatment system is available on the market which can treat all different kinds of hazardous waste. The choice which kind of system will be the most suitable for a specific waste stream will depend on the national waste strategy, the healthcare waste management plan of the facility but also on the combined costs, the safety aspects, the environmental friendliness, the availability and the quality of the system. Of outmost importance for the choice of treatment technologies shall be maintenance and operation aspects.

Most kinds of hazardous waste (especially the dozens kinds of chemical waste) are only generated in comparable small amounts and the treatment in the hospital is often not feasible. The choice whether or not to treat waste on-site or to hand it over to a specialized waste treatment service company depends on several factors as the availability of this kind of service companies, the kind and amount of waste generated, the quality of service offered, etc. For certain kind of waste (e.g. highly infectious waste) the on-site treatment however is required out of hygiene and risk reasons.

In the following, general information for the application of waste treatment methods for selected HCW-streams is provided. For detailed information it is recommended to contact the locally responsible authorities, to get in contact with the supplier of this kind of equipment and to visit the pertinent web-sites from WHO, UNEDP, etc. To avoid misunderstandings, in the following a strict distinction between waste treatment (a process to e.g. render waste harmless) and waste disposal (final or long-time storage) is made.

5.1 Treatment levels - infectious waste treatment

Different treatment methods for the decontamination of healthcare waste are today existing which reach different treatment levels. There are four international accepted levels of treatment defined by the Centres for Disease Control and Prevention (CDC), the Robert Koch Institute (RKI) and the World Health Organization (WHO):

Level 1 – Low level disinfection:

Inactivation of most vegetative bacteria, fungi, and some viruses. This level of treatment does not inactivate mycobacteria (e.g. bacteria causing tuberculosis) and bacterial spores. This level of treatment is inadequate for HCW treatment and is not recommended.

Level 2 – Intermediate level disinfection:

Inactivation of mycobacteria, all viruses, fungi and vegetative bacteria. It does not include the inactivation of bacterial spores. This level is also defined as the destruction of all micro organisms except high numbers of bacterial spores. These two definitions are essentially equivalent. Tests for intermediate level disinfection must show that a 6 log (logarithm to the base 10) reduction of the micro organism most resistant to the treatment is attained. This level does not include inactivation of bacterial spores which are required in Level 3 (e.g. for Anthrax – Bacillus anthracis) and Level 4 (e.g. Tetanus - Clostridium tetani) and therefore is only suitable for the pre-treatment of waste, prior to final treatment.

Level 3 – High level disinfection:

The killing of all microbial life forms present in a healthcare waste load (including Bacillus anthracis) as evidenced by the inactivation of surrogate pathogens (bacterial spores) having death curves similar to the most resistant human pathogens. Such surrogate pathogens may not be the forms most resistant to a particular treatment process but are similar in

resistance to most human pathogens found in infectious waste. This level of treatment requires the inactivation of a specific quantity of a resistant surrogate pathogen, thus assuring that the waste is treated to reduce the quantity of infectious agents present in the waste stream to a level that does not present a significant risk to human health or the environment. A minimum of 4 log reduction of spores of either B. stearothermophilus or B. subtilis by thermal inactivation technologies is accepted as indicating high level and intermediate level disinfection. A 4 log 10 reduction is equivalent to a 99.99 % reduction in spores.

Level 4 – Sterilization:

The killing of nearly all microbial life (including Clostridium tetani) forms as indicated by complete inactivation of specific concentrations of those organisms recognized as most resistant to the treatment process. Sterilization is evidenced by a minimum 6 log reduction in spores of B. stearothermophilus. A 6 log 10 reduction is equivalent to a 99.9999 % reduction in spores. Exemptions are unconventional agents associated with the transmissible spongiform encephalopathies (TSEs) like Creutzfeldt-Jakob disease or variant Creutzfeldt-Jakob disease. For the sterilization of waste contaminated with these diseases, special treatment programs (e.g. VSV-autoclaving with a temperature of 134°C for 60 Minutes) are required.

5.2 On-site treatment of HCW

While for highly infectious waste at least the on-site pre-treatment of the waste has to be carried out to minimize possible hygiene risks, also for other waste streams the on-site treatment might be a possible solution, either out of cost reasons or as no external service provider is available.

5.2.1 Treatment of infectious waste and highly infectious waste

Infectious waste shall be treated either by steam disinfection or by incineration. Highly infectious waste shall be preferably pre-treated (disinfected) using steam treatment methods. The treatment of highly infectious waste as cultures, blood, stool, etc. by chemicals (disinfectants) shall only be carried out if no autoclave or other steam treatment system is available.

The treatment of highly infectious waste shall be carried out near the place of waste generation to minimize transport risks (e.g. near or in the laboratory). The treatment of normal infectious waste can be carried out at a central area, located at a hygienically uncritical site with a good accessibility for the waste worker. At the waste treatment place, necessary PPE (Personal Protection Equipment), the SOP´s (Standard Operating Procedures) for the waste treatment and necessary consumables (e.g. plastic bags, chemicals, etc.) shall be available. The waste treatment shall be carried out only in an area with restricted access.

Chemical disinfection of highly infectious waste

Highly infectious solid waste (e.g. cultures) or highly infectious liquids (e.g. from cholera patients) shall be collected separately and disinfected with an appropriate disinfectant. Buckets containing stools of patients with acute diarrhoea may be disinfected through addition of chlorine oxide powder or dehydrated limeoxide (CaO). Sodium hypochlorite (NaOCl) as a chemical disinfectant is not effective for disinfection of liquids with high organic content such as blood or stools! Powerful disinfectants are often hazardous and toxic; many are harmful to skin and mucous membranes. For treatment, to be disinfected highly infectious waste shall be soaked in the disinfection solution for not less than 12 hours (over night).

Note: The chemical disinfection of waste is not a recommended method! If possible, thermal treatment methods (e.g. autoclaving) should be applied.

Thermal treatment of highly infectious waste and/or infectious waste

Different kinds of thermal (steam based) treatment systems are available. All these technologies have one thing in common which is steam. As heat is applied to water, its temperature rises until it reaches its boiling point or saturation temperature at which point water is turned into steam. At atmospheric pressure the saturation temperature of water is 100°C. At higher pressures (e.g. in the pressure vessel of an autoclave), the saturation temperature is higher. For example, at a pressure of 3.2 bar, water boils at 134°C. When steam is at its saturation temperature, the condition is referred to as a saturated condition and the steam is known as saturated steam. Autoclaves and other steam-based systems generally operate at saturated conditions.

Steam based systems are inactivating micro organism by heat (coagulation of the proteins). The inactivation process however combines effects of moisture, heat, and pressure. Compared with the usage of hot air (dry heat disinfection), a steam atmosphere has certain advantages for the treatment of healthcare waste:

- Steam contains more heat energy (the enthalpy energy of the steam will be set free during the condensation on the waste) and can transfer therefore more heat into to be disinfected waste then other medias.
- In a wet condition, germs are more heat sensible then in a dry condition. Due to the moist, even spores will expand and loose their normal heat resistance.
- Steam under heat and pressure works through hydrolysis like a soft acid.

This process has been used for disinfecting or sterilizing medical instruments in hospitals since 1876, when Charles Chamberland built the first pressure steam sterilizer. Infectious healthcare waste may contain many of the same pathogens that are associated with contaminated medical instruments and supplies. Therefore, it was a natural progression to utilize autoclaves to decrease or eliminate the potential bio-burden contained in medical waste.

Steam based treatment systems today mainly differ in the way how to remove air out of the treatment chamber and out of the waste - by this in how to guarantee a pure, saturated steam atmosphere for the treatment process. Typical processes used are gravity, pre-vacuum or fractionated vacuum-steam-vacuum cycles.

For the quality of a steam based disinfection or sterilization process the most important parameters are therefore:

- The complete removal of the air and replacement with steam to avoid the so called “Cold island problem” – air pockets in the treatment chamber where air was not replaced by steam.
- The quality of the used, saturated steam (minimizing of inert gazes).
- The treatment time and temperature (measured after the waste reached the process temperature).

For the waste treatment, the waste is packed in thermo stable (heat resistant) plastic bags, normally made from PP (Polypropylene), as normal plastic bags made from PVC or PE are not heat resistant and melt at a temperature of >80°C. The plastic bags shall not be hermetically closed but only closed by a simple knot to allow steam to enter the bag and to penetrate and heat up the waste.

The packed waste should not be loaded directly in the autoclave but in a trolley or a basket to avoid the contact of the bags with the autoclave wall and to allow steam to better penetrate the bags. Chemical indicators can be used to monitor the waste treatment (change of colour after successful treatment). The waste treatment shall be carried out according to the instruction provided by the manufacturer. Main parameters to be obtained are:

- Start up parameters for the removal of air (e.g. pressure) and the reaching of the treatment temperature.
- Treatment time (Time for disinfection / sterilization starting after removal of air and heating up of autoclave and waste).
- Pressure / Temperature during treatment.

Typical treatment times are 30 minutes at 105°C, 20 minutes at 121°C or 10 minutes at 134°C. The measurement of the treatment time starts after the heating up time. The needed time for heating up depend on the type of autoclave and the to be treated waste and can be up to 1 hour (e.g. for gravity type autoclaves).

Note: Autoclaves can handle only a limited load of liquids per load. For the maximum amount of liquids allowed per treatment cycle, please contact the manufacturer or check the operation manual. Also note: Thermo-stable plastic bags are about 5-10 times more expensive than other bags. A sufficient budget for the bags must be available. The costs for the bags must be considered when deciding to use steam treatment methods.

5.3 Overview of HCW treatment plants

5.3.1 Steam based treatment plants for infectious waste

Gravity displacement autoclaves and retorts

A basic autoclave consists out of a metal chamber sealed by a charging door and surrounded by a steam jacket. Steam is introduced into both the outside jacket and the inside chamber which is designed to withstand elevated pressures. Heating the outside jacket reduces condensation in the inside chamber wall. A "retort" is similar to an autoclave, except that a retort has no steam jacket. It is therefore cheaper to construct but requires a higher steam temperature than an autoclave. Problematic can be the high amounts of condensates generated. Retort-type designs are found mostly in large-scale applications.

The system of gravity displacement (or downward-displacement) autoclave relies on gravity for the exchange of cool heavy air for steam (steam is lighter than air). The steam enters at the top of the device and gradually replaces the existing cooler air as it moves toward the outlet at the bottom of the chamber. The removal of all air from the chamber is essential to ensure penetration of heat into the waste. The efficiency of the system therefore highly depends on the method of packing and loading of the waste into the autoclave to prevent the formation of air pockets where the existing air may not be displaced by steam, resulting in partly not treated waste. Problems are occurring if the waste is packed in bags, preventing the displacement of the air. As during normal appliance the steam penetration may be less complete, these systems are today not recommended for the healthcare waste treatment.

To minimize the problems of air pockets, systems have been developed which apply a mechanical processing (shredding) before the steam treatment for the purpose of improving the transfer of heat into the waste, achieving more uniform heating of the waste, rendering the waste unrecognizable, and/or making the treatment system a continuous (rather than a batch) process, e.g. by using oil heated auger systems (an auger is essentially a large screw that rotates inside a cylinder, thereby moving the waste forward). These new systems have sometimes been referred to as "advanced" autoclaves.

Note: Pre-shredding or pre-grinding should not be done before disinfection to protect workers from exposure to pathogens released in the air by the mechanical process. The exception is when shredding or grinding is an integral part of a closed system designed in such a way that the air stream from the mechanical process is disinfected before being released to the surroundings.

Microwave systems

Microwave treatment is essentially a steam disinfection process since water is added to the waste and disinfection occurs through the action of moist heat and steam generated by microwave energy. Various studies show that the lethal effect of microwaves on microbial organisms is primarily due to moist heat; without water or steam, microwave energy alone results in no significant cell inactivation.

Microwaves are very short waves in the electromagnetic spectrum. Microwave disinfection systems consist of a disinfection area or chamber into which microwave energy is directed from a microwave generator (magnetron). Typically, 2 to 6 magnetrons are used with an output of about 1.2 kW each. The waves of microwave energy cycle rapidly between positive and negative at very high frequency, around 2.45 billion times per second. This causes water and other molecules in the waste to vibrate swiftly as they try to align themselves to the rapidly shifting electromagnetic field. The intense vibration creates friction, which, in turn, generates heat, turning water into steam. Some systems are designed as batch processes and others are semi-continuous.

Note: Continuous working microwave systems normally need a pre-shredding of the waste. In that case, same requirements on the shredding system have to be applied as mentioned before (closed system, air stream must be disinfected). It is a misconception that metals cannot be treated in the microwave disinfection system. Metals that are too large or too hard to go through the shredder, such as steel plates or prosthetic pieces, cannot be treated in the unit, but only because they would damage the shredder.

Pre-vacuum autoclave

A more effective method to displace air with steam is the use of a vacuum pump to evacuate air before introducing steam. Pre-vacuum autoclaves remove air from the treatment chamber to create a high vacuum prior to the introduction of steam. This procedure allows the autoclave to reach operating temperatures more rapidly and allows the steam to penetrate the waste load more completely by reducing the chances for air pockets within the waste load.

Note: As an absolute vacuum is technical not possible, normally a vacuum of about 100 mbar is applied, resulting in that not all the air is removed out of the treatment chamber and the waste. Therefore, treatment time and temperature should be adjusted to this situation (Typical is 30 minutes holding time at 134°C after reaching the treatment temperature).

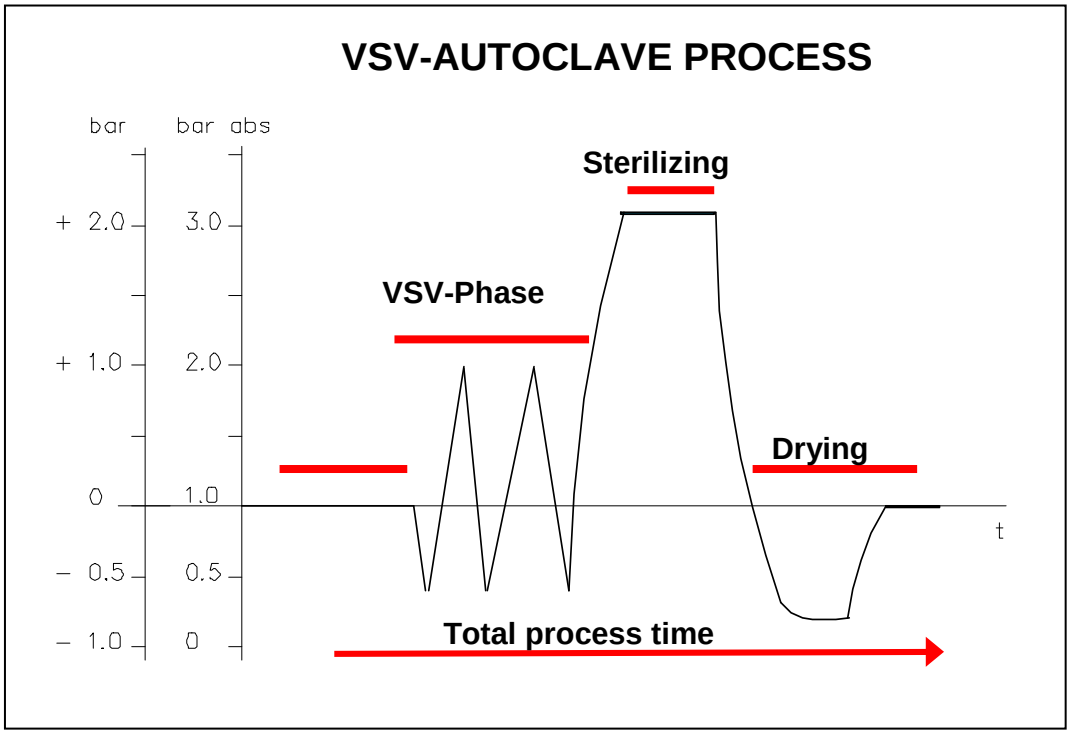
Fractionated autoclave

Also called "advanced pre-vacuum autoclave" or Vacuum-Steam-Vacuum Autoclaves (VSV-Autoclaves)

To ensure the total removal of air out of the treatment chamber and the waste load (to guarantee that the entire waste load will be penetrated by steam) certain countries and organizations (e.g. Germany – Robert Koch Institute) recommend the use of the so-called "fractionated, high vacuum-cycle". With this treatment cycle, air is removed by several time creating high vacuums alternating with saturated steam introduction. The advantages of this

treatment cycle are evidence based. In the medical sector, this treatment cycle is today considered as "State-of-the-Art" for steam sterilization. (See also: DIN-EN 285 – Sterilization – Steam sterilizers – Large sterilizers)

Figure 13: Sample of an advanced fractionated autoclave cycle (VSV)



Example of a VSV sterilization cycle:

- Phase: Loading of the autoclave with infectious waste
- Phase: VSV-Cycle (3 times vacuum of 300 mbar followed by two times steam shots of about 1900 mbar)
- Sterilizing at 134°C with a holding time of 10 minutes at 3200 mbar
- Drying and cooling down of the waste

Note: Due to the better removal of air and the pre-heating of the waste during the VSV-Phase, sterilization time can be minimized. This autoclave cycle normally allows the cooling down and drying of the treated waste prior the removal from the autoclave by creating a post-vacuum.

5.3.2 Capacity planning for steam treatment plants

For the planning of the needed treatment capacity of steam treatment plants, the main parameters are:

- To be treated waste amount in kg per day [A in kg] – (e.g. 50 kg per day)
- Needed Security due to variable waste amounts [S in %, minimum 25%]
- Waste density [D in kg/l] - (if not available 0,1 kg/l)
- Needed total batch time per treatment cycle (incl. loading and unloading) [T_T in h] – (e.g. 1.5 hours)
- Working hours per day [T_W in h/d] – (e.g. 8 hours per day)

The outcome of the calculation will be:

1. Needed minimum loading capacity per treatment cycle (Volume of trolley or basket) [V_{load} in l]

$$V_{load} = (A + A^*S) / ((T_W - 1) ^*D / T_T)$$

Example: $V_{load} = (50 \text{ kg} + 50 \text{ kg}^*25\%) / ((8 \text{ h} - 1) * 0.1 \text{ kg/l} / 1.5 \text{ h})$

$$V_{load} = 134 \text{ l}$$

Autoclave manufacturer normally indicate the total chamber volume and not the loading capacity. If a manufacturer is not able to indicate the waste loading capacity per cycle, 30% of the needed minimum loading capacity should be added.

$$V_{Chamber} = V_{load} * 1.3$$

Example: $V_{Chamber} = 139\text{l} * 1.3$

$$V_{Chamber} = 174 \text{ l}$$

5.3.3 Incineration

Incineration should be applied only to infectious waste and not highly infectious waste. Highly infectious waste should be pre-treated and afterwards being incinerated as infectious waste. Only in exceptional cases where a pre-treatment (thermal, chemical) is not possible, highly infectious waste might be incinerated. In that case the highly infectious waste shall be double packed and separately transported direct to the incinerator for immediate treatment. Highly infectious waste and infectious waste should not be collected together.

Traditional, incineration was the most used treatment method for healthcare waste in the past. Due to upcoming concerns of the environmental impacts from emissions (Flue gas, bottom ash, contaminated fly ash and waste water from the flue gas treatment), companies and research institute started to develop alternative treatment systems in the late 70´s in Europe.

Advanced hazardous waste incinerators

By incineration, hospital waste and the pathogen agents are oxidized. State of the art incinerators are two chamber systems, equipped with a wet or dry flue gas treatment system and continues emission monitoring (CEM)-System. While in the first chamber the gasification of the waste take place, in the second chamber the produced gas is combusted at a temperature of 800 – 1200°C and pathogens are destructed. One problem of the incineration of hospital waste is the high content of PVC. By the incineration of PVC often HCl is formed which may will result in hazardous and cancer causing gases like Dioxin and Furan.

Appropriate hazardous waste incineration is a highly advanced technology that can adequately treat a wide range of hazardous HCW. The key parameters of controlled incineration are summarized as "TTT": combustion at a sufficiently high Temperature (for hazardous waste between 1,100°C and 1,200°C in the combustion chamber) for a long enough Time (in Europe 2 seconds), in a combustion chamber with a sufficient Turbulence. A sufficient oxygen supply must be guaranteed in the second chamber in order to achieve a complete combustion and to minimize problematic gases (CO).

An incinerator requires highly skilled operators. Preventive and regular maintenance must be guaranteed and the supply of spare parts (which often has to be imported), must be secured. Properly controlled hazardous waste incineration is a relatively expensive treatment method and therefore mainly used for centralized treatment systems. In addition, secondary waste streams, including air emissions, bottom ash and hazardous fly ash are generated. Environmental controls of incinerators in developed countries have been tightened in recent years, principally because of pollutants such as dioxins and heavy metals.

Small Scale Incinerators (SSI)

Under certain circumstances (e.g. disaster, lack of budget) today still small scale incinerators are used. These incinerators came during the last years under criticism due to the relatively high rate of emissions created and the frequently break downs and operation problems. Today, different types of SSI are available, from very simple to more complex ones. The main four categories are:

- Controlled burning (e.g. drum burner),
- Single stage, grate burner (e.g. simple oven or brick burner),
- High thermal SSI,
- Advanced SSI.

While the first two categories should not be used due to the extremely high emission rates, high thermal SSI and advanced SSI might be an option if more advanced incinerators or autoclave systems are not available. If using the systems, of extreme importance will be the correct construction of the incinerators (e.g. using of fire bricks and high alumina fire cement for the incineration chamber) and operation of the treatment plants (e.g. pre-heating and permanent feeding for high thermal SSI). SSIs have a relative short lifespan (3-5 years) and need high maintenance effort (Regularly exchange of chimneys and other metal parts).

Of utmost importance for the successful operation of the incinerators is a working segregation system as the incinerators are designed for the incineration of healthcare waste with a relatively high calorific volume and not for household waste. In the following, samples of SSI can be found.

Figure 14: Drum burner, single stage burner, De-Montfort SSI, Advanced SSI

5.3.4 Treatment of chemicals and pharmaceuticals

Photo-chemicals (Silver recovery)

The X-ray processing results in spent developer and spent fixer which are normally the largest groups of liquid chemical waste in a hospital. Waste fixer and developer shall be kept and treated separately. The fixer solution contains concentrations of toxic silver that are too high to be discharged to the sewer but can be recovered. The silver concentration in a fixing bath should be normally not higher than 5-8 g/l, however goes up under certain circumstances to >10 g/l!

The two common types of silver recovery processes are metallic replacement and electrolysis. Metallic replacement, the more easy way, makes use of the fact that iron is more active than silver. The silver thiosulfate complexes from the solution react with the iron in the steel wool. The iron goes into solution and the silver precipitates with the iron and settles to the bottom of the unit as a sludge. When used properly, these units can reduce silver concentrations to below 1 ppm in the effluent at a low cost. The sludge can be collected and sold.

Note: The fixer is still considered a hazardous waste after this treatment and shall be disposed of carefully.

In a continuous working process, the iron (steel wool) is placed in a container referred to as a metallic replacement cartridge (MRC). One cartridge can recover more than 95% of the silver from silver-rich solutions (such as fixer and bleach-fix) while a series of two cartridges can recover more than 99%. A series arrangement will also prevent breakthrough, which occurs as small channels develop in the iron.

Encapsulation

Encapsulation is the separate collection of high density hazardous waste (not infectious waste) in larger container, boxes or drums, the adding of an immobilizing material, the sealing of the container and the final controlled disposal on a landfill. The encapsulation process is carried out to prevent the rapid leakage of chemicals however does not change the chemical characteristics (and risks) of the chemicals. Encapsulation should be only carried out if other disposal possibilities are not available. As collection container either boxes made of high-density polyethylene or metallic drums can be used. The collection container are carefully filled with the hazardous waste (e.g. heavy metal containing waste, batteries, etc.) and then filled up with a medium such as plastic foam, bituminous sand, cement mortar, or clay material. After the medium has dried, the containers are sealed and disposed of in landfill sites.

Inertization / Stabilization

This method is mainly used for the stabilization of incinerator ash and for the inertization of crushed pharmaceuticals, solid chemicals and small amounts of liquid chemical waste. The crushed waste will be mixed with cement, lime or other substances in order to avoid the risk of mobilization of toxic substances into the groundwater.

Note: Cement and lime are alkaline and may react with other hazardous substances which may will result in the creation of toxic gas. Extreme caution must be taken when adding and mixing the waste into the cement and lime and PPE must be available and worn.

For the inertization of pharmaceutical waste, the packaging should be removed, the pharmaceuticals ground, and a mixture of water, lime, and cement added. A homogeneous mass is formed and cubes are produced which then can be transported to a suitable storage site. The typical proportions for the mixture are:

- 65% waste (e.g. crushed pharmaceutical waste)
- 15% lime
- 15% cement
- 5% water

The process is reasonably inexpensive and can be performed using relatively unsophisticated equipment. Other than personnel, the main requirements are a grinder to crush the pharmaceuticals, a concrete mixer, and supplies of cement, lime, and water.

5.4 Off-site treatment of HCW

In the healthcare waste sector, a general world wide trend towards the outsourcing of cleaning and disposal services and the set up of central treatment plants by private companies can be noticed. Hospitals generate a wide range of different hazardous waste streams. As most kinds of waste (with the exemption of infectious waste) are mainly generated in small quantities, own treatment systems are in most cases not feasible and waste should be handed over (if existent) to hazardous waste haulers or treatment companies. Especially for photo chemicals, pick-up and treatment services can be found in most countries.

By transferring waste to third parties the liability for the generated waste does not stop (polluter pays principle). It is the task of the waste generator (hospital) to ensure that the waste will be transported and treated in a legal acceptable way which mainly can be ensured by handing over

the materials only to waste haulers and treatment plant operators with valid licenses for the transportation and treatment of the specific kind of waste. Interface will be in most cases the interim storage of the hospital. To document the transfer of the responsibility, waste manifest or transfer notes are used.

Another possibility for the off-site treatment of waste is the cooperation of hospitals with the industry. Typical example for possible cooperation is the co-incineration of cytotoxic waste in cement kilns, the handing over of used oil to oil refineries and the treatment of organic solvents in industrial distillation units as e.g. often existent in larger printing companies.

For radioactive materials but also for other hazardous materials it is today common business behaviour to include in the supply contract a take-back duty for the used materials by the supplier. For certain waste streams, e.g. batteries and other, already formal take-back systems are installed in some countries. Also in some countries the collection of minor amount of hazardous waste from households is organized by the government and hospitals might be included.

5.5 Disposal of HCW

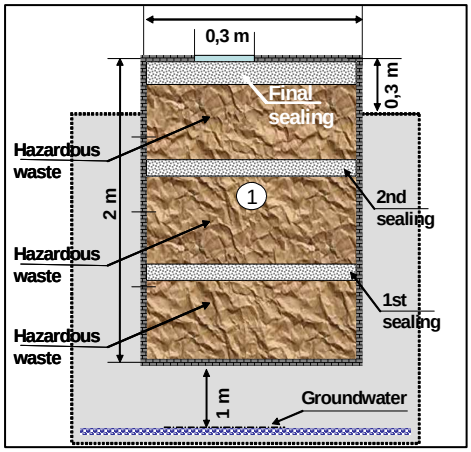
Generally hazardous and non-hazardous solid HCW should not be disposed of on-site (within the compound of the hospital). Non-hazardous waste shall be always handed over to the responsible municipality and shall be disposed of together with other municipal or domestic waste. Hazardous waste shall be handed over to specialized companies. Only under certain circumstances (remote areas, non-existent hazardous waste landfills, etc.) it might be considered to dispose of certain hazardous waste streams (e.g. sharps, incinerator ash, placentas, etc.) within the hospital.

5.5.1 On-site disposal of HCW

Solid hazardous waste

The on-site disposal of solid waste shall be carried out only in a controlled way. Waste shall be only allowed to be disposed of in special designed and lockable areas, managed by trained and authorized persons. If the to be disposed of waste has the potential to pollute the groundwater (e.g. incinerator ash), it will have to be disposed of in hermetically sealed pits (e.g. hazardous waste pit). The site of the pits shall be as far as possible away from public accessible areas and from hygienically critically areas (e.g. Kitchen, etc.). After filling of the pits they shall be hermetically sealed and the location of the pits recorded for future cleaning up of the site. If possible, waste as incinerator ash shall be inertizised prior disposal in the waste pit.

Figure 15: Sketch of a hazardous waste pit



Hazardous waste pit

The hazardous waste pit (1) is a long-term storage place for hazardous, non-reactive waste. The pit is constructed out of 4 standard concrete rings with a diameter of about 1m. The pit will be made watertight by adding a concrete layer on the bottom. The top is closed, loading can be done via a lockable hatch.

After the pit is filled with about 0,5 meter waste, it is encapsulated by a 0,15 m concrete layer. Afterwards again 0,5 m of waste can be added, sealed and again 0,5 m of waste can be added. At the end, the pit is finally sealed.

Heavy metal containing waste (e.g mercury, cadmium, etc.) shall never be disposed on-site but shall be inertizised and/or encapsulated for long-term storage on-site (e.g. collection in hermetically closable, large barrels) or for disposal on suitable landfills.

Liquid hazardous waste

While liquid, non-hazardous waste (e.g. non-infectious urine, stool, rinsing liquids, etc.) can be disposed of via the sewage system, liquid hazardous waste (liquid infectious waste, liquid chemicals, etc.) shall only be disposed of after pre-treatment (see before). Hazardous, liquid chemicals shall be separately collected and pre-treated as good as possible (e.g. adjustment of the pH by carefully mixing acids and bleach).

Fixer shall never be poured down the drain. If no other disposal option is available, the de-silvered fixer solution can be mixed with developer and water and disposed of down the sewer or septic system if diluted in a proper way. Spent developer is permitted to be discharged into the sewer provided it is diluted with water and the developer is acceptable for disposal in the sanitary sewer. Developer should not be poured in an septic tank system as it may will effect the anaerobic micro organism. Strong, outdated disinfectants shall never be poured in the drain but should be used for other, uncritical cleaning activities as cleaning of toilets.

5.5.2 Off-site disposal of HCW

Preferred method for the final disposal of risk and non-hazardous waste is the off-site disposal. Non-hazardous waste can be disposed off in the same facility used for other domestic or municipal waste. For the transportation, it is recommended to sign a service contract with the local disposal company or municipality. If possible, non-hazardous waste should be picked-up for disposal at least twice per week to avoid bad odour.

Hazardous waste shall only be handed over to a third party for final disposal if the company is licensed and the way of final waste disposal known and in accordance with the legal requirements. The waste generator (hospital) shall control periodically if the transportation and treatment equipment is sufficient and if all process requirement (e.g. regularly disinfection of transportation truck) are fulfilled. As for the off-site treatment, also for the off-site disposal of hazardous waste a hazardous waste transfer note shall be used to minimize long-term liability.

6 Healthcare waste management systems

The introduction of a waste management system in a hospital cannot be done "overnight" as it will influence the organization of the hospital and will change work processes. New responsibilities and duties will be created, to be followed information flows must be cleared and employees have to be informed and trained. To achieve this, a detailed planning of each of to be carried out steps is required. Often it is advisable not to change already existing HCW systems at once, but to start with pilot wards and departments. After the successful implementation in these organization units, also the other wards and departments of the hospital can be included. In the following, the main steps for the introduction of sustainable HCW management systems are explained.

6.1 Healthcare waste audit

The HCW Audit is the first step for the implementation of an economical and eco-logical waste management system. Before actions towards a modern waste management can be done, a detailed picture of the current situation of the existing waste management must be available.

The objective of a HCW Audit is to conduct a survey of the waste streams in a hospital and to check where, what kind, how, how much and why the waste is generated. This has to be carried out under consideration of the different sectors and sub-sectors of a hospital. A HCW Audit can be carried out in the entire hospital or for selected or single departments.

6.1.1 The main steps of a HCW audit

A) The planning of the HCW audit

Before the waste audit can start, a basic research structure must be worked out to ensure a smooth and successful investigation.

Following points should be cleared before starting a waste audit:

- General agreement by the board of directors on the HCW audit,
- Definition of the expected results,
- Definition of the to be researched hospital areas,
- Definition of the to be researched information,
- Definition of the to be researched kind of waste,
- Definition of research period,
- Calculation of the needed time,
- Calculation of the needed materials,
- Calculation of the supported staff,
- Set up of a master plan and a mile-stone planning for the waste audit.

B) Information gathering

The first step of the waste audit is to collect necessary information about the current waste management in the hospital.

This will include the gathering of information about:

- Kinds of waste generated in each department,
- Segregation, collection, transportation, storage, disposal, documentation of the different waste groups,
- Existing and available waste equipment,

- Recycling and reuse of materials,
- Level of awareness and knowledge among the staff about the waste hazards,
- Occupational safety situation,
- Information of the expected waste generation, based on existing disposal documentation or based on purchasing records and experience,
- What kind of hazardous materials are used,
- Information on disposal costs and income from recyclable materials,
- Information on ongoing or planned waste initiatives.

The information can be collected during visits to the different departments based on an in forehand prepared list and questionnaires.

Moreover inspection and analysis of the existing documentation of the waste disposal is a source for information about the generated waste amounts in the hospital. Nurses, cleaners, transportation workers should be interviewed in the terms of occupational safety and sharps accidents. Existing waste management equipment such as bins, bags, containers, trolleys, incinerator, as well as protective clothing should be investigated and recorded in an inventory.

C) Waste stream analysis

During an audit it might get visible that the available data are not sufficient, not trustable or are completely missing. To fill this information gap, often the only possibility is to conduct a waste stream analysis, which means to collect information on the quality and quantity of the waste stream by hands-on investigation. To achieve a trustable data basis, for an analysis period of not less than 1 – 3 weeks (at least 7 days + 1 trial day = 8 days) the complete, defined waste stream must be measured. Typical to do:

- Controlled measurement of quantity (volume, weight) and quality (segregation, etc.) of the specified waste streams from the specified areas
- Daily documentation of the results of the carried out research (Per stream and area: Volume, weight, quality, date)
- Documentation of the research area (Number of patients, occupation rate of the beds, etc.)
- Evaluation and analysis of the collected data per research area.

6.2 Implementing a HCW management system

To implement sustainable a successful HCW management system, certain steps are recommended to be followed. In the following, the main parts for a “step-by-step” implementing strategy can be found. The strategy is designed and takes into account the following general conditions:

- The strategy is divided in 4 (four) major phases. Only after carrying out all four project phases, a complete and practical “state-of-the-art” waste management system will be implemented and in operation.
- The proposal is set-up under the general conditions for waste management in development and transitional countries under consideration of existing guidelines and directives.
- The proposal is based on a non-existing or only basically existing waste management system in the hospital.

The four project phases are divided in different work packages and work steps. The set up of a waste management system should be carried out under the leadership of the director of the

hospital and should be implemented by a trained Healthcare Waste Officer (HWO), who should form a project team. The main steps after the carrying out of the HCW audit will be:

- Set up of an obligatory waste policy,
- Development of a waste program,
- Development of an action plan,
- Implementation of the system.

Of special relevance will be the post-check of the implemented system to allow and continuous improvement!

6.2.1 Step I: Set up of the project and HCW audit

First and prerequisite of any activity must be the general agreement of the board of directors to start the improvement of the existing waste handling. At this stage, often the problems created by hospital waste are not known in detail and also the scale of problems is unknown. To improve the transparency an HCW Audit is carried out. Based on the collected data, a decision can be taken whether an improvement of the waste management system is necessary or not. For the research and for the possible following steps, a work group has to be set up and must be organized. The typical proceedings for the Phase I are:

Project preparation and organization

As a starting point, a healthcare waste working group will be formed. Participants should be the management staff of the relevant departments and committees. Possible members could be:

- The Director or a Vice Director as the chair
- The HWO as the secretary of the working group.
- Matrons, head of departments,
- Representatives of the departments: pharmacy, radiology, laboratory, blood bank, administration
- Engineering, logistic, support (kitchen, laundry, etc.)
- Other relevant staff members

The number of participants should not be less than 4 and not more than 12.

HCW meetings

The HCW working group should meet regularly during the phase 1, if possible once per week, during phase 2 and 3 every second or third week, during phase 4 once per month or less. In the meetings, the HWO as secretary will inform the working group about the results of the last carried out steps and will discuss with the members the contain, target and necessary doings for the next step(s).

Basis analysis

Waste is generated on different locations in the hospital, which can be classified as followed:

- Primary functions (e.g. normal care unit, intensive care unit, operation theatres, etc.)
- Secondary functions (kitchens, pharmacies, depots, sterilization, laboratories, internal technical areas, administration)

To get a transparent, general picture about the momentary situation and as basis for the following steps, a basis analysis should be carried out. For this, the hospital will be systematically divided and sub-divided and each sector will be investigated. The information and data's needed will be investigated by the HWO and other members of the working group by analyzing of existing material. For complementation and verifying of the existing material and data, the PT will make interviews and visitations. After the research, the results will be evaluated and presented to the working group.

Healthcare waste audit

Based on the results of the basic analysis, in areas with to less available data, a waste audit shall be carried out in two steps to get a detailed picture of the momentary situation and to enable the work group to develop an action and waste management plan for the hospital. Each step of the audit includes different sort of action:

Step 1: Information gathering

- Total volume of each type of waste generated in the facility.
- Volume of each type of waste generated by each specific area.
- Current costs associated with the disposal of each type of waste.
- Waste management initiatives currently in place.
- Waste equipment analysis.

Step 2: Waste stream analysis

- Weighing and sorting of all non-hazardous and hazardous waste from the sub-divided waste generators for a period of one week.
- Waste that could threaten the staff (e.g. biomedical waste, sharps, etc.) shall not be sorted and only weighed.
- Internal waste logistic analysis
- Input – Output analysis to determinate kind and amount of not correct disposed of waste (e.g. chemical waste).

After the waste audit the results will be evaluated. Based on the results of the basic analysis and of the waste audit, a short report regarding the existing situation of the current waste management system will be written and presented to the board of directors.

Clearance of the external disposal options

In developing and transitional countries, disposal and treatment options for different waste streams are often limited. Therefore it must be cleared which waste streams can be disposed externally (e.g. household waste, waste for recycling, photo chemical waste) and for which waste streams internal solutions must be found (highly infectious waste, pharmaceuticals, infectious waste, etc.) of in which way.

Mile Stone – First decision

After presenting the results, the board of directors has to decide whether or not the waste management project shall be continued. If it will be decided that the project shall be continued, next steps will be:

- Set up of a formal waste management group, team or committee,
- Set up of a waste policy as visible commitment of the board of directors for a waste management system,

- Development of a waste management plan.

6.2.2 Step II: WMT, Policy and HCW Management Plan

The Waste Management Team (WMT) - Roles and responsibilities

Set up of a formal waste management team (committee)

The waste management team should consist of people from all working levels: management, medical service, hygienic department and logistic services. In principle, the formal waste management team can consist out of the same people who were involved in the carrying out of the first step.

The HCW policy

To "legalize" the activities of the HCW working group and to show this to the hospital staff not directly involved in the working group, a waste policy as commitment of the board of directors towards an improvement of the waste management system should be set up.

Set up of an internal HCW policy

A general hospital waste policy shall be formulated. The task of the policy will be:

- To be a visible sign from the management that they support the activities
- A statement to declare that a proper waste management is one of the targets of the hospital
- A document to show the public that the hospital is concerned about environmental issues
- To define the importance of the waste management compared with other targets of the hospital

The hospital waste policy should contain at least:

- The general healthcare principles of the institution
- A statement on the environmental principles
- Date, signature, stamp of the director
- The Annex with the yearly to be implemented waste management action plan

The HCW policy shall mirror the general ideas of the management for the waste management program. In the yearly to be updated annex, the details of to be implemented targets should be explained. Only targets which are possible to be implemented should be considered.

The HCW management master plan

Waste management plan

After the assessment of all waste streams generated in the hospital and a review on existing waste management practices, the working group should formulate a draft waste management plan. This waste management plan should function as the long-term planning for the implemented waste management system.

The waste management plan should contain following points:

- Present situation and quantities of waste generated,
- Compliance with applicable regulations,
- Responsibilities, tasks and duties,
- Waste classification and segregation,

- On-site handling, transport and storage practices,
- Identification and evaluation of waste treatment and disposal options for the different waste groups,
- Possibilities for waste minimization, reuse and recycling,
- Identification and evaluation of the options and associated costs,
- Record keeping and supervision,
- Training and monitoring of the training,
- Estimation of the costs related to the waste management,
- Strategy for implementation of the plan.

The waste management plan should include also details as:

- Location and organization of collection and storage facilities,
- Required material and human resources,
- Responsibilities,
- Procedures and practices
- Training and capacity building concept

After setting up the waste management plan, a weak point analysis should be carried out to identify points of improvement.

Weak point analysis

As many as possible points of improvement should be collected by the waste management group. In most cases the amount of to be improved weak points will be too many and too manifold to improve them all at once. An analysis of the different weak points shall be carried out to identify most urgent to be solved problems. This analysis should be carried out under consideration of:

- Risks for humans (Direct risk, indirect risk, level of the risk factor, etc.),
- Economical risks (Short term, long term, liability, etc.),
- Risks for the environment and the public health (Short term risk, long term risks, etc.).

Depending on the available financial and time resources, it should be decided which of the most urgent points can be improved in the first year. These weak points should be included in the annex of the waste policy as short term targets. The other points shall be included in the waste management plan as medium or long term targets. Depending on the place of the weak point in the hierarchy, they shall be included in the action plan for the second or third year.

Mile Stone – Second decision

After agreement with the board of directors, the waste policy shall be legalized, the waste management team shall be formally implemented and the final waste management plan signed to become the official healthcare waste management plan. The next steps should be:

- Development of HCW action plans with action points
- Development of the necessary tools

Before the set up and implementation of the different action points, a waste management action plan should be developed.

6.2.3 Step III: The HCW action plan and HCW tools

Waste management action plan

The waste management action plan is the overview of to be implemented single action points and will show the chronological order of the planned implementation, needed time and

budgets and will show the responsibilities. The action plan will show the planned actions for a period of one year.

For each single action point, a detailed project planning is required which must include:

- The overall objective of the planned action,
- The main target of the action point,
- Date of kick-off,
- Needed working time for the project,
- Needed financial or other resources for the project,
- Planned closing day of the project,
- Expected results of the project (indicators).

HCW Action-Teams for action points

For the set-up of the project planning for the action points and for the solving of special, non-general problems (e.g. cytotoxic waste, environmental purchasing, waste logistics, etc.), the HWO should form together with the relevant persons action teams. Each action team should get a clear task and target. To be carried out work should be done by the members of the action teams in cooperation with the HWO.

Management tools

To enable the involved person and especially the HWO to carry out an efficient and transparent work, certain tools have to be developed prior the start or the implementation of the new waste management systems. These tools should be developed by members of the HCW working group. Which tools shall be developed depends on the target of the specific hospital. Typical tools to be developed include:

Waste manual

In it, all necessary information for the management of the different waste streams can be found. In addition, all relevant organizational information and operation procedures are explained. Generally, a waste manual should contain:

- The hospital waste policy
- The HCW regulations
- The HCW management plan
- Organization of the waste management:
- General Waste Management Organization
- Job description of relevant positions
- General process organization
- Standard Operation Proceedings for hazardous work (SOP)
- A task- and responsibility matrix

Waste operation book

The operation book is the daily work book for the waste manager. In it, the waste record sheets, waste balances, consignments notes, incidents and accidents records and the monitoring system for the training can be found.

Waste guideline

The waste guideline is the hospital information tool for the daily handling of healthcare waste and should be available at every department. Typically, in a waste guideline all relevant information for each group of waste are described:

- The waste definitions

- To be used receptacles / packaging
- Way of collection
- Organization of the record keeping
- To be followed way for disposal

Monitoring and record keeping system

To ensure a lasting success of the introduced system, a standardized monitoring system must be developed for the weekly and monthly monitoring. To be able to determinate weak points in the carrying out of the introduced system and to increase the transparency, a waste generator based record keeping system must be developed. The use of checklists is recommended.

Mile Stone - Third decision

After the HCW action plan and the necessary tools are developed, this should be presented to the board of directors. A written agreement on the budget for the financial resources and the needed working time will be needed to avoid that the set up and implementation will be endangered later by missing resources. Next steps should be:

- Transferring the action plans in practice,
- Implementation of the new concept,
- Start to operate the new system.

6.2.4 Step IV: Implementation and operation of the HCW system

The implementation shall be carried out department by department or building by building depending on the structure of the hospital. After informing and training of the staff, on a fixed day the new system starts to operate. After the system is in operation, further tasks like incident and accident training and reporting will be implemented.

Waste logistic equipment

To guarantee a proper start of the waste management system, necessary equipment must be available before like sufficient colour coded bins and bags, labels, correct transportation equipment, storage places, etc. This equipment must be prepared and be available in a sufficient quantity latest a week before the implementation starts.

Education and training for hospital staff

Basis of every waste management system is a high knowledge level of the involved people in how to segregate, handle and collect the waste. A healthcare waste management system is not effective unless daily applied by all involved staff (including physicians), in a consistent and accurate way.

Implementation

Short after the information and training campaign, the new way of working should be implemented and started on a fixed date. To avoid disturbance of the normal operation of the hospital, setting up of equipment of information material will sometimes be required to be carried out during the night.

Set up of an information system for patients and visitors

Next to the staff, patients and visitors are the second group of waste generators. Via an easy information system, the basic segregation principles of the new system should be explained to them (e.g. usage of small leaflets).

Implementing emergency response

Spills and injuries will happen when managing hazardous waste. The procedures to follow after an incident or accident should be found in the waste manual. The staff should be prepared and trained for emergencies and the necessary equipment should be available. Clean up of dangerous spills should be carried out only by designated, specially trained personal. After every spillage, injury or other accidents and incidents a report will be written and given to the HWO. The report shall include the nature of the accident or incident, where and when it occurred, which staffs were directly involved and other relevant circumstances (see also the chapter on safety and emergency).

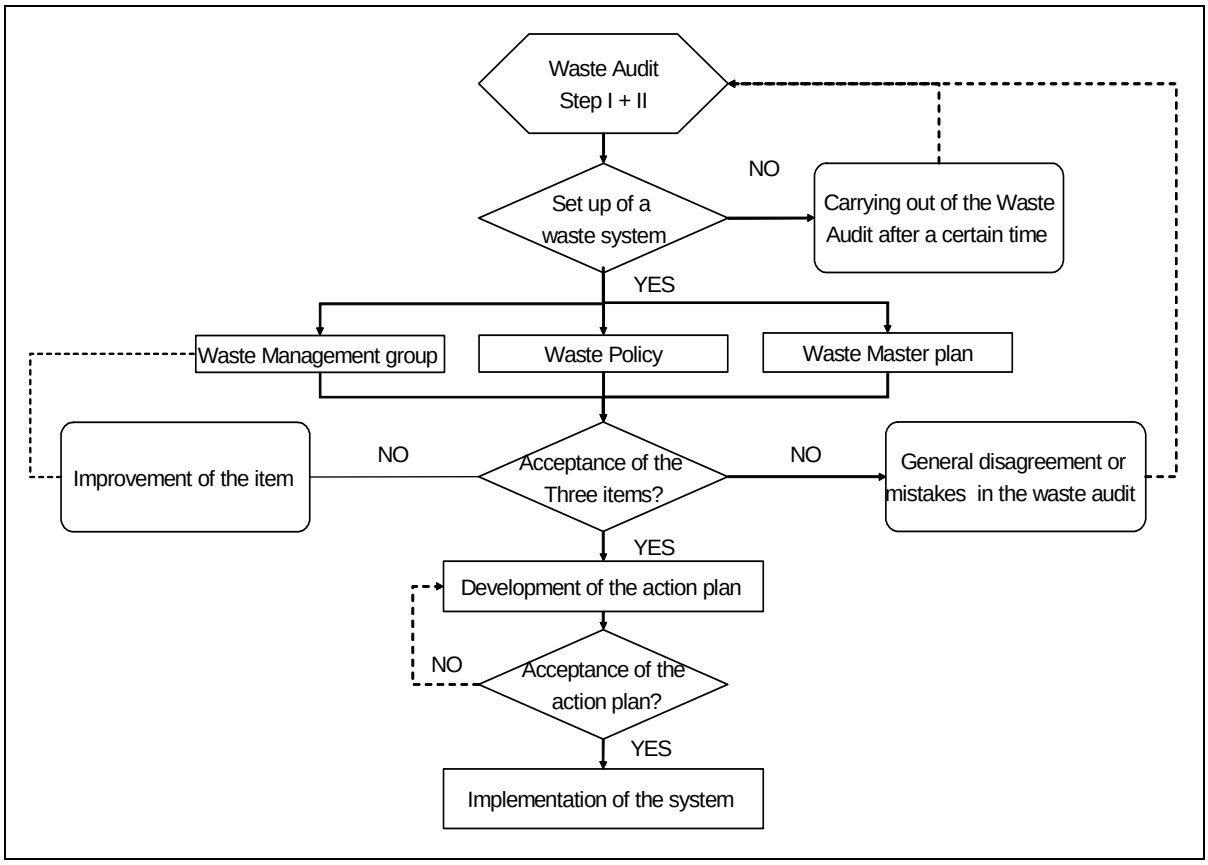
Evaluation

After a fixed time, the implemented system must be evaluated. Still existing weak points shall be identified and the management adjusted. After all weak points are solved, new waste management system will be finalized.

6.2.5 Overview – set up of HCW waste management systems

In the following, an overview on how to implement HCW management systems can be found.

Figure 16: Decision making path – Implementing HCW systems



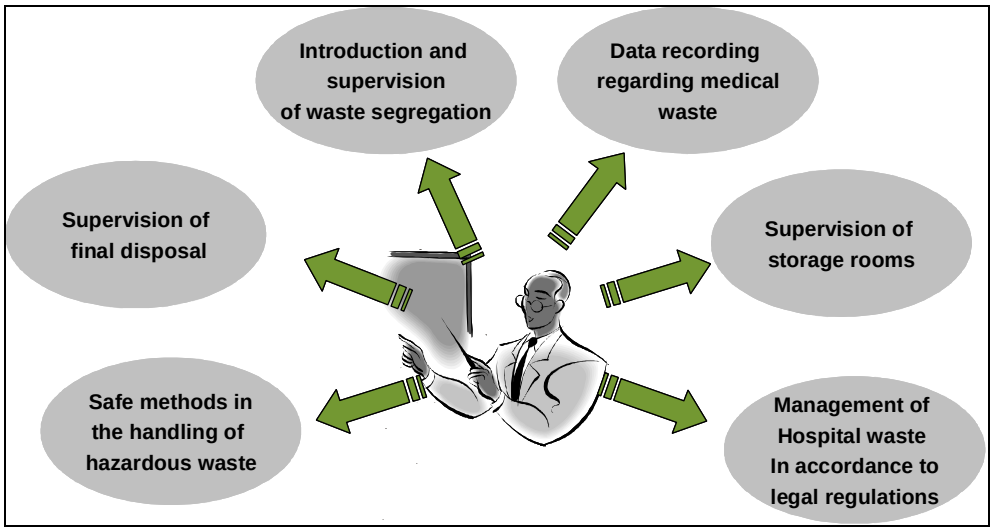
6.3 The Healthcare Waste Officer (HWO)

The hospital waste officer is the head of the waste management in the hospitals. He is responsible for the supervision of the introduced waste management, introduction of new methods and for the training of the employees.

As the "spider in the waste management web" he/she is connected to all parts of the waste management, is monitoring all parts of the waste management and is controlling the income and expenditures of a waste management system. Tasks and duties of the HWO:

A) General waste management
B) Compliance with legal regulations
C) Training
D) Recycling and waste minimisation
E) Safety and communication

Figure 17: Working fields of a Healthcare Waste Officer (HWO)



A) General waste management:

- In consultation with the waste management team, annually review the waste management policy. Prepare annual audits of waste disposal and a cost analysis; prepare a budget line for the entire healthcare waste management services.
- Identify, track, and monitor wastes throughout the facility. Identify waste streams being generated within the hospital; achieve optimal waste prevention, minimisation and economy by reviewing each waste stream against the hospitals waste management policy. Annually review the methods of containment for each waste stream, and the waste descriptions and instructions given to staff and, if applicable, contractors.
- In consultation with other managers from the hospital and outside organisations, identify the hazards presented by each waste stream and specify control mechanisms necessary to eliminate or reduce to acceptable levels of the risk to health and the environment.
- Monitor environmental compliance with policies, regulations (permits, licensing and record keeping) in the areas of solid wastes, hazardous materials, infectious materials, training, stack emissions/effluent, and sewer wastes.
- Develop, implement and manage a comprehensive general and hazardous waste collection and interim storage system, capable of servicing the healthcare community in the hospital in collaboration with other organisations as private vendors. Responsibilities include tracking and storage management of the waste streams as well as the monitoring and auditing of on-site waste treatment and waste disposal.

B) Compliance of laws and regulations:

- Ensure that the healthcare waste collection/disposal service is compliant with the regulation of hazardous waste management and with the regulations of Healthcare waste management. Ensure that the technical standards for waste and sewage treatment are fulfilled. Be environmentally aware of any legislative changes to enable effective

liaison with other departments. Produce annual reports on the carriage of dangerous goods and other aspects of waste management as required.

- Identify changes in all pertinent governmental regulations. Communicate changes to the waste management team and develop action plans for compliance.
- Maintain and monitor all documentation required for compliance. Be ready for immediate inspection by regulatory agencies as appropriate.
- Assume responsibility for managing the permitting process for all activities carried out within the facility, which are regulated by government environmental protection and safety control agencies. This function includes the identification of the needs for permits, preparing and submitting applications, maintaining an inventory of permits, and renewing these permits in a timely manner.
- Monitor incidents and accidents with hazardous healthcare waste. Prepare an annual report and provide problem identification and solving.

C) Training:

- Ensure that sufficient staff training programmes are available with respect to the segregation of waste, environmental matters and the carriage of dangerous goods and hazardous waste.
- Develop and carry out orientation and on-going departmental training programs pertaining to hazardous materials and waste policies, procedures and regulations.
- Monitor documentation of legally mandated training.
- Verify employee knowledge levels and effectiveness of training programs.

D) Recycling and waste minimization:

- Identify, inventory, track and monitor recyclable materials within the facility.
- Develop, implement and manage comprehensive recycling systems capable of servicing the healthcare community in the hospital in collaboration with other organisations as private vendors on a local and countywide basis. Responsibilities include tracking and marketing (sale) of the waste streams.
- Maintain all required records and reports for receipt, transportation, storage and sale of valuable waste streams. Develop an annual program for the spending of the income from the waste recycling in cooperation with the waste management team and present to board of directors.
- Identify opportunities for and coordinate waste minimization activities. Develop implement and manage comprehensive waste prevention and minimization systems.
- Work with regulatory agencies on waste minimization programs. Identify partnership, sponsorship, and grant opportunities, or other external funding sources where appropriate and applicable.
- Coordinate the development of product procurement policies that encourage the purchase of recycled and/or environmentally sound items. Coordinate product evaluation activities with Purchasing, Vendors, and Hospital Departments as appropriate. Identify and coordinate the use of reusable products (instead of disposable) when feasible.
- Maintain waste minimization records and reports.

E) Safety & Communication:

- Maintain a knowledge base of bio-safety, environmental, and general safety practices including worker exposure monitoring.
- Coordinate bio-safety matters with the Infectious Control Committee and the Safety Officer as appropriate.
- Coordinate the spill prevention, control, and emergency response programs.
- Coordinate with all departments to plan, develop, integrate, utilize, monitor, and comply with environmental operational policies and procedures.
- Work with government and accreditation agencies relative to permitting and compliance. Assist with any investigations or surveys or practices as appropriate.
- Formulate and recommend legislative, regulatory, professional and public positions for institutional support.
- Management of the OSHA Material Safety Data Sheets (MSDS) and of SOPs.

7 Safety and emergency

Healthcare facilities are categorised as a risk working environment due to the frequently handling of hazardous goods and hazardous waste. Spillages and injuries are the most common emergencies related to hazardous waste. For hazardous goods and waste, basically the same response procedures are applied.

To be followed procedures in case of emergencies should be fixed in Standard Operating Procedures (SOPs´). Staff should be prepared and trained for emergencies and the necessary equipment (e.g. spillage kit) should be easily available. The clean up of accidents with hazardous materials should be carried out only by designated, specially trained personal and must be supervised. For emergency situations all departments should have their own detailed emergency plan.

Recommended hierarchy of risk control:

1. Elimination of hazard
2. Engineering controls
3. Administrative controls
4. Work practice controls
5. Personal Protective Equipment (PPE)

7.1 Occupational health & safety (OHS)

7.1.1 Training on emergency response

All staff handling hazardous materials like infectious waste, radioactive, chemical, cytotoxic waste must know how to react in case of injuries or exposure to these hazardous substances. By training the staff must learn how to behave and which steps must be followed. A typical training program should include:

1. Immediate first aid measures,
2. Immediate reporting to a responsible designated person,
3. Retention, it possible, to the item and details of its source for identification of possible infections,
4. Additional medical care as soon as possible,
5. Medical surveillance, blood or other tests if indicated,
6. Recording the incident,
7. Investigation, determination and implementation of remedial action,

To ensure that all staff will receive training, a monitoring system will have to be set up.

7.1.2 Standard operating procedures (SOPs)

Today, good quality systems in hospitals are based on its Standard Operating Procedures (SOPs). SOPs are a set of instructions having the force of a directive, covering those features of operations that lend themselves to a definite or standardized procedure without loss of effectiveness. SOPs can be defined “detailed, written instructions to achieve uniformity of the performance of a specific function". SOPs are necessary for a healthcare organization to achieve maximum safety and efficiency of the performed clinical and non-clinical operations.

The primary purpose of SOPs for HCW is to guide and standardize risk working procedures in order to ensure a safe and efficient work result. It is therefore crucial that staff read and follows the SOPs and it becomes very important for the staff to train them on these SOPs so that they are actually aware of why and how SOPs can play an important role in fulfilling regulatory

requirements and how they can help to protect their health. The general rule for SOPs is: “Write down what you do, do what is written down”.

Writing SOPs is not an easy process. It is very time-consuming and involves analysis of processes. However, it pays big dividends when complete. The responsible person should be very clear on the objectives of the SOPs while writing them and should explain in an easy and accurate way each of the working steps necessary for the to be standardized procedure. The typical contents of a SOP should include:

1. A descriptive title,
2. In some contexts the purpose of the SOP,
3. Date when the SOP became operative,
4. The edition number and a statement that this edition replaces an earlier edition from an earlier date,
5. The exact distribution of SOPs,
6. The signature of the person responsible for writing the SOP,
7. The signature of the person responsible for authorising the SOP.

SOPs for hazardous healthcare waste should additionally include:

- Examples of the hazards and the international symbol,
- Safety standards and general handling,
- Emergencies and spillages [Contact Tel.],
- First Aid [Contact Tel.],
- Waste Disposal [Contact Tel.],
- Address and Contact number of the responsible HWO,
- Description of the disposal possibilities.

Because SOPs include who, what, where, how and why of hospital operations, it is important for the staff to become familiar with the SOPs and to integrate them into the training program.

7.1.3 PPE, vaccination & spillage kits

To avoid accidents, staff must be provided with the necessary Personal Protection Equipment (PPE). This equipment includes but is not limited to:

- Eye wear,
- Goggles,
- Face shield,
- Respiratory protection,
- Clothing,
- Footwear,
- Safety shoes,
- Overshoes,
- Apron, laboratory coat,
- Gloves.

No glove is suitable for all uses, different gloves must be provided for different proceedings. All Gloves have a finite breakthrough time.

Normally all employees in a hospital, but at least all medical, nursing and cleaning staff should be immunized against tetanus and hepatitis B. Vaccination should be made available free of charge unless:

- The employee has had already the vaccination,
- Antibody testing reveals immunity.

The vaccination must be performed by a licensed healthcare professional.

To response in a fast way on spillages, the provision of spillage kits are recommended. Spillage kits are a collection of items which will be needed during the clean up of a spillage. They can be either pre-fabricated or can be self assembled items.

Table 4: Sample of contents of spillage kits

Infectious fluid	Mercury	Cytotoxic materials
• Infectious waste plastic bag • None-sterile latex gloves, a mask and goggles • Hypochlorite detergent (sodium hypochlorite). • Sufficient amount of paper towels • Plastic shovel	• None-sterile latex gloves, a mask and goggles • Brush • Plastic shovel • Wooden spatula and pipette • Mercury spill collector which incorporates a foam pad • Large syringe or hand operated vacuum pump device • Labelled waste receptacle	• Two pairs of protective gloves • Liquid proof gown • Safety goggles • Respirator mask (high-efficiency particulate HEPA) • Overshoes • Sufficient quantity of absorbents • Small plastic scoop and tongs to collect glass • Disposal bags • Hazard signs

Figure 18: Spillage kit for mercury, cytotoxic materials, worker with PPE

7.2 Management of emergency situation

Accidents and incidents are unplanned and uncontrolled events which could, or has, led to people being injured, damages of equipment or other loss. Accidents are not mysterious events. There is always a reason for them and they can be prevented. It is possible to plan and control activities in the workplace to ensure that accidents do not occur!

Emergency situations can not totally be avoided. To avoid a negative increase of the impact, staff has to respond in a planned and qualified way on the situation.

7.2.1 Incident and accident response

In case that staff is unsure how to behave on a certain accident as a spillage, the general proceeding shall be:

- Evacuation of the accident area and proceeding to a safe location.
- Estimation whether enough experience is existent to clean up the spill and if all necessary PPE is in reach to clean up the spill.
- If able to clean up the spill, follow proper cleanup procedures and use proper personal protection. Manage the generated waste as appropriate.
- If unable to clean up the spillage, isolate the spill area to keep persons away, and post signs as necessary.
- Inform the HWO or other responsible person (supervisor).

It is recommended to elaborate proceedings and safety procedures for the following incidents and accidents:

- Spillage of body fluids and blood,
- Needle stick injuries
- Broken mercury thermometer
- Spillage of gluteraldehyde or formalin
- Spillage of cytotoxic waste
- Spillage of infectious waste during transportation

Proceedings for incidents involving human injuries (accident):

- Immediate human injuries occur from pricks, tissue scratches, inhalation etc.
- Any human injury must be immediately reported to the Supervisor.
- If a superficial (minor) injury occurs First Aid may be applied.
- For significant (major) injuries a doctor should be consulted.
- In severe cases the injured person should be brought to the casualty department for treatment.
- A report has to be set up. Needle-stick or sharp injuries must be handled in accordance with the specific policy and a special report has to be filled.

7.2.2 Reporting of accidents & incidents

After every spillage, injury or any other accident and incident, a report must be shall be written and provided to the person in charge (HWO). The report should include the nature of the accident or incident, where and when it occurred, which staffs were directly involved and other relevant circumstances. An anonymous quarterly report about all accidents and incidents should be send quarterly to the authority.

Incident & accident reporting

Incidents that result in an injury (accident) and incidents that either result in damage or no consequence (near miss/unsafe incidents) are to be reported and a cause analysis conducted so that remedial action can be taken to rectify the situation. All persons have the responsibility to report accidents and unsafe incidents to their supervisor and/or Health and Safety Representative. Completed report cards shall be sent to the HWO for review and recording.

Reporting of needle-stick and sharps accidents

Needle stick accidents and accidents with sharp items belong to the most common accidents in the healthcare sector. Of special relevance is to be able to identify the source of a possible pathogen (e.g. the patient) and to be able to determine the likelihood of a disease transfer. For this, special report forms are necessary and should be used.

8 Training and capacity building

All hospital personnel, including senior staff, must be educated in order to convince them of the soundness of the comprehensive healthcare waste management strategy of the hospital. The training activities shall be designed and shall target the main four categories of personnel:

- Medical doctors,
- Nurses and assistant nurses, laboratory staff,
- Hospital cleaners and waste workers,
- (Managers and regulatory staff).

In the design and the carrying out of the courses the different knowledge and position of the trainees must be considered. The training must include:

- Information on the healthcare waste policy of the healthcare facility,
- Informing of the staff of the personal responsibilities and role,
- Technical instruction on how to practices for the target group.

The training shall be given under consideration of the different knowledge level and under consideration of cultures and religious aspects. It must be repeated and refreshed each year to update with policy changes. Participants have to sign their participation in the training. The HWO will be responsible for the monitoring to ensure that everybody participate in the training. Of special relevance will be to set up a training system for new employed staff.

In the following table, the main modules to be trained for the different target groups can be found.

Table 5: Sample training modules for different target groups

	Training module	Medical doctors	Nursing staff	Cleaners, orderlies
1	Healthcare waste policy and principles	■	■	■
2	Healthcare waste regulations	■	■	■
3	Classification of waste	■	■	■
4	Risks of waste	■	■	■
5	Waste containers and bags		■	■
6	Preparation for transporting		■	
7	Labelling of waste containers and bags		■	■
8	Labelling of storage places			■
9	Standard Operation Procedures (SOP)	■	■	■
10	Incidence and accidence procedures and reporting		■	■
11	Central storage rooms			■
12	Storage			■
13	Ward storage areas		■	
14	Occupational safety of Healthcare personnel	■	■	
15	Occupational safety of serving staff			■

	Training module	Medical doctors	Nursing staff	Cleaners, orderlies
	(transport, storage)			
16	Record keeping			
17	Transporting and routing			
18	Cleaning of containers, vehicles and storage facilities			
19	Responsibilities			
20	Treatment and disposal methods			
21	Accounting			
22	Test and certification			

It shall be the task of the HWO in cooperation with the WMT and the nursing sector to set up a training system. In several hospitals, training on infection control is carried out together with the training on healthcare waste management.