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REPUBLIC OF YEMEN

WORLD HEALTH ORGANIZATION

YEMEN EMERGENCY HUMAN CAPITAL PROJECT, FIRST AND SECOND ADDITIONAL FINANCING

(P176570)

MEDICAL WASTE MANAGEMENT PLAN

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1. Introduction

1.1 Project Context

The Yemen Emergency Human Capital Project (EHCP) P176570 (the parent project) is jointly implemented in the Republic of Yemen by World Health Organization (WHO), United Nations Children's Fund (UNICEF) and United Nations Office for Project Services (UNOPS) with the fund of World Bank. The project development objective is to provide essential health, nutrition, water, and sanitation services to the population of Yemen. Second additional financing (AF2) project (P176570) for the EHCP is planned in which similar components/activities under the parent project will be financed and implemented. Unless specified, the term (project) hereinafter is referring to EHCP parent, AF1and AF2.

Under the EHCP parent, AF1 and AF2, WHO will be one of the grant recipients and the managing and implementing entity, where the organization is responsible for the respective activities based on the project design and the implementation experience under the Emergency Health and Nutrition Project (EHNP) and Yemen COVID-19 Response Project (YCRP). WHO managed to set implementation mechanisms in place for the projects, through the existing local public system structures, to deliver various results on the ground during the ongoing conflict in Yemen. Since March 2015, WHO further strengthened and expanded its operational capacities and presence in the country to address the health issues at different levels.

WHO will implement material measures and actions so that its components are implemented in accordance with the World Bank Environmental and Social Standards (ESSs). The Environmental and Social Commitment Plan (ESCP) sets out material measures and actions needed during the implementation as well as documents or plans required to manage the associated risks and impacts. The Medical Waste Management Plan (MWMP) is one of such documents that has been prepared by WHO and its overall objective is to prevent and/or mitigate the negative effects of medical waste on human health and the environment. This updated MWMP is relevant to the WHO intervention only and will apply to EHCP parent, AF1 and AF2 projects.

This plan has been prepared in order to ensure that the proposed project activities incorporate sound environmental and social management principles and practices and complies with World Bank environmental and social standards (ESSs), the applicable WBG EHS guidelines, Good International Industry Practice (GIIP), and is consistent with the WHO relevant guidelines, as well as with the applicable environmental policies and legal requirements of the Republic of Yemen.

The plan hereinafter will address the risks associated with medical waste generated during the provision of healthcare services supported by the WHO under the project. It includes advocacy for good practices in medical waste management and is to be used by health, sanitary and cleaning workers who manage medical waste in the supported facilities under the Project. In addition, good practices and procedures for the waste packaging and storage, segregation, transportation, treatment, and disposal are detailed within this plan.

A monitoring program has been developed including indicators to address potential negative impacts of medical waste so that unforeseen impacts are detected, and the mitigation measures implemented efficiently. The monitoring plan includes indicators for the storage, segregation, and disposal of the medical waste. The monitoring program will be implemented both internally as part of the project's overall monitoring and reporting process, and externally by the Third-Party Monitoring (TPM) service which will be used under the project.

1.2 Project Components

The project development objective is to provide essential health, nutrition, water, and sanitation services to the population of Yemen.

Project Development Level Indicators are:

- Beneficiaries of health, nutrition and/or population services provided through the project (cumulative number – disaggregated by gender, children under the age of 5, and Internally Displaced Persons (IDPs)).
- People provided with access to improved water and sanitation services in selected urban and rural areas (cumulative number – disaggregated by gender).

The parent project components are detailed below:

Component 1: Improving Access to Healthcare, Nutrition, and Public Health Services (US$104.95 million equivalent)

This component aims to continue to ensure the delivery of Minimum Service Package (MSP) services and strengthen the integration of the primary, secondary, and tertiary healthcare and community levels through four subcomponents described below.

Subcomponent 1.1: Improving Access to MSP Services at Primary Healthcare Level (implemented by UNICEF)

Subcomponent 1.2: Improving Access to Essential Preventive and Curative Nutrition Services (implemented by UNICEF)

Subcomponent 1.3: Improving Access to the MSP at Secondary and Tertiary Healthcare Levels (implemented by WHO)

This subcomponent will ensure the continuum of care at the first referral centers and hospitals by supporting, inter alia:

i. Management of severe acute malnutrition (SAM) cases at in-patient Therapeutic Feeding Centers/Stabilization Centers for patients with complications or who failed home-based Outpatient Therapeutic Program.
ii. Provision of Basic Emergency Obstetric and Neonatal Care (BEmONC), Comprehensive Emergency Obstetric and Neonatal Care (CEmONC), and other MSP services in targeted referral centers.
iii. Diarrhea treatment centers to manage cholera cases.
iv. Screening and case management of non-communicable diseases and its complications including diabetes, hypertensions, tumors, and mental health.
v. Sustaining the national capacity of blood banks.
vi. Strengthening the capacity of central public health laboratories.

Subcomponent 1.4: Sustaining the National Health System Preparedness and Public Health Programs (implemented by WHO)

This subcomponent will sustain the National Health System Preparedness and Public Health Program by, inter alia, supporting:

vii. Disease prevention and public health campaigns, including in relation to vaccine preventable diseases and neglected tropical diseases, to prevent disease outbreaks.

viii. The Integrated Nutrition Surveillance System (INSS), to provide ongoing nutrition, health, and food security information to inform decisions in a timely manner.

ix. Strengthening systems and resilience-building measures to support the epidemiological and diagnostic laboratory capacity of the local institutions, particularly the reference labs at the governorate level

x. Disease surveillance, including maintaining the electronic disease early warning system (eDEWS).

In addition, this subcomponent will enhance the preparedness of the public health system to respond to disease outbreaks through nationwide rapid response teams at the district and governorate levels to ensure immediate multi-sectoral coordination and response to outbreaks.

Component 2: Improving Access to Water Supply and Sanitation (WSS) and Strengthening Local Systems *(implemented by UNOPS)*

Subcomponent 2.1: Restoring Access and Improving Quality to WSS Services in Selected Urban and Rural Areas (implemented by UNOPS).

Subcomponent 2.2: Emergency Support for WASH Interventions in Response to COVID-19 Pandemic and Flash floods (implemented by UNOPS).

Subcomponent 2.3: Enhanced Capacity Building of Water and Sanitation Institutions at the Local Level (implemented by UNOPS).

Component 3: Project Support, Management, Evaluation and Administration *(implemented by UNICEF, WHO, and UNOPS)*

This component will support the implementation, administration, management, monitoring and evaluation, and environmental and social aspects of the Project, including: (i) Direct Cost; (ii) Indirect Cost; (iii) provision of consultancy services required for Project monitoring, evaluation and coordination at the local level; (iv) conducting independent audits of Project activities; (v) audit; and (vi) Third-Party Monitoring. It will also support the provision of technical assistance for system strengthening and service delivery improvement.

Component 4: Contingent Emergency Response *(implemented by UNICEF, WHO, and UNOPS)*

The zero-dollar CERC will be in place to provide expedited response in case of emergency. An Emergency Response Operational Manual will be prepared jointly and agreed with the World Bank for use if this component is triggered.

Components and subcomponents included under the parent project will be supported by the AF with expansion to include additional health facilities. The only subcomponent added under the AF project is:

Subcomponent 1.5: Health System Strengthening (Implemented by WHO and UNICEF)

To continue building individual and institutional capacities, the AF will support better health information systems, quality-of-care improvements, and enhanced public financial management for the health sector.

1.3 Legal and Regulatory Framework

Applicable Yemeni regulations include:

- Law No: 20/1999 for establishment the Cleanliness Fund.
- Law No: 26/1995 Environmental Protection Law.
- Law No: 39/1999 Regulate the Public Cleanliness requirements in addition to the rules and responsibilities for managing several types of waste.
- Water Law No. 33 / 2002 and modified in 2006 after the creation of Ministry of Water and Environment. Its by-law was issued in 2011 by the Cabinet decree.
- Public Health Law, Law No: 04/2009

World Bank and WHO guidelines include:

- World Bank Environmental and Social Framework.
- WBG EHS Guidelines for Healthcare Facilities, issued on April 30, 2007.
- WHO guidance for safe management of wastes from health-care activities
- WHO resources include technical guidance on: (i) laboratory biosafety, (ii) infection prevention and control, (iii) rights, roles and responsibilities of health workers, including key considerations for occupational safety and health, (iv) water, sanitation, hygiene and waste management,

2. Existing Medical Waste Management System/Practices & lessons learned from parent and AF1

At present there is limited capacity in appropriate management of hospital or healthcare waste across the country. Although some good basic groundwork has been carried out in an attempt to bring about improvements, the situation remains deplorable and represents a serious health risk, not only to medical staff but also to the general public. Mixing most of the hospital waste with municipal solid waste worsens the problem. Most healthcare facilities have no common standards for source separation, collection bins, collection equipment for the disposal of medical waste. Disposable syringes, body organs, plastic bottles lay astray in the open dumps of the hospital waste. Some hospitals and municipalities burn their waste, which results in the production of large amounts of highly toxic gases. Therefore, the risk of injury and infection resulting from the improper management of the waste is high.

Within the supported facilities under the ongoing EHNP and YCRP, WHO is supporting the capacity building of healthcare workers where regular training sessions are conducted on the appropriate management of medical waste as well as the standard infection prevention and control principles. In addition, the supported healthcare facilities are provided with the waste management and infection prevention and control supplies on a regular basis, including disinfectants, bins, bags, and safety boxes in addition the Personal Protective Equipment that is necessary for the safety of healthcare workers. Monitoring of adherence and the level of implementation of waste management requirements in the supported healthcare facilities is being performed by Third Party Monitoring agencies and WHO monitoring and

evaluation team. Corrective and preventive measures are determined based on the monitoring outcomes and addressed in a timely manner with the relevant authorities to avoid any deviation.

Under EHNP where 72 healthcare facilities are supported, the current waste management condition is described below as per the recent Third-Party Monitoring TPM reports:

- Waste segregation is satisfactory performed in 61 out of 72 healthcare facilities in which the waste is being segregated at source as recommended.
- Lacking adherence to full PPE requirements observed in 21 healthcare facilities out of 72 healthcare facilities.
- 40 supported facilities have a functional incinerator each.
- Dedicated burial pits for sharps, organic and generated ash are not available within the vicinity of the supported facilities in which the final disposal is performed either in substandard pits within the facilities or in areas within the city municipality.

As for YCRP and as per the recent TPM report that covered 31 supported facilities the current waste management condition is described below:

- Lacking adherence to full PPE requirements observed in 3 healthcare facilities out of 31 healthcare facilities.
- 15 supported facilities have a functional incinerator in each.
- Dedicated burial pits for sharps, organic and generated ash are not available within the vicinity of the supported facilities in which the final disposal is performed either in substandard pits within the facilities or in areas within the city municipality.

More than 50 percent of the existing incinerators within the supported facilities under EHNP and/or YCRP are primary and lacking the minimum requirements for safe waste incineration such as the necessary temperature range, desired chimney's height or flue gases combustion.

For improving the overall condition of medical waste management and under the ongoing EHNP and YCRP, WHO is currently finalizing the installation arrangements of Waste Treatment Units including waste incinerators to properly dispose the generated hazardous waste within 50 supported healthcare facilities. The proposed waste treatment units include dual chambers De-MontFort-Mark-A incinerators suitable for the incineration of infectious waste at 900°c temperature in addition to dedicated burials pits for the final disposal of ash, organic waste, and sharps waste. Environmental and Social Management Plan has been developed by WHO in which it includes the necessary mitigation measures, arrangements and requirements for safe installation and operation of the proposed units. The necessary design, contractual, installation and operational requirements have been determined and the Waste Treatment Units will not have significant adverse impact on personnel or on the environment. WHO guidance and recommendations included in the safe management of wastes from health-care activities will be followed during the operation phase of the Waste Treatment Units.

Lessons learned from the parent project and first additional financing:

- Facilities managers and senior MoPHP officials play critical role towards enforcing the environmental and social aspects including IPC and medical waste management. WHO strives continuously to increase understanding of managers for their accountability in ensuring compliance and encourages the allocation of limited operational budgets in each facility to E&S compliance
- The importance of continuous capacity-building for health workers, ensuring a sustainable supply of waste management materials, and regular monitoring and evaluation to identify areas for improvement.
- The importance of establishing medical waste treatment and disposal units, based on need.

3. Standard Guidelines on Medical Waste Management

Medical waste refers to the entirety of waste generated by healthcare and medical research facilities and laboratories. Though only 10-25% of medical waste is considered hazardous, posing various health and environmental risks, it is essential that a comprehensive plan be developed to prevent and mitigate these risks.[1]

The safe and sustainable management of medical waste is a public health imperative and a responsibility of partners working in the health sector. Improper management of medical waste poses a significant risk to patients, health-care workers, the community, and the environment. This problem can be solved by the right investment of resources and commitment and will result in a substantive reduction of disease burden and corresponding savings in health expenditures.[2]

The effective management of medical waste is an integral part of a national health-care system, and as such needs to be integrated in this project. A holistic approach to medical waste management should include a clear delineation of responsibilities, occupational health and safety programs, waste minimization, adequate storage conditions for the medical supplies and segregation, the development and adoption of safe and environmentally-sound technologies, and capacity building. Best practices for safely managing health-care waste should be followed in healthcare facilities, which includes assigning responsibility and sufficient human and material resources to segregate and dispose of waste safely.

As highlighted by WHO recommendations[3], the first step in medical waste management is to minimize waste. A standardized assessment tool should be developed to identify gaps in the management process, including occupational health and safety issues. Though all staff are responsible for managing waste, to ensure optimal waste management, it is recommended to establish a facility-based Waste Management Committee and designate a single waste management project lead. The project lead should coordinate the medical waste management system and be supported by the health facility management. In addition, the roles and responsibilities of key personnel engaged in waste management activities should be defined during all phases (i.e., generation, segregation, transportation, and final disposal) and a waste-management committee should be established.

Annex 3 details the segregation, treatment and disposal principals for healthcare waste categories in accordance with the World Bank Environmental, Health, and Safety Guidelines for Health Care Facilities.

Waste Handling Safety Measures

- All personnel handling infectious medical waste shall wear gloves and additional protective medical clothing and personal protective equipment (PPE) appropriate to the level of risk they encounter and shall remove any protective medical clothing used prior to leaving the work area and to place it in a designated area or container. When performing procedures where splashing is not expected, gloves are the minimum PPE that may be worn.
- Protective medical clothing and PPE should not be sent for laundering unless sterilized.

[1] Yves Chartier, Jorge Emmanuel, Ute Pieper, Annette Prüss, Philip Rushbrook, Ruth Stringer, William Townend, Susan Wilburn, Raki Zghondi, eds, Safe management of wastes from health-care activities (Malta: World Health Organization, 2014), page 3.
2 http://www.who.int/water_sanitation_health/facilities/waste/hcwprinciples.pdf?ua=1;
3 http://apps.who.int/iris/bitstream/10665/85349/1/9789241548564_eng.pdf

- Where splashing may occur or when infectious medical waste bags or containers may contact more than the worker's hands and wrists, the following is required in addition to gloves:
    - Appropriate protective medical clothing should be of material that does not permit infectious medical waste from penetrating and reaching workers' clothes or skin.
    - Eye protection, surgical face masks, and face shields when personnel may reasonably anticipate facial exposure to infectious medical waste.
    - Implement immunization for staff members, as necessary (e.g. vaccination for hepatitis virus, tetanus immunization).

Waste Segregation Strategies

At the point of generation, waste should be identified and segregated. Non-hazardous waste, such as paper and cardboard, glass, aluminum and plastic, should be collected separately and recycled. Food waste should be segregated and composted. Infectious and / or hazardous wastes should be identified and segregated according to its category using a color-coded system. If different types of waste are mixed accidentally, waste should be treated as hazardous. Other segregation considerations include the following:

- Avoid mixing general health care waste with hazardous health care waste to reduce disposal costs.
- Segregate waste containing mercury for special disposal.
- Management of mercury containing products and associated waste should be conducted as part of a plan involving specific personnel training in segregation and clean up procedures.
- Segregate waste with a high content of heavy metals (e.g. cadmium, thallium, arsenic, lead) to avoid entry into wastewater streams.
- Separate residual chemicals from containers and remove to proper disposal containers to reduce generation of contaminated wastewater. Different types of hazardous chemicals should not be mixed.
- Establish procedures and mechanisms to provide for separate collection of urine, feces, blood, vomits, and other wastes from patients treated with genotoxic drugs. Such waste is hazardous and should be treated accordingly.
- Aerosol cans and other gas containers should be segregated to avoid disposal via incineration and related explosion hazard.
- Segregate health care products containing PVC to avoid disposal via incineration or in landfills.

On-site Handling, Collection, Transport and Storage

- Seal and replace waste bags and containers when they are approximately three quarters
- Full bags and containers should be replaced immediately.
- Identify and label waste bags and containers properly prior to removal.
- Transport waste to storage areas on designated trolleys / carts, which should be cleaned and disinfected regularly.
- Waste storage areas should be located within the facility and sized to the quantities of waste generated, with the following design considerations:
    - Hard, impermeable floor with drainage, and designed for cleaning / disinfection with available water supply
    - Secured by locks with restricted access
    - Designed for access and regular cleaning by authorized cleaning staff and vehicles
    - Protected from sun, and inaccessible to animals / rodents
    - Equipped with appropriate lighting and ventilation
    - Segregated from food supplies and preparation areas
    - Equipped with supplies of protective clothing, and spare bags / containers

- Unless refrigerated storage is possible, storage times between generation and treatment of waste should not exceed the following:
  - Temperate climate: 72 hours in winter, 48 hours in summer
  - Warm climate: 48 hours during cool season, 24 hours during hot season
- Store mercury separately in sealed and impermeable containers in a secure location.
- Store cytotoxic waste separately from other waste in a secure location.
- Store radioactive waste in containers to limit dispersion, and secure behind lead shields.

Transport to External Facilities

- Transport waste destined for off-site facilities according to the guidelines for transport of hazardous wastes / dangerous goods in the General EHS Guidelines.
- Transport packaging for infectious waste should include an inner, watertight layer of metal or plastic with a leak-proof seal. Outer packaging should be of adequate strength and capacity for the specific type and volume of waste.
- Packaging containers for sharps should be puncture-proof.
- Waste should be labeled appropriately, noting the substance class, packaging symbol (e.g. infectious waste, radioactive waste), waste category, mass / volume, place of origin within hospital, and final destination.
- Transport vehicles should be dedicated to waste and the vehicle compartments carrying waste sealed.

Disposal of Contaminated Waste

In facilities that have a waste zone, this is the final disposal site of medical waste. A fully functional waste zone should have the following components:

- An incinerator or burner for treatment of soft waste.
- An ash pit for disposal of residues from the incinerator or burner and a covered pit with a hatch lid.
- A sharps pit for disposal of sharps containers. A sealed, covered pit with a 1m length of pipe incorporated in the top to prevent access to the contents.
- An organics pit for disposal of human tissue and other biological waste.
- An infiltration facility or sewer for the disposal of liquids.

Types of medical wastes are detailed in annex 1 and non-exhaustive list is outlined in the table below.

Common medical waste and disposal methods

Waste Item*	Waste Collection	Storage	Treatment/Disposal
Needles, ampoules, scalpels, broken glass and vials	Closed sharps container	No	Sharps pit
Needle caps, syringes (w/o needles), masks, gloves, paper and dressings	Soft bucket	Temporary	Incinerator/ash Pit
Human body tissue, blood and fluids	Organics bucket	No	Organics pit
Wastewater	Bucket	No	Sewer/Infiltration facility
Domestic waste	Bin in communal area	No	Domestic waste pit

Best Practices for the Disposal of Liquid Contaminated Wastes

Liquid contaminated waste (e.g. human tissue, blood, feces, urine and other body fluids) requires special handling, as it may pose an infectious risk to healthcare workers with contact or handle the waste. Steps for the disposal of liquid contaminated wastes are the following:

- Wear PPE (utility gloves, protective eyewear and plastic apron)
- Carefully pour waste down a utility sink drain or into a flushable toilet and rinse the toilet or sink carefully and thoroughly with water to remove residual waste. Avoid splashing.
- If a sewage system doesn't exist, dispose of liquids in a deep, covered hole, not into open drains. This should be located at a safe distance from water sources.
- Decontaminate specimen containers by placing them in a 0.5% chlorine solution for 10 minutes before washing them.
- Remove utility gloves (wash daily or when visibly soiled and dry).
- Wash and dry hands or use an antiseptic hand rub as described above.
- Acids and alkalis should be diluted; pH neutralized and disposed of to the sewer with water. Neutralization can be done with lime, which is cheap and effective.

In cases where wastewater is not discharged to sanitary sewage systems, HCF operators should ensure that wastewater receives on-site primary and secondary treatment, in addition to chlorine disinfection. Techniques for treating wastewater in this sector include source segregation and pretreatment for removal / recovery of specific contaminants such as radio isotopes, mercury, etc.; skimmers or oil water separators for separation of floatable solids; filtration for separation of filterable solids; flow and load equalization; sedimentation for suspended solids reduction using clarifiers; biological treatment, typically aerobic treatment, for reduction of soluble organic matter (BOD); biological or chemical nutrient removal for reduction in nitrogen and phosphorus; chlorination of effluent when disinfection is required; dewatering and disposal of residuals as hazardous medical / infectious waste.

Additional engineering controls may be required for (i) removal of active ingredients (antibiotics and miscellaneous pharmaceutical products, among other hazardous constituents), and (ii) containment and treatment of volatile constituents and aerosols stripped from various unit operations in the wastewater treatment system.

The most contaminated wastewater will come from the mortuary, showers, laundry, and kitchen washing area. Wastewater from this area must, therefore, be disposed of in soak pits possibly after first going through grease traps (so that the soak pit does not become clogged). Soak always must be located at least 30 meters from any groundwater source and the bottom of any soak away pit is at least 1.5 meters above the water tables.

Best Practice for the Disposal of Solid Contaminated Wastes

Solid contaminated waste (e.g. surgical specimens, used dressings and other items contaminated with blood and organic materials) may carry microorganisms. Remember:

- Never use hands to compress waste into containers
- Hold plastic bags at the top
- Keep bags from touching or brushing against the body while lifting or during transport

Steps for the disposal of solid contaminated wastes are:

- Wear heavy-duty or utility gloves when handling and transporting solid waste.
- Wearing glasses if you are working with material that may splash into your face or eyes
- Dispose of solid waste by placing it in a plastic or galvanized metal container with a tight-fitting cover. Never recap needles after use.
- Collect the waste containers on a regular basis and transport the burnable ones to the
- incinerator or area for burning.

If incineration is not available or waste is non burnable, bury it. Remove utility gloves (wash daily or when visibly soiled and dry).

- Wash and dry hands or use an antiseptic hand rub as described above.
- Disposing of waste into designated containers as soon as it is generated
- Wearing boots, overalls, glasses and gloves when disposing of waste
- Using adequate tools to avoid contact with waste (brush, shovel)

It should be mentioned that properly designed and operated sanitary landfills will protect against air and groundwater contamination. Disposal of waste into open dumps is not considered good practice and should be avoided. Pre-treatment of waste prior to land disposal may involve encapsulation (filling containers with waste and an immobilizing material and sealing the containers).

Incineration

Incineration is a high-temperature process that reduces the volume and weight of waste. This process is usually selected to treat waste that cannot be recycled, reused, or disposed of in a sanitary landfill or dumpsite. Medical waste produced under this project will be incinerated at health facilities that are equipped with incinerators. In facilities with no incinerators, waste will be properly collected and safely transported to bigger facilities with incinerators.

Types of Incinerators

Incinerators can range from extremely sophisticated, high-temperature ones to very basic units that operate at much lower temperatures. All types of incinerators, if operated properly, eliminate micro-organisms from waste and reduce the waste to ashes. Four basic types of incinerators are used for treating waste:

- Double-chamber, high-temperature incinerators are designed to burn infectious waste.
- Single-chamber, high-temperature incinerators are less expensive and are used when double chamber incinerators are not affordable.
- Rotary kilns operate at high temperatures and are used for destroying cytotoxic substances and heat-resistant chemicals.
- Drum or brick (clay) incinerators operate at lower temperatures and are less effective but can be made locally using readily available materials.
- Waste Types that Should Not Be Incinerated

While it is possible to incinerate soft waste, the below categories SHOULD NOT be incinerated:

- Pressurized gas containers (aerosol cans)
- Large amounts of reactive chemical waste
- Silver salts and photographic or radiographic wastes
- Plastic containing polyvinyl chloride (blood bags, IV tubing or disposable syringes)
- Waste with high mercury or cadmium content, such as broken thermometers, used batteries and lead-lined wooden panels
- Ampoules or vials, as molten glass will cause the grate to block up and vials can explode.
- Bottles of chemicals and reagents due to risk of explosion and formation of toxic gases.
- Needles due to the risk of needle stick injury from the metal ash.
- Expired drugs.
- Kitchen waste as this is wet, does not burn and will lower the efficiency.

Solid wastes that should not be incinerated will be packaged, transported to and disposed of in Government recognized landfill.

Suggested incinerators at small scale health facilities

De Mont Fort mark 8-A incinerator model is considered a suitable option for waste disposal. The incinerator is a double chambered refractory structure having metal components in the form of waste loading door, ash removal door, and chimney. The incinerator operates on burning medical waste at a specific temperature range from 850 °C to 900 °C. The temperature range should be monitored by a high temperature digital thermometer mounted with the main structure. Close monitoring of the controlled burning reduces the emission of dioxin and furan which are the main objectionable environmental pollutants of incineration. Dioxin/furan formation is minimized by ensuring that incineration only takes place at temperatures above 800oC (Rossi and Schettler 2000).[4] Therefore, the temperature should reach 850oC before starting loading and burning of the waste which would avoid dioxin emission to the environment.

Waste is loaded from the waste loading door after preheating using kerosene oil as supplementary fuel. The temperature is maintained in the desired range by waste loading frequency. After burning infectious waste in the primary combustion chamber the toxic gases find passage in the secondary combustion chamber where further oxidation reduces the amount of dioxin and furans as a result atmosphere receive less polluting flue gases. This type will effectively get rid of approximately 6-7 kg of infectious waste per hour and can be operated for two hours daily five days a week following the best operation practices.

Open Burning

Open Burning is not recommended as it is dangerous, unsightly and the waste might be scattered by wind. If open burning must be done, burn in a small, designated area, transport waste to the site just before burning and remain with the fire until it is out.

[4] https://www.who.int/water_sanitation_health/medicalwaste/en/smincinerators.pdf

Burying Waste

Only small quantities of contaminated and hazardous waste need to be buried. In healthcare facilities with limited resources, safe burial of waste on or near the facility may be the only option available for waste disposal. To limit health risks and environmental pollution, some basic rules are:

- Access to the disposal site should be restricted (Build a fence around the site to keep animals and children away).
- The burial site should be lined with a material of low permeability (e.g. clay), if available.
- Select a site at least 50 meters (164 feet) away from any water source to prevent contamination of the water table. The site should have proper drainage, be located downhill from any wells, free of standing water and not in an area that floods.
- Large quantities (over 1 kg) of chemical (liquid) wastes should not be buried at the same time; burial should be spread over several days. Safe on-site burial is practical for only limited periods of time (1–2 years), and for relatively small quantities of waste. During the interval, staff should continue to look for a better, permanent method for waste disposal.

4. Guidelines on Emergency Preparedness and Response

Emergency events occurring in a HF may include occupational exposure to infectious materials, accidental releases of infectious or hazardous substances to the environment, medical equipment failure, failure of solid waste and wastewater treatment facilities and fire. These emergency events are likely to seriously affect medical workers, communities, the HF's operation, and the environment.

One person needs to be designated as responsible for the handling of emergencies, including coordination of actions, reporting to managers and regulators, and liaising with emergency services, and a deputy will be appointed to act in case of absence. In health-care establishments, spillage is probably the most common type of emergency involving infectious or other hazardous material or waste. Response procedures are essentially the same regardless of whether the events involve waste or material in use, and should ensure that:

- The waste management plan is respected.
- Contaminated areas are cleaned and, if necessary, disinfected.
- Exposure of workers is limited as much as possible during the clearing up operation.
- The impact on patients, medical and other personnel, and the environment is as limited as possible.
- Health-care personnel are being trained for emergency response, and the necessary equipment will be provided to ensure that all required measures can be implemented safely and rapidly.
- Written procedures for the different types of emergencies were drawn up. For dangerous spills, the clean-up operation will be carried out by designated personnel specially trained for the purpose.

In case of a needle stick injury, bleeding of the wound should be encouraged, and the area should be washed under clean running water. The remaining elements of the accident response plan should then be followed. The feasibility of provision Hep-B protection for all healthcare workers and administering post-exposure prophylaxis (PEP) in case of needle-stick injuries to be assessed and evaluated by the healthcare authorities.

The purpose of incident reporting should not be seen as punitive and active support by managers should encourage prompt and accurate reporting.

General procedures in case of spillages

The actions listed below provide an example of typical measures that could/should be taken in case of accidental spillages of healthcare waste.

- Evacuate the contaminated area.
- Decontaminate the eyes and skin of exposed personnel immediately.
- Inform the designated person who should coordinate the necessary actions.
- Determine the nature of the spill.
- Evacuate all the people not involved in cleaning up.
- Provide first aid and medical care to injured individuals.
- Secure the area to prevent exposure of additional individuals.
- Provide adequate protective clothing to personnel involved in cleaning-up.
- Limit the spread of the spill.
- Neutralize or disinfect the spilled or contaminated material if indicated.
- Collect all spilled and contaminated material. [Sharps should never be picked up by hand. brushes and pans or other suitable tools should be used]. Spilled material and disposable contaminated items used for cleaning should be placed in the appropriate waste bags or containers.
- Decontaminate or disinfect the area, wiping up with absorbent cloth. The cloth (or other absorbent material) should never be turned during this process, because this will spread the contamination. The decontamination should be carried out by working from the least to the most contaminated part, with a change of cloth at each stage. Dry cloths should be used in case of liquid spillage. for spillages of solids, cloth impregnated with water (acidic, basic, or neutral as appropriate) should be used.
- Rinse the area and wipe dry with absorbent cloths.
- Decontaminate or disinfect any tools that were used.
- Remove protective clothing and decontaminate or disinfect it if necessary.
- Seek medical attention if exposure to hazardous material has occurred during the operation.

5. Medical Waste Management Procedure

Guidelines and standards that are included in sections 3 and 4 are the best practices according to international guidance and WHO recommendations. It is not expected that all of these measures are applicable and realistic within the context of Yemen, however the project's responsibility to identify the risks and most practical mitigation measures as applicable in the operating environment to mitigate the medical waste management risks that are inherent in the activities supported through the project.

Under the ongoing EHNP and YCRP, WHO is currently finalizing the installation arrangements of Waste Treatment Units including waste incinerators to properly dispose the generated hazardous waste within 50 supported healthcare facility by the best applicable option that does not have significant adverse impact neither on personnel nor on environment. The proposed Waste Treatment Units will include dual chamber incinerators in which the installation, operation, and maintenance is as per WHO guidance for safe management of wastes from health-care activities.

In addition, WHO is supporting the capacity building of healthcare workers where regular training sessions are conducted on the appropriate management of medical as well as the standard infection prevention and control principles.

Such effort will be continued within the project (in particularly the Waste Treatment Units Installation) and WHO therefore will work with the responsible authorities during the various Project implementation stages to improve the waste management condition to the possible extent.

5.1 Project Implementation and Institutional Arrangements

Under the EHCP parent and AF, WHO will be one of the grant recipients and will be the managing and implementing agency, where the organization is responsible for the respective activities based on the project design and the implementation experience under the Emergency Health and Nutrition Project and Yemen COVID-19 Response Project YCRP. WHO managed to set implementation mechanisms in place for the projects, through the existing local public system structures, to deliver various results on the ground during the ongoing conflict in Yemen. Since March 2015, WHO further strengthened and expanded its operational capacities and presence in the country to address the health issues at different levels.

In 2019 the MoPHP established an institution (General Directorate) dedicated to medical waste management in Healthcare Facilities. This directorate is working on the ground and already coordinates with all agencies working in healthcare programs. They already started preparing the medical waste national guidelines and are participating in the training of health facility staff. This institution is planned to expand further to the GHO levels. WHO will coordinate with this directorate to facilitate the implementation of the provisions of this plan and further to ensure medical waste management sustainability beyond the scope and duration of the project.

Ideally and at facility level, it is recommended that waste management / infection control team needs to be nominated by the in charge of the hospital. Generally, this will comprise of:

1. Director of the hospital.
2. Infection control nurse.
3. Nursing Supervisor.
4. Senior Pharmacist.
5. Lab technician.
6. Ward master.
7. Sanitary supervisor.
8. Registrar Medicine / Surgery / Radiology / Gynecology and Obstetrics.

WHO has included Environmental and Social Specialists as part of its PMU for the project. The Specialist will be responsible for oversight of the MWMP and will work closely with WHO personnel at central and field levels. WHO field staff will be closely involved in conducting the management, monitoring, and reporting of environmental and social risk management aspects throughout project implementation.

The TPM agent that will be hired to monitor implementation activities under the project, will include in their monitoring process indicators to measure and report on implementation of the MWMP provisions.

5.2 Operation Requirements for Established Waste Treatment Units under the Project

The Project might support the establishment of waste treatment units within the supported facilities in which the operation of those units and incinerators is fatal and needs to follow the applicable guidelines to avoid any adverse impacts on the communities and environment resulted from inappropriate operation. Installation and operation of incinerators have the potential of causing significant environmental and social risks. These could include air pollution due to toxic fumes resulting from poor site selection, inadequate stack height, burning of unsegregated waste at low temperatures etc. Heavy metals in the incinerator ash could pollute soil and water, if not properly disposed in a safe burial pit. Inadequate storage facilities for fuel could result in fire hazards during operations.

Summary of the general requirements need to be considered during the waste treatment units' operation is detailed below, however the risks associated with the establishment and operation of incinerators and appropriate mitigation measures will be detailed further in the relevant site-specific Environmental and Social Management Plans in accordance with the WBG EHS guidelines for health facilities and the WBG General EHS guidelines. This will include requirements for site selection, procurement and storage of construction materials within a hospital setting, stack height, requirement of ash pit and ash disposal, any official permits needed for operating an incinerator; monitoring of optimal operations including management of temperature range and air emissions; plans for operation, maintenance and inspection; OHS of workers and community health and safety risks, etc.

- Capacity building for the workers involved in the incinerators' operation on the incineration temperature range and waste loading frequency.
- Capacity building for healthcare workers on infection prevention and control requirements as well as waste management and segregation principles.
- Enforcement in coordination with the healthcare facilities management the appropriate segregation of waste at source.
- Installation of awareness materials and guidelines on the appropriate segregation process as well the necessary guidelines on incinerators operation.
- Provision of the waste management supplies where required and ensure compliance to the segregation requirements.
- Provision of the necessary PPE for workers involved in the waste treatment unit's operation and monitoring regularly the level of adherence.
- Coordination with the healthcare authorities and facilities management to implement any necessary maintenance or inspection activities for the installed waste treatment units.
- Corrective and preventive actions for any non-compliance with the waste treatment unit's operation requirements shall be determined, followed up and implemented in coordination with the healthcare authorities.
- Ensure that the Project Grievances Mechanism channels are available in the healthcare facilities and to address immediately any grievances related to the installed incinerators' operation.
- Waste treatment unit operation to be included in any stakeholder engagement activities by the Project team. Concerns, suggestions and recommendations of the stakeholders need to be addressed accordingly.

5.3 Awareness Raising and Capacity Building

Healthcare staff will need to be trained and aware of good practices and procedures of waste management and infection control under this plan. Such practices and procedures should be disseminated to the healthcare facilities to be considered as part of the project activities through the following options:

- Designating members of the teams to train other healthcare staff, waste management workers and cleaners on the management of generated waste.
- Installation of signs and instructions of good practices/procedures for waste management within the healthcare facilities as well as during the other campaigns supported by the Project.
- Conducting regular training and awareness sessions for the healthcare workers on the appropriate waste management practices.
- Where applicable, third-party waste management service providers are provided with the relevant training.
- Training on the appropriate operation and maintenance of the installed Waste Treatments Units and Incinerators.

The Project Stakeholders Engagement Plan (SEP) covers the engagement strategy and approach to the necessary infection prevention and waste management topics and relevant stakeholders. Awareness raising among patients and families could be achieved through the deployment of posters and leaflets on infection prevention and waste management best practices.

5.4 Waste Management Supplies and Equipment

For appropriate management of the generated medical waste, supported healthcare facilities should be equipped with proper equipment and materials. Such supplies are very important to facilitate implementation of the provisions of this management plan and the Project (based on the available budget) will cover the costs of procurement and distribution of mentioned supplies to the supported healthcare facilities. These could be among others:

- Color-coding containers and safety boxes. Waste bins, bags, drums or other containers, including liquid waste containers.
- Personal Protective Equipment.
- Cleaning and disinfection supplies.
- Others as required.

6. Monitoring Plan

Monitoring is required to follow-up on decisions made to intervene in various activities of medical waste management in order to protect human health and the environment. This can be achieved through periodic internal and external processes of monitoring and evaluation on a continuous basis, at all institutional levels.

To achieve the MWMP objectives, the implementation of the plan must be monitored by both internal and external bodies including the WHO, Government Health Offices as well as Third Party Monitoring agencies. These bodies will use existing institutional arrangements as mentioned in section 5 for proper waste management at health units and facilities.

6.1 Monitoring Objectives

The aim of the monitoring is to establish appropriate criteria to address potential negative impacts of MWM and the unforeseen impacts are detected, and the mitigation measures implemented at an early stage. Specific objectives of the monitoring plan are to:

- Address any additional impacts appropriately.
- Check the effectiveness of the recommended mitigation measures.
- Ensure that the proposed mitigation measures are appropriate.
- Demonstrate that medical waste management is being implemented according to plan and existing regulatory procedures.
- Provide feedback to implementing partners to make modifications to the operational activities where necessary.
- To ensure the established waste treatment units under the Project are adequately operated and to implement the necessary corrective or preventive actions for any observed deviations.

6.2 Monitoring Arrangements

The medical waste management plan will be monitored both internally and externally. Internally, the plan will be part of the project's overall monitoring and reporting. WHO will work with the relevant health authorities towards ensuring that the staff hired at the unit/facility level will be monitoring the implementation of the Medical Waste Management Plan. Externally, the project will use third party monitoring service for intervention and activities under each component of the project. To this end, a TOR has been drafted for the TPM service, including tasks on monitoring the implementation of the medical waste management. The cost of implementing the monitoring plan is included as part of the project's cost.

6.3 Monitoring Indicators

Considering the type of interventions implemented by this project which are anticipated to have limited, site-specific impacts, the following will be used to monitor progress in implementing the medical waste management plan:

- Existence of human resource capacity in healthcare facilities with basic knowledge to deal with medical waste.
- Development of mechanisms for proper and safe medical waste management and disposal.

The monitoring of environmental effects is necessary so that the predicted impacts are addressed effectively and efficiently through the mitigation measures indicated. Specific monitoring indicators for consideration include the following:

Internal Packaging and Storage

- Segregation of waste (at point of origin)
- Storage bins / bags
- Frequency of removal

External Packaging and Storage

- Segregation of waste
- Storage area
- Frequency of waste removal
- Amount of waste generated

Treatment and Disposal

- Incineration and installed waste treatment units' operation
- Sterilization by Heat
- Sanitary Landfill

Administration

- For effective record keeping, each health institution shall keep records on:
- The type and volume or weight of waste generated
  - The means of transportation, type and volume transported
  - Commissioned waste contractor (company name, type of license, treatment and disposal).
  - Disposal method - volume incinerated, volume treated and disposed

Annex 2 includes a questionnaire for monitoring medical waste management in the supported facilities. The questionnaire will be filled by the project focal points in the governorates in coordination with the facilities representatives periodically and if any modification or expansion occurred. The survey will be used by the project team as a reference to determine the needs and to prepare the required plans.

7. Cost of Implementing the Medical Waste Management Plan

The estimated budget for implementation the medical waste management within the supported facilities includes the cost of training, waste management supplies provision, installation of incinerators and deployment of awareness messages as well as the cost of monitoring and visits. Project activities including the trainings and workshops will involve participants from all governorates and supported facilities based on the need and in coordination with the relevant authorities. The estimated budget is as below:

MWMP Implementation Costs	USD
Training and Monitoring 1. Training on Infection Prevention and Control including Medical Waste Management to the workers in supported facilities. 2. Visits, Monitoring, and reporting.	200,000
Supplies Procurement 3. Procurement of supplies such as: waste bins, bags, safety boxes. 4. Procurement of PPE to the waste management workers.	200,000
Waste Treatment Units Installation 5. Installation of Waste Treatment Units within the supported facilities	250,000
TOTAL USD	**650,000**

Annex 1: Major Categories of Medical Waste

Waste type	Description
1. Infectious waste	Infectious wastes are susceptible to contain pathogens (or their toxins) in sufficient concentration to cause diseases to a potential host. Examples include discarded materials or equipment, used for the diagnosis, treatment and prevention of disease that has been in contact with body fluids (dressings, swabs, nappies, blood bags etc). It also includes liquid waste such as faeces, urine, blood or other body secretions.
2.Pathological and anatomical waste	Pathological waste consists of organs, tissues, body parts or fluids such as blood. Anatomical waste consists in recognizable human body parts, whether they may be infected or not.
3. Hazardous pharmaceutical waste	Pharmaceutical waste includes expired, unused and contaminated pharmaceutical products, drugs and vaccines. This category also includes discarded items used in the handling of pharmaceuticals like bottles, vials and connecting tubing.
4. Hazardous chemical waste	Chemical waste consists of discarded chemicals (solid, liquid or gaseous) that are generated during disinfecting procedures. They may be hazardous (toxic, corrosive, flammable or reactive) and must be used and disposed of according to the specification formulated on each container.
5. Waste with a high content of heavy metals	Waste with high contents of heavy metals and derivatives are highly toxic (e.g. cadmium or mercury from thermometers or manometers).
6. Pressurized containers	Pressurized containers consist of full or emptied containers or aerosol cans with pressurized liquids, gas or powdered materials
7. Sharps	Sharps are items that can cause cuts or puncture wounds (e.g. needle stick injuries). They are highly dangerous and potentially infectious waste. They must be segregated, packed and handled specifically within the HCF to ensure the safety of the medical and ancillary staff.
8. Highly infectious waste	This includes microbial cultures and stocks of highly infectious agents from medical laboratories. They also include body fluids of patients with highly infectious diseases.
9. Genotoxic/cytotoxic waste	Genotoxic waste includes all the drugs and equipment used for mixing and administration of cytotoxic drugs. Cytotoxic drugs or genotoxic drugs are drugs that have the ability to reduce the growth of certain living cells and are used in chemotherapy for cancer.
10. Radioactive waste	Radioactive waste includes liquids, gas and solids contaminated with radio nuclides whose ionizing radiations have genotoxic effects. These include x- and g-rays as well as a- and b- particles.

Source: Safe Management of Wastes from Health-Care Activities, WHO 1999

Annex 2: Medical Waste Management Monitoring Questionnaire

Health Facility (name, location): _____

_____

_____

No. of inpatients: _____ /day

No. of outpatients: _____ /day

No. of beds (total): _____ /day

Type/Category of Health Facility (tick one):

☐	Tertiary: Specialist, National, Teaching Hospitals
☐	Secondary: Governorate Gen. Hospitals, Sub-HCF Hospital, Private Hospitals
☐	Primary; Health Centre, Dispensary
☐	Mobile healthcare unit

Type of solid waste produced and estimated quantity

(Consult classification and mark X where waste is produced)

Type	Estimated Quantity
Sharps	
Pathological waste	
Infectious waste	
Pharmaceutical waste	
Pressurized containers	

Waste segregation, collection, storage, and handling

Describe briefly what happens between segregation (if any) and final disposal of:

Sharps _____

Pathological waste _____

Infectious waste _____

Pharmaceutical waste _____

Pressurized containers _____

Waste segregation, collection, labelling, transport, and disposal

1. Handling of segregated waste	Sharps	Pathological waste	Infectious waste	Pharmaceutical waste	Pressurized containers
Indicate by X the type of waste (if any) that is segregated from general waste stream.					
Where is the segregation taking place (i.e. operating room, laboratory, among others)?					
What type of containers/bags (primary containment vessels) are used to segregate waste (bags, cardboard boxes, plastic containers, metal containers, among others)? describe accurately.					
What type of labelling, colour-coding (if any) is used for marking segregated waste? Describe					
i. Who handles (removes) the segregated waste (designation of the hospital staff member)? ii. Is the waste handler using any protective clothing (gloves, among others) during waste handling? Yes/No.					
What type of containers (plastic bins, bags, cardboard boxes, trolleys, wheelbarrows, safe boxes, metal containers, among others) are used for collection and internal transport of the waste? Describe.					
Where is the segregated waste stored while awaiting removal from the hospital for disposal? Describe.					
Describe briefly the final disposal of segregated waste (taken to municipal landfill, buried on hospital grounds, incinerated (external incinerator, own incinerator), open burned, removed from premises, among others)					

If removed from premises; who is responsible for removal? Health facility/self, private collector, State Environmental protection Agency					
If removed from premises; what form of transport is used? Enclosed waste track, open waste track, open pick-up, among others					
How often is the waste removed from site?					
Daily					
3 – 4 times per week					
1 – 2 times per week					
Once a week					
Every two weeks					
Once a month					
Less often					

Is safety clothing issued to staff involved in medical waste collection, i.e. gloves, aprons, among others? ☐ Yes ☐ No

If yes, please list the safety clothing/items issued to medical waste collectors and the frequency of issue:

Items issued	**Daily**	**Weekly**	**Monthly**	**As Needed**
Aprons				
Gloves				
Safety shoes				
Overhauls				
Others (specify)				

Which of these waste collection, handling, transport and disposal activities are undertaken by Health-care staff and which are outsourced? List the party responsible for that activity, where the activity is outsourced, and the start and end dates of the contract entered into:

ACTIVITY	RESPONSIBLE PARTY (self/facility, Environmental Protection Agency, Private collector, among others)	NAME OF THE RESPONSIBLE PARTY/PRIVATE COLLECTOR
Collection		
Handling		
Transport		
Incineration		
Disposal		

Personnel involved in the management of Health-care waste

1. (a) Designation of person(s) responsible for organization and management of waste collection, handling, storage, and disposal at the hospital administration level.

_____

_____

(c) Has he/she received any training on hospital waste management? Yes ☐ No ☐

If yes, what type of training and of what duration?

_____

Annex 3: Treatment and Disposal Methods for Healthcare Waste Categories

Type of waste	Summary of treatment and disposal options/notes
Infectious waste: Includes waste suspected to contain pathogens (e.g., bacteria, viruses, parasites, or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts. Includes pathological and anatomical material (e.g., tissues, organs, body parts, human fetuses, animal carcasses, blood, and other body fluids), clothes, dressings, equipment / instruments, and other items that may have come into contact with infectious materials.	**Waste Segregation Strategy**: Yellow or red colored bag/container, marked "infectious" with international infectious symbol. Strong, leak proof plastic bag, or container capable of being autoclaved. **Treatment:** Chemical disinfection; Wet thermal treatment; Microwave irradiation; Safe burial on hospital premises; Sanitary landfill; Incineration (Rotary kiln; pyrolytic incinerator; single-chamber incinerator; drum or brick incinerator) [e] • Highly infectious waste, such as cultures from lab work, should be sterilized using wet thermal treatment, such as autoclaving. • **Anatomical waste** should be treated using Incineration (Rotary kiln; pyrolytic incinerator; single-chamber incinerator; drum or brick incinerator).
Sharps: Includes needles, scalpels, blades, knives, infusion sets, saws, broken glass, and nails etc.	**Waste Segregation Strategy**: Yellow or red color code, marked "Sharps". Rigid, impermeable, puncture-proof container (e.g., steel or hard plastic) with cover. Sharp's containers should be placed in a sealed, yellow bag labeled "infectious waste". Treatment: Chemical disinfection; Wet thermal treatment; Microwave irradiation; Encapsulation; Safe burial on hospital premises; Incineration (Rotary kiln; pyrolytic incinerator; single-chamber incinerator; drum or brick incinerator) [e] • Following incinerators, residues should be landfilled • Sharps disinfected with chlorinated solutions should not be incinerated due to risk of generating POPs • Needles and syringes should undergo mechanical mutilation (e.g., milling or crushing) prior to wet thermal treatment
Pharmaceutical waste: Includes expired, unused, spoiled, and contaminated pharmaceutical products, drugs, vaccines, and sera that are no longer needed, including containers and other potentially contaminated materials (e.g. drug bottles vials, tubing etc.).	• Waste Segregation Strategy: Brown bag / container. Leak-proof plastic bag or container. • Treatment: Sanitary landfill[a]; Encapsulation[a]; Discharge to sewer [a]; Return expired drugs to supplier; Incineration (Rotary kiln; pyrolytic incinerator [a]); • Safe burial on hospital premises[a] as a last resort. • Small quantities: Landfill disposal acceptable, however cytotoxic and narcotic drugs should not be landfilled. Discharge to sewer only for mild, liquid pharmaceuticals, not antibiotics or cytotoxic drugs, and into a large water flow. Incineration acceptable in pyrolytic or rotary kiln incinerators, provided pharmaceuticals do not exceed 1 percent of total waste to avoid hazardous air emissions. Intravenous fluids (e.g., salts, amino acids) should be landfilled or discharged to sewer. Ampoules should be

Type of waste	Summary of treatment and disposal options/notes
	crushed and disposed of with sharps. • Large quantities: Incineration at temperatures exceeding 1200 °C. Encapsulation in metal drums. Landfilling not recommended unless encapsulated in metal drums and groundwater contamination risk is minimal.
Genotoxic / cytotoxic waste: Genotoxic waste may have mutagenic, teratogenic, or carcinogenic properties, and typically arises from the feces, urine, and vomit of patients receiving cytostatic drugs, and from treatment with chemicals and radioactive materials. Cytotoxic drugs are commonly used in oncology and radiology departments as part of cancer treatments.	**Waste Segregation Strategy:** See above for "infectious waste". Cytotoxic waste should be labeled "Cytotoxic waste". **Treatment:** Return expired drugs to supplier; Chemical degradation; Encapsulation[a]; Inertization; Incineration (Rotary kiln, pyrolytic incinerator); • Cytotoxic waste should not be landfilled or discharged to sewer systems. • Incineration is preferred disposal option. Waste should be returned to supplier where incineration is not an option. Incineration should be undertaken at specific temperatures and time specifications for particular drugs. Most municipal or single chamber incinerators are not adequate for cytotoxic waste disposal. Open burning of waste is not acceptable. • Chemical degradation may be used for certain cytotoxic drugs – See Pruss et al. (1999) Annex 2 for details. • Encapsulation and inertization should be a last resort waste disposal option.
Chemical waste: Waste may be hazardous depending on the toxic, corrosive, flammable, reactive, and genotoxic properties. Chemical waste may be in solid, liquid, or gaseous form and is generated through use of chemicals during diagnostic / experimental work, cleaning, housekeeping, and disinfection. Chemicals typically include formaldehyde, photographic chemicals, halogenated and nonhalogenated solvents d, organic chemicals for cleaning / disinfecting, and various inorganic chemicals (e.g., acids and alkalis).	**Waste Segregation Strategy:** Brown bag / container. Leak-proof plastic bag or container resistant to chemical corrosion effects. **Treatment:** Return unused chemicals to supplier; Encapsulation[a]; Safe burial on hospital premises[a]; Incineration (Pyrolytic incinerator[a]; • Facilities should have permits for disposal of general chemical waste (e.g. sugars, amino acids, alts) to sewer systems. • Small hazardous quantities: Pyrolytic incineration, encapsulation, or landfilling. • Large hazardous quantities: Transported to appropriate facilities for disposal, or returned to the original supplier using shipping arrangements that abide by the Basel Convention. Large quantities of chemical waste should not be encapsulated or landfilled
Radioactive waste: Includes solid, liquid, and gaseous materials that have been contaminated with radionuclides. Radioactive waste originates from activities such as organ imaging, tumor localization, radiotherapy, and research / clinical laboratory procedures, among others, and may include glassware, syringes, solutions, and excreta from treated patients.	**Waste Segregation Strategy:** Lead box, labeled with the radioactive symbol. Treatment: Radioactive waste should be managed according to national requirements and current guidelines from the International Atomic Energy Agency. IAEA (2003). Management of Waste from the Use of Radioactive Materials in Medicine, Industry and Research. IAEA Draft Safety Guide DS 160, 7 February 2003.
Waste with high content of heavy metals: Batteries, broken thermometers, blood pressure gauges, (e.g., mercury and cadmium content).	**Waste Segregation Strategy:** Waste containing heavy metals should be separated from general health care waste. **Treatment:** Safe storage site designed for final disposal of hazardous waste. • Waste should not be burned, incinerated, or landfilled. Transport to specialized facilities for metal recovery

Type of waste	Summary of treatment and disposal options/notes
Pressurized containers: Includes containers / cartridges / cylinders for nitrous oxide, ethylene oxide, oxygen, nitrogen, carbon dioxide, compressed air and other gases.	**Waste Segregation Strategy:** Pressurized containers should be separated from general health care waste. **Treatment:** Recycling and reuse; Crushing followed by landfill • Incineration is not an option due to explosion risk • Halogenated agents in liquid form should be disposed of as chemical waste, as above
General health care waste (including food waste and paper, plastics, cardboard.	**Waste Segregation Strategy:** Black bag / container. Halogenated plastics such as PVC should be separated from general health care facility waste to avoid disposal through incineration and associated hazardous air emissions from exhaust gases (e.g. hydrochloric acids and dioxins). **Treatment:** Disposal as part of domestic waste. Food waste should be segregated and composted. Component wastes (e.g., paper, cardboard, recyclable plastics [PET, PE, PP], glass) should be segregated and sent for recycling.

Source: Safe Management of Wastes from Health-Care Activities. International Labor Organization (ILO), Eds. Pruss, A. Giroult, and P. Rushbrook (1999)

Notes:

a) Small quantities only
b) Low-level infectious waste only
c) Low-level liquid waste only
d) Halogenated and nonhalogenated solvents (e.g., chloroform, TCE, acetone, methanol) are usually a laboratory-related waste stream for fixation and preservation of specimens in histology /pathology and for extractions in labs.
e) Note on incinerators. Pyrolytic and rotary kiln incinerators should be used. Use of single-chamber and drum / brick