YEMEN COVID-19 RESPONSE PROJECT

EMERGENCY HEALTH AND NUTRITION PROJECT

WASTE TREATMENT UNITS INSTALLATION

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN
ESMP

Cleared version: November 2021
Updated: April 2022

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ABBREVIATIONS AND ACRONYMS

BOQ	Bill of Quantities
CoC	Code of Conduct
COVID-19	Coronavirus Disease 2019
EHNP	Emergency Health and Nutrition Project
ESHS	Environmental, Social, Health and Safety
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
GBV	Gender Based Violence
GM	Grievance Mechanism
HF	Healthcare Facility
ICMWMP	Infection Control and Medical Waste Management Plan
IPC	Infection Prevention and Control
LMP	Labor Management Procedure
MoPHP	Ministry of Public Health and Population
OHS	Occupational Health and Safety
PAPs	Project-affected parties
PMU	Project Management Unit
PPE	Personal Protective Equipment
SEA/SH	Sexual Exploitation and Abuse / Sexual Harassment
SEP	Stakeholder Engagement Plan
TPM	Third Party Monitoring
UNICEF	United Nations Children's Fund
WASH	Water, Sanitation and Hygiene
WB	World Bank
WHO	World Health Organization
WTU	Waste Treatment Unit
YCRP	Yemen COVID-19 Response Project

1. INTRODUCTION

The safe and sustainable management of medical waste is a public health imperative and a responsibility of partners working in the health sector which is an important factor considered during the implementation of EHNP and YCRP in the Republic of Yemen. Improper management of healthcare waste poses a significant risk to patients, healthcare workers, the communities, and the environment. To overcome the current challenges in implementing adequate waste management across the supported healthcare facilities under Yemen Emergency Health and Nutrition Project (EHNP) and/or Yemen COVID-19 Response Project (YCRP), the WHO will install complete Waste Treatment Units (WTU) to improve the overall waste disposal condition and to protect Workers, Environment and communities from any adverse impact resulted from the generated waste.

Launched in 2017, the Yemen Emergency Health and Nutrition Project EHNP aims to contribute to the provision of basic health, essential nutrition, and Water, Sanitation and Hygiene (WASH) services across Yemen in all 333 Districts and 22 Governorates. The EHNP is jointly implemented by World Health Organization WHO and United Nations International Children's Emergency Fund UNICEF, leveraging each organizations' comparative advantage and areas of expertise along with partnership and support of the World Bank (WB). The EHNP aims to support the national health system in Yemen through financing health and nutrition services and assists in maintaining the existing health system capacity through support and engagement of public healthcare facilities and communities.

Yemen COVID-19 Response Project YCRP is a recent partnership between the WB and WHO launched in April 2020. The project has been established with support and finance from the WB and is implemented by WHO to prevent, detect and respond to the threat posed by COVID-19 and strengthen national systems for public health preparedness. The project aims to help Yemen immediately respond to and mitigate the risks associated with the COVID-19 outbreak in the country.

For adequate implementation of the Environmental and Social requirements following the WB standards, the below documents have been developed, approved, and published in the WHO and WB websites. Below documents are applicable to any activities financed by WB under the EHNP or YCRP to ensure adequate protection for the personnel, environment and communities from any adverse impact resulted from the implemented activities:

Emergency Health and Nutrition Project Safeguards documents are:

- Environmental and Social Management Framework ESMF
- Medical Waste Management Plan

Yemen COVID-19 Response Project Safeguards documents are:

- Environmental and Social Management Framework ESMF
- Infection Control and Medical Waste Management Plan ICMWMP
- Stakeholders Engagement Plan SEP
- Labor Management Procedure LMP

Waste Treatment Units (WTUs) will be implemented within the boundaries of 50 Healthcare Facilities (HFs) supported by the EHNP and/or YCRP. The detailed design of the WTU has been prepared by the WHO with the technical support and approval of the World Bank Environmental and Water, Sanitation and Hygiene WASH teams.

Environmental and Social Safeguards of this intervention (Waste Treatments Units WTUs installation) will be implemented in accordance with the requirements that detailed in the safeguards' documents of EHNP and YCRP detailed above. The higher environmental and social standard will be applied for all 50 WTUs where there are any gaps between the Environmental and Social instruments prepared for EHNP and YCRP.

EHNP and/or YCRP will be indicated hereinafter in this document **(Project/s)** and the proposed intervention (Waste Treatment Units installation) will be indicated hereinafter **(Subproject)**.

In accordance with the ESMF of EHNP and YCRP, screening process shall take place for the interventions or subprojects implemented under the main Projects. Therefore, the screening of this subproject was performed as per the YCRP ESMF screening requirements as it is as per the higher environmental and social standards. This subproject will involve civil work activities with moderate risk level associated with the intervention, hence the Environmental and Social Management Plan (ESMP) was determined as suitable instrument to address the Environmental and Social risks and impacts. Screening form as per the YCRP ESMF is available in annex 1.

This ESMP however is meant to present further details and clarity on the environmental and social risks associated with the installation/operation of WTUs in the supported HFs in addition to propose the mitigation measures that need to be implemented. The ESMP will include the general and common information applicable for all sites including the WTU design in addition to the strengthen mitigation measures. Moreover, the annex 6 will include environmental and social requirements for each site that contains the layout, photos, consultation, recommendations, and any site-specific details. Annex 6 that includes the indicated specific details about each facility is available in the link SITE-SPECIFIC ENVIRONMENTAL AND SOCIAL REQUIREMENTS

An ESMP consists of the set of mitigation, monitoring, and institutional measures to be taken during implementation and operation of a project to eliminate adverse environmental and social risks and impacts, offsets them, or reduce them to acceptable levels. The plan also defines the activities summary, level of responsibilities, communication summary, reporting and monitoring requirements as well as the waste management and Grievance Mechanism (GM) requirements.

The following was considered during the development of project documentations including this plan: review of existing condition across the supported facilities, consultancy, and independent audit for the existing Waste Treatment Units WTU in addition to the communication with the facilities and MoPHP authorities. Potential impacts on the healthcare service, environment, and community during the implementation and operation of the identified WTU have been identified in addition to provide the necessary risk mitigation measures applicable for the subproject.

An official letter issued from the MoPHP to WHO explaining the ministry's request to facilitate the implementation of De-Mont-Fort-Mark8A incinerators in the targeted healthcare facilities as soon as possible. The installation of WTUs is inside the healthcare facilities under the MoPHP authority, management of medical waste generated from healthcare facilities is the responsibility of each healthcare facility and it should meet the applicable regulations. The selection of exact WTU location in each facility is implemented in coordination with each facility management and official authorization is obtained for each prior the start of civil work.

Yemeni Regulations

The MoPHP is responsible for the management of healthcare sector in the country and to ensure all required regulations are implemented. The applicable Yemeni regulations on the healthcare waste management include:

- Public Health Law, Law No: 04 / 2009
- Law No: 20/ 1999 for establishment the Cleanliness Fund.
- Law No: 39 / 1999 Regulate the public cleanliness requirements in addition to the roles and responsibilities for managing types of waste.

- Law No: 26 / 1995 EPL Environmental Protection Law that defined the hazardous and nonhazardous waste.

Recently issued guideline namely the National Guideline for Healthcare Waste Management 2020, includes the types of waste in addition to the recommended storage, treatment, and disposal methods as well as the recommended color coding as detailed below:

- Infectious Waste: Yellow colored bag/container marked “infectious” with biohazard symbol.
- Pathological Waste: Red colored bag/container with biohazard symbol.
- Sharp Waste: Yellow colored puncture proof container with biohazard symbol.
- Chemical/pharmaceutical Waste: Brown colored leak proof container/bags.
- General Waste: Black bag/container.

2. BASELINE INFORMATION

2.1. STATUS OF HEALTHCARE WASTE MANAGEMENT

At present there is limited capacity for proper management of hospital or healthcare waste in Yemen as there is lack of infrastructure such as Waste incinerators or burial pits and limited enforcement of the applicable rules and regulations. Although some good basic groundwork has been carried out to bring about improvements, the situation remains deplorable and represents a grave health risk, not only to medical staff but also to public. Most healthcare facilities have no common standards for source separation, collection bins, collection equipment for the disposal of medical waste.

Since different types of generated waste from HF need different treatment methods, the HFs around the country are using different treatment methods based on the available infrastructures and resources. Disposable syringes, body organs, plastic bottles lay astray in the open dumps of the hospital wastes. Some hospitals and municipalities openly burn the wastes, which results in the production of large amount of highly toxic gases. Effort made by several Non-Governmental Organizations to install various types of incinerators within the Healthcare Facilities, but the operation of such incinerators is not sustainable for several reasons such as: high operation or maintenance cost, fumes emissions, high energy consumption and therefore the HFs are using other options for final disposal of waste such as open burning.

Under EHNP where 72 Healthcare facilities are supported, the final disposal method of generated waste is described below as per the recent Third-Party Monitoring (TPM) reports:

- 40 supported facilities have a functional incinerator.
- Dedicated burial pits for sharps, organic and generated ash are not available within the vicinity of the supported facilities.

As for the YCRP where 37 COVID-19 Isolation Unit are supported and as per the recent TPM report the final disposal method of generated waste across 17 Isolation units is described below:

- 8 supported facilities have a functional incinerator.
- Dedicated burial pits for sharps, organic and generated ash are not available within the vicinity of the supported facilities.

More than 50% of the available incinerators are primary and the necessary main components of WTUs such as crushers and shredders are not available.

The annex 6 includes specific information about each healthcare facility in which the WTUs will be installed.

2.2. PERFORMANCE EVALUATION OF INSTALLED WASTE TREATMENT UNITS

Prior taking the final decision on the appropriate WTU that will be installed in the supported facilities under the EHNP/YCRP, 2 pilot WTUs have been installed in 2018 by WHO in the HFs namely Al-Jumhori in Saadah governorate and Al-Thawrah in Hodeidah governorate.

For the purpose of evaluation of the operational status and integrity of the installed WTUs and based on the World Bank request, an independent consultation survey conducted in May 2020 in which detailed **Audit Report** available in annex 8 has been issued. The Independent Audit Report has been reviewed and validated by the World Bank WASH and Environmental teams.

The Audit Report concludes the following:

The medical waste treatment units that were implemented locally in both sites (Sa'adah and Hodeidah), have been in operation since 2018 in which the following components are available:

1- De Montforte Incinerator-Mark 8a, 2- Safety box reducer, 3- Glass crusher, 4- Organic pit, 5- Ash pit, 6- Sharp pit, 7- Cleaning and disinfection basin.

Further technical information on the WTU design and components are available in section 3 as well as in the annexed Audit Report.

The advantage of implementing the medical waste treatment unit inside the hospital is avoiding contamination of the infectious medical waste inside and outside the hospital.

This type of treatment units is suitable for Yemen as:

- It is considered an environmentally friendly if used and implemented properly.
- It has low construction and operation cost.
- It does not need high-skilled labor neither for construction nor for operation.
- It doesn't require energy for operation and can be operated by limited amount of fuel.
- It can fulfill the purpose of medical waste treatment and management.
- It is most suitable for less crowded areas especially in rural areas so that the open burning practice is stopped, and the medical waste is managed and controlled inside the hospital to protect the neighbor and local community and the patients from infectious waste.

The following points need to be considered in any future design or implementation of similar WTU (which has been addressed during the final design of this WTU subproject):

- Implementing the treatment unit away from the residential area or adding carbon filters and installing adequate chimney covers.
- To add up a temperature thermometer to measure, control and monitor the temperature of the incinerator during the incineration so that the pre-heating should take place up to 600 °C, at which the medical waste is to be loaded after which the range of 600 °C - 900 °C is maintained during incineration. The installed WTU under the Projects and for further reduction of pollutants emission, the operation and infectious waste loading temperature will be maintained at 850 °C to 900 °C.
- To add up an evaporation basin which would replace discharging the chemicals into the sewerage network in order to prevent its impact on the soil, groundwater, agriculture crops, farmers and workers working in the sanitation system.
- To install Smoke- absorbing activated carbon filters at the chimneys' pinnacle of the incinerators and to the ventilators of the pits to prevent the odor and smoke from spreading to the local community with decreasing the CO/CO2 gasses resulted from destruction of dioxins in the secondary chambers.

- Implementing of the glass crusher as the applied model in Sa'adah, as opposed to the model in Hodeidah.

In regards the liquid medical waste treatment, the following precautions should be considered during the operation phase of the WTU as recommended by the Audit Report:

- The disposable chemicals come out from the equipment set or the lab tests or the x-ray film development should be either diluted with an amount of water to decrease the concentration up to the non-harmful concentration level, and discharged promptly to the sewerage network, or instead, subjected to evaporation by constructing an evaporation basin to evaporate these chemicals under sunlight, then the powder residues can be buried.
- Medicines contains heavy metals such as silver, cadmium, chromium, copper, lead, mercury, selenium and zinc should not be disposed to the sewerage networks.

3. SUBPROJECT ACTIVITIES DESCRIPTION

3.1. PLANNING AND IMPLEMENTATION ARRANGEMENTS

The safe and sustainable management of healthcare waste is a public health imperative and a responsibility of partners working in the health sector. Improper management of healthcare waste poses a significant risk to patients, health-care workers, the community, and the environment.

Medical waste refers to the entirety of waste generated by health care 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.

The right investment of resources and commitment will result in a substantive reduction of disease burden and corresponding savings in health expenditures. The effective management of healthcare waste is an integral part of the EHNP and YCRP therefore this longtime investment has been launched to ensure appropriate management of healthcare waste within the boundaries of the supported HFs which by result will provide the protection for personnel, communities and environment from any adverse impact.

The detailed design of WTUs, Bill of Quantities (BOQ), studies, layouts, and implementation arrangements have been prepared based on the previously installed WTUs considering the independent Audit Report recommendations and shared with World Bank WASH and Environmental teams for validation and approval. Once operational, the proposed design of WTUs will have a minimal adverse impact on the environment and air quality as concluded by the independent consultant Audit Report briefed in section 2.1 and available in annex 8. The proposed WTU design will offer the best recommended option for final disposal of the generated healthcare waste in line with the World Health Organization guideline for appropriate management of healthcare waste that detailed in the Safe management of wastes from healthcare activities. Moreover, the WTU design as well as the offered waste treatment and disposal methods are in line with the WB guidelines and recommendations included in the Environmental, Health, and Safety Guidelines for Health Care Facilities, April 2007.

For the purpose of selecting the WTU location within each HF, Waste Treatment Units Site Selection Report as per the template in annex 2 has been prepared by Project Engineers for each supported facility and it includes the minimum requirements needed for the installation of WTU. Each report has been prepared after site visits to the supported HFs under EHNP and/or YCRP, the prepared and endorsed reports are included in annex 6. The selection of WTU location within the HFs considers the nuisance minimization from odor, noise and fumes resulted by the incinerator operation and the below requirements have been addressed, in which the lessons learned from audit report were considered:

- The site is within the HF boundaries and owned by the HF.
- The location shall be in adequate distance from the sensitive HFs building, healthcare areas and neighborhood. Such distance shall vary from one site to another considering the HF total area.
- Wind direction shall be considered in which the sensitive healthcare premises and adjacent communities' buildings (if any) shall be located upwind of the WTUs.
- No sewage, water lines or underground infrastructure is available within the selected location for WTUs. The availability of overhead cables shall also be considered.
- The selected location shall consider the patients and staff movement and crowded areas as well as providing adequate routes of waste transportation from the HF premises.

Final selection of sites in the targeted facilities conducted and the selection report for each site is available in the annex 6. The selection report includes in addition to the layout, photos, and stakeholder engagement summary the site-specific environmental and social requirements with the required mitigations needed.

The installation of WTU will be performed inside healthcare facilities under the MoPHP authority, management of waste generated from the healthcare facilities is the responsibility of each facility and it should meet the applicable standards. The selection of exact WTU location in each facility is implemented in coordination with each facility management and official authorization is obtained from each facility's management prior the start of civil work.

Two designs of the WTU have been proposed as detailed in section 3.2 and will be implemented in 50 HF, listed in in section 3.4. The selection of WTU type and targeted healthcare facility has been made based on the facility size, current waste management condition, allocated budget in addition to the site visits and recommendations of Projects engineers at governorate level that detailed in the site selection report.

The work activities expect to take from 30 to 50 working days in each supported HF in which the number of workers will vary based on the implementation stage. The expected maximum number of workers in any working day is 10 workers with the use of heavy machineries or equipment in the excavation, sites leveling and concrete work.

Once completed, the contractor will be responsible for the initial operation and startup of the waste incinerators. The necessary temperature tests, generated smoke status, and ash quality checks shall be conducted during the initial operation, and it shall meet the design criteria of WTU. Handover of the WTU of each HF shall be performed after the completion and acceptance of the necessary tests in attendance of the subproject Supervision Engineer, contractor representatives, and HF management**.**

As part of the contract scope and to ensure safe operation of the installed WTU, contractor shall install awareness materials as well providing training to all waste management workers and supervisors on the safe operation and maintenance of the installed incinerators and equipment.

Once the civil work and necessary tests completed, the WTU in each facility will be handed over to each facility's management. The operation of installed WTU at each site will be the responsibility of each facility's management where the applicable rules and regulations shall be followed. Contractor and as part of the subproject scope will be responsible for conducting training on the safe operation and maintenance of the WTU.

Since the WTUs will be installed within healthcare facilities supported by the Projects, the support will be continued to those facilities which includes logistics supply and training on the proper management and handling of waste during the Projects lifetime. Monitoring of the environmental and social requirements including the waste management process as well as the WTU operation will be performed by the TPM WHO monitoring, and evaluation as part of the overall Projects performance monitoring.

3.2. WASTE TREATMENT UNITS DESIGN

The WTUs will be implemented and installed entirely within the boundaries of the existing Healthcare Facilities listed in section 3.4 where no work will be implemented outside those boundaries.

Based on the lessons learned and recommendations of the Audit Report for the existing units as detailed in annex 8, the proposed design of WTUs has considered the implementation of necessary additional requirements which include:

- Adding up activated carbon filter at the exhaust chimney for each incinerator unit to prevent odor and smoke as well as to reduce the emission of pollutants that resulted from the incineration process.
- Installation of thermometer for temperature monitoring and incineration control.
- Chimney's height is 4 meters for the WTUs Type B and 5 meters for WTUs type A.
- Evaporation basin is included within the design of WTUs type A.
- Including the glass crusher in the design of WTUs type A.

3.2.1. TYPE A WASTE TREATMENT UNITS

This design will be implemented in 39 HFs and it includes the below main components where the main layout and diagrams are shown in the figures 1, 2 and 3. This design will be suitable for the treatment and disposal of the following types of healthcare waste:

I. Infectious waste.

II. Pathological waste.

III. Small amounts of pharmaceutical waste.

IV. Sharp waste.

Other types of waste that include radioactive waste, chemicals with heavy metals as well as the general waste shall be treated and disposed as per the applicable regulation in the country which is the responsibility of each HF management as part of their own general waste management system and considering the YCRP Infection Control and Medical Waste Management Plan requirements. Guideline on the waste management principles and incinerators operation is available in annex 7.

- **Waste Treatment Units Area and Services**

  The total area of this type is 100 m² where the incineration units, pits, evaporation basin, services, bathroom, doffing room in addition to washing and storage areas are located inside roofed, fenced area with controlled access points to prevent unauthorized entry. The general site includes glass crusher as well as plastic -shredder machines. Figures 1 and 2 provide further details on the design and layout of such. The generated healthcare waste will not be double handed at the WTU and waste segregation shall be performed at source. The design includes dedicated rooms for delivery only prior the final treatment or disposal (mentioned as sorting room) symbol L in the figure 1.

  Transportation of waste from healthcare facilities to WTU will vary from site to site, the cleaning of any containers can be performed in the washing room (symbol D in the figure 1). Drainage and wastewater will be directed to each facility's sewage network which is either public network or soak pits dedicated for each facility.

- **De Mont Fort Mark 8-A Incinerator**

  Dual chamber refractory structure incinerator with metal components in the form of waste loading door, ash removal door, and chimney. The chimney is 5 meters high equipped with rainwater protection and activated carbon filters dedicated for medical waste incineration units. For the

installed WTU and incinerators under the Projects, the operation and hazardous waste loading temperature will be maintained at 850 °C to 900 °C. Waste is loaded from waste loading door after preheating using kerosene oil as supplementary fuel. The temperature is maintained in the desired range by waste loading frequency. After waste burning in the primary combustion chamber the generated gases furtherly treated and oxidized in the secondary combustion chamber to reduce the amount of dioxin and furans resulting a lower atmospheric pollution gases. This type will effectively incinerate approximately 6-7 kg of infectious waste per hour. This design includes a dedicated safety box burner in which the chimney has similar characteristics of the main incinerator chimney.

Figure 3 includes the main components design and implementation requirements of the incineration unit.

- **Waste Pits** for final disposal of waste are **Organic waste pit**, **Ash pit** and **Sharp pit** where the roof and floor slab are made from reinforced concrete and the surrounding walls are built from solid blocks. The pits' covers will be surrounded by metal barriers to avoid any slip, trip, or fall hazards considering that the provided space is enough for the workers movement. Once filled, the waste pits shall be sealed by concrete. Waste removal is not expected nor recommended considering that the lifetime of WTU is 10- 15 years.

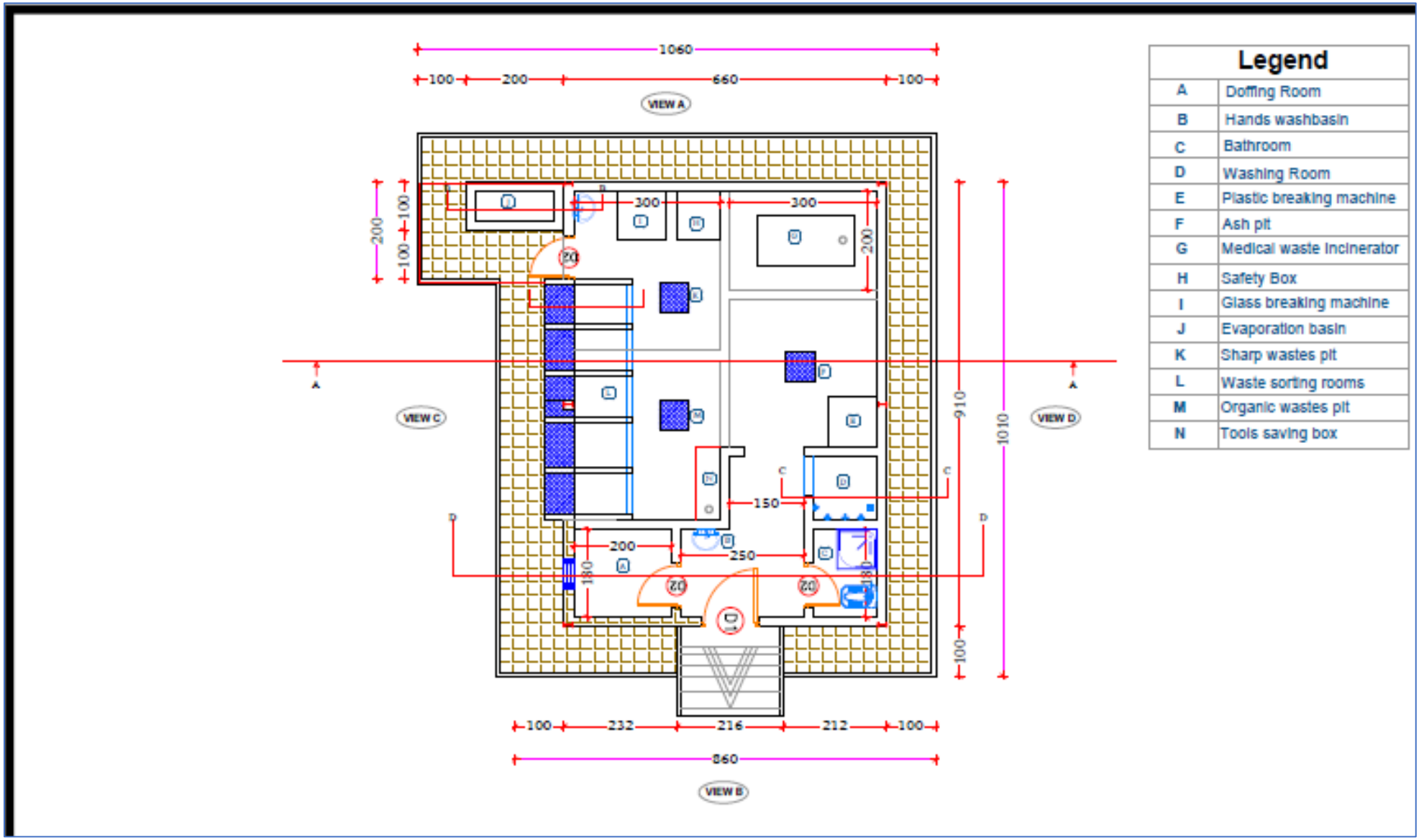


Figure 1 WTU Type A Layout

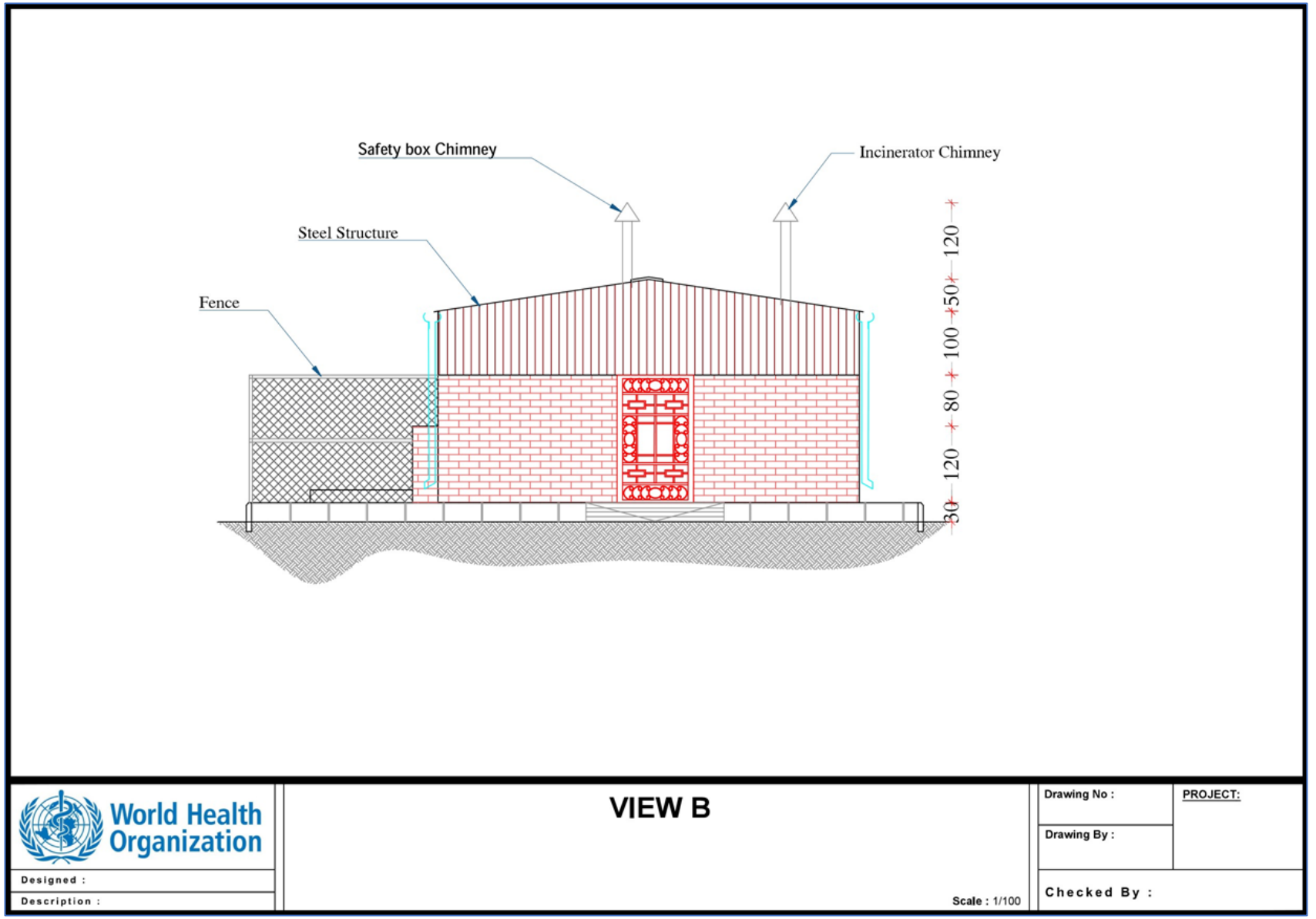


Figure 2 WTU Type A Side view

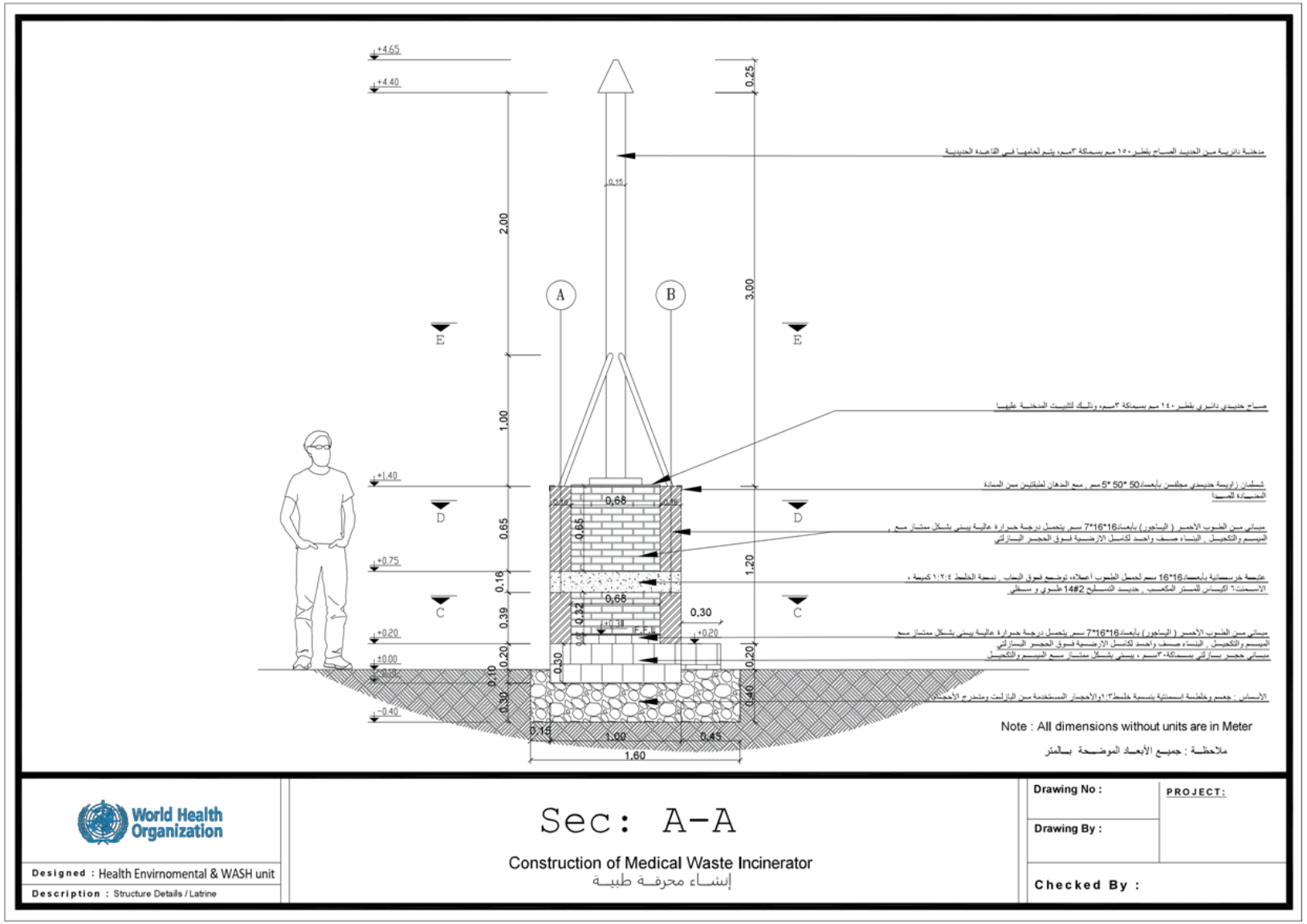


Figure 3 WTU Type A De Mont Fort Incineration Unit

3.2.2. TYPE B WASTE TREATMENT UNITS

This design will be implemented in 11 HFs and it includes the below main components where the main layout and diagrams are shown in the figures 4, 5 and 6. This design will be suitable for the treatment and disposal of the following types of healthcare waste:

I. Infectious waste

II. Pathological waste

III. Sharp waste

Other types of waste that include radioactive waste, chemicals with heavy metals as well as the general waste shall be treated and disposed as per the applicable regulations in the country which is the responsibility of each HF management as part of their own general waste management system and considering the YCRP Infection Control and Medical Waste Management Plan requirements.

- **Waste Treatment Units Area and Services**

  The total area of this type is 45 m² where the incineration units, pits and services areas are located inside roofed, fenced area with controlled access points to prevent unauthorized entry. Figures 4 and 5 providing further details on the layout of such.

- **Intermediate Metal Incinerator**

  Dual chamber burner made from mild steel (low carbon steel) with minimum of 3 mm thickness which can be locally structured. This metal structure incinerator includes waste loading door, ash removal door, and chimney in addition to the primary and secondary combustion chambers. The chimney is 4 meters high equipped with rainwater protection and activated carbon filters dedicated for medical waste incineration units. Combustion temperatures to more than 850 °C have been achieved during tests which is sufficient to reduce the risk of formation of toxic flue gases and pollutants.

  This dual chamber metal incinerators have similar loading, burning, and ash removal characteristics of the De Mont Fort incinerators described in 3.2.1.

  Figure 6 includes the main components design and implementation requirements of the incineration unit.

- **Waste Pit** for final disposal of ash and Sharp waste where roof and floor slab are made from reinforced concrete and the surrounding walls are built from solid blocks. Once filled, the waste pits shall be sealed by concrete. Waste removal is not expected nor recommended considering that the lifetime of WTU is 10- 15 years.

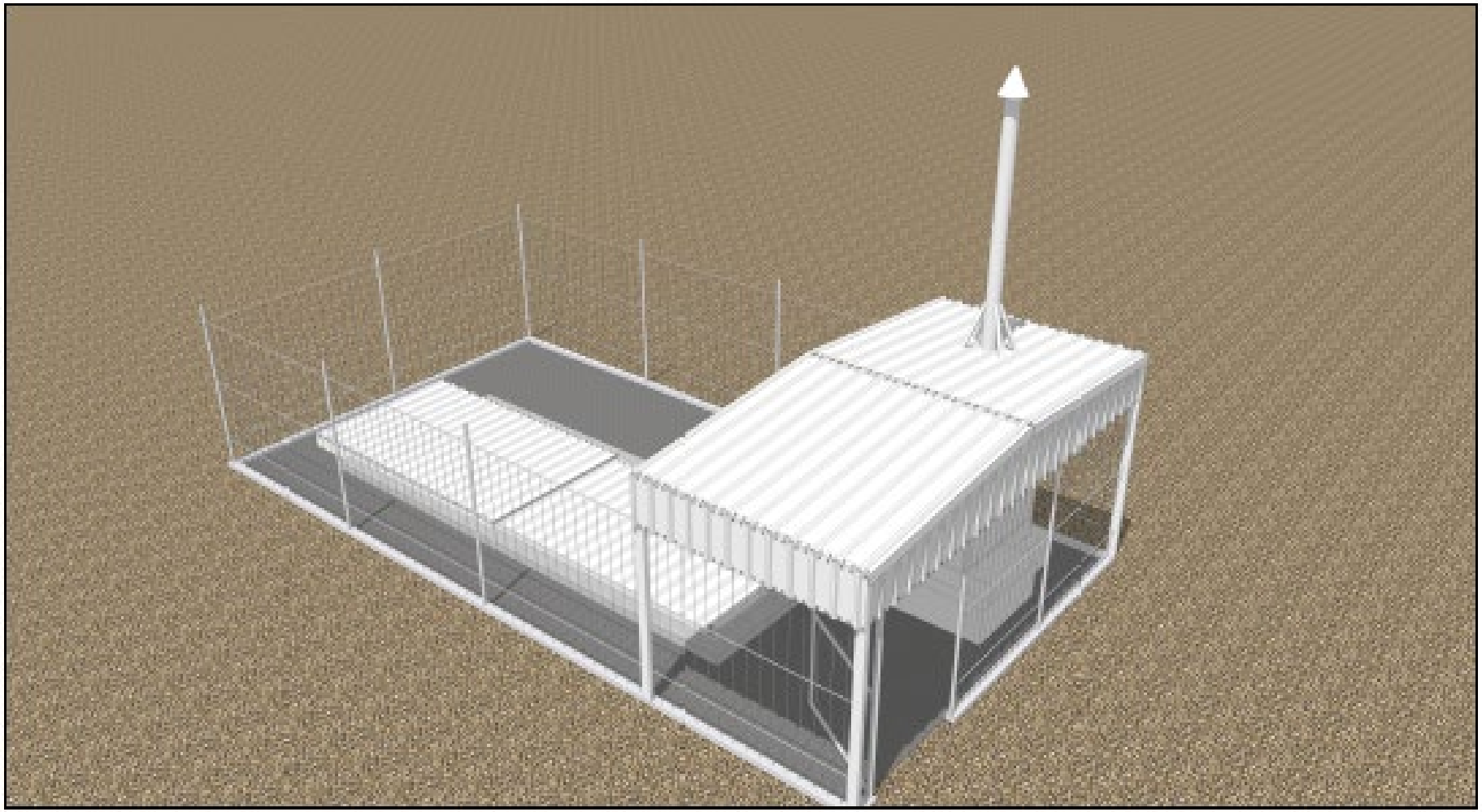


Figure 4 WTU Type B General View

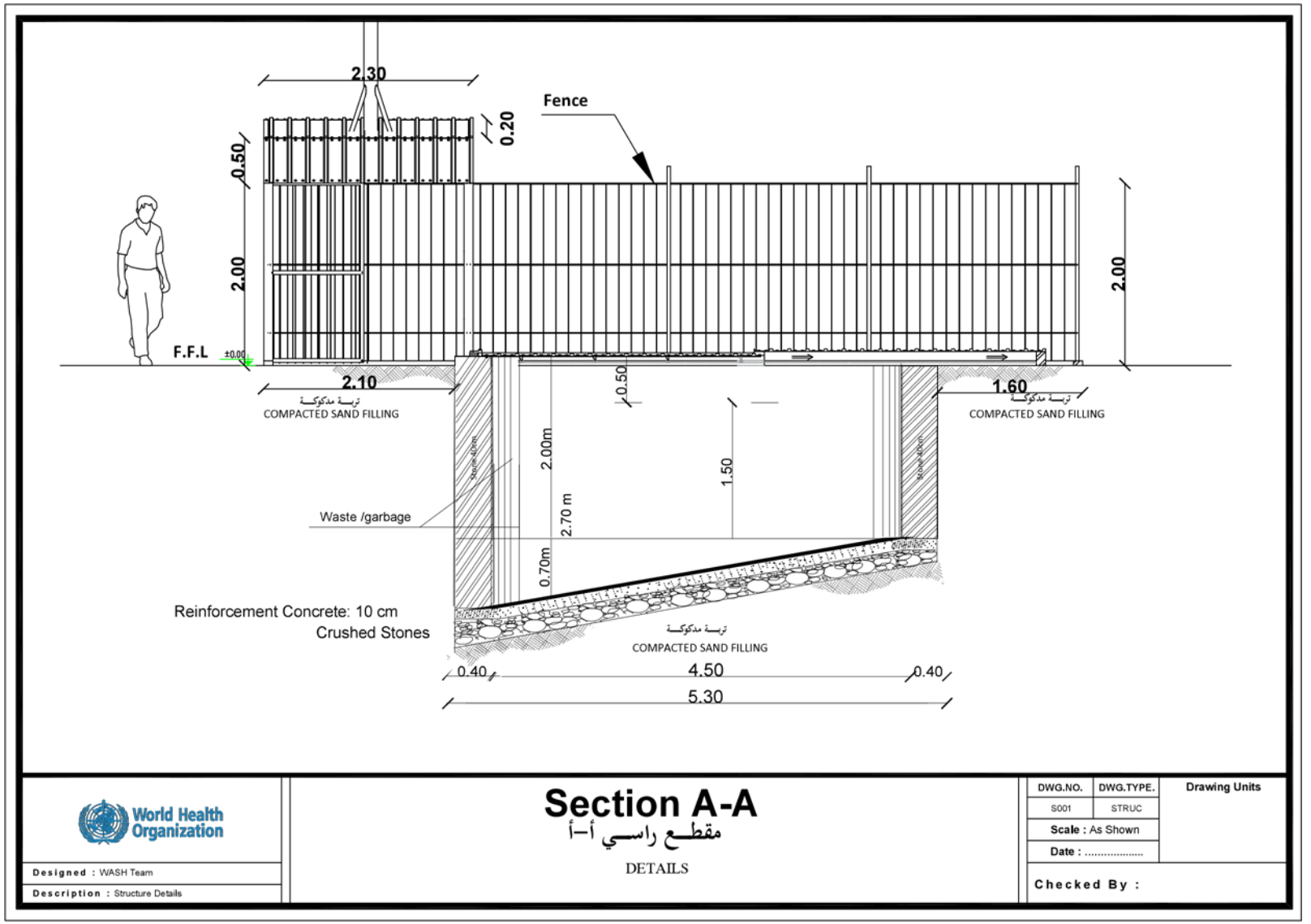


Figure 5 WTU Type B Layout

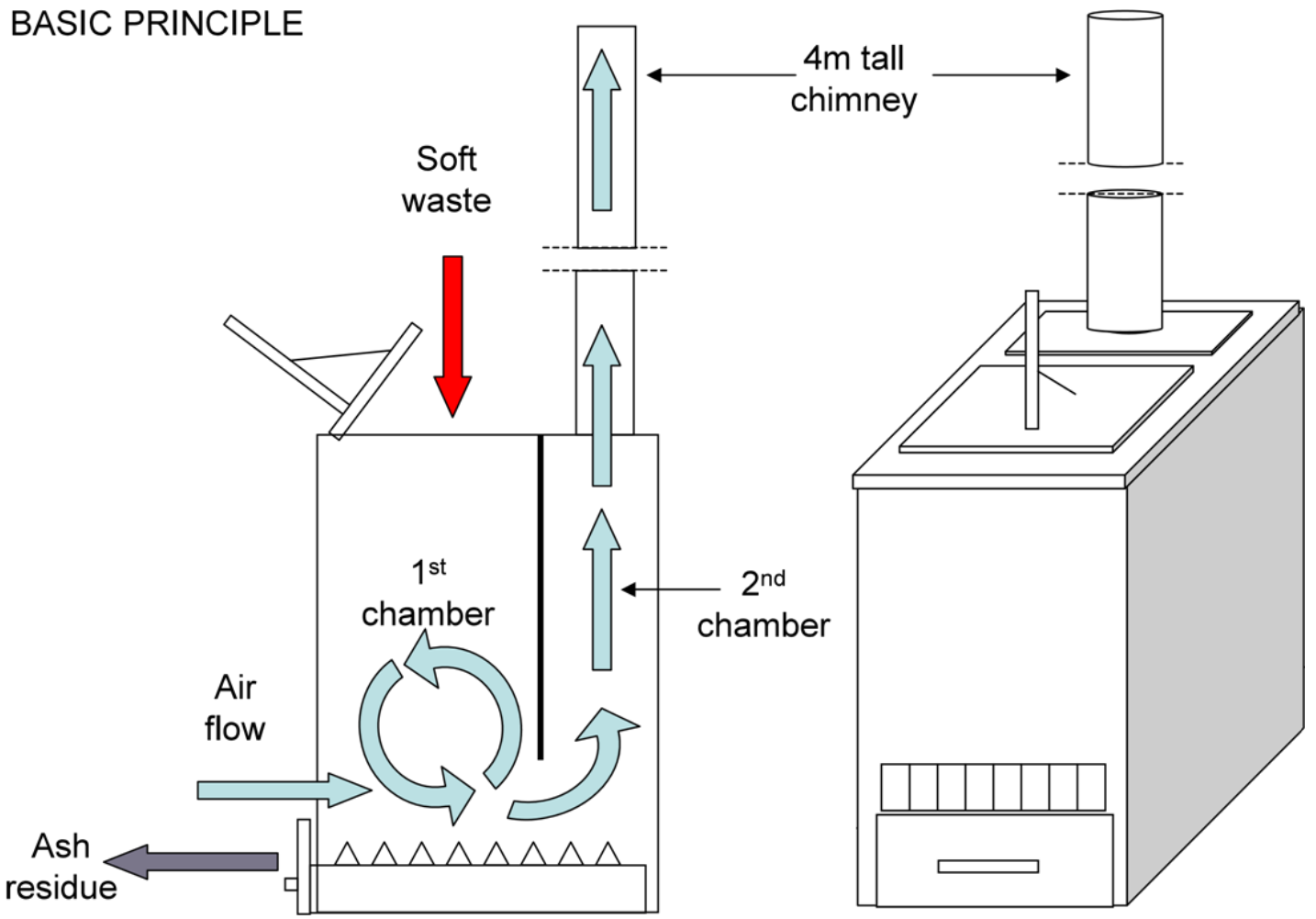


Figure 6 WTU Type B Intermediate Metal Incineration Unit

3.3. SUBPROJECT IMPLEMENTATION TIMEFRAME

		Waste Treatment Units Installation Timeframe in months															
No	Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Assessment – Initial selection of sites and obtaining the necessary approvals																
2	Preparation of the detailed BOQs / Technical clearance																
3	Tendering Process, evaluation of bids																
4	Contracting and sites handover																
5	Installation of the WTU and civil work																
6	Necessary tests Implementation and handover to the HF management																
7	Defects liability period																

3.4. HEALTHCARE FACILITIES

The updated list of HFs supported under EHNP and/or YCRP in which the proposed WTUs will be installed is detailed in below tables. Those facilities have been selected considering the TPM reports, existing waste management conditions, focal points in the governorates recommendations as well as the healthcare authorities' recommendation. The site-specific information and recommendations for each healthcare facility are included in the selection reports available in annex 6.

The selection of WTU design type (A or B) versus the healthcare facility has been made based on the facility size, current waste management condition, allocated budget in addition to the site visits and recommendations of Projects engineers at governorate level.

No	Governorate	District	Name of Hospital	Support	WTU Design
1	Al-Hodeidah	Bajil	Bajil Hospital	EHNP	Type A
2	Hajjah	Hajjah	Al-Jumhouri Hospital	EHNP	Type A
3	Saada		Al-Talh Hospital	EHNP	Type A
4	Hajjah	Khayran Al-	Khayran Al-Muharraq H.	EHNP	Type A
5	Hajjah	Qafl Shammar	Qafl Shammar Hospital	EHNP	Type A
6	Al-Mahweet	Al-Mahweet	Al-Jumhouri Hospital	EHNP	Type A
7	Raimah		AlThulaya hospital	EHNP	Type A
8	Ibb	Ibb	Al-Thawra Hospital	EHNP	Type A
9	Taiz	Taiz	Al-Nashmah hospital	EHNP	Type A
10	Sana'a Gov.	Bani Matar	Matna 26th Sept H.	EHNP	Type A
11	Amran	Amran	22 May General Hospital	EHNP	Type A
12	Dhamar	Dhamar	Dhamar General H.	EHNP	Type A
13	Al-Baidhah	Baidhah City	Al-Thawra Hospital	EHNP	Type A
14	Al-Baidhah	Rada'a	Radaa Hospital	EHNP	Type A
15	Al-Jawf	Al-Hazm	Al-Hazm Hospital	EHNP	Type A
16	Aden	Al-Sheikh	AL-Sadaka Hospital	EHNP	Type A
17	Lahj	Al-Hota	Ibn Khaldoon	EHNP	Type A
18	Al-Dhalee	Al-Dhalee	Al-Wahdah Hospital	EHNP	Type A
19	Abyan	Khanfar	Al-Razi Hospital	EHNP	Type A
20	Hadramout	Al-Mukalla	Ibn Sina Hospital	EHNP	Type A
21	Hadramout	Sayoon	Sayoon Hospital	EHNP	Type A
22	Hadramout	Tarim	Shibam Hospital	EHNP	Type A
23	Hadramout	Al-Katin	Al-Katin Hospital	EHNP	Type A
	Hadramout		Alhayah Hospital	EHNP	Type A
24	Al-Mahara	AlGhaidhah	Al-AlGhaidhah Hospital	EHNP	Type A
25	Shabwah	Ataq	Ataq Hospital	EHNP	Type A
26	Shabwah	Maifaa	Azzan Hospital	EHNP	Type A
27	Shabwah	Baihan	AL-Dofiah Baihan H.	EHNP	Type A
28	Shabwah	AsSaid	AsSaid Hospital	EHNP	Type A
29	Lahj	Yafaa	14 October Hospital	EHNP	Type A
30	Mareb	Mareb City	Mareb General Hospital	YCRP	Type A
31	Ibb	Jiblah	Jiblah Hospital	YCRP	Type A
32	Dhamar	Maaber	Alwehdah hospital	YCRP	Type A
33	Taiz	AlTorbah	Khalifah hospital	YCRP	Type A
34	Taiz		Althawrah hospital	YCRP	Type A
35	Taiz		Aldhabab hospital	YCRP	Type A
36	Mareb		New University hospital	YCRP	Type A

No	Governorate	District	Name of Hospital	Support	WTU Design
37	Mareb		Alhazmah hospital	YCRP	Type A
38	Lahj		Alanad hospital	YCRP	Type A
39	Abyan	Zunjubar	Zunjubar hospital	YCRP	Type B
40	Sana`a	Bani Matar	AlHumiat Hospital	YCRP	Type B
41	Ibb	Ibb City	Alsahoul IU	YCRP	Type B
42	Dhamar	Dhamar City	Faculty of Education	YCRP	Type B
43	Hajjah	Hajjah City	Vocational institute	YCRP	Type B
44	Raimah	Bilad Altaam	AlMithaq hospital	YCRP	Type B
45	Taiz	AlMakha	AlMakha hospital	YCRP	Type B
46	Socotra		AlOmoma Center	YCRP	Type B
47	Aden		Alamal Center	YCRP	Type B
48	Hadramout		Alfalak AlHumiat hospital	YCRP	Type B
49	Sa`da	Quhza	Quhza Medical Center	YCRP	Type B
50	Lahj	AlHabeelin	Radfan Professional Center	YCRP	Type B

4. INSTITUTIONAL ARRANGEMENTS AND RESPONSIBILITIES

4.1. EHNP / YCRP PROJECTS ORGANIZATION

The Project Management Unit (PMU) within the WHO is responsible for the overall implementation of the EHNP and YCRP activities in Yemen in addition to liaise with WB the implementation arrangements and progress. Environmental and social team within the PMU is responsible for ensuring all applicable environmental and social requirements are well addressed and implemented and the team consists of environmental and social safeguards officers, gender based violence GBV officer and grievance mechanism Officer. WASH team within the PMU is responsible for the planning and implementation of the WASH and civil work interventions in the supported facilities as well as maintaining the necessary coordination with the MoPHP authorities and WB team.

4.2. ROLES AND RESPONSIBILITIES

Entity / Position	Responsibilities
PMU WASH Team	I. Responsible for the preparation / review of the design, documentations, bill of quantities and contracting arrangement for the subproject. II. Responsible for following up of the subproject implementation activities as per the proposed design and timeframe and to ensure adequate cooperation with the official MoPHP and facilities authorities. III. Closely following up the onsite implementation and maintaining the coordination with the Supervision Engineers. IV. Providing the necessary WASH and waste management supplies to the supported facilities during the operation of the WTUs.
Supervision Engineer	I. Assigned from the PMU side (1-2 Supervision Engineer in each governorate and they will be responsible for WTUs implementation within their respective governorates) to follow up onsite the implemented activities and to ensure the work performed by the contractor is in line with the proposed design and the necessary environmental and social requirements are adequately addressed. II. Regular reporting to the PMU shall be maintained by the Supervision Engineer on the subproject implementation status as well as the level of compliance to the environmental and social requirements detailed in this plan. Annex 5

Entity / Position	Responsibilities
	compliance report shall be prepared and filled in weekly basis based on the site observations. III. The Supervision Engineer, in collaboration with the facility and MoPHP official authorities, will be responsible for sites hand over to / from the contractor upon the work start / completion.
PMU Environmental and Social Safeguards Officers	**Civil Work Phase** Will oversee the environmental and social requirements implementation as stated in the projects ESMF and as per the present ESMP during the various implementation stages of this intervention. Responsible for maintaining the communication and visits to the subproject sites to verify compliance where needed. Review the regular environmental and social compliance reports, as per the annex 5 template, that will be issued by onsite engineers. Evaluate the findings and issue the recommended corrective or preventive actions. **WTUs Operation Phase** Follow up the implementation of the Projects environmental and social requirements including the medical waste management during the operation of WTU as part of the overall compliance monitoring in the supported facilities. Review the TPM reports and follow-up findings on the Environmental and Social requirements and in particularly those related to the healthcare waste management and the operation of WTUs in the supported facilities.
PMU GBV Officer	Responsible for the implementation of the GBV requirements as stated in this plan in addition to follow up, address and resolve any GBV issues during the civil work as well as during the Projects lifetime.
PMU GM Officer	Responsible for the overall GM process ensuring all related grievances are recorded, followed up and resolved accordingly during the civil work as well as during the Projects lifetime.
HFs Management	**Civil Work Phase** I. Selecting in coordination with Supervision Engineers the location of WTU in each facility as per the Projects requirements that detailed in annex 2 in addition to providing the necessary official permission for the subproject implementation. II. Responsible for following up the onsite implementation of WTU in coordination with the supervision engineer. III. Ensure the performance quality and handing over the site to / from the contractor in coordination with the supervision engineer. **WTUs Operation Phase** IV. Responsible for the operation of WTU as part of the overall waste management process in the facility including assignment of workers (civil servants). V. Ensure compliance to waste management requirements detailed in the applicable guidelines including waste segregation at source in addition to ensure safe operation and maintenance of the WTUs.

Entity / Position	Responsibilities
Contractor	I. Responsible for onsite implementation of the Environmental and Social requirements in compliance with the contract and the ESMP as well as the applicable rules and regulations. II. Contractor shall nominate and hire qualified and trained personnel to implement the subproject activities including Environmental, Social, Health and Safety (ESHS) Officer at each site. III. The contractor shall ensure all workers involved in the subproject implementation are trained and covered with insurance for any work-related injuries or incidents. IV. Contractor shall provide training on the safe operation and management of the WTU to HF waste management staff as well as installing the related awareness materials. V. Contractor is responsible for the initial operation and startup of the waste incinerators. The temperature tests and generated smoke, and ash quality status shall be conducted during the initial operation and result values shall meet the design criteria of WTU.
Contractors ESHS Officers	I. ESHS officer assigned by contractor for each site is responsible for following up closely the activities onsite and to ensure adequate protection for the Environment, Assets, Communities, and Workers form any adverse impact that might be resulted from subproject implementation. II. Responsible for the provision of necessary awareness and training to the contractor workers on the Occupational Health and Safety (OHS), Waste Management and other Environmental and Social requirements.
Third Party Monitoring	**Civil Work Phase** I. Check the implementation arrangements and safeguards compliance during the civil work activities. **WTUs Operation Phase** I. Follow up as part of the YCRP and EHNP overall projects monitoring the safeguards requirements implementation at the supported facilities including the monitoring of healthcare waste management.

5. COMMUNICATION AND CONSULTATION

5.1. STAKEHOLDER ENGAGEMENT AND INFORMATION DISCLOSURE

Stakeholders Engagement Plan (SEP) for the YCRP is already developed by WHO in which the Project stakeholders have been identified along with the engagmenet requiremenets during the various stages of activities implementation. SEP requirements will be applicable for the supported facilities under EHNP in which this subproject activities will be implmeneted. As per the SEP, timely communication with the Project stakeholders on any planned activities is needed. SEP details the communication requirements and methods including public meetings, mass/social media communication, site visits or any alternative online methods considering the COVID-19 pandemic and restriction. Moreover, the project Grievance Mechanism is also detailed in the Project SEP in which the main channels applicable for this subproject is available in section 6 of this ESMP. The SEP requirements were considered during this subproject planning and preperation stages including during the preperation of this ESMP.

The subproject stakeholders as classified below were approached during the various preperation stages of this subproject and additional comminication will be maintained during the implementation and operation of the proposed WTU under this subproject. The engagement activities implemented during the various preperation stages for this subproject are detailed in section 5.3 of this ESMP, additional information on the methods, numbers or types of consulted stakeholders and topics discussed are available in annex 3. For each facility included under this subproject, the details of personnel approached as well the specific concerns and requirements raised are included in the site specific environmnetal and social requirements available within annex 6 of this ESMP.

The Project related information and activites including the environmnental and social documents are disclosed in the WHO Yemen country office social media channels and website. Accordingly, this ESMP will be translated to Arabic and both English and Arabic versions will be disclosed in the the WHO Yemen country office website. Moreover, the Project GM channells are regularley announced through the WHO social media channels and are posted within the supported health facilities permises for stakeholder to send their complaints or suggestions about the Project performance and supported activites. These GM channels will be posted around the subproject areas so any community members, healthcare workers or contractor workers can identify the reporting channels of any complaints or suggestions.

5.2. SUBPROJECT STAKEHOLDER CLASSIFICATION

This subproject has a broad range of stakeholders, who directly or indirectly affected by the planned activities. These stakeholders are broadly categorized in to the following two categories in accordance with Environmental and Social Standard ESS 10 guidelines.

Project-affected parties (PAPs)

PAPs are defined as “those likely to be affected by the project because of actual impacts or potential risks to their physical environment, health, security, cultural practices, well-being, or livelihoods”. This category may include individuals or groups, including local communities. They are the individuals or households most likely to observe changes resulted from the subprojects environmental and social impacts.

Within the scope of this subproject, there are two main categories for the project-affected parties, namely the local communities residing in the project areas and the health authorities.

Local Communities and healthcare workers residing in the subproject areas

This category of PAPs includes the people identified based on their geographical location in the vicinity of the subproject sites, and the healthcare workers who will benefit from the improvement of the waste treatment units after the implementation. The local communities who will benefit from the improved Health services, are considered as indirect beneficiaries of the current project.

Healthcare authorities

Category of PAPs also includes the MoPHP, GHOs, DHOs, and Health Facilities, and they are identified based on their interest and influence on the project and Health facilities.

Other interested parties

There are several other interested parties with stakes in the project including project staff; supervision engineers; contractors and their workers as well as the non-governmental and humanitarian organizations.

5.3. STAKEHOLDER ENGAGEMENT DURING PLANNING, PREPARATION AND DESIGN

The design of WTUs, layout and BOQ were determined based on the independent Audit Report recommendations considering the WB WASH and Environmental teams’ validation and approval. This design is considered as an environmentally friendly incineration and disposal method where the adverse impacts on environment are minimal both during the implementation and operation phases. The stakeholder

engagement activities conducted during the preparation and design phases of this subproject including during the preparation of this ESMP focused among others on the subproject details, implementation arrangements, targeted facilities, expects benefits as well the associated risks, impacts and mitigation measures.

5.3.1 CONSULTATION WITH MOPHP AND HEALTHCARE AUTHORITIES

The waste management status across the supported facilities under EHNP and/or YCRP was main topic of discussion between the WHO staff, PMU and the official health authorities during the past few years. The identifying / implementing long terms solution to improve the current condition of waste management across the supported facilities was essential to overcome the final waste disposal challenges faced by the facilities management in which several findings were regularly raised within the TPM reports or during the Projects staff visits to the supported facilities. Within this context and once the proposed WTU design evaluated and recommended by the independent audit report, the Project team established the necessary communications on the proposed WTU design and appropriate locations requirements (Jan 2021 to April 2021) with the health facilities management. Several site visits by Project teams and Engineers performed to identify the initial list of facilities suitable for this type of treatment units. Meanwhile, coordination meetings were conducted by the Project team with healthcare authorities at central level in which the design details, implementation requirements and expected benefits with the associated risk and impacts were discussed. The following main topics/outcomes were determined during this initial consultation on the subproject implementation, the involved personnel and entities of this consultation stage is available in annex 3:

- Determination of the intervention components including the applicable locations and initial list of facilities suitable for this type of WTU.
- Evaluating the advantages and expected outcomes of the intervention.
- Evaluating the risks, impacts, and any recommended mitigations.
- Evaluating the overall satisfaction and acceptance of the proposed WTU design within different level of authorities.
- Gathering recommendations and suggestions that could improve the design and implementation.
- Identifying the initial WTU locations within the supported HFs.

5.3.2 CONSULTATION DURING WTU LOCATIONS IDENTIFICATION

To identify the exact WTU location within the supported facilities, several conditions were determined by the Project team as prerequisite to ensure the installed units will have the minimum impacts on the healthcare workers, communities and environment. These set of requirements as included in section 3.1 of this ESMP were reflected in standard template as of annex 2 (Waste Treatment Units Sites Selection Report Template) to help the Project Engineers to identify the suitable location of WTU in coordination with the health facilities management. To identify WTU locations and ensure all requirements are met for each facility under this subproject the Engineers responsible for the determination the WTU locations were selected from the MoPHP staff and the additional awareness on the requirements were conducted by the Project team. Several site visits conducted by the nominated engineers to the targeted facilities in which the annex 2 has been filled and the suitable location of WTU within the facilities has been selected in coordination with the facility personnel and the exact locations were endorsed the responsible authorities. Based on the issued information for each site the annex 6 site specific environmental and social requirements have been prepared for each facility under this subproject.

The following were covered with each facility management and healthcare workers during the engineers site visits to the supported facilities:

- Briefing introduced on the WTU design, layout, components, waste incineration and disposal arrangements.
- Prerequisite and necessary conditions for the WTU location selection within each facility.
- Details of the risks, impacts and recommended mitigations associated with the establishment and operation of the WTU were discussed.
- Necessary arrangements for civil work implementation and the recommended mitigations by the Projects.
- Implementation timeframe and the expected benefits with the adverse impacts that could be resulted were discussed.
- The projects GM principle and channels were communicated to the different parties involved in the with encouragement from the projects side to use such mechanism for any suggestions or issues related to the EHNP/YCRP and particularly to the WTUs installation.

To ensure inclusive consultations with the PAP, additional engagement has been performed at facility level in which the WTU details, risks and impacts were introduced to wider beneficiaries within each healthcare facility. The details of involved personnel in each site, dates, and the specific concerns raised are available in annex 6 for each facility. Such consultations were performed by the supervision engineers with the support and guidance of the Project team in which the following has been considered:

- The PMU team trained the engineers to assure the meaningful consultations will be conducted within the facilities covered by this subproject.
- The methods of engagement that were used are interviews and meetings. The project tries to assure meaningful consultations with the affected parties by involving the different categories of HFs' staff includes Management staff, waste management workers, and other administrative workers.
- People from the HF's vicinity, patients, and community members have been involved to the possible extent.
- The topics discussed were: 1) Project's financing and implementation; 2) The purpose of the consultations; 3) Discussing the environmental and social negative impact and the risks and concerns of the current waste treatment; 4) The purpose and advantages of the Waste treatment units have been discussed including the technical specifications of Waste treatment Unit, 5) The concerns, and suggestions in regards the WTU establishment; 6) Arrangements with contractors; and 7) Grievance Mechanism and its purpose were discussed and the GM channels were disclosed with them.

Summary of the stakeholder engagement and consultation outcomes are listed in the below table, mitigation measures for some specific concerns raised already integrated in this ESMP. As mentioned earlier the specific concerns, consulted parties' details, dates of consultations as well as any other details are available with the annex 6 for each facility included within this subproject.

Common concerns and considerations.	Stakeholders' common suggestions	Mitigation Measures
➢ Increase the awareness of the HF's personnel.	✓ sensitize the health facility staff on the process of sorting, collection, and transportation. ✓ Awareness that shows the dangers of waste ✓ Awareness of the staff, especially the cleaners.	• Under YCRP and EHNP activities' complementarity, this activity is covered under other activities and is taking place at this point of time. • Currently YCRP and EHNP project are installing the waste management and Hygiene promotions posters and banners.

Common concerns and considerations.	Stakeholders' common suggestions	Mitigation Measures
		• Training on MWM is being conducted by YCRP and EHNP for Health Care Workers responsible for management of waste.
Some of the cleaning workers do not have sufficient knowledge of the correct burning method in the new incinerator ➢ Operators are not trained on waste disposal ➢ Inability to control and operate the incinerator. ➢ There are instructions on how to dispose of waste.	✓ Train operators on how to operate and maintain the incinerator. ✓ Waste sorting and disposal in the incinerator instructions ✓ Conducting incinerator's training on SOP ✓ Instructions for operations ✓ Instructions on providing appropriate treatments for burning chemicals	• Contractors are going to train the Waste Management Workers on the Standard Operation Procedures. • Instruction posters on the proper segregation and disposal will be installed by the contractor.
Designing consideration ➢ The incinerator's entrance may affect the walk of patients and visitors ➢ The effect of smoke on respiratory patients. ➢ Rainwater flow ➢ Size	✓ Ensure the entrance does not affect the walk of patients and visitors ✓ The location of the incinerator should be downwind ✓ Considering the rainwater flow during the site sections. ✓ Making an incinerator commensurate with the size of the hospital ✓ The incinerator shall have a large area for proper disposal of waste	All concerns have been considered in the improved designed and reflected in the site specific ESMPs during the WTU location selection.
➢ Continuous follow-up and maintenance.	✓ Periodic maintenance and awareness	Maintenance needs are limited to replacement of filters and provide supplies like chlorine and PPEs for workers. And this will be covered by the YCRP and EHNP during the Projects lifetime.
➢ Maintenance issues.	✓ Provide the necessary materials such as sterilizers and filters periodically whenever the need arises ✓ Maintain the incinerator regularly	
➢ Ensure the availability of collecting room ➢ Allocation of dedicate team for incinerators operation from the facility staff	✓ Medical waste collection room. ✓ Appointing an independent department in the health facility specialized in waste management. ✓ Assign administrative tasks to deal with environmental and health waste, starting with the director of the health facility, then the departments, and ending with the cleaners. ✓ Determining a clear workflow for the team trained to operate the incinerator at the appropriate working times and hours for the community and the hospital administration	The project is going to sensitize and encourage the management as a complementary action with installing incinerators, awareness, and IPC training as follow: 1- To establish and put more attention on implementing the waste management procedures and assigning clear tasks. 2- Dedicated incinerator team. 3- Dedicated MWM members. 4- Engagement with the community regarding the incinerator operation.

Common concerns and considerations.	Stakeholders' common suggestions	Mitigation Measures
➢ The fumes emitted during the operation of the incinerator and its effect on nearby people. ➢ The incinerator did not absorb the existing waste.	✓ Filters will be installed to reduce smoke ✓ Increasing the length of the chimney and making filters in it to reduce the fumes emitted. ✓ The new waste treatment unit to contain solutions and tools that limit the emissions, such as carbon filters, plastic shredding machines and glass crushing machines, and unit's design is environmentally friendly. ✓ The new incinerator must have a high temperature.	All these concerns are addressed in the new design: 1- Filters added. 2- Height of chimney is 5 meters. 3- Plastic shredding machines and glass crushing machines are added. 4- All WTU installed under the Projects the temperature shall reach more than 850 C before start loading and burning of the infectious waste which would avoid dioxin emission to the environment, also the WTU will equipped with the thermometer to monitor the temperature.

The requirements and mitigations indicated in this plan have been addressed with the EHNP/YCRP staff, WASH team members, supervision engineers and WASH supervisors at governorate level and will be further communicated to the contractors and all involved parties including the health facilities management.

5.4. STAKEHOLDER ENGAGEMENT DURING SUBPROJECT CIVIL WORK / OPERATION PHASE

Communication with the involved parties, as classified in the YCRP SEP and in the previous sections, during implementation will be maintained to ensure safe and smooth execution of the subproject components within the targeted HFs as guided by the YCRP SEP. The Projects team is reaching the targeted facilities and beneficiaries by site visits, WHO representatives in the governorates, phone, or online interviews and through coordination with the Projects engineers/focal points who will be present during the WTU civil work and operation.

EHNP/YCRP WASH and safeguards team will maintain the necessary arrangements with contractors, Supervision Engineers, MoPHP and HFs management to follow up closely the activities implementation as per the proposed design taking in consideration the safeguards and mitigation requirements indicated in this ESMP as well as the EHNP and YCRP ESMFs. The stakeholder engagement activities during the civil work as well as the operation of the installed WTU will be implemented accordingly and communities' concerns will be addressed by the Project team.

The implementation of waste management requirements including adequate segregation, safe operation of incinerators is the responsibility of facilities management and this will be monitored by the TPM in addition to the EHNP/YCRP responsible officers. The PMU team will maintain regular and continuous coordination with the facilities' management to identify any gaps and to implement any corrective actions.

6. GRIEVANCE MECHANISM GM

6.1. INTRODUCTION

The main objective of a Grievance Mechanism GM is to assist to resolve complaints and grievances in a timely, effective, and efficient manner that satisfies all parties as defined in the YCRP SEP. Specifically, it provides a transparent and credible process for fair, effective, and lasting outcomes. It also builds trust and cooperation as an integral component of broader community consultation that facilitates corrective actions.

The WTUs within the supported HFs will be implemented under the EHNP and/or YCRP and the projects GM channels have been previously disseminated and circulated via several means including the social media channels and posts at the supported facilities. Those channels will be made available to receive any complaints or requests related to the proposed intervention in the supported HFs. The GM channels will be posted by the contractors and visible around each facility work areas and this will be communicated and ensured by the Supervision Engineer. The GM channels will be posted around the subproject site during and after the WTU implementation process. In addition, regular communication with stakeholders will be maintained and will include the GM channels dissemination.

Contractor at each site shall undertake the primary responsibility for his staff grievances and appropriate mechanism shall be provided by each contractor. Work-place grievances should be addressed by each contractor in a timely manner and the Supervision Engineer in each site shall verify the implementation of this requirement in each site.

6.2. GRIEVANCES MANAGEMENT

The projects' GM channels detailed hereafter are managed by PMU GM officer responsible for overall management to ensure adequate follow-up and closure of all received grievances. The grievances will be referred to the relevant officer in the organization and the unresolved complaints will be escalated to the projects' management level (or WHO management level) as appropriate.

The GM is accessible to a broad range of projects stakeholders who are likely to be affected directly or indirectly by the subproject. These will include beneficiaries, community members, subproject implementers/contractors, civil society, media—all of whom will be encouraged to refer their grievances and feedback to the GM. All stakeholders could submit their comments or grievances anonymously through the applicable channels and they also could request their name to be kept confidential.

The grievance raised are recorded within one day. While the timeframe for redress will depend on the nature of the grievance, health and safety concerns in work environment or any urgent issues will be addressed immediately. The complainant can appeal if he is not satisfied and reopen the complaint.

GM process is detailed in the following chart:

EHNP- GM channels	
Toll free number	**8004090**
Email	yemgrmehnp@who.int
Complaint Boxes	Inside the HF
YCRP- GM channels	
Toll free number	**8000844**
Email	yemgrmcovid19@who.int
WhatsApp / SMS	776999014

6.3. SEA/SH GRIEVANCES

SEA/SH related grievances related to the subproject that received through the GM channels listed above will be handled by the projects GBV officer with strict confidentiality in accordance with the Good Practice Note on Addressing Sexual Exploitation and Abuse in World Bank-Financed Projects[1]. This will include referrals to GBV service providers, if the survivor approves, to support as appropriate.

Relevant training has been provided on the GBV SEA/SH grievances appropriate handling method as well as the referral channels. This included training on how to collect SEA/SH cases confidentially and empathetically (with no judgement). The guidelines on how to address SEA/SH grievances in accordance with Good Practice Note on Addressing Sexual Exploitation and Abuse in World Bank-Financed Projects are integrated in the training provided for any focal points that are part of the SEA/SH grievances mechanism and resolution mechanism.

WHO's fundamental principles of integrity, accountability, independence, impartiality, respect, and professional commitment are documented in the Code of Ethics and Professional Conduct. WHO has no tolerance for physical violence and sexual harassment and has clear guidelines and recourses for its staff and collaborators to make available reporting and protection mechanisms and address any acts of physical violence and sexual harassment. The objective of this policy is to address the behavior of WHO staff and collaborators towards third parties and to protect vulnerable populations in the countries that WHO serves from sexual exploitation and abuse at the hands of WHO staff and collaborators in order to ensure the integrity of WHO's activities.

WHO makes available channels to facilitate the reporting of such violations, giving priority to SEA, and is committed to ensuring prompt and effective response to SEA reports (i.e. investigate and sanction as appropriate), not retaliating and defending/protecting staff who come forward. In addition, WHO is committed to acting to prevent SEA from occurring in the first place by putting in place a communication and raising awareness plan, and monitoring/tracking information concerning SEA.

Any suspect misconduct or SEA issues could be reported by the staff or beneficiaries to WHO's Integrity Hotline which facilitates the reporting across the Organization. It is an independent service which takes in reports in confidence and, where warranted, **anonymously**. A web intake form and an email address (ethicsoffice@who.int) are available to report SEA issues and it will be dealt as a priority, and WHO's relevant Regional Directors and the Director-General will be informed immediately upon receipt of such a report.[2]

7. SUBPROJECT ENVIRONMENTAL AND SOCIAL MANAGEMENT

7.1. INTRODUCTION

Waste management across the supported facilities is considered an essential component of the EHNP and YCRP intervention where the necessary supplies and training to ensure safe and adequate management of waste are delivered periodically. In other hands, the lack of adequate infrastructure in HFs (mainly the waste incineration units and/or burial pits) are the main challenges in which safe and adequate disposal of waste cannot be assured without. Therefore, this intervention is essential, and the projects team maintained regular coordination with the involved parties to guarantee this sustainable investment for further improvement of the healthcare waste management across the country.

The design of WTUs, layout and BOQ were determined based on the independent Audit Report recommendations considering the WB WASH and Environmental teams' comments, validation, and approval. This design is considered as an Environmentally friendly incineration and disposal method where

[1] Good Practice Note – Addressing SEA/SH in World Bank Financed Projects
[2] WHO Sexual Exploitation and Abuse Prevention and Response, Policy and procedures, March 2017

the adverse impact on Environment is minimal both during the implementation and operation phases. In addition, the sustainability of operation is guaranteed as it needs low operation cost, minimum amount of energy and limited skills.

Generally, the Waste Treatment Units installation will have positive Environmental and Social Impacts as it will enhance the overall management of healthcare waste in the supported facilities, and it will prevent adverse impacts that resulted from substandard disposal methods such as open burning or burying of waste. The WTUs will be installed within the vicinity of HFs in which there is no encroacher or squatter and the WTUs will be located in fenced area and the security personnel will not be engaged. Such subproject will guarantee adequate tracking, management, and disposal of waste without generating any additional risks to the environment and communities during the transportation or disposal of waste in other sites.

This section, however, details the negative or positive potential impacts of the subproject during the implementation / operation stages in addition to the applicable mitigation measures.

The potential negative impacts of the subproject expected to be site based, localized and with temporary Environmental and Social effect. Screening of subproject activities as per the requirements of YCRP ESMF has been performed and the screening form is available in the annex 1.

The analysis of potential risks and impacts during the implementation and civil work activities is detailed in section 7.2 while those related to the operation of WTUs are detailed in section 7.3.

7.2. WTUs INSTALLATION AND CIVIL WORK POTENTIAL RISKS AND IMPACTS

Contractor shall implement all safeguards requirements as included in this plan and any other projects documents by qualified and trained personnel and any violations to the projects safeguards requirements during the implementation various stages will lead to penalties against the contractor. Any energy source used by the contractor during the civil work shall be kept safely away from the movement of personnel or equipment. Construction or allocation of labor camps is not expected during the civil work at any of the healthcare facilities, however adequate latrines shall be provided to the staff and it should be connected to the nearest sewage network or wastewater collection tanks. Work activities shall be performed only during the daytime and no work is allowed or expected during nighttime.

In facilities where old incinerators are existing and after coordination with each facility management, there might be a need to decommission those units after the complete installation and operation of the new WTU. It is worthy to mention that those existing units which are going to be decommissioned are mainly small burners and it doesn't include any pits for final disposal of ash or hazardous waste. Therefore, the associated risk is expected to be low as the decommissioning activities will involve only minor civil work, removal of debris and reinstatement of the ground. In the below sections, risks and impacts of the decommissioning activities will be included along with the mitigation measures and these requirements will be added to the site-specific reports available in annex 6 for facilities in which decommissioning activities will take place.

The decommissioning activities and removal of the existing burners will be performed according to the local regulations in line with the World Bank Group Environmental, Health and Safety guidelines.

I. Water and Landscaping

Contractor shall ensure all materials that will be used in the civil work activities are sourced from authorized quarries. Usage of explosives, child or forced labor is prohibited to source any of the civil work materials. Only limited amount of the civil work materials shall be stored within the work area that is enough for the daily work to avoid any potential waste accumulation resulted from the excessive storage.

Solid waste generated from the subproject will be considered as domestic solid waste and construction waste. Disposal of such waste in an uncontrolled way might result in soil contamination or might affect the

human health at the area. The contractor shall follow and implement the waste management guidelines available in the annex 4 for appropriate management of waste.

Wastewater that is generated from the civil work activities including latrines may cause soil contamination when it is not properly managed therefore the disposal of any hazardous waste is prohibited in the HF yards or in the sewage system. Contractor will be obliged to collect, transport, and dispose such wastewater including from latrines in authorized areas allocated by the authorities.

For facilities where the decommissioning of existing burners is needed; the generated waste including bricks, metal components or concrete shall be transferred to the city municipality as general construction waste or to be reused/recycled as appropriate. The generated scattered litters and waste shall be handled carefully to avoid any injuries. Contractor is required to reinstate the land after the decommissioning of existing units and remove any visible or invisible concrete remains.

Secondary containments shall be provided for the hazardous substances, fuel or hydrocarbons storage to contain any potential leak that result in soil or water contamination.

Contractor, Supervision Engineer, and HF managements will be required to follow up closely the implementation of waste management process and disposal according to the subproject requirements and the applicable rules and regulations. In addition to reduce the waste generation, to the extent possible all recyclable waste will be properly segregated and treated.

Waste management guideline is available in annex 4 which provide details on the appropriate segregation, handling and disposal of waste for the contractors to implement during the civil work activities at all sites.

II. Ambient Air Quality

The potential impact on air quality during the subproject civil work is the generation of pollutants from energy sources/vehicles or dust from different site activities such as excavation, concrete work, cleaning, decommission of existing units … etc. Although the generated dust is limited but it might impact the human health and potentially the workers or neighboring communities (when the work is implemented at the areas adjacent to the hospital external walls).

Although painting work is limited, the emitted volatile components might cause irritation to eye and respiratory system of the workers.

Mitigation measures required for this component are to limit the dust generation during civil work or excavation by spraying water in addition to install barriers around the civil work areas to avoid any emissions ingress to the occupied premises. Additionally, provision of the necessary Personal Protective Equipment (PPE) to the workers as well as regularly conducting the appropriate training and supervision to ensure compliance. The generators used as energy source shall be well maintained, adequately selected and located in addition to minimize the energy or fuel usage to the possible extent.

III. Natural habitats; Flora and Fauna

The WTUs will be implemented within the boundary of existing HFs under the MoPHP authority, some sites might include vegetations or trees that need to be removed for the purpose of installing the WTUs. The magnitude and impact on such are expected to be low. Where natural habitats exist, finding alternative sites shall be considered. Where alternative sites cannot be identified, civil work impact on the natural habitats shall be minimized and carefully implemented in the designated areas only without any further deteriorations. Appropriate reinstatement shall be performed once the civil work completed and adding up trees or vegetations where applicable.

IV. Noise and visual impacts

The different activities that will be implemented during the civil work will potentially have noise and visual impact risks. This could be resulted from machinery movement, concrete work, excavation, and the building activities. The health service provision as well as the nearby communities (when the work is implemented at the areas adjacent to the hospital external walls) might be temporarily disturbed due to the generated noise.

Noise generating activities will be avoided in the peak hours of health service provision and the contractor will ensure the integrity of equipment in addition to use low noise source equipment with appropriate maintenance and the provision of PPE to the workers. Additionally, the barriers surrounding the work area will be implemented to help in decreasing the impact on the health service provision or the neighboring communities.

Once the civil work completed, reinstatement of the subproject site is the responsibility of contractor and all waste, debris, soil or any other materials resulted from the civil work shall be removed in addition to restoring the original condition to the possible extent.

V. Archeology and Cultural Heritage

The WTUs will be implemented within the boundary of existing HFs under the MoPHP authority in which it is not considered as archeological or cultural heritage area, therefore negligible impact is expected on this aspect. Moreover, the civil work supplies shall be sourced by contractors from authorized quarries.

Although not anticipated, for any chance finds during the subproject activities the site shall be fenced to avoid unauthorized entry and the relevant authorities shall be immediately notified. PMU team also shall be notified to follow up and implement the necessary actions.

VI. Transportation and Vehicle Movements

Vehicles and equipment movement within the civil work areas might lead to routes obstruction and injuries to the workers or to the communities, therefore the following measures at minimum shall be implemented:

- Dedicated routes for the movement of machinery, vehicles, and equipment away from the patients flow or emergency access.
- Trained and qualified operators / drivers.
- Movement within the HF yards needs to be always guided by banksman for signaling.
- The dedicated route shall be arranged away from any excavated or work at height area and no movement is allowed during the nighttime.
- Regular checks and inspections for the vehicles or equipment to confirm the integrity, records to be kept available for any inspection.
- Reduction of any route closure times, if any, and considering the health service provision as priority.
- Any alternative routes shall be provided with adequate lighting and signage.

VII. Occupational Health and Safety

Occupational health and safety risks might affect the contractors' workers if the necessary safeguards are not well implemented. Those risks are associated with the: excavation work, vehicles movement, work at height, confined spaces, cementing /concrete work, and the other civil works within the subproject scope.

The magnitude and impact of those risks is expected to be low, and this is subjected to the implementation of necessary mitigations such as: activities risk assessment by the contractor, provision of the necessary PPE and training, adequate supervision, protection of any soil or structure collapse, provision of barriers around the civil work areas, safe access and egress to the excavated areas, adequate lighting, correcting and

reporting the unsafe condition within the subproject site. Civil work areas shall be kept free of obstacles with adequately storage of materials and equipment.

COVID-19 infection transmission among the workers could be resulted and the contractor will be responsible for providing the necessary PPE, handwashing facilities, disinfectants as well as implementing any other infection prevention and control measures. Contractor in other hand shall ensure all workers onsite are fit, not developing any COVID-19 symptoms, and provided with the necessary awareness, training, and communication in regular basis.

Contractor workers and work areas shall be kept separated, to the best possible extent, from any interaction with the healthcare services provided within the hospital.

The contractor shall ensure all workers involved in the subproject implementation are covered with insurance for any work-related injuries or incidents.

VIII. Community Health and Safety

In general, the subproject implementation will cause positive impact on the community as it will ease and ensure sustainable healthcare services through the hospital and will ensure appropriate waste management.

In other hand, some negative impacts might be resulted from the civil work activities such as dust, noise, vehicle movements and disturbing temporarily the healthcare services. Movement restriction in some areas might be resulted as well and there will be a need for alternative routes provision. Patients, healthcare workers, and visitors might be affected or injured from the exposure to civil work or excavation activities, therefore all work areas (civil or excavation areas) shall be controlled, provided with adequate barriers, sufficient lighting during night, and clear signs / instructions to avoid any unauthorized entry.

IX. Employment Opportunities

Employment opportunities will be generated to the local society from the subproject implementation in the supported HFs. This will have a positive impact on society' economic especially with the current crisis in the country whereas limited private sector employment opportunities and irregular salary payment to the governmental workers.

X. Labor Issues, GBV and SEA/SH

All project workers are expected to be local and from the same communities. The expected maximum number of workers in any working day at each site is 10 workers. Labor risks including forced labor, child labor, Gender Based Violence GBV, SEA and SH are not expected or with low magnitude and impacts, and to mitigate this risk the requirements will be included in the contracts and Code of Conduct (CoC) in which the contractor will be obliged to follow along with his workers. Enforcement of CoC implementation among the contractor and workers will be ensured by the project WASH and GBV team.

Register of the workforce detailing the personnel information including age with copy of their official documents. In addition, Supervision Engineer shall screen / verify labors involved in the project activities by obtaining the identification documents and any finding shall be reported immediately.

Contractor at each site shall undertake the primary responsibility for his staff grievances and appropriate mechanism shall be provided. Work-place grievances should be addressed by each contractor in a timely manner and the Supervision Engineer in each site shall verify the implementation of this requirement in each site. In addition, the projects GM channels will be made available for contractors' workers as well as any concerned party to raise any grievance related to the labor issues during the subproject implementation. Grievances related to labor issues that received via the Projects GM channels will be handled and treated with high priority to provide timely and effective solutions.

Any GBV or SEA/SH grievances shall be managed as detailed in section 6.3 of this ESMP.

XI. CIVIL WORK ENVIRONMENTAL AND SOCIAL RISKS ASSESSMENT AND MITIGATIONS

No	Environmental / Social Aspect	Potential Impact	Significance	Risk Response and Mitigation Measures	Responsibilities	
					Implementation	Monitoring
1	Water and Landscaping	Soil contamination	Low	• Site shall be cleared, cleaned and all trees to be removed prior work start. • Implementation of waste management process and disposal according to the projects' requirements and the applicable rules and regulations using the annex 4 requirements as guideline for waste collection, segregation, and disposal. • Waste will be transported to authorized and licensed landfill or dump site which is designated by the city municipality. • Reduction of the waste generation to the possible extent and to ensure all recyclable waste is properly segregated and treated. • Eliminate any waste disposal to the water ways or within the healthcare facility boundary. • Contractor to assign of dedicated waste collection team provided with the necessary training and Personal Protective Equipment PPE. • Dedicated waste collection area shall be arranged by the contractor and to include adequate number of bins for each type of waste. • Decommissioning of existing burners, if any, shall be performed in coordination with the facility management, generated waste shall be recycled / disposed as appropriate. • The decommissioning activities and removal of the existing burners shall be performed according to the local regulations in line with the World Bank Group Environmental, Health and Safety guidelines. • Waste shall be segregated at source into color appropriate bins/receptacles. This should be collected twice a day to avoid waste accumulation in the hospital • Work areas shall be kept free of any debris, scattered litters, or any type of waste. • Only limited amount of the civil work materials shall be stored within the work area that is enough for the daily work and contractor to avoid any potential waste accumulation resulted from excessive storage. • Wastewater resulted from the latrines or the civil work activities shall be collected and disposed in authorized locations if cannot be connected to the sewage network. • Secondary containments shall be provided for hazardous substances, fuel or hydrocarbons storage to contain any potential leak. • Once the civil work/decommission of existing units completed, reinstatement of the subproject site is the responsibility of contractor and all waste, debris, soil, or any other materials resulted from the civil work shall be removed from the site.	Contractor	Supervision Engineer (Weekly) / Contractor ESHS Officer (Daily) / Third Party Monitoring (Spot check)
		Improper waste management and disposal	Low			
		Human health and safety	Low			

No	Environmental / Social Aspect	Potential Impact	Significance	Risk Response and Mitigation Measures	Responsibilities	
					Implementation	Monitoring
2	Ambient Air Quality	Human health impacts from generated dust	Low	• The generators used as energy source shall be adequately selected, maintained and located in addition to minimize the energy or fuel usage to the possible extent. • Machines or vehicles shall be adequately selected and maintained regularly to reduce any pollutant emissions. • Spraying water regularly to reduce dust generation. • Where required, install barriers around the civil work areas to avoid any emissions to the occupied premises. • Dust generated activities durations and timing to be arranged in accordance with the health service provision and in coordination with the facility management. • Additional protection around the healthcare provision areas needs to be implemented to avoid any dust ingress such as curtains around the entrances, windows, or any other openings. • Provision of the necessary PPE to the workers as well as regularly conducting the appropriate training and supervision.	Contractor	Supervision Engineer (Weekly) / Contractor ESHS Officer (Daily) / Third Party Monitoring (Spot check)
		Effect on the facility Healthcare services	Low			
3	Natural habitats; Flora and Fauna	Damage or removal the trees or vegetations to install the WTU	Low	• Selected site for WTU installation does not include any rare species including trees or vegetations. • Civil work effect on the natural habitats, where any, shall be minimized and carefully implemented in the designated areas only without any further deteriorations • Appropriate reinstatement of site once civil work completed considering restoring the original. • Civil work supplies and materials shall be sourced from authorized queries.	HFs Management / Supervision Engineer	EHNP / YCRP PMU
4	Noise and visual impacts	Nuisance to the nearby facilities and personnel Disturbance of the hospital services. Inappropriate site rehabilitation	Low	• Machines or vehicles shall be adequately selected and maintained regularly. • Noise generating activities will be avoided in the peak hours of health service provision and the timing to be arranged with healthcare facility management • Usage of low noise generation tools, machines and equipment. • Contractor will ensure the integrity of equipment and the provision of PPE to the workers • The barriers surrounding the work area shall be installed to help in decreasing the impact on the health service provision or the neighboring communities. • Once the civil work completed, reinstatement of the subproject site is the responsibility of contractor and all waste, debris, soil or any other materials resulted from the civil work shall be removed in addition to restoring the original condition to the possible extent.	Contractor	Supervision Engineer (Weekly) / Contractor ESHS Officer (Daily) / Third Party Monitoring (Spot check)

No	Environmental / Social Aspect	Potential Impact	Significance	Risk Response and Mitigation Measures	Responsibilities	
					Implementation	Monitoring
5	Archeology and Cultural Heritage	civil work materials source	**Low**	• All the materials that will be used in the civil work activities shall be sourced from authorized quarries and suppliers. • For any chance finds during the subproject activities, the site shall be fenced to avoid unauthorized entry and the relevant authorities shall be immediately notified. PMU team also shall be notified to follow up and implement the necessary actions.	Contractor / Supervision Engineer	PMU / HFs management
6	Transportation and Vehicle Movements	Personal injuries Damage to the assets or equipment	**Low**	• Dedicated routes for the movement of machinery, vehicles, and equipment away from the patients flow or emergency access. • Trained and qualified operators / drivers are assigned for the heavy vehicles and equipment. • Movement of heavy vehicles within the subproject areas and healthcare facility yards needs to be always guided by banks man for signaling. • The dedicated route shall be arranged in safe distance from any excavated or work at height area and no movement is allowed during the nighttime. • Regular checks and inspections for the vehicles or equipment to confirm the integrity, records to be kept available for any inspection. • Reduction of any route closure times, if any, and considering the health service provision as priority. • Any alternative routes shall be provided with adequate lighting and signage.	Contractor	Supervision Engineer (Weekly) / Contractor ESHS Officer (Daily) / Third Party Monitoring (Spot check)
7	Occupational Health and Safety	Workers Injuries	**Moderate**	• Provision of regular training to the workers on the occupational health and safety, hazard identification and control requirements during all subproject activities. • Adequate level of supervision at the subproject sites to ensure workers adherence to the requirements. • Work at height is adequately controlled and supervised on secured platforms and all falling protection means are provided. • Provision of the necessary PPE, based on the nature of tasks, to the workers. • Install physical protection in any excavated areas to prevent any soil collapse. • Provide safe egress and ingress from any excavated area. • Movement of vehicles and equipment shall be properly controlled in dedicated routes by certified operators. • To properly arrange the work area and avoid any slip/trip or fall hazards. • Contractor to prepare incident response and emergency plans that detail the required actions and responsible parties. • Provision of First Aid supplies at the subproject sites with trained personnel.	Contractor	Supervision Engineer (Weekly) / Contractor ESHS Officer (Daily) / Third Party Monitoring (Spot check)

No	Environmental / Social Aspect	Potential Impact	Significance	Risk Response and Mitigation Measures	Responsibilities	
					Implementation	Monitoring
				• Electrical and mechanical equipment used in the civil work shall be well maintained with regular inspection prior the work starts. • Any work involves energy sources including electrical work shall be adequately planned and to be performed by qualified personnel with close supervision. • All workers involved in the subproject implementation shall be covered with insurance for any work-related injuries or incidents.		
		Occupational diseases		• Regular training and toolbox talk on the infection prevention measures and control. • Separate access for contractor workers to the work areas without any interaction with the healthcare activities (to the possible extent). • Provision of latrines, handwashing facilities, disinfectants as well as any other COVID-19 infection prevention and control measures. • Contractor shall ensure all workers onsite are fit, not developing any COVID-19 symptoms, and provided with the necessary awareness, training, and communication in regular basis.		
8	Community Health and Safety	Human injuries from exposure to the vehicle movement, civil or excavation work	**Low**	• All work areas (civil or excavation areas) shall be controlled, provided with adequate physical barriers. • Sufficient lighting during night, in addition to clear signs / instructions to avoid any unauthorized entry to the work areas.	Contractor	Supervision Engineer (Weekly) / Contractor ESHS Officer (Daily) / Third Party Monitoring (Spot check)
		Restricted movement within the hospital premises	**Low**	• Alternative and safe routes or walkways shall be provided for any access blocked by the subproject activities, safe patients flow shall be ensured. • Adequate lighting, signage and protection for any alternative routes shall be implemented. • Priority shall be given to the patients flow and emergency access at any point of time during civil work activities. • Routes' closure or access blockage to be minimized and the work areas shall be categorized and divided in coordination with the healthcare facility management. • GM availability in the subproject site and regular consultation with Project stakeholder during the civil work activities.		
9	Employment Opportunities	Employment opportunities will be generated from the Subproject activities	**Positive**	**NA**		

No	Environmental / Social Aspect	Potential Impact	Significance	Risk Response and Mitigation Measures	Responsibilities	
					Implementation	Monitoring
10	Labor Issues	Labor influx, child labor, forced labor GBV, SEA/SH	Low	• Contractual obligations to reduce the labor issues as well as SEA/SH risks. • Enforcement of the CoC implementation for GBV- SEA/SH among contractor and staff. • Labor register to be maintained and updated by contractor to include necessary information as well as labors' age with copy of official documents. • Labors' screening and age verification (more than 18 years by official documents or ID) at work site by the Supervision Engineer and to stop/report any observed deviations. • EHNP/YCRP GM channels will be made available to contractor workers as well as any concerned party to raise any grievance related to the subproject implementation. • Labor issues grievances received via the Project GM channels will be handled and treated with high priority to provide effective solutions for the complainant. • Contractor at each site shall undertake the primary responsibility for his staff grievances and appropriate mechanism shall be provided. Work-place grievances should be addressed by each contractor in a timely manner.	Contractor	Supervision Engineer (Weekly) / Contractor ESHS Officer (Daily) / Third Party Monitoring (Spot check)

Significance Rating	High	Moderate	Low	Positive

7.3. WTUs OPERATION POTENTIAL RISKS AND IMPACTS

The operation of the whole Waste Treatment Units will be the responsibility of each healthcare facility's management as part of the overall waste management process considering the application MoPHP guidelines and the YCRP ICMWMP. Guidelines and instructions on the appropriate waste management, emergency response procedures, and level of responsibilities that need to be strictly implemented during the WTU operation are detailed in the YCRP ICMWMP as well as the MoPHP guidelines that will be applicable for all sites covered by this subproject. Moreover, guideline on the waste management principles and incinerators operation is available in annex 7.

The EHNP and YCRP will not include recruitment of dedicated manpower for the purpose of operation the WTUs as those workers will be civil servants from the facilities' existing staff. The EHNP and YCRP support will continue during the lifetime of the Projects which include the logistics supply as well as training for the workforce (civil servants) on the appropriate healthcare waste management with compliance monitoring to ensure adequate OHS measures are implemented.

The WTUs type A design will be suitable for the treatment and disposal of the following types of healthcare waste:

I. Infectious waste
II. Pathological waste
III. Small quantities of pharmaceutical waste
IV. Sharp waste

While the WTUs type B design will be suitable for the treatment and disposal of the following types of healthcare waste:

I. Infectious waste
II. Pathological waste
III. Sharp waste

Other types of waste that include radioactive waste, chemicals with heavy metals as well as the general waste shall be treated and disposed as per the applicable regulation in the country which is the responsibility of each HF management as part of their own general waste management system following the MoPHP guidelines and YCRP Infection Control and Medical Waste Management Plan requirements. The segregation and color-coding requirements are previously indicated as per the MoPHP guidelines and it shall be followed/implemented by the management of supported HFs.

For the purpose of selecting WTU location within each HF, Waste Treatment Units Site Selection Report template available in annex 2 has been issued by the Project Engineers for each supported facility and it includes the requirements needed for safe installation of WTU. Each report has been prepared after site visits to the supported HF and in coordination with the management of each facility. The selection report of each facility is available in the annex 6.

Once in operation, the Waste Treatment Units will have positive environmental and social impacts as it will enhance the overall management of healthcare waste in the supported facilities, and it will prevent adverse impacts that resulted from substandard disposal methods such as open burning or burying of waste. The WTUs will be installed within the vicinity of HFs which will guarantee adequate tracking, management, and disposal of waste without generating any additional impacts on the environment and communities during the transportation or disposal of waste in other sites.

Dedicated power supply generators will not be used within the WTU as the incinerators will require minimal amount of fuel for starting the fire only and the crushers or shredders are manually operated. The energy for lighting only if will be obtained from each facility power supply.

The potential impacts of waste incineration are detailed below. Design considerations as well as the implementation of contractual/operational arrangements have been determined to reduce any adverse impacts that could result from the operation of the WTUs include but not limited to:

- Detailed training shall be provided by the contractor, as part of the contract scope, to each HF staff on the appropriate operation and maintenance requirements of the WTU following the Projects guidelines.
- Strengthen engagements between the Projects with the MoPHP authorities and management of supported facilities towards enforcing the implementation of appropriate waste management process following the MoPHP guidelines and Projects plans.
- Support by the Projects to the targeted healthcare facilities to be continued during the Projects lifetime which includes the training on appropriate waste management and logistics supply.
- Deployment of instructions, guidelines on the safe management of waste by the contractor upon the completion of civil work and by the Project at later stages during the Projects lifetime.
- Monitoring the implementation of waste management process and the operation of WTU by the Projects TPM as well as during the PMU members site visits.
- Implementing Immediately the corrective/preventive actions for any deviations observed or reported by the Projects in coordination with MoPHP authorities.
- Strengthen communication from the Projects side with all parties at facility level and addressing timely any concerns or feedback.
- GM channels availability at the supported facilities that could be used to raise any related concerns in addition to address any such concern with high priority.

I. Water and Landscaping

The operation of WTUs in the supported facilities will cause positive impact on this aspect as the final disposal method of generated healthcare waste will be in reinforced concrete pits within the vicinity of HFs and the substandard burial or disposal of waste will be eliminated. Spills are not anticipated or with minimum impacts as the WTUs will not require massive fuel consumption for operation and no dedicated generators are needed.

The selection of WTU location will consider safe distance from any surface or rainwater sources which has been addressed for each site as detailed in the annex 6 for each site.

II. Ambient Air Quality

The generated fumes from the healthcare waste incineration process might affect the atmosphere and air quality. The selected incinerator design is dual chamber environment friendly units that provide sufficient temperature and gases flow to reduce the generation of such pollutants. The combustion principles and operation arrangements, previous operation experience and the independent Audit Report recommendation confirmed this summary.

Dioxin/furan formation is minimized by ensuring that incineration only takes place at temperatures above 800°C (Rossi and Schettler 2000).[3] Although the Audit report indicates the possibility of waste loading at 600°C, for all WTU installed under the Projects the temperature shall reach more than 850°C before start

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

loading and burning of the infectious waste which would avoid dioxin emission to the environment. The temperature range will be monitored by a high temperature digital thermometer mounted with the main structure to ensure complete waste combustion. The temperature range shall be maintained in the desired range by waste loading frequency. Additionally, the appropriate waste segregation at source is additional factor that will help in reducing the pollutants emissions as a result if the incineration. Those requirements will be included in the training that will be conducted to healthcare workers by contractor upon civil work completion or within any subsequent training conducted under the Projects. Visible instruction on the temperature range and appropriate segregation requirements will be posted in the WTU site as well as in the healthcare facility premises.

In addition, the activated carbon filters installed at the incinerators chimney will reduce the pollutants associated with the flue gases and at the same time remove odor and smell that could be generated.

Commissioning and initial startup of the incinerators will be performed by the contractor where the necessary temperature tests, generated smoke status, and ash quality checks shall be conducted, and it shall meet the design criteria of WTU. Handover of the WTU in each HF shall be performed after the completion and acceptance of the necessary tests in attendance of the subproject Supervision Engineer, contractor representatives, and HF management. Furthermore, and once the civil work completed, the contractor shall conduct the necessary training on the appropriate operation of WTU s to the HF staff and waste management workers as well will install guidelines and awareness materials.

Further guideline on the waste management principles and incinerators operation is available in annex 7.

Additionally, the below measures will be introduced to reduce the impact of incinerator operation:

- HFs management shall ensure safe management, segregation and tracking of waste to ensure safe operation of the WTUs.
- Ensuring the incinerators operation and infectious waste loading is performed only at the dedicated temperature range.
- Regular training from the EHNP/YCRP side on the appropriate waste management practices to the facility staff including WTU operators.
- Provision of adequate supplies needed for the waste segregation and transportation process.
- Regular inspection for the incinerator general condition including the visual check for the air supply route, bricks, exhaust, chimney's metallic body, thermometer, loading and ash doors.
- Implementation of the necessary maintenance for the incinerators units and replacement of activated carbon filters in regular basis (annually) with the support of EHNP/YCRP if needed.
- Incinerators' operation time and duration to be determined considering the weather conditions as well as any specific needs of the healthcare service or communities.
- Strengthen communication from the EHNP/YCRP side on the WTU operation and implement the corrective actions accordingly.

III. Natural habitats; Flora and Fauna

The WTUs will be implemented within the boundary of existing HFs under the MoPHP authority, no impact is expected from the operation of WTU as the area will be fenced and secured.

IV. Noise and visual impacts

Noise generation during the operation of the WTUs is not anticipated as no generators or high noise equipment will be used during operation, the power source needed for lighting only will be supplied from the HF main power source.

V. Archeology and Cultural Heritage

The WTUs will be implemented and operates within the boundary of existing HFs under the MoPHP authority in which no impacts could be resulted from the WTU operation on the archeology or cultural heritage.

VI. Occupational Health and Safety

Occupational health and safety risks might affect the waste management workers during the operation of WTUs and incineration units if the necessary safeguards are not well implemented. Those risks are resulted from, waste handling, loading/offloading activities, machines operation, exposure to hazardous materials/fumes, sharp objects, infectious diseases, and exposure to excessive heat. Workers who will be involved in the operation of WTUs are to be from the healthcare facilities staff, civil servants, and they will remain subjected to their governmental contractual arrangements. The Project will not be involved in the recruitment or management of such workers; however, the workers occupational health and safety will be considered by the Projects and the monitoring of safeguards implementation will be performed as part of the Projects monitoring scope by the relevant TPM.

The magnitude and impact of those risks are expected to be low, and this is subjected to the implementation of necessary mitigations such as: provision of the necessary PPE, training, adequate supervision, proper waste segregation at source within the HFs premises, awareness materials deployment, hand washing facilities and disinfectants. It will be the responsibility of HFs management to implement the mentioned arrangements onsite and to ensure strict adherence. YCRP and EHNP support will be provided to the HFs to the possible extent to ensure safe and adequate management of waste during the operation of the installed WTU.

Guidance on the WTU operation associated hazards, PPE and OHS requirements is available in annex 7.

VII. Community Health and Safety

The installed WTUs including the incinerators units will improve the overall waste management condition in the supported facilities and it will cause positive environmental and social impacts.

The selected incinerators are dual chambers environment-friendly units producing lower atmospheric pollution gases that could cause adverse impacts on communities. Chimney's activated carbon filters will provide additional purification layer for the generated gases. Additionally, the height of chimney will ensure adequate dispersion of generated fumes in a way not affecting the neighboring communities or the healthcare service provision with the facilities.

In other hand the exact location of WTU has been selected by the Project engineers considering the communities, healthcare services and wind directions as per the requirements of annex 2 in which detailed report has been issued for each site.

Sensitive healthcare premises and neighboring communities (if any) shall be located upwind of the WTUs location.

VIII. Labor and working condition

Workers who will be involved in the operation of WTUs are to be from the healthcare facilities staff, civil servants, and they will remain subjected to their governmental contractual arrangements. The Project will not be involved in the recruitment or management of such workers; however, the monitoring of relevant safeguards implementation will be performed as part of the Projects monitoring scope by the relevant TPM.

I. WTUs OPERATION ENVIRONMENTAL AND SOCIAL RISKS ASSESSMENT AND MITIGATIONS

No	Environmental / Social Aspect	Potential Impact	Significance	Risk Response and Mitigation Measures	Responsibilities	
					Implementation	Monitoring
1	Water and Landscaping	Soil contamination from the contaminated waste Human health and safety	Low	• Final disposal method of generated healthcare waste will be in reinforced concrete pits within the vicinity of HFs. • The selection of WTU location will consider safe distance from any surface or rainwater sources.	Design and installation arrangements	
2	Ambient Air Quality	Human health impacts from generated fumes. Environmental and air quality impact from toxic pollutants	Low	• The selected incinerator design is dual chamber environment friendly incinerators that provide sufficient heat and gases flow to reduce the generation of pollutants. • The combustion principles and operation arrangements, previous operation experience and the independent Audit Report confirmed this incineration units have minimal adverse impact on the environment and air quality.	Design and installation arrangements	
				• Initial startup of the incinerators will be performed by the contractor where the necessary temperature tests, generated smoke status, and quality checks shall be conducted, and it shall meet the design criteria of WTU. • The incinerators chimney will be equipped with activated carbon filter elements as additional layer for gases purification. • Handover of the WTU in each HF shall be performed after the completion and acceptance of the necessary tests in attendance of the subproject Supervision Engineer, contractor representatives, and HF management. • To ensure safe operation of WTUs, the contractor will provide the necessary training to the HF staff and waste management workers as well will install guidelines and awareness materials.	Contractor	Supervision Engineer / HFs Management
				• Additional training and awareness session will be conducted by the EHNP/YCRP Projects. • Provision of the necessary spare parts required for maintenance and in particularly the filter replacement elements as well as the temperature monitoring devices. • Provision of adequate supplies needed for the waste segregation and transportation process. • Regular training from the EHNP/YCRP side on the appropriate waste management practices to the facility staff including WTU operators. • Closely follow up the WTU operation with strengthen communication from the EHNP/YCRP side on the WTU operation and implement the corrective actions accordingly.	EHNP and/or YCRP	Projects team / TPM

No	Environmental / Social Aspect	Potential Impact	Significance	Risk Response and Mitigation Measures	Responsibilities	
					Implementation	Monitoring
				• HFs management will need to ensure safe management, segregation and tracking of waste to ensure safe operation of the WTUs. • During operation, the hazardous waste loading and incinerators operation shall be maintained in temperature range from 850 °C to 900 °C. The temperature range shall be monitored by a high temperature digital thermometer mounted with the main structure to ensure complete waste combustion. The temperature is maintained in the desired range by waste loading frequency. • Implementation of the necessary maintenance for the incinerators units and replacement of filters in regular basis (annually) with the support of EHNP/YCRP if needed. • Incinerators' operation time and duration to be determined considering the weather conditions as well as any specific needs of the healthcare service or communities. • Regular inspection for the incinerator general condition including the visual check for the air supply route, bricks, exhaust, chimney's metallic body, thermometer, loading and ash doors. • Additional instructions on the waste management principles, WTU operation and safety requirements need to be installed by the Projects and facilities management.	HFs Management	
3	Natural habitats; Flora and Fauna	**NA**	**NA**	**NA**		
4	Noise and visual impacts	**NA**	**NA**	**NA**		
5	Archeology and Cultural Heritage	**NA**	**NA**	**NA**		
6	Occupational Health and Safety	Waste management workers Injuries	**Low**	• Provision of the necessary PPE to the workers as well as regularly conducting the appropriate training as part of the Projects overall support. • Provision of handwashing facilities, disinfectants as well as any other COVID-19 infection prevention and control measures. • Awareness materials deployment by the contractor upon the civil work completion and by the EHNP/YCRP where necessary.	EHNP and/or YCRP HFs Management	Projects TPM
				• Proper waste segregation at source within the HFs premises and to ensure adequate color coding following the applicable guidelines. • To properly arrange the work area and avoid any slip/trip or fall hazards. • Staff assignment (civil servants) for proper operation of the WTU with continuous supervision.	HFs Management	Projects TPM

No	Environmental / Social Aspect	Potential Impact	Significance	Risk Response and Mitigation Measures	Responsibilities	
					Implementation	Monitoring
7	Community Health and Safety	Affect the neighboring communities or healthcare service by the generated fumes	Low	• Set of criteria as explained in Ambient Air Quality control measures were considered during the design, contractual and operational arrangements of the WTUs and incinerators. • Chimneys' height will provide adequate dispersion/dilution of fumes and gases resulted from the combustion process.	Design and installation arrangements	
				• WTU selection considering adequate distance from nearby healthcare service or neighboring communities. • Sensitive healthcare premises and neighboring communities (if any) shall be located upwind of the WTUs selected location.	Supervision Engineer / HFs Management	EHNP / YCRP PMU team
				• Communities' concerns and feedback on the WTU operation that received through the regular consultations shall be seriously handled and appropriate corrective actions shall be implemented. • Project GM channel visibility in the WTU location as well as in the supported facilities premises as part of the Projects overall GM visibility during the operations phase of the WTU.	EHNP and/or YCRP	Projects TPM
				• Adequate supervision on the WTUs operation by the HFs management considering the necessity of close supervision and enforcement of appropriate segregation of waste.	HFs Management	Projects TPM

Significance Rating	High	Moderate	Low	Positive

7.4. MONITORING AND REPORTING

Monitoring of the environmental and social requirements implementation during the **civil work** at each site shall be performed in weekly basis by the Supervision Engineer assigned from the EHNP/YCRP side as well as the visits of PMU team where necessary. Regular reports on the compliance to the section 7.2 requirements shall be issued by Supervision Engineers to the PMU WASH officers. In other hand, progress reports shall be issued on the implementation status and shall address / overcome any challenges in the implementation. Such reports need to include any deviations or anomalies with the necessary corrective and preventive measures. Contractor incompliance of the Projects environmental and social requirements that detailed in this ESMP or in the applicable regulations will lead to apply the WHO guidelines including contracts termination and/or banning future business with the respective contractor.

From the contractor side the environmental and social implementation monitoring shall be performed in each site by dedicated and qualified ESHS officer assigned permanently for the subproject in each HFs.

Environmental and Social Compliance Monitoring Report available in annex 5 shall be filled based on the site visits by the Supervision Engineer in weekly basis for each site and to be sent to the PMU Environmental and Social Safeguards team. Moreover, the compliance report shall be filled by the contractor ESHS officer for each site on a weekly basis and will be kept with the contractor and will be requested where needed.

Contractor and Supervision Engineer are required to report immediately, to the EHN/YCRP WASH officers, any incident or accident in relation with the subproject activities; the event then shall be reported to the World Bank within 48 hours.

During the **operation of WTUs**, the HF management shall ensure adequate incinerators operation as per the applicable guidelines and management of waste that including proper segregation at source. The monitoring of the requirements included in section 7.3 shall be performed by the Project TPM as part of the overall monitoring for the Projects supported facilities as well as the responsible WASH and Safeguards officers. Monitoring of compliance in the supported facilities is also performed by the WHO M&E in which monitoring reports are issued regularly.

8. ESMP IMPLEMENTATION COST

Implementation cost of the ESMP during civil work activities is estimated as below:

No	Implementation Cost	Cost at each site USD	Total Cost USD
1	Production and dissemination of communication materials on the Environmental, Social and GM requirements at each HF.	200	10,000
2	Travel of Projects team for monitoring purposes where needed.	200	10,000
3	Supervision of Environmental and Social requirements implementation. Provision of awareness sessions on OHS to the subproject workers.	500	25,000
	TOTAL USD	**900**	**45,000**

ANNEX 1 SUBPROJECT SCREENING FORM

Subprojects Screening Form

This form is to be used by the Project Management Unit (PMU) to screen for the potential environmental and social risks and impacts of a proposed subproject. It will help the PMU in identifying the relevant Environmental and Social Standards (ESS), establishing an appropriate E&S risk rating for these subprojects and specifying the type of environmental and social assessment required, including specific instruments/plans. Use of this form will allow the PMU to form an initial view of the potential risks and impacts of a subproject***. It is not a substitute for project-specific E&S assessments or specific mitigation plans.***

Subproject Name	Installation of Waste Treatment Units WTUs within the YCRP, EHNP Supported Facilities
Subproject Location	Yemen – Different Governorates and Healthcare facilities
Subproject Proponent	MoPHP and HFs Authorities / Contractors for site implementations
Estimated Investment	
Start/Completion Date	January 2022 – October 2022

Questions	**Answer**		**ESS relevance**	**Due diligence / Actions**
	Yes	No		
Does the subproject involve civil works including new construction, expansion, upgrading or rehabilitation of healthcare facilities and/or waste management facilities?	✔		ESS1	ESIA/**ESMP, SEP**
Does the subproject involve land acquisition and/or restrictions on land use?		✔	ESS5	RP / SEP
Does the subproject involve acquisition of assets for quarantine, isolation or medical treatment purposes?		✔	ESS5	To be excluded / ineligible
Is the subproject associated with any external waste management facilities such as a sanitary landfill, incinerator, or wastewater treatment plant for healthcare waste disposal?		✔	ESS1/ESS3	ESIA /ESMP, SEP
Is there a sound regulatory framework and institutional capacity in place for healthcare facility infection control and healthcare waste management?	✔		ESS1	ESIA/**ESMP**, SEP
Does the subproject have an adequate system in place (capacity, processes and management) to address waste?	✔		ESS1/ESS3	ICMWMP
Does the subproject involve recruitment of workers including direct, contracted, primary supply, and/or community workers?	✔		ESS2	**LMP, SEP**

Does the subproject have appropriate OHS procedures in place, and an adequate supply of PPE (where necessary)?	✔		ESS1/ESS2	ESIA/**ESMP**
Does the subproject have a GRM in place, to which all workers have access, designed to respond quickly and effectively?	✔		ESS10	**SEP**
Does the subproject involve transboundary transportation (including Potentially infected specimens may be transported from healthcare facilities to testing laboratories, and transboundary) of specimen, samples, infectious and hazardous materials?		✔	ESS1/ESS3	ESIA/ESMP, ICMWMP, SEP
Does the subproject involve use of security or military personnel during construction and/or operation of healthcare facilities and related activities?		✔	ESS4/ESS1	ESIA/ESMP, SEP
Is the subproject located within or in the vicinity of any ecologically sensitive areas?		✔	ESS6/ESS1	ESIA/ESMP, SEP
Is the subproject located within or in the vicinity of any known cultural heritage sites?		✔	ESS8	ESIA/ESMP, SEP
Does the project area present considerable Gender-Based Violence (GBV) and Sexual Exploitation and Abuse (SEA) risk?		✔	ESS1	ESIA/ESMP, SEP

Conclusions:

1. **Proposed Environmental and Social Risk Ratings (High, Substantial, Moderate or Low). Provide Justifications.**
   Moderate
2. **Proposed E&S Management Plans/ Instruments to be further developed**
   Existing applicable YCRP safeguards instruments: ESMF, LMP, SEP and ICMWMP.
   ESMP developed for this intervention and will be implemented throughout the intervention lifetime by the contractors under the supervision of YCRP PMU WASH and safeguards teams.

Guidelines for screening and applicable instruments:

- **ESIA is applicable for High-Risk activities and those with physical environmental footprints.**
- **ESIA / ESMP are not applicable for supply activities such as PPE, etc. However, Project ICMWMP needs to be applied in such cases.**

ANNEX 2 WASTE TREATMENT UNITS SITES SELECTION REPORT TEMPLATE

الشروط الاساسية لاختيار موقع وحدة معالجة النفايات الطبية

.....	Governate محافظة	.....	District مديرية	.....	Hospital مستشفى
.....	Date التاريخ	.....			Engineer المهندس المشرف

- **يتم اختيار موقع مناسب لوحدة معالجة النفايات الطبية (محرقة النفايات الطبية مع الملحقات والمدافن) في المستشفيات وذلك حسب الاشتراطات التاليه:**
- **A suitable site shall be chosen for the medical waste treatment unit (medical waste incinerator with burying pits) within the hospitals, according to the following requirements:**

- من شروط انشاء وحدة معالجة النفايات الطبية (محرقة النفايات الطبية مع الملحقات والمدافن) هو-ضرورة إيجاد أرض ملائمة لإنشاء المحرقة ولهذا يجب اختيار موقع مناسب للمحرقة داخل المستشفى بحيث لا تؤثر بيئيا على المستشفى او المساكن المجاورة للمستشفى.
- Main conditions for establishing a medical waste treatment unit (medical waste incinerator with burial pits) is the necessity of finding suitable land for the establishment of the incinerator. For this, a suitable location for the incinerator must be chosen inside the hospital so that it does not affect the environment, hospital operation or the nearby residents.
- **شروط الموقع على النحو التالي :**
  - ان يكون الموقع ملك للمستشفى ويكون داخل حوش (حرم) المستشفى
  - ان يكون الموقع بعيد عن بنايات المستشفى والبنايات السكانية المجاوره للمستشفى وبمعنى اخر يتم اختيار موقع مناسب بحيث لا يعترض عليه مستقبلا (بعد الانشاء) اي من السكان المجاورين للمستشفى او المرضى الرقود في المستشفى او الموظفين في المستشفى او الزوار للمستشفى او السكان الساكنين في مباني السكن التابعة للمستشفى بسبب تشغيل المحرقة ومكوناتها
  - أن يكون موقع المحرقة بعكس اتجاه الرياح السائدة وبمعنى اخر الرياح في المنطقة لن تقوم بنقل الابخره الى مباني المستشفى والبنايات السكانية المجاوره للمستشفى.
  - ان يكون الموقع في مكان لا تتجمع ولا تمر فيه مياه السيول والامطار وبعيد عن بيارات المستشفى او بيارات الحي.
- **The below requirements shall be considered:**
  - The site should be owned by the hospital and be inside the hospital yard
  - The site should be far from the hospital buildings and the residential buildings adjacent to the hospital. In other words, a suitable location is chosen so the operation of the incinerator and its components will not be rejected in the future (after installation) by the residents adjacent to the hospital, patients in the hospital, hospital staff, visitors to the hospital, or any other affected communities.
  - The location of the incinerator should be downwind, in other words, the winds in the area will not transfer the fumes to the hospital buildings and residential buildings adjacent to the hospital.
  - The site should be in a place where torrential rain and flood waters do not pass, and far from hospital or neighborhood sewage pits.

- **اقسام المستشفى Hospital Sections and components :**

No	Section

- **اسقاط التصميم الخاص بوحدة المعالجة ويتم توضيح الموقع في خريطة ويوضح فيها بالرسومات التالي:**
- **Layout of the Waste Treatment Unit Location within the Health facility and indicating the following details:**

Hospital name: District: Governorate:	اسم المستشفى: المديرية: المحافظة:
Hospital Location:	موقع المستشفى :
Clarify the chosen location of the dimensions of the waste treatment unit	توضيح الموقع الذي تم اختياره مع توضيح ابعاد وحدة المعالجة حسب الرسومات المرفقة
Hospital buildings	تسمية مباني المستشفى
Explanation of the hospital yards	توضيح حرم/حوش المستشفى
Clarification of the residences adjacent to the hospital and the distances from the hospital and the incinerator in meters	توضيح المساكن المجاوره للمستشفى والمسافات/البعد عن المستشفى وعن المحرقة بالمتر
Clarifying hospital buildings and identifying distances from the incinerator in meters	توضيح مباني المستشفى و رسم المسافات/ البعد عن المحرقة بالمتر
Clarification of the hospital's medical housing buildings and drawing the distances from the site of the incinerator	توضيح مباني السكن الطبي الخاص بالمستشفى ورسم المسافات/البعد عن موقع المحرقة
Illustration with graphics the paths of torrential water and rain inside the hospital	توضيح بالرسومات مسارات مياه السيول والامطارداخل المستشفى
Illustration of the hospital sewage pits locations if any	توضيح بالرسومات مواقع البيارات التابعة للمستشفى
Illustration the wind direction	توضيح اتجاه الرياح بالرسومات
Clarify the current waste collection areas within the hospital	توضيح الموقع الحالي لتجميع النفايات داخل المستشفى
Clarify the location of the previous incinerator (if any)	توضيح موقع المحرقة السابقة (في حال كانت موجوده داخل المستشفى)

- **LAYOUT (INCLUDING THE WTU LOCATION) اسقاطات المستشفى ومبانيها مع توضيح الموقع الذي تم اختياره للمحرقة وأي متطلبات موجودة في الجدول السابق واتجاه الرياح ويمكن وضع أكثر من خريطة**

- **Photos for the hospital and selected location صور الموقع الذي تم اختياره للمحرقة مع صور توضح النفايات واماكن تجميعها في الوقت الحالي**

- **Names of interviewed hospital staff or nearby residents اسماء الأشخاص الذين تمت مقابلتهم وسؤالهم عن ارائهم بخصوص انشاء المحرقة وتوابعها سواء من موظفي المستشفى أو من السكان المجاورين**

Name الاسم	Gender الجنس	Designation الصفة أو الوظيفة

- **Conclusion and Recommendations ملاحظات المهندس أو ادارة المستشفى او المستفيدين والسكان المجاورين**

1	
2	
3	
4	
5	

ANNEX 3 CONSULTATION AND COMMUNICATION SUMMARY

Summary of Involved Parties During Consultation with MoPHP and Healthcare Authorities

Regular meetings conducted between WHO and relevant MoPHP to discuss the implementation arrangements and proposed designs and locations as follow. Coordination meeting in March 2021 in the MoPHP Sana'a with the attendance of:

No	Name	Gender	Designation
1	Dr. Ali Jahaf	Male	MoPHP
2	Murtadha Almurtadha	Male	MoPHP
3	Eng. Abdullah Alshaikh	Male	MoPHP
4	A.Alkudus Alsharafi	Male	WHO
5	A.Almalik Maofadhal	Male	WHO
6	Nosheen Mohsen	Female	WHO

December 2020 field visits by the Project team to supported facilities involved the following:

No	Name	Gender	Designation
1	Dr. Fadhl ALKABI	Male	Alamal Isolation Unit Manager – Aden
2	Dr. Mohsen Murshed	Male	Ibn Khaldoon Hospital Manager – Lahj
3	Dr. Helmi Ahmed	Male	Ibn Khaldoon Isolation Unit Manager – Lahj
4	Dr. Saleh Hassan	Male	Radfan Isolation Unit Manager– Lahj

Regular visits between Jan 2021 and April 2021 maintained by the Project focal points in the governorates to the supported HFs involved the management of each facility

No	Name	Gender	Designation	Health Facility – Governorate
1	Dr. Mutahar Alsaheli	Male	HF Manager	AlHazm Hospital - Aljawf
2	Dr. Neama Ali	Female	Health Operations Supervisor	Alnasr Hospital - Aldhalea
3	Dr. Nashwan Alhusami	Male	HF Manager	Algumhori Hospital – Taiz
4	Dr. Muntaser Aldahiah	Male	Isolation Unit Manager	Zungobar Hospital – Abyan
5	Dr. Kefaya Aljazeai	Female	HF Manager	Al-Sadaka Hospital – Aden
6	Dr. Helmi Ahmed	Male	Isolation Unit Manager	Ibn Khaldoon Hospital – Lahj
7	Dr. Raed	Male	Deputy Manager	Radfan Isolation Unit – Lahj
8	Dr. Khaled Shaipan	Male	HF Manager	Ibn Sina Hospital – Hadhramout
9	Dr. Yaser Bamatraf	Male	Manager	Ibn Sina Hospital – Hadhramout
10	Dr. Khaled Alayashi	Male	HF Manager	Ataq Hospital – Shabwah
11	Dr. Abdullah Albani	Male	HF Manager	Baihan Hospital – Shabwah
12	Dr. Ali AbuBakr	Male	HF Manager	Assaid Hospital – Shabwah
13	Dr. Khaled Ismail	Male	Services Manager	Mareb Hospital – Mareb

Summary of Involved Parties During WTU Locations Identification

The specific concerns, consulted parties' details, dates of consultations as well as any other details are available with the annex 6 for each facility included under this subproject. However, the table below is summarizing the type, gender and total number of individuals involved during the various consultation stages for each site.

Reports for of the facilities are being validated and once finalized will be submitted in batches to WB for clearance and the below table will be updated with the final consultation summary.

No	Governorate	Name of Hospital	Healthcare workers		Residents around the facility		Other Community members		Total Number	
			M	F	M	F	M	F	M	F
1	Al-Hodeidah	Bajil Hospital	7	4	22	5			29	9
2	Hajjah	Al-Jumhouri Hospital	19	6	4				23	4
3	Saada	Al-Talh Hospital	15	8	3	4	1	3	19	15
4	Hajjah	Khayran Al-Muharraq H.								
5	Hajjah	Qafl Shammar Hospital	11	5	11	5	4	2	26	12
6	Al-Mahweet	Al-Jumhouri Hospital	8	5	4	5			12	10
7	Raimah	AlThulaya hospital								
8	Ibb	Al-Thawra Hospital	4	3	3	1			7	4
9	Taiz	Al-Nashmah hospital	9	14	1		4	1	14	15
10	Sana'a Gov.	Matna 26th Sept H.	9	11	5	5			14	16
11	Amran	22 May General Hospital	23	7	6	6	3		33	13
12	Dhamar	Dhamar General H.	19	11	2	3	2		23	14
13	Al-Baidhah	Al-Thawra Hospital	17	9	3	3	4	1	24	13
14	Al-Baidhah	Radaa Hospital	4	5	1	1	6	5	11	11
15	Al-Jawf	Al-Hazm Hospital	9		2		1	1	12	1
16	Aden	AL-Sadaka Hospital								
17	Lahj	Ibn Khaldoon								
18	Al-Dhalee	Al-Wahdah Hospital	8	4			5	1	13	5
19	Abyan	Al-Razi Hospital	6	7	3				10	3
20	Hadramout	Ibn Sina Hospital	4	4	1	5			5	9
21	Hadramout	Sayoon Hospital	13	10	4			3	17	13
22	Hadramout	Shibam Hospital	10		10				20	
23	Hadramout	Al-Katin Hospital	9	2					9	2
*	Hadramout	Alhayah Hospital	9	2	5				14	2
24	Al-Mahara	Al-AlGhaidhah Hospital	9	4	5	7	4		18	11
25	Shabwah	Ataq Hospital	13	11	4		4		21	11
26	Shabwah	Azzan Hospital								
27	Shabwah	AL-Dofiah Baihan H.	12	5	3	3	5	2	20	10
28	Shabwah	AsSaid Hospital								
29	Lahj	14 October Hospital								
30	Mareb	Mareb General Hospital	4	1	4	3	5	1	13	5
31	Ibb	Jiblah Hospital	8	2	5	3			13	5
32	Dhamar	Alwehdah hospital	20	12	2	3			22	15
33	Taiz	Khalifah hospital	10	10	3		1		14	10
34	Taiz	Althawrah hospital								
35	Taiz	Aldhabab hospital								
36	Mareb	Kara hospital	1		6		2	1	9	1
37	Mareb	Alhazmah hospital			3	1	5	1	8	2

No	Governorate	Name of Hospital	Healthcare workers		Residents around the facility		Other Community members		Total Number	
			M	F	M	F	M	F	M	F
38	Lahj	Alanad hospital								
39	Abyan	Zunjubar hospital								
40	Sana`a	AlHumiat Hospital								
41	Ibb	Alsahoul IU	4	1	4	4	2		10	5
42	Dhamar	Faculty of Education								
43	Hajjah	Vocational institute	13	5	5		1		19	5
44	Raimah	AlMithaq hospital	13	6	5	4			18	10
45	Taiz	AlMakha hospital								
46	Socotra	AlOmoma Center								
47	Aden	Alamal Center								
48	Hadramout	Alfalak AlHumiat hospital	9	5			3	2	12	7
49	Sa`da	Quhza Medical Center	11	6	4		2		17	6
50	Lahj	Radfan Professional Center								

M – Male F – Female

Healthcare workers category includes management, doctors, nurses, cleaners, and administrative workers of the facility.
Residents around the facility category includes the people living in adjacent areas to the facility.
Other Community members category includes patients, visitors or any other community member not living in facility's adjacent premises.

The methodology used to approach stakeholders

- ✓ Meetings, Interviews and Phone calls

Stakeholders involved[4]

Wherever possible the below affected parties have been involved:

- ✓ Different categories from the HF's staff
  - Management.
  - Healthcare Workers.
  - Waste management workers.
  - Administrative workers.
- ✓ People from the HF's vicinity.
- ✓ Patients.
- ✓ Community members.

Considerations

Wherever possible the below vulnerable have been involved:

- ✓ Women.
- ✓ Elderly people over 60 years old.

The information disclosed and discussed

The disclosed and discussed information in brief is

Project financing and implementation: World Bank financing and WHO implementation.

[4] The participants' attendance sheets include participants' signatures and phone numbers and were deleted in the annex for privacy.

The purpose of the consultation

Ensuring that the activity will be carried out better after taking beneficiaries important opinions and taking their concerns and suggestion into consideration before and during the implementation for mitigation measures.

Discussing the environmental and health negative impact and the issues of the current waste treatment

- For the HFs that do not have incinerators what are the environmental and health risks and concerns, and their suggestions of mitigation measures.
- For the HFs that have old or small incinerators, what are the environmental and health risks and concerns, and their suggestions of mitigation measures.

The purpose of the WTUs has been discussed

To develop a solution for the medical waste disposal for a clean and healthy environment in Health Facilities and vicinities.

Technical specifications of Waste treatment Unit

Technical specifications that ensure more efficiency and less impact to the environment.

- Incinerators details and type of waste that can be treated in the WTU
- Installation of activate carbon filters on the incinerators chimney
- Installation of shredder to decrease the plastic waste burning
- Height of the chimney
- Operation details of the incineration units.

Their concerns, and suggestions If the project is going to install a new WTU to mitigate their concerns.

Complaint Mechanism

The Project GM purpose has been explained and the channels have been shared with participants.

In order to provide better services, the project has established a complaint mechanism to ensure that people can submit a suggestion, complaint, or inquiry regarding the project activities. and there is a grievance mechanism to respond to all grievances or suggestions.

	EHNP	YCRP
Toll-free number	8004090	8000844
Email	YEMGRMehnp@who.int	YEMGRMcovid19@who.int
SMS/ WhatsApp		776999014

Arrangements with contractor: The concerns of the importance of the necessary arrangements before and during the implementation of the works. The below mitigation measures have been discussed with them for their further suggestions:

- Contractors should coordinate with the health facility management to ensure that the work area is arranged in safely manner.
- The Contractor shall arrange the necessary equipment, manpower and logistics prior to commencing any activity in close coordination with the HF's management.
- Contractors should consult the health facility managers from the beginning with the work plan and schedule to engage them in monitoring
- The contractor shall share work procedures with the health facility management including working hours, occupational health and safety measures, environmental protection, and waste disposal requirements to ensure the safety of workers, health care workers, and vicinity.
- The contractor shall train his workers and provide them with appropriate personal protective equipment.
- If needed, the health facility may need to contribute and provide a brief awareness session on IPC and COVID-19 basic precautions for contractor workers.

ANNEX 4 WASTE MANAGEMENT GUIDELINE DURING CIVIL WORK ACTIVITIES

1. Introduction

This guideline is meant to provide the necessary instructions to contractors onsite on the appropriate management and disposal of the generated waste from rehabilitation site at the supported facilities under EHNP/YCRP. This guideline includes the types of generated waste, segregation, storage, and disposal methods.

Contractor is responsible for implementation the waste management at the project site as per the applicable rules and regulation and shall avoid under any circumstances dispose the generated waste in a way that could result in harm to the environment or communities.

Storing materials delivered to site carefully to minimize potential damage and creation of waste (off ground storage, maintain original packaging, covered protection from the weather and protection from collision by vehicles).

The main principles of effective waste management in the project site are:

Reduce: efficient use of resources to eliminate or reduce the generation of waste

Reuse: eliminate the waste disposal or incineration by reuse the generated waste

Recycle: recycle the generated waste and avoid disposal or incineration

2. Storage of hazardous substances and wastes

Storage and handling of hazardous substances
Substances that may harm people or the environment shall be handled and stored in a way that prevents accidental release.

- Drip trays shall be placed under leaking under generators, vehicles, and other equipment to prevent spills of hydrocarbons reaching the soil or watercourses.
- Storage of hazardous substances shall have secondary containment, so that leaking liquids can be contained in the event of a failure. Secondary containment should ideally have a capacity of at least 110% of the holding capacity of the primary storage.
- To avoid leaks, proper funnels should be used when decanting to other containers. It is recommended to use a hand pump rather than a funnel and smaller containers for frequent/routine transfers from one container to another (or to a vehicle tank).

Waste storage areas shall be provided on site with:

- Enough space should be allocated on site for the waste expected to be generated.
- Storage areas shall be indicated on site plans for communication purposes.
- Storage areas shall have clear signage to ensure different wastes are stored in the correct place.
- Storage area shall be enclosed to prevent waste escaping – i.e. spread of waste by wind-blown; if possible covered skips are suggested to be used.
- Where possible, waste should be protected from the rain fall/water ingress.
- Waste storage shall not be in the area prone to flooding or on the slope.
- Location of the waste storage should be located within min 30 m from human settlings, animal pastures, water bodies, water sources etc.

Hazardous wastes shall not be mixed with non-hazardous waste and the below shall be considered:

- Organic waste shall not be mixed and stored with non-organic waste.
- Hazardous wastes shall be stored in suitable containment, on impermeable surface.

3. Waste segregation, treatment, and disposal

3.1 Types of waste

- Organic waste
- Inert waste - materials that do not cause environmental pollution or harm to human health or endanger the quality of any surface water or groundwater when deposited in a landfill under normal conditions. These include rocks, ceramics, concrete, masonry, and brick rubble.
- non-hazardous waste - include timber and bitumen
- hazardous waste - waste that is deemed to be harmful to life and/or damaging to the environment. It may be corrosive, reactive, explosive, oxidizing, carcinogenic or flammable i.e asbestos, acids, alkaline solutions, oily sludges, waste oils and wood preservative

3.2 Waste Reuse / Recycle

To the possible extent, the construction and demolition debris should be prevented from disposal into the landfills. This can be achieved by reuse and recycle materials on site. Following examples present how materials can be re-used in which some of the items are applicable to the this intervention:

- Excavated material can be reused for backfilling, this eliminates the need to import other material onto site saving time and money.
- Excavated material (gravel, stone, sand) or other suitable construction waste (brick, concrete) can be used as cover material at the landfill, backfill at new construction sites, for the reclamation of wetlands, for the filling of low-lying areas subject to regular flooding or can be sold to other engineering contractors.
- Scrap metal - has a residual value and can be sold to the scrap metal dealers
- Local waste market should be investigated - potential for recovery and reuse of materials from the waste such as recycling of paper, metals, glass, and plastic.

3.3 Waste Segregation

Segregation is an important step in the waste management procedure as it will help in the recycling and treatment process. It will also ensure no contamination is resulted from the generated hazardous waste:

- Provision of designated waste bins and areas as per each type of generated waste.
- Briefing and awareness to staff on the segregation requirements.
- Organic waste SHALL be segregated from non-organic waste.
- Hazardous waste SHALL be segregated from non-hazardous waste.
- Allocate enough space for the storage and ensure regular transportation.

3.4 Waste Disposal

Disposal of waste from site must only be carried out as per the applicable rules and regulations in an authorized and licensed areas / facilities.

It is essential to carry out review of the local waste practices - what waste facilities are available in the country/governorate. No extension or implementation for new waste disposal areas is allowed under the project.

ANNEX 5 CIVIL WORK ENVIRONMENTAL AND SOCIAL COMPLIANCE MONITORING REPORT

Subproject Title				**Contractor Name**		**Date**	
Governorate		**Health Facility**		**Engineer / ESHS Officer Name**		**Signature**	

1. **List of activities implemented by contractor during the reporting period**

No	Activity Description	Number of workers
1		
2		
3		

2. **Environmental and Social Requirements Implementation**

The symbol ✔ shall be marked under the relevant condition. **Not Applicable** shall be marked only when the activities implemented are not relevant to the mitigation measures proposed.

No	Requirements	Addressed in the Project site			Not Applicable
		Fully	Partially	No	
1	**Water and Landscaping**				
	Implementation of waste management process and disposal according to the projects' requirements and the applicable rules and regulations.				
	Waste is transported to authorized and licensed landfill or dump site which is designated by the city municipality.				
	Reduction of waste generation to the possible extent and to ensure all recyclable waste is properly segregated and treated.				
	Waste disposal to the water ways or within the health facility boundary is not allowed.				
	Dedicated waste collection team provided with the necessary training and Personal Protective Equipment PPE is assigned.				
	Dedicated waste collection area is arranged by the contractor adequate number of bins for each type of waste is provided.				
	Waste segregation at sources is performed and waste transportation outside the hospital yards is performed in regular basis and no waste cumulation within the facility is observed.				
	Work areas is kept free of any debris, scattered litters, or any type of waste at any point of time.				
	Only limited amount of the civil work materials is stored within the work area that is enough for the daily work to avoid excessive storage that might be source of waste generation.				
	Wastewater resulted from the latrines or the civil work activities is collected and disposed in authorized locations.				
	Secondary containments are provided for the of fuel or hydrocarbons storage, soil or water contamination is not observed at any of the work sites.				
	once civil work or decommissioning of existing units completed, reinstatement of such site is performed by the contractor and all waste, debris, soil or any other materials resulted from the civil work removed from the site.				
2	**Ambient Air Quality**				

No	Requirements	Addressed in the Project site			Not Applicable
		Fully	Partially	No	
	Energy source generators are adequately selected, maintained and inspected in regular basis. Minimum emissions are generated during operation.				
	Spraying water regularly to reduce dust generation during excavation activities.				
	Where required, barriers around the civil work areas are installed to avoid any emissions to the occupied premises.				
	Dust generated activities durations and timing to be arranged in accordance with the health service provision and in coordination with the facility management.				
	Additional protection around healthcare provision areas needs to be implemented to avoid any dust ingress such as curtains around the entrances, windows, or any other openings.				
	Provision of the necessary PPE including face masks and goggles to the workers as well as regularly conducting the appropriate training and supervision.				
	Machines or vehicles are adequately selected, free of any damage, inspected and maintained regularly to reduce any pollutant emissions.				
3	**Noise and visual impacts**				
	Machines, generators or vehicles used during the civil work are free from any damage, adequately selected, located in appropriate location and maintained/inspected regularly.				
	Noise generating activities are avoided in the peak hours of health service provision and the timing is arranged with health facility management.				
	Usage of low noise generation tools, machines and equipment				
	Integrity of equipment is ensured by the contractor and the provision of PPE to the workers includes ear protection.				
	When required, barriers surrounding the work area are installed to help in decreasing the impact on the health service provision or the neighboring communities.				
4	**Transportation and Vehicle Movements**				
	Dedicated safe and appropriate routes for the movement of machinery, vehicles, and equipment are arranged away from the patients flow or emergency access.				
	Trained and qualified operators / drivers are assigned for the heavy vehicles and equipment.				
	Movement of heavy vehicles within the subproject areas and healthcare facility is always guided by banks man for signaling.				
	The dedicated vehicles / equipment route is arranged away from any excavated or work at height areas and no movement is allowed during the nighttime.				
	Regular checks and inspections for the vehicles or equipment is performed to confirm the integrity, records to be kept available for any inspection.				
	Reduction of any route closure times, if any, and considering the health service provision as priority.				
	Alternative routes are provided with adequate lighting and signage.				
5	**Occupational Health and Safety**				
	Workers are trained on the OHS requirements, necessary PPE are provided to the workers as well as regularly conducting the appropriate supervision.				

No	Requirements	Addressed in the Project site			Not Applicable
		Fully	Partially	No	
	Work at height is adequately controlled and supervised on secured platforms and all falling protection means are provided.				
	Physical barriers and signs are installed in and around any excavated areas to prevent any soil collapse or personnel/falling.				
	Safe egress and ingress from excavated areas are provided with secure means.				
	Movement of vehicles and equipment properly controlled in dedicated routes by certified operators.				
	The work areas are properly arranged with no slip, trip or fall hazards.				
	Provision of First Aid supplies at the subproject sites with trained personnel.				
	Contractor has prepared incident response and emergency plans that detail the required actions and responsible parties.				
	Electrical and mechanical equipment/tools used in the civil work are well maintained with regular inspection prior the work starts.				
	Any work involves energy sources including electrical work shall be adequately planned and to be performed by qualified personnel with close supervision.				
	All workers involved in the subproject implementation shall be covered with insurance for any work-related injuries or incidents.				
	Regular training and toolbox talks are conducted for workers on the infection prevention measures and control.				
	Latrines, handwashing facilities, disinfectants as well as any other COVID-19 infection prevention and control measures are provided for the workers				
	Contractor ensures all workers onsite are fit, not developing any COVID-19 symptoms, and provided with the necessary awareness in regular basis.				
	Separate access for contractor workers to the work areas without any interaction with the healthcare activities (to the possible extent).				
6	**Community Health and Safety**				
	All work areas (civil or excavation areas) are controlled, provided with adequate physical barriers.				
	Sufficient lighting is available during night, in addition to clear signs / instructions to avoid any unauthorized entry to the work areas.				
	Alternative and safe routes or walkways are provided for any access blocked by the subproject activities, safe patients flow shall be ensured.				
	Adequate lighting, signage and protection for any alternative routes is implemented.				
	Priority is given to the patients flow and emergency access at any point of time during civil work activities.				
	Routes' closure or access blockage minimized, and the work areas are categorized and divided in coordination with the health facility management.				
	Project GM channels are installed in the work site and visible for community members.				
7	**Labor Issues**				
	Enforcement of the CoC implementation for GBV- SEA/SH among contractor and staff. All workers are aware and signed the COC				

No	Requirements	Addressed in the Project site			Not Applicable
		Fully	Partially	No	
	Labor register is maintained and updated by contractor and includes the necessary information as well as labors' age and identification documents.				
	Labors' screening and age verification (more than 18 years) at work site by the Supervision Engineer and to report immediately to PMU any observed deviations.				
	Projects GM channels and awareness materials are available to contractor workers as well as any concerned party to raise any grievance related to the subproject implementation.				
	Contractor at each site is undertaking the primary responsibility for his staff grievances and appropriate mechanism is provided. Work-place grievances are addressed by each contractor in a timely manner.				
	Workers are provided with adequate rest means in the subproject site and working hours are respected.				

3. Recommendations, Conclusion and Notes

1	
2	
3	

4. Supported Photos

ANNEX 6 SITE-SPECIFIC ENVIRONMENTAL AND SOCIAL REQUIREMENTS

This annex will include the final selection report of each facility as per the template of ESMP annex 2 that defined the minimum requirements needed for selection WTU location. The reports are compiled and contains the Projects Engineers reports after the site visits in coordination with facilities management and reviewed by PMU team. The site-specific requirements are included with the environmental and social mitigation measures, monitoring requirements in addition to the consultation and communication summary.

Reports for 12 facilities are included in the ESMP submitted for WB clearance on 31 of October 2021, the reports of same facilities have been updated based on the minor comments received from WB team and resubmitted on 22 of November 2021. Remaining reports are being prepared, reviewed, and/or validated and once finalized will be submitted in groups using the same format of the first batch to WB for clearance.

Due to the files size, the annex 6 including the selection reports is available in the below online link:

SITE-SPECIFIC ENVIRONMENTAL AND SOCIAL REQUIREMENTS

ANNEX 7 GUIDELINE ON THE WTU OPERATION AND OCCUPATIONAL HEALTH AND SAFETY

A. WASTE TREATMENT UNIT OPERATION

1. Scope

This guideline is meant to provide additional information on the waste treatment operation requirements that need to be considered during the project lifetime. The waste management requirements as included in the World Bank general EHS guidelines, EHS guidelines for waste management facilities, EHS guidelines for healthcare facilities and WHO relevant recommendations such as Safe management wastes from healthcare activities shall be considered where applicable during the various operation stages of the WTU. Local regulations and rules shall be applied on all workers (civil servants) involved in the WTU operation including those stated in the Projects documents.

Within the organizational structure of each supported facility, the management shall determine and appoint the staff responsible for WTU operation ensuring all of them are adequately trained and qualified to perform their tasks.

2. Responsibilities

Level of responsibilities in regards the installed units operation requirements at each facility is detailed below

Facility Management

- Ensuring appropriate implementation for the waste management requirements during the day-to-day operation.
- Monitor the workers performance ensuring full adherence to waste segregation, collection, transport and disposal to prevent any injuries or occupational diseases.
- Assignment of qualified and trained staff responsible for waste management and the operation of WTU as well as capable to handle any emergencies.
- Ensuring waste segregation at source is properly implemented by all staff in all facility premises.
- Reporting immediately to the projects team any incidents related to the WTU operations.
- Liaising with the EHNP/YCPR team on any additional support needed for appropriate operation of the WTU.
- Ensuring the workers requirements / queries are timely and adequately responded.

EHNP/YCRP Projects

- Provision of the required PPE and waste management supplies.
- Conducting additional training and awareness on the waste management and WTU operation to the healthcare workers and incinerators operators.

EHNP/YCRP Environmental and Social Team

- Monitoring the waste management performance at the facility level, determine and implement the necessary corrective and or preventive actions.
- Conducting site visits and meeting with workers where needed.

- Ensuring the GM channels are available for supported facilities workers to raise any queries in regards the waste management requirements in addition to respond affectively and timely to such grievances.
- Review TPM reports and ensuring all findings are addressed adequately with the facilities managements.

Healthcare workers

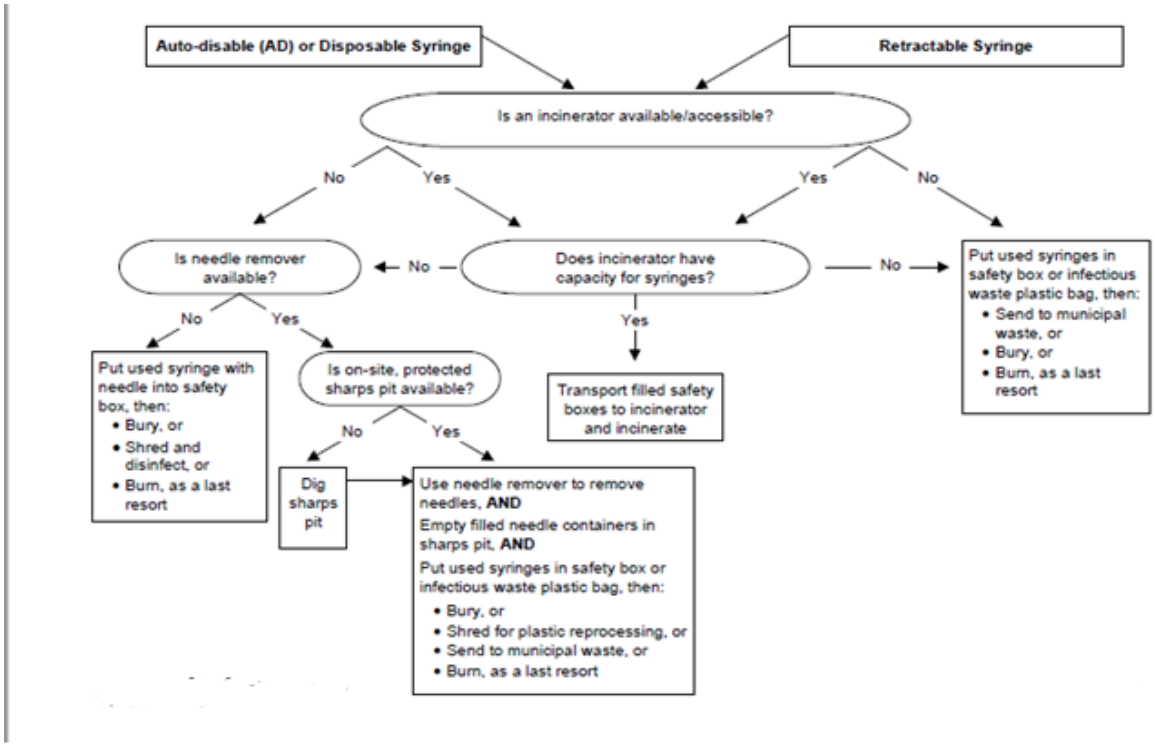
- Full adherence to the waste management requirements and ensuring waste is segregated at source without any deviations
- Workers responsible for the WTU operation shall implement this guideline requirements and ensure the incineration of waste is maintained as per the required guidelines
- Reporting to facilities management and / or projects team any incompliances, deviations and anomalies that might lead to incidents or injuries.

3. Waste segregation, collection, transportation and disposal

3.1 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.
- 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.
- Aerosol cans and other gas containers should be segregated to avoid disposal via incineration and related explosion hazard.
- Segregate products containing PVC to avoid disposal via incineration or in landfills.
- Needles and syringes should be cut using dedicated cutter before disposal
- 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.



Approximate Capacity of Safety Boxes

	5 liter	10 liter
Number of syringes with needles	100	200
Number of syringes without needles	235	470
Weight, syringes with needles	0.5 kg	1.0 kg
Weight, syringes without needles	1 kg	2 kg

3.2 On-site handling, collection, transport and storage

- Seal and replace waste bags and containers when they are approximately three quarters full.
- Full bags and containers should be replaced immediately.
- Identify and label waste bags and containers properly prior to removal.
- Transport waste to storage/disposal areas using designated trolleys / carts, which should be cleaned and disinfected regularly.
- Temporary 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.

- Away 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.
- All waste types shall not be double handed or re-segregated at any point including within the waste treatment units prior the final disposal.
- Store mercury separately in sealed and impermeable containers in a secure location until final disposal as per the applicable local regulations.
- Store cytotoxic waste separately from other waste in a secure location until final disposal as per the applicable local regulations.
- Store radioactive waste in containers to limit dispersion, and secure behind lead shields until final disposal as per the applicable local regulations.

3.3 Segregation, collection and disposal recommendations

3.3.1 WHO guidelines on the healthcare waste classification [5]

Waste categories	Descriptions and examples
Hazardous healthcare waste	
Infectious waste	Waste known or suspected to contain pathogens and pose a risk of disease transmission, e.g., waste and wastewater contaminated with blood and other body fluids, including highly infectious waste such as laboratory cultures and microbiological stocks; and waste including excreta and other materials that have been in contact with patients infected with highly infectious diseases in isolation wards.
Sharps waste	Used or unused sharps, e.g., hypodermic, intravenous or other needles; auto-disable syringes; syringes with attached needles; infusion sets; scalpels; pipettes; knives; blades; broken glass.
Pathological (Organic) waste	Human tissues, organs or fluids; body parts; foetuses; unused blood products.
Pharmaceutical waste, cytotoxic waste	Pharmaceuticals that are expired or no longer needed; items contaminated by, or containing, pharmaceuticals. Cytotoxic waste containing substances with genotoxic properties, e.g., waste containing cytostatic drugs (often used in cancer therapy); genotoxic chemicals.
Chemical waste	Waste containing chemical substances, e.g., laboratory reagents; film developer; disinfectants that are expired or no longer needed; solvents; waste with high content of heavy metals, e.g., batteries, broken thermometers and blood pressure gauges.
Radioactive waste	Waste containing radioactive substances, e.g., unused liquids from radiotherapy or laboratory research; contaminated glassware, packages or absorbent paper;

[5] https://apps.who.int/iris/bitstream/handle/10665/259491/WHO-FWC-WSH-17.05-eng.pdf

Waste categories	Descriptions and examples
	urine and excreta from patients treated or tested with unsealed radionuclides; sealed sources.
Non-hazardous or general healthcare waste	
	Waste that does not pose any specific biological, chemical, radioactive, or physical hazard.

3.3.2 WHO guidelines on the waste storage and collection [6]

Waste categories	Color of container and markings	Type of container	Collection frequency
Infectious waste	Yellow with biohazard symbol	Leak-proof strong plastic bag placed in a container (bags for highly infectious waste should be capable of being autoclaved)	When three-quarters filled or at least once a day
Sharp waste	Yellow, marked SHARPS with biohazard symbol	Puncture-proof container	When filled to the line or three-quarters filled
Pathological (Organic) waste	Yellow with biohazard symbol	Leak-proof strong plastic bag placed in a container	When three-quarters filled or at least once a day
Chemical and pharmaceutical waste	Brown, labelled with appropriate hazard symbol	Plastic bag or rigid container.	On demand
Radioactive waste	Labelled with radiation symbol	Lead box	On demand
General healthcare waste	Black	Plastic bag inside a container or container which is disinfected after use	When three-quarters filled or at least once a day

3.3.3 Recommendations for healthcare waste segregation, collection, and disposal within the installed waste treatment units

Classification	Storage Means	Treatment Means	Disposal Means
General domestic waste including pressurized cans	Black bins / bags	Recycle / reuse or public landfill	Public landfill
Infectious waste	Yellow bags / bins with biohazard symbol	Main incinerator De Montforte Mark 8a	Ashes and remains in the ash pit
Organic waste such as placenta and human tissue	Red bags / bins with biohazard symbol	Organic pit	Organic pit

[6] https://apps.who.int/iris/bitstream/handle/10665/259491/WHO-FWC-WSH-17.05-eng.pdf

Classification	Storage Means	Treatment Means	Disposal Means
Pharmaceutical waste liquid (small quantities)	Brown bins with the proper hazard symbol	Evaporation basin instead of sewage network with strict consideration and attention to the type, manufacturer recommendations and applicable regulations	Remains to be treated based on the manufacture recommendations
Glass waste	Puncture-proof container	Glass crusher	Sharp pit
Sharp waste; needles, syringes	Safety boxes, yellow or red with biohazard symbol. Usage of needle cutter is recommended	safety box reducer	Sharp pit

Additional recommendations on the healthcare waste streams, treatment and disposal are available in:

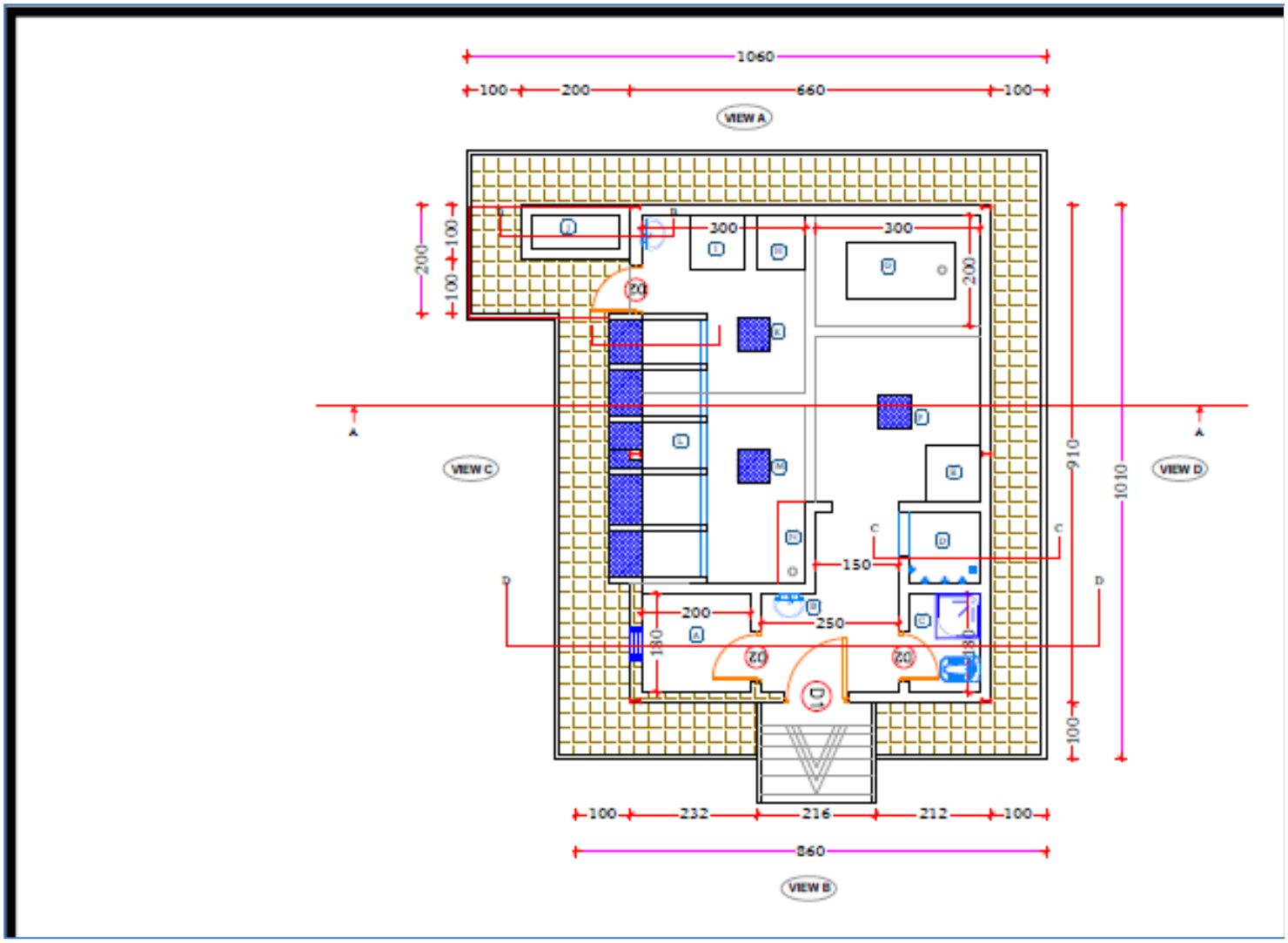
Environmental, Health, and Safety Guidelines for Health Care Facilities - English

Environmental, Health, and Safety Guidelines for Health Care Facilities - Arabic

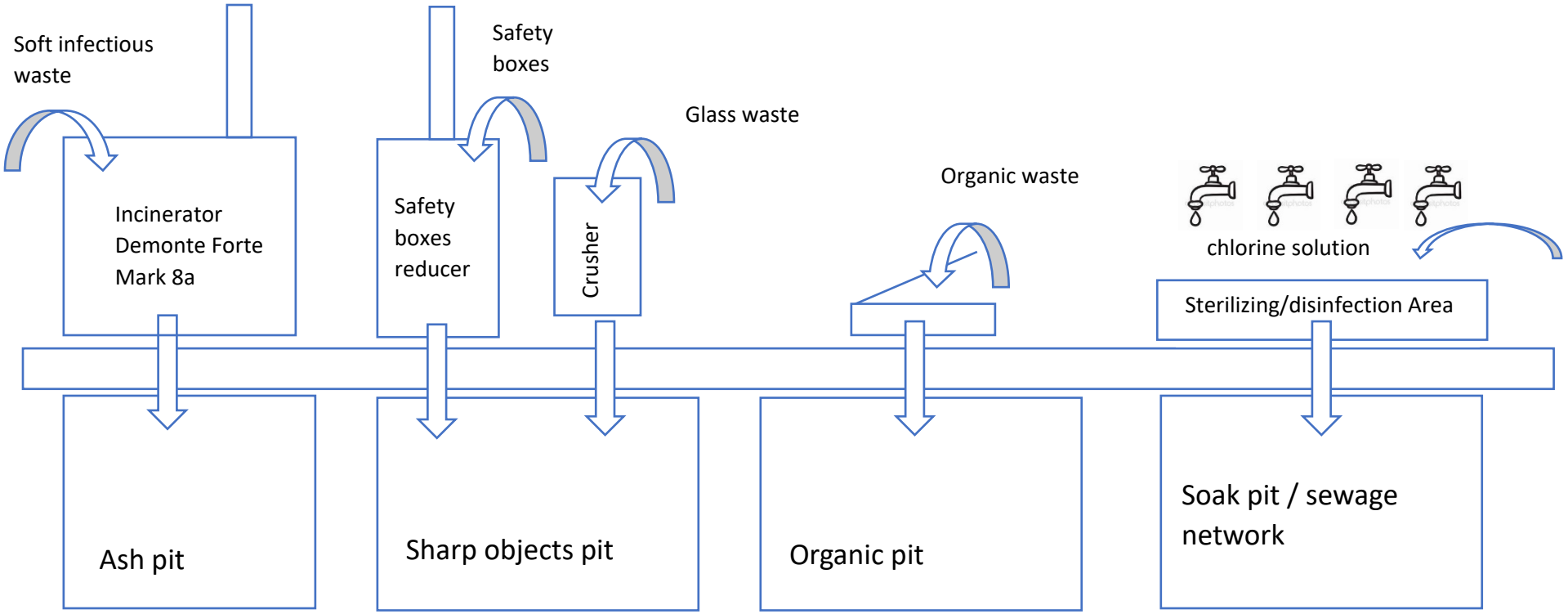
4. WTU Components and operation requirements

4.1 WTU Layout

Legend	
A	Doffing area
B	Hands washing basin
C	Baths
D	Washing/disinfection area
F	Ash pit
G	Infectious waste incinerator
H	Safety box reducer
I	Glass crusher
J	Evaporation basin
K	Sharp waste pit
L	Waste receiving area
M	Organic waste pit
N	Tools box



Simple diagram of main waste streams treatment and disposal



4.2 De Montforte Mark 8a incinerator

Operation guideline [7]

General remarks

- Be careful not to injure yourself by burns, cuts caused by exploding vials or ampoules, or needle stick injuries (all sharps which could accidentally have slipped into the soft waste). So always wear your protective equipment during incineration: overall with long legs and sleeves, heavy duty gloves, safety boots, respirator and face shield / goggles, leather apron if available.
- The removal of the (ash) residues before starting a new incineration cycle is important because they may hinder a good combustion (e.g., due to blockages of the air flow).
- The recommended additional combustibles (for preheating) are dry firewood or dried coconut shells, because their glowing residues in the ashtray help to maintain a temperature buffer when the incinerator is opened to add a new batch of waste. Kerosene and (natural) gas have a higher heating value, but as they don't leave glowing residues behind, they don't have the temperature buffer effect. On top of that, special safety and operator's measures will be required.
- A good combustion, which makes a roaring noise, will consume the soft waste very fast. Therefore, it is important to stay beside the incinerator to keep on charging new batches of (soft) waste. Once the last batch of soft waste has been added into the incinerator and a good fire is noticed as well in the primary as in the secondary combustion chambers, no particular actions have to be done anymore. This is because the fire will die out eventually once all combustible material has been incinerated.
- Once a waste bin is emptied, it can be moved towards the washing area of the waste zone for cleaning and disinfection!
- Hands should be washed with water and soap after the intervention.
- **Do not incinerate**:
    - Pressurized gas containers
    - Large amount of reactive chemical waste
    - Silver salts, photographic or radiographic waste
    - Halogenated materials such as PVC plastics
    - Waste containing mercury, cadmium and other heavy metals
    - Sealed ampoules or vials
    - Radioactive waste

Curing the incinerator

- Heat up charcoal until it is hot, outside of the incinerator. In absence of charcoal, normal wood can be burnt as well until hot residues are obtained.
- Transfer the hot charcoal in the incinerator's ashtray.
- Slide the ashtray inside the incinerator to heat it up slowly.
- Remove the ashtray from the incinerator once the charcoal has cooled down completely.
- Repeat this action several times, depending on the humidity of the incinerator.
- Try having the charcoal a little hotter each time, until it is eventually red hot.

[7] Guidelines and photos are from MSF construction & operation manual of De Montfort incinerator – 2012

- **The curing of the incinerator is essential. When the incinerator is put in function without this procedure, the humidity (water) inside its refractory bricks and mortar will expand rapidly, leading (rather) quickly to irreparable cracks. The curing procedure will permit the humidity to evaporate slowly, thus reducing the risk of these cracks.**
- **Curing is always done for high-temperature ovens / incinerators made with refractory bricks. In high-income countries, the slow evaporation is reached by keeping the oven / incinerator during several days at a constant temperature of 150 °C with gas burners. As this might be difficult to implement in low-income countries, the above-mentioned procedure is proposed.**

Operation steps

	
Step 2 Remove the ashtray from the incinerator. Make sure the residues have cooled down enough to avoid injuries and not to damage the cleaning equipment.	**Step 1** Open the residues (ash) pit.
	
Step 4 Wipe the remaining ashes off the ashtray into the residues pit by means of a small brush.	**Step 3** Empty the ashtray in the residues pit.

	
Step 6 Empty the dustpan in the residues pit.	**Step 5** Clean the lower inner part of the incinerator by means of a brush and a dustpan
	
Step 8 Put the ashtray back in the incinerator. Don't slide the ashtray completely to the back yet, as the fire will be lit via the ashtray opening.	**Step 7** Close the residues pit.
	
Step 10 Choose a waste bin with plenty of paper and cardboard (e.g., from the administration), and pour some via the loading door into the incinerator. Load maximum up to half the height of the combustion chamber, without compacting.	**Step 9** Open the loading door of the incinerator.

	
Step 12 Close the loading door. It is recommended to make it a habit to always stand aside the air inlet, which is integrated within the ashtray door (see further).	**Step 11** Add some dry firewood on top of the paper and cardboard. The wood sticks should have a diameter of maximum 2 – 3 cm, and not be longer than the loading opening of the incinerator. Make sure the wood is really dry. Dried coconut shells or wood shavings can be used as well.
	
Step 14 Close the ashtray door completely once the fire has taken off well.	**Step 13** Light the paper and/or cardboard via the ashtray opening, and let the fire take.

Step 16

Prepare for loading (soft) waste when high flames are visible in the secondary combustion chamber.
In case the fire in the primary combustion chamber starts to die out without having flames in the secondary combustion chamber or if the temperature below 850°C, more dry firewood (or dried coconut shells / wood shavings) will have to be added.

Step 15

Verify after a while via the little peephole at the back of the incinerator if flames start to develop in the secondary combustion chamber.
This may take some minutes.

Step 18

Fill the incinerator via the loading door with (soft) waste or more dry firewood / coconut shells / wood shavings.
The additional combustibles are only necessary if no flames are visible in the secondary combustion chamber.

Step 17

Open the loading door.
Always stand to the side of the incinerator and behind its loading door when the latter is opened. With the ongoing fire, a big flame might shoot out of the primary combustion chamber just after the loading door has been opened.

Step 19

Close the loading door immediately once the filling is completed in order to avoid that too much heat is lost.
Always stand to the side of the incinerator when closing the loading door as a flame might shoot out of the air intake at the bottom of the incinerator (integrated within the ashtray door). This is a risk when the loading door is closed too quickly.

Step 20

Verify shortly after via the little peephole at the back of the incinerator if flames are still visible in the secondary combustion chamber. If not or when temperature goes below 850°C, add plenty of dry wood.

High quantities of wet (soft) waste reduce the combustion temperature a lot (potential sizzling noise), thus the fire in the secondary chamber can't be sustained.

Step 21

Keep on repeating the filling procedure on a very regular basis until all the (soft) waste has been incinerated.
(steps 17 till 20).
Experience will learn when new batches of (soft) waste will have to be added. But be aware that once the incinerator is working properly, the combustion process goes very fast.

Step 22

Push the waste that has fallen beside the loading opening into the incinerator by means of a metal stick or a solid brush, after having added the last batch of (soft) waste.

Step 23

Close the loading door and let the last batch burn until the fire dies out naturally.

No extra attention should be given to the last batch, except when the fire would die out immediately due to a too high humidity content of the waste. If this is the case, additional combustibles should be added.

The ashes should only be removed after they have cooled down completely, so at the next incineration cycle (e.g., the next day).

4.3 Safety box reducer

Operation guideline [8]

General remarks

- **Don't use** the Safety Box Reducer for any other waste than AD-syringes stored in Safety Boxes (glass sharps might explode due to the heat, causing serious injuries / the ashes of soft waste will fill up the sharps pit too fast).
- If a second Safety Box needs to be eliminated, wait until the first one is burning well before adding the second one.
- Make sure to wear all the Personal Protective Equipment during operation; overall (multipurpose) heavy duty gloves, safety boots, face shield (or goggles), respirator (or at least dust mask) and preferably a leather apron.
- Hands should be washed with water and soap after the intervention.

Curing the incinerator

- Heat up charcoal until it is hot, outside of the Safety Box Reducer.
- In absence of charcoal, normal wood can be burnt as well until hot residues are obtained.
- Transfer the hot charcoal in a metal tray.
- Slide the tray inside the Safety Box Reducer **to heat it up slowly.**
- Remove the tray from the Safety Box Reducer, once the charcoal has cooled down completely.
- Repeat this action several times, depending **on the** humidity of the Safety Box Reducer.
- Try having the charcoal a little hotter each time, until it is eventually red hot.
- **The curing of the Safety Box Reducer is essential. When the Safety Box Reducer is put in function without this procedure, the humidity (water) inside the refractory bricks and mortar will expand rapidly when fired, leading (rather) quickly to irreparable cracks. The curing procedure will permit the humidity to evaporate slowly, thus reducing the risk of these cracks.**
- **Curing is always done for high-temperature ovens / incinerators made of refractory bricks. In high-income countries, the slow evaporation is reached by keeping the oven / incinerator during several days at a constant temperature of 150 °C by means of gas burners. As this might be difficult to implement in low-income countries, the above-mentioned procedure is proposed.**

[8] Guidelines and photos are from MSF construction & operation manual of Safety Box Reducer – 2012

Operation steps

	
Step 2 Slide the “full” Safety Box inside the Safety Box Reducer.	**Step 1** Open the loading door of the Safety Box Reducer and check if there are any blockages of the previous cycle.If there are blockages, push them downwards with a metallic poking bar.
	
Step 4 Light the Safety Box at its handle and verify if the fire catches well. A piece of burning paper can ease the lighting.	**Step 3** Pour some kerosene over the Safety Box, mainly on and around its handle.

Step 5

Close the door and let the Safety Box with its content burn.

No extra attention should be given to a well flaming Safety Box as it will burn completely, and the residues (ashes and needles) will fall straight into the sharps pit.

4.4 Chemical disinfectants

The aim of disinfection is to eliminate microorganisms or at least reduce their numbers to an acceptable level.

The types of chemicals used for disinfection of healthcare waste are mostly chlorine compounds, aldehydes, lime-based powders or solutions, ozone gas, ammonium salts and phenolic compounds. Formaldehyde and ethylene oxide are no longer recommended for waste treatment due to significant hazards related to their use.

Characteristics of sodium hypochlorite (NaOCl) as a chemical disinfectant

Application

Active against most bacteria, viruses and spores; not effective for disinfection of liquids with high organic content, such as blood or stools; widely used for treatment of wastewater. For waste, operating parameters should be adjusted on the basis of bacteriological tests.

Physical and chemical properties

Available as aqueous solution with 2–12% of active chlorine; at ambient temperature, slowly decomposes into sodium chlorate, sodium chloride and oxygen; solutions of low concentration are more stable; solutions should be protected from light, which accelerates decomposition; reacts with acids to produce hazardous chlorine gas.

Health hazards

Irritant to skin, eyes and respiratory tract; toxic.

Protective measures

Gloves and protective eyeglasses should be worn during handling of sodium hypochlorite to protect skin and eyes; in case of eye contact, the eyes should be rinsed abundantly with water.

Corrosiveness

Aqueous solutions are corrosive to metals; usually stored in plastic containers in well-ventilated, dark and leakage-proof rooms; should be stored separately from acids.

Comments

Sodium hypochlorite may be widely used because of relatively mild health hazards. Unused solutions should be reduced with sodium bisulfite or sodium thiosulfate and neutralized with acids before discharge into sewers. Large quantities of concentrated solutions should be treated as hazardous chemical waste.

Sodium hypochlorite is a commonly used disinfectant in health-care facilities and often referred to as "hypochlorite". It is readily available and effective in inactivating bacteria, fungi and viruses, as well as controlling odour. However, the biocidal activity of hypochlorite is diminished by a high organic content in liquid waste, such as blood. It is an irritant of the respiratory tract, skin and eyes, and should be handled carefully.
Do NOT mix chlorine solution with other cleaning products or chemicals.
Do NOT put chlorine solution in mouth or eyes.

Utility gloves or heavy-duty, reusable plastic aprons are cleaned with soap and water, and then decontaminated with 0.5% sodium hypochlorite solution each time they are used. Sodium hypochlorite at 0.1% (1000 ppm) can be used for surfaces disinfection and 0.5% (5000 ppm) for disinfection of blood or bodily fluids spills in healthcare facilities. [9]

5. Emergency Preparedness and Response

Emergency condition related to the waste treatment units operation might occur including occupational exposure to infectious materials, accidental releases of infectious or hazardous substances to the environment, medical equipment failure, failure of waste treatment facilities.

The healthcare waste management plans shall be implemented including the continuous monitoring of workers health and safety as well as the handling, treatment, storage, and disposal of waste. The following measures need to be implemented in all supported facilities:

- Proper training of workers.
- Provision of equipment and clothing for personal protection.
- Establishment of an effective occupational health program that includes immunization, post exposure treatment, and medical surveillance where applicable.

5.1 Emergency response

One staff member from the existing facility staff shall be designated as responsible for the handling of emergencies within each facility, including coordination of actions, reporting to managers and regulators, and liaising with emergency services, and a deputy shall be appointed to act in case of absence. In healthcare 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 spillage involves 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.

5.2 Response to injuries

All staff handle healthcare waste shall be trained to deal with injuries and exposures. The program includes the following elements:

- Immediate first-aid measures, such as cleansing of wounds and skin, and eyes washing with clean water.
- In immediate report of the incident to a designated responsible person of the item involved in the incident; details of its source for identification of possible infection; additional

[9] https://apps.who.int/iris/bitstream/handle/10665/331846/WHO-2019-nCoV-IPC_WASH-2020.3-eng.pdf

medical attention in an accident and emergency or occupational health department, as soon as possible.
- Medical surveillance.
- Blood or other tests if indicated.
- Recording of the incident.
- Investigation of the incident, and identification and implementation of remedial action to prevent similar incidents in the future.

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

5.3 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.
- Provide first aid and medical care to injured individuals.
- 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.
- 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 as 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 the 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.

5.4 Reporting accidents and incidents

All waste management staff shall be trained in emergency response and made aware of the correct procedure for prompt reporting. Accidents or incidents, including near-misses, spillages, damaged containers, inappropriate segregation, and any incidents involving sharps shall be reported to the designated person in the facility. The report should include details of:

- The nature of the accident or incident.
- The place and time of the accident or incident.
- Any other staff who were directly involved.
- The direct and indirect causes as well as the consequences.
- Photos of the incident scene.
- Corrective and preventive actions performed.
- The precautionary measures implemented and recommendations to prevent reoccurrence.

B. OCCUPATIONAL HEALTH AND SAFETY REQUIREMENTS

1. Scope

This guideline is meant to provide additional information on the occupational health and safety requirements need to be considered during the WTU operation. The OHS requirements as included in the World Bank general EHS guidelines, EHS guidelines for waste management facilities and EHS guidelines for healthcare facilities will be considered where applicable during the various operation stages of the WTU. Local regulations and rules shall be applied to all workers involved in the WTU operation including those stated in the projects documents.

Within the organizational structure of each supported facility, the management shall determine and appoint the staff responsible for WTU operation ensuring all of them are adequately trained and qualified to perform their tasks.

2. Responsibilities

Level of responsibilities in implementing the OHS requirements at each facility is detailed below

Facility Management

- Ensuring appropriate implementation for the OHS requirements during the day-to-day operation.
- Monitor the workers performance ensuring full adherence to prevent any injuries or occupational diseases.
- Provision of the necessary supplies for waste management as well as the necessary PPE.
- Assignment of qualified and trained staff responsible for the operation of WTU as well as capable to handle any emergencies.
- Ensuring waste segregation at source is properly implemented in all facility premises.
- Reporting immediately to the projects team any OHS incidents or injuries related to the WTU operations.
- Liaising with the EHNP/YCPR team on any additional support needed for appropriate operation of the WTU.
- Ensuring the workers requirements / queries are timely and adequately responded.

EHNP/YCRP Projects

- Provision of the required PPE and waste management supplies.
- Conducting additional training and awareness on the waste management and WTU operation to the healthcare workers and incinerators operators.

EHNP/YCRP Environmental and Social Team

- Monitoring the OHS performance at the facility level, determine and implement the necessary corrective and or preventive actions.
- Conducting site visits and meeting with workers where needed.
- Ensuring the project GM channels are available for supported facilities workers to raise any queries in regards the OHS requirements in addition to respond affectively and timely to such grievances.
- Review TPM reports and ensuring all findings are addressed adequately with the facilities managements.

WTU Workers

- Full adherence to the PPE and OHS requirements during the waste handling and WTU operation.
- Reporting to facilities management and / or projects team any incompliances, deviations and anomalies that might lead to incidents or injuries.

3. Personal Protective Equipment

- PPE shall be provided to the workers involved in the WTU operation in adequate quality and quantity. PPE shall be provided and replaced in regular basis.
- Workers shall always adhere and wear the necessary PPE during the incinerators' operation or exposure to the waste.
- Workers shall use the PPE while in duty, all PPE shall be removed prior leaving the workstation.
- Adequate hand hygiene shall be implemented at all times.
- WTU are provided with toilets and showers for workers to use prior leaving the WTU and after exposure to any waste.

Minimum PPE requirements for the workers involved in the WTU operation is available below:

Objective	Associated Hazards	Recommended PPE	Replacement Frequency Examples
Eye and face protection	Flying objects, molten metal, liquid chemicals, gases or vapors, light heat radiation.	Safety glasses, safety goggles, face shields, etc.	Damage, broken parts, splash, scratches, lack of visibility etc.
Respiratory protection	Dust, fogs, fumes, mists, gases, smokes, vapors.	Facemasks with appropriate filters for dust removal and air purification (chemicals, mists, vapors and gases).	According to the protection equipment type, manufacturer instruction, visible damage, defect, breathing difficulty, etc.

Objective	Associated Hazards	Recommended PPE	Replacement Frequency Examples
Body Protection	Heat radiation, chemicals, dirt, etc	Apron, long sleeve Coverall	Dirt, dust accumulation, torn.
Head protection	Falling objects, inadequate height clearance, etc.	Helmets	Visible damage or break, shelf life, excessive exposure to dirt, etc.
Hearing protection / if needed	Noise	Ear plugs or earmuff, based on the required noise reduction level	Based on the protection type (single or multiple use), visible damage etc.
Hand protection	Hazardous substances, sharp objects, cuts or lacerations, vibrations, extreme temperatures.	Gloves made of rubber or synthetic materials (Neoprene), leather, steel, insulating materials, etc.	Visible damage, torn, dust accumulation, etc.
Foot protection	Falling or rolling objects, pointed objects. Corrosive or hot liquids.	Safety shoes and boots for protection against moving & falling objects, liquids and chemicals.	Visible damage, torn, liquid penetration, etc.

4. Hazards Associated with the WTU Operations

Hazards associated with the work at the WTU include:

- Slip / trip / fall.
- Flying, sharp objects.
- Exposure to heat.
- Exposure to dust, fumes.
- Occupational diseases.
- Exposure to hazardous substances, toxic materials, pathogens, and biological microorganism.
- Fire and chemical spills.
- Ergonomically hazards from the physical activities.
- Psychological hazards including stress, work dissatisfaction and social issues.

5. Applicable Mitigation Measures

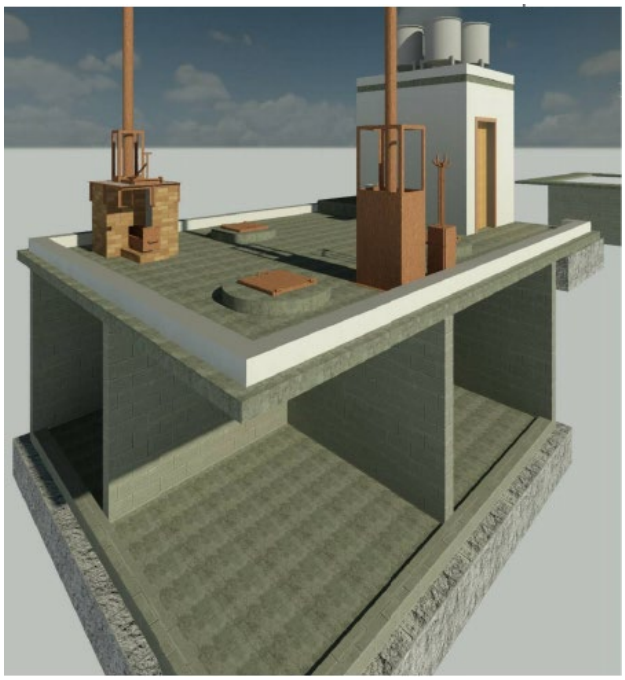
Mitigation measures that need to be applied to provide necessary protection to the workers involved in the WTU operation include:

- Qualified and trained workers are assigned for the WTU operation.
- Regular monitoring by the facilities management for the waste management process as well as the WTU operation.
- Provision of PPE, IPC and waste management supplies in adequate quality and quantity,

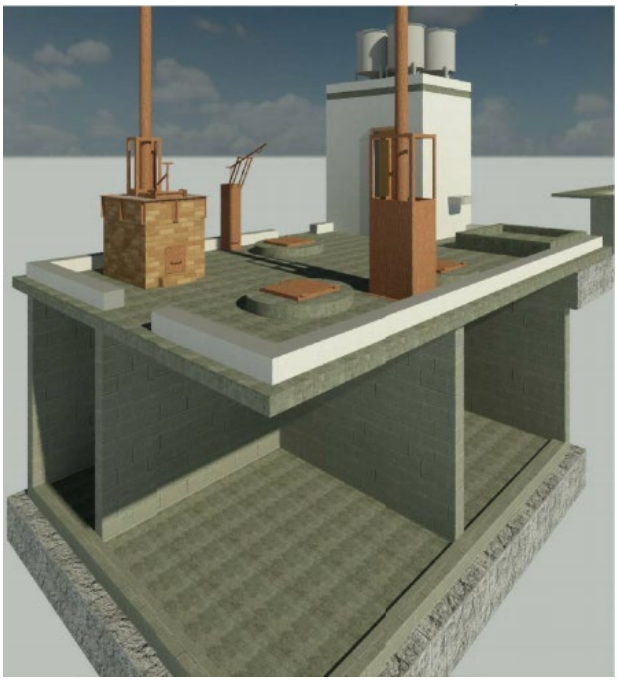
- Regular inspection for the WTU premises and incinerators operation.
- Full adherence to the PPE requirements by the WTU workers.
- Implementing the IPC practices and cleaning for the WTU areas in regular basis.
- Waste shall not be segregated at source and no additional segregation is implemented within the WTU areas.
- Appropriate procedure for emergencies management shall be followed.
- Workers immunization as applicable.

ANNEX 8 AUDIT REPORT - EXISTING WASTE TREATMENT UNITS EVALUATION

Performance Evaluation of Medical Waste treatment at two tertiary hospitals in Yemen



Hodeidah MWU



Sa'adah MWU

Final Draft Report

Prepared by

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June 2020

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Performance Evaluation of Medical Waste treatment at two tertiary hospitals in Yemen

1. Summary:

This assignment reviews the locally implemented medical waste treatment and disposal units by WHO in two General hospitals, namely Al-jomhoori in Sa'adah and Al-Thawrah in Hodeidah both in Yemen. The treatment unit consists of several components as follows: 1- De Montforte Incinerator-Mark 8a, 2- Safety box reducer, 3- Glass crusher, 4- Organic pit, 5- Ash pit, 6- Sharp pit, 7- Cleaning and disinfection basin.

The units were implemented at 2018 and handed over to the hospital's administration after the on-job training by the contractor and later by WHO office.

The units were implemented by using material from local market with imported refractory bricks and cement to resist the high temperature of more than 600^{o}C. The main missing component was the temperature indicator thermometer which control and monitor the De Montfort incinerator's efficiency (ACFincieratorsandsharpmangament2017). During the mission of the consultant, digital thermometer at each unit was installed to facilitate studying the performance and efficiency of the De Montforte incinerators during its operation, and make sure that the temperature reaches more than 600^{o}C before start loading and burning the infectious waste which would avoid dioxin emission to the environment at the combustion first and second chambers through the three steps of burning i.e. drying, pyrolysis and combustion (practical action 2000).

When comparing the two units in both hospitals, it was noticed that they are almost identical with only different glass crushers and the absence of the safety fence around the safety box reducer in Sa'adah. Interestingly, according to the BOQ of the contractor, iron sheet was implemented at the internal walls of the sharp pit, which would be subjected to corrosion at that humidity site, which suggest being eliminated in the future. Both units are operated 8 hrs. a day within two shifts, 7 days a week. The operation is conducted by a contractor in Sa'adah while in Hodeidah the unit is operated by the hospital staff.

The treatment unit in Sa'adah is situated in the old city at crowdy residential area and close to the hospital buildings which make it unsuitable position that led to complaints from both residents and hospital staff. However, due to the mild weather in Sa'adah with low humidity, the components metallic part is still in a good condition with less corrosion. On the other hand, the treatment unit in Hodeidah is situated in the same vicinity of the hospital but at a remote area with no residential buildings and at the same time far from the hospital buildings which make it suitable position with no complaints from the neighborhood nor hospital staff. However, due to the natural weather conditions in Hodeidah as a coastal area with high temperature and humidity, the components metallic part was highly corroded and deteriorated with high corrosion. This difference in weather was not considered during the selection of the metal type, thickness and coating, which led to deterioration of chimneys, its caps and stop of operating safety box reducer which would decrease drastically the shelf life of the treatment units.

Comparing the implemented units with the manual of the standard design found in the internet concerning the De Montforte incinerator, it was found that the design period is 3-5 yrs. It was noticed that there is missing parts not implemented, such as internal and external framework that prevent walls cracking, baffle plate at the loading door, top framework filled with concrete and sand insulation that prevent escaping the smoke from the incinerator to the room during operation, the front ventilation openings that supply air to agitate the flame, the chimney spigot, the channel to divert rain from chimney. Accordingly, the detailed drawings for the as built and standard design was prepared for both units in Sa'adah and Hodeidah.

The incinerators chimneys, its cap, and the body of the safety box reducer should be replaced with stainless steel especially at coastal area such as Hodeidah.

It is recommended to repair the deteriorated parts in both units such as the pits covers with plastic material or with thickness of 5mm iron sheets, the chimney at both Hodeidah and Sa'adah, the rainwater angles of the chimney at the roof level, install baffle sheet at the loading door, air front opening, applying the ash tray cover which found standstill not used during the field visit as it is meant to agitate the flame with air, repairing ash tray, repairing the external iron sheet of the safety reducer in Hodeidah, decrease the level of the taps and handwash basing and disinfection taps, install shelves for the room, tiling the room floor to facilitate proper washing and cleaning of the floor, painting with epoxy the cleaning and disinfection, change the opening direction of the external and internal doors to be opened to outside for the sake of safety for easy escape of the operator in case fire happened inside, replace the roof insulation material with glass wool insulator to avoid corrosion and deterioration of the steel roof.

Out of calculation of the operation cost of around 600 US $/month and estimated cost of implementation of around 35,000 US $, for five years, the total cost will last around 70,000 us $ as the cost of the treatment unit implementation and operation every 5 yrs.

It is also recommended to consider the missing parts in the future projects such as shown in the attached drawings such as: the bracing frameworks at the top of the De Montforte incinerator to fix the internal and external bricks, the glass crusher in Hodeidah need to be replaced with the same model as in Sa'adah.

Moreover, several observations were noted during the field visit regarding to the segregation at different sections of the hospitals, such as the un-controlled segregation at different sections of the hospitals where some time they mix the medical with domestic garbage that increase the volume of the waste need to be incinerated which reduce the life span of the unit. On the other hand, sometimes, they unconsciously drop the medical waste in the domestic garbage which would harm and infect the people and environment inside and outside the hospitals, including the workers working in the domestic garbage and the pickers at the landfill site as well as the soil and groundwater. The consultant during the mission has conducted training and awareness sessions with the concerned staff of the health facilities in both Hodeidah and Sa'adah gathering the quality control responsible and cleaning staff as well as unit operating staff and the head of the different medical sections. A separate meetings were also held with the head of each Hospital to discuss our recommendations for the short and long term rehabilitation program, operation and develop consciousness of the importance of the segregation and continuous on the job training with PPE, utilizing the contractor of the treatment unit operation in preparing formal manual and conduct training to apply it, place awareness flashes, posters and stickers on the medical waste disposal containers with providing enough containers and PPEs to protect the community, staff patients and visitors, especially from infection with cholera and Corona (Covid-19) and hepatitis.

Regarding to the liquid waste, the contaminated blood should also be disinfected by means of adding chlorine or using autoclave before discharged in the sewerage network. The chemicals and medias from labs and expired liquid medicine should be collected in plastic bottles and treated in a suggested evaporation basin that could be designed according to the volume of the chemicals and medicine to be disposed and later the dried material to be incinerated. Nevertheless, to achieve healthy and clean environment and avoiding complaints of the people living around the unit from the smoke and odor getting out of the incinerator's chimneys and the pits ventilation columns, it is recommended to install an activated carbon filter to be installed at the top of the chimneys. Corrosion resistant type and thickness of metal should be considered.

The challenges facing the hospital in medical waste management is as follows: define the generated wastes outcomes from each section, both solid or liquid, define the route and method of treatment. This needs group efforts from the quality control officer and the section heads. This will result in a guide of classification of waste with type of treatment. This will result in an operation manual to connect each type of waste with the treatment component of the unit under direct supervision of the quality control department.

Nevertheless, it is not logic to use such important project for a short period and transfer to another site, rather we recommend evacuating the pits when it gets 80% full while using the suggested standby location for organic pit to be enough for one year. Also two standby sites for new future implementation of the De Montforte incinerator and safety box incinerator. Arrangements are for the chimney opening at the steel roof and opening for the safety box reducer at the RC slab to the sharp pit - see engineering drawings- see Annex-5.

It is recommended to use such low cost medical waste treatment units provided that implementing with complete parts of all units as mentioned in the attached engineering detailed drawings under engineering supervision, with high quality material, operating with high performance and environmentally safe, with proper medical waste management including segregation, flow line for each type of waste with proper treatment needed, prepare operation manual with more stringent operation in association of awareness.

2. Introduction:

Medical Solid and Liquid Waste Management entails a proper approach to creating sustainable systems that are economically affordable, socially acceptable and environmentally effective.

Reasons to Prioritize Proper Medical Waste Disposal

- **Legal** – Maintaining compliance with OSHA guidelines for how to manage and dispose medical waste helps to reduce legal liabilities.
- **Health** – Properly collecting and disposing waste helps to minimize potential infection risks from contaminated materials.
- **Environment** – Using proper treatment methods like incineration helps to keep hazardous medical waste out of landfills and oceans.

Health care waste generated from health facilities is second most hazardous waste after radioactive waste. It is generated as a by-product from the health care services. Major portion (i.e. 85%) of the health care waste is like general waste while a small portion (i.e. 15%) represent the hazardous and infectious waste which poses high health risk to the health workers and communities. The composition of Domestic and Medical components in the health care waste is shown in Table (1) and Fig. 1.

Table 1. waste produced in the Hospitals

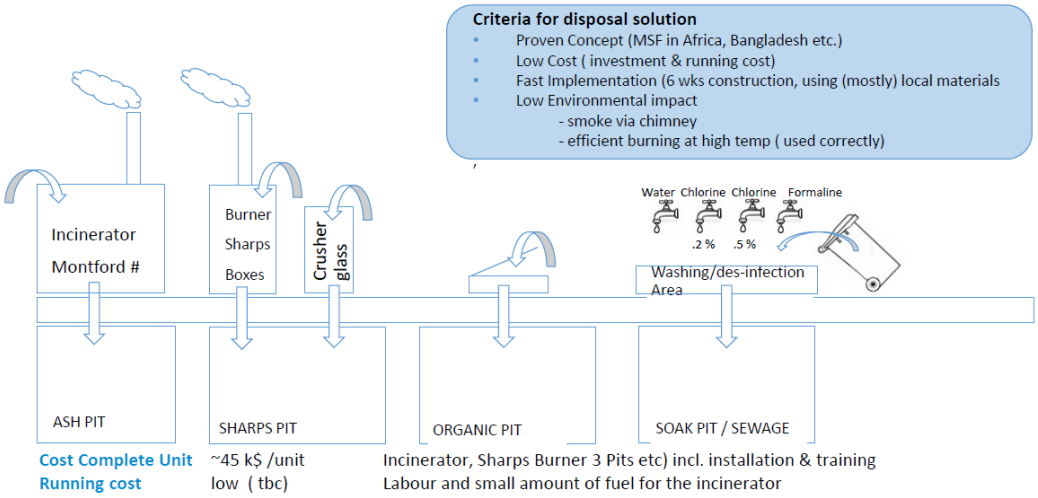
Domestic Waste (85%)	Medical waste (15%)
• Domestic Waste including pressurized cans	• Infectious waste
	• Organic waste (placenta and human body tissue)
	• Glass waste
	• Sharps in Safety box
	• Pharmaceutical waste
	• Chemical and liquid lab waste • Expired blood • Contaminated blood

The situation is more alarming when consider the increased in the rate of infections worldwide, e.g. recent studies indicates that 33% of the hepatitis B and 42% of hepatitis C infections are occurring due to direct or indirect exposure to infectious waste. The current practice in most of the hospitals is to co-dispose (without segregation) with the normal domestic waste to the open dump sites for open burning.

A HCWM system consist of hardware components including waste treatment unit, tools and equipment, trained personnel to perform and supervise, and a system to transport and disposed of hazardous waste from the point of generation to disposal unit.

The existing situation of the health facilities is that most of the hazardous waste is either openly burned or thrown away with domestic waste. Keeping in mind the environmental impacts of medical waste, the cost of mismanagement of the medical waste is larger than treatment cost. It should be ensured that the treatment units are constructed according to the technical guidelines along with training of the supporting staff and following the best practice for its operation reducing the volume of waste through segregation and proper treatment for each waste category.

It is important to note that no one single treatment method can manage all the waste materials in an environmentally effective way. Thus combination treatment methods suited to each type of medical waste are chosen.
The suggested treatment unit for the hospitals is shown as the following schematic diagram (Fig. 1) Medical waste management



Source (WHO, WB, UNICIF)
Fig. 1. The suggested treatment unit for the hospitals

The proposed treatment unit is already in use in Yemen and other countries. Under EHNP, WHO conducted assessment which identified HFs for implementing corrective actions and presented recommendations of medical waste management & disposal options, including required capacity building and training activities of concerned health care staff on medical waste management and assigning a staff in the health facility to be in charge of managing waste at HF level. Table (2) shows the summary of WHO recommended waste classification, collection and disposal methods

Table 2: Summary of WHO recommended waste classification, collection and disposal methods (WHO, 2018)

Classification	Definition	Collection	Disposal
Sharps	Needles, scalpels, ampoules, broken glass/vials	Puncture-resistant container marked SHARPS	Direct disposal or burnt

Organic/ Anatomical	Human tissues, organs or fluids; body parts; fetuses	Yellow plastic container with lid (puncture resistant, leak proof)	Disposed daily into placenta pit
Hazardous/chemical	Waste managed on case by case basis.	Follow specific in-country guidelines and advice of specialist	
Infectious (MSF class as Soft)	Waste contaminated with blood and other bodily fluids; cultures and stocks of infectious agents from laboratory	Yellow plastic container with lid (puncture resistant and leak proof)	Burnt at 900 ^{o}C
General Waste (MSF class as Soft and handle as per Infectious waste)	Waste that does not pose any particular biological, chemical or physical hazard (accounts for 85% of facility waste)	Black colored containers	Recycled/burnt/ buried

Table 3 show the types of biomedical waste and their options
Table 3: Different types of biomedical waste and their disposal options

Cat	Waste composition	Disposal options
1	Human anatomical waste-human tissues, organs, body part	Incineration/Deep burial
2	Animal waste-animal tissue, fluid, blood, carcass, etc	Incineration/Deep burial
3	Microbiology and biotechnology waste-from labs	Autoclave/Microwave/Incineration
4	Sharp waste-needles, syringes, scalpels (used/unused)	Incineration for needles and sharp waste, needle cutters to be introduced where the plastic will be shredded and soaked in 0.2% Clorine solution for 2 hrs .
5	Discarded medicines and cytotoxic drugs	Incineration/Landfill
6	Soiled waste-items contaminated with blood and body fluids	Cleanining/disinfection/Autoclave /Microwave/Incineration
7	Solid waste-tubes, catheters, intravenous sets	Disinfection/Autoclave/ Microwave
8	Liquid waste -laboratory, washing, cleaning housekeeping	Disinfection /Discharge to drains
9	Incineration ash-ash from incineration of any BMW	Municipal landfill
10	Chemical waste	Chemical treat/Landfill/To drains

Ebola-contaminated items are frequently incinerated following local regulations. Once burned to smithereens, previously contaminated items are relatively harmless, according to the CDC. A CDC report entitled "Ebola-Associated Waste Management" mentions that "Ebola-associated waste that has been appropriately incinerated, autoclaved (sterilized), or otherwise inactivated is not infectious, does not pose a health risk, and is not considered to be regulated medical waste or a hazardous material under Federal law (Ebola waste management guide, 2014).

The De Montforte Incinerator is relatively low cost and when built correctly, reaches temperatures above 900°C

It consists of a double combustion chamber, which increases both the residence time of the (flammable) gases and turbulence, resulting in better combustion (Fig. 2).

Table 4. components of an infectious waste incinerator

Component	Purpose	How it works
Primary combustion	Dry, heat and convert waste to gases, some oxidation and pyrolysis may occur	Auxiliary fuel (e.g., natural gas is used to raise the chamber temperature to 1600-1800^{O}F to initiate and maintain combustion
Secondary combustion chamber	Oxidize gaseous waste into carbon dioxide and water	With sufficient oxygen present (supplies as air), 1800oF and above efficiently convers organic components of the waste into carbon dioxide and water
Boiler	Recover heat from exhaust gases	A heat exchanger converts water to steam, steam can be used for heating and cooling
Air pollution control devices	Remove hydrogen chloride, other acid gases, and particulate	-
Stack	Disperse exhaust gases	Release exhaust gases from the secondary combustion chamber of a height and location that allows dilution to safe concentrations.

Considerations when operating De Montforte incinerators:

- A De Montfort can run almost entirely on infectious waste, with no other fuel apart from in the preheating phase, the final burning phase or if the waste is extremely wet. Generally, preheating is undertaken using non-hazardous waste.

Infectious waste should be added once there is a fire in the second chamber (verified using the peep hole). To ensure complete burning, an additional 1-2 kg of non-medical waste is added 8-10 minutes after the entire medical waste has been loaded.

- If using a stovepipe thermometer, the temperature should be maintained between 600ºC and 900ºC by controlling the waste-loading rate. Robust flames in the secondary combustion chamber (via peep hole) and a roaring noise are good indicators of a sound fire/combustion. If using a stove pipe thermometer, the incinerator is first heated to 600ºC (pre-heating phase). The heat generated

in an incinerator is enough to explode glass objects like vials. This can harm the operator and/or damage the incinerator. Therefore, if using an incinerator to burn sharps, then extra attention is also required at waste segregation points, ensuring whole vials are not put in the safety boxes. To minimize handling of sharps, MSF recommends the use of a sealed sharps pit (MSF, 2010; 2012). This involves disposing of vials immediately when they enter the waste zone. If you are burning sharps in safety boxes, the safety boxes can be added one at a time. The recommended rate of destruction is 1 safety box every 8-10 minutes (6-7 kg per hour). If a large volume of safety boxes is produced, MSF recommend construction of a safety box reducer directly above a sharps pit (MSF, 2010; 2012). The reducer design is a single chamber volume reducer which is only used for sharps boxes that are burnt with kerosene. After burning, the ash falls directly into the sharp pit. Note the safety box reducer is only for safety boxes and is in addition to a De Montfort Incinerator used for soft waste. (ACFincieratorsandsharpmangament)
During incineration, verify the operators have necessary PPE and inoculations and ensure the operator and supervisor have a clear understanding of the risks. Practitioners should also support ongoing monitoring and periodic inspection of record keeping, increasing vigilance in respecting protocols for the safe management of waste.

To ensure that these medical treatment units cause no harm to the environment, this environmental audit is conducted to review key risks and impacts related to the two piloted units.

De Montforte mark 8-A incinerator model was selected as a suitable option of waste disposal for these two health facilities. The De Montfort Incinerator is relatively low cost. The incinerator is actually a double chambered refractory structure having metal components in the form of waste loading door, ash removal door (ash tray), and chimney (Fig. 2).
The following details provides a short overview of the "path" followed by waste within the De Montfort double chamber incinerators. To visualize what is described below, each step number refers to those present on the cross-section drawing.

1 Waste is loaded through the loading door at the top of the primary combustion chamber, which is then closed on an airtight sand seal.
2 In the primary combustion chamber the waste is heated by radiation from the hot firebricks in the absence of air. As the previous load or fuel is burned away, the load falls down the chamber by gravity and progressively dries.
3 As the waste nears the combustion zone at the level of the air inlets, it is pyrolyzed and burned.
4 The ash will then fall through the fire grate before being removed through the ash door once the incineration process is finished.
5 During this primary combustion process some of the products are given off as combustible gases such as carbon monoxide. These combustible gases are forced to go through the gas transfer tunnel.
6 gasses reach the secondary combustion chamber where they meet a further supply of air from the air hole in the back of the incinerator. They then undergo secondary combustion, raising the temperature even higher, and reducing the gases to stable compounds such as carbon dioxide. This flame can be stabilized by turbulence caused by wire mesh in the secondary chamber, which also glows red hot to reignite the flame should it be extinguished for any reason. Correct operation of the incinerator can be checked by looking (with great precaution!) through the air holes in the secondary chamber to observe visible flames in the secondary chamber. The secondary chamber is built as large as the primary chamber to maximize the retention time of the gases in the hottest zone, thus killing off any pathogens and also breaking down some of the particulates in the outlet gases.
7 The hot gases in the chimney are less dense than the surrounding air and this difference provides the driving force to induce more air into the combustion chambers. This driving force requires the chimney to be at least 4m high (Fig.3).

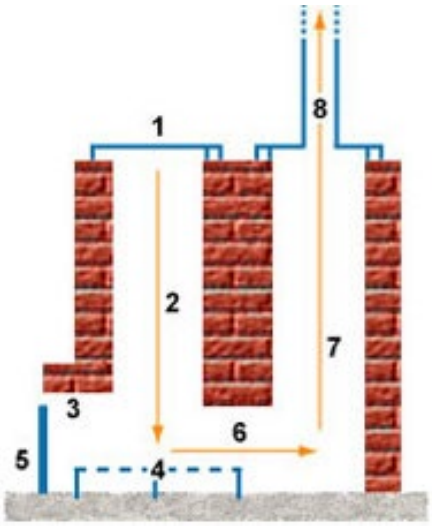


Fig. 2 Flow of the smoke inside the incinerator

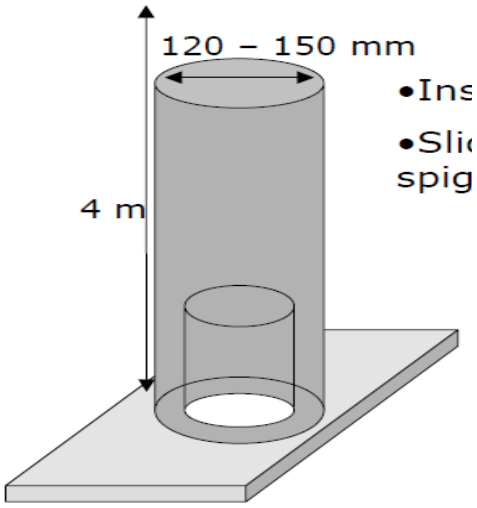


Fig. 3. The Chimney size and height with spigot

The Chimney should be protected from rain by channels at the roof and at the top of the chimney by a cap (Fig. 4).

The ash tray should have angles at the top to facilitate allowing ash to go down to the tray while keeping the waste burning at the top of the angles as well as to help the air going through (Fig. 5).

A white construction sand is placed in the U-profiles of the base frame of the cover and the chimney

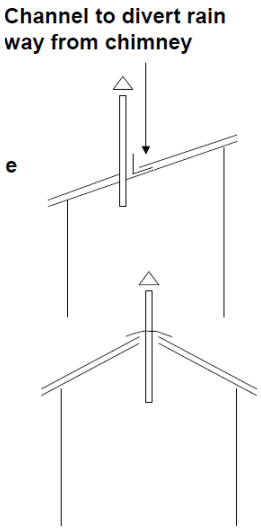


Fig. 4. The rain protection cap and channel

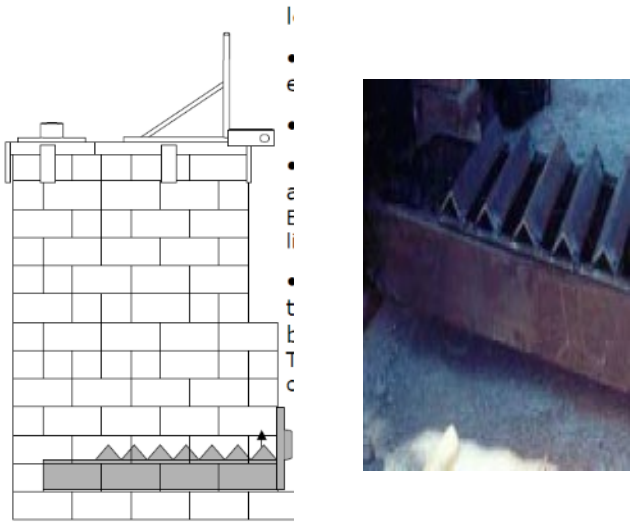


Fig. 5. The ash tray with the angles

to function as a seal to avoid gasses escaping via the top frame. The cover edge of the loading door will be placed at the middle of U shape (Fig. 6).

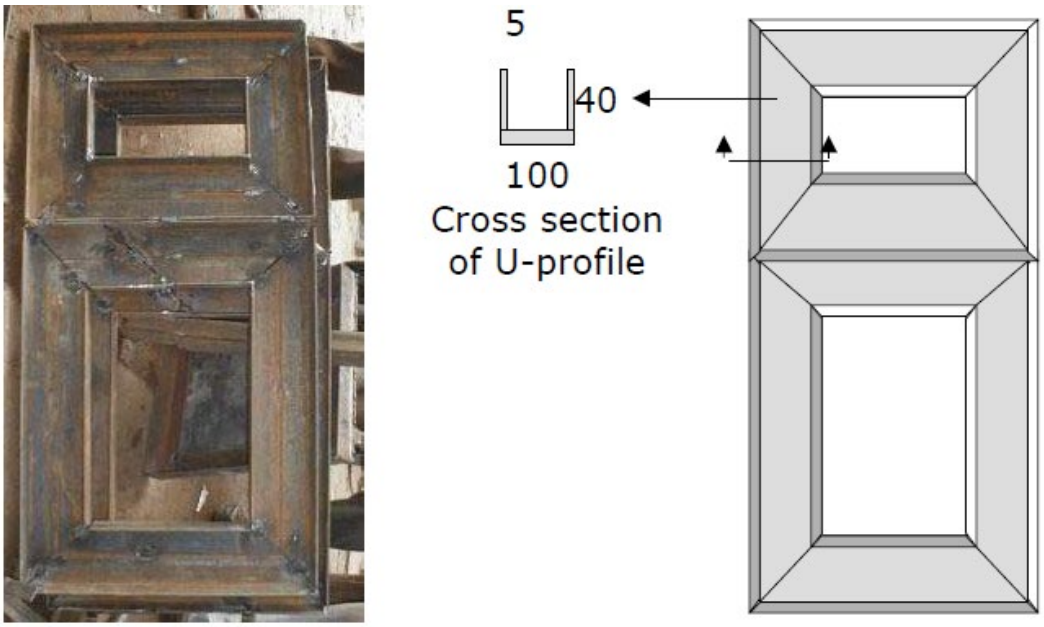


Fig. 6. the top frame with U shaped to be filled with while construction sand.

The fuel could be supplied from installed tank at a side of the incinerator with a control valve (Fig. 7). The iron part should be painted to resist heat (Fig. 8)

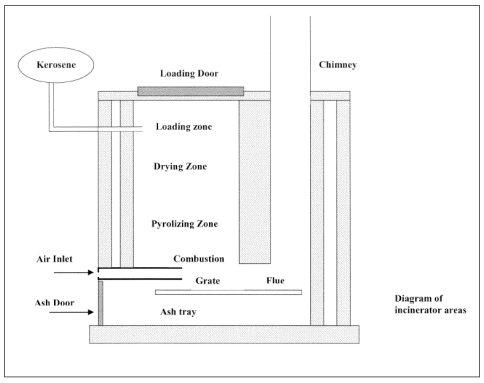


Fig. 7. Supplying the diesel though valve from a hanging tank

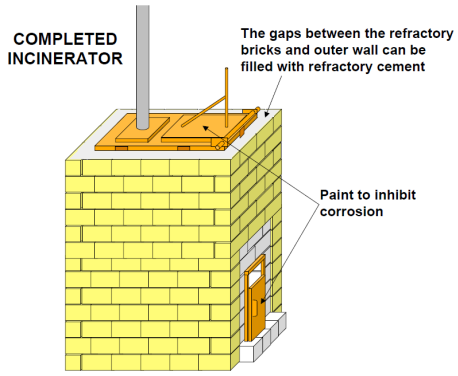


Fig. 8. The complete incinerator with iron frames items painted with specific paint to inhibit corrosion.

The incinerator operates on burning of medical waste in specific temperature range from 600°C to 900°C. The temperature range should be monitored by a high temperature digital thermometer mounted with the main structure (see Fig. 9)(ACFincieratorsandsharpmangament2017). A protection fence is installed around the chimney to protect the workers from the heat of the incinerator (Fig. 10)

Close monitoring of the controlled burning reduces the emission of dioxin and furan which are the main objectionable environmental pollutants of incineration. Waste is loaded from waste loading door after pre-heating using kerosene or diesel as supplementary fuel.

The temperature is maintained in the desired range by waste loading frequency. After burning of 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 De Montforte incinerator will affectively get rid of approximately 6-7 kg of infectious waste per hour and can be operated for two hours daily five days a week (480-560 Kg/ month) following the best operation practices.
Activated carbon injection (ACI) is a most widespread technology to control PCDD/F emissions. Dioxins are absorbed by activated carbon captured in a bag filter (BG), with an average removal efficiency of 95%. (Everaert etal 2002; fritsky etal 2000) Placing activated carbon filter at the pinnacle of the chimney to allow absorbing the odor and smoke produced during incineration (Fig. 11)

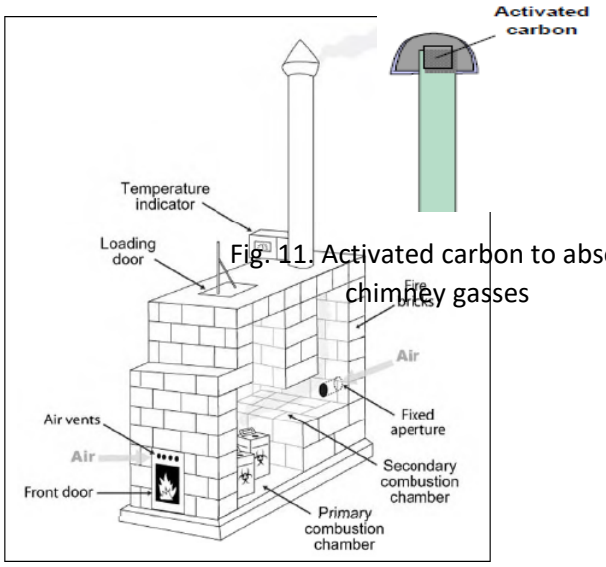


Fig 9. De Monteforte with digital thermometer mounted

Fig. 11. Activated carbon to absorb chimney gasses

Fig. 10. Chimney with protected fence

3. Scope of Work (TOR)

- Phase 1: assessment of the healthcare waste management practices (liquid and solid healthcare waste)
- Phase 2: evaluate the efficiency of the incinerators through close monitoring
- Phase 3: Consensus meeting with hospital administration on the recommended actions and finalization and submission of project report.

4. Tasks to be performed

1. Evaluate the performance and efficiency of the incinerator in terms of: a) efficiency of the incineration process, b) safety of the incinerator's operation c) environmental and health impacts of resulting residual materials after the incineration process.
2. Assess the current practices of the healthcare waste management and develop linkages with improving the efficiency of the incinerators.
3. Assess the condition of incinerator in comparison with its standard design and required operational inputs i.e. fuel consumption…etc, and advise remedial measures in case of any discrepancy found.
4. Provide the estimates of the capital expenditures of the incinerator. the capital expenditure of incinerators includes comprise materials/fabrication costs, labor costs, and costs associated with management and training.
5. Advise and provide recommended measures to improve the performance efficiency of incinerator by preparing the maintenance schedule and inventory list.
6. To identify the key healthcare waste management issues and challenges facing by the hospital administration.
7. Identify the priority activities and interventions required to improve the health care waste management practices.
8. Advise on the environmental, health and safety soundness and economic feasibility of this type of incinerators to be replicated in other health facilities in Yemen.

5. Methodology of conducting this assignment:

1. A thermometer was purchased and tested to be applied as indicator to monitor the temperature reaches more than 600^{o}C

Field visits to both Sa'adah and Hodeidah: The field visit to Hodeidah was conducted at 10-11 April 2020. The head cleaning/service department at Hodeidah Hospital were met- Mr. Ahmed Mughanjar (head of service section, Ahmed Qadri (head of cleaning section), and the head of the treatment unit (Abkar Yehya) and the workers responsible for operating the treatment unit and hospital cleaning process. The field visits to Sa'adah were conducted at 4, 5 and 22 April 2020. The Service manager at the Hospital Dr. Salah Al-Shami and his crew as well as the Quality control manager and representative of Ruxel company, the contractor for operating the treatment unit and hospital cleaning process, to conduct the following activities:

- Paying visits to different sections of both hospitals to investigate the way of segregation for each type of medical waste and discuss the availability of the means for segregation and management steps for medical waste with considering the different environmental and health impact of each type.
- Investigating the components of the medical waste treatment units in both hospitals
- Do site measurements for the different unit and accordingly prepare the detailed Engineering drawings for the as built units.
- Installation of the thermometers for both main (De Montforte) incinerator, during the incineration and monitoring the temperature in association with training of the operator and getting the receipt of the thermometers from the head of the Hospital approving this step (annex-1) the temperature monitoring during the incineration. (ACFincieratorsandsharpmangament2017)
- Investigation of the operation of the other parts of the treatment units, such as the safety box reducer, glass crusher, organic pit, ash pit, sharps pit, disinfection-cleaning ground basin… etc.
- For the sake of calculating the filling period of the pits and checking the shelf life of the different components the following steps were conducted:

Weighing the medical waste before and after the incineration to check the shrinkage of waste volume as ash and allow for calculating the filling period of the ash pit.

Measuring the Empty depths of the Pits by dangling the tape measure to the waste level in order to calculate how much time left to fill the pits and compare it with the design capacity.

From the weighs of each type of waste, a Calculation was conducted to check the filling period of the Pits and compare it with the design capacity.

- Conduct discussion with the operators (the contractor in Sa'adah and the cleaning department in Hodeidah) on the way of the collecting, storing and treating the segregated medical waste and treatment conducted for each type
- Conduct a training/awareness session for the responsible personnel's at quality control, cleaning section, treatment unit operators, and head of sections at each hospital;
- Finally, a meeting with the management of each hospital to report and discuss the findings during the mission considering how to modify the existing treatment unit and the needed actions to develop the health waste management in the hospitals.

6. Results achieved during of the mission:

Before the field visit, the thermometers were purchased from the local market in Sana'a and tested as temperature indicator to monitor the temperature of more than 600^{o}C (Photos 1)

Testing the thermometer under the flame.

The wire showed resistance to heat with the digital thermometer showed the achieved temp of 612^{o}C.

Photos 1: testing the purchased thermometer before the field visits

The conducted field visit to both Sa'adah and Hodeidah have resulted into the following findings:

Phase 1: Assessment of the healthcare waste management practice for liquid and solid health care waste:

For the sake of investigating the segregation of the medical waste in the hospitals, a field visit to several sections of the two hospitals were conducted as follows:

6.1. Medical Waste Management at Al-Thawrah hospital, Hodiedah and Al-Jomhory hospital, Sa'adah (photos 2 and 3)

The visits to the different section at both Hospitals - Al-Thawrah Hodeidah hospital (photos 2) and Al-Jomhoory Sa'adah Hospits (photos 3) are shown as follows:







Photo 2: during visits to the different sections at Hodeidah Hospital



Photo 3: during visits to the different sections at Sa'adah Hospital

During the field visit, different departments at the two hospital were visited during their duty hours, and a close look was made about the situation of the waste segregation process inside the departments, which is mainly done by the medical staff assisted by janitors in transporting and storing the waste in its specific locations. Based on what was observed, a lack of both commitment and awareness amongst some members of the medical staff and janitors. The required procedure was discussed by the consultant with the staff at each section considered as on the job training and

awareness, and the medical staff were guided to concentrate on proper and importance with explaining the expected risk and the need for their attention and cooperation to achieve the main goal of segregation, which will avoid the pollution risk on the community and the hospital staff. The main recommendation was as follows: waste containers must be labeled or properly color-coded in order to achieve proper and visual segregation of the medical waste.

Segregation process inside the departments is implemented partially except for the needles as they are clearly separated in Safety Boxes as well as the organic waste. The medical waste containers were not encoded with the required colors due to a lack of enough quantity. Also, baskets are not sufficient in the crowded departments such as emergency, surgery, and orthopedics. This has a negative impact on medical waste management.

AT both sites, the laboratory and the blood bank, the chemicals and contaminated blood are discharged into the sewerage network, which might lead to pollution of water, groundwater, and soil and ultimately to the WWTP operators. In this concern, it is recommended to: 1- installation of septic tank before discharge to the sewerage network or cesspit; 2- disinfect the infected blood before discharge to sewerage system through adding chlorine or by autoclave.

From the point of view of medical waste management, the following is recommended:

- Forming a Medical Waste section, which includes supervision, follow-up, awareness-raising and training, and is affiliated to the Quality Control Department

Prepare or update SOP and conduct training and awareness for the hospital staff and the janitors including the decision makers in Hospital. Out of this, each section will identify the specific generated waste and its related component in the treatment unit

- Construct a specific evaporation basin for drying and evaporation of chemicals, and medicine, autoclave or chlorine solution to sterilize the infected blood before discharging to the sewerage system.

Phase 2: evaluate the efficiency of the medical waste treatment units

The Medical waste treatments in both hospitals were visited as shown in photos 4.

Sa'adah Medical Waste treatment Unit

Hodeidah Medical Waste treatment Unit

Photos 4. During Visiting the treatment unit in Hodeidah and Sa'adah hospitals

in Sa'adah, the selected site for the treatment unit was found not suitable. The site is close to the crowdy area of Sa'adah old city and at the middle of the hospital buildings, which make people complain from the odor and the smoke, which implies installing activated carbon filter (Everaert etal 2002; fritsky etal 2000) to absorb the pollutants, which would escape from the chimney. In Hodeidah, the site is well selected at a distance from the hospital indicating proper selection from the environmental and social point of view.

- The treatment units implemented in both hospitals, namely Al-Thawrah General hospital in Hodeidah and Al-Jomhory General hospital in Sa'adah are identical. Both consists of the following components:

1. **De Montforte Incinerator**: for burning of infectious waste. Incineration is applied to the disposal of: Dialysis wastes, all pathological wastes, injectable, soiled surgical dressings, swabs and other contaminated wastes such as card board vomit, urine bowls, sputum, pus, wound exudate, waste from body fluid spillage, Suspected-noninfectious source as PPE, dressings, feminine hygiene, nappies, continence pads.

- **Chimney:** used to disperse the smoke up in the air

2. Ash pit: used to dispose the ash from burnt infectious waste
3. Safety box reducer: Due to the use of high volume of safety boxes, a specific incinerator is used for burning the safety box.

- **Chimney:** used to disperse the smoke up in the air

4. Sharps pit: the burnt safety box is felt directly to the sharp pit. In Addition, expired dry drugs and medicines, and crushed glass are disposed into the sharp pit. Pressurized containers, polyvinyl chloride (PVC) plastics (intravenous sets, catheters and PVC containers for sharps), vials of vaccines, mercury thermometers (preferably collect for mercury recovery) will also be disposed of in the Sharps Pit. Note that all pits need to be sealed (water-tight) and a minimum of 2 m above the water table to avoid contamination.

- **Ventilation column:** to disperse the odor up in the air at higher elevation of 4m above ground level;

5. Glass crusher: Vials are crushed by a glass crusher and then disposed of in the sharps pit;
6. Organic Pit: used to dispose of anatomical waste such as Human tissue, placenta, cytotoxic tissues. Note: Infected carcasses and infected blood are not disposed in the organic pit (it will be recommended to buried carcasses in the cemetery while infected blood should be disinfected and poured with the liquid waste).

- **Ventilation column:** to disperse the odor up in the air at a height of 4m above ground level)

7. Waste corner: the segregated waste is collected from different Hospital sections and transported by specific trolley to be stored temporarily and securely at waste corner inside the treatment unit building for re-segregation for the sake of distribution among the different treatment components.
8. Cleaning tools room: to store detergents, disinfectants, tools, log book and protective equipment;
9. Disinfection- washing ground basin: the basin through floor drain is used to discharge the liquid waste such as outdated blood from blood bank, expired liquid medicine, chemicals from labs, disinfection/washing the trolleys and infected baskets, X-ray films development media, all are discharged to the sewerage network. Washing is applied by means of several disinfectant solutions such chlorine, dettol, formaline and Water through taps connected to a network supplying from roof tanks (septic tank will be recommended);
10. Wall- hand Washing basin: used for handwashing of the workers through taps with water and chlorine connected to a network supplying from roof tanks;

11. The Main Building: An enclosure building with a lockable door to prevent access by children and un-authorized persons, scavenging animals and birds (it will be recommended to make the doors open towards outside direction for the sake of escaping in case fire happened inside the unit).

From the field visits, a comparison between both units at Hodeidah and Sa'adah is as follow:

The main building: In Hodeidah the inside ceiling protection layer was burned, and the chimney of the safety box reducer was corroded and deteriorated just before the ceiling end which allow the smoke to get back in the building instead of dispersing up in the air. This imply replacing the chimney (photos 5)

Burned ceiling with corroded and deteriorated chimney at the treatment unit in Hodeidah

Protected ceiling at the treatment unit in Sa'adah (wool fiber glass insulation layer will be recommended for the steel roof)

Photos 5. The roofs of the incinerators in both Hodeidah and Sa'adah Hospitals

De Montforte incinerator: The main incinerator (De Montforte -8a) components at the two hospitals (Photos 6) are identical with both having a protected 6 inches' iron chimney, top loading door, ash door, two, first and second combustion chambers, back opening for air circulation and monitoring (at which the sensor of the temperature indicator thermometer is placed). The ash is collected at the ash tray and its cover (the cover is not used) and disposed to the ash pit.

Hodeidah De Montfort incinerator

Sa'adah De Montforte incinerator

Photo 6.

From the site, it shows that frequent clogging of the chimney in Hodeidah which prevent the smoke from dispersing to the air, it rather comes back to inside the building through the cracks of the body

where the operators might be affected. This implies a continuous maintenance of the chimney and repairing the cracks of the chimney body which happened due to the absence of the framework (the framework will be recommended for the future projects as essential part of the incinerator- see engineering design -Annex-5) the operator in Sa'adah is placing a sealing material around the loading door during the burning. Chimneys caps is also broken in both sites and need to be replaced (photos 7)






Hodeidah De Montforte incinerator Sa'adah De Montforte incinerator

Photos 7. Chimney cap, cracks and smoke in the two sit's incinerators

The operators at both sites are used to weigh the medical waste and register it in the log-book (phots 8). The registered information at both units are summarized in Annex -4

Outdated clean Blood and infected ones are both discharged into the sewerage network while the emptied plastic bags are incinerated (note: it is recommended to disinfect the infected blood before discharging to the sewerage network; installation of Septic tanks is recommended to receive the medical waste before discharged to the sewerage system)

The registration of the weighed different types of wastes reached and treated at the treatment unit on daily basis on the log-book was noticed during the field visits (Photos 8).

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Log-book in Hodiedah

Log-book in Sa'adah

Photo 8. Looking at the log-book to see the registration of the weights of the different medical solid waste

During the field visit, as an example, the De Montforte incinerator was operated to evaluate its burning process performance. the weighing balance was used to weigh a sample of infectious medical waste to test and compare the weights before and after burning (Photos 9).

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Weighing a waste sample using the balance in Hodeidah

The balance used to weigh the waste before burning

The ash tray and the ash after burning the infecteous waste to find the weight difference before and after burning

Photo 9. investigate the reduction of weight after incineration

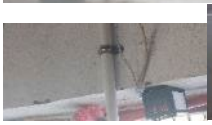
Installation of the temperature thermometers and investigate the weight reduction: During the field visit, the temperature measurements of the De Montforte incinerator has taken place by installing the newly bought thermometer by the consultant. Installation of the temperature thermometers for both (De Montforte) incinerators, during the incineration and monitoring the temperature in association with training of the operators. The temperature monitoring during the incineration is shown in photos 10. An important instruction was given to the operator to preheat the incinerator up to 600^{o}C prior to loading the medical waste. The temperature thermometer was installed with placing the sensor in the second chamber through the back-air opening. The De Montforte incinerator was monitored during its operation. The heating process was conducted by the operator starting with heating the incinerator by using cartons with spraying diesel for about

10 minutes till the flame temperature reached 600°C, then started to feed with medical waste from the loading door of the incinerator.
The medical waste was weighted as 5kg before incineration. The operator closed the loading door. The smoke start rising up to the second chamber and escaping through the chimney. During monitoring the digital temperature screen showed more than 750-800 °C indicating that the incinerator is working within enough rang of temperature of 600—900 °C.
The ash was cooled and then weighed which resulted in 0.5kg of Ash (10% of the original weight, which indicated a decrease of 90% of the weight), then disposed at the ash pit. With ash pit volume of 27m^3. The pit is supposed to be enough for 12-15 yrs. the checked calculation is discussed elsewhere in this report. For documentation, a receipt of the thermometers signed by the Hospital director was issued (annex -1). Note: It will be recommended to install a smoke- absorbing activated carbon filters at the chimney which would prevent the smoke from spreading to the local community and the CO/CO_2 gasses.

Hodeidah

Temperature monitoring by thermometer during incineration in Hodeidah

Sa'adah



Temperature monitoring by thermometer during incineration in Sa'adah

Photos 10. Installation of the temperature thermometer in both hospitals

Safety box reducer: From the field visit, it was noticed that the safety box reducer in Hodeidah consists of protection fence around the 6 inches' iron chimney (photos 11), which is not the case in Sa'adah. This recommend implementing protection fence around the chimney of the safety box reducer in Sa'adah.
The Safety box reducer for burning the sharps inside the safety box. The reducer's casing is made of iron sheets at 3mm thickness for the main body and chimney.

The burning process was conducted by the operator by putting the safety box inside the incinerator and flame it to burn the safety box for ½ an hour till the safety box has become ash and felt down with the sharps inside the sharp pit.

Safety box reducer chimney with protected fence in Hodeidah

Safey box reducer chimney with un-proteced fence in Sa'adah

Figure 3: MSF Safety Box Reducer over a Sharps pit

Photos 11. Safety box reducer in both sites

Glass crusher: The glass crusher is used to decrease the volume of the glass. Both crushers in Hodeidah and Sa'adah are operated manual as they have been manufactured locally. However, as shown the method of crushing in Hodeidah is by lifting the hammer vertically, while it is easily done in Sa'adah by adding an arm to make lifting the hammer easy. The height of the crusher is only 70cm in Hodeidah while it is around 120cm (photos 12). (it will be recommended to install the same crusher model in Hodeidah as the case in Sa'adah).

Glass crusher in Hodeidah

Glass crusher in Sa'adah

Photos 12. Glass crusher in both sites

Cleaning tools room: The cleaning tools and material room is investigated in both hospital and found that the room is not used properly (photos 13). tiling floor and installing shelves in the room are recommended.

Hodeidah

Sa'adah

Photos 13. Cleaning tools in both sites

Washing /disinfection ground basin: The washing/ disinfection ground basin is used for cleaning and disinfecting the containers/trolleys as well as for disposing the outdated blood chemicals and expired liquid medicine. Four disinfectants are contained at four taps (i.e. water, chlorine, Dettol and formalin). These liquids are supplied through a four roof upvc tanks each of 0.5 m^3 (photos 14). Also a hand washbasin with water and chlorine taps are also connected to the same roof upvc tanks. The hand wash basin in Sa'adah need drainage instead of the broken one. Moreover, both

hand wash basins in Hodeidah and Sa'adah need to be lowered in level to prevent splashing to the workers body.

Ground and wall handwash basin in Hodeidah

Drainage of the handwash basin is broken in Sa'adah

Roof plastic tanks in Hodeidah

Roof plastic tanks in Sa'adah

Photos 14. Washing /disinfection ground basin with associated pipes, taps and roof tanks

Taps in Hodeidah and Sa'adah need to be extended from the walls to reach the basin as it is at the moment close to the walls, which make it discharge the flow out of the containers standing at the edge of the basin. The basins themselves need epoxy as a protective coating material as it is already deteriorated.

The Pits: Due to the high humidity associated with high temperature in Hodeidah, the pit iron covers were corroded (Photos 15), which recommend replacing them with iron sheets of 5mm thickness or any other material resisting the corrosion.

Corroded iron covers in Hodeidah

Non-corroded iron covers in Sa'adah

Photos 15. The pits cover at both sites

The three pits namely, Ash pit, sharps pit, organic pit were investigated and the volume of contents were measured in order to check /estimate its design capacity (photo 16).

Measuring the pits filled contents in Hodeidah	Measuring the pits filled contents in Sa'adah

Photo 16. Measuring the depth of the disposed waste in the pits

Average measured Impty Depths of pits in both sites: Ash pit= sharps pit= organic pit= 2m to piled waste peak = assumed 2.5m if flatly distributed, which means the depth of disposed waste= 0.5m within two years of operation

6.2. Analysis and synthesis:

6.2.1. The filling period of pits for 80% full -based on measurements of the disposed waste in the pits.

To calculate the capacity of the treatment unit components the following calculation was conducted based on the collected data from the treatment units.

The design volume of each pit is the same with 3m (length) x3m (width)x3m (depth)=27m^3

During the field visit, the Depths of the pits were measured with the following results: The depth of the disposed waste is about 0.5m for two years since operation (2018-2020), that means about 15% is used which suggests a filling period of 12 years to fill the pit volume. This recommends evacuating the pits when reached 80%, which suggest 10 years to evacuate the pits. The safety precautions during the process of evacuation should be highly considered.

6.2.2 Design capacity of the De Montforte - based on the produced / incinerated waste volume:

This De Montforte incinerator will affectively get rid of approximately 6-7 kg of infectious waste per hour and can be operated for two hours daily five days a week (480-560 Kg/ month), with shelf life =3-5 years

Weight of infectious waste in Sa'adah= 15753 kg/yr. or 1313 kg/month or 44 kg/day, by dividing this amount by 8hrs of incineration, the resulted rate of incineration is 5.5 kg/hr. which is less than the capacity of the incinerator which means it is enough.

6.2.3. Ash pits filling period for 80% full -based on weighted/ produced waste assuming 10% is converted to ash - Weight of infectious waste= 15753 is reduced to 10% during incineration= 1575 kg/ash or 1.5 m3/yr. which means the pit will be filled after 27/1.5= 18 year, with 80%, the evacuation period for ash pit is around 14 years in Sa'adah.
While for Hodeidah with infectious waste =13373= 1337kg ash or 1.3m3/yr., pit will be filled after 27/1.3=20yrs with 80%, the evacuation period for ash pit is around 16 years in Hodeidah.

6.2.4. Organic pits filling period for 80% full -based on weighted/ produced waste assuming 50% is digested:

Weight of organic matter disposed= 4888/yr. or around 5 m3/yr. which is expected to be reduced by 50% reaching 2.5m3/yr. including the added soil, this conclude that the filling period is 27/2.5=10 yrs., for 80% full, the evacuation period for organic pit is around 8 years in Sa'adah

While for Hodeidah, Weight of organic matter disposed= 16440kg/yr. or around 16m3/yr. which is expected to be reduced by 50% reaching 8m3/yr. including the added soil, this conclude that the filling period is 27/8=3 yrs., for 80% full, the evacuation period for organic pit is around 3 years in Hodeidah

6.2.5. Check for the design capacity of Safety box reducer- based on the produced boxes:

Number of safety boxes = 3409 boxes/ yr.= 282 boxes /month= 9.5 box /day, will be burned with 5 hrs./ day which means this safety box reducer is enough

6.2.6 Check for the design capacity of Glass crusher- based on the produced glass waste:

Glass crushed = 4890 kg/yr. = 408kg/month or 13.5 kg/day, as this is done manually at 2kg/ 10minutes, which conclude that around two hrs. is needed which is enough.

6.2.7 Sharp pit filling period of sharps pits for 80% full -based on weighted/ produced waste:

Weight of Safety box = 3409 box = 1700kg/ yr. = 1.7 m3/yr.

Weight of crushed glass= 4890kg= 4.8m3/yr.

Total =6.5 m3 /yr.

The filling period= 27/6.5=4 years for 80% full, 3 yrs. is the filling period for Sa'adah.

While for Hodeidah, 3740 box=1800kg/yr.=1.8m3/yr.;

Weight of crushed glass= 6187 kg/ 6.2 m3/yr.;

Total =8 m3/yr.

The filling period 27/8= 3.5 yrs., for 80% full, 3yrs if the filling period for Hodeidah

To summarize: Table 5: shows the evacuation period for the different pits based on site calculation and weight records by the staff

Pit/	Based on records		Based on site measurements
	Sa'adah	Hodeidah	Sa'adah and Hodeidah
Ash pit	14	16	10
Organic pit	8	3	
Sharp pit	3	3	

Since the numbers calculated are scattered, we might use the calculated numbers based on site measurements, which resulted in a filling period of 10 years. Given that, the ash and sharp pits could be evacuated immediately without any harm while the organic need to stay for one year till digestion take place.

This suggests a standby organic pit to be constructed in the vicinity of the treatment unit (see the engineering drawing- Annex-5)

Regarding the De Montforte incinerator and safety box reducer, it is recommended to have a standby space for future replacement, beside the existing ones taking into consideration the arrangements connection with the roof and pit, so that it will be ready to be constructed when one or both of them need to be replaced. Maybe it is wise to order the refractory bricks and cement as it needs to be imported (see engineering drawings -Annex -5).

- Monitor the filled volume of the pits and plan for implementing the standby organic pit to evacuate the contents of the filled pit in order to gain the continuity of re-using the available land;

Avoid using the incinerators to burn the non-hazardous medical waste.

Phase 3: Consensus meeting with hospital administration on the recommended actions and finalization and submission of project report:

6.3. Meeting and training for the staff of the two hospitals: (photo 17). See Annex -2 for the names and minutes of meeting

Hodeidah Sa'adah

Meeting with the staff at Hodeidah hospital

Meeting with the staff at Sa'adah hospital

Photo 17. conducting awareness/ training session with the responsible

The meeting was held with the staff from the cleaning department and Quality control in addition to the heads of departments. A short training session was conducted by the consultant on the method and importance of avoiding risks from the medical waste and the collective responsibility of each individual in sorting each type of waste.

As part of the mission, a meeting was conducted with the management staff in both hospitals.

In Sa'adah, Dr. Nabil Abdullah Ali Khatira, Deputy The general manager of financial and administrative affairs with the presence of the quality control officer and the contractor responsible for cleaning in the hospital (Annex -2- the minutes of meetings).

In Hodeidah

Meeting with the Hodeidah vice director

Meeting with Hodeidah director

In Sa'adah

Meeting with the Sa'adah director

Photo 18. Meetings with the responsible in both sites

Based on the paid several visits to the medical waste treatment unit and the several departments with thorough and intensive meetings and discussions with the medical and service staff in both hospitals and the training of the staff, after all that, a meeting was held with the administrative staff of the two hospitals to inform them about the comments raised by the consultant regarding the medical waste management and the necessary requirements in improving performance. Both decision makers have promised to make the necessary improvements in segregation and maintenance for some parts of the medical waste treatment units.

6.4. Operation cost analysis for the treatment units:

Cost estimation for the treatment unit including De Montforte incinerator:

To estimate the operation cost, the following assumptions were as follows:

- Two labors are used for transporting the medical waste to the treatment unit.
- Two labors are working in the unit
- Cost of labors= 4*50,000=200,000 YR/month

- Supervisor = 150,000 yr./month

The cost in $= 584$

- The amount of fuel: diesel of 0.25 l for each burning
- No of burnings 7 times/d
- The amount of waste burned each time =10kg.
- The amount of fuel needed for waste burned per day = 0.25*7=1.75 l/d
  The cost of fuel per day =1.75*345 yr./l=603 around one US $/d= 30 $/month
  Total cost = 610 $/month including the free cost of the cartons for pre-heating as part of hospital waste.

Due to the unavailability of the as built drawings, site measurements for the medical waste treatment unit was conducted and accordingly, the BoQ of the units were checked (Annex -3) and the detailed engineering drawings are attached in Annex-5

7. Conclusions:

1. Regarding to the Medical waste management, the following tables (6) and fig. (12) summarizes the overall view.

Table 6. Medical waste produced in Health facilities (WHO, 2018):

Waste	Classification	Treatment Means	Disposal Means
Domestic Waste (85%)	Domestic Waste including pressurized cans	Public landfill	Public landfill
Medical waste (15%)	Infections waste	Main incinerator	Ash pit
	Organic waste such as Placenta, human tissue and blood	Organic pit	Organic waste pit and sewerage for blood while empty bags go to main incinerator; infected blood should be disinfected/treated from virus before discharged to sewerage network
	Glass waste	Glass Crusher	Sharp pit
	Sharps in Safety box	safety box reducer incinerator	Sharp pit
	Pharmaceutical waste	Powder go to main incinerator; Liquid go to sewerage, while evacuated glass go to glass crusher	Incinerator; sewerage network; glass crusher
	Chemical and liquid lab waste	Existing situation: sewerage network	Evaporation basin: instead of sewerage network, d, it should be collected in a plastic bottles and go to evaporation basin, then the dried chemicals go to incinerator

Fig. 12 summarizes the suggested plan of MWM is as follows:

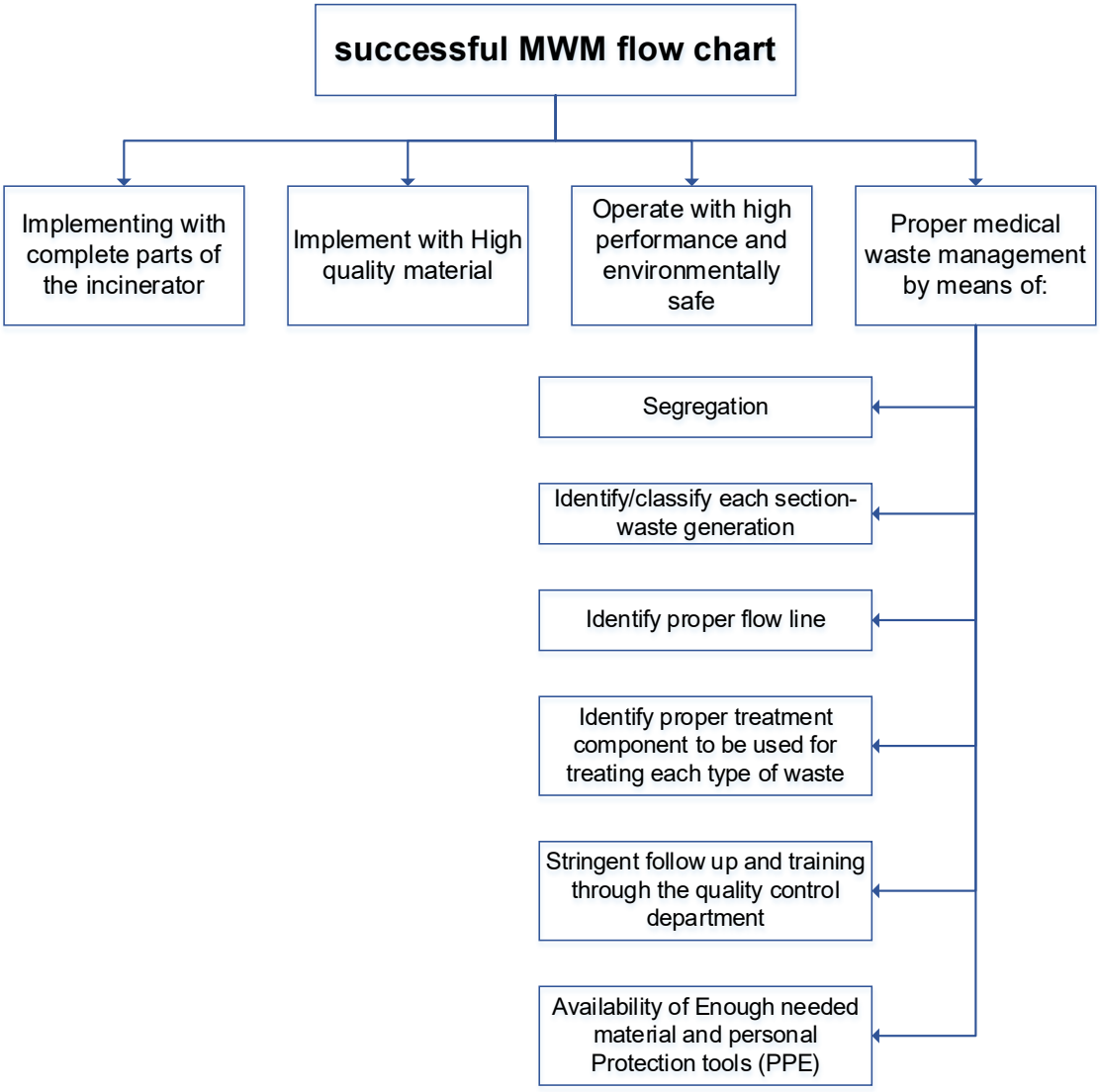


Fig.12 the suggested MWM

Table 7. the suggested maintenance, replacements, additions, future additions

Components of the medical waste treatment and disposal unit/ missing and non-implemented parts

Component	Missing and un- implemented part	Action needed	
		Immediate for the existing unit	Future projects
De Montforte incinerator -- Design criteria -	Airtight sand seal; A white construction sand is placed in the U-profiles of the base frame of the cover and the chimney to function as a seal to avoid gasses escaping via the top frame. The cover edge of the loading door will be placed at the middle of U shape.		√
	Brace the incinerator with 5mm L-shaped steel framework at the top perimeter of the incinerator in order to refrain the outer layer of bricks masonry from cracking and buttressing it (see engineering design -Annex-5). Note: The operator in Sa'adah is placing a sealing material around the loading door during the burning.	√	√
	The Chimney should be protected from rain by channels at the roof and at the top of the chimney by a cap- (see engineering drawings).	√	√
	Place the ash tray cover during the incineration to facilitate keeping the waste burning at the top of the angles as well as to help the air going through the ash tray cover angles to agitate the flame.	√	√
	All iron parts should be painted to resist heat	√	√
	a high temperature digital thermometer is needed as implemented by the consultant as part of this assignment	Already Done by the consultant	√
	Maintain/ replace the deteriorated chimney pipes in Hodeidah and replace the broken chimney caps in both sites.	√	
	Maintain Ash door with frame with adding air supply pipe	√	
Safety box	Implement the missing protection fence around the chimney of the safety box reducer in Sa'adah.	√	

	Maintain/ replace the body 3mm iron sheets in Hodeidah with implementing the missing coating with heat resistance and anti-corrosion material	√	
	Implement fixing the body with iron sheet to the ground RC concrete with sealed silicon to prevent corrosion due to water;	√	√
	Implement baffle sheet to avoid heating the outside door cover	√	√
Chimneys and ventilators	Installing carbon filters at the pinnacles of the chimneys and ventilators to absorb smoke and odors during operation especially if the unit is implemented in a croudy area or close to the hospital buildings such as the case of Sa'adah.	√	√
	The chimney pipe material should be made/replaced with anti-corrosion material such as stainless steel and heat-resistant material;		√
Glass crusher	Replace the glass crusher in Hodeidah as the same one in Sa'adah with adding the arm instead of vertical crushing in order to make it easy for operation;	√	√
	The iron sheet should be 5mm thickness;	√	√
	Fixing the crusher by iron sheet to the ground RC concrete;	√	√
	Fixing the crusher to the I BEAM with angles instead of iron tubes	√	√
Solid and liquid waste management -HCWM	waste containers must be labeled or properly color-coded in order to achieve proper and visual segregation of the medical waste.	√	√
	medical wastes are evacuated from the pits and dumping it to a specific landfill when they are 80% of their filling capacity.	√	√
	Prepare a training manual for workers that includes the time frame and mechanism for evacuating the medical wastes from the pits and dumping it to a specific landfill when they are 80% of their filling capacity.	√	√
	Forming a Medical Waste section, which includes supervision, follow-up, awareness-raising and training, and to be affiliated to the Quality Control Department	√	√
	Prepare or update SOP and conduct training and awareness for the hospital staff and the janitors including the decision makers in Hospital. Out of this, each section	√	√

	will identify the specific generated waste and its related component in the treatment unit		
	Provide enough PPE for both cleaning and treatment/ disposal staff;	√	√
Medical waste treatment	installation of septic tank before discharge to the sewerage network or cesspit; 2- disinfect the infected blood before discharge to sewerage system through adding chlorine or by autoclave.	√	√
	Construct a specific evaporation basin for drying and evaporating liquid wasted chemicals, and expired liquid medicine	√	√
	Provide autoclave and/ or chlorine solution to sterilize the infected blood before discharged to the sewerage system	√	√
	Bury carcasses in the cemetery	√	√
The main building	Let the doors open towards outside direction for the sake of escaping in case fire happened inside the unit	√	√
	Implement thermal wool fiber glass insulation layer for the building steel roof	√	√
	Repairing the wall hand washing basin by replacing the drainage pipe (syphon) in Sa'adah;	√	
	Lower down the level of the hand wash basin to prevent water splashing into the worker's body and clothes;	√	√
	Paint the wash basin with epoxy as a protective coating to resist the corrosion due to chemicals;	√	√
	To Affix shelves onto the walls of the storeroom to utilize the room in organizing and preserving PPEs and cleaning tools;	√	√
	Add up a bathroom in or near to the treatment unit for the sake of worker hygiene with shower and cleaning tools and providing washing machine for the operators to wash their clothes to clean themselves before leaving from the unit.	√	√
	Tile the floors of the treatment unit including the storeroom and paint the wash basin with epoxy chemicals resistant;	√	√
Cleaning/ disinfection basin	Reduce the level of Taps to the level of trolleys to avoid splashing;	√	√

	Extend the taps from the walls to reach the basin as it is at the moment close to the walls, which make it discharge the flow out of the containers standing at the edge of the basin.	√	√
	Repair the disinfection basins with epoxy as a protective coating material as it is already deteriorated in both sites Hodeidah and Sa'adah.	√	
Hand wash basin	Repair the drainage of the hand wash basin with decreasing its level to avoid splashing water and chlorine to the janitors	√	√
Pits	Monitor and plan for Evacuation of the ash and sharp pits immediately when they are 80% full, while leaving the organic pit for a year till the organic material get digested. By the meantime, a standby organic pit is implemented for a year (see engineering drawings- Annex -5). The safety precautions during the process of evacuation should be highly considered. The safety precautions during the process of evacuation should be highly considered.	√	√
	Consider having a standby space and arrangements for future implementing new incinerators (main and safety box) just before the existing ones get deteriorated. Arrangements are for the chimney opening at the steel roof and opening for the safety box reducer at the RC slab to the sharp pit - see engineering drawings- see Annex-5.	√	√
	Replace the corroded iron pits covers at Hodeidah with 5mm iron sheet and coating with corrosion protective material;	√	
	Raising the pit covers by 5cm from the ground level to facilitate putting the waste and avoid wash water reaches the covers.	√	√

8. Recommendations and corrective actions:

During the field visit, the medical waste treatment units that were implemented locally at both sites (Sa'adah and Hodeidah), the following components are available. These treatment units are in operation since 2018.

The most advantage of implementing the medical waste treatment unit inside the hospital is avoiding contamination of the infectious medical waste inside and outside the hospital. This type of treatment units is suitable for Yemen, as it has low construction and operation cost, does not need high skilled labor, no need for energy. It can fulfill the purpose of medical waste treatment and management. It is most suitable for the areas with low crawdy, especially in rural areas so that the open burning practice is stopped and the medical waste is managed and controlled inside the hospital to protect the neighbor and local community and the patients from infectious waste. It is considered an environmentally friendly if used and implemented properly.

- It is worthy to use this type of treatment units, with taking into consideration the following issues:

Pertaining the design of the treatment units:

Inadvertently, the designer overlooked some components of the medical waste treatment unit mentioned as follows:

- Implementing the treatment unit away from the residential area or adding carbon filters and fixing the chimney covers;
- To add up a temperature thermometer to measure, control and monitor the temperature of the incinerator during the incineration so that the pre-heating should take place up to 600^{o}C, at which the medical waste is to be loaded after which the range of 600-900 is maintained during incineration;
- To add up an evaporation basin which would replace discharging the chemicals into the sewerage network in order to prevent its impact on the soil, groundwater, agriculture crops, farmers and workers working in the sanitation system;
- To install Smoke- absorbing activated carbon filters at the chimneys' pinnacle of the incinerators and to the ventilators of the pits to prevent the odor and smoke from spreading to the local community with decreasing the CO/CO_2 gasses resulted from destruction of dioxins in the second chambers.
- Implementing of the glass crusher as the applied model in Sa'adah, opposing to the model in Hodeidah;
- Plan a time frame and mechanism for evacuating the medical wastes from the pits and dumping it to a specific landfill when they are 80% of their filling capacity.

Regarding to the liquid medical waste treatment, the following precautions should be considered:

- The disposable chemicals come out from the equipment set or the lab tests or the x-ray film development should be either diluted with an amount of water to decrease the concentration up to the non-harmful concentration level, and discharged promptly to the sewerage network, or instead, subjected to evaporation by constructing an evaporation basin to evaporate these chemicals under sunlight, then the powder residues can be burned to avoid any toxicity or pollution. Health workers, especially medical laboratories, must be fully aware of the type of chemicals that they deal with in terms of their severity, methods of handling and proper disposal
- Medicines contains heavy metals such as silver, cadmium, chromium, copper, lead, mercury, selenium and zinc should not be disposed to the sewerage networks.

- All patients 'body fluids such as blood or the infected blood must be sterilized by using autoclaves before they get discharged to the sewerage networks to avoid groundwater, soil contamination, which suggests providing autoclave in the needed sections of the hospitals.

Pertaining the medical waste management:

- Attention should go to segregation and limiting the treatment to the medical materials with excluding the municipal waste which would increase the lifetime of the treatment units and the pits.
- Conducting frequent training and Raising awareness to medical staff, cleaners and treatment units' staff through the following means:
  - Place stickers on containers and fleet
  - Putting awareness educational stickers for medical staff, visitors, and accompanying persons regarding warnings about sorting of infectious medical materials and the importance of dealing with them properly.
  - Preparing and Operating awareness flashes on the TV in the waiting rooms and lounges about the danger of touching the medical waste and the importance of sorting it out and avoiding mixing it with municipal waste
  - Establishing or activating a specific department/ section for hazardous medical waste management
  - Preparing an operational manual for the management of medical waste that includes the following (Fig. 12):
  - Defining the medical wastes coming from each department separately and how to sort them out, transporting, storing, treating and disposing them;
  - Determining and providing the necessary tools and equipment required for each department according to its specific disposed medical waste;
  - Determine the treatment method for each type of medical waste by sorting them out to their specified treatment unit;
  - Providing occupational safety tools (PPE) for the cleaning staff and treatment units' operators that includes a guideline which should be followed to prevent risks during managing medical waste.

With regard to emptying out the pits and constructing a new components of incinerators at its end of shelf life:

- As long as the volume of each pit is 27 m3, and based on what has been realized, some of the pits will become full before the other, depending on the varying amounts of different wastes coming out of different sections. This implies designing the pits size based on case by case for each hospital. Moreover, to utilize the land at the utmost, the pits should be emptied out into a special landfill and reusing the pits again;
- When these wastes are removed, it should be taken into consideration to value the hazardous risk associated with removing them on the assigned worker. Therefore, the following actions should be considered:
  - Leaving the organic pits when it gets 80% full as a stopgap measure for a given period of time till organic material has decomposed, while implementing the standby one (See-Eng. Drawings- Annex-5).
  - Immediate ash and sharps pits evacuation when the get 80%full (as the ash and sharps toxicity has become tempered and ineffective) and directly reuse them;
  - Use all safety measures including PPEs and protective clothing, such as gloves, apron, google, caps, masks, respirators, seat belts, helmets, paws, and special shoes (gumboots) that bear sharp materials, organic matter and ash in the emptied pits.
- Consider the alternative site near the treatment unit's site for constructing the new components when the shelf life of the existing ones is reached (see Eng. Drawings-Annex-5);

<u>For future if applicable to other hospitals or health facilities:</u>

- In the radiology departments, the used chemicals should not be discharged to the sewerage network. Evaporation pan could well be one way to solidify the pollutants and then burn it in the incinerator. Limestone could also be used to balance the acidic solutions before disposing them.
- Radioactive fluid wastes should not be disposed to the sewerage network, they must be collected and stored in special boxes according to their quantities, chemical and radiological compounds could have half-life allowing them to be treated by means standstill in containers with the needed residence time.
- Toxic drugs used for the treatment of tumors can be treated with chemicals such as Potassium permanganate and Sulfuric acid to break them and their effect and turn them into non-dangerous fluids

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10.Annexes:

10.1 Annex 1: Official letters issuing handing over the temperature indicators thermometer to both Hodeidah and Sa'adah

Republic of Yemen
Ministry of Health
Organization of Al-Thawra
Hospital - Hodeidah

الجمهورية اليمنية
وزارة الصحة العامة والسكان
هيئة مستشفى الثورة العام بالحديدة

هيئة مستشفى الثورة العام بالحديدة
مكتب رئيس الهيئة
الصادر العام
الرقم :
التاريخ :
المرفقات :

التاريخ :2020/04/20م
المرجع :

إلى من يهمة الأمر

الموضوع : إستلام جهاز قياس درجة الحرارة الرقمي لمحرقة النفايات الطبية

نحيطكم علماً بأنه تم استلام جهاز قياس درجة الحرارة الرقمي لاستخدامه لمراقبة درجة الحرق في المحرقة الرئيسية في وحدة معالجة النفايات الطبية في المستشفى والذي تم تجربته لقياس درجة حرارة الحرق والتي وصلت إلى 786°درجة مئوية وذلك أثناء زيارة الفريق البيني برئاسة الخبير البيني الدكتور المهندس / فضل علي النزيلي للاطلاع على عملية إدارة المخلفات الطبية بالمستشفى وتقييم وحدة المعالجة بتاريخ ١٠-١١ إبريل ٢٠٢٠م والذي تم تكليفه من قبل منظمة الصحة العالمية بالتعاون مع وزارة الصحة العامة والسكان .

وتقبلوا خالص تحياتنا ،،،

د/ خالد احمد سهيل
رئيس هيئة مستشفى الثورة العام

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الإدارة العامة للخدمات

هيئة المستشفى الجمهوري بصعدة
السكرتارية
الصادر

إلى من يهمة الأمر

الموضوع:استلام جهاز قياس درجة الحرارة الرقمي لمحرقة النفايات الطبية

تحيطكم علما بأنة تم استلام جهاز قياس درجة الحرارة الرقمي لاستخدام لمراقبة درجة الحرق في المحرقة الرئيسية في وحدة معالجة النفايات الطبية في المستشفى والذي تم تجربته لقياس درجة حرارة الحرق والتي وصلت أكثر من (١٠٠٠)درجة مئوية وذلك اثناء زيارة الفريق البيني برئاسة الخبير البيني الدكتور المهندس /فضل علي النزيلي للاطلاع على عملية إدارة المخلفات الطبية بالمستشفى وتقييم وحدة المعالجة بتاريخ ٢٠٢٠/٤/٢٢م والذي تم تكليفه من قبل منظمة الصحة العالمية بالتعاون مع وزارة الصحة العامة والسكان.

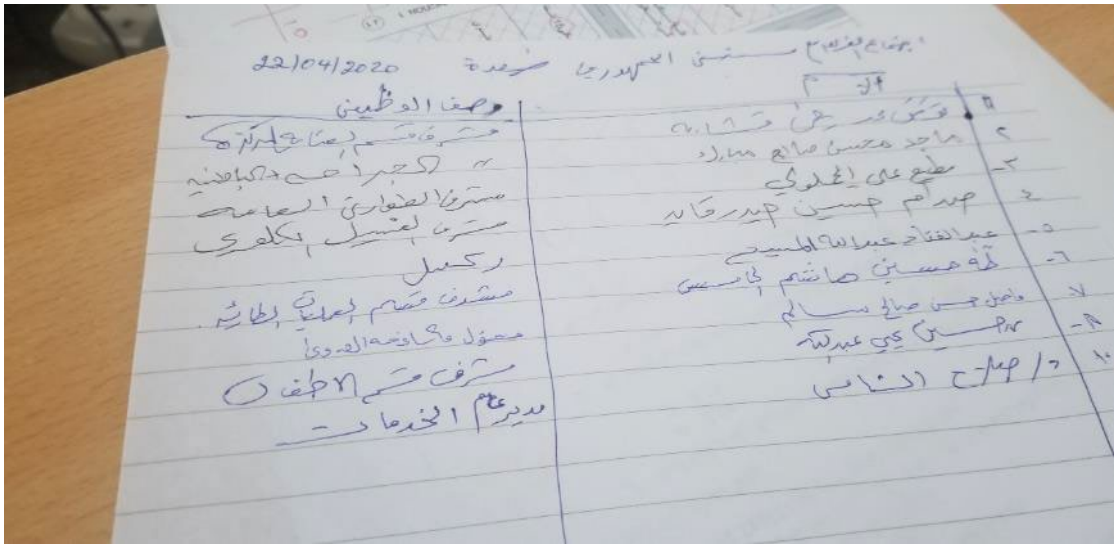
وتقبلوا خالص الشكر ،،،

رئيس هيئة المستشفى الجمهوري العام
د. صلاح عبدالله قربان

10.2 Annex -2: Meeting with the responsible and decision makers at both hospitals during the field visits

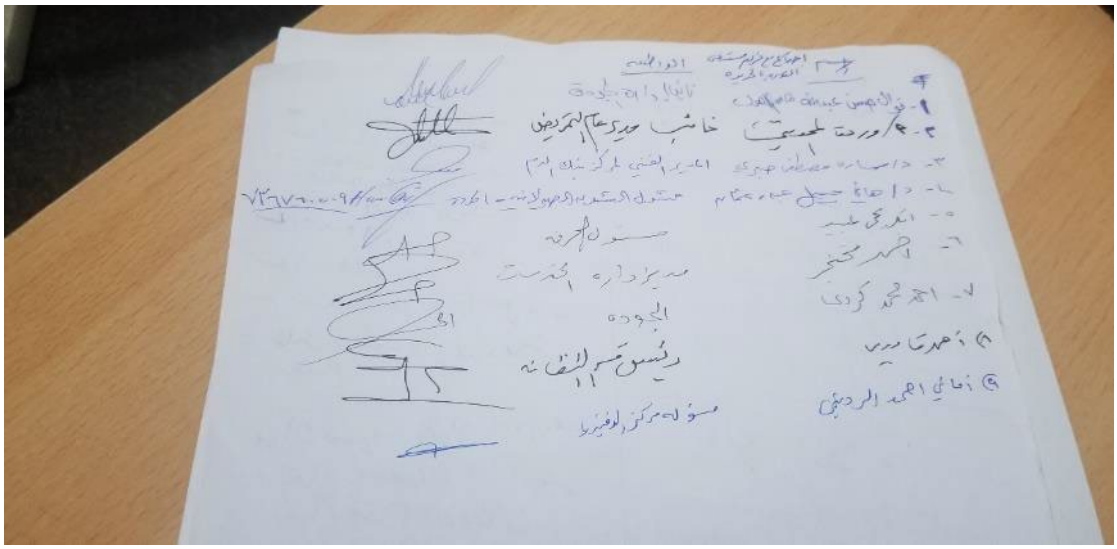
10.2.1. Table 8. minutes of meeting with HCWM staff at Sa'adah Hospital

No.	Name	position
1	Dr.Tawfiq Mohamed Qashabah	Head intensive care Unit
2	Dr. Salah Al-Shami	Head Service Dept
3	Dr. Majed Mohsen Saleh Mubarak	Surgery and endogenous section
4	Muteea Ali Al-Hamlooqi	Head General Emergency
5	Saddam Husein Haider Qaid	Head Kidney wash
6	Abdufattah Abdallah Al-Maseeh	Contractor of the cleaning and treatment unit
7	Taha Husen Al-Hamis	Head emergency operations
8	Fadhel Husen Saleh Salem	Head Infectious control /Quality control
9	Husein Yehya Abdalla	Head pediatrics section



10.2.2. Table 9. minutes of meeting with HCWM staff at Hodeidah Hospital

No.	Name	position
1	Dr. Nawal Mohsen Abdallah	Head quality control
2	Wardat Al-Mahweety	Nursery dept.
3	Dr. Sarah Mostafa Sabri	Head Blood bank
4	Hani Jamil Abdo Othman	Head pharmaceutical affairs /QQ
5	Abkar yehya Obaid	Head Treatment unit
6	Ahmed Mukhangar	Head Service Dept.
7	Ahmed Mohamed Kurdi	Quality control
8	Ahmed Qadri	Head Cleaning dept.
9	Amany Ahmed Al-Radamy	Head diphtheria section



10.2.3. Table 10. meeting with decision makers in Hodeidah and Sa’adah

No	name	Position	Location

1	Dr. Nabil Abdullah Ali Khatira	Deputy Director director for financial and administrative affairs	Sa'adah hospital
2	Dr. khaled Suhail-	Director General	Hodeidah hospital
3	Dr. Radman Al-Hammadi-	deputy director for technical affairs	Hodeidah hospital

General Notes: The decision makers took action in corrective maintenance in repairing/replacing the deteriorated parts of the treatment units and as well in proper segregation of medical waste according to the recommendation discussed and documented in this report.

10.3. Annex -3. Table 11. Bill of Quantities for the Medical Waste unit

No.	Description of Works	Unit	Quantity	Hodeidah	Sa'adah
1	Levelling Works	M2	100	100	100
2	Excavation works for the three pits as per drawings and for foundation of tools room and pits walls	M3	107	116.5	121
3	Boulder stone with concrete mix as foundation for cement Block walls of pits and tools room at a width of 60 cm and a depth of 60cm.	M3	27	17	15.5
4	Solid block work at 20cm thick for walls of Pits and tools room and for fence up to 1m high	M2	148	146	166.2
5	Plastering and painting for fence walls and tools	M2	104	130.3	155.3
6	Supply and install rough iron sheets at 1.5mm for sharp pit walls	M2	36	36	36
7	Excavation at a depth of 15 cm for the whole unit including around the three pits	M3	7	7	7
8	Boulder stone work with no concrete around pits in the excavated area in item 7	M3	7	7	7
9	Reinforced Concrete slab on top of pits at size of: depth 15cm width 8m, length 9 m. Work include installation of steel plate with bolts for fixing steel columns of the roof as per drawings and taking into consideration all openings in the roof including the	M3	13	13	13
10	Reinforced concrete beams above the block wall at a size of 20cm *30cm	M3	1.5	1.5	1.5

11	Incinerator: Build the incinerator as per the attached file considering that the insulation layer between the internal wall and the external wall is compulsory made of thermal wool fiber insulator	No.	1		
12	Safety box reducer: Build the Safety Box reducer as per the attached file.	No.	1	-sharp pit has plastic ventilation pipe	
13	Glass crusher Supply and install glass crusher as per the attached	No.	1	Glass crusher is made of iron sheets	
14	Supply & install H- steel columns size 10	No.	8	6	6
15	Supply and install steel roof at 68m^2 including main H-beams size 12 with secondary beams 40*80 of 1,25 mm and the necessary zinc sheeting excluding roof of cleaning tools room.	M2	68	65	41
16	Supply &install gutters for roof rain water	Lump sum	1	1	1
17	Supply &install a fence of 40*80mm steel tubes size 1.25mm horizontal and vertical.	M2	13	47	17
18	Supply &install steel gate of 40*80mm steel tubes size 1.25 mm	M2	2.4	2.4	2.4
19	Supply &install ventilation column on top of the pits as per drawings.	No.	2	Plastic ventilation pipes 6” dia-2 no.	2
20	Supply and install pits iron cover as per drawings	No.	4	3	3
21	Supply &install 4 upvc tank size 0.5m3 with piping and 4 taps, one from each tank (water, chlorine, Dettol, Formalin) to the wash basin-disinfection sink.	No.	4	Tanks are plastic not fiber glass-4 no.	4

22	Supply & install washing- disinfection basin made of acrylic size 2*2m. The work includes all drainage and all fittings to the ground floor.	No.	1	1 الحوض صبه ولايوجد اكريليك	1 الحوض صبه ولايوجد اكريلك
23	Supply and install floor drain. works include all connection piping to the nearest sewerage manhole, and making sure there is enough slope to drain.	No	1	1	1
24	Supply &install hand washing basin with single tap, and drainage, valve and pipe hose- wall mounted tap. Work includes connecting water supply from chlorinated tank.	No.	1	There is two taps, one with chlorine and the other with water	1
25	Supply & install a manhole size 60*60cm. Works include excavation, cement block work, plastering, coating with epoxy, with cover and connection from the unit to the nearest manhole and from manhole to	Lump sum	1	1	1
26	Supply & install electric network for the unit including 13 lambs 20wat LED, 2single switch, 2 twin switch, one waterproof lamb, 3 electric socket, main switch breaker, check/testing, and connection to hospitals	Lump sum	1	1	1
	Total				

10.4. Annex -4

Table 12. Medical Waste production in Sa'adah Hospital for one month (March 2020)

Medical Section	Safety box (#)	Glasses/vials (kg)	Organic waste (kg)	Infectious waste (kg)
Emergency	28	29		
Em. Operations	26	29		69
Normal Operations	26	28		89
Dialysis	56	37		1514
Lab and blood bank	27	26	170*	72
Child admission	24	28		120
Ward -4	23	31		
Ward -3	27	27		
Female section	28	26		
Intensive Care	38	43		107
Vaccination	18	24		
Dental	12	15		
Delivery	29	37	361	
Total	**362**	**380**	**531**	**1971**

Table 13. Waste production for Sa'adah for one year from The Sa'adah Hospital:

Month	Safety box (#)	Glasses/vials (kg)	Organic waste (kg)	Infectious waste
J	225	379	413	869
F	236	280	323	764
M	223	261	298	1044
A	244	285	539	1920
M	266	348	411	2157
J	289	329	413	2123
J	281	336	371	1949
A	308	384	394	1823
S	282	381	401	1759
O	349	1087	452	1896
N	347	426	433	1880
D	359	394	440	1646
Total	**3409**	**4890**	**4888**	**15753**

Table 14. Waste production for Hodeidah for one month from Hodeidah Hospital:

Month	Safety box (#)	Glasses/vials (kg)	Organic waste (kg)	Infectious waste
J-2019	194	472	811	1132
F-2019	195	405	691	1136
M- 2019	228	501	830	1035
A-2019	274	562	1053	1038
M-2019	330	488	1067	931
J-2019	271	409	1211	657
J-2019	303	463	1398	635
A-2019	275	493	1638	673

S- 2019	358	502	1801	810
O- 2019	425	596	1912	1157
N- 2019	391	585	2016	1631
D -2019	496	711	2012	2538
Total	**3740**	**6187**	**16440**	**13373**

10.5. Annex 5. Engineering Drawings of the Medical Waste Unit at Sa’adah and Hodeidah General Hospitals