

## Section II

### Installation

(For consulting engineers, contractors, and procurement officers)

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## 2.1 WDU design concept and features

The design concept groups together each of the essential elements required for waste disposal at a primary health facility and integrates them into a single Waste Disposal Unit (WDU).<sup>1</sup>

The major advantages of a design concept are:

- **Economic:** A single shelter protects the incinerator, waste store, fuel store, records, tools, clothes, ash and needle pit. This reduces costs substantially when compared with separate locations for waste storage, incinerator protection, etc.
- **Security:** A single, locked enclosure protects the waste store, fuel store, incinerator, ash pit and needle pit.
- **Convenience of use:** Waste, fuel, records, tools, clothes and ash deposit are placed at a single protected location.
- **Minimized exposure to toxic emissions:** Minimal ash handling; chimney emissions directly into outside atmosphere; good cross ventilation; and air extraction above loading door help to minimize exposure to toxic emissions.
- **Labor saving:** Collected waste can be safely deposited for storage in the WDU without involving the operator, as there are holes for safety boxes and needle containers in the WDU.
- **Motivation for operator:** The operator has the sole rights of access to the WDU location, hence a sense of ownership which encourages good operating practices.

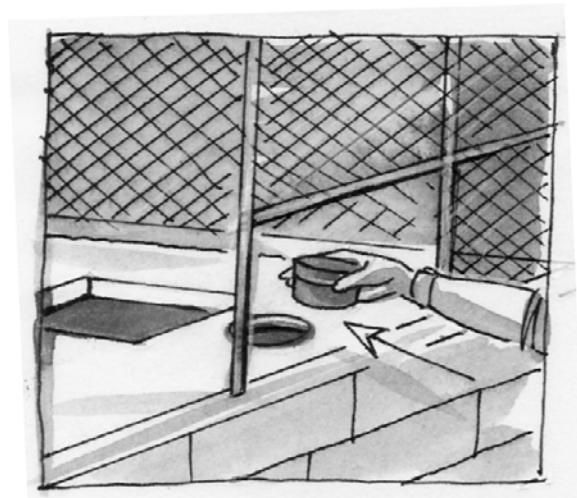
## 2.2 A brief description of the operational aspects and storage capacities

The WDU occupies an area of about 2.6 m x 3 m. The layout of the WDU is such that the safety boxes and other waste to be disposed are stored in a designated area at ground level adjacent to the incinerator prior to being loaded for burning through the loading door, which is at the top of the incinerator. Preheating and supplementary fuel is stored at ground level also adjacent to, but on the other side of, the incinerator before being used. The fuel is then use for lighting and preheating the incinerator by loading through the ash door at the front of the incinerator.

The incinerator can be readily accessed for purposes of cleaning, maintenance and safety. Ash from the incinerator is dragged with a rake directly into the ash pit positioned directly in front of the ash door, and does not need to be collected and moved. A convenient location is provided to store tools, protective clothing and records. A shelter with a lockable door, combined with a protective fence, protects the entire facility from the elements, and makes the facility completely secure.

A needle pit hole to deposit needles

**Figure 2.1 Holes to deposit safety boxes and needles**



<sup>1</sup> (See. Section I: Figure 1.2 for details.)

directly into the needle pit is accessible from outside the facility. Safety boxes can also be added to the waste store through a drop-box type of arrangement, without having to open the doors of the WD, as show in Figure 2.1.

The incinerator is designed to burn 6 to 7 kg/hr of waste. If it is used for 2 hours per day for 5 days a week, the current “Best Practices”, it destroys 280 safety boxes per month.<sup>2</sup>

The ash and needle pit has a volume of 3.25 m<sup>3</sup> (meters cube). This capacity can store ash and needles generated over a 10-year period. There will be no need to empty the pit if the incinerator is used to maximum capacity. It can, however, be readily emptied by removing the slabs at ground level that cover the ash and needle pit, should the need arise.

The waste store has the capacity to store more than 200 reasonably well-arranged five-litre size safety boxes (or 130 boxes randomly placed), in addition to soft medical wastes. This represents more than a week’s supply, assuming 12 boxes per day burned over a period of 2 hours.<sup>3</sup> Personnel responsible for handling the waste can deposit the safety boxes and plastic containers into the secured zone through the drop-box, without having to unlock the WDU.

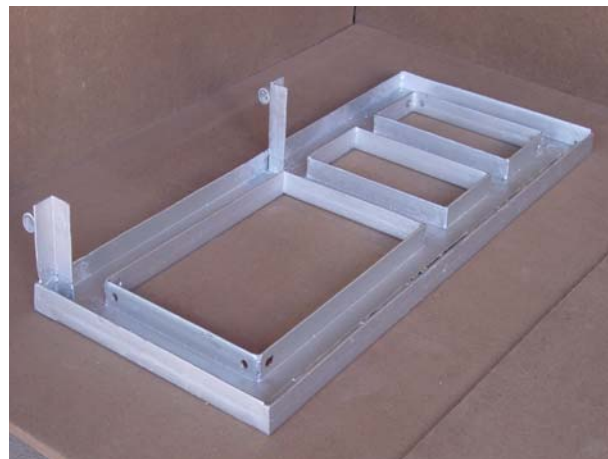
The fuel store has the capacity to store wood, coconut or other combustible agro-waste sufficient for one week, assuming daily burning sessions.

### 2.3 Construction drawings

The construction drawings presented here are produced according to approved civil and mechanical engineering drafting practices.<sup>4</sup> Metallic and civil components are dimensioned in millimeters (mm). To assist persons less familiar with orthographic projection, each fabricated component or sub-assembly is also shown as a 3D isometric drawing or photo image (e.g., see Figure 2.2.). The WDU components and associated drawing references, where applicable, are displayed in Table 2.1, Table 2.2, and Table 2.3. When the “kit procurement option” is chosen (see paragraph 2.4.3), items identified in Table 2.3 as included in the kit are supplied as a consolidated shipment of components inclusive of refractory bricks, mortar, etc.

Each drawing of a fabricated metallic component includes a list of the component parts and the dimensions used to make the fabricated component. Tolerances (the free play between moving components) are specified where applicable. The type of finish or protective coating required for each component is also specified.

**Figure 2.2 Example of photo image to assist metal worker**



<sup>2</sup> Rapid assessments conducted in several countries in 2003 did not identify sites burning this quantity per month. For example, the average number in Burkina Faso was 58 safety boxes per month.

<sup>3</sup> Burning according to “Best Practices” should not exceed these levels if it is to be in compliance with environmental norms for use of the De Montfort incinerator that are considered acceptable.

<sup>4</sup> ISO 128-1:2003

The complete set of construction drawings for the fabricated metallic, masonry and outsourced components are shown in the Appendices.

**Table 2.1 Assembly drawings and sectional plans**

<b>Title of assembly drawing or plan</b>	<b>Drawing ref. No.</b>	<b>General description</b>
Excavation Plan	CV/00	Dimensions of excavation plan
Foundation Plan	CV/01	Details of footing for the ash pit walls
Plan at 0.9 m Level	CV/03	Top view of the floor at the base of the incinerator
Masonry Work Details for Incinerator	CV/04	Sectional side view of the incinerator (centreline of incinerator)
Plan at 1.8 m Level	CV/05	Top view downwards from 1.8 m
Side Elevation (section AA of CV05)	CV/06	Sectional side view of the WDU (centerline of incinerator)
Roof Plan	CV/14	Top view downwards of corrugated sheets on roof trusses and rafters

**Table 2.2 Locally supplied materials and components**

<b>Title of drawing or component</b>	<b>Drawing ref. No.</b>	<b>General description of components or materials</b>	<b>Quantity/ WDU</b>
Pre-Cast Components	CV/02	Pre-cast slabs and item details	1 Set
Steel Column 1A-1B	CV/07	Fabricated steel column for the shed	1 Set
Steel Column 2A-2B	CV/08	Fabricated steel column for the shed	1 Set
Steel Column 3A-3B	CV/09	Fabricated steel column for the shed	1 Set
Steel Chain Link Panels and Doors	CV/10	Chain Link Doors and Panels	1 Set
Steel Horizontal Connectors	CV/11	Horizontal members	1 Set
Steel Diagonal Support, Rafters, Purlins	CV/12	Details for diagonals, rafters and purlins	1 Set
Steel Fabricated Storage Box	CV/13	Cabinet for keeping tools, tackles, records, etc. for the operators	1 Set
GI Corrugated Roof Sheet	CV/15	GI corrugated sheets with apertures for chimney	1 No.
Chimney support cables	None	4-6 mm diameter stranded corrosion resistant.	3 lengths of 6m
G I Corrugated Roof Sheet	None	= or >1.5 mm gauge, galvanized or equivalent. (sheet = 2 m x 1 m)	9
Hollow Concrete Blocks	None	Ref. Tech Spec: Table 2.5, Item 4)	115 Nos.
Portland Cement	None	Ref. Tech Spec: Table 2.5, Item 5)	2.25 tons
Sand: For Concrete Structure	None	Ref. Tech Spec: Table 2.5, Item 6)	3.95 m <sup>3</sup>
Aggregate (Gravel): RCC and PPC	None	Ref. Tech Spec: Table 2.5, Item 7)	1.53 m <sup>3</sup>

**Table 2.3 Imported (Kit) or locally supplied components**

<b>Title of drawing or component</b>	<b>Drawing ref. No.</b>	<b>General description of component or materials</b>	<b>Quantity/ WDU</b>
Fabrication Drawing for Top Frame (PART A)	ML/FAB/001	Fabrication and material details: top frame and loading door hinge	1
Fabrication Drawing for Loading Door (PART B)	ML/FAB/002	Fabrication and material details: loading door and hinge pin	1 Set
Fabrication Drawing for Front Door Frame (PART C)	ML/FAB/003	Fabrication and material details for frame of the ash door of incinerator	1 Set
Fabrication Drawing for Front Door (PART D)	ML/FAB/004	Fabrication and material details for the ash door, hinge pin and cotters	1 Set
Fabrication Drawing for Spigot (PART E)	ML/FAB/005	Fabrication and material details for the chimney spigot	1 Set
Fabrication Drawing for Grate (PART F)	ML/FAB/006	Fabrication and material details for the grate	1
Fabrication Drawing for Intermediate Bridge (PART G)	ML/FAB/007	Fabrication and material details for the frame that supports the bridge	1
Fabrication Drawing for Vertical Support (PART H)	ML/FAB/008	Fabrication and material details for the rear vertical support	2
Fabrication Drawing for Vertical Frame (PART I)	ML/FAB/009	Fabrication and material details for the front vertical support	2
Fabrication Drawing for Horizontal Supports(PART J)	ML/FAB/010	Horizontal lower support for the vertical frame	1
A Self-adjusting Draft Control and Tee for Chimney	ML/FAB/011	Fabrication details for self adjusting draft control and tee OR Tech Spec: Table 2.7 Item 0. <sup>5</sup>	1 Set
Fabrication Drawing for Stove Pipe and Chimney Components OR Outsourced Components	ML/FAB/012	Fabrication and material details for chimney sections, cap and strainer cable fixing, OR ( Ref. Tech Spec: Table 2.7, Item 2)	8 sections pipe. 1 set comps.
Stovepipe thermocouple and analogue dial indicator	None	Ref. Tech Spec: Table 2.7, Item 1). <sup>6</sup>	1
Refractory Brick	None	Ref. Tech Spec: Table 2.5Item 1)	180 Nos.
Refractory Cement OR Refractory Mortar	None None	Cement: Tech Spec Table 2.5, Item 2). Mortar: Tech Spec: Table 2.5, Item 3)	30 kg or 110 kg
High Temperature Paint	None	Ref. Tech Spec: Table 2.6, Item 1)	2 kg
Rust Proof Primer	None	Ref. Tech Spec: Table 2.1, Item 2)	2 kg

The quantities of materials indicated in Table 2.2, 2.3, and 2.4 are estimated actual quantities. The quantities should be procured a little in excess of the suggested figures. The margin will

<sup>5</sup> Source Ref: Red Hill General Store, 21 Oak Knoll Drive, Hillsville, VA 24343, USA, Phone: +1-800-251-8824, Fax: +1-276-728-5885, Email: [sales@redhillgeneralstore.com](mailto:sales@redhillgeneralstore.com)

<sup>6</sup> Source Ref: Source Ref: Duggal Bros, 610 Budhwarpet, Pune 411002. Tel: 0091 20 24459288. Fax 0091 20 24463726

depend upon the numbers of WDUs to be constructed by a single entrepreneur (i.e. 20 percent margin for less than 5 WDUs, and 10 percent margin for more than 5 WDUs).

Estimated quantities of metallic materials are provided in Table 2.4.

**Table 2.4 Materials used to fabricate metal components**

Item	Description	Quantity/WDU
MS Angle	35 mm x 35 mm x 6 mm	182 m
MS Plate	3 mm thick	2.3 m <sup>2</sup>
MS Flat	35 mm x 3 mm	4.0 m
GI Flat Sheet	= or >1.5 mm gauge. 2 m x 1 m	2 No.
GI Corrugated Sheet	= or >1.5 mm gauge. 2 m x 1 m	,9 nos.
Chain Link Fence	40 mm mesh, 3 mm dia wire	16 m <sup>2</sup>
Nuts, Bolts, Washers	M8 x 30 mm long	200 Sets
Nuts, Bolts, washers	M8 x 50 mm long	100 Sets
J Bolts, Washers, Tar Washers, Nuts	M8 x 125 mm long	100 Sets
Strainer Cables,	4-6 mm diameter stranded corrosion resistant.	3 lengths of 6 meters each
Strain Adjusters, End Lugs and Clamping Bolts for Strainer Cables	To fit each 4-6 mm diameter strainer cable Corrosion resistant	3 sets <sup>7</sup>
Reinforcing Bar	10 mm dia mild steel, -0.395 kg/m	50 m
	6 mm dia mild steel, -0.222 kg/m	80 m

Materials for all components are standardized to the extent possible and are specified by category in Table 2.5 to Table 2.8.

**Table 2.5 Non-metallic components**

<b>1) Refractory Brick</b>	Quantity/WDU	180 (includes 10% margin)		
Dimensions	Standard size (mm)	225	112.5	62.5
Temperature range:	Up to 1200 <sup>0</sup> C.			
	Duty cycle: 8 hrs (ambient to 1200 <sup>0</sup> C) for 3000 cycles			
Composition	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub>	CaO
	>40%	< 2%	<50%	<15%
Other components may include TiO <sub>2</sub> , MgO, Na <sub>2</sub> O, K <sub>2</sub> O etc., but the total will not exceed 2%				
Thermal conductivity	Low thermal conductivity less than 0.5 W/mK			
Structural strength	Cold crushing strength not less than 40 MPa			
Porosity:	20-25%			

<sup>7</sup> A set is comprised of 4 end lugs, 8 cable clamps, and 1 strain adjuster.


<b>2) Refractory Cement</b>	Quantity/WDU	30 kg (Includes 10% margin) <sup>8</sup>		
Composition	Al <sub>2</sub> O <sub>3</sub>	Si O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO
	> 40%	<1%	< 2%	>2%, <40%
Curing times (min.)	Initial: 24 hours before first firing			
Temperature range:	Daily cyclic temperature range: ambient to 1200 <sup>0</sup> C			
	>3000 duty cycles			
<b>3) Refractory Mortar</b>	Quantity/WDU	Approx 110 kg		
Mixing ratio	Water/Mortar ratio = 0.2:1			
Curing time	Keep the surface from drying out by covering with wetted cloth or burlap if the weather is hot or dry and should be allowed to cure for at least 24 hours before firing			
Temperature range	The initial firing, known as calcining, is critical. During this time the refractory is slowly heated from room temperature to the full operating temperature. This should be done over a long time as well, to allow the moisture to escape the refractory.			
Structural strength	Cold crushing strength: Not less than 40 Mpa			
<b>4) Hollow Concrete Blocks</b>	Quantity/WDU	115 (includes 10% margin)		
Size/Strength	400 x 200 x 100 mm crushing strength: 50 kg/cm sq			
<b>5) Portland Cement</b>	Quantity/WDU	0.73 m <sup>3</sup> (Approx. 2226 kg)		
Grade	Ordinary Portland cement (O.P.C) 143 grade			
<b>6) Sand: Concrete Structure</b>	Quantity/WDU	3.05 m <sup>3</sup>		
Sand specification	<4 percent silt or clay <2 percent mica granular size < 2 mm			
<b>7) Aggregate (Gravel): RCC &amp; PPC</b>	Quantity/WDU	1.53 m <sup>3</sup>		
Specification	5 parts < 40 mm, 2 parts < 12.5 mm, 1 part < 3.35 mm			

<sup>8</sup> Frequently supplied as premixed mortar, in which case 110Kg required.

**Table 2.6 Paint and rust proofing**

<b>1) High Temperature Paints</b>	Quantity/WDU	2 kg
Specification	Silver or Black. Polymer-based, usable up to 700° C. Curing (bake) at 200° C for 1 hour. Sprayed or applied by brush. Sand surface prior to application to remove oxidation. Clean surface with Xylene or equivalent. Alternative: (1200° C) water-based paint with Al, Zn and Iron Oxide in the pigment.	
<b>2) Rustproof Primer</b>	Quantity/WDU	2 kg
	Weldable primer. Recommended only at welded seams	
<b>3) External Paint</b>	Quantity/WDU	5 kg
	Zinc-based, external grade	

**Table 2.7 Outsourced components**

<p><b>1) Stovepipe thermocouple and analogue dial indicator</b></p> <p>Range 0-1200 °C.</p> <p>Source Ref: Duggal Bros, 610 Budhwarpet, Pune 411002. Tel: 0091 20 24459288. Fax 0091 20 24463726</p> 	<p><b>3) A Self-adjusting Draft Control and Tee for Chimney</b></p> <p>Operating temperature: 0-800° C; 6" Draft Control; fine-threaded Adjustment Stud with balance weight on end; gives good regulation; Draft regulated by turning adjustment screw; made of 28 gauge blued steel; adjustment range: .01 in. to .12" .</p> <p>Source Ref: Red Hill General Store, 21 Oak Knoll Drive, Hillsville, VA 24343, USA, Phone: +1-800-251-8824, Fax: +1-276-728-5885, Email: <a href="mailto:sales@redhillgeneralstore.com">sales@redhillgeneralstore.com</a></p>
<p><b>2) Chimney Pipe</b></p> <p>Black Stove Pipe 24" straight joint, 6" black, 6" X 24", 24 gauge; entirely self-locking; no tools needed to close seams; put together by simply inserting tongue on one edge and pressing together until it snaps. Joint can be cut to any length without destroying the lock.</p> 	



**Table 2.8 Curing**

<b>1) Refractory Mortar</b>	Initial: >24 hours before first firing First Firing: Low gentle heat NOT exceeding 250 <sup>0</sup> C for 3 hours
<b>3) Masonry/Concrete Structure</b>	Initial: 7 days to 50% strength Full: 28 days to full strength

## 2.4 The construction process

### 2.4.1 Tasks

Prior to starting construction, all construction materials and metallic components should be made available at the site and inspected along with the tools required for construction. The health care facility should provide a safe place to store the materials during construction. The tasks involved at each step in the construction process are detailed in Table 2.9.

**Table 2.9 Steps in the construction process and quality control**

Task	Sub-Task	Drawing Reference	Level of Effort (person days)
<b>Preparation</b>	Procure materials and manufacture or import components. Transport all WDU components and materials to site, check and store them carefully.	All items listed in Table 2.2 and Table 2.3. Figure 2.3. STEP 1.	2 days (excluding component manufacturing time)
<b>WDU foundation and Ash/ Needle Pit</b>	Excavation	Excavation Plan: CV/00 and Figure 2.3. STEP 2.	21
	Footings to floor level	Foundation Plan: CV/01 and Figure 2.3. STEP 3	
	PCC slab under incinerator and RCC removable slabs	Precast Components: CV/02. Plan at 0.9 m Level: CV/03 and Figure 2.3. STEP 4	
	Curing		
	<i>Inspection and Quality Control (1)</i>		
<b>De Montfort Incinerator</b>	Metallic frame grouted into PCC slab	Figure 2.3 STEP 5 and STEP 6	10
	<i>Inspection and Quality Control (1a)</i>		
	Lower section refractory brickwork	Masonry Work Details for Incinerator: CV/04. Figure 2.3. STEP 7 and STEP 8	
	Bridge and intermediary refractory brickwork	Figure 2.3. STEP 9	
	Upper refractory brickwork with Ash, loading door & spigot assembly	Figure 2.3. STEP 10	
	Curing		

Task	Sub-Task	Drawing Reference	Level of Effort (person days)
	<i>Inspection and Quality Control</i>		
<b>WDU wall, roof and enclosure structure</b>	Masonry walls, RCC removable slabs needle and safety box aperture	Plan at 1.8 m level: CV/05 and Figure 2.3. STEP 11	12
	Curing		
	Roof trusses	Side Elevation (section AA of CV05): CV/06 and STEP 12 and STEP 13	
	Roof cladding	Roof Plan: CV/14	
	Chimney, cap and draft control		
	Temperature Indicator		
	<i>Inspection and Quality Control</i>		
<b>WDU finishing</b>	Operator work zone		13
	External/Internal rendering of walls		
	Mesh fence, door and storage fittings	STEP 14.	
	<i>Inspection and Quality Control</i>		

To understand the construction process better, Figure 2.3 shows pictorially the sequence of each important step in the construction process.

**Figure 2.3 Sequence of steps in construction process**

*Figure 2.3.1 All construction material available at site*

