

# Managing Health Care Waste Disposal

Guidelines on How to Construct, Use,  
and Maintain a Waste Disposal Unit

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# **Guidelines**

How to  
Construct,  
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Waste Disposal Unit



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The incinerator is based on the DeMontfort model VIII. PATH conducted field trials of the DeMontfort in Kenya, Burkina Faso, and Senegal, and collected some data from Indonesia. This data and experience have informed the current "Best Practices" for a WDU, and are reflected in these guidelines. The dimensions of the incinerator were fixed after extensive experimentation at ITPI; however, the basic design features and the approximate dimensions of the DeMontfort incinerator were retained from the original. We would like to acknowledge the solid foundation provided by the work of Professor Jim Picken and his team at the DeMontfort University in the United Kingdom.

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## Introduction

Health care waste is considered the second most hazardous waste, after radioactive waste in the United Nations listing (i.e., the Basel Convention). Health care waste is a by-product of health care. Although most of this waste is not more dangerous than regular household waste, certain types of health care waste represent a higher risk to health. These include infectious waste (15 percent to 25 percent of total health care waste), of which sharp waste constitutes 1 percent, body part waste 1 percent, chemical or pharmaceutical wastes 3 percent, and radioactive, cytotoxic or broken thermometers less than 1 percent.<sup>1</sup>

It is estimated that the Southeast Asian countries produce approximately 1,000 tons of health care waste daily.<sup>2</sup> At the annual meeting of the Safe Injections Global Network (SIGN) in 2004, the International Association of Safe Injection Technology provided an estimate of 30 billion syringes used worldwide each year. Though the quantities of health care waste have increased exponentially, the waste disposal facilities have not kept pace. In fact, in many countries they are grossly inadequate. In 1999, the World Health Organization (WHO) estimated that the proportion of health care facilities that do not use proper waste disposal methods ranges from 18 percent to 64 percent worldwide.

Further, the composition of medical waste has changed since the 1950s from mostly cellulose waste (gauze, swabs, paper, etc.) to more heterogeneous waste streams with larger percentages of disposable materials, resulting in a significant increase in the use of plastics and composite materials. The percentage of hazardous materials like mercury and other heavy metals in medical waste has also increased. The change in the content of health care waste necessitates a review of the methods used in their treatment.

Mismanagement of healthcare waste puts the community, the patients and healthcare workers at risk, both in terms of the risks from inadequate storage, transportation and disposal of infectious waste, and from the environmental risks arising from hazardous burning in open pits, or badly maintained incineration equipment.

In less developed and transitional countries where resources are limited, a recent WHO policy paper notes that “small-scale incinerators are used as an interim solution.”<sup>3</sup> Incineration, when used according to “Best Practices,” can be a cheap and comparatively less hazardous way of disposing of health care waste. It must be borne in mind too that the costs of not having a waste disposal system are much higher than having one, even if it is still inadequate.

The De Montfort incinerator was developed by Professor Jim Picken at De Montfort University in the United Kingdom in the Nineties. Early laboratory and field trials took place in 1999. More than 800 De Montfort incinerators were constructed from 2001 to 2004, many

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<sup>1</sup> "Safe management of wastes from healthcare activities"; Edited by A. Prüss, E. Giroult and P. Rushbrook, 1999, WHO, ISBN 92 4 154525 9

<sup>2</sup> Alex Hildebrand, *The Work of WHO in the South East Asian Region, Report of the Regional Director, 2003-2004*, WHO/SEARO, New Delhi, India. June 2004: pp. 77.

<sup>3</sup> “WHO Health-care Waste Management Policy Paper,” WHO. September 2004.

to destroy large quantities of sharps produced during measles campaigns. Evaluations of the technical performance of these incinerators in several countries reveal shortcomings arising generally from inconsistencies in dimensional and construction quality. These experiences also demonstrate the importance of an integrated waste disposal solution rather than simply adopting a single new gadget. It also demonstrates the need for an entire health care waste management system for long-term results.

This set of guidelines addresses dimensional and construction quality inconsistencies by providing clear technical specifications and engineering drawings for each component of the De Montfort. It also presents an integrated solution where waste and burned waste storage provision, along with shelter, security, starting fuel, tools, protective clothing and record-keeping, are a part of the Waste Disposal Unit (WDU). The guidelines have kept in mind the limitations at different locations when suggesting solutions. For instance, in some countries, refractory materials may not be available and local capacity to manufacture these materials may be limited. Such countries can make use of an imported kit. In developing these guidelines, controlled testing field trials were conducted and relevant outcomes examined to incorporate design improvements.

The guidelines focus on the product specification, installation, operation, and maintenance of a WDU, principally the De Montfort incinerator. These can be supplemented by an *Operator's Manual*, which are distributed to all the trainee technicians, and "Trainer Presentation" materials, which are used by the training instructors.<sup>4</sup>

The guidelines are divided into four sections. Section I provides an overview of the waste disposal management and how to use the De Montfort incinerator. The overview is intended for anyone interested in the principles of operation, environmental considerations, management and economics of the WDU. Section II covers installation, including technical specifications of components, the construction process, tendering and quality control issues, and is intended for consulting engineers, contractors and procurement officers. Section III is a training manual intended for trainers of waste disposal unit (WDU) operators and offers a plan for training programs. Section IV addresses maintenance and planning and other procedures, and is intended for ministry of health managers, maintenance contractors, and other relevant personnel.

To inform these guidelines, data was collected from field trials of the De Montfort. Rapid assessments were conducted in Kenya, Burkina Faso, and Senegal, and some data was also collected in Indonesia. This data and experience have informed the current "Best Practices" for a WDU, and are reflected in these guidelines.

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<sup>4</sup> The *Operator's Manual* and training instructor presentation materials may be obtained from PATH.



## Section I

# The Waste Disposal Unit: Using the De Montfort Incinerator

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## 1.1 Health care waste management

Health care waste management (HCWM) has been described as “a process to help ensure proper hospital hygiene and the safety of health care workers and communities. It includes planning and procurement, construction, staff training and behavior, proper use of tools, machines and pharmaceuticals, proper disposal methods inside and outside the hospital, and evaluation.”<sup>1</sup> Health care waste management systems enable health care waste to be managed responsibly, without harming the community or the environment.

## 1.2 Components of an HCWM system

An HCWM system is comprised of: i) hardware, including equipment such as categorized waste containers, ash and needle pits, incinerators, transport, needle cutters, etc.; ii) management personnel, to plan, direct, supervise and control; and iii) a process that systematizes the segregation and routing of waste from its point of generation to final disposal, whether through destruction, transformation or recycling.

## 1.3 Purpose of HCWM systems for primary health facilities

HCWM is required in primary health facilities to minimize the risk of contamination of patients, health workers and the general public through infectious waste. Recent studies indicate that as much as 33 percent of Hepatitis B virus (HBV) and 42 percent of Hepatitis C virus (HCV) infections arise from direct or indirect exposure to infectious waste<sup>2</sup>. Many recent studies have reported a convincing link between unsafe injections and the transmission of hepatitis B and C, HIV, Ebola and Lassa virus infections and malaria. Five studies attributed 20 to 80 percent of all new hepatitis B infections to unsafe injections, while three implicated unsafe injections as a major mode of transmission of hepatitis C.<sup>3</sup>

Good HCWM also improves hygiene and operational efficiency in primary health facilities, in addition to reducing the environmental pollution that arises from poor waste segregation and destruction practices.

HCWM ensures:

- Safe containment of infectious and non-infectious waste at the location where the waste is produced;
- Separation of waste into categories so that it is processed appropriately;
- Safe and prompt transport of contained waste to a point of temporary storage prior to processing, and
- Proper processing of waste according to WHO-recommended practices.

**A Waste Disposal Unit is only one element of an HCWM system, and must be used as an integral part of the system for it to be effective.**

<sup>1</sup> “Health Care Waste Management”, *At a Glance Series*, World Bank, June 2003.

<sup>2</sup> WHO Website, Unsafe injection practices -a plague of many health care system [http://www.who.int/injection\\_safety/about/resources/BackInfoUnsafe/en/](http://www.who.int/injection_safety/about/resources/BackInfoUnsafe/en/). Accessed on June 28, 2004.

<sup>3</sup> *Unsafe injections in the developing world and transmission of blood borne pathogens: A Review*, L. Simonsen, A. Kane, J. Lloyd, M Zaffran and M Kane, *Bulletin of WHO*, 1999: 77(10):789-800.

## 1.4 Focus of the current guidelines

The guidelines focus upon specifications, installation, and operation and maintenance procedures of a WDU: in this case, the De Montfort incinerator.

The guidelines:

- Target those seeking a general understanding of small-scale incineration, inclusive of management, environmental and economic considerations.
- Provides specifications of materials required to construct a WDU inclusive of a De Montfort incinerator, engineering drawings of each component, options for procurement, and a step-by-step construction guide. They also detail the maintenance practices to be observed.

The guidelines include in Section III a training plan, which describes how to train De Montfort waste disposal unit operators. An *Operator's Manual* is under development to assist with comprehensive understanding of the "Best Practices" required to ensure efficient disposal of waste.<sup>4</sup>

## 1.5 The WDU and its components

The central element of a WDU is the De Montfort incinerator. If built according to specifications, maintained properly, and operated according to "Best Practices", the De Montfort incinerator can dispose of infectious and non-infectious waste simply, quickly and with minimal environmental consequence.

A WDU is made up of several elements, as shown in Figure 1.1, to enable trained operators to safely process and dispose of infectious waste. These elements include:

- A De Montfort incinerator to burn waste and reduce it. The De Montfort destroys 6-7 kg per hour (or 6 safety boxes per hour) if used as per recommended practices.
- An ash/needle pit, where residual ash, glass, metallic parts, including needles, are safely deposited after incineration. Needles from a needle cutter may also be deposited in the pit. The ash/needle pit is large enough to store incinerated residues for at least ten years without being emptied. Residue from one incineration session weighs approximately 0.5 kg. A pit of 3.25m<sup>3</sup> stores ash from the burning of approximately 300 safety boxes per month over a period of twelve years.
- A shelter to protect the De Montfort incinerator, the operator and the waste being incinerated from rain. The shelter also protects the fuel, like wood or agro-residues, required to preheat the incinerator, and the operator's tools, protective clothing and records. Moreover, it supports the chimney that is four meters in height.
- A waste store to securely accumulate waste that is to be incinerated, and where tools, records and protective equipment can be kept. The store has the capacity to stock at least 200 safety boxes, if neatly stacked.

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<sup>4</sup> Information on how to identify a Health Care Facility for installation of a WDU, and how waste should be collected, transported, and stored at a single location to justify the capital investment and amortisation of the equipment are provided in the training module *Safe Disposal of Syringes and Needles in the Context of Health Care Waste Management Systems*.

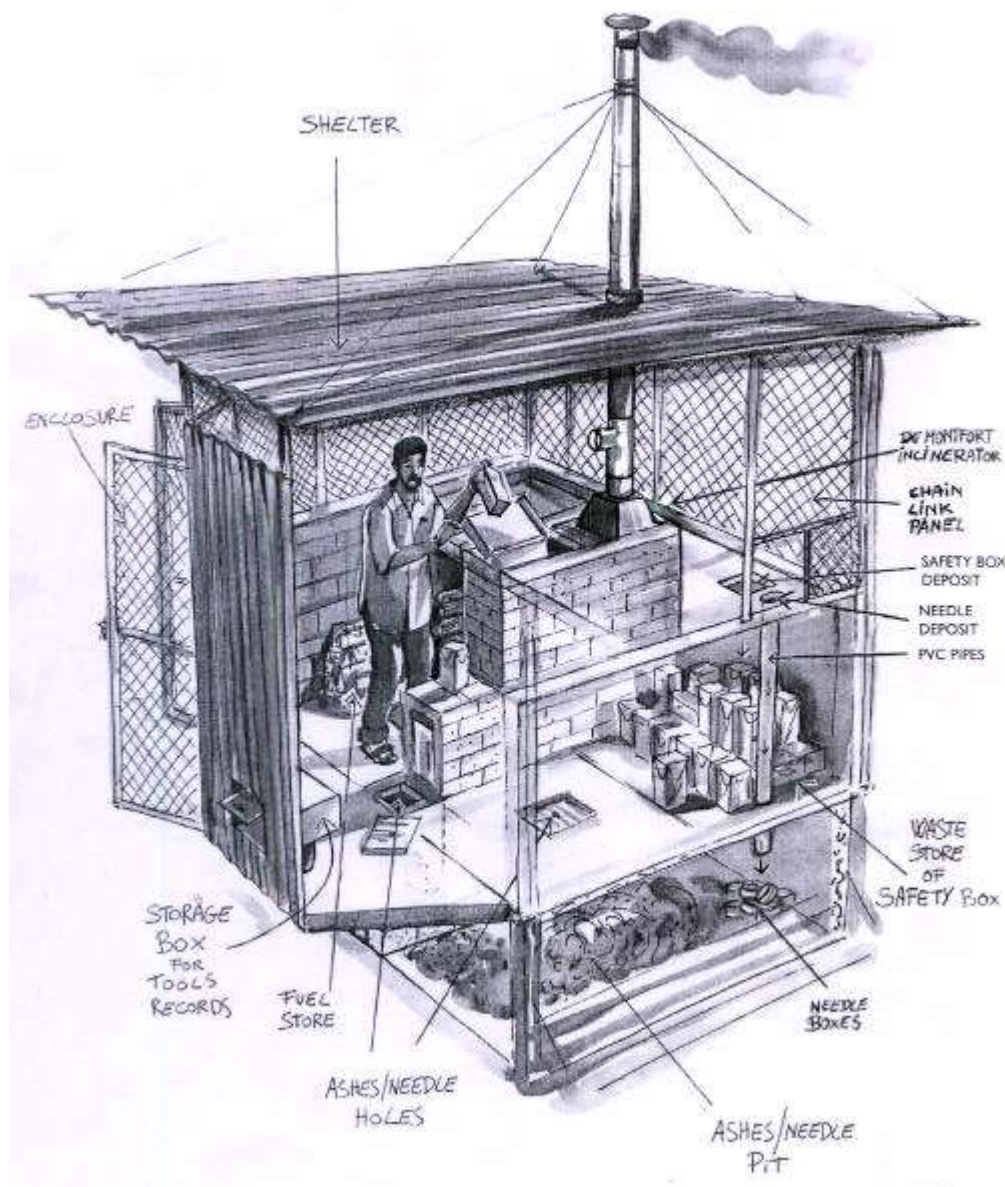
PATH, "Safe Disposal of Syringes and Needles," PowerPoint presentation at WHO Taskforce on Immunization (TFI), Luanda, 3-5 December 2003.

[http://www.afro.who.int/ddc/vpd/tfi2003/presentations/waste\\_management\\_safe.ppt](http://www.afro.who.int/ddc/vpd/tfi2003/presentations/waste_management_safe.ppt)

(Accessed on July 8, 2004.)

- A fuel store to stock agro-residues or wood required to preheat the incinerator. The store has enough capacity to stock waste for at least five incineration sessions, both for pre-heating and supplementing medical waste.
- A storage box to keep tools, protective clothing and records.
- An enclosure with a lockable door to prevent access by children and unauthorized persons as well as scavenging animals and birds.
- A safety box deposit hole to allow the health worker to drop the safety box into the enclosed protected area when the incinerator operator is not present.
- A needle container deposit hole, which allows the health worker to empty the needles safely into the ash/needle pit when the incinerator operator is not present.

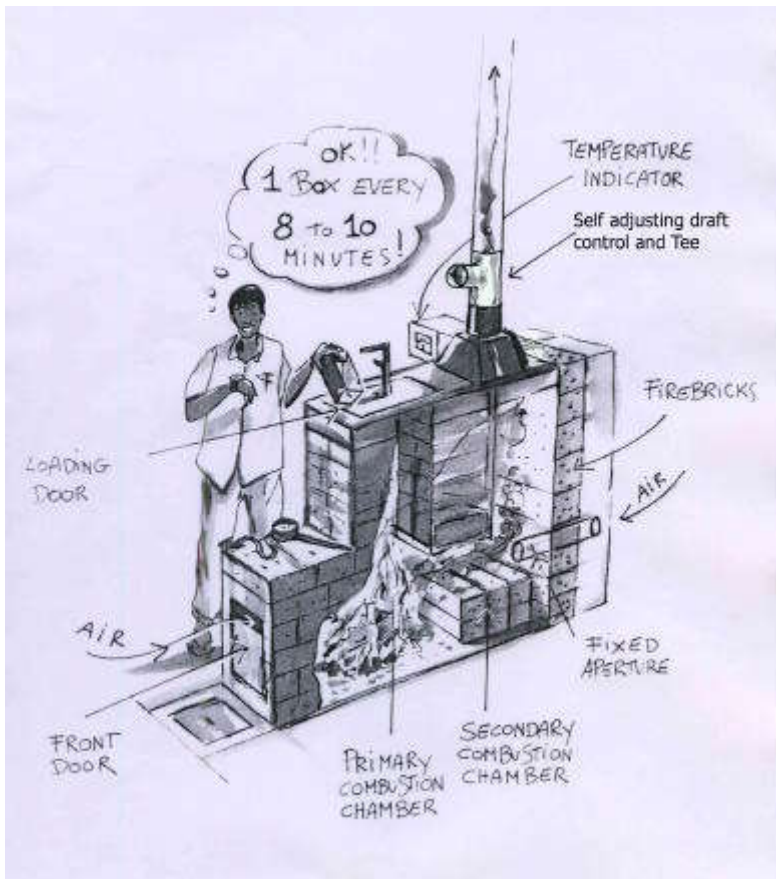
**Figure 1.1 Components of the WDU**



## 1.6 How the De Montfort works

The incinerator is made of firebricks and prefabricated metal components, which can be manufactured locally or imported. The structure is assembled and built at the site using mortar of Portland or refractory cement. No specialized tools are required.

**Figure 1.2 How the De Montfort functions**



The incinerator comprises primary and secondary combustion chambers. The burning zone of the primary chamber is accessible through a door at the front, which lets in air, allows the operator to light the fire, and also allows her/him to remove the ash. The medical waste is dropped in through a loading door above the primary chamber. The secondary chamber, which is inaccessible to the operator, is separated from the primary chamber by a brick column with an opening at the bottom to induce a cross draught during operation. Additional air is drawn into the secondary chamber through a small opening in the lower section of the rear wall of the secondary chamber. This air mixes with the partially burnt flue gas from the primary chamber and causes secondary combustion. A self-adjusting draught control for regulating heat output and burn

time is mounted at the base of the chimney and controls the flue gases in the chimney. A stove pipe thermometer mounted at the neck of the chimney indicates when the medical waste should be loaded. A 4 meter-high chimney mounted above the secondary combustion chamber releases the flue gases into the atmosphere. (See Figure 1.2.)

## 1.7 Operating principles

Waste is warmed, dried and melted in the primary combustion chamber, before being burnt at the grate in the primary combustion chamber. Partially burned flue gas and particulates are drawn from this primary area into the secondary chamber, where additional air induces secondary burning before the flue gases are evacuated into the atmosphere through the chimney. All pathogens thus pass through two high temperature zones: one at the grate, and one in the secondary burning zone.



### 1.7.1 The burning cycle

The burning cycle contains three phases:

- 1) Preheating period: The primary chamber is loaded, lit and the temperature indicated on the stove pipe thermometer brought to approximately 600<sup>0</sup> C in 20 to 30 minutes by burning non-medical waste, i.e., firewood, coconut shells, etc., which is supplemented by kerosene or diesel fuel as may be necessary.
- 2) Medical waste disposal: Once the temperature in the primary chamber has reached 600<sup>0</sup> C, the safety boxes containing only syringes, or intermixed with small bags of infectious, waste, are loaded at a rate that maintains a constant and good, but not fierce, fire in the grate (approximately 6 kg/hr of safety boxes).
- 3) Burn down/close down period: Eight to ten minutes after the entire medical waste has been loaded, an additional 1 kg to 2 kg of non-medical waste is added to ensure that complete burning occurs.

### 1.7.2 Operating temperatures

The right operating temperatures should be maintained. This means:

- The temperature in the secondary chamber, which is displayed on the stove pipe thermometer, should be maintained between 600<sup>0</sup> C and 900<sup>0</sup> C by controlling the waste-loading rate.
- Temperatures above 900<sup>0</sup> C should be avoided since this increases velocities and burning in the chimney, which induces dense black smoke and reduces gas residency time.
- Temperatures below 600<sup>0</sup> C should also be avoided since toxic emissions (dioxins and furans) increase at lower temperatures.

## 1.8 Destruction capacity

### 1.8.1 Types of waste

The De Montfort incinerator has the capacity to destroy any medical or domestic waste, which is combustible. However, it should only be used to destroy the following material:

- 1) Sharps, including syringes with needles attached, razor blades, scalpels and any other sharp objects which may be contaminated, like glass, but excluding vials (unless open) or ampoules.
- 2) Infectious non-sharp waste, like tissues and materials, or equipment; which has been in contact with blood or body fluids, including swabs, bandages and any other waste; which may be contaminated.<sup>5</sup>
- 3) Non-infectious waste, which does not include polyvinyl chloride (PVC) plastic bags, may be destroyed if it cannot be transported to a municipal waste disposal facility or if no alternative environmentally sound solution for disposal is available. (One can easily distinguish between PVC and polypropylene since PVC sinks in water, while polypropylene floats. This can be demonstrated to the ward personnel responsible for placement of waste in containers.)

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<sup>5</sup> Auto-disable and disposable syringe bodies where a needle cutter or needle remover has removed the needles should not be incinerated if disinfection and recycling can be practiced consistently and reliably.

The De Montfort should **not be used** to destroy:

- 1) Waste containing broken thermometers, IV fluid bags, PVC plastic bags, closed glass vials<sup>6</sup> and ampoules, or
- 2) Wet waste.

### 1.8.2 Waste in safety boxes

Used syringes in 5 (liter) WHO-approved safety boxes are the most common waste to be destroyed, especially during immunization campaigns. A safety box filled with used syringes weighs approximately 800 gm to 1400 gm. Safety boxes in primary health facilities sent for incineration typically weigh anything between 800 gm<sup>7</sup> and 1000 gm<sup>8</sup>.

**Figure 1.3 Types of Waste**



12kg and 9 kg of safety boxes per hour, respectively. If waste is loaded at the rate of 6-7 kg per hour, and stove pipe temperatures are maintained between 600 °C and 900 °C, then smoke emissions reduce considerably.

**Recommended Rate of Destruction: 1 safety box every 8 to 10 minutes**

If burning is fierce and waste is loaded rapidly, then internal temperatures increase, which may cause toxic emissions to reduce, but the levels of black smoke increase.

**A careful balance between the rate of loading the incinerator and maintaining the incinerator operating temperature is required to minimize levels of visible smoke emissions and toxic emissions.**

<sup>6</sup> Open glass vials may be incinerated. Ref IT Power India test report, Incidence of Vial Explosions in the De Montfort Incinerator.

<sup>7</sup> Average weight of 94 safety boxes measured in Burkina Faso, Rapid Assessment of the WDU, PATH, June 2003.

<sup>8</sup> Average weight of 34 safety boxes measured in Kenya, Rapid Assessment of the WDU, PATH, June 2003.

<sup>9</sup> An emissions test in May 2003 on a De Montfort incinerator by Professor Jim Picken concludes that optimal burning rate combining high temperature levels with low smoke levels is achieved at 6 safety boxes/hr (6 kg-7 kg per hour).



## 1.9 Emissions: importance of controlling the waste-stream

Incinerators can produce toxic emissions such as carbon monoxide (CO), dioxins (polychlorinated dibenzo-para-dioxins or PCDDs), and furans (polychlorinated dibenzofurans or PCDFs). Carbon monoxide is produced by poor and incomplete combustion. These emissions can be reduced by good design and good operating procedures. Dioxin and furan emissions occur through burning of chlorine-containing wastes, e.g., PVC and other plastics. In general, since exposure to dioxins and furans is mostly through food intake (WHO 2001), the emissions from incinerators should not be allowed to blow across cultivated land. Emissions are minimized by good waste segregation practices to eliminate inclusion of PVC waste, and appropriate practices for high-temperature incineration. Incinerators are, however, estimated to emit a significant fraction of the global emissions of dioxins and furans.<sup>10</sup>

### 1.9.1 The World Health Organization position

From an environmental perspective, incineration of health care waste is not the ideal solution for health care waste disposal. Nevertheless, it is often the most viable option for developing and transitional countries. In these countries especially, there is a significant disease burden associated with poor management of health care wastes, since options for waste disposal are limited. There is also the issue of costs. Incineration of health care wastes may therefore be the preferred interim solution for disposing of health care waste. In situations where incineration presents itself as the best option, care needs to be taken to ensure that exposure to toxic air pollutants associated with burning is reduced to the minimal. One way in which this could be done is to limit the incineration of health care and other wastes to less-densely populated areas, e.g., rural areas.<sup>11</sup> As less polluting waste disposal technologies become available and resources permit, incinerators will gradually be replaced with safer waste treatment/disposal alternatives.

The WHO has found it inappropriate to recommend acceptable limits for dioxin and furan emissions in the proximity of small-scale incinerators. This is mainly because: most small-scale incinerators, including the De Montfort, do not meet the already existing but widely diverse standards: 0.1 ng toxic equivalency (TEQ)<sup>12</sup> 13/m<sup>3</sup>N to 5 ng TEQ/m<sup>3</sup>N for new incinerators in Europe and 10 ng TEQ/m<sup>3</sup>N for incinerator facilities already in use in Japan.<sup>14</sup> Further, there are a number of technology barriers. Small-scale incineration cannot be equipped with emission reduction and control devices, since such devices are unaffordable on a small scale. However, new generation, gas/electric-powered, small-scale incinerators for destruction of safety boxes are now commercially available.<sup>15</sup> These meet the European Union environmental norms, but are only suited for use at locations with regular electricity and gas supply.

Until countries have access to environmentally safe options for the management of medical waste, incineration may still be seen as the main option for such disposal. To make

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<sup>10</sup> Medical waste incinerators were estimated to account for 21 percent of known sources of dioxin and furan emissions in the U.S. in 1987.

<sup>11</sup> This was a main recommendation from a WHO-organized and sponsored meeting on "Small Scale Incineration/Dioxin and Furan emissions", 15 December 2003, WHO Geneva, Switzerland.

<sup>12</sup> TEQ is a calculated figure used to estimate the overall toxicity of multiple types (congeners) of dioxin-like chemicals at once.

<sup>13</sup> Toxicity equivalent at 40 hours per week.

<sup>14</sup> Source reference: Teruyoshi EHARA, Programme for the Promotion of Chemical Safety (PCS), WHO.

<sup>15</sup> Mediburner, Oulu, Finland.

incineration as safe as possible, “Best Practice” tools should be made available and enforced (e.g., pre-heating and not overloading the incinerator, or incinerating only at temperatures above 800° C). These guidelines are one element in the effort to reinforce a process of building “Best Practices.”

WHO suggests that additional country assessments are necessary to gauge the national authorities’ capacity to cope with the problem of health care waste. Such assessments will help lead to the development of appropriate health care waste management national policies and technologies.

### 1.9.2 Summary of dioxin emission estimates<sup>16</sup>

The available data related to emissions relevant to small-scale incinerators (without air pollution control equipment) appear to fall into three groups:

- 1) **Best practice:** Properly operated and maintained units which utilize sufficient temperatures, afterburners (secondary combustion chambers), and other features that limit dioxin/furan production. For such units, a reasonably conservative estimate of the emission concentration is 10 ng TEQ/Nm<sup>3</sup>.<sup>17</sup> This limit may not be conservative for small brick-type units like the De Montfort design, which has a very short (<0.2 s) and variable residence time.

#### **Incineration for “Best Practices should not exceed 2hrs/day.**

- 2) **Average practice tends to include:** Improperly designed, constructed, operated or maintained units that feature afterburners. Emissions from the SICIM Pioneer incinerator in Thailand, and United Nations Development Programme (UNDP) Class 2 tests range up to 600 ng TEQ/Nm<sup>3</sup>, though most tests show lower emissions. Using a 500 ng TEQ/Nm<sup>3</sup> value may be conservative, however, given that the available data are admittedly scarce.
- 3) **Worst case equipment use:** Incinerators without an afterburner. The UNDP estimates an emission concentration of 4000 ng TEQ/Nm<sup>3</sup> for this simple technology.

### 1.9.3 Relative risks

For persons other than those with direct occupational exposure and contact with the ash residue, and if “Best Practices” are applied and incineration usage levels for waste disposal do not exceed 2 hrs/day, emissions represent less than 1 percent of the WHO provisional intake level for adults and children. As for the safety worker, sufficient precautions must also be taken to minimize exposure to toxins through consistent use of protective clothing, face masks and gloves.

To maintain risks at a small fraction of the WHO levels considered to be acceptable when “expected practices” are applied, utilization rates should not exceed one time per month, and each use should not exceed an hour.

If there is no provision for afterburning (secondary burning) when disposing of waste through drum burning or incineration, a “worst case” situation is likely. In this case, even if

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<sup>16</sup>Batterman, Stuart. *Assessment of Small-Scale Incinerators for Health Care Waste*. Water, Sanitation and Health, Protection of the Human Environment, World Health Organization. For more information, contact S. Batterman at Environmental Health Sciences, University of Michigan, 109 Observatory Drive, Ann Arbor, MI 48109 USA

<sup>17</sup> Taken from the 90<sup>th</sup> percentile AP42 emission factor analysis.

incineration is undertaken only once a month for an hour, it may cause unacceptable intake and risk levels.

#### 1.9.4 Measures to minimize emissions

To reduce emissions, adhere to the following Best Practices:

- Rigorously segregate waste so that no PVC (IVs, etc.) waste is incinerated.
- Ensure that the incinerator is built according to recommended dimensions, using appropriate materials, and that it is functioning properly, and the chimney is clear of excessive soot.
- Ensure that the incinerator is preheated adequately and that supplementary fuel is added whenever necessary to maintain the burning temperature above 600<sup>0</sup> C.
- Load the incinerator according to the recommended “Best Practices”.
- Minimize burning in the chimney through correct loading practices and regulation of the self-adjusting draft control in the chimney. This increases the gas residency period.
- Adopt rigid quality control measures.

### 1.10 WDU management

Once an appropriate location to install the WDU has been identified, the other key management issues that need attention include budgetary provision, choice of site at the location, application of a “Best Practices” approach by the WDU operator, motivation of health care waste management personnel, and an effective supervisory mechanism for HCWM. The following sections discuss the issues related to installation, sustainable operation, and maintenance of a WDU.

#### 1.10.1 Capital expenditure

Capital expenditure of WDUs comprise materials/fabrication costs, labor costs, and costs associated with management and training. Capital expenditure is generally borne by international donor agencies or central, state or provincial governments ( See paragraph 1.11.1 for more details). Managers of WDUs at primary health facilities while not usually directly involved in mobilization of resources for capital expenditure, assume responsibility for assigning and coordinating personnel for training programs, HCWM supervising, and oversight of installation.

#### 1.10.2 Operating budget and expenditures

In addition to the capital expenditure incurring on procurement and installation of the equipment and training, waste processing also requires financial resources to meet recurrent costs on personnel, fuels and maintenance. Health care facility budgets must include an annual provision for recurrent costs, and the management should carefully control the disbursements. During field evaluations it was observed that the absence of financial resources for recurrent costs is one of the most common reasons for failure of waste management programs. Some HCWM programs have successfully introduced a “burning fee” to offset or finance recurrent costs.

### 1.10.3 Siting

Siting is the process to determine where the WDU should be placed at a primary health facility. The location of the WDU can significantly affect the dispersion of smoke and particulates from the chimney, and the resultant exposure of workers and the public to toxins. Siting must also address issues of permission, ownership, access and convenience. A Best Practices approach should be adopted to find a location that, “to the maximum extent practicable, minimizes potential risks to public health and the environment.”<sup>18</sup>

Experience with the De Montfort incinerators highlights the importance of good siting, and the importance of involving stakeholders, including medical personnel, nearby residents and incinerator operators, in the process of selecting the most appropriate site.

The following strategy should be adopted when selecting a site for the WDU:

- Involve individuals responsible for HCWM at the primary health facility in siting decisions.
- Involve health workers and members of the local community in the decision process.
- Respect national policies and regulations.
- Take guidance from a person or organization experienced in siting waste disposal units. This is mandatory.

The WDU should be built at a location where:

- It is convenient to use.
- It is NOT close to patients’ wards and other occupied or planned buildings.
- There is low public presence/passage.
- Flooding does not occur.
- No flammable roofs or inflammable materials are stored within a radius of 30 meters.
- Prevailing winds blow smoke away from buildings and NOT across cultivated land.
- Security risk is minimized.

### 1.10.4 Procurement Strategy

The guidelines propose two options for procurement: a locally built WDU, where all the raw materials are sourced and manufactured locally, transported to the site, and assembled. (Such would be the case in India and South Africa). The other option is the “imported kit” option, where the parts are prefabricated, integrated with materials which may not be locally available (e.g., refractory brick and refractory cement), and imported as a pre-packaged kit which is then assembled at the site. Whatever option is adopted is an important management decision and will have substantial impact upon capital costs, workload of the local implementing agency, and—above all—good operational performance. Criteria for a decision making process to select the most appropriate option are listed in Section II, Paragraph 2.5.4.

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<sup>18</sup> The US Environmental Protection Agency regulates the burning of hazardous waste in incinerators under 40 CFR Part 264/265, and in boilers and industrial furnaces under 40 CFR Part 266. U.S. Environmental Protection Agency, “Draft: Technical Support Document for HWC MACT Standards,” February 1996, [http://www.epa.gov/epaoswer/hazwaste/combust/tech/tsd\\_v2.pdf](http://www.epa.gov/epaoswer/hazwaste/combust/tech/tsd_v2.pdf) (Accessed July 7, 2004).

### 1.10.5 WDU operator

Several rapid assessments in 2003<sup>19</sup> of waste management practices and incinerator performance highlight management and incinerator operator constraints as critical factors in good HCWM. Major constraints identified were inconsistent design standard, inadequate quality control during installation, and inadequate operator training and motivation. The following operator-related measures should be adopted to ensure good WDU performance:

- Only a trained, qualified and equipped operator should operate the incinerator.
- The operator must be on-site while the incinerator is functioning.
- The operator must be motivated to follow “Best Practices.”
- The WDU should be operated according to Best Practices to minimize emissions and other risks.
- Operators must have long-term contracts or be permanent hires.

Long-term or permanent operator contracts are the often the most difficult of the above points to address. WDU operation is usually not a full-time job, and frequently WDUs are operated by casual labor responsible for grounds maintenance. At some sites, casual laborers are rotated periodically in compliance with labor laws. This approach is strongly discouraged since training efficient operators is time-consuming and expensive; and operator knowledge and commitment are essential for good incineration practices. Operators should be contracted for longer terms or be on permanent payrolls.

In some instances, district-based cold chain maintenance technicians manage the WDUs. This practice is to be encouraged since cold chain technicians have a technical profile, habitually maintain records, and can recognize maintenance needs.

### 1.10.6 Supervision

Even if operators are well-trained, supervision is essential. Supervision provides quality control and recourse to improve other aspects of waste management, in particular segregation and disposal practices.

Every country should have a collaborative mechanism for developing a regulatory framework for HCWM, such as a national HCWM committee to develop and underpin national policies for handling, processing and destruction of infectious waste at all health facilities, including primary health facilities.<sup>20</sup>

Each primary health facility should designate an HCWM supervisor, with operational linkages (directly or indirectly) to the HCWM Committee. The responsibilities of the HCWM supervisors at these facilities include:

- Training all primary health facility staff in HCWM practices;
- Ensuring good waste segregation practices;
- Coordination and supervision of waste transportation, packaging, storage and handling;

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<sup>19</sup> Based on studies of Burkina Faso, Kenya, Senegal, Benin, and Nigeria, and the Rapid Assessment of the WDU, PATH, June 2003.

<sup>20</sup> Recommendation offered to the Task Force on Immunisation (TFI) in an overview of GAVI/ITF workshops, Luanda, Angola 3-5 December 2003.

- Monitoring of waste processing at the WDU and other appropriate locations (municipal facilities);
- Supervision of the WDU operator; and
- Reporting.

#### 1.10.7 Motivation

One of the key barriers to good HCWM is the absence of motivated operators and HCWM supervisors and the lack of effort to motivate them. Waste management, handling, and disposal are not generally considered ennobling tasks, hence special efforts need to be made to motivate personnel involved. One way of motivating the personnel is through schemes offering financial incentives for good performance. Good training and creating awareness in the community of the importance of good waste management can also improve motivation levels. (Training of operators is discussed in Section III.)

#### 1.10.8 Maintenance

Maintenance is required for all processes that entail the use of technology. Maintenance of WDUs is no exception. (Issues of maintenance and planning are discussed in detail in Section IV.)

Supervision and control of maintenance quality are a management responsibility and are just as much a part of WDU management responsibility as budgetary provision. Usually, maintenance responsibility is outsourced under an Annual Maintenance Contract (AMC), in which case there is scope to include performance guarantees in the contract agreements for services. In some countries, the maintenance responsibility is assumed directly by the maintenance infrastructure of the ministries of health. Operating policies will determine the approach adopted. Economic and quality of service considerations should be the primary factors in selecting a maintenance option.

### 1.11 WDU Costs

In reviewing De Montfort economics, costs directly relating to the WDU and its operation are considered, and not the costs of transport, packaging and management which are part of general HCWM costs and not specific to WDUs.

#### 1.11.1 Capital costs

The capital cost of a WDU will vary from location to location, depending on the following factors:

- Whether the “Local Build” or the “Imported Kit” (which comprises prefabricated metallic components and other materials not readily available in many countries) option is chosen
- Material and labor costs and the profit margin required by the equipment manufacturer.
- The number of WDUs to be installed.
- The remoteness and accessibility of sites.
- The type of contractual approach adopted.
- The scope of services (maintenance contracts, performance bonds, etc.) defined in the supply agreement.

Table 1.1 provides indicative distribution of capital costs of WDUs for programs ranging from 5 to 100 WDUs.

**Table 1.1 Estimated percentage of capital costs for manufacturing, constructing, and commissioning a WDU**

Cost components	5 WDUs	100 WDUs
Materials/Fabrication	33%	47%
Labor	13%	25%
Management/Training	54%	28%

This distribution is based upon actual cost estimates obtained in India in 2004, where the total capital costs were USD 950 per WDU when 100 WDUs had to be constructed, and USD1800/WDU when only 5 WDUs had to be constructed. The economies of scale are due primarily to the management/training component; the materials and fabrication costs reduce by only 25 percent with large-scale production.

#### 1.11.2 Recurrent costs

The WDU equipment is designed to operate for 10 years before total replacement. Financial provision to cover the recurrent costs of WDUs over a ten-year period should be made when planning a HCWM system. Typical recurrent costs include:

- Wood, coconut shell, or kerosene needed to preheat the incinerator and supplement burning of medical waste at each burn cycle. For one complete cycle (i.e. preheating, incineration, and cool down), about 8 kg of wood is required. It is assumed the wood is dry.
- Salaries, social benefits and performance incentives of the WDU operator and supervisor.
- Replacement of labor and worn out parts.

Retraining and quality assurance are necessary. Table 1.2 provides indicative percentage distributions of annual recurrent costs of WDUs for the first year when retraining occurs, and for other years over a 10-year life cycle. Figures presented assume a level of utilization of 120 safety boxes per month.<sup>21</sup>

**Table 1.2 Estimated percentage distribution of recurrent costs for construction and commissioning a WDU**

Cost components	First year recurrent costs		Second to tenth year annual recurrent costs	
	5 WDUs	100WDUs	5 WDUs	100WDUs
Parts and maintenance	14%	14%	20%	17%
Fuel	23%	30%	33%	34%
Salaries/benefits	34%	42%	47%	49%
Retraining	29%	14%	(offered annually)	(offered annually)

<sup>21</sup> The average utilization rate observed in Kenya was 58 safety boxes per month.

Recurrent costs in India are projected to be USD430/WDU per year for a HCWM program consisting of 5 WDUs in those years when retraining is conducted, and USD300 otherwise. For large programs of 100 WDUs, recurrent costs are estimated at USD 330 with retraining conducted, and USD 290 with retraining. No significant economies of scale are achieved with larger programs, except in years when retraining occurs.

### 1.11.3 Cost efficiency

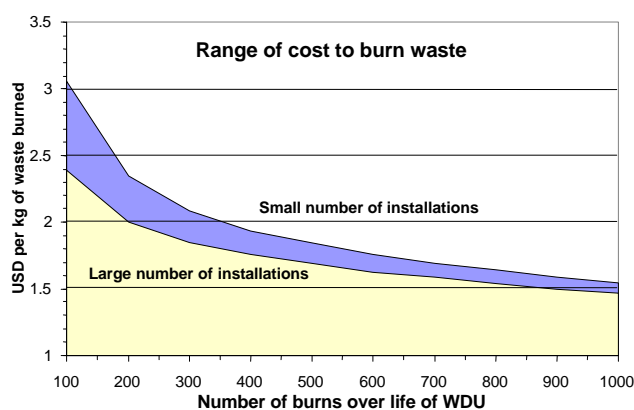
While capital and recurrent costs associated with setting up and operating a WDU are important from a budgetary perspective, it is ultimately the cost efficiency of destroying medical waste that is of greatest importance. The major factors that influence cost efficiency are:

- The level of utilization: (quantities of waste destroyed). To a large extent, this is dependent upon choosing an appropriate location for the WDU<sup>22</sup> and the HCWM practices; in particular; management, quality control, collection and transportation.
- Capital and recurrent cost: Although contingent upon locally available material and labor costs, these costs are also determined by good contracting practices and rigorous quality control.
- Life expectancy of the WD: Its duration is largely dependent upon the engineering design, component quality, installation standards, and operator practices.

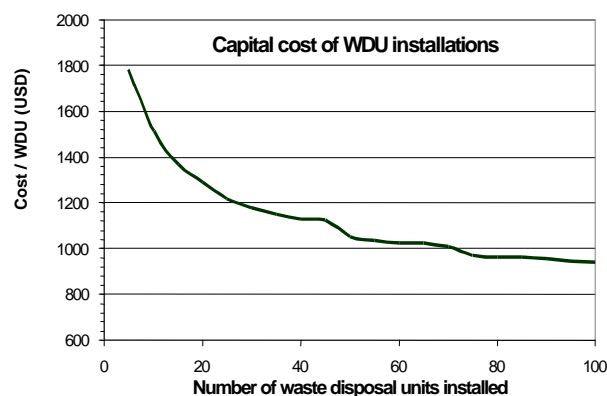
Based upon data gathered from India, Graph 1.1 and Graph 1.2 provide estimates of the:

- Link between the level of utilization of a WDU and the costs of burning waste over the operating life of the WDU; and
- Link between WDU capital cost to program size.

**Graph 1.1 Level of utilization versus cost of burning waste**



**Graph 1.2 WDU capital costs versus program size**



<sup>22</sup> An Overview of GAVI/ITF Workshops during 2002-2003 for the WHO Task Force on Immunization (TFI), John S. Lloyd, Luanda 3-5 December 2003.



These charts provide a basis for decision-makers to estimate capital and recurrent costs, and cost efficiency of a planned WDU program. Annual maintenance costs are based upon 100 burns per year, each for a period of 2 hours, at a rate of loading of 6 boxes per hour.<sup>23</sup>

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<sup>23</sup> The financial model may be requested via email at [nvm@itpi.co.in](mailto:nvm@itpi.co.in) or [tjh@itpi.co.in](mailto:tjh@itpi.co.in).

## 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.

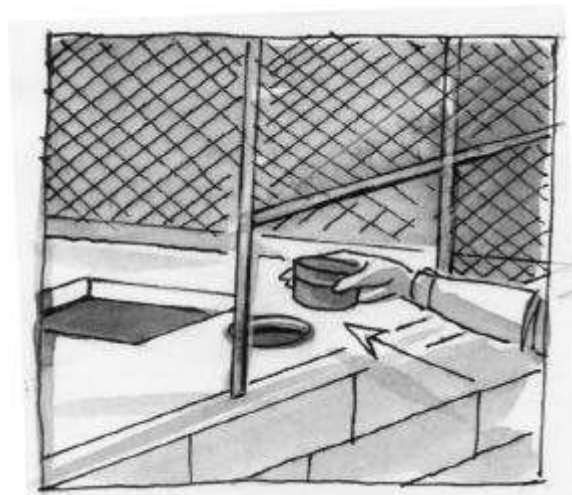
## 2.2 A brief description of the operational aspects and storage capacities

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.

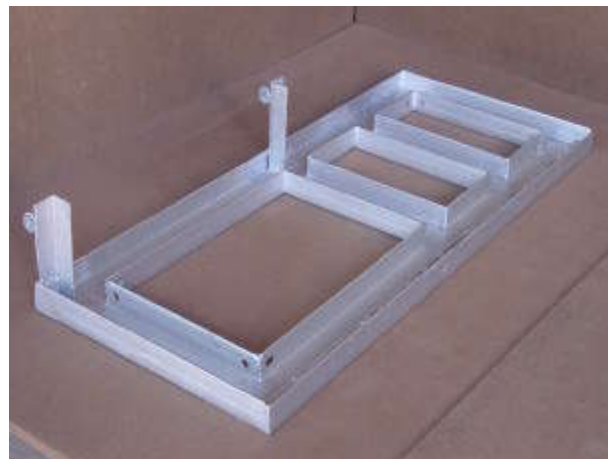
The fuel store has the capacity to store wood, coconut or other combustible agro-waste sufficient for one week, assuming daily burning sessions.

### 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 2.5 Item 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**

<b>Task</b>	<b>Sub-Task</b>	<b>Drawing Reference</b>	<b>Level of Effort (person days)</b>
<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



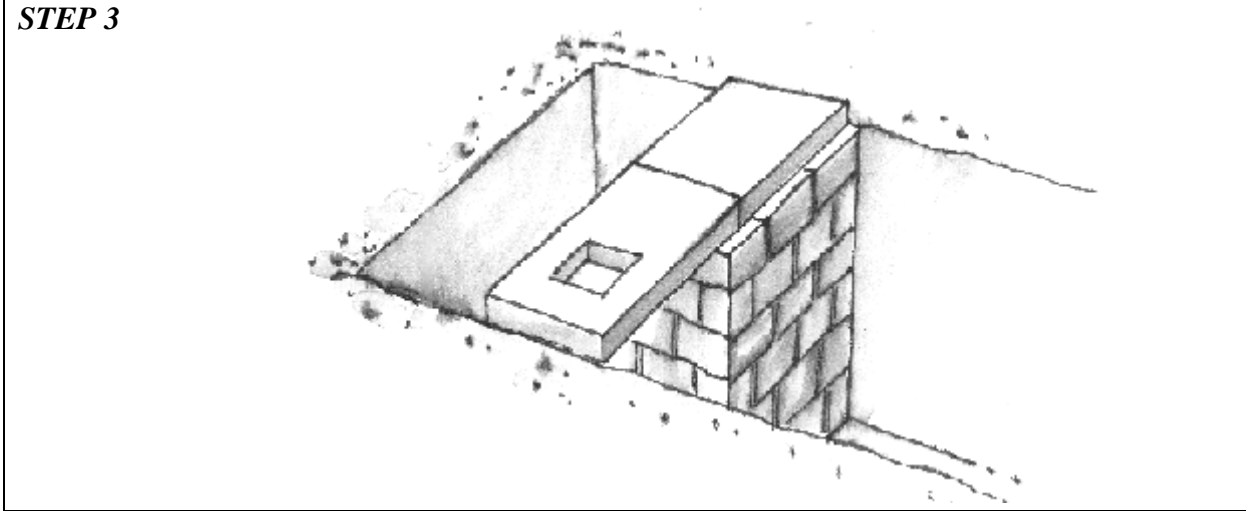
*Figure 2.3.2 Digging WDU foundation and ash pit*

**STEP 2**



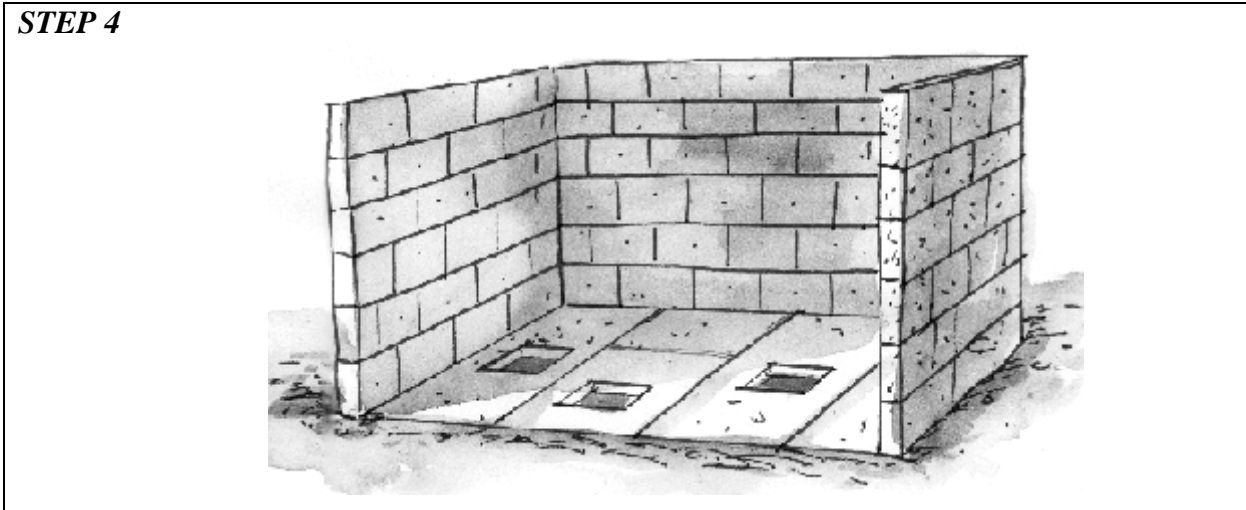
*Figure 2.3.3 Pouring incinerator slab and supporting wall*

**STEP 3**



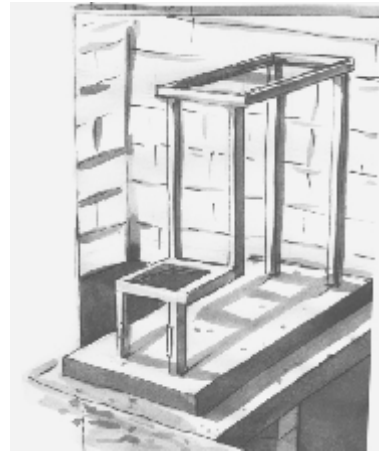
*Figure 2.3.4 Placing RCC removable slabs*

**STEP 4**



*Figure 2.3.5 Placing metallic frame and grouting frame in PCC slab*

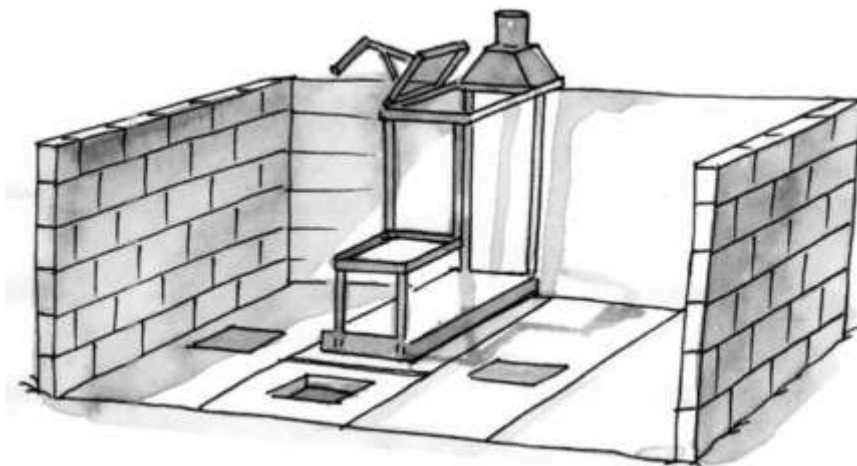
**STEP 5**



Temporary brick surround to retain mortar.

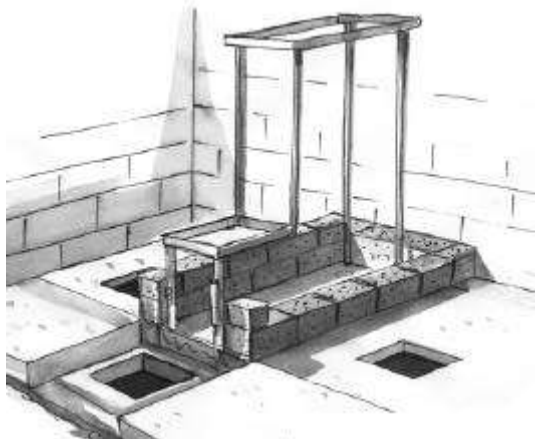
*Figure 2.3.6 The metallic frame grouted in the PCC slab, ready to start refractory bricks*

**STEP 6**



*Figure 2.3.7 Mounting refractory bricks around metallic frame*

**STEP 7**



*Figure 2.3.8 Building refractory bricks and positioning block of bricks in base.*

**STEP 8**

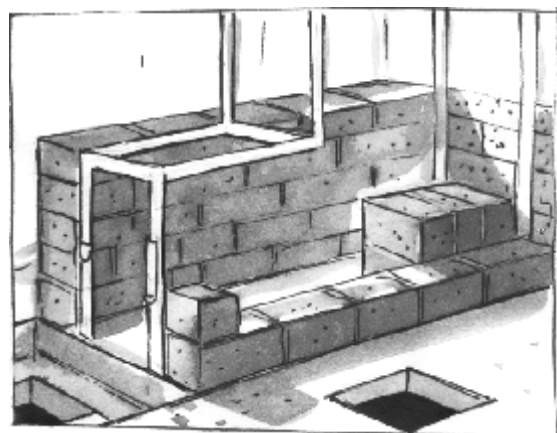




Figure 2.3.9 Adding refractory bricks around ash door and bridge

**STEP 9**

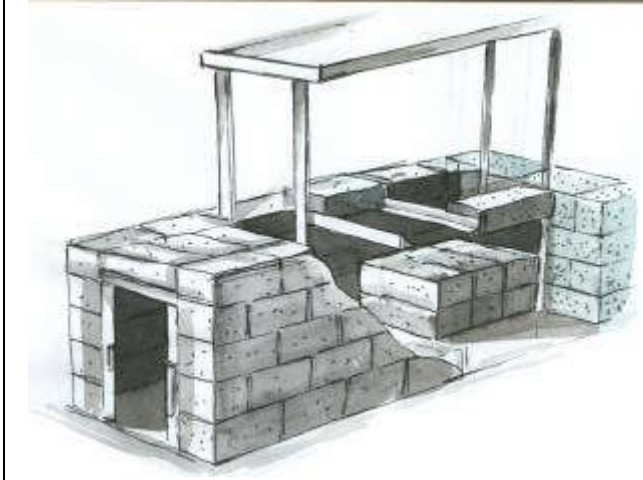


Figure 2.3.10 Finished incinerator masonry with loading door

**STEP 10**



Figure 2.3.11 Placing Slabs on finished incinerator brickwork.

**STEP 11**

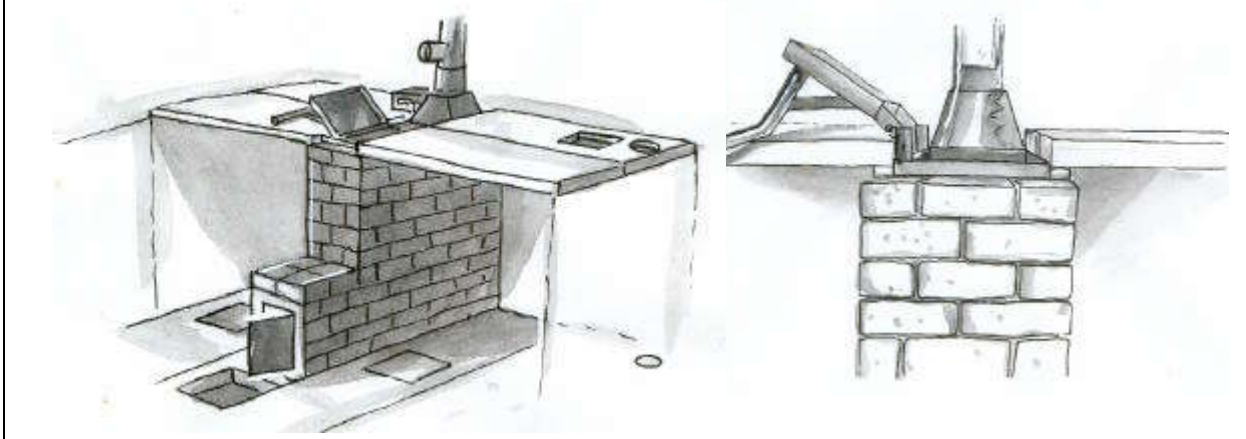
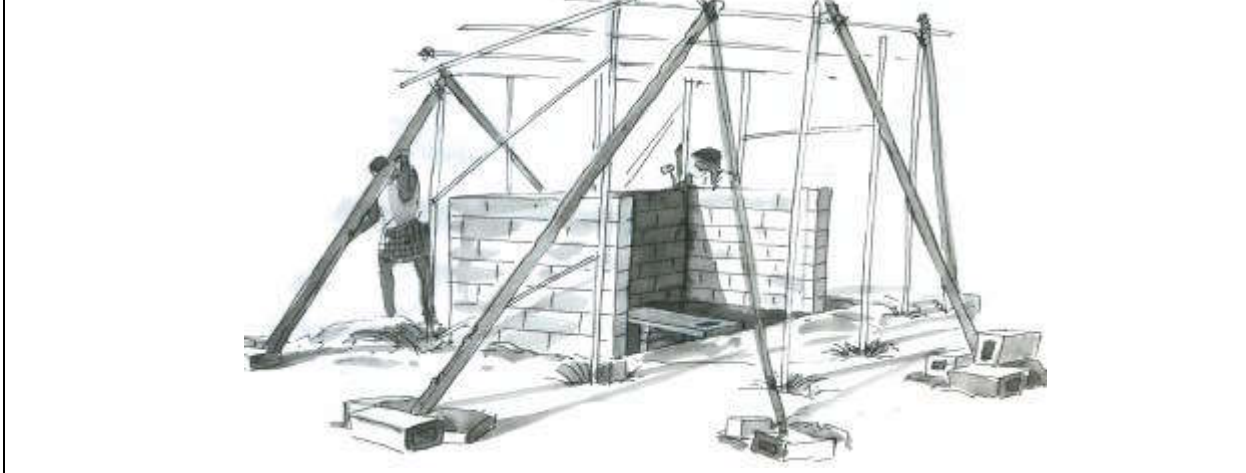


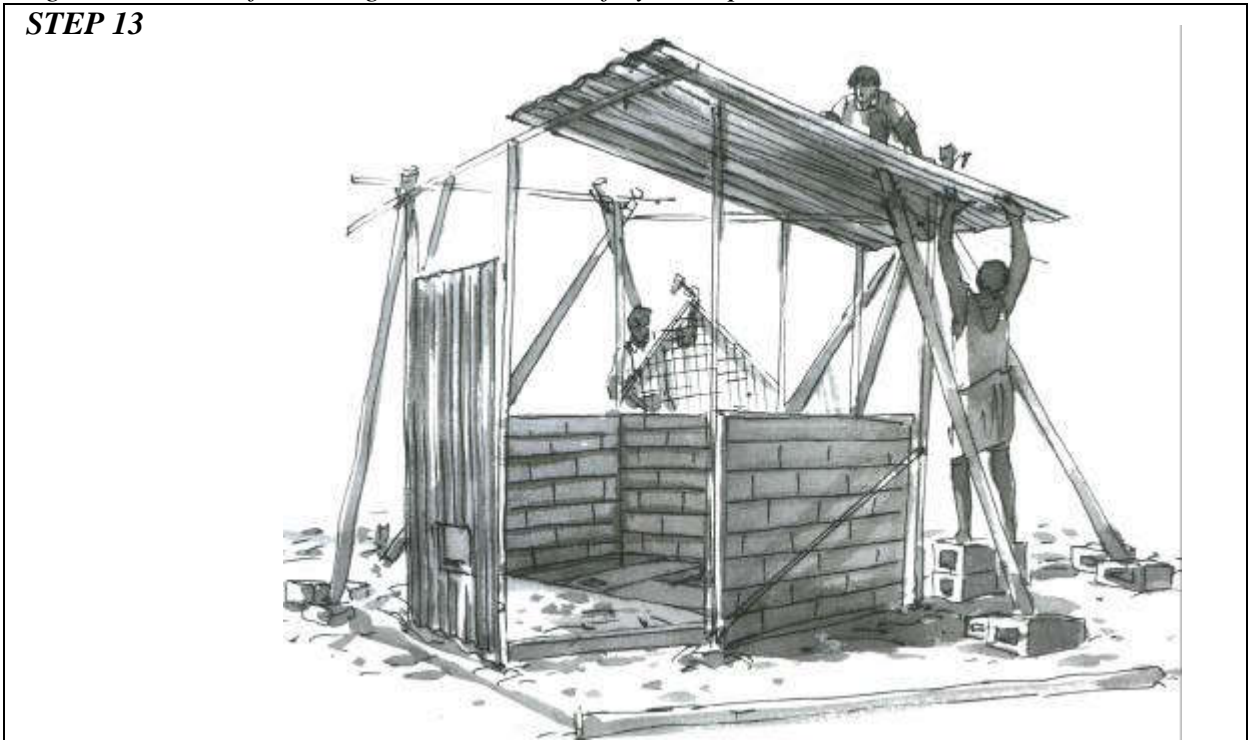
Figure 2.3.12 Shelter and enclosure support frame

**STEP 12**



*Figure 2.3.13 Roof cladding and door with safety box aperture*

**STEP 13**



*Figure 2.3 14 Finished WDU with chain link fence, spigot and ash door mounted*

**STEP 14**



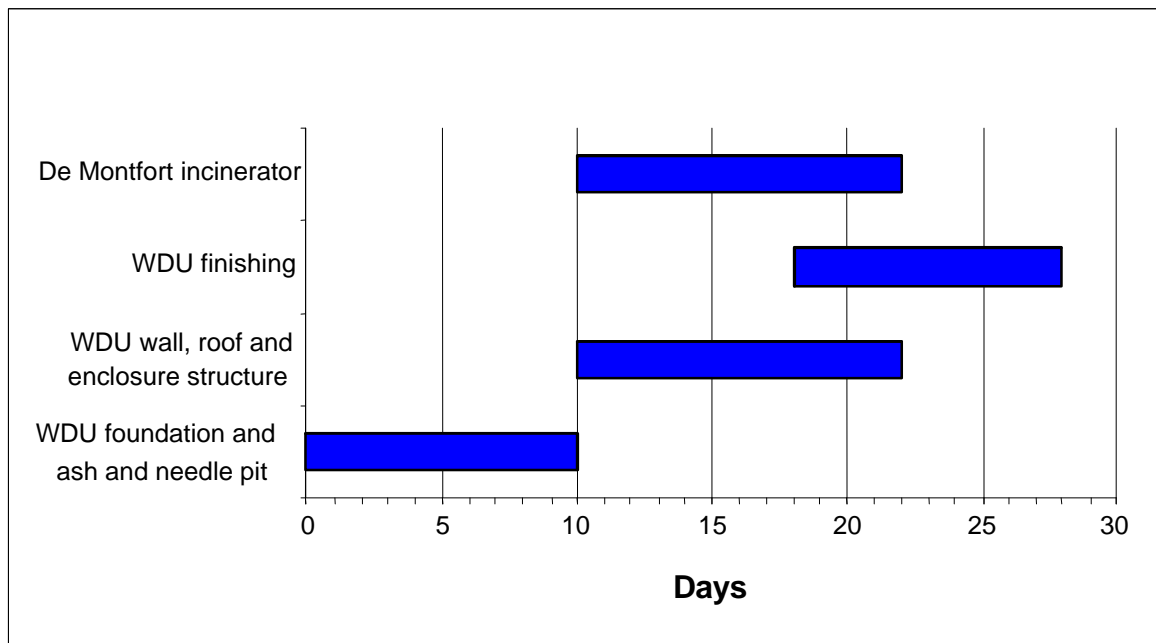
### 2.4.2 Construction timeline

The time required to build a WDU will depend upon workforce availability, skills and quality control. It should take approximately 1 to 4 weeks. Table 2.10 and 2.11 show the sequence and the linkages between the construction activities.

**Table 2. 10 Steps in the construction process**

Step in the Construction Process	Start Day	Duration (No. of Days)
WDU foundation and ash/needle pit	0	9
WDU wall, roof and enclosure structure	10	12
WDU finishing	18	10
De Montfort incinerator	10	12

**Figure 2.4 DWDU Construction Schedule**



### 2.4.3 Kit or local manufacturers' method

When planning HCWM programs, two options could be considered for procuring the components and labour of the Waste Disposal Unit. Table 2. 11 assists procurement agents to choose an appropriate option.



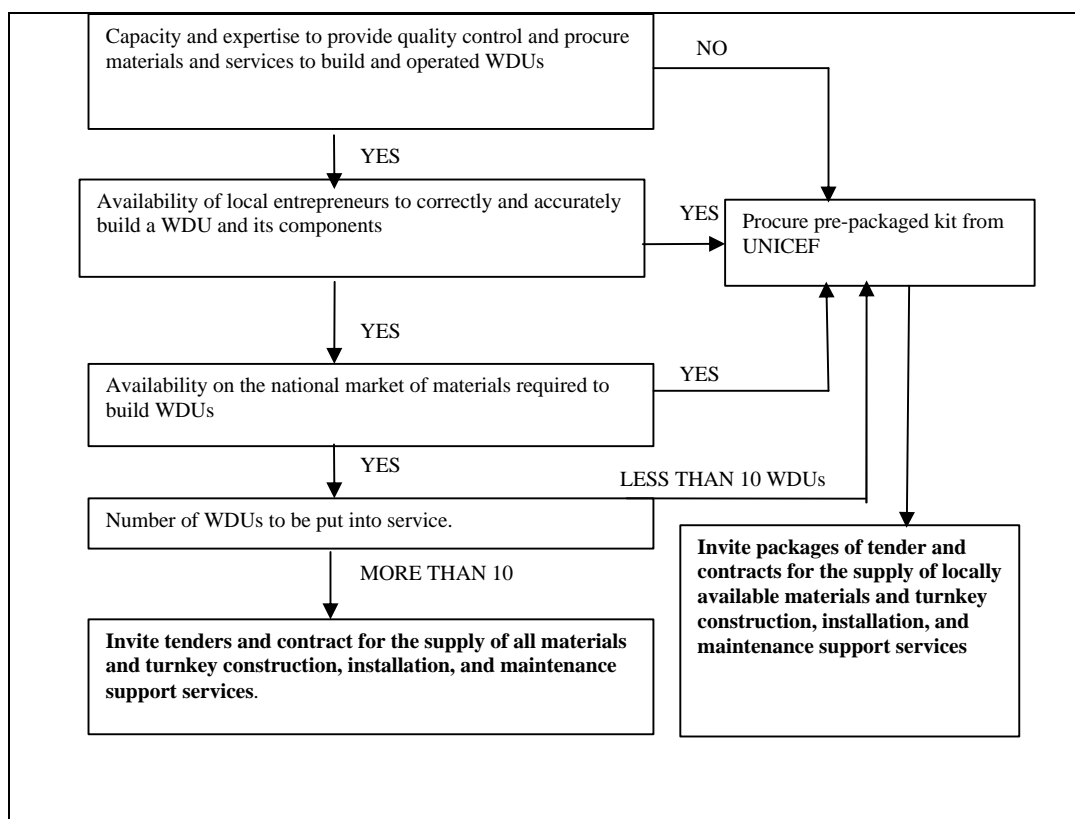
**Table 2. 11 Options for procurement agents**

<p style="text-align: center;"><b>Option 1: Imported Kit</b> Pre-packaged/Imported components</p>	<p style="text-align: center;"><b>Option 2: Local</b> Locally sourced components</p>
<p>The pre-packaged kit includes everything which is listed in Table 2.3. Procure a pre-packaged kit from UNICEF (listed in Product Information Sheets PIS/PQS), which includes all the fabricated metal components and the other materials (e.g. refractory bricks/cement) not readily available in the country where the HCWM program plans to use the WDUs.</p>	<p>Invite tenders and contract for the supply of all materials and turnkey construction, installation, training and maintenance support services.</p>
<p>The kit does not contain everything that is required and some things have to be procured locally. Invite tenders and contract locally for the supply of locally available materials not included in the UNICEF kit These materials are defined in Table 2.2. Also invite tender for turnkey construction, installation, training and maintenance support services.</p>	<p>Provide quality control, or contract experienced consultant services.</p>
<p>Provide quality control, or contract experienced consultant services.</p>	

2.4.4 Decision process for procurement approach

Figure 2.5 outlines the flow diagram for the Procurement Approach.

**Figure 2.5 The decision to procure a flow diagram**



## 2.5 Tender specification

Tender specification addresses the following main components: construction, training, and maintenance.

A limited number of entities should be invited to submit their tenders. Tendering procedures must be aligned with local practices, with clear recourse to the contractor in the event of sub-standard or non-performance. The selected contractor must deliver according to the tender specification.

The essential elements of each component are summarized below.

### 2.5.1 Construction

In addition to the standard provisions defined by international agencies and national governments, the tender specification should contain the following:

- Set of plans and assembly drawing as listed in Table 2.1.
- Set of drawings and quantities of locally supplied materials and components as listed in Table 2.2.
- Set of engineering drawings as listed in Table 2.3
- Specifications and estimated quantities of metallic materials as listed in Table 2.4.
- Specifications and estimated quantities of non-metallic components as listed in Table 2.5.
- Specifications and estimated quantities of paint and rust proofing, outsourced components and curing procedures as listed in Table 2.6, Table 2.7 and Table 2.8 respectively.
- A list of steps in the construction process defined in Table 2.9 according to the construction schedule in Table 2.11.
- Definition of the Quality Control process (specified by procurement agency).
- Component, provisional and final receiving report templates (specified by procurement agency).
- Terms and conditions of a performance bond or some similar arrangement to ensure that maintenance services are assured over 10 years.

### 2.5.2 Training

Rapid assessments of experiences operating the De Montfort incinerators highlight the importance of operator training and the impact of training on achieving “Best Practices”.

Tender specification should include provision for the following training:

- 1) Introductory training for all new WDU operators.
- 2) Retraining of WDU operators after approximately one year of operational experience.
- 3) Follow on training/retraining as deemed necessary to ensure operation of WDU as per “Best Practices”

The scope and content of each training component is provided in Section III: Training for operators of the De Montfort waste disposal unit.

An “Operator’s Manual” should be provided to each operator trained.

The training plan needs of supervisory staff assigned HCWM responsibilities at primary health facilities are not addressed in these guidelines. Supervisory staff should be familiar with these “Best Practices” for a WDU operation.

Operator training/re-training costs estimates are presented in Section I.

### 2.5.3 Maintenance

Feedback from evaluations of country programs clearly indicates that the invitation for tenders should not be restricted to a “construction contract”. Training and maintenance should necessarily be included to ensure quality and sustainability. Maintenance options must be carefully considered when inviting tenders. Also, success stories of local maintenance practices should be considered.

Well-known and proven maintenance practices include:

- Inclusion of an “Annual Maintenance Contract (AMC)” with a payment structure comprising an initial disbursement for installation services, subsequent annual disbursements for maintenance services, and a retainer (performance) bond payable upon successful completion of services. This approach is often difficult for funding agencies to administer since the payments extend over a long timeframe.
- Inclusion of a Maintenance Contract (MC), with a payment structure where the discounted value of maintenance over the maintenance period is paid upon fulfilling the installation and training requirements. A declining guarantee facility or performance bond deposited by the contractor is mandatory to ensure quality services are provided.<sup>9</sup>
- Inclusion of a Maintenance Contract, where the negotiated amount for installation and services, plus operating fee, are assigned to a bank or Non-Banking Financial Intermediary (NBFC) along with a “draw-down” agreement. The HCWM supervisor would have to certify, at each primary health facility, that the WDU has been adequately serviced and is functioning effectively. The contractor would then present signed certificates to the assigned bank or NBFC to release any payment due.

The scope and services of maintenance are outlined in Section IV. The estimated cost of maintenance is provided in Section I.

## 2.6 Contractor selection

The quality of services in many countries where the De Montfort incinerators have been installed has been unsatisfactory, resulting in sub-standard construction, sub-optimal performance, and dissatisfaction at the national government level.<sup>10</sup>

The poor quality is primarily an outcome of inadequate quality control and the lack of experience of entrepreneurs contracted for the services.

In programs where installation and maintenance services have to be contracted for more than 10 WDUs, the contracts should be awarded only to contractors who demonstrate technical and managerial capacity.

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<sup>9</sup> As the age of the equipment increases, the performance may decrease, hence the guarantee will be less as time progresses.

<sup>10</sup> Small-Scale Incinerator Rapid Assessments in Kenya and Burkina Faso, PATH, June 2003. For more information, contact Terry Hart via email at [tjh@itpi.co.in](mailto:tjh@itpi.co.in).

A potential contractor can demonstrate technical capacity by building a WDU. The WDU could either be the pre-packaged kit type or locally manufactured, depending upon the option adopted in a particular program. Agencies soliciting tenders should shortlist qualifying tenders and then invite the short-listed bidders to build a demonstration model. The bidder must supply the materials.<sup>11</sup>

Contractors should satisfy the following criteria:

- Construction or supply of incinerator metallic components as defined in Table 2.3 to be 100 percent compliant with the engineering drawings provided in the Appendices. (Does not apply to kit-type WDUs.)
- Construction of WDU to be 100 percent compliant dimensionally with engineering drawings provided in the Appendices.
- All materials must meet specifications defined in Table 2.5 to Table 2.8.
- Cold crushing strength<sup>12</sup> of the refractory mortar used for the incinerator should not be less than 40 Mpa or Mega Pascal (N/m<sup>2</sup>).
- The installed WDU must satisfy the agency and/or representative of the national government upon visual inspection.

## 2.7 Quality Control

The failure of a number of HCWM programs has been attributed to poor quality control. Strict quality control is essential beginning with the program planning stage through to the construction and training stages, and throughout maintenance service.

The onus of quality control falls on the agency and/or national government responsible for the HCWM program planning and implementation. If professional resources are not available to ensure adequate quality control, then the services should be outsourced. (This is a common practice throughout construction industry.)

Quality control is required during all the phases with regard to the following:

- 1) **Planning and preparation:** Validate decisions on the mode of contracting for services and materials (kit or local procurement), specifically; inputs which determine whether to adopt the kit or local procurement approach, and choices related to tender document formulation, and bid evaluation.
- 2) **Materials reception:** Verify compliance of materials supplied with the technical and material specifications.
- 3) **Evaluation of demonstration models:** The demonstration models constructed by the short-listed tendering entrepreneurs need to be evaluated.
- 4) **Construction phase:** Verify each step as defined in the construction timeline (see Table 2.10)

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<sup>11</sup> The costs of the demonstration model should be reimbursed to the bidder awarded the contract. The contract is awarded for a specific number of units. Hence, it is possible to either a) absorb the cost of the building WDU at a convenient site or b) build a demonstration unit on a site where it is required anyway. This approach helps to ensure that only serious bidders are involved, and that the quality of their work can be checked prior to giving the contract.

<sup>12</sup> Cold crushing strength refers to the capacity to withstand loading at ambient temperature and not the elevated (operating) temperature.

- 5) **Operator and supervisor training and certification:** Ensure training in “Best Practices” for all operators.
- 6) **Maintenance and service:** Make periodic visits to monitor post-installation maintenance and ensure service support for a 10-year period.

The quality control process should follow regular practices of reporting.

## Section III

### Training Plan

(For training operators of the De Montfort waste disposal unit)

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### 3.1 Training program planning and organization

A formal training program is mandatory for operators of the De Montfort waste disposal unit (DWDU). The training program should include all operators, irrespective of whether they are new or experienced.

The organization contracted to install and maintain the DWDUs, or any other organization responsible for training DWDU operators, should administer the training program, which could be held over a two-day period.

A one-day re-training program for all DWDU operators is required on a regular basis (at least once a year for one day) to ensure internalization of “Best Practices.”

Training materials include:

- *Managing Health Care Waste Disposal: Guidelines on How to Construct, Use, and Maintain the De Montfort Incinerator* which comprises Section I: The Waste Disposal Unit: Using the De Montfort Incinerator; Section II: Installation; Section III: Training Plan; and Section IV: Maintenance and Planning. Appendices with construction drawings are also included
- An *Operator’s Manual*, provided by the programme sponsor or through PATH<sup>1</sup>, and
- Trainer presentation materials, also provided by the program sponsor or through PATH<sup>2</sup>.

### 3.2 Participants, facilitators, and materials

Each operator training program should be limited to no more than 10 operators. All trainee operators are to be provided with an *Operator’s Manual* during the training program.

It is recommended that two facilitators conduct the Operator Training Program.

Each training program should be organized close to a location equipped with a functional DWDU built to specification, and equipped with the tools, equipment and materials required to correctly operate it. A supply of fuel, a stock of sharps as well as soft medical waste (sufficient for six burning sessions), and safety equipment should be available for demonstrations (A full list of tools and equipment is provided in the *Operator’s Manual*). It is also important to have simple classroom and projection facilities for presentation purposes.

All DWDU trainee operators attending a training program should be provided with protective clothing, an *Operator’s Manual*, which includes registers to keep records.

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<sup>1</sup> Program for Appropriate Technology in Health ([jlloyd@path.org](mailto:jlloyd@path.org))

<sup>2</sup> Program for Appropriate Technology in Health, for copies of the latest material, contact Mr. John Lloyd at PATH. Email [jlloyd@path.org](mailto:jlloyd@path.org).

### 3.3 Calendar for trainers of DWDU operators

Table 3.1 below provides trainers with the topics and training schedule to be followed when running an operator training program.

**Table 3.1 Training calendar and content**

<b>DAY 1</b>		
<b>Time</b>	<b>Topic</b>	<b>Location</b>
9:00 - 9:10	Registration	Classroom
9:10 - 9:30	Introduction to training	Classroom
9:30 - 10:00	Health care waste management	Classroom and visit to health facility
10:00 - 10:20	Safety	Classroom
10:20 - 10:30	<b>TEA</b>	
10:30 - 11:30	Introduction to DWDU and its parts	Site visit to DWDU
11:30 - 11:45	Management of waste in DWDU	Site visit to DWDU
11:45 - 12:15	Introduction to <i>Operator's Manual</i> and operator's tasks and responsibilities	Classroom
12:15 - 12:35	To burn or not to burn	Classroom and site visit
12:35 - 13:00	Review	Classroom
13:00 - 14:00	<b>Lunch</b>	
14:00 - 14:20	Preparing to incinerate	Site visit
14:20 - 14:50	Getting started	Site visit
14:50 - 15:50	Loading and destroying medical waste	Site visit
15:50 - 16:00	<b>TEA</b>	
16:00 - 16:30	Loading and destroying medical waste	Site visit
16:30 - 17:00	Burn down/ cool down	Site visit
<b>DAY 2</b>		
9:00 - 09:20	Cleaning, ash removal and operator maintenance responsibilities	Site visit
09:20 - 09:40	Record keeping and monthly reporting	Site visit
09:40 - 09:50	Security	Site visit
09:50 - 10:00	<b>TEA</b>	
10:00 - 13:00	Practical experience	Site visit
13:00 - 14:00	<b>Lunch</b>	
14:00 - 15:30	Practical experience	Site visit
15:30 - 15:40	<b>TEA</b>	
15:40 - 16:40	Review session	Classroom
16:40 - 17:10	Maintenance practices and Security	Classroom and site visit
17:10 - 17:40	Feedback on course and trainee information sheets	Classroom
17:40 - 18:00	<b>Closing remarks</b>	



### **3.4 Training program description**

All classroom presentations will be supported by slides, which are provided in the “*Trainer presentation materials*”.

### **3.5 Day 1: Agenda items**

#### **3.5.1 Introduction (20 minutes: classroom)**

Twenty minutes will be devoted to the introduction. It will begin with an “ice breaker” so that participants get to know each other and feel comfortable together. The facilitator will introduce the topic and talk of best practices. The brief outline of the workshop and other logistics will be shared with the participants, and the training course materials distributed.

#### **3.5.2 Health care waste management (30 minutes: classroom and visit around health facility)**

This session will discuss how to plan Health Care Waste Management. It will examine the steps in the management process and the operator’s contribution to “responsible health care”. The following elements of waste management will be covered:

- The purpose and importance of good waste management practices.
- Mapping of waste generated within a district and collected at a waste disposal unit (WDU).
- Existing and planned waste segregation and packaging arrangements.
- Human resources and the tasks and responsibilities of the personnel with regard to waste management
- How waste is to be transported to the DWDU
- The alternative methods used to destroy waste, and the advantages and disadvantages.

#### **3.5.3 Safety (20 minutes: classroom)**

This session will cover the importance of safety measures to minimize the risks to operators, health workers, the local community, the DWDU and the environment. The topics include:

- 1) Responsible conduct of operators
- 2) Cleanliness of the work area
- 3) Possible effects of toxic emissions on:
  - DWDU operators.
  - Local communities through inhalation exposure, but mainly through consumption of contaminated food.
  - Regional global environment, through the discharge of toxic and persistent chemicals.
- 4) Procedures for dealing with suspected contaminations.
- 5) Personal safety includes vaccinations against hepatitis B, routine hygiene and regular medical examinations.

**BREAK (10 minutes)**

#### 3.5.4 Introduction to the DWDU and its parts (60 minutes: site visit to DWDU)

The participants will learn about the DWDU. Each component will be defined and described. The participants will also learn about the tools and other related equipment. An experienced operator will demonstrate how to use the incinerator.

#### 3.5.5 Management of waste in the DWDU (15 minutes, site visit to DWDU)

For safe management of incoming waste, the DWDU operators need to follow the steps outlined in the *Operator's Manual*. The operator has to note down the type, quantity, and origin of the waste.

#### 3.5.6 Introduction to the *Operator's Manual* and the operator's tasks and responsibilities (30 minutes: classroom)

All trainee operators are entitled to receive an *Operator's Manual*. This session will outline the tasks of the operator, which include adhering to "Best Practices", minimizing risk and maintaining records.

#### 3.5.7 To burn or not to burn (20 minutes: classroom and site visit)

Only if the criteria listed in the *Operator's Manual* are met should the incinerator be lit. All the safety measures must be followed. Each of the 8 topics for consideration should be reviewed and checked.

#### 3.5.8 Review (25 minutes: classroom)

This session will cover the overall review of 1<sup>st</sup> day pre lunch sessions. The trainer will clarify the doubts and queries raised by the participants.

LUNCH BREAK (60 minutes)

#### 3.5.9 Preparation (20 minutes, site visit including checks and weighing)

During this session, the facilitator goes through the preparatory steps inclusive of the checklist of materials that must be available at the DWDU. S/he also stresses the fact that wet health care waste should not be burned, petrol (gasoline) should not be used, and protective clothing should be worn.

#### 3.5.10 Getting started (30 minutes: site visit group demonstration)

The trainee is taken step-by-step through the process of lighting up and stabilizing the temperature at 600°C.

#### 3.5.11 Loading and destroying medical waste (90 minutes: site visit group demonstration)

This one-hour session examines the "Best Practices" for loading and destroying medical waste. All the do's and don'ts with regard to the following are demonstrated:

- Rate of loading.
- Reading and sensing temperatures.

- Mixtures of waste.
- Safety and precautions.

BREAK (10 minutes)

#### 3.5.12 Burn down/cool down (30 minutes: site visit group demonstration)

This session covers what needs to be done after the entire waste has been burned up, including the dos and don'ts and the procedures.

### 3.6 Day 2: Agenda items

The sessions on Day 2 are devoted to the post-burning activities, including clean-up, and the very important activity of record keeping and reporting.

#### 3.6.1 Cleaning, ash removal, and operator maintenance responsibilities (20 minutes: site visit demonstration)

The session emphasizes the importance of wearing protective clothes, and checking procedures to ensure that all parts of the DWDU are operating correctly.

#### 3.6.2 Record keeping and monthly reporting (20 minutes: site visit)

The session discusses the content of the three reporting registers and the procedures for reporting.

#### 3.6.3 Security (10 minutes: site visit)

Security of the DWDU is reviewed.

BREAK (10 minutes)

#### 3.6.4 Hands-on practical experience: Operating the DWDU (180 minutes: site visit)

- 1) Divide participants into 3 groups.
  - Group 1: Follows the procedures described in the *Operator's Manual* and operates the DWDU.
  - Group 2: Records each step of the procedure performed by Group 1 and identifies procedural errors.
  - Group 3: Records the smoke levels, gauge temperatures, loading rates, usage of fuel, and medical waste.
- 2) Reverse the roles of each group and repeat the procedures in the *Operator's Manual*.

LUNCH (60 minutes)

#### 3.6.5 Hands-on practical experience: Continued (1.5 hours)

- 3) Reverse the roles of each group outlined above and repeat the procedures in the *Operator's Manual*.

BREAK (10 minutes)

### 3.6.6 Review session: (60 minutes: classroom)

Group discussion: The working groups exchange experiences with regard to

- Actual operation of the DWDU.
- Procedures.

### 3.6.7 Maintenance practices and security (30 minutes: classroom and site visit)

- Likely defects to look for in the DWDU.
- Security measures and procedures.

### 3.6.8 Feedback and trainee information sheets (30 minutes: classroom)

In this session the trainer requests all participants to complete a feedback form (Form 1) and Trainee Information sheet (Form 2).

The facilitator thanks the participants and summarizes the training modules and proceedings.

## 3.7 Retraining of DWDU operators

If operators are well trained, more than half the job is done. Well-trained operators will adhere to “Best Practices”, thereby reducing emissions and risk. Operators do, however, need to be re-trained periodically. Retraining has two purposes: it serves to maintain motivation levels, and helps identify—and hopefully correct—poor practices.

Retraining of DWDU operators is recommended for one day annually.

A single facilitator can run the retraining programs.

Retraining programs also provide an opportunity to integrate a small number of new operators who have not participated in the earlier training.

Topics addressed under the re-training programs should broadly cover those presented in the initial DWDU training program. There should however be greater emphasis on sharing experiences and learning. The likely content of a retraining program is outlined below:

- Review of steps in the *Operator’s Manual*.
- Demonstration by operators of “Best Practices.”
- Review of DWDU faults, defects, and problems encountered.
- Review of operational shortcomings observed since previous training.

**Form 1: Training Feedback**

**DWDU Training feedback Sheet**

**(DO NOT WRITE YOUR NAME ON THIS SHEET)**

**I. ORGANISATION**

	Opinion	Comments
<b>Directions/arrangements to reach the location/venue of the training program</b>	<input type="checkbox"/> Clear <input type="checkbox"/> Manageable <input type="checkbox"/> Difficult	
<b>Did the program begin at the correct time on both days?</b>	<input type="checkbox"/> Yes <input type="checkbox"/> Yes – only on one day <input type="checkbox"/> No	
<b>Lecture schedule was followed as planned</b>	<input type="checkbox"/> Yes <input type="checkbox"/> Some minor changes <input type="checkbox"/> Not followed	
<b>On site visits were followed as per schedule</b>	<input type="checkbox"/> Yes <input type="checkbox"/> Some minor changes <input type="checkbox"/> Not followed	
<b>Overnight accommodation provided, <u>if any</u></b>	<input type="checkbox"/> Good <input type="checkbox"/> Okay <input type="checkbox"/> Unsatisfactory	
<b>Arrangement for lunch, snacks, etc.</b>	<input type="checkbox"/> Good <input type="checkbox"/> Adequate <input type="checkbox"/> Unsatisfactory	

**II. FACILITIES**

	Your rating	Comments
<b>Facilities at the classroom including audiovisual aids</b>	<input type="checkbox"/> Good <input type="checkbox"/> Okay <input type="checkbox"/> Unsatisfactory	
<b>Electricity availability during the program</b>	<input type="checkbox"/> Always available <input type="checkbox"/> Occasional power failure <input type="checkbox"/> Frequent power failures	

III. PROGRAM CONTENT

	Your Rating	Comments
<b>Lectures on <i>Managing Health Care Waste Disposal: Guidelines on How to Construct, Use, and Maintain the De Montfort Incinerator</i></b>	<input type="checkbox"/> Good <input type="checkbox"/> Okay <input type="checkbox"/> Not clear	
<b>Lecture on Introduction to Operator's Manual and operator's tasks &amp; responsibilities</b>	<input type="checkbox"/> Good <input type="checkbox"/> Okay <input type="checkbox"/> Not clear	
<b>Overhead presentation</b>	<input type="checkbox"/> Good <input type="checkbox"/> Okay <input type="checkbox"/> Not clear	
<b>Site sessions</b>	<input type="checkbox"/> Good <input type="checkbox"/> Okay <input type="checkbox"/> Not clear	
<b>Revision</b>	<input type="checkbox"/> Good <input type="checkbox"/> Okay <input type="checkbox"/> Not clear	
<b>Quality of material and manuals</b>	<input type="checkbox"/> Good <input type="checkbox"/> Okay <input type="checkbox"/> Not clear	
<b>Quality of facilitation and knowledge of the resource person</b>	<input type="checkbox"/> Good <input type="checkbox"/> Okay <input type="checkbox"/> Poor	
<b>Number of tools at the workshop</b>	<input type="checkbox"/> Sufficient <input type="checkbox"/> Not sufficient	
<b>Language for communication at the program</b>	<input type="checkbox"/> I could easily understand <input type="checkbox"/> I had difficulty (comment) <input type="checkbox"/> Used local language	

IV. OVERALL OPINIONS

<b>YOUR OVERALL EVALUATION OF THIS PROGRAM</b> <input type="checkbox"/> Excellent <input type="checkbox"/> Very Good <input type="checkbox"/> Good <input type="checkbox"/> OK <input type="checkbox"/> Poor
--

Your Signature:

Date:

Place:

**Form 2: Trainee Information Sheet**

**TRAINEE INFORMATION SHEET (INFORMATION ON TRAINEE AND HEALTH CENTER)**

Health facility assigned to	Position/Responsibilities	Program dates
		Place: Start Date: Duration:

**To be filled by participant (tick ✓ wherever applicable)**

Name of the participant			Optional Age (years)
Designation	<input type="checkbox"/> Chief	<input type="checkbox"/> Supervisor	Gender: <input type="checkbox"/> M <input type="checkbox"/> F
Qualification	<input type="checkbox"/> Post Graduate	<input type="checkbox"/> Graduate	<input type="checkbox"/> Diploma <input type="checkbox"/> Trained on the job
Type of Health Facility	<input type="checkbox"/> Private Business	<input type="checkbox"/> Not for Profit NGO	<input type="checkbox"/> Government
Contact details (Personal Address)	Number & Street		
	City/Town		District
	State	Country	Pin <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
	Telephone		Fax Number
	Web		
Experience in Health Sector	Overall Experience in Health Sector <input type="text"/> <input type="text"/> Years		
	Type of experience <input type="checkbox"/> House keeping – Collection and disposal, <input type="checkbox"/> Management systems - waste destruction, <input type="checkbox"/> Maintenance and operation of waste destruction facilities		
Were you aware of these before this training program	<input type="checkbox"/> Effects of Dioxins <input type="checkbox"/> Best/safe practices - destruction of medical waste <input type="checkbox"/> Record keeping and monthly reporting of medical waste generated in health facility		
Practice used for medical waste destruction at your facility	<input type="checkbox"/> Open air / open pit burning		<input type="checkbox"/> Landfill
	<input type="checkbox"/> Incinerator		<input type="checkbox"/> DeMontfort Waste Disposal Unit
	<input type="checkbox"/> Any other methods _____		
Total medical waste generated at your facility (average annual)	<input type="checkbox"/> < 100 kg <input type="checkbox"/> 500 kg <input type="checkbox"/> 1000 kg <input type="checkbox"/> 3000 kg <input type="checkbox"/> > 5000 kg <input type="checkbox"/> Any Other number: _____		
Hazardous medical waste generated at your facility (average annual)	<input type="checkbox"/> < 10 kg <input type="checkbox"/> 50 kg <input type="checkbox"/> 100 kg <input type="checkbox"/> 1000 kg <input type="checkbox"/> > 2000 kg <input type="checkbox"/> <input type="checkbox"/> Any Other number: _____		
Is your health facility a member of any medical waste related association?	<input type="checkbox"/> Yes. <input type="checkbox"/> No. If yes, specify name of association: <input type="checkbox"/> Don't know		
Contact of others who want to attend training. (use separate sheet if required)	Name		
	Number & Street		
	City/Town		District
	State	Country	Pin <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
	Telephone		Mobile Phone
How did you learn about this program?	<input type="checkbox"/> First information <input type="checkbox"/> IT Power India Pvt. Ltd. <input type="checkbox"/> Colleague <input type="checkbox"/> Employer <input type="checkbox"/> Other:		
In what language would you like to receive the training material?	<input type="checkbox"/> English <input type="checkbox"/> French <input type="checkbox"/> Spanish <input type="checkbox"/> Other Language:		

## **Section IV:**

### **Maintenance and Planning**

**(For ministry of health managers, maintenance contractors, and personnel)**

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#### **4.1 Maintenance responsibility**

A well-constructed WDU is designed to be durable and reliable. If the WDU has been built according to the specified standards, and maintained adhering to “Best Practices”, it will function efficiently for many years.

A qualified official other than the operator should inspect the WDU once every six months. An independent assessment will ensure greater freedom for the inspecting authority and provide an impartial view of the system’s operation. It is suggested that the services of a government environmental health officer, HCWM manager, or air pollution control specialist be enlisted for the inspection.

Normal wear and tear of the unit is to be expected. But if this is coupled with poor operation and maintenance practices, the WDU’s components will deteriorate rapidly. This will result in both a decrease in combustion quality and an increase in emissions, causing potential risks to the operator and to the public. Proper operation and maintenance extend the life, effectiveness, and reliability of the equipment, but require a coherent maintenance plan.

WDUs operated according to “Best Practices” require:

- 1) Maintenance planning; i.e.: that any services contracted for construction, training or any other activity should include maintenance as a component.
- 2) Preventive maintenance (i.e. inspections and scheduled maintenance visits); and
- 3) Unscheduled maintenance (i.e. response to maintenance requests for repairs of failed components).

Various persons, including ministry of health managers, maintenance contractors, HCWM supervisors and WDU operators have a role to play in the maintenance process.

#### **4.2 Contract for maintenance services**

Maintenance services are to be included as a component of services contracted right from the planning phase of a HCWM program. (Details of this process are defined in Section II, paragraph 2.6.4)

#### **4.3 Planning**

The importance of good maintenance planning should not be underestimated. Proper planning will enable coordination of necessary maintenance actions and schedules with budget, authorizations, human resources, procurement, transport, logistics, and reporting, etc., facilitating operations and eliminating extra costs. Maintenance planning is required for every HCWM program where WDUs are to be installed. Table 4.1 outlines the chronology, tasks and schedule of a typical maintenance program.

Preparation of a similar maintenance plan chart, adapted to local conditions, is required for any HCWM program. The HCWM program manager should review and approve the plan.

**Table 4.1 Model Maintenance Plan**

<b>Assumptions</b>			
1	Annual maintenance cycle	2 visits/yr	
2	Number of WDUs in program	50	
3	Average number of inspections/working day	2.5	
4	Average number of maintenance visits/working day	2	
5	Parts reordering cycle	Once/year	
		<b>Activity schedule</b>	
		<b>Cycle 1</b>	<b>Cycle 2</b>
		<b>Week No.</b>	<b>Week No.</b>
<b>Inspection</b>			
Proposal and inspection visit schedule	Inspector	1	27
Budget approval	HCW Prog. Mgr	2	28
Inspection (all sites)	Inspector	4-8	30-34
Inspection report	Inspector	10	36
Inspection report approval	HCW Prog. Mgr	12	38
<b>Scheduled Maintenance</b>			
Maintenance plan and schedule	Contractor	14	40
Budget approval	HCW Prog. Mgr	16	42
Inventory check for parts in stock	Contractor	16	42
Quotations and procurement order for parts not in stock	HCW Prog. Mgr	16	42
Withdrawal of available components from stock	Contractor	18	44
Scheduled maintenance visits (all sites)	Contractor	18-24	44-50
Maintenance report to HCWM	Contractor	26	52
Maintenance report approval (HCWM)	HCW Prog. Mgr	28	54
Financial settlement of contractor's services	HCW Prog. Mgr	Completion of contract/cycle	Completion of contract/cycle
<b>Unscheduled Maintenance</b>			
Request for maintenance from primary health facility (PHF)	HCWM at PHF	Date of Demand (DD)	
Budget approval for unscheduled maintenance visit	HCW Prog. Mgr.	DD+1 day	
Acquisition of parts required for maintenance	HCW Prog. Mgr.	DD+2 days	
Unscheduled maintenance visit	Contractor	DD+2 days	
Maintenance report to HCWM	Contractor	DD+3 days	
Maintenance report approval (HCWM)	HCW Prog. Mgr.	DD+4 days	
Financial settlement of contractor's services	HCW Prog. Mgr.	DD+6 days	

#### 4.4 Stock of replacement parts

Budget, human resources, logistics, and parts inventory must support every maintenance plan, if it is to be effective.

Table 4.2, provides a list of the components and materials, and their required quantities, which need to be stocked at the location to ensure efficient operations. The quantities indicated are based on the assumption that 10 WDUs are included in a maintenance program. Quantities for larger or smaller programs should be adjusted on a pro-rata basis.

**Table 4.2 Recommended stock of spare parts**

<b>Title of drawing or component</b>	<b>Drwg ref. No.</b>	<b>Quantity/10 WDU</b>
Fabrication Drawing for Top Frame (PART A)	ML/FAB/001	2
Fabrication Drawing for Loading Door (PART B)	ML/FAB/002	5 Sets
Fabrication Drawing for Front Door Frame (PART C)	ML/FAB/003	5 Sets
Fabrication Drawing for Front Door (PART D)	ML/FAB/004	5 Sets
Fabrication Drawing for Spigot (PART E)	ML/FAB/005	5 Sets
Fabrication Drawing for Grate (PART F)	ML/FAB/006	10
Fabrication Drawing for Intermediate Bridge (PART G)	ML/FAB/007	5
Fabrication Drawing for Vertical Support (PART H)	ML/FAB/008	4
Fabrication Drawing for Vertical Frame (PART I)	ML/FAB/009	4
Fabrication Drawing for Horizontal Supports (PART J)	ML/FAB/010	2
Self-adjusting draft control and tee for chimney	ML/FAB/011	5 Sets
Fabrication drawing for stove pipe and chimney components OR Outsourced components	ML/FAB/012	10 Sets
Stovepipe Thermocouple	None	10
Refractory Brick	None	400 Nos.
Refractory Cement OR Refractory Mortar	None None	100 kg or 300 kg
High Temperature Paint	None	20 kg
Rust Proof Primer	None	10 kg
GI Corrugated Sheet (= or >1.5 mm gauge), 2m x 1m	None	5
Chain Link Fence (40 mm mesh, 3 mm dia wire)	None	20 m <sup>2</sup>
Nuts, Bolts, Washers (M8 x 30 mm long)	None	100
Nuts, Bolts, Washers (M8 x 50mm long)	None	50
J Bolts, Washers, Tar Washers, Nuts (M8 x 125 long)	None	50
Strainer Cables,( 4-6mm dia stranded corrosion resistant).	None	6
Strain adjusters, end lugs and clamping bolts for strainer cables	None	6

#### **4.5 Preventive maintenance**

Preventive maintenance ensures that the equipment functions efficiently and reduces the risk of equipment failure. Such maintenance ensures that:

- 1) Contaminated waste is reliably eliminated.
- 2) Equipment to destroy waste is available in good working condition.
- 3) The need for unscheduled maintenance visits is reduced.
- 4) Maintenance costs are under control—planned, scheduled maintenance is more cost-effective than unplanned, unscheduled maintenance.

A qualified official must inspect the installed WDU every six months. A complete inspection should cover the incinerator, the WDU structure, the tools and protective clothing, and the records. (These tasks are detailed in Table 4.3, Table 4.4, Table 4.6 and 4.7)

A qualified ministry of health official or program officer should conduct the inspections.

Once the WDU inspection is complete, an inspection report has to be submitted to the HCWM supervisor for review. The report should include:

- Requirements regarding repairs/replacement of parts,
- Schedule for completion of recommended actions, and
- Program budget for repairs.

Approval of the inspection report authorizes the following activities to proceed:

- 1) To draw from stock or procure the replacement parts required for the scheduled maintenance.
- 2) To embark upon a scheduled maintenance program based upon the budget and schedule provided in the inspector's report.
- 3) To contract or amend an existing contract for maintenance services.

#### **4.6 Scheduled maintenance**

Scheduled maintenance is the routine repair work carried out subsequent to the inspector's visit to each WDU in a HCWM program. Work is conducted as specified in the inspection report once approvals are given, replacement parts made available and budgets finalized.

A scheduled maintenance program reports on each maintenance task performed and documents the actions, replacement parts, and status of each WDU on completion of the scheduled maintenance visit. Scheduled maintenance is to be carried out as per an approved maintenance plan. (See, e.g., the maintenance plan provided in Table 4.1.)

#### **4.7 Unscheduled maintenance**

Unscheduled maintenance is defined by unforeseen defects that impair effective functioning of the WDU. Request for such maintenance has to be made by the person in charge of HCWM at the health facility.

Unscheduled maintenance is expensive since it requires deployment of maintenance personnel to a single location, and should only be undertaken if the requirement is urgent.

#### **4.8 Summary**

With adequate planning, resources and maintenance, operators should be able to successfully maintain a fully functional waste disposal unit.

**Table 4.3 Inspection of Incinerator Parts**

Responsible person:			Status of Incinerator Part					Date of inspection:			
Inspection item	Masonry & mortar	Loading door	Ash door	Top plate	Incin. frame	Stack spigot	Temp gauge	Flue valve	Inter bridge	Grate	Stack
Response option	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
<b>Incinerator (metallic parts)</b>											
Hinge or hinge pin damaged											
Closing latch working, jammed or broken											
Detached from masonry											
Part warped or twisted											
Part badly corroded											
Requires repainting											
Partially or fully blocked											
Not operating correctly and affecting functioning of incinerator											
<b>Incinerator (masonry parts)</b>											
Major cracks											
Mortar repair required											
Bricks loose or missing											
Bricks cracked											

*Note: Shaded cells do not need to be filled as other columns address these questions.*

**Table 4.4 Inspection schedule of tasks (WDU structure)**

Responsible person:		Inspection of WDU structure					Date:		
<b>WDU structure (metallic parts)</b>									
Inspection item	Vertical angle iron members	Horizontal angle iron members	Stack guy lines	Chain link frames	Door	Waste hatch	Manhole covers	Tool/Clothing container	
Response option	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	
Parts badly corroded									
Part warped or twisted									
Part badly damaged									
Painting required									
Operating correctly									
<b>WDU structure (concrete parts)</b>									
Inspection item	Floor-level	Counter-level	Ash pit	Safety Box Store	Needle store	Enclosure			
Response option	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No			
Walls damaged									
Concrete slabs damaged									
Apertures in slabs badly damaged									
Operating correctly									

*Note: Shaded cells do not need to be filled as these questions are addressed in other columns.*

**Table 4.5 Inspection schedule of tasks (tools and protective clothing)**

Responsible person:			Inspection of tools and protective clothing					Date:		
Inspection item	Ash rake	Dustpan	Brush	Weighing scale	Sand Bucket	Fire-retardant gloves	Eye protection/ Face mask	Overall/ Protective clothing	Shovel	Lock for WDU door
Response option	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No	Yes/No
Item available										
In good condition										

**Table 4.6 Inspection schedule of tasks (records)**

Responsible person:		Inspection of records		Date:	
Inspection item	Operator waste disposal record	Inspection and maintenance visits	Repairs and maintenance		
Response option	Yes/No	Yes/No	Yes/No		
Records available					
Records complete					

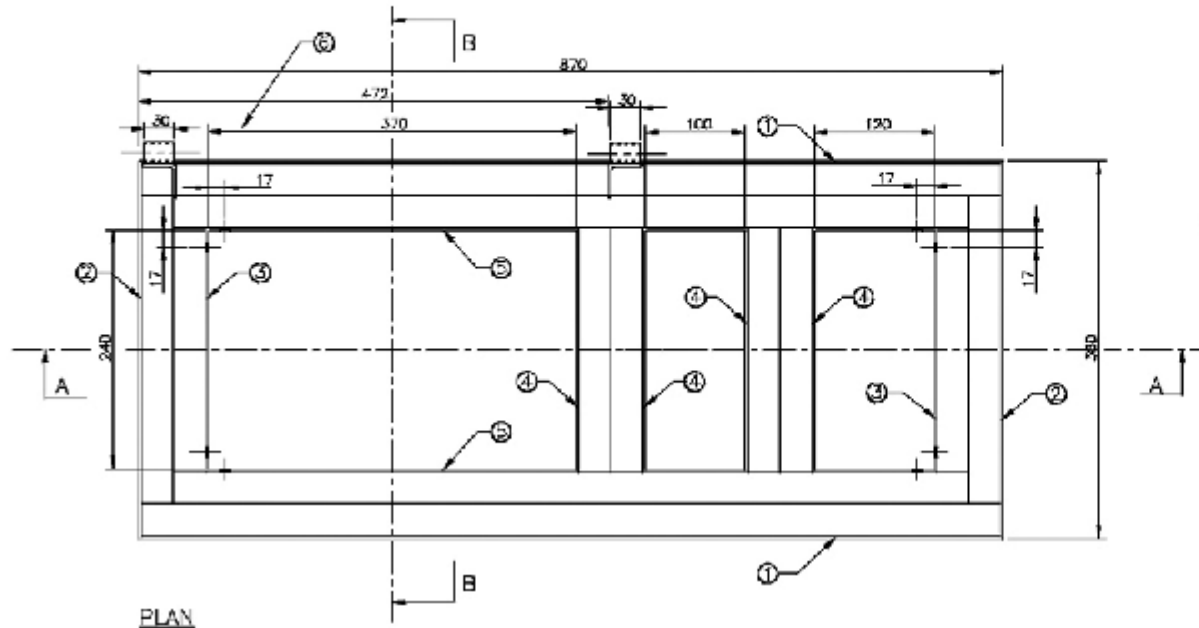
**Table 4.7 Inspection schedule of tasks (service need)**

Responsible person:	Inspection of service needs (Yes/No, Comments)	Date:
Excessive ash in incinerator		
Excessive soot in stack		
Excessive ash/needles in pit		
Excessive safety boxes in store		
Excessive fuel stocks in store		

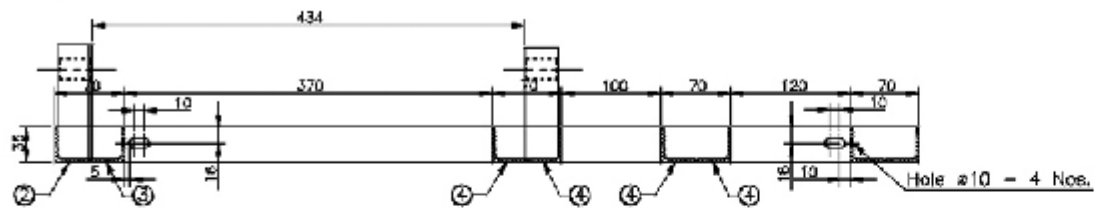
## **Appendix I**

### **Construction Drawings**

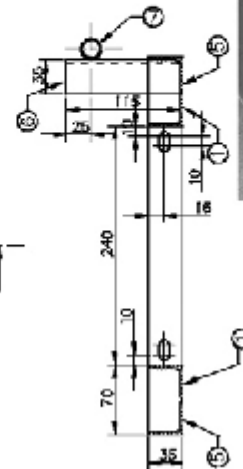




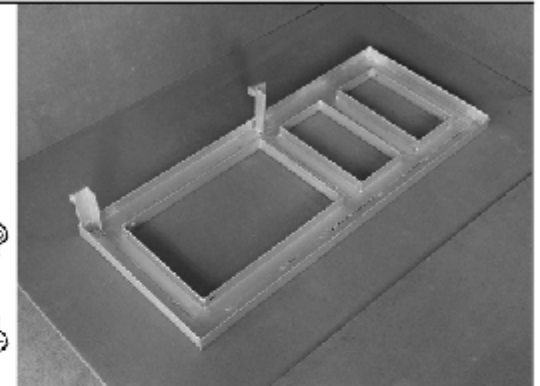
PLAN



SECTION A-A



SECTION B-B



ITEM	DESC.	SIZE	UNIT	QTY.	WEIGHT	NET	GROSS
7.	PIPE	O.D. 21, 1.5 thk - 30 lg.	M.S.	2	0.29	0.58	
6.	ANGLE	ISA 35 x 35 x 6 thk. - 115 lg.	M.S.	2	0.38	0.72	
5.	ANGLE	ISA 35 x 35 x 6 thk. - 200 lg.	M.S.	2	2.56	5.12	
4.	ANGLE	ISA 35 x 35 x 6 thk. - 240 lg.	M.S.	4	0.76	3.04	
3.	ANGLE	ISA 35 x 35 x 6 thk. - 310 lg.	M.S.	2	1.00	2.00	
2.	ANGLE	ISA 35 x 35 x 6 thk. - 380 lg.	M.S.	2	1.22	2.44	
1.	ANGLE	ISA 35 x 35 x 6 thk. - 870 lg.	M.S.	2	2.80	5.60	

- NOTE:
1. ALL DIMENSIONS ARE IN MM. U.O.S.
  2. ALL HOLES SHOULD BE MADE BEFORE WELDING DUE TO INSUFFICIENT SPACE FOR DRILLING MACHINE
  3. ALL JOINTS MUST BE COATED WITH SPECIAL PRIMER BEFORE WELDING AND AFTER GRIND FINISHING.
  4. COMPONENT MUST BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT
  5. QUANTITY 1 NO.

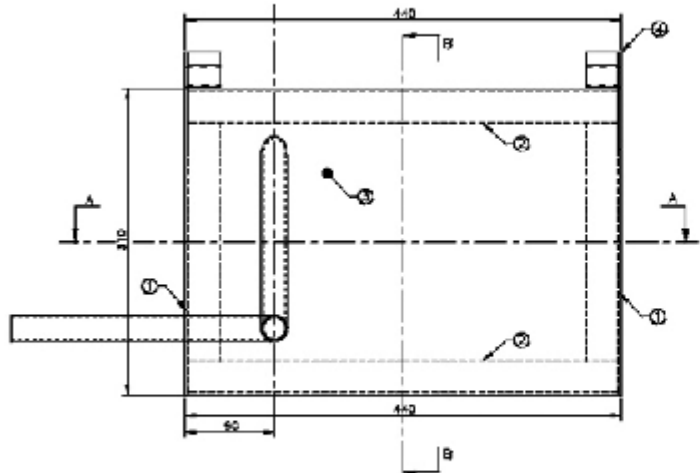
NO.	DATE	DESCRIPTION	BY
5.			
4.			
3.			
2.	11-06-04	ADDITIONS IN NOTE	NAK
1.	02-03-04	ANGLE THK INCREASED TO 6	NVM

		NAME	DATE
Designed			
Drawn		B.ALA	26.12.03
Checked			
Approved			
Drawing No.		ML/FAB/001	Rev.
SCALE		1:5	2

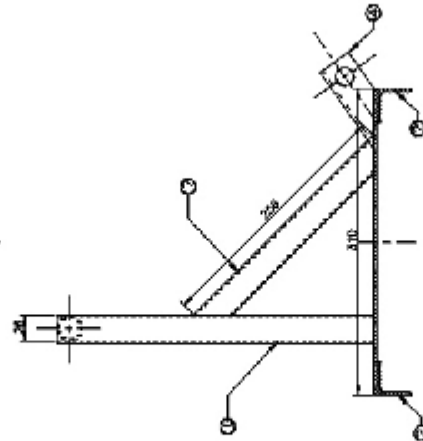
DeMontfort Incinerator Mark 8-ITPI

FABRICATION DRAWING FOR  
TOP FRAME (PART A)

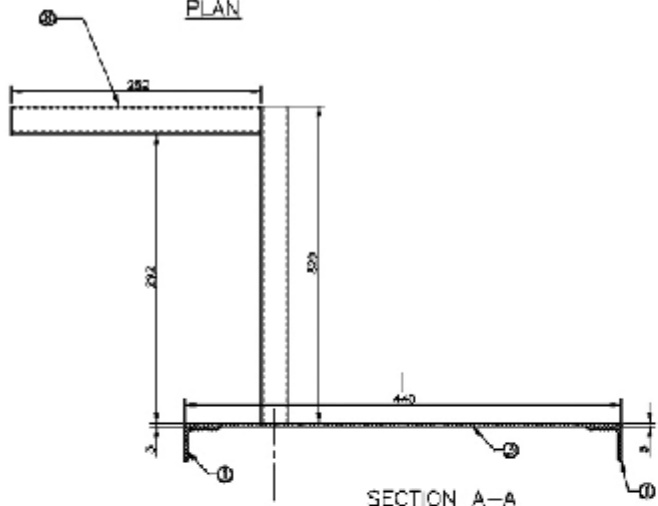
Program For Appropriate Technology In Health



PLAN

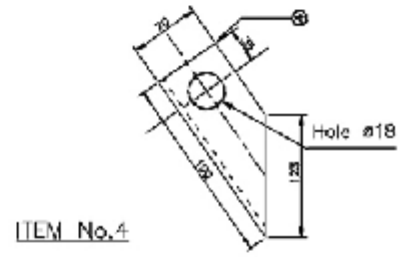
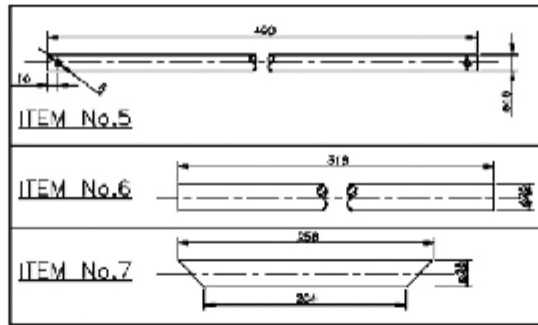
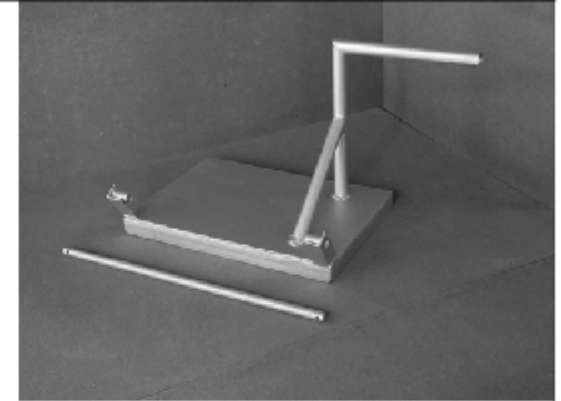


SECTION B-B



SECTION A-A

(HINGE DETAIL NOT SHOWN FOR CLARITY)



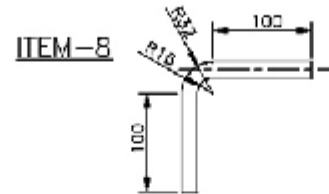
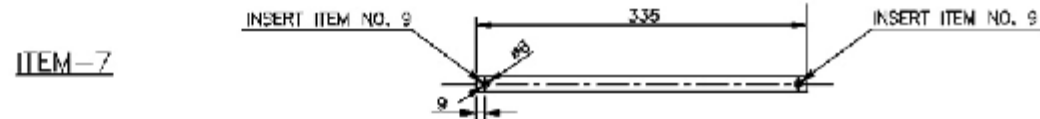
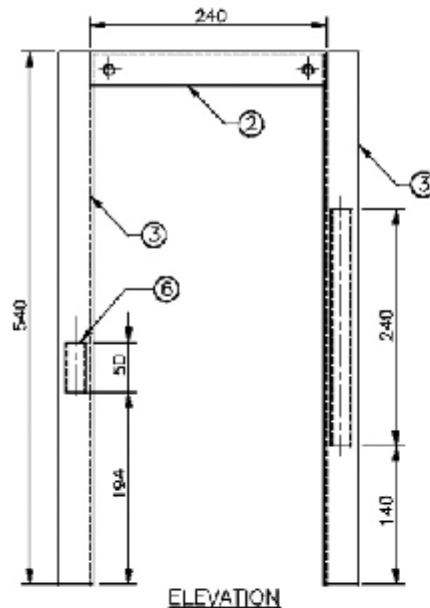
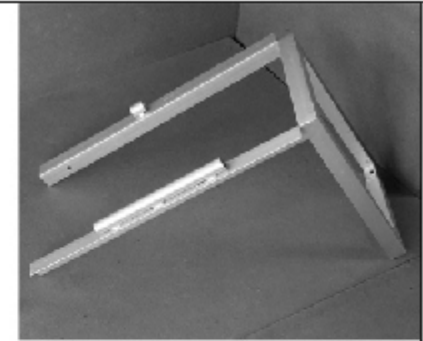
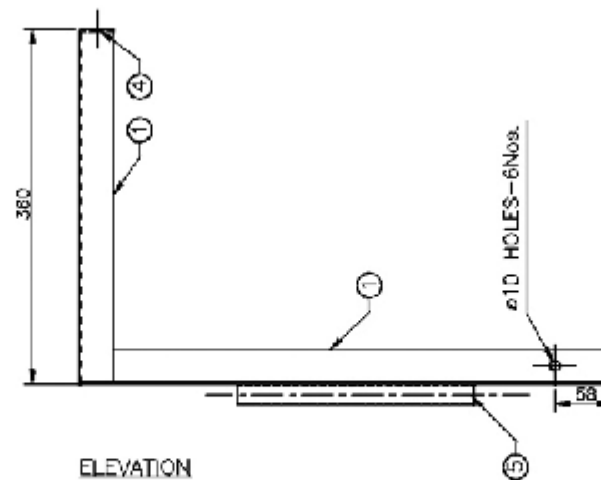
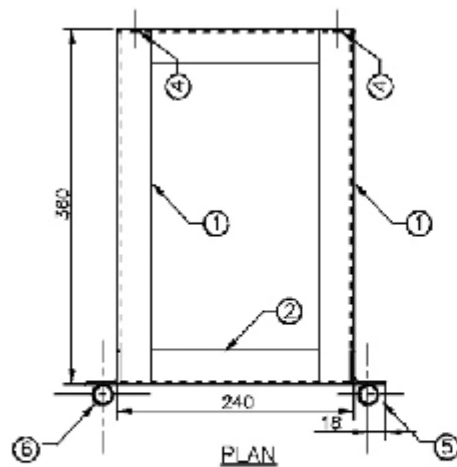
ITEM No.4

ITEM	DESC.	SIZE	MATL.	QTY.	UNIT	TOTL
8	PIPE	O.D. 24, 2.6 thk. - 252 lg.	M.S.	1	0.51	0.51
7	PIPE	O.D. 24, 2.6 thk. - 258 lg.	M.S.	1	0.52	0.52
6	PIPE	O.D. 24, 2.6 thk. - 320 lg.	M.S.	1	0.64	0.64
5.	ROD	ø16 - 460 lg.	M.S.	1	0.78	0.78
4.	ANGLE	ISA 35 x 35 x 6 thk. - 95 lg.	M.S.	2	0.32	0.32
3.	SHEET	440 x 310 x 3 thk.	M.S.	1	3.21	3.21
2.	ANGLE	ISA 35 x 35 x 6 thk. - 310 lg.	M.S.	2	1.00	2.00
1.	ANGLE	ISA 35 x 35 x 6 thk. - 440 lg.	M.S.	2	1.40	2.80
ITEM	DESC.	SIZE	MATL.	QTY.	UNIT	TOTL

NOTE:  
 1. ALL DIMENSIONS ARE IN MM. U.O.S.  
 2. ALL JOINTS MUST BE COATED WITH SPECIAL PRIMER BEFORE WELDING AND AFTER GRIND FINISHING.  
 3. COMPONENT MUST BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT  
 4. QUANTITY 1 NO.

NO.	DATE	DESCRIPTION	BY
5.			
4.			
3.			
2.	11-08-04	ADDITION IN NOTE	NAK
1.	02-03-04	ANGLE THK INCREASED TO 6	NVM

DeMontfort Incinerator Mark B-TPI		NAME	DATE
Designed			
Drawn	BALA	28.12.03	
Checked			
Approved			
SCALE	1:5	Program For Appropriate Technology In Health	Drawing No. ML/FAB/002
			Rev. 2



ITEM	DESC.	SIZE	MATL.	QTY.	UNIT	TOTAL WEIGHT
9.	SPLIT PIN	FOR ø6 HOLE IN ø16 ROD	M.S.	2	-	-
8.	ROD	ø16 - 250 lg.	M.S.	1	0.41	0.41
7.	ROD	ø16 - 335 lg.	M.S.	1	0.41	0.41
6.	PIPE	O.D. 24, 2.6 thk. - 50 lg.	M.S.	1	0.05	0.05
5.	PIPE	O.D. 24, 2.6 thk. - 240 lg.	M.S.	1	0.24	0.24
4.	ANGLE	ISA 35 x 35 x 6 thk. - 240 lg.	M.S.	1	0.36	0.36
3.	ANGLE	ISA 35 x 35 x 6 thk. - 505 lg.	M.S.	2	0.81	1.62
2.	ANGLE	ISA 35 x 35 x 6 thk. - 240 lg.	M.S.	1	0.36	0.36
1.	ANGLE	ISA 35 x 35 x 6 thk. - 357 lg.	M.S.	2	0.50	1.00

NOTE:  
 1. ALL DIMENSIONS ARE IN MM. U.O.S.  
 2. MATCH CENTERLINES IF PIPE DIMENSIONS VARIES  
 3. ALL JOINTS MUST BE COATED WITH SPECIAL PRIMER BEFORE WELDING AND AFTER GRIND FINISHING.  
 4. COMPONENT MUST BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT  
 5. QUANTITY 1 NO.

NO.	DATE	DESCRIPTION	BY
5.			
4.			
3.			
2.	10-06-04	ITEM-8 MODIFIED CHANGES IN ELEVATION VIEW	NAK
1.	02-03-04	ANGLE THK INCREASED TO 6	NVM

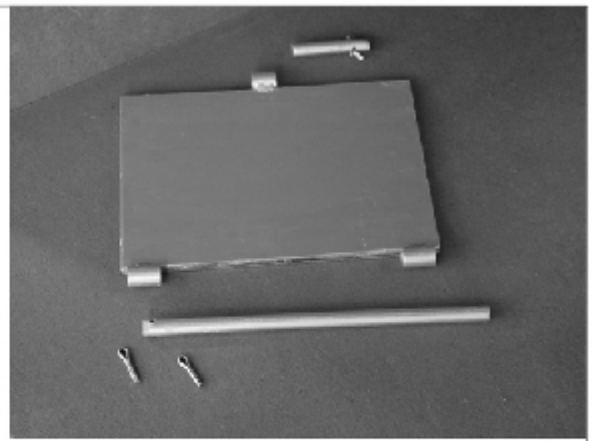
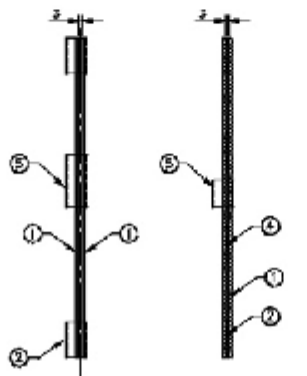
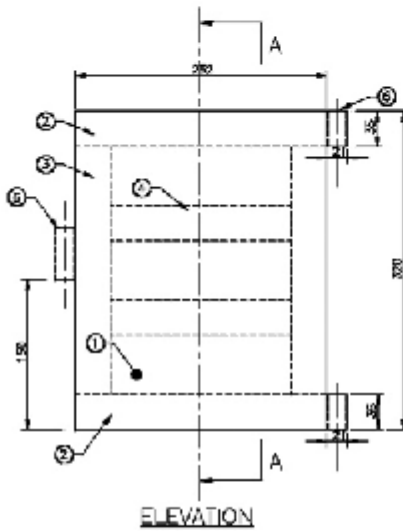
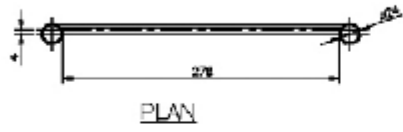
*DeMontfort Incinerator Mark 8-TPI*

FABRICATION DRAWING FOR  
 FRONT DOOR FRAME (PART C)

Program For Appropriate Technology In Health

	NAME	DATE
Designed		
Drawn	GAALA	26.12.03
Checked		
Approved		

Drawing No.	Rev.
ML/FAB/003	2



NOTE:  
 1. ALL DIMENSIONS ARE IN MM. U.O.S.  
 2. MATCH CENTERLINES IF PIPE DIMENSIONS VARIES  
 3. ALL JOINTS MUST BE COATED WITH SPECIAL PRIMER BEFORE WELDING AND AFTER GRIND FINISHING.  
 4. COMPONENT MUST BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT  
 5. QUANTITY 1 NO.

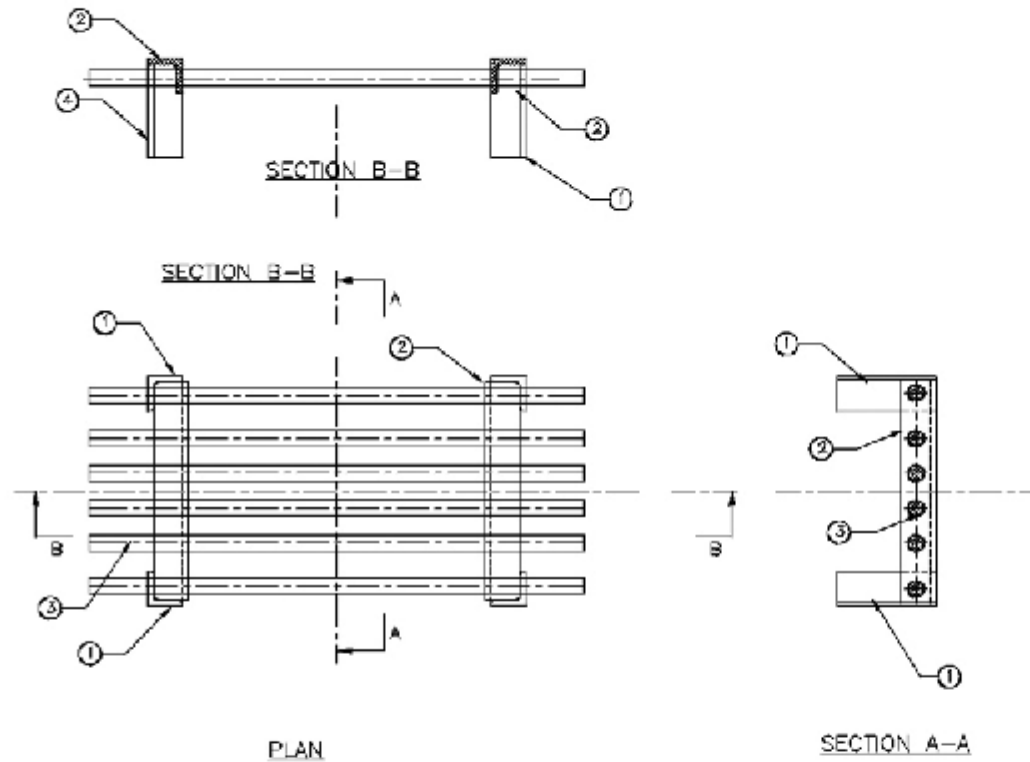
ITEM	DESC.	SIZE	MATL.	QTY.	UNIT	REMARKS
6.	PIPE	O.D. 24, 2.8 thk. - 35 lg.	M.S.	2	0.07	0.14
5.	PIPE	O.D. 24, 2.8 thk. - 50 lg.	M.S.	1	0.10	0.1
4.	FLAT	35 x 3 - 182 lg.	M.S.	2	0.22	0.44
3.	FLAT	35 x 3 - 250 lg.	M.S.	2	0.50	1.00
2.	FLAT	35 x 3 - 252 lg.	M.S.	2	0.50	1.00
1.	SHEET	252 x 320 x 3 thk.	M.S.	2	1.91	3.82

NO.	DATE	DESCRIPTION	BY
5.			
4.			
3.			
2.	10-06-04	CHANGES IN ELEVATION	NAK
1.	02-03-04	HINGE MADE EXCENTRIC	NVM

		NAME	DATE
Designed			
Drawn		BALA	25.12.03
Checked			
Approved			
SCALE	1:5	Drawing No.	Rev.
Program For Appropriate Technology In Health		ML/FAB/004	1

**DeMontfort Incinerator Mark 8-IITI**  
**FABRICATION DRAWING FOR**  
**FRONT DOOR (PART D)**





NOTE:  
 1. ALL DIMENSIONS ARE IN MM. U.O.S.  
 2. ALL JOINTS MUST BE COATED WITH SPECIAL PRIMER BEFORE WELDING AND AFTER GRIND FINISHING.  
 3. COMPONENT MUST BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT  
 4. QUANTITY 1 NO.

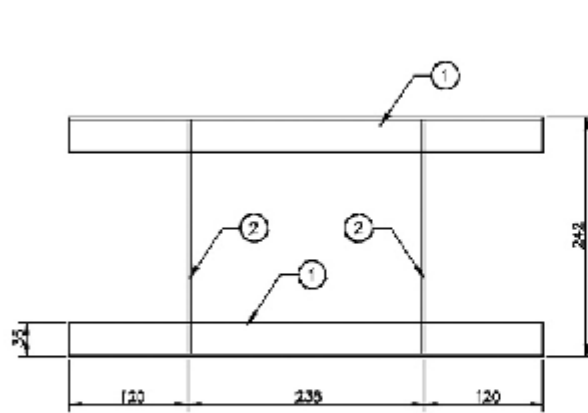
NO.	DATE	DESCRIPTION	BY
5.			
4.			
3.	10-06-04	GRATE DESIGN MODIFIED	NAK
2.	23-03-04	LONGITUDINAL MEMBERS IN ANGLE ARE REPLACED BY ROUND BARS	NAK
1.	02-03-04	ANGLE THK TO 6; WIDTH REDUCED BY 10	NVM

ITEM	DESC.	SIZE	MATL.	QTY.	UNIT	TOTAL
3.	ROD	φ16 - 500 lg.	M.S.	6	0.90	5.40
2.	ANGLE	ISA 35 x 35 x 6 thk. - 220 lg.	M.S.	2	0.74	1.48
1.	ANGLE	ISA 35 x 35 x 6 thk. - 100 lg.	M.S.	4	0.32	1.28

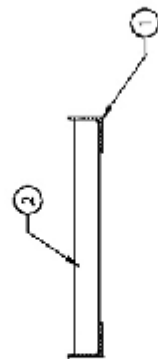
		NAME	DATE
Designed			
Drawn		E ALA	2E 12.03
Checked			
Approved			
Drawing No.		Rev.	
ML/FAB/006		2	

**FABRICATION DRAWING FOR GRATE (PART F)**

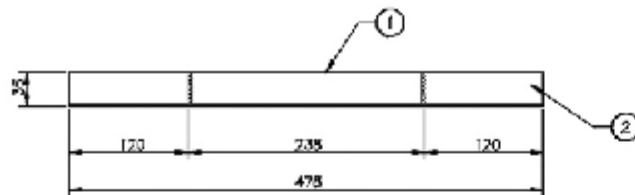
*Program For Appropriate Technology In Health*



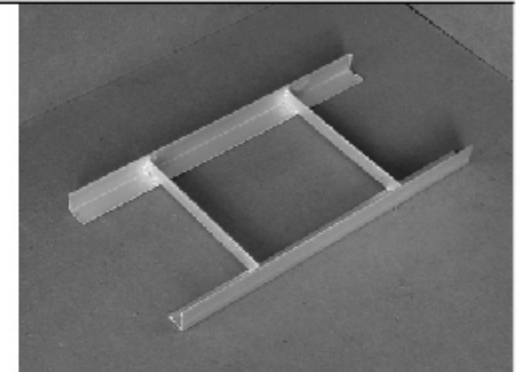
PLAN



SECTION B-B



SECTION A-A



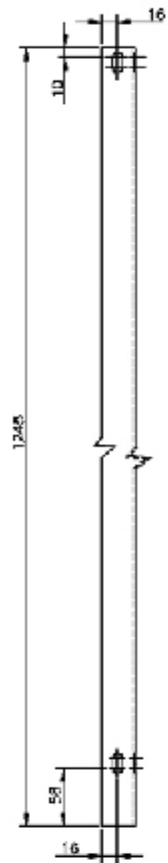
NOTE:

1. ALL DIMENSIONS ARE IN MM. U.O.S.
2. ALL JOINTS MUST BE COATED WITH SPECIAL PRIMER BEFORE WELDING AND AFTER GRIND FINISHING.
3. COMPONENT MUST BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT
4. QUANTITY 1 NO.

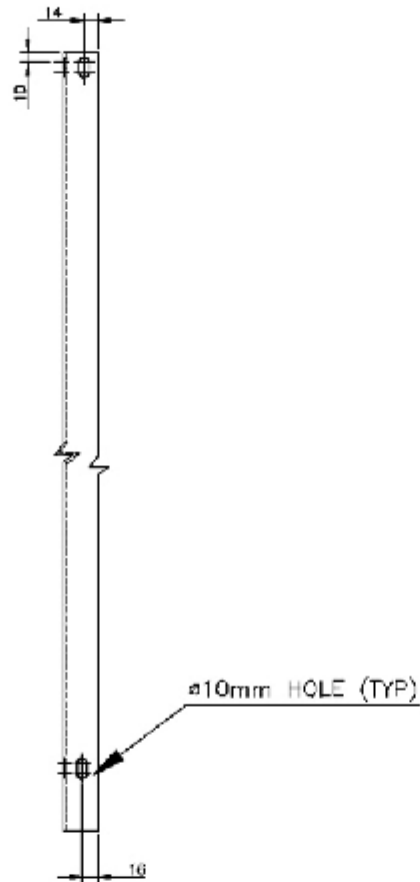
ITEM	DESC.	SIZE	MATL.	QTY.	UNIT	TOTAL
2.	FLAT	25 x 3 thk - 236 lg.	M.S.	2	0.05	0.10
1.	ANGLE	ISA 35 x 35 x 6 thk - 478 lg.	M.S.	2	1.22	2.44
					UNIT	TOTAL
					WEIGHT	

5.			
4.			
3.			
2.	11-06-04	ADDITIONS IN NOTE	NAK
1.	02-03-04	ANGLE THK INCREASED TO 6	NVM
NO.	DATE	DESCRIPTION	BY

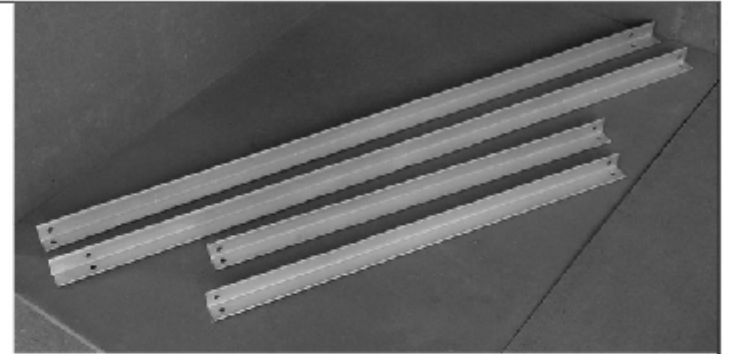
<b>DeMontfort Incinerator Mark 8-ITPI</b>		DESIGNED	NAME	DATE
		DRAWN	B. ALA	26.12.03
		CHECKED		
		APPROVED		
FABRICATION DRAWING FOR INTERMEDIATE BRIDGE (PART G)			DRAWING NO.	REV.
SCALE 1:5			ML/FAB/007	2
Program for Appropriate Technology in Health				



SIDE VIEW



ELEVATION



NOTE:

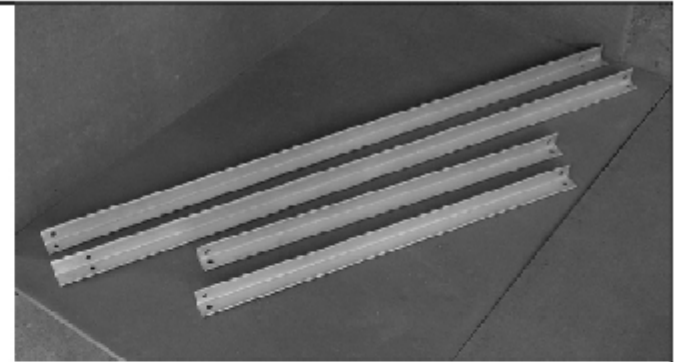
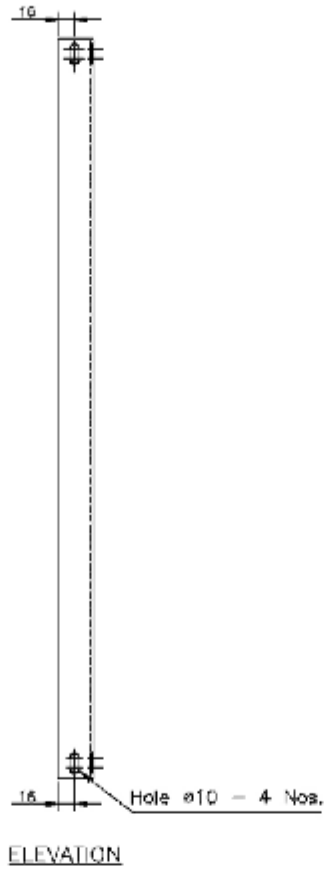
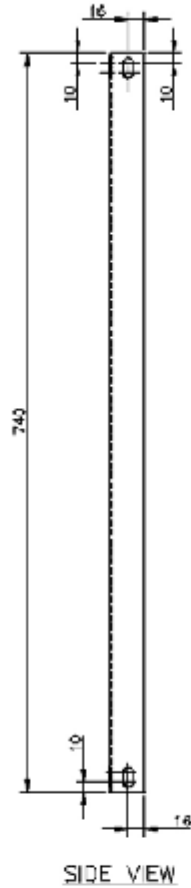
1. ALL DIMENSIONS ARE IN MM. U.O.S.
2. ALL HOLES MUST BE COATED WITH SPECIAL PRIMER BEFORE AND AFTER DRILLING.
3. COMPONENT MUST BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT
4. QUANTITY 2 NO.
5. TOTAL WEIGHT 4.00KG.

5.			
4.			
3.			
2.	11-06-04	ADDITIONS IN NOTE	NAK
1.	02-03-04	ANGLE THK INCREASED TO 8	NVM
NO.	DATE	DESCRIPTION	BY

1.	ANGLE	ISA 35 x 35 x 6 THK - 1245 lg.	M.S.	2	4.00	8.00
ITEM	DESC.	SIZE	MATL.	QTY.	UNIT	TOTAL
					NO.	WEIGHT

<b>Demonfort Incinerator Mark 8-ITP!</b>  <b>FABRICATION DRAWING FOR</b> <b>VERTICAL SUPPORT (PART H)</b>			NAME	DATE
			Designed	
			Drawn	B.ALA 26.12.03
			Checked	
			Approved	
			Drawing No.	Rev.
			ML/FAB/008	2
			<i>Program For Appropriate Technology in Health</i>	





- NOTE:
1. ALL DIMENSIONS ARE IN MM. U.O.S.
  2. ALL HOLES MUST BE COATED WITH SPECIAL PRIMER BEFORE AND AFTER DRILLING.
  3. COMPONENT MUST BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT
  4. QUANTITY 2 NO.

5.			
4.			
3.			
2.	11-06-04	ADDITONS IN NOTE	NAK
1.	02-03-04	ANGLE THK INCREASED TO 6	NVM
NO.	DATE	DESCRIPTION	BY

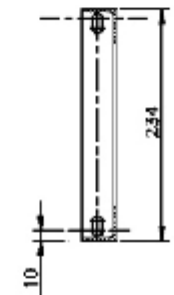
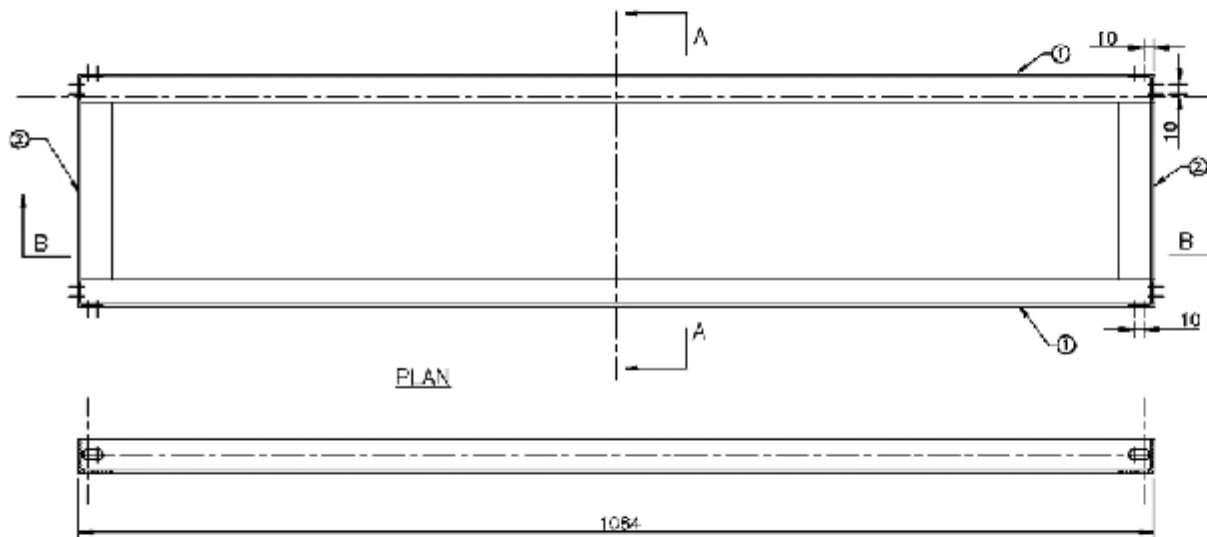
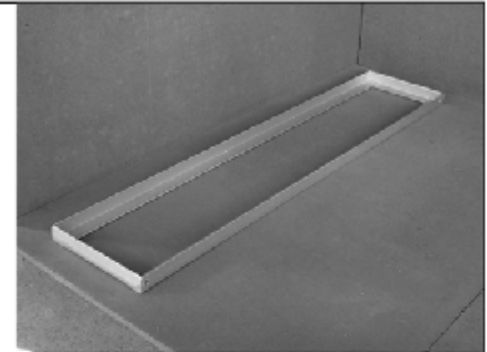
1.	ANGLE	ISA 35 x 35 x 6 thk - 740 lg.	M.S.	2	2.34	4.68
ITEM	DESC.	SIZE	MATL.	QTY.	UNIT	WGT.

*DeMantfort Incinerator Mark 8-ITPI*

**FABRICATION DRAWING FOR  
VERTICAL SUPPORT (PART I)**

*Program For Appropriate Technology In Health*

	NAME	DATE
Designed		
Drawn	BALA	20.12.03
Checked		
Approved		
Drawng No.	ML/FAB/009	Rev
		2



SECTION A-A

PLAN

SECTION B-B

ITEM	DESC.	SIZE	MATL.	QTY.	UNIT	WEIGHT	COST
2.	ANGLE	ISA 35 x 35 x 6 thk. - 234 lg.	M.S.	2		0.76	1.52
1.	ANGLE	ISA 35 x 35 x 6 thk. - 1084 lg.	M.S.	2		3.48	6.96

NOTE:

1. ALL DIMENSIONS ARE IN MM. U.O.S.
2. ALL JOINTS MUST BE COATED WITH SPECIAL PRIMER BEFORE WELDING AND AFTER GRIND FINISHING.
3. COMPONENT MUST BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT
4. QUANTITY 1 NO.

NO.	DATE	DESCRIPTION	BY
5.			
4.			
3.			
2.	11-08-04	ADDITIONS IN NOTE	NAK
1.	02-03-04	ANGLE THK INCREASED TO 6	NVM

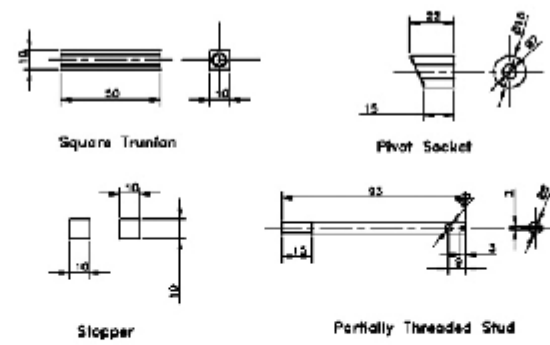
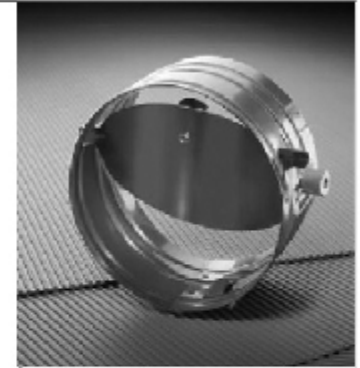
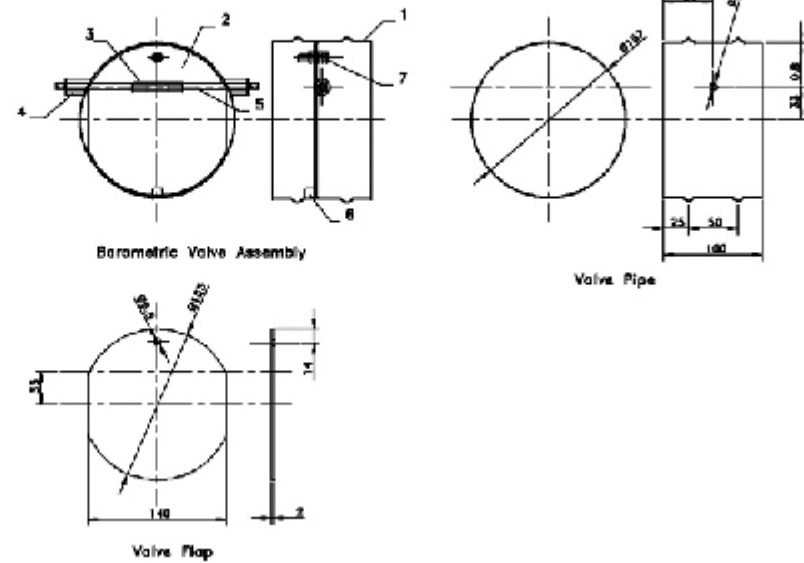
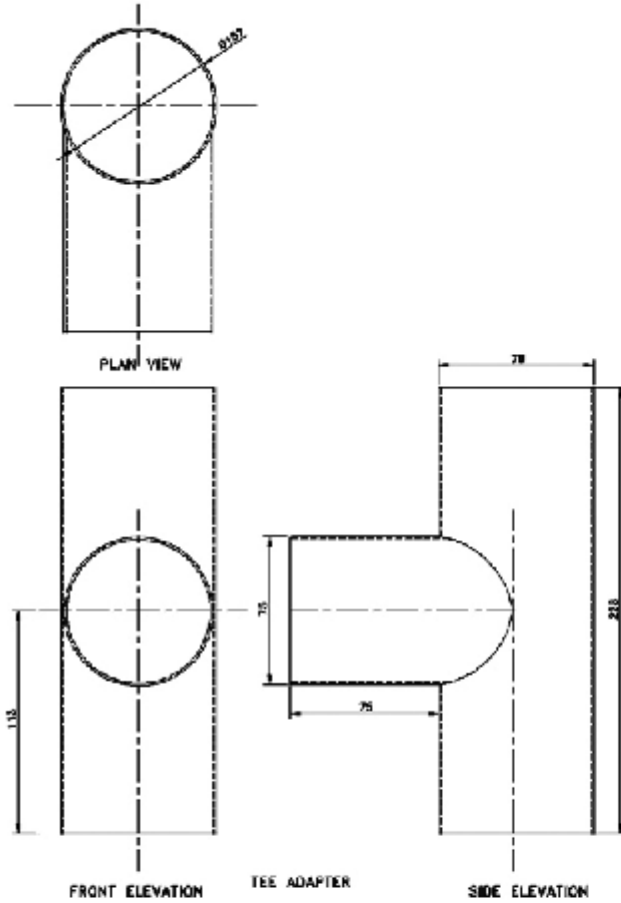
*DeMontfort Incinerator Mark B-ITPI*

**FABRICATION DRAWING FOR  
HORIZONTAL SUPPORTS (PARTS J)**

SCALE  
1:5

*Program For Appropriate Technology In Health*

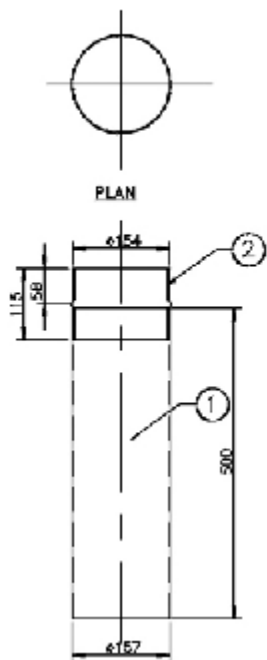
	NAME	DATE
Designed		
Drawn	BALA	28.12.03
Checked		
Approved		
Drawing No.	ML/FAB/010	
Rev.	2	



ITEM NO.	DESC.	SIZE	MATL.	QTY.	UNIT	TOTAL WEIGHT	REMARKS
7.	PIPE	O.D. 150, 2.5 THK. - 225 LG	S.S.	1	4.5	4.3	-
8.	PIPE	O.D. 150, 2.8 THK. - 450 LG	U.S.	1	3.0	6.0	-
7.	Bar with 2 Hole	M8 x 25 Long Bar with 2 Hole	S.S.	1	-	-	-
8.	Stopper	10 x 10 x 10	U.S.	1	0.05	0.05	-
5.	Partially Thrd Stud	46 x 90 long	U.S.	2	0.02	0.04	-
4.	Pivot Socket	Ø18 x 40 long	U.S.	2	0.05	0.12	-
3.	Square Trunion	10 x 10 x 55 long	U.S.	1	0.24	0.24	-
2.	Valve Flap	Ø157x 2 Jkt.	U.S.	1	0.31	0.31	-
1.	Valve Pipe	516 x 113 x 0.8 THK.	G.I.	1	0.44	0.44	-
					<b>TOTAL</b>	<b>10.81</b>	

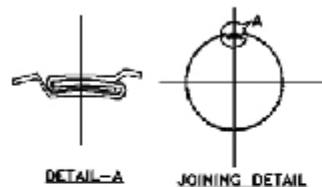
NOTE:  
 1. ALL DIMENSIONS ARE IN MM. U.O.S.  
 2. ALL JOINT MUST BE COATED WITH SPECIAL PRIMER BEFORE WELDING AND AFTER GRIND FINISHING.  
 3. COMPONENT MUST BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT  
 4. QUANTITY 1 NO.

DeMontfort Incinerator Mark 8-ITPI		DESIGNED	NAME	DATE
Title		Drawn	INVM	06.02.04
SELF ADJUSTING DRAFT CONTROL		Checked		
		Approved		
Scale	Program For appropriate Technology In India	Drawing No.		Rev.
4:1		ML/FAB/011	1	



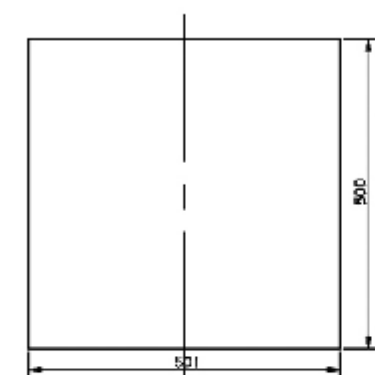
ELEVATION

NOTE: MATERIAL 1.6 THK. G.I. SHEET

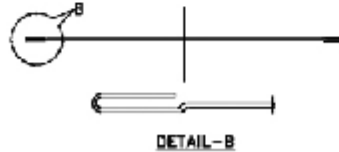


DETAIL-A

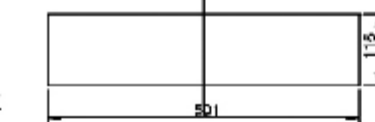
JOINING DETAIL



DEVELOPMENT OF STACK PIPE



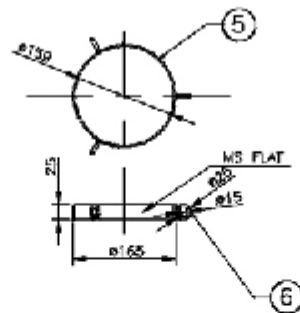
DETAIL-B



DEVELOPMENT OF ADAPTER

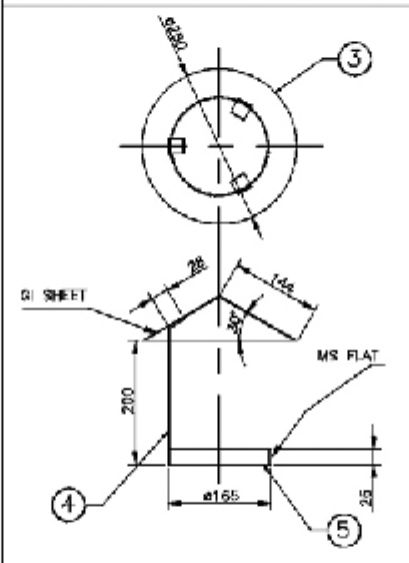
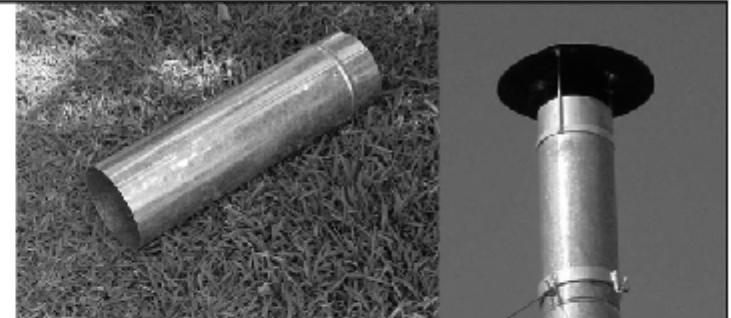


DETAIL-B



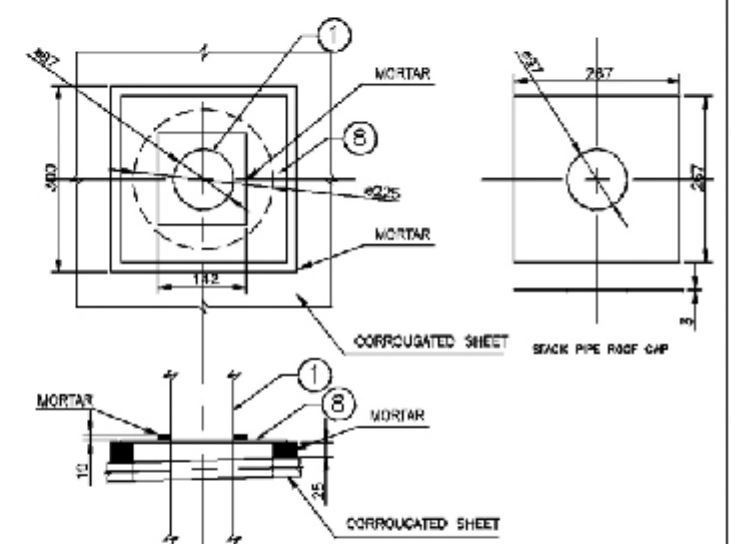
5

6



4

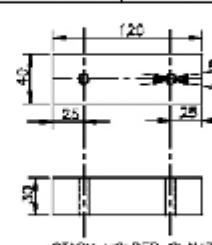
5



CORRUGATED SHEET

STACK PIPE ROOF CAP

CORRUGATED SHEET



STACK HOLDER CLAMP

Sl. No.	DESCRIPTION	QTY	UNIT	REMARKS	DATE
8.	STACK PIPE ROOF CAP	387 x 287 x 3 THK	M.S.	1	-
7.	STEEL MULTISTRAND ROPE	8 x 4000 GL	M.S.	4	-
6.	ROOF TENG	85 x 25 LG.	M.S.	4	-
5.	SUPPORT RING	25 x 3 FLAT 500 LG.	M.S.	2	0.20
4.	CAP SUPPORT	25 x 3 FLAT 175 LG.	M.S.	3	0.10
3.	STACK CAP	8 148 x 1.8 THK	GL.	1	0.21
2.	ADAPTER PIECE	505 x 115 x 1.8 THK	GL.	8	0.73
1.	STACK PIPE	501 x 900 x 1.8 THK	GL.	8	3.12
TOTAL					38.0

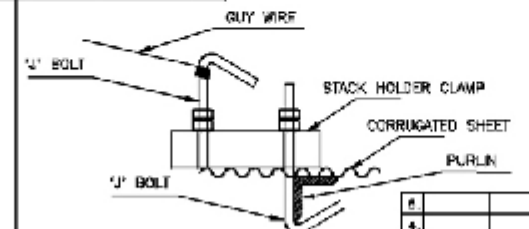
DeMontfort Incinerator Mark B-ITPI

NAME	DATE
Designed	
Drawn	19.12.83
Checked	
Approved	

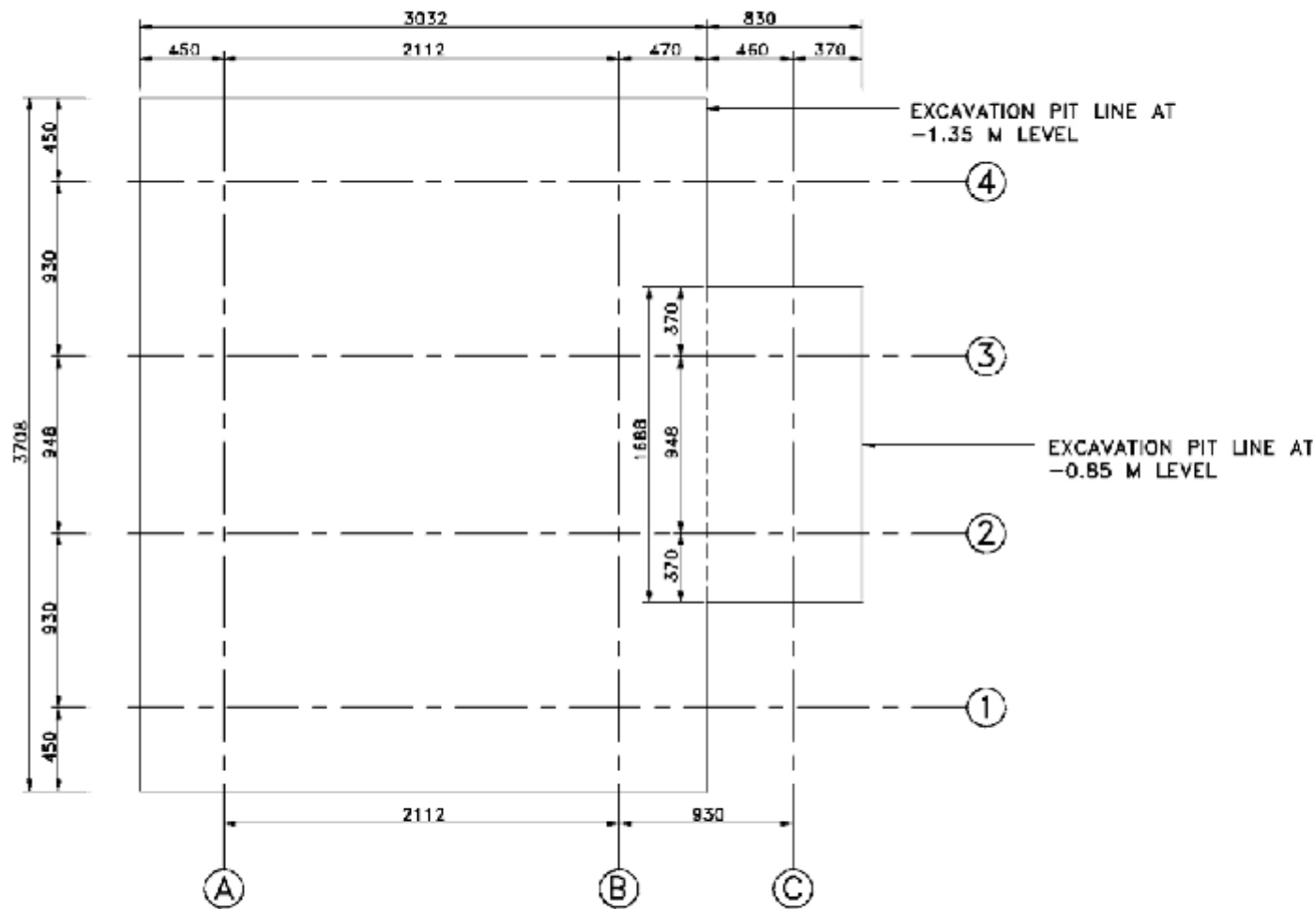
NO.	DATE	DESCRIPTION	BY
1.	02-03-84	PART LIST, PARTS & PHOTO ADDED	HNW
2.	08-03-84	DEVELOPMENT OF ADAPTER IS ADDED	HNW
3.	11-08-84	STACK HOLDING ARRANGEMENT IS ADDED	HNW

Scale: 1:1  
Job No.:  
Program: For Appropriate Technology in Health  
Drawing No.: ML/FAB/012  
Rev: 3

NOTE:  
1. ALL DIMENSIONS ARE IN MM U.O.S.  
2. ALL JOINTS MUST BE COATED WITH SPECIAL PRIMER BEFORE WELDING AND AFTER GRIND FINISHING.  
3. COMPONENT MUST BE PAINTED WITH HEAT RESISTANT ALUMINUM PAINT  
4. QUANTITY 8 NOS.

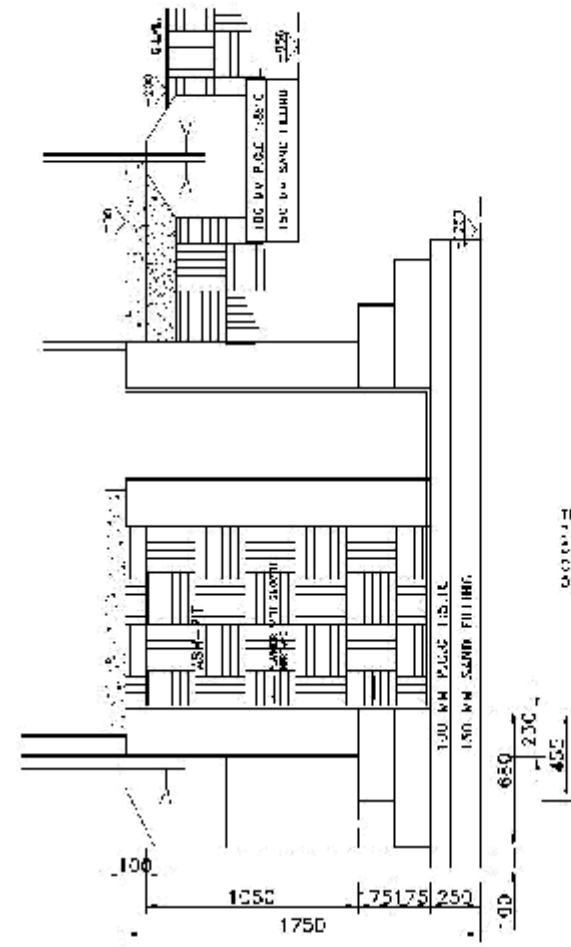
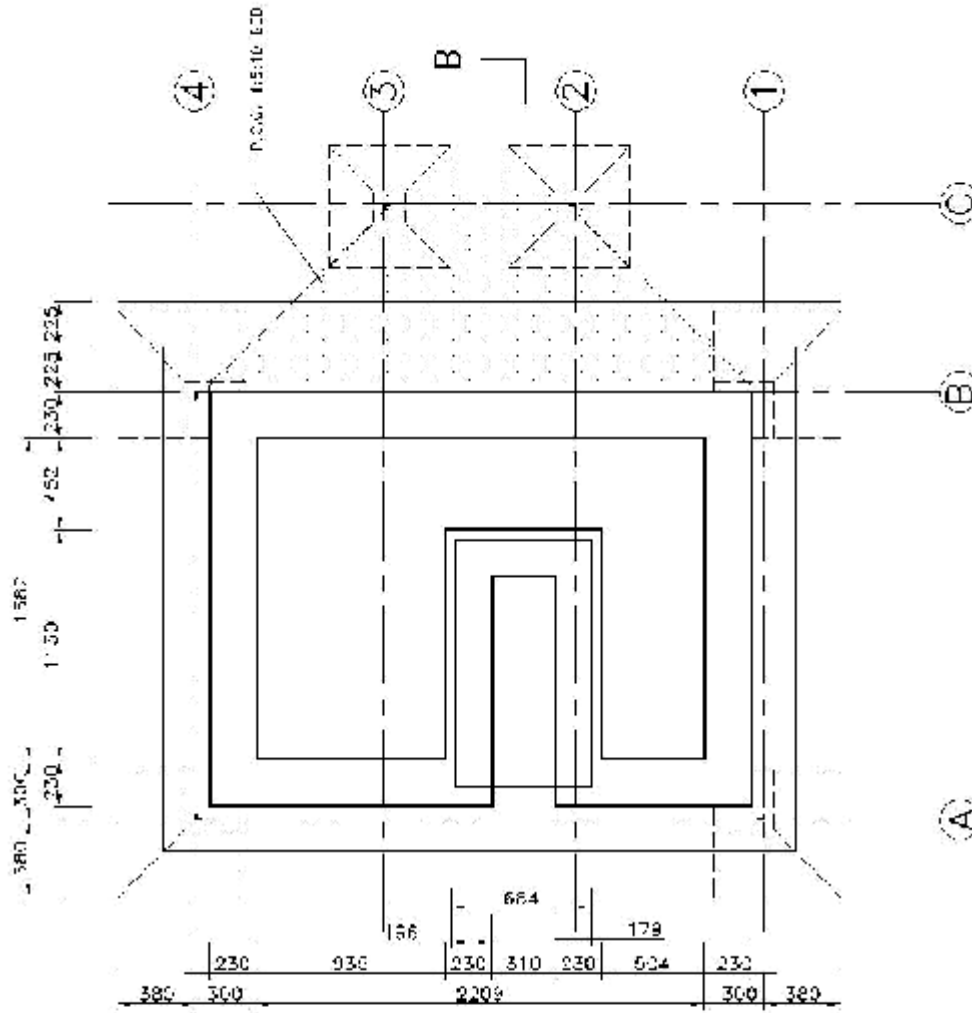


ARRANGMENT FOR STACK HOLDING WITH GUY WIRE



NOTE: 1. ALL DIMENSIONS OTHER THAN MENTIONED ARE IN MM

			DeMontfort Incinerator Mark B-ITPI		NAME	DATE
1.			Title <b>EXCAVATION PLAN</b>		Designed	
2.	08-06-04	DRAWING NUMBER CHANGED			NWK	Drawn
3.			Scale 1:25		Checked	
1.	01-03-04	CENTRELINES MODIFIED			SUPRTI	Approved
NO.	DATE	REVISION DETAILS	BY	Program For Appropriate Technology In Health		Rev.
				Drawing No.	CV/00	2



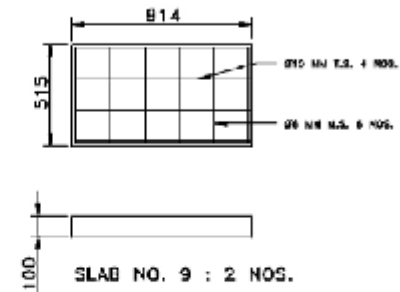
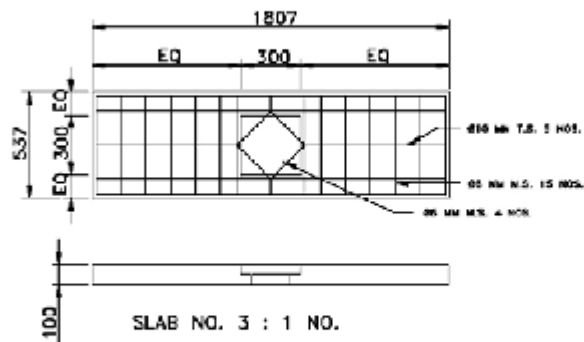
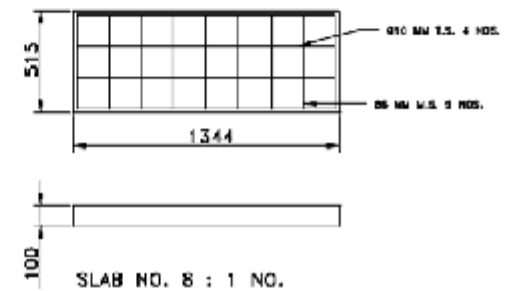
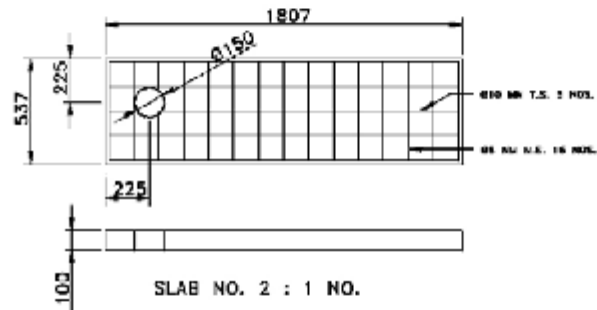
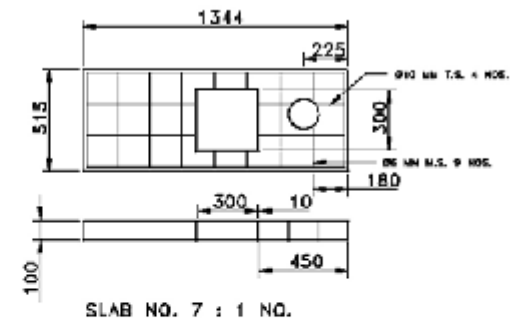
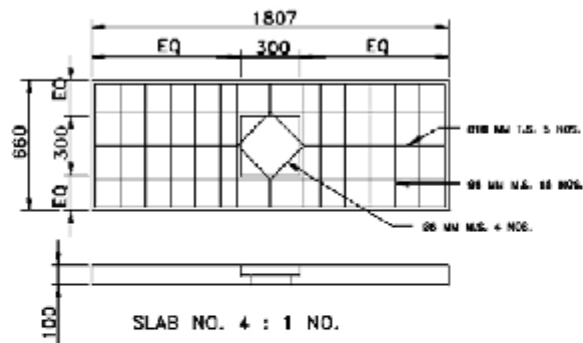
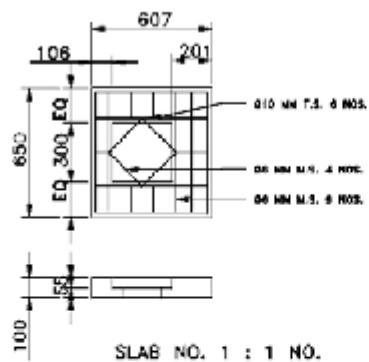
THIS IS RECOMMENDED CONSTRUCTION DETAIL BASED ON THE SITE SOIL CONDITIONS. THE CONTRACTOR MAY CHANGE THE DETAIL FOR BEST SUCCESSE AT LOWER COST.

FOUNDATION SECTION BB

NOTE: ALL DIMENSIONS OTHER THAN MENTIONED ARE IN MM

1	07-09-04	LEVEL RE VIEW FROM E.D. EXPOSED CHANGED	REV
2	08-08-07	DRAWING NUMBER CHANGED	REV
3	03-04-04	CHANGE IN FOUNDATION SECTION WALL UNDER INCUBATOR MODIFIED, ASHPT DEPTH INCREASED	REV
4	23-03-04	WALL UNDER INCUBATOR MODIFIED	REV
5	03-03-04	WALLS, COLUMN BASES & P.O.G. BED MODIFIED	SUPP
NO.	DATE	REVISION DETAILS	BY

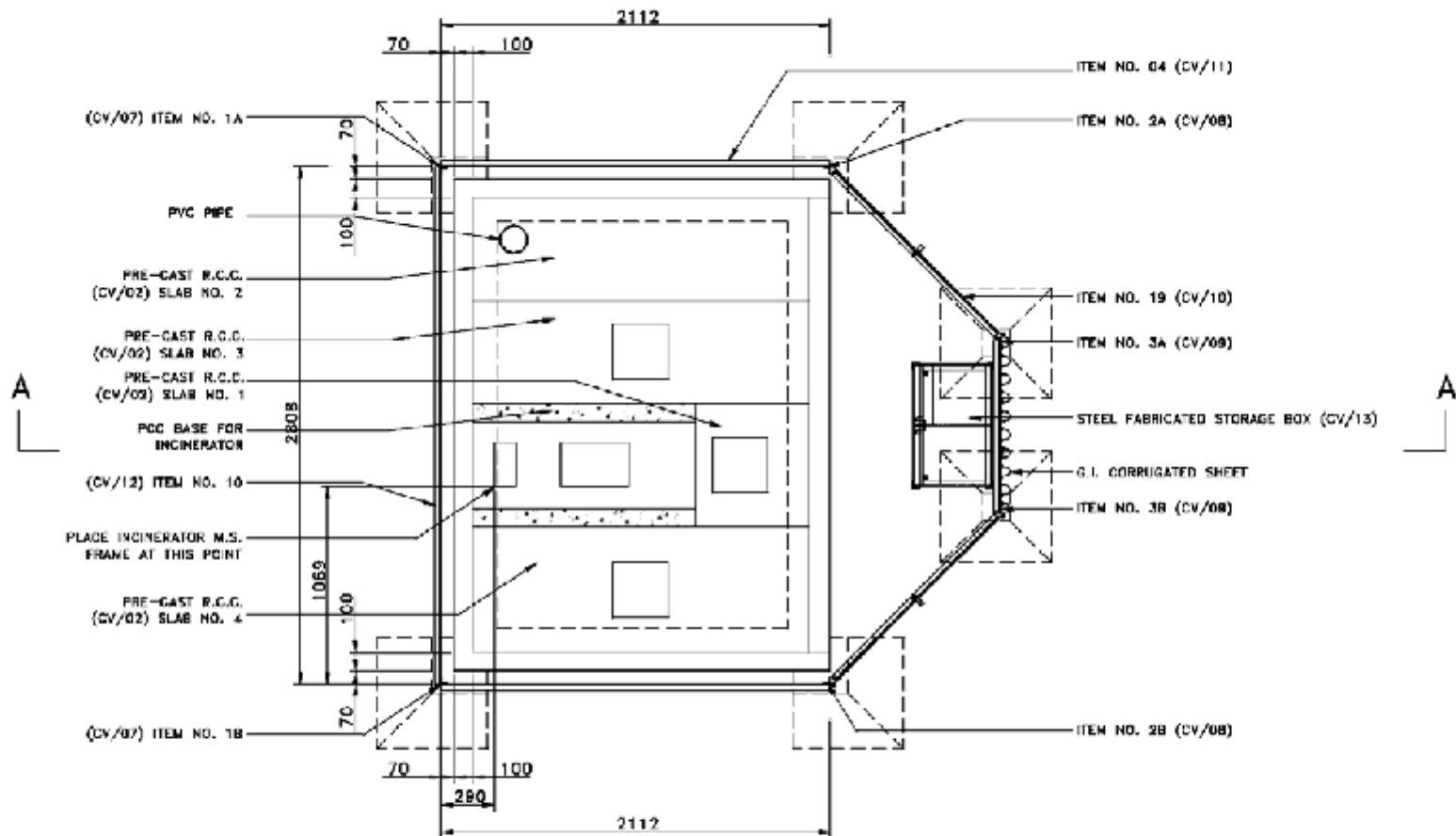
DeMontfort Insulation Mark 2-17P1		DATE	
FOUNDATION PLAN		DATE	
Drawn	DATE	14-02-04	
Checked			
Approved			
Drawn By	DATE		
Checked By			



NOTE:  
1. ALL DIMENSIONS OTHER THAN MENTIONED ARE IN MM

NO.	DATE	REVISION DETAILS	BY
6.	06-06-04	DRAWING NUMBER CHANGED	NAK
4.	02-01-01	SLAB NO. 1 MODIFIED	NAK
3.	22-05-04	SLAB NOS. 2, 3 & 4 MODIFIED, SLAB NOS. 5 & 6 DELETED	NVM
2.	08-03-04	SLAB NO.6 IS MODIFIED AND SLAB NO.8 IS ADDED TITLE IS CHANGED	NAK
1.	01-03-04	6 MM RING INTRODUCED IN SLAB NOS. 1, 3 & 6 ALL SLAB SIZES MODIFIED	SUPHII

Title		NAME	DATE
PRE-CAST COMPONENTS		Designed	
		Drawn	B.A.L.A. 17-02-04
		Checked	
		Approved	
Program For Appropriate Technology In Health		Drawing No.	Rev.
		CV/02	5



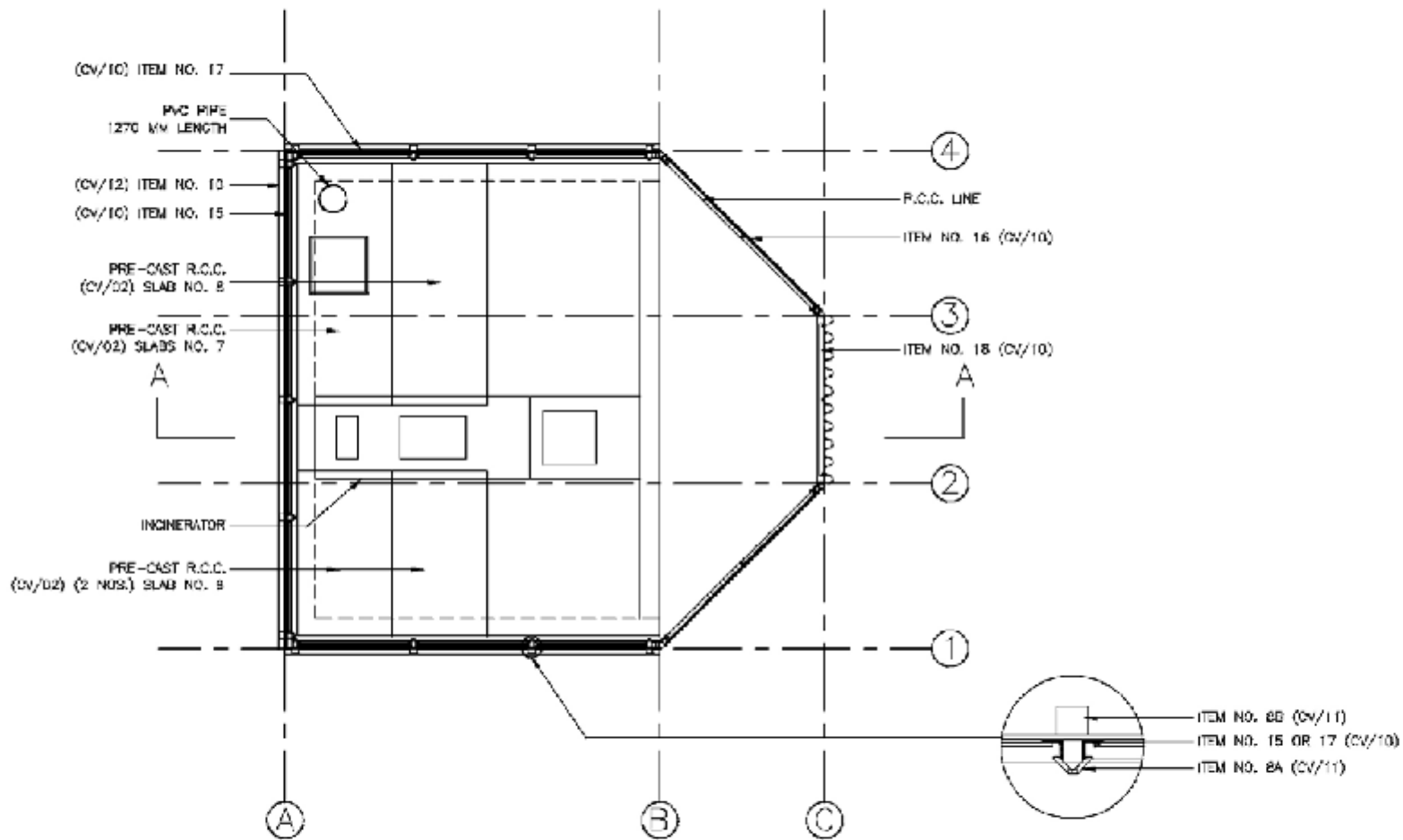
NOTE:  
1. ALL DIMENSIONS OTHER THAN MENTIONED ARE IN MM

4.	08-06-04	DRAWING NUMBER CHANGED, NAMING EDITED	NAK
4.	03-04-04	INCINERATOR SLAB MODIFIED AREA AROUND INCINERATOR FILLED PCC	NAK
3.	23-03-04	SLAB NOS. 2, 3 & 4 MODIFIED ORIENTATION OF SLABS CHANGED	NVM
2.	08-03-04	SLABS MODIFIED AND NOS. CORRECTED, DOOR BOLT'S MODIFIED, ITEM NO. 14 IS REMOVED	NAK
1.	01-03-04	INCINERATOR M.S. FRAME LOCATED, DIMENSIONS MODIFIED, DOOR-BOLT ADDED	SUPRIE
NO.	DATE	REVISION DETAILS	BY

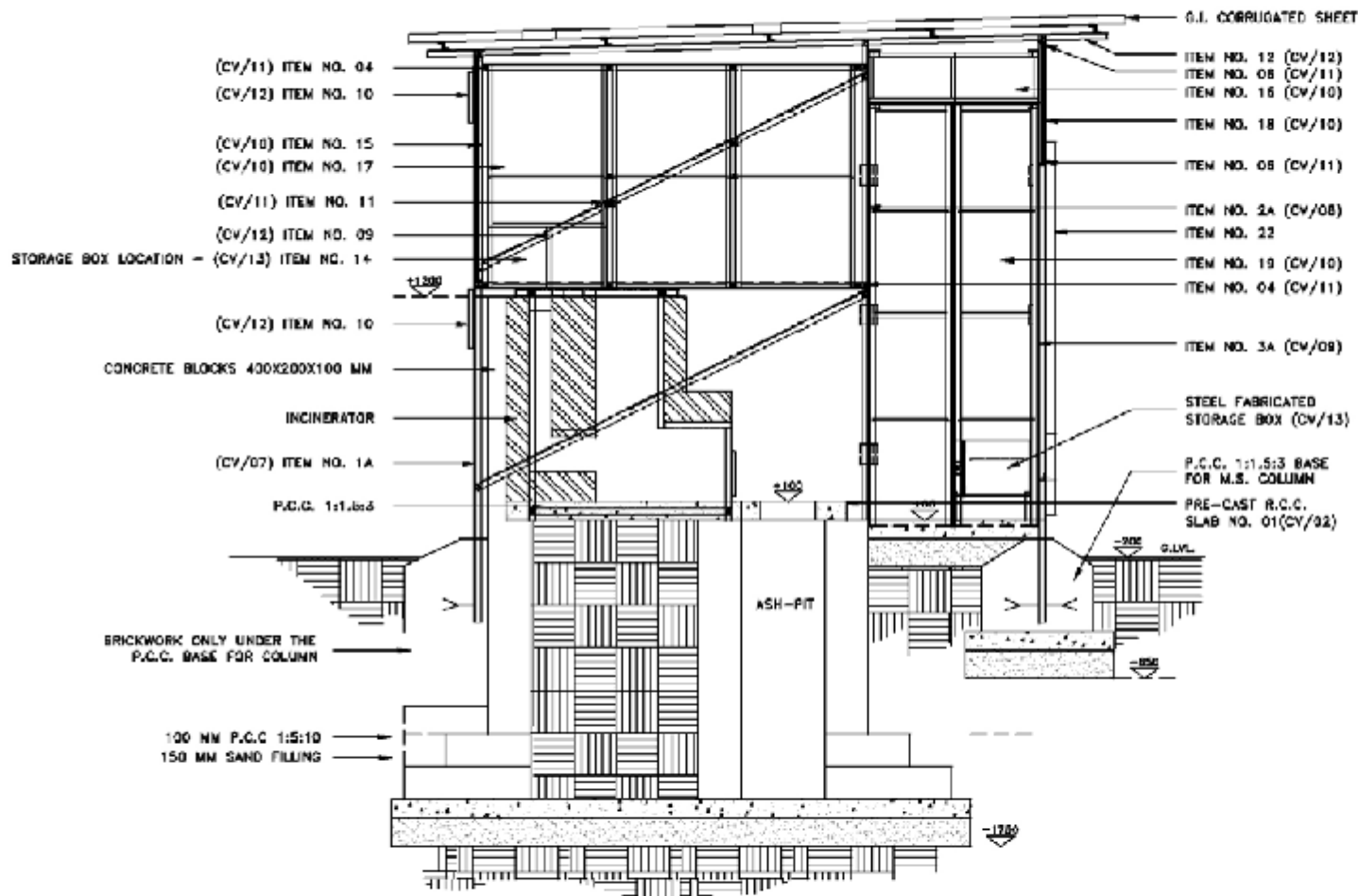
<b>DeMontfort Incinerator Mark D-ITPI</b>		Designer	NVM	DATE
		Drawn	BALA	17-02-04
<b>PLAN AT 0.9 M LVL.</b>		Checked		
		Approved		
Scale 1:25	Program For Appropriate Technology In Health	Drawing No.	CV/03	Rev 5





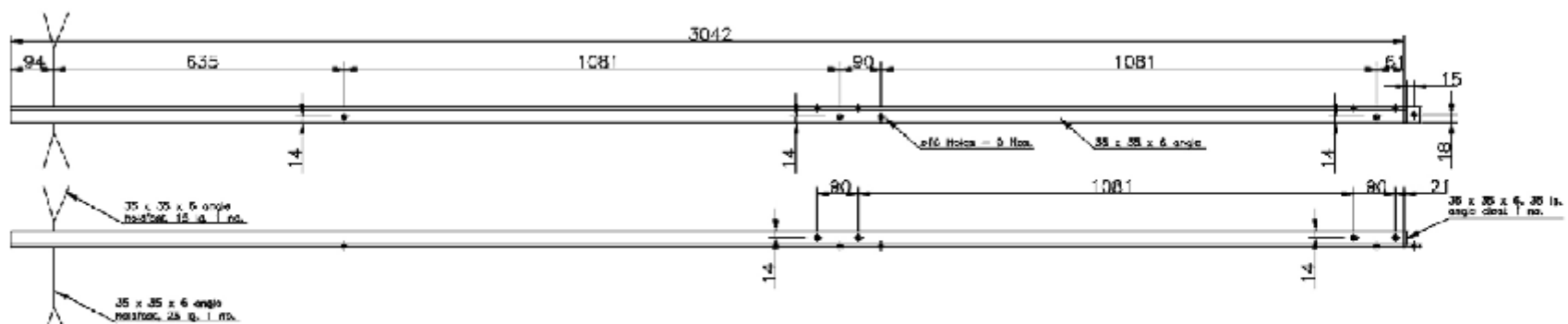


NO.	DATE	REVISION DETAILS	BY	Scale	Program	Drawing No.	Rev.	
4					<b>DeMontfort Incinerator Mark 8-ITPI</b>	Designed		
3	05-05-04	DRAWING NUMBER CHANGED, NAMING EDITED	NAK	1:20		<b>PLAN AT 1.8 M LVL.</b>	Drawn	B.A.L.A. 7-03-04
2	09-03-04	MODIFIED SLAB NO. 7 IS ADDED, ITEM NO. 18 REMOVED	NAK				Checked	
1	01-03-04	ITEM NO. 8 MODIFIED	SUFRTI			Approved		
					<i>Program For Appropriate Technology In Health</i>	CV/05	3	

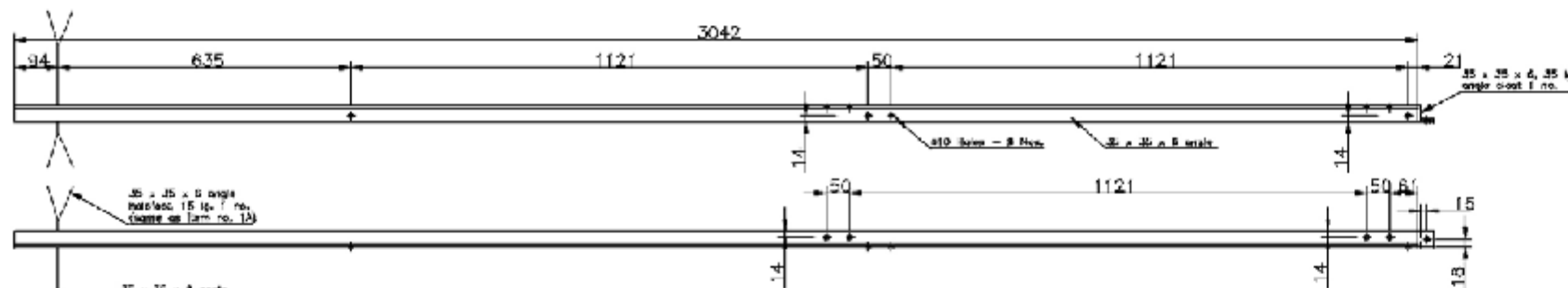


4.	08-08-04	ITEM NO. DETAILS AND TITLE IS MODIFIED	NAK
4.	2-08-04	ITEM NO. DETAILS AND TITLE IS MODIFIED	NAK
3.	03-04-04	INCINERATOR BASE MODIFIED, ASH PIT HOLE SLAB ASH PIT DEPTH INCREASED	NAK
2.	09-03-04	MODIFIED ITEM NO. 17 IS ADDED ITEM NO. 14 IS DELETED	NAK
1.	01-03-04	DIAGONAL SUPPORTS MODIFIED, PANEL FIXING DETAIL MODIFIED, LEVELS INTRODUCED	SUPRITI
NO.	DATE	REVISION DETAILS	EY

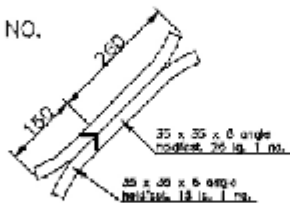
DeMontfort Incinerator Mark 8-ITPI TITLE: SIDE ELEVATION (SECTION AA OF CV05)		NAME	DATE
		Designed	
Scale: 1:50 Program For Appropriate Technology In. Bwala.		Drawn	E/ALA 17-02-94
		Checked	
		Approved	
		Drawing No.	Rev.
		CV/06	5



COLUMN  
ITEM NO. 1A : 1 NO.



COLUMN  
ITEM NO. 1B : 1 NO.



- NOTE:
1. ALL DIMENSIONS ARE IN MM.
  2. ALL JOINTS IN FABRICATION ARE WELDED AND GRIND FINISHED.
  3. SURFACE OF ALL COMPONENTS IS COATED WITH PRIMER (RED OXIDE).
  4. ALL COMPONENTS ARE PAINTED WITH ZINC/ZINC CHROMATE PAINT.

NO.	DATE	REVISION DETAILS	BY	DATE	NAME	DATE
4.						
3.	08-06-04	DRAWING NUMBER CHANGED, HOLDFAST RELOCATED	NAK		Designed	
2.	08-03-04	TITLE IS CHANGED	NAK		Drawn	B.A.L.A. 17-03-04
1.	01-03-04	HOLE LOCATIONS MODIFIED	SUPR.T.		Checked	
					Approved	
					Design No.	Rev.
					Program For Appropriate Technology In Health	3
					CV/07	

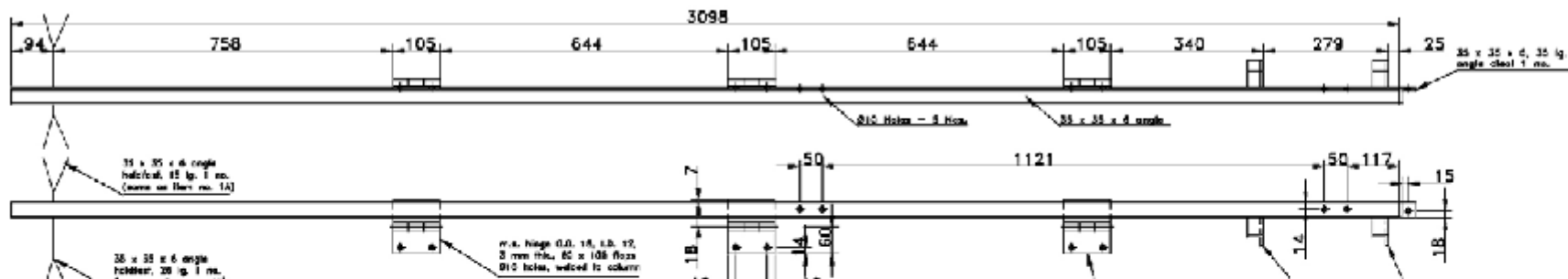
DeMontfort Incinerator Mark 8-ITPI

STEEL COLUMN 1A-1B

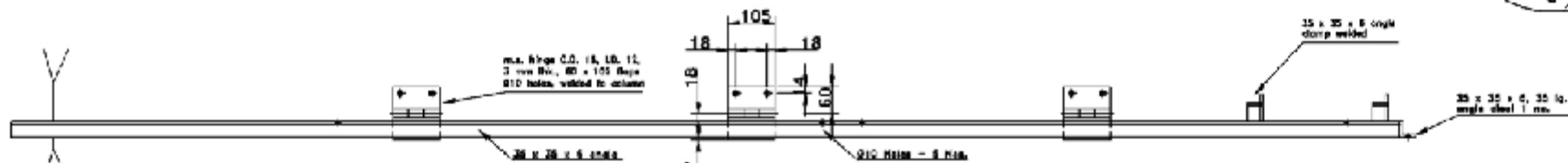
Program For Appropriate Technology In Health

CV/07

3



COLUMN  
ITEM NO. 2A : 1 NO.



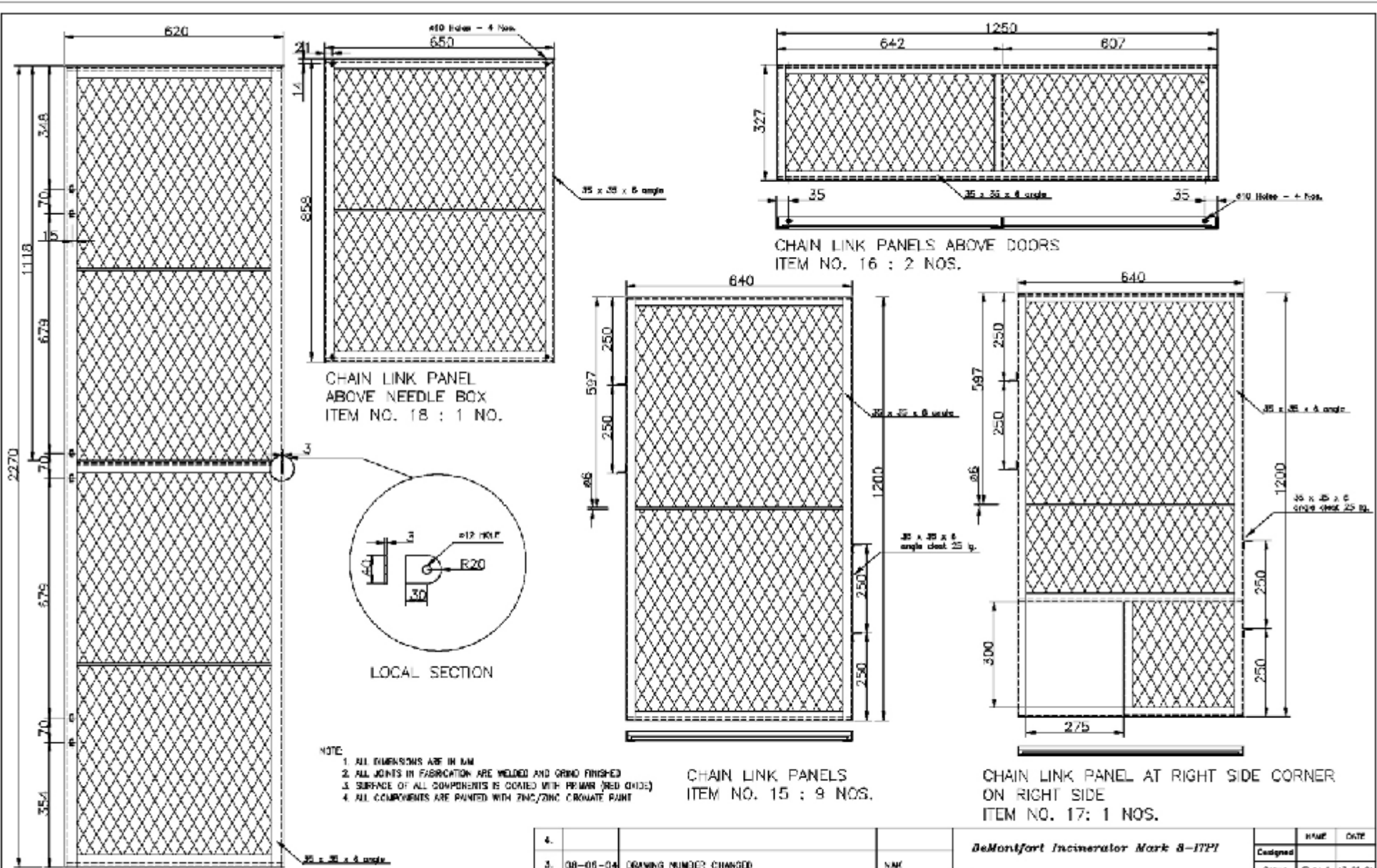
COLUMN  
ITEM NO. 2B : 1 NO.

NOTE:

1. ALL DIMENSIONS ARE IN MM.
2. ALL JOINTS IN FABRICATION ARE WELDED AND GRIND FINISHED
3. SURFACE OF ALL COMPONENTS IS COATED WITH PRIMER (RED OXIDE)
4. ALL COMPONENTS ARE PAINTED WITH ZINC/ZINC CHROMATE PAINT

NO.	DATE	REVISION DETAILS	BY	DATE	REVISION DETAILS	BY	NAME	DATE
4.								
3.	08-08-04	DRAWING NUMBER CHANGED	NAK					
2.	08-03-04	TITLE IS CHANGED	NAK					
1.	01-03-04	PINOLS, CLAMPS INTRODUCED IN ITEM NOS. 2A & 2B	SUPPIT					
				<i>DeMontfort Incinerator Mark B-DEPI</i>				
				Title				
				<b>STEEL COLUMN 2A-2B</b>				
				Date				
				<i>Program For Appropriate Technology In Health</i>				
				BY				
				DRAWING NO.				
				CV/08				
				REV.				
				3				





CHAIN LINK DOORS  
ITEM NO. 19 : 4 NOS.  
FASTENERS IN 2 NOS., PIPES IN 2 NOS.

CHAIN LINK PANEL  
ABOVE NEEDLE BOX  
ITEM NO. 18 : 1 NO.

CHAIN LINK PANELS ABOVE DOORS  
ITEM NO. 16 : 2 NOS.

CHAIN LINK PANELS  
ITEM NO. 15 : 9 NOS.

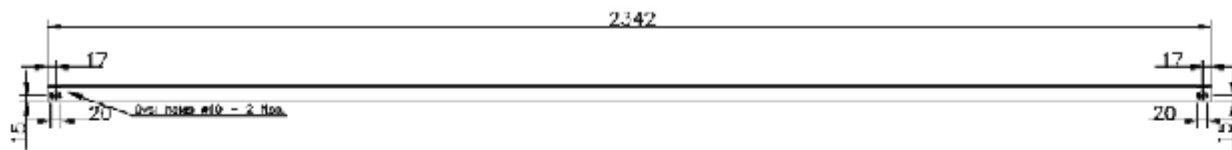
CHAIN LINK PANEL AT RIGHT SIDE CORNER  
ON RIGHT SIDE  
ITEM NO. 17: 1 NOS.

- NOTE:
1. ALL DIMENSIONS ARE IN MM
  2. ALL JOINTS IN FABRICATION ARE WELDED AND GRIND FINISHED
  3. SURFACE OF ALL COMPONENTS IS COATED WITH PRIMER (RED OXIDE)
  4. ALL COMPONENTS ARE PAINTED WITH ZINC/ZINC CHROMATE PAINT

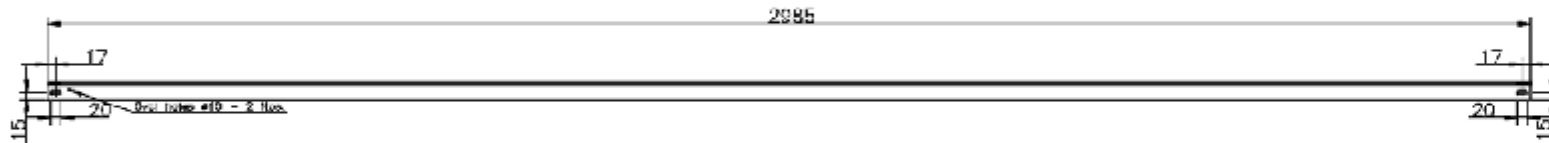
NO.	DATE	REVISION DETAILS	BY	DATE	NAME	DATE
4.						
3.	08-06-04	DRAWING NUMBER CHANGED	N/A		<i>DeMontfort Incinerator Mark 8-ITPI</i>	
2.	08-03-04	ITEM NO. 17 INSERTED, DOOR LATCH IS MODIFIED ITEM NO. 15 IS REQUIRED TO 9 NOS.	N/A		<b>STEEL CHAIN LINK PANELS AND DOORS</b>	
1.	01-03-04	ITEM NOS. 16 & 19 ACQUIRED	SUPP/IT			
					Program For Appropriate Technology In Health	
					Designed	
					Drawn	E.A.L.A 17-02-04
					Checked	
					Approved	
					Drawing No.	Rev.
					CV/10	3



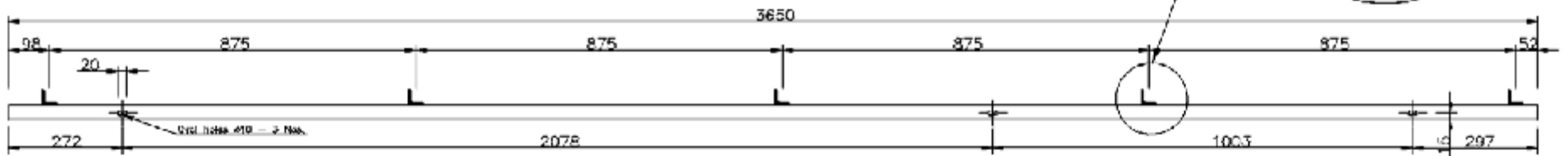
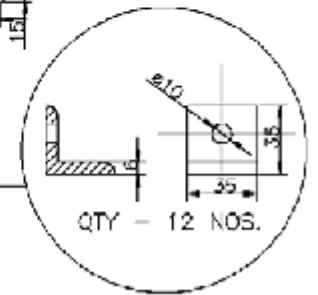




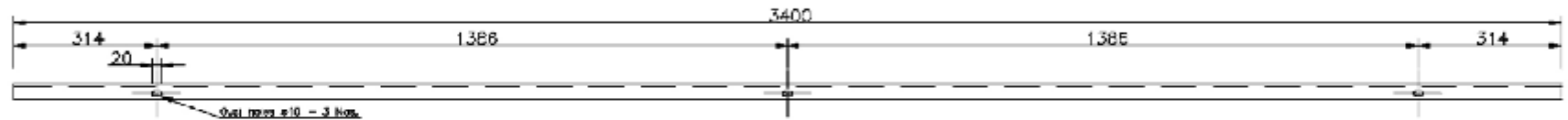
SHORT DIAGONAL SUPPORT  
ITEM NO. 09 : 4 NOS.



LONG DIAGONAL SUPPORT  
ITEM NO. 10 : 2 NOS.



RAFTERS  
ITEM NO. 12 : 3 NOS.



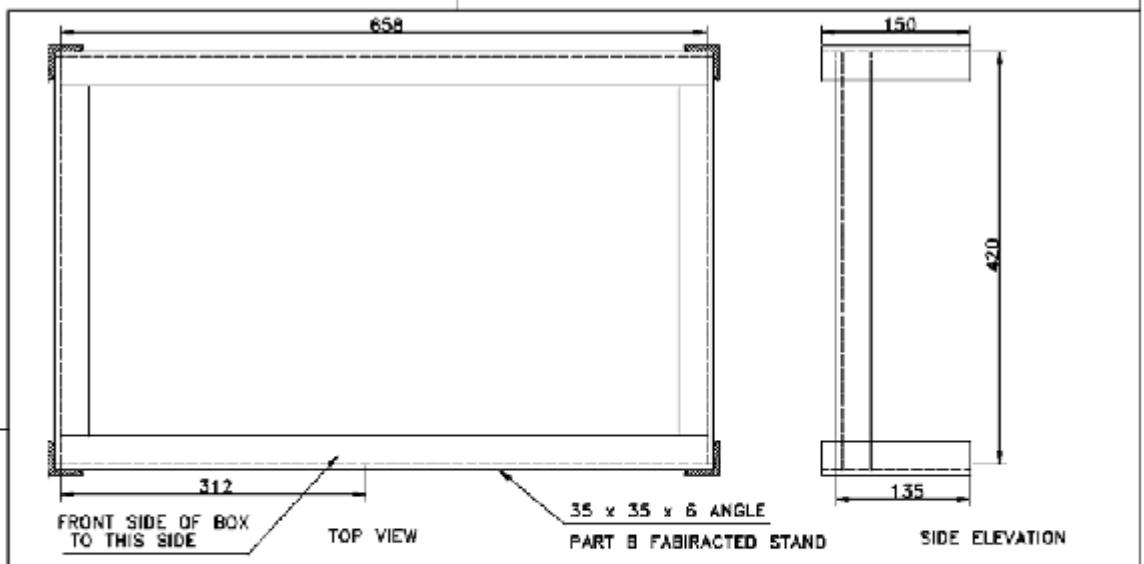
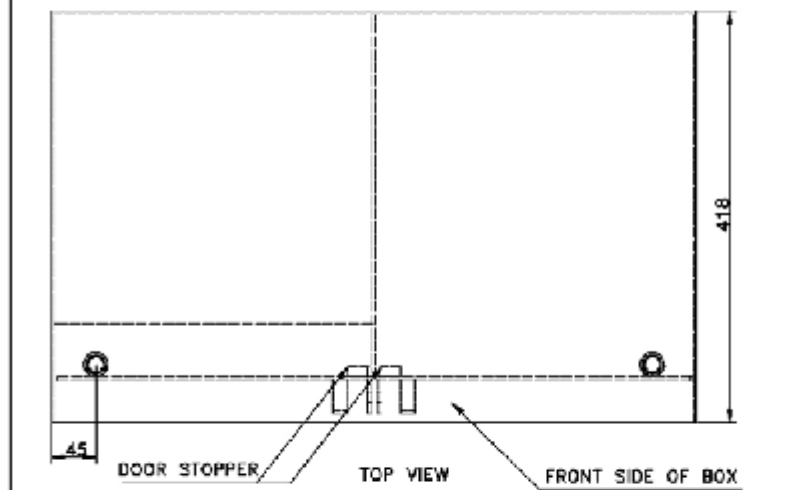
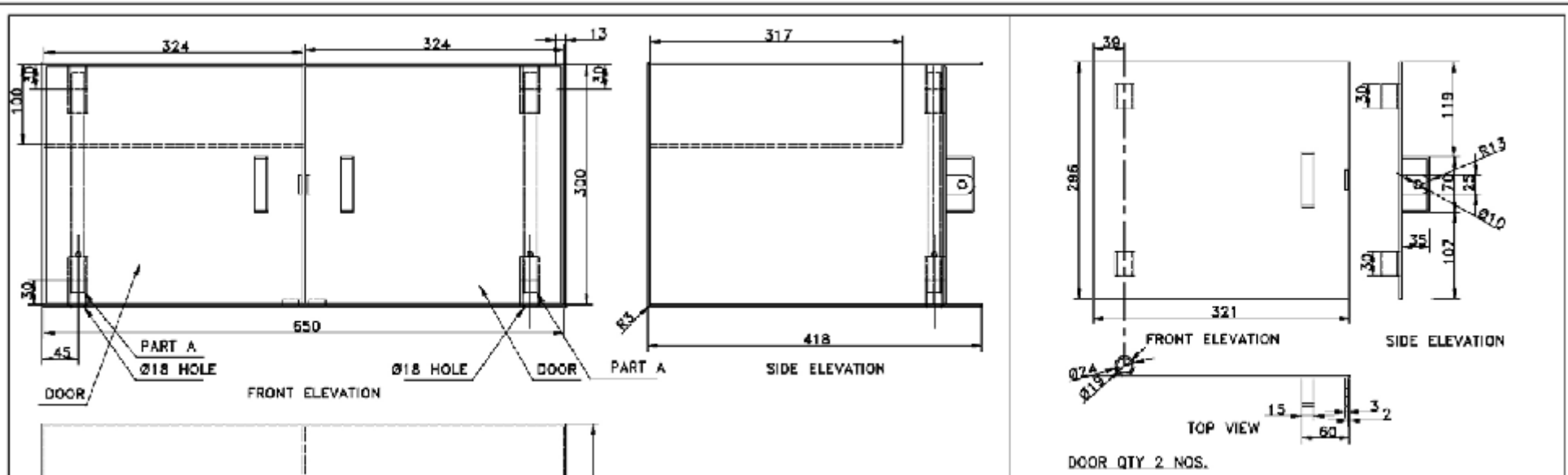
PURLINS  
ITEM NO. 13 : 5 NOS.

- NOTE:
1. ALL DIMENSIONS ARE IN MM.
  2. ALL JOINTS IN FABRICATION ARE WELDED AND GRIND FINISHED
  3. SURFACE OF ALL COMPONENTS IS COATED WITH PRIMER (ZINC CHROME)
  4. ALL COMPONENTS ARE PAINTED WITH ZINC/ZINC CHROMATE PWNF

NO.	DATE	REVISION DETAILS	BY	DATE	REV.
4.					
3.					
2.	08-03-04	TITLE IS CHANGED, DETAILS OF PIECE ADDED	NAK		
1.	01-03-04	ITEM NOS. 9 & 10 MODIFIED	SUJPRITI		

DeMouffort Incinerator Mark B-ITPI Title <b>STEEL DIAGONAL SUPPORT, RAFTERS, PURLINS</b>		NAK Date Program For Appropriate Technology In Health	NAK DATE 17-05-04
Checked Approved Drawing No. CV/12	Rev. 2		

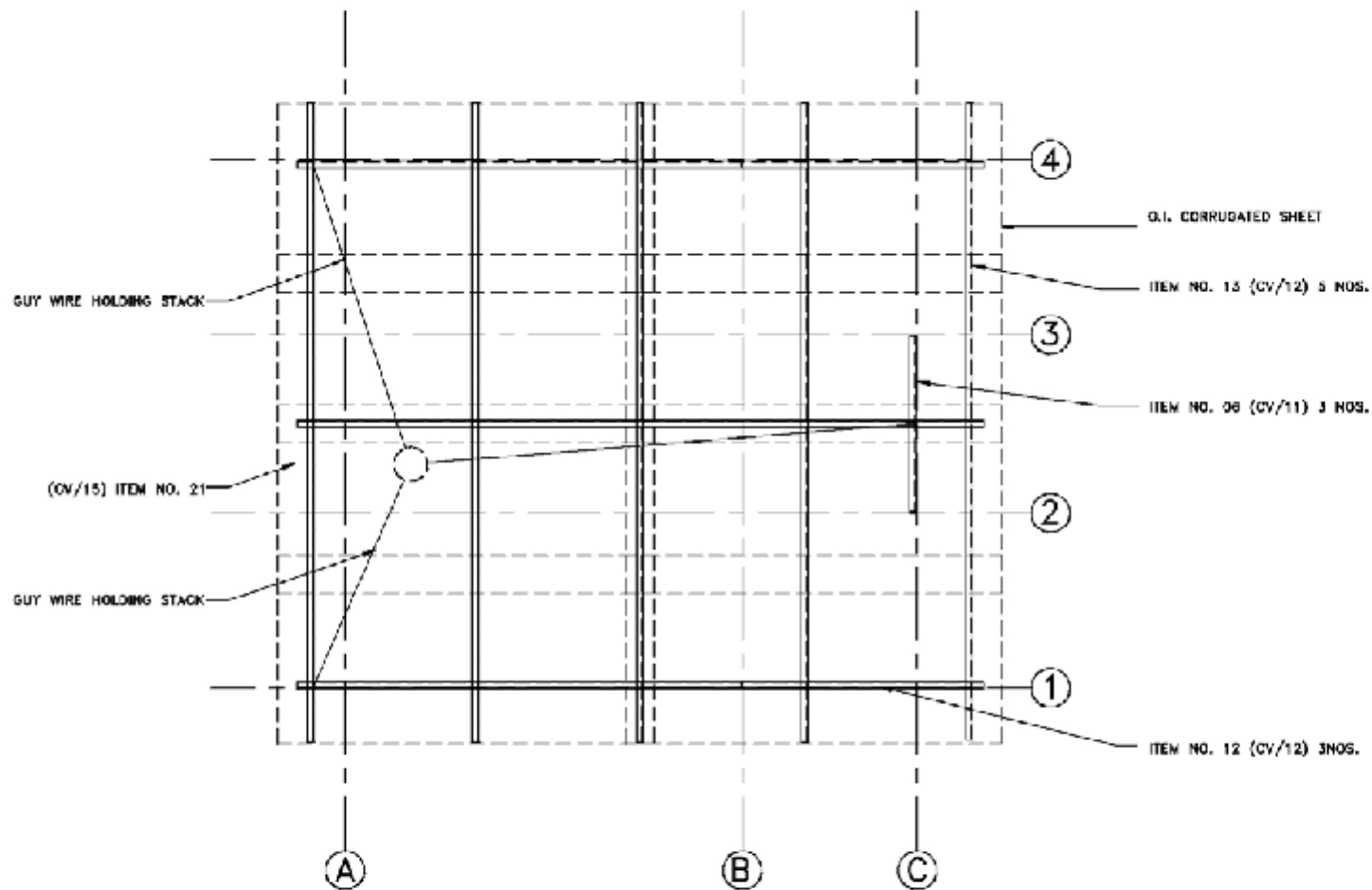


- NOTES:**
1. ALL DIMENSIONS ARE IN MM
  2. ALL COMPONENTS OTHER THAN ROD AND PIPE ARE MADE FROM 3MM THICK PLATE
  3. ALL JOINTS ARE WELDED AND GRIND FINISHED
  4. TOWER BOLT OF 100 MM-150 MM IS WELDED FROM INSIDE TO ONE OF THE DOORS
  5. SURFACE OF ALL COMPONENTS IS COATED WITH PRIMER (RED OXIDE)
  6. ALL COMPONENTS ARE PAINTED WITH ZINC/ZINC CHROMATE PAINT UPON ASSEMBLY
  7. TWO NOS OF 5MM DIA. SPLIT PINS ARE USED TO FIX THE DOORS ALONG WITH PART 'A'

NO.	DATE	REVISION DETAILS	BY	DATE	NAME	DATE
4.					Designed	
3.					Drawn	RAJA 17-10-04
2.	05-06-04	REDESIGN AND REDRAWING	NAK		Checked	
1.	11-03-04	DESIGN AND DRAWING	NAK		Approved	
					Scale	Program For Appropriate Technology In Health
					Drawing No.	CV/13
					Page	2

*DuMontfort Incubator Mark 8-ITPI*

**STEEL FABRICATED STORAGE BOX**

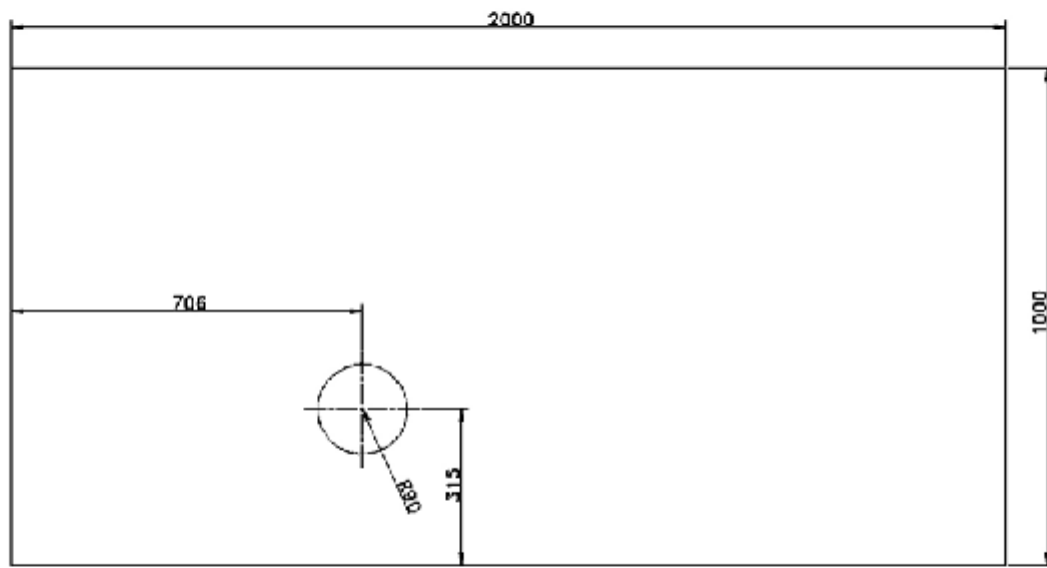


**NOTE:**

1. GUY WIRE HOLDING STACK ARE FIXED TO THE 'U' BOLTS CLOSER TO THREE CONDITIONS SHOWN IN ABOVE PROFILE

2. MORE DETAILS FOR FIXING THE GUY WIRES ARE GIVEN IN DRAWING 'M/FAB/013'

1.					DeMontfort Incinerator Mark B-177P1	DATE	
3.						Drawn	
2.	08-08-04	DRAWING NUMBER CHANGED, NAMING MODIFIED	NWK		ROOF PLAN	Drawn	B.A.L.A. 17-02-04
1.	01-03-04	ITEM NO.06 MODIFIED, STACK HOLE REPOSITIONED	SUPRIIN			Checked	
NO.	DATE	REVISION DETAILS	BY		Program For Appropriate Technology In Health	Approved	
						Drawing No.	
						CV/14	2



G.I. CORRUGATED SHEET WITH HOLE FOR CHIMNEY  
 ITEM NO. 21 : 1 NO.

NOTE:  
 1. ALL DIMENSIONS ARE IN MM.  
 2. 1.6 MM THICK G.I. CORRUGATED SHEET

4.					<b>DeMontfort Incinerator Mark 8-1771</b> Title <b>G.I. CORRUGATED ROOF SHEET</b> Scale <i>Program For Appropriate Technology In Health</i>	NAME	DATE
3.				Designed			
2.				Drawn		B.A.L.A.	17-02-04
1.				Checked approved			
NO.	DATE	REVISION DETAILS	BY		Drawing No.	Rev.	
					CV/15	1	

