Introduction:
Managing hazardous waste – and more specifically medical waste\(^1\) - in emergency and post-emergency responses is a huge challenge for humanitarian organisations. Crisis-affected countries are often poorly equipped to manage waste in the field and legislation is either non-existent or not properly enforced. In keeping with the principle of 'Do no harm' which governs all humanitarian interventions, it is the responsibility of every humanitarian organisation to treat the medical waste that it produces as well as possible so that it does not contaminate the soil and/or people.

In many contexts, eliminating medical waste by incineration would appear to be the most appropriate solution. In 1996, De Monfort University in Leicester (UK) launched a research programme to develop low-cost, effective incinerators that can be built in almost all developing countries. In France, the ‘De Montfort’ incinerator was initially used by Médecins Sans Frontières (MSF) and then gradually by other organisations.

Characteristics of the incinerator and how it is used:
Since the first models were developed in the mid-1990s, several improvements have been made. Today there are several models that can be built depending on the quantity of waste to be incinerated\(^2\).

\[
\begin{align*}
1 &- \text{ Loading door} \\
2 &- \text{ Primary combustion chamber} \\
3 &- \text{ Air inlet} \\
4 &- \text{ Fire grate} \\
5 &- \text{ Ash door} \\
6 &- \text{ Gas transfer tunnel} \\
7 &- \text{ Secondary combustion chamber} \\
8 &- \text{ Chimney}
\end{align*}
\]

\(^1\) Medical waste is made up of sharps, burnable waste (e.g. plastic other than PVC, non-sharp infectious waste, etc.), organic waste (e.g. placenta, etc.).

\(^2\) For example, Mark 8 allows a volume of 12 kg/hour to be incinerated for a hospital of 300 beds.
There are 3 stages in operating the incinerator:

- Pre-heating: the incinerator is lit with non-medical fuel, which is then added to increase the temperature.
- Treatment of medical waste: when the temperature of the primary chamber has reached 600°C, medical waste is incinerated at a rate of 6-7 kg per hour. The temperature of the secondary chamber, indicated on the stove pipe thermometer should be maintained between 600°C and 900°C, ensuring that waste is loaded at a regular rhythm.
- Total combustion / end of the operating session: 8-10 minutes after the medical waste has been loaded, add 1 to 2 kg of non-medical waste to ensure that any waste residue has been completely burned.

For optimal use of the incinerator, it should not be used for more than 2h/day.

What waste can be incinerated?

- Non-sharp infectious waste;
- Non-infectious waste (warning: no PVC);
- Non-airtight sharps (no ampoules or closed glass bottles);
- No wet waste.

Smoke produced:

- No heat-resistant pathogens:
  - Chamber 1 (combustion) at 760°C
  - Chamber 2 (gas) at 871°C
  → Decontaminated smoke
- Non-toxic (dioxins, furans, etc.) : T° > 850°C (ideally 1200°C)
  → Smoke not harmful

Cost between 250 and 1000 $ depending on the model and the context, and 100 €/year for maintenance (fuel, small repairs).

Materials needed to build the incinerator: fire bricks, pre-made metal components, Portland or fire cement. No need for specialist tools.

The construction of an incinerator within a Waste Disposal Unit (WDU) requires about 30 days.

Incineration rate of 6-7 kg per hour.

Average lifespan: 10 years.
### Examples of ‘De Montfort’ incinerators @MSF

<table>
<thead>
<tr>
<th>Disadvantages</th>
<th>Advantages</th>
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<tbody>
<tr>
<td>- Cost of the construction (depending on the model).</td>
<td>- Destroys waste that is dangerous for the environment and for people’s health.</td>
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<td>- The building instructions need to be adhered to strictly(^3).</td>
<td>- Intermediate technology, that can be used anywhere, is easily replicable and for which the building materials can be found in the majority of humanitarian contexts.</td>
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<td>- Dioxin and furan emissions (&gt; WHO standards); about 1.5 ng/m(^3) incinerated whereas the WHO recommends 0.1 ng Toxic Equivalency (TEQ) / m(^3).</td>
<td>- Low construction and operating costs in relation to the lifespan (10 years).</td>
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<td>- The importance of the operator: this technique depends to a great extent on people to ensure that the incineration instructions are respected (need for training and support).</td>
<td>- Decontaminated and practically harmless smoke even though above WHO standards (the incinerator must nevertheless be installed outside the city).</td>
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<td>- The difficulty of finding staff available only 2 hours per week (certain organisations ask the person in charge of the cold chain to look after this task).</td>
<td>- Best provisional option for treating medical waste in crisis contexts, particularly in remote areas.</td>
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<td>- Maintenance cost (100€/year) which can be difficult for the health centre to raise after the NGO has left.</td>
<td>- Can be built relatively quickly (compatible with humanitarian project cycle).</td>
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<td>- The importance of carefully segregating waste in advance so that not all waste is put into the incinerator (for example, medicines cannot be incinerated, nor can chlorinated materials).</td>
<td>- Not necessary to have electricity to operate it.</td>
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<td>- The problem of cracks in the fire bricks (the importance of maintenance).</td>
<td>- The WHO has recommended installing this incinerator in several countries (e.g. Mali).</td>
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<td>- A strict protocol regarding the type of medical waste that can be incinerated and the temperature that needs to be reached.</td>
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<td>- Having to wait for a certain volume of waste before using the incinerator.</td>
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\(^3\) For example, changing the position of the air inlet for the second chamber could modify the output and, consequently, the characteristics of the smoke produced.
To explore this topic further:


- Incineration in health structures of low-income countries: construction and operation of the De Montfort Incinerator (MSF, 2012)