Deployable Incinerators for Sustainable Waste Management and Energy Recovery

SAME European Engineer Capabilities Workshop
March 1, 2017
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1. Why is waste such a challenge in forward operations?
2. How to select an incinerator that actually is better than a burn pit.
3. Innovative mobile waste incinerators.
4. Taking on-base waste management further – moving to zero waste and recovering energy.
Military base waste represents a complex mix of materials. The assured destruction of an incinerator is desirable for many of the waste types that can pose significant risks if not properly disposed of.
Proper sanitation is essential to personnel health and safety

Run off from waste can pose a risk of exposure to chemical hazards

Animals are attracted to waste and can become vectors for disease, particularly where they are exposed to the pathogens inherent in decomposing waste.
Transporting Waste Off-Base: Risks

Movement of waste off-base increases exposure to creating environmental contamination

Trucks coming onto the base can reduce base security
Burn pits were/are used extensively on base camps because they are thought to be the most expedient method of waste disposal behind the wire.

Health Effects on base personnel.
Health effects from exposure to chemicals found in burn pits may include cancer, neurological effects, reproductive effects, respiratory toxicity, and cardiovascular toxicity. Troops who have worked in these areas are subject to higher rates of asthma, emphysema, and rare lung disorders.

Resident is quoted saying: “It’s making everyone sick, especially the children”
Radio Free Europe

Mission progress can be impeded by negative relations with host nationals.
Small Incinerators and Emissions

Some small incinerators are as bad as a burn-pit due. Three common pitfalls to avoid:

1. Poor design
2. Overstated Capacity for the Waste Material (undersized equipment)
3. Not Fit-for-Purpose (originally designed for other waste types: dead animals, dry waste materials, etc.)

Inadequate design = Incomplete Combustion
Some emissions are directly correlated with the waste feedstock. Other emissions can be largely controlled with good design. All emissions can be controlled using technology – when appropriate.

<table>
<thead>
<tr>
<th>Avoided with good design</th>
<th>Control by diversion of some waste materials or use of Air Pollution Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Monoxide</td>
<td>Hydrogen Chloride</td>
</tr>
<tr>
<td>Dioxins and Furans</td>
<td>Sulfur Oxides</td>
</tr>
<tr>
<td>Particulate Matter</td>
<td>Nitrogen Oxides</td>
</tr>
<tr>
<td>Unburned Hydrocarbons</td>
<td>Metal Oxides, Metal Vapours</td>
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Claims need verification under similar conditions

Request the independent lab test data, obtained using the correct methods, and tested when burning the same waste you need to process.

“Meets EU Directive”

“Clean Emissions”

“EPA Approved”
The 3Ts of Clean Combustion

Keys to clean combustion: **Time, Temperature** and **Turbulence**

- **Time**: Secondary Combustion Chamber Retention Volume > 1 second
- **Temperature**: Auxiliary Fuel Burner to ensure minimum temperatures of 850°C to 1000°C
- **Turbulence**: Excess Air Supply to Create Turbulence for Mixing and provide Oxygenation of Gases

Properly designed exhaust stack to create required draft.
How to Guarantee Incomplete Combustion

- Inadequate supply of air and/or fuel
- Lack of control over temperatures and oxygen supply
- Impractical refractory insulation that breaks down readily
- Lack of proper door seals
- Inadequate draft

- Manual controls require an experienced Operator to babysit
- Uncontrolled Temperatures
- Unrestricted air ingress due to poor door seals, latching and lack of properly designed draft
Without air pollution control, batch loading is best. Starved air ensures that there is minimal turbulence inside the primary chamber. There should be no loading hot and no stoking of the waste bed. This prevents the fly-ash (particulate matter) generation and avoids the products of incomplete combustion such as Carbon Monoxide and Dioxins and Furans.

A large Secondary Combustion Chamber provides the best outcome and provides contingency for times when the operator over-stuffs the machine – this will happen!
Step One: Be specific about the waste characteristics.

Detailed Analysis from ARL provides “average” waste characteristics for the typical base camp wastes which range in density by 55%.

<table>
<thead>
<tr>
<th>Waste Category</th>
<th>Standard mix</th>
<th>Cardboard/paper challenge mix</th>
<th>Food waste challenge mix</th>
<th>Plastics challenge mix</th>
<th>Wood challenge mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Density</td>
<td>6.0</td>
<td>9.1</td>
<td>9.0</td>
<td>4.0</td>
<td>11.0</td>
</tr>
<tr>
<td>(lbs./cu.ft.)</td>
<td></td>
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This is extremely important because small incinerators are limited by their internal volume and confusion about the density can lead to serious errors in sizing the correct equipment.
How to avoid a System that is Undersized

Step Two: Specify the quantity of waste to be processed in a 24-hour day.

- Specify the waste processing requirement on a daily basis.
- How many batches are acceptable?
- Will a soldier be dedicated to burning 24/7? (If so you will need a continuous feeder to reduce the safety risk of loading to a hot chamber - and the emissions will not be as good.)
- Or do you want true batch burning? (Best for systems under 15 tons per day)
- Don’t be fooled by a “burn rate” (kg/hr) – this number is meaningless in the context of a batch system.

Step Three: Find out the Actual Useable Volume of the Machine

- Verify the actual practical useable volume of the incinerator
- Compare it to what is needed: density x weight = volume
First of its kind Mobile Incinerator with mobile/containerized Air Pollution Control (APC) and Continuous Emissions Monitoring System (CEMS) proven to meet EU Directive

- Equipment built to support troops that can deploy anywhere in the world – arctic, desert, tropics
- All infrastructure must be up + running within 1-2 days of arrival
- Disposal of 2000 kg of waste (500 person camp)
The Swedish Armed Forces are taking expeditionary base camp waste management to the next level.
Waste incineration with Energy Recovery – there are some simple ways to derive energy benefits without trying to produce power from small amounts of waste.

Containerized Waste Disposal System (2000 kg/day) with APC & Hot Water Recovery

Heat Exchanger can produce up to 250 LPM ($\Delta T=35^\circ C$)
Comprehensive Waste Management

Mobile Waste Incinerator (EU Compliant with Energy Recovery)

- Recycling Station with Weigh scale
- Containerized Composter
- Waste Storage
- Operations
- Ash Storage (30 days)
Simple, small, fit for purpose, less fuel, clean emissions

Primary Chamber – where waste is loaded and gasified

Centre Tricon contains the control panel and interconnecting duct

Secondary Chamber – Oxidation of the gases generated from the combustion of waste

Three interconnecting Tricon ISO containers with the same footprint as one standard 20’ ISO container. Each module weighs less than 10,000 lbs and can be lifted with a forklift.
Small scale incinerator with energy recovery

Produce up to 1025 USG hot water (from 66F to 150F), in less than 3 hours, while burning 500 lbs of waste.

Reduces reliance on diesel/JP8 fired hot water heaters for showers, laundry and kitchens.

Exhaust Stack for Waste Disposal

Exhaust Stack for optional Heat Recovery Module

Primary Chamber with door closed

View of interior of the interconnecting chamber and the control panel (note: without the hot water recovery the panel is smaller)

Optional Energy Recovery Module
Waste type: Standard Mix
Burn cycle time: 5 hours
Fuel Required: 30 USG.
Energy Recovery: 1000 Gallons of hot water $\Delta T = 84^\circ F$

Before: 420 lbs.

After: 41 lbs., Weight Reduction: 90%, Volume Reduction: 98%
True Fit for Purpose

Easy to deploy:
- Transportable by aircraft with or without a HCU pallet
- Move and set-up by forklift (crane not required)
- Can withstand road, sea and air transport including DROPS, Steep angle loading, rail-impact etc.
- Set-up and strike within hours without tradespeople

Easy to operate:
- Loading that is sensible and ergonomic and can be done in 1-2 batches in 24 hours (freeing up personnel for more important tasks)
- Controls that are simple and easy to use

Robust and Reliable:
- Materials of construction must be heavy-duty
- Reliability = components designed to withstand difficult climatic conditions (range of temperatures, dust/sand, etc.), can be supported in-the-field by soldier without specialization,

Can dispose of the required waste:
- Proven to be able to process the correct quantity of the given waste materials

Produces the minimal emissions possible without Air Pollution Control
• Addressing waste issues now will reduce costs, avoid future costs and provide a valuable source of energy for the base.

• The rewards go beyond positive economics and include risk avoidance, image improvement and trust building.

• EWS has a modular, scaleable mature technology that can be relied upon in-theatre to manage waste and deliver on these critical objectives.
Thank you for your interest!

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