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**POSTPRINT**



**TRANSPORTABLE WASTE-TO-ENERGY  
SYSTEM (TWES) ENERGY RECOVERY FROM  
BARE BASE WASTE**

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*Transportable Waste-to-Energy System (TWES)*  
*Energy Recovery from Base Waste*



Air Force Research Laboratory  
Airbase Technologies Division  
(AFRL/RXQ)  
Tyndall Air Force Base, Florida





Nov. 2007

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*Transportable Waste-to-Energy Sys.*
  
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**Objectives & Technologies**

- Novel design → initial prototype testing indicates low pollution emissions
- Refine design to insure stable, long-term operation and minimize power requirements
- Characterize & incorporate system to shred bulk waste
- Air-transportable size & weight

**Description**

A furnace to combust shredded solid waste at domestic & deployed bases: Currently, trash such as wood, paper, plastic, tires, etc. are removed and/or partially burned. Instead the furnace, coupled with a shredder, will completely burn the waste and provide heat for water or other needs.

**Payoff**

- Reduce trash removal requirements at deployed military bases – Improved security
- Convert trash to heat at home & abroad to heat water for heating, showers, cleaning equipment; absorption A/C
- Potential for cleaning UXO with direct heat or steam
- Potential for neutralizing chem/bio weapons

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IMAGE: “Furn Trailer Painted 2007\_2.JPG”



• Trash *OR* Fuel!

- Shipping materials: pallets, plastic wrap, foam pellets, cardboard boxes, etc.
- Worn-out supplies: clothing, tents, wooden or plastic building materials
- Daily trash: disposable dishes, water bottles, MRE containers, old documents,
- Maintenance waste streams: dirty fuel, oil, liquid solvents.



**solid waste production in Balkins**

Combustable Waste	5,620	lb/soldier/year
<small>US Army CERL, "Base Camp Solid Waste Characterization Study"</small>		
Airmen	1,100	airmen
Daily Production	16,924	lb/day
	705	lb/hr



## Bare-Base Need for TWES



- Foreign vendors transport the trash  
→ Manual inspections of garbage trucks
- Or, US personnel haul to external dump site  
→ risk injury of scavengers
- Or, partial, smoky burning on-site.



**Predicted Benefit of TWES** **AFRL**  
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- For 1,100 airmen
  - 700 lb/hr solid waste produced by base
  - 20% efficiency [(Net Electricity Gen.)/(Heat Value of Waste Material)]
  - Net electricity 205 kW
  - Corresponds to 13 gal/hr in a 38% efficient MEP-12 diesel generator
- Per 1 ton of Solid Waste

1 ton solid waste → 586 kW-hr electricity ← 37 gallons diesel fuel

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Heating Value

- Municipal Solid Waste 11,620 kJ/kg = 5,000 Btu/lb (Curlee and Das, 1991, chp4, p.181, pdf p.34)
- No. 2 Fuel Oil 45,263 kJ/kg



- Many County Governments sponsor Waste-to-Energy recycling facilities.
  - W-to-E is simplified way to get most value from unwanted trash
  - Recycling requires greater sorting and additional energy input



Bay County, Florida



Miami-Dade County, Florida



- Potential Uses of Heat

- Heat water for showers, laundry, dishes
- Heat facilities
- Steam clean equip., engines
- Produce electricity; Absorption cooling



Water heater fueled by JP-8





Bulk Trash



Shredded Fuel



Shredder



TWES Furnace



## Furnace System for TWES



- Furnace "FURN" has been built and tested.



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IMAGE: "Furn Trailer Painted 2007\_2.JPG"



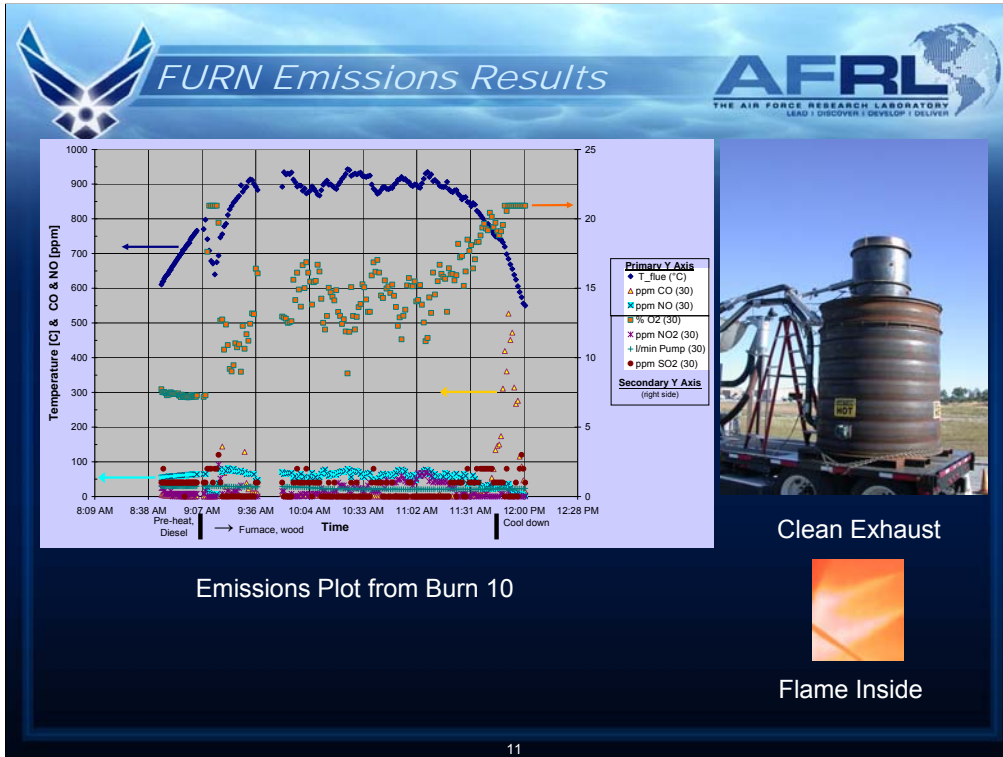
*Deployable Furnace System Design*

**Target Operating Conditions**

Feed rate	100 to 500 lb/hr = 45 to 227 kg/hr
Heat Content	± 11,620 kJ/kg
Material bulk density	5 to 8 lb/ft <sup>3</sup> , 80 to 130 gm/Liter
Volumetric flow of solids	20 to 100 ft <sup>3</sup> /hr = 9.5 to 47 L/min (based on 5 lb/ft <sup>3</sup> )
Particle size	3/8" in all dimensions and smaller, including dust
Total Airflow	145 to 730 SCFM, = up to 20,696 SLPM, to match the feed rates.

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•Municipal Solid Waste      11,620 kJ/kg = 5,000 Btu/lb (Curlee and Das, 1991, chp4, p.181, pdf p.34)



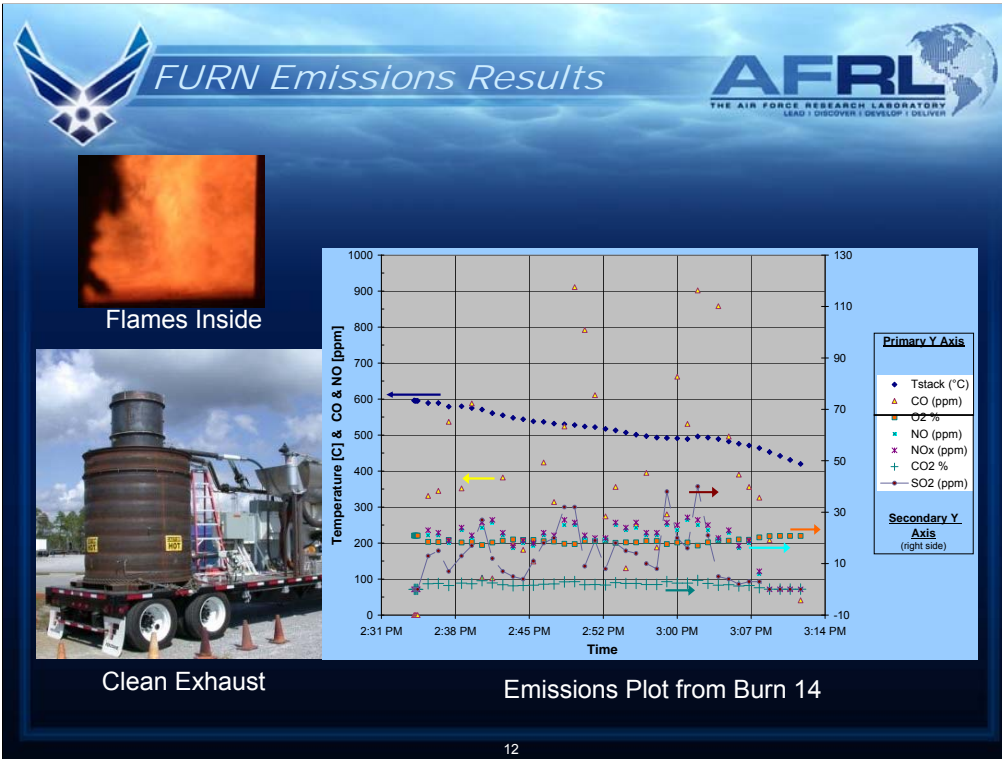
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Graph from Burn 10 (~ 10:00AM)

Emissions limits from EPA and/or FDEP may be added later.

IMAGES: (1) Burn 07 outside, clean exhaust: "small\_Furn Burn07 3\_37PM Outside and invisible exh.JPG"

(2) Burn 13, inside bright flame "cropped\_Furn Burn 13 02\_55PM 1.JPG"

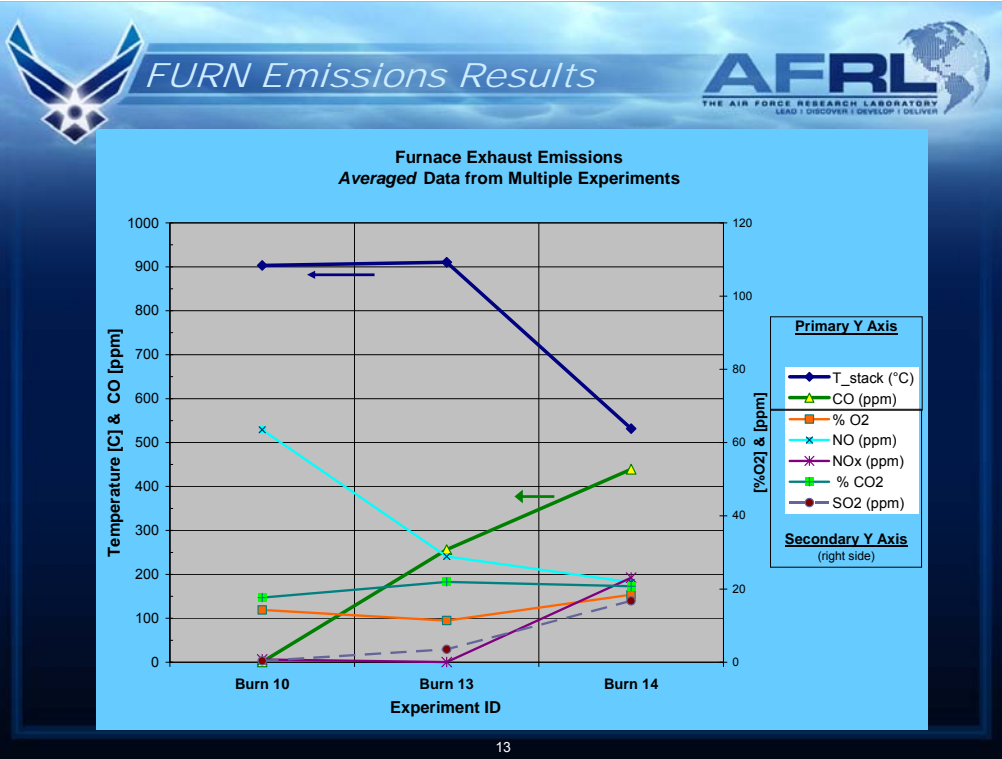


Graph from Burn 14

Emissions limits from EPA and/or FDEP may be added later.

IMAGES: (1) Burn 13 inside furnace: “small\_ Furn Burn 13 02\_27PM 2.JPG”

(2) Burn 08 outside, most of trailer, clean exhaust “small\_ Burn08 12\_06pm furn trailer clean exhaust.JPG”



Averaged emissions results from Burn 10, Burn 13, and Burn 14. Averaging usually occurred over a period of 20 to 35 minutes.

Emissions limits from EPA and/or FDEP may be added later.



## Converting FURN to TWES



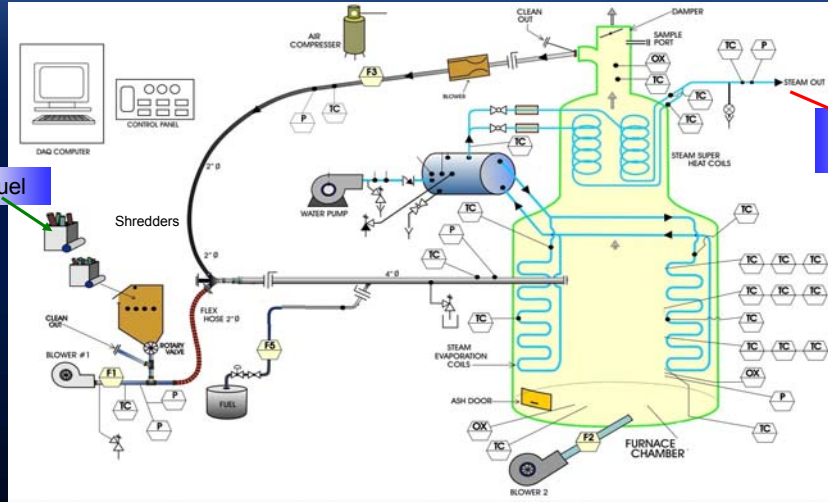
- Next, add steam generator, steam turbine, and electric generator
- Have funding from DOE Federal Energy Management Program (FEMP) to initiate the conversion.



- Will install and test electricity production at Tyndall AFB



# TWES Process Diagram



Fuel

Useful heat

 TWES Research @ Tyndall AFB  THE AIR FORCE RESEARCH LABORATORY  
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IMAGE “small\_ Furn Burn 02\_001 sunrise.JPG”