Raytheon

*Customer Success Is Our Mission*

# Solid Waste Exploitation

**Raytheon UTD**

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# Waste to Energy

# How much solid waste?

- Force Provider Solid Waste Characterization Study, *Natick Soldier Center* (August 2004), determined that the field-feeding waste in a Force Provider Training Module at Fort Polk (550 personnel and 65 staff) produced:
  - 4.1 lbs of waste per person each day (2500 lbs per day)
  - Daily energy heating value of 16,600,000 BTU (4.9 MW-h)
  - Equivalent of 410 kilograms of JP8
  - When converted to electricity at 25 % efficiency, provides 51 kW of continuous power

# How much solid waste?

- A recent study sponsored by the Air Force's Combat Support Systems Program Office (Eglin AFB, 2000) analyzed the solid waste stream for an 1,100 person Harvest Falcon bare-base operation based at Prince Sultan Air Base produced:
  - 7 to 11 tons of solid waste daily
  - 85 to 124 cubic yards daily
  - 23 to 40 MW-h of energy
  - 3 metric tons of JP-8

# Gains from Waste to Energy

- Exploitation of solid waste as energy will:
  - reduced dependence on logistical fuel
  - reduced solid waste hauling
  - improved environmental soundness
    - 85% of combustible solid wastes are typically derived from renewable, non-fossil origins
    - Carbon dioxide, a biomass based fuel, has a lower operating temperature (when compared with a diesel-driven generator), which translates to production fewer pollutants such as oxides of nitrogen (NOx)

# Guidelines

- A waste-to-energy system should:
  - Be deployable and space efficient
  - Be durable to survive environment and transport
  - Be able to handle varying waste streams
  - Not add a large logistics demand
  - Require minimal training to operate and maintain

# Energy Extraction Methods

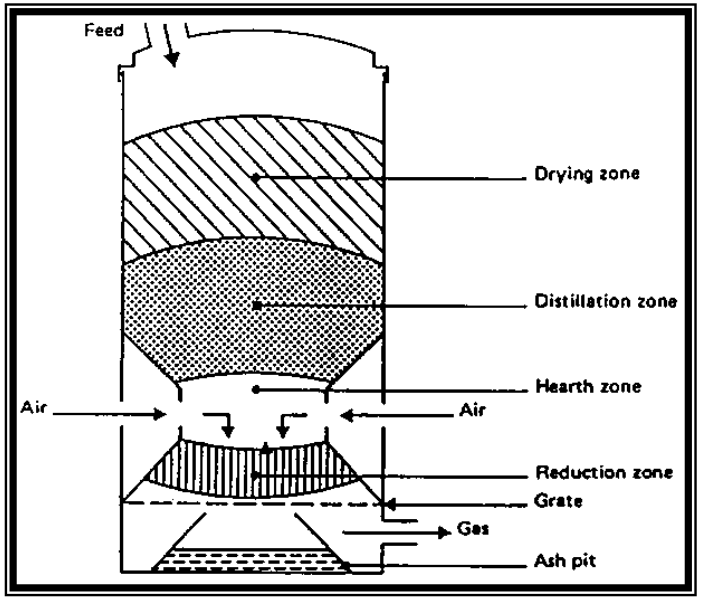
- Anaerobic Digestion
- Plasma Gasification
- Thermal Depolarization
- Thermal Gasification

# Heat to Power

- Solid Oxide Fuel Cells
- Stirling and Brayton Cycle (gas turbine)
- Rankin Cycle (steam turbine)
- Dual-fuel and Converted Internal Combustion Engines (diesel engine)

# Thermal Gasification

- Thermal gasification in the form of a fixed-bed, downdraft gasifier has the advantages of:
  - Simplicity of design,
  - Historically proven,
  - High thermal conservation efficiency (75%),
  - and low tar output
- The best option for use with deployed base camp operations.



# Technical Challenges

- Homogenization and densification of solid wastes
- Gas clean-up
- Thermal management

# Homogenization and densification of solid wastes

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- Segregation of metals and non-combustibles, pulverizing, mixing, and compacting the solid waste into pellets or briquettes.
- Current equipment is large, heavy, and ill-suited to the environment of deployed base camp operations.
- A compact easy to operate system is needed.

# Gas Clean-up

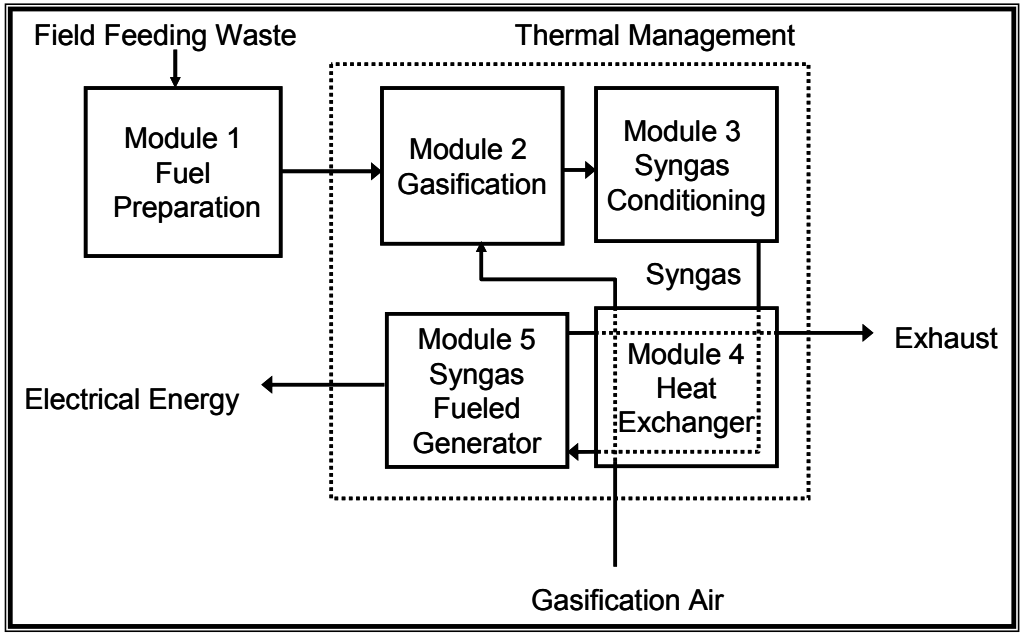
- Reducing and removing producer gas contaminants is a principal challenge.
- Primary contaminate is tar.
- Robust, easy to operate, low-tar gasifier is needed.

# Thermal Management

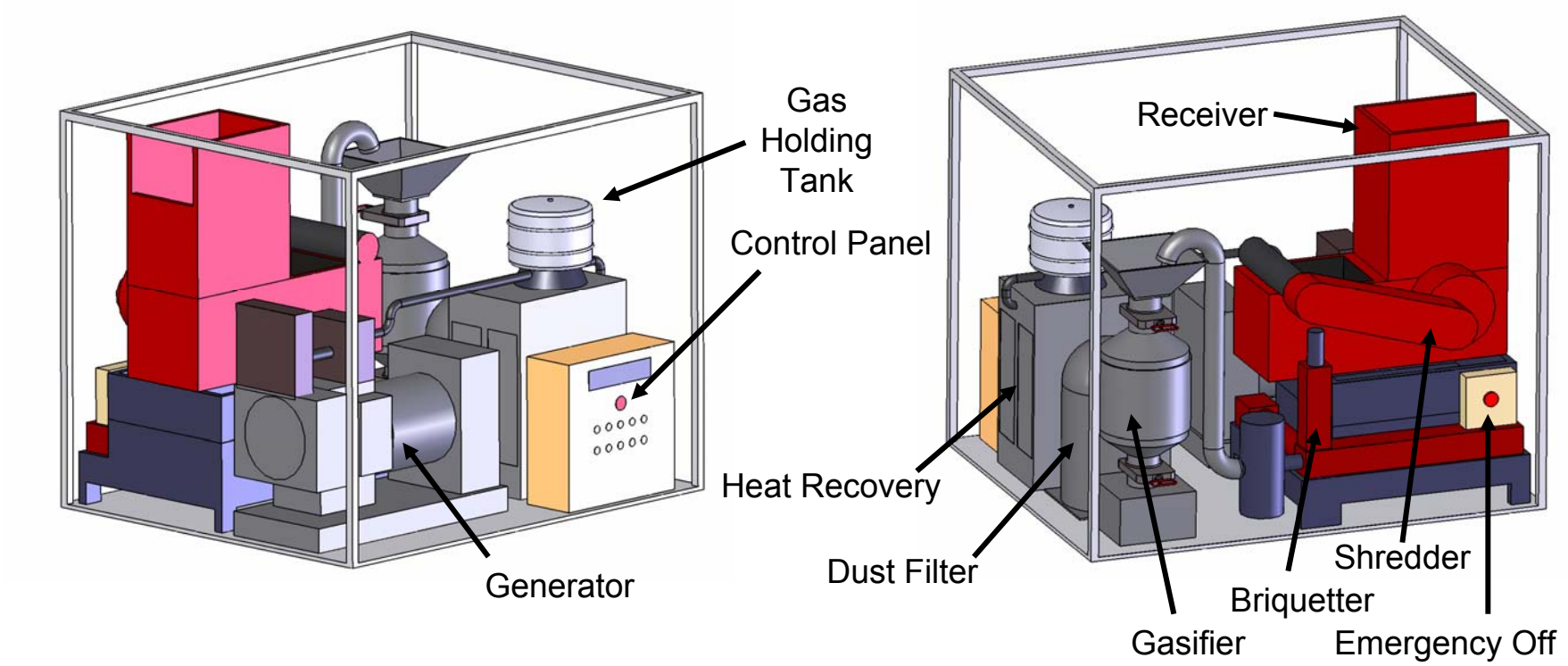
- Controlling conductive heat loss and returning the usable heat to increase efficiency
- The challenge is to accomplish the objective of thermal efficiency without undue complexity and within reasonable costs

# Approach

- A five-module gasifier addresses the challenges of processing Solid Wastes by integrating a small-scale package, reducing ‘tar’ and other producer contaminants, and maintaining thermal management



# Containerized Waste to Energy

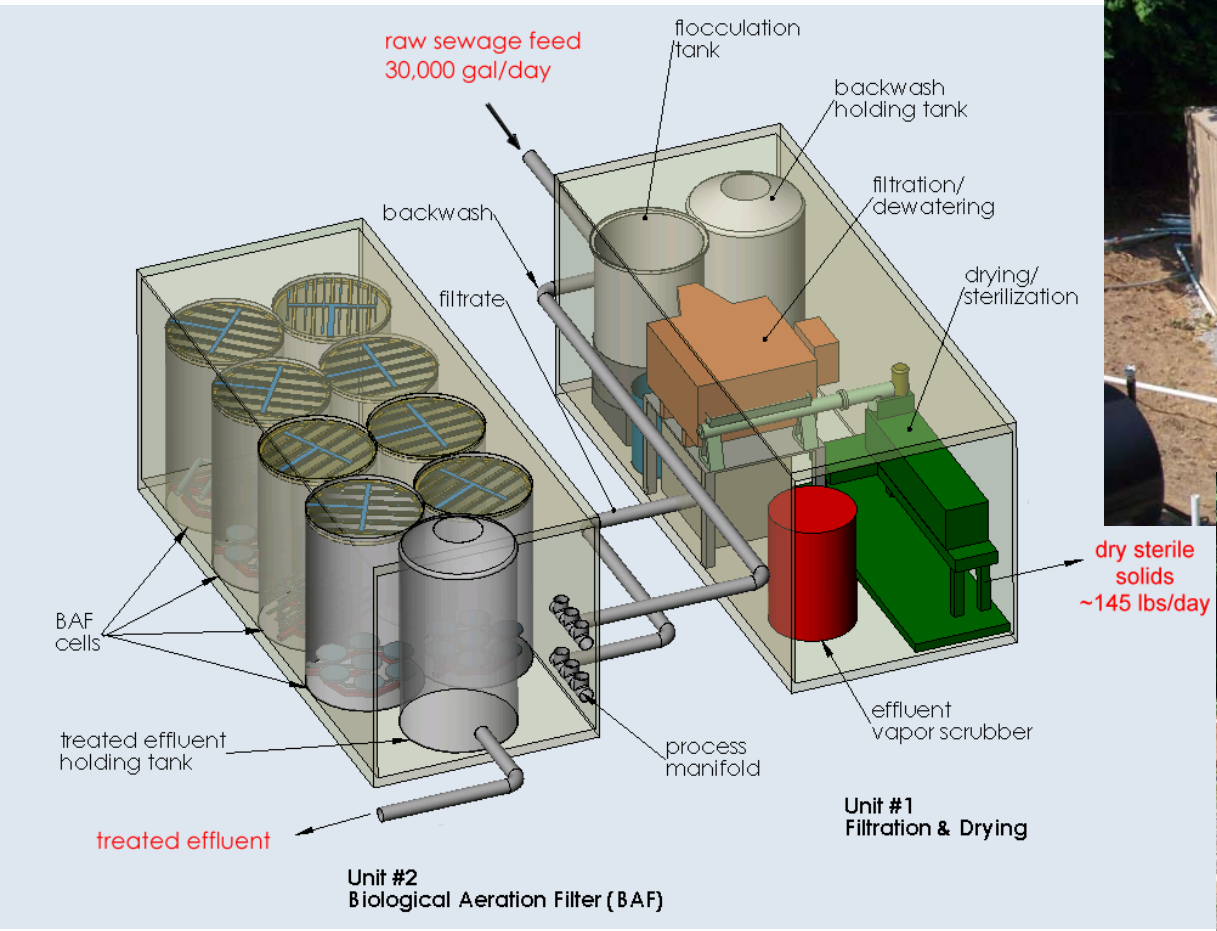



## Concept for 50-kW Unit

# Other Raytheon UTD Efforts

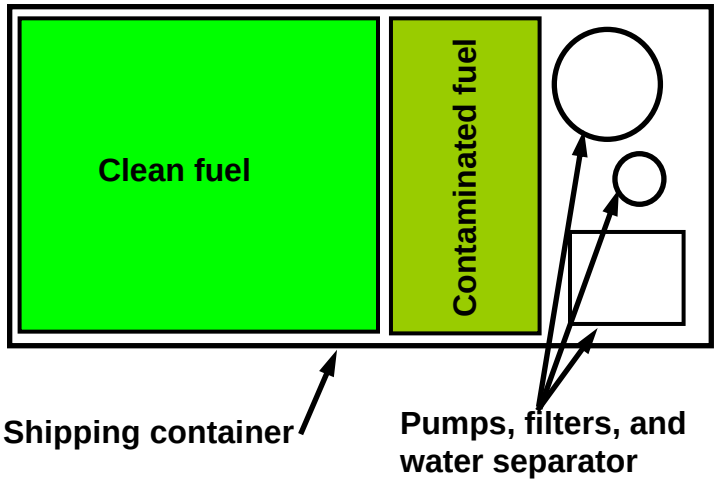
- Deployable Wastewater Treatment System (DWTS)
- Modular Deployable Fuel Facility (MDFF)

# Deployable Wastewater Treatment System (DWTS)




- Designed for the 550 solder Force Provider base camp
- 30,000 gal/day of combined blackwater/greywater (with 30% more than sustained demand)
- Meets discharge limits of 30 mg/L BOD and TSS
- Prototype unit tested, production unit designed (not built), requires 6 months testing before production run

# Modular Deployable Fuel Facility (MDFF)





**Need:** Small USG bases receive fuel from local indigenous vender or from US source transported by indigenous truckers. Local trucks are dirty and truckers will sometimes "cut" fuel with water. USG needs a fuel receiving, cleaning, and storage facility that can easily be deployed and installed at these bases.

**Objective:** Create a self-contained (inside a CONEX) fuel facility with the capability of receiving contaminated fuel, removing water and particulates (dirt) from the fuel, storing the fuel and transferring the clean fuel to diesel generator daytanks.

**Approach:** Develop and construct a prototype diesel fuel module:

- System will be sized to fit inside a single 10 x 20 shipping container. The design will make use of all COTS equipment and materials.
- System will focus on providing a portable, easy to install and easy to operate system.
- Fuel handling safety equipment and features will be incorporated.
- Provide storage space in module for 12 months of system consumables.
- Initial demonstration of the capability to client using diesel and highlight potential adaptability for other fuels (i.e. JP-8)

**Potential Applications:** USG bases in Afghanistan, Iraq, and other remote sites. System can be customized for diesel and JP-8 applications. The system is scaleable to base needs.