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OFFICE OF PREPUBLICATION AND SECURITY REVIEW

Implementing Waste Disposal Alternatives in Overseas Contingency Operations

Office of the Deputy Assistant Secretary of Defense (Environment, Safety, and Occupational Health)

December 2017

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Purpose

Respond to House Report 115-200, p. 82:

Overseas Waste Disposal Technology Development

"…provide a briefing… that provides an update on the progress made toward achieving the goals stated in the report required by section 317 of Public Law 111-84, as well as an update regarding how the Department is implementing lessons learned regarding waste-disposal technologies in overseas contingency operations."

Implementing Waste Disposal Alternatives in Overseas Contingency Operations

- **Pursuant to Section 317 of the NDAA for FY 2010, DoD provided a May 2010 Report to Congress, "*Burn Pits in the Context of the Contemporary Operating Environment*"**
  - Provides a holistic overview of solid waste management and health challenges, and efforts to overcome them during expeditionary operations
  - Established the way ahead on alternatives to open-air burn pits

- **Report laid out a plan to develop and implement alternatives to the use of open-air burn pits. Goals include:**
  - Change in Policy and Doctrine
  - Practices on the Ground
  - Materiel Solutions

Change in Policy and Doctrine

DoD policy prohibits the disposal of covered waste in open air burn pits during contingency operations (with exceptions)

- **DoDD 3000.10, *"Contingency Basing Outside the United States,"* 10 Jan 2013**
  - Directs organizations to pursue joint, scalable capabilities that use operational energy efficiently, minimize waste, manage environmental health risk, and minimize the logistics footprint.

- **DoDI 4715.22, "*Environmental Management Policy for Contingency Locations,"* 18 Feb 2016**
  - Disposal of covered waste in open-air burn pits is prohibited unless it is determined that no alternative disposal method is feasible in accordance with DoDI 4715.19. Open-air burning must be authorized and conducted in accordance with DoDI 4715.19 and supplementary requirements as outlined in the Contingency Location Environmental Standards (currently under development) and environmental management plan.

Change in Policy & Doctrine

- **DoDI 4715.19, "*Use of Open-Air Burn Pits in Contingency Operations,*" 15 Feb 2011; change 4, Oct 2017**
  - Establishes policy, assigns responsibilities, and provides procedures regarding the use of open-air burn pits and the prohibition of the disposal of covered waste in open-air burn pits during contingency operations, except in circumstances in which no alternative disposal method is feasible.

- **US Central Command (CENTCOM) Regulation 200-2, "*Environmental Quality – CENTCOM Contingency Environmental Standards*", 23 May 2013**
  - Provides environmental guidance and best management practices for U.S. base camps operated by CENTCOM personnel engaged in contingency operations within the CENTCOM area of responsibility.

Practices on the Ground

Requirements for Use of Open-Air Burn Pits

- **Combatant Commanders (CCDR) must make a determination that no alternative disposal method for covered waste is possible other than in an open-air burn pit**

- **CCDR must notify Congress no later than 30 days after determination is made to use an open-air burn pit**

- **Contingency Location conducts ambient air monitoring to evaluate health hazards from multiple sources**
  - Provide Ambient Air Monitoring Report to the CCDR
  - Include sampling results, risk assessment, and mitigation recommendations
  - Store results in the Defense Occupational and Environmental Health Readiness System

- **Provide a Health Risk Assessment report on each covered-waste open-air burn pit location**
  - No later than 180 days after notice is provided
  - Justify subsequent 180-day periods if covered waste continues to be disposed in the open-air burn pit.

Practices on the Ground

Tactics, Techniques, and Procedures

- **For each contingency operation, the operational commander must develop and approve a solid waste management plan**
  - Address the disposal of any covered wastes
  - Address the life cycle of solid waste management
  - Review and update annually
- **Waste minimization strategies (current and future)**
  - Rapid and effective waste reduction
  - Reduce, reuse, recycle where possible
  - Redesign MRE packaging to reduce the amount of materials and use materials that breakdown easily
  - Additive manufacturing
  - Novel expeditionary battlefield manufacturing processes using recycled and reclaimed materials

Practices on the Ground

Tactics, Techniques, and Procedures (cont'd)

- **Remove waste off-base using local national contract**
  - Common practice but there are challenges
  - Difficult to find vendors that meet U.S. standards
  - Expensive
  - Lack of understanding of requirements for shipping of HW
  - Lack of local environmental expertise
  - Lack of in-country recycling/disposal capability
  - In-country permitted practices/facilities that pose health risk
- **Procure and implement incineration technology**
- **Test and evaluate Waste-to-Energy (W2E) technologies for contingency operations**
  - Assess operational requirements, capabilities, gaps, and technologies to field systems that have a high rate of waste reduction and energy recovery
  - Several military facilities in the U.S. equipped with W2E systems
- **Request information from industry**
  - Established the Joint Deployable Waste-to-Energy (JDW2E) public site to include contingency base needs and requirements
  - Held Industry Days in 2013 and 2016

Technology Implementation

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- **DoD continually assesses incinerator and waste-to-energy technologies to determine feasibility for use at contingency bases.**
- **Considerations and unique military requirements include:**
  - Ease of operation (set up, tear down, operate, maintain)
  - Minimize energy consumption
  - Transportable configurations
  - Availability of test & evaluation data on commercial systems
  - Ability to handle variable, high-moisture content and mixed waste
  - Capability to handle 1-3 tons of waste/day
  - Ability to characterize solid, liquid, and gas emissions
  - Ability to obtain air permits for continuous training, test and evaluation, and eventual deployment
  - Rugged; capable of operating in harsh environments (tropical, desert, extreme cold)
  - Significant volume reduction
  - Logistics, labor and footprint requirements
  - Potential lack of infrastructure to make use of energy generated

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Operational Energy Capability Improvement Fund (OECIF) and Strategic Environmental Research & Development (SERDP) funded R&D

- **A military W2E converter could supply base camps with useful energy in the form of electricity**
  - Supplement the fuel transported by supply convoys over long distances
  - Would make solid waste management less resource intensive
  - Decrease health risks associated with current waste management techniques

- **OECIF and SERDP funded W2E R&D ($6.45 million) from FY 2012 - FY 2015 with the following goals:**
  - Process 1-3 tons/day
  - Produce non-hazardous residue
  - Net energy efficiency >50%
  - Minimal labor with no manual presorting
  - Size: No more than two 8'x8'x20' ISO containers; desire is one ISO container

- **Several systems were demonstrated and results documented**
  - Updraft gasification
    - Efficient but high tar content in syngas
  - Downdraft gasification
    - Significant requirement for waste pre-treatment
    - Air insertion required at numerous locations to ensure complete combustion
  - Modified updraft rotary kiln gasification
    - Engineering challenges and high tar content
  - Tar management
    - Catalytic reactor
    - High temperature tar cracking

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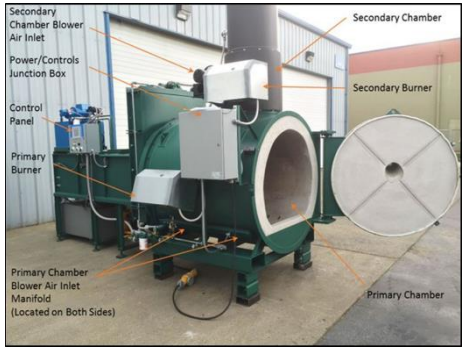
Natick Soldier Research Development and Engineering Center & Army Research Lab W2E Study

Phase 1 (completed in 2014)

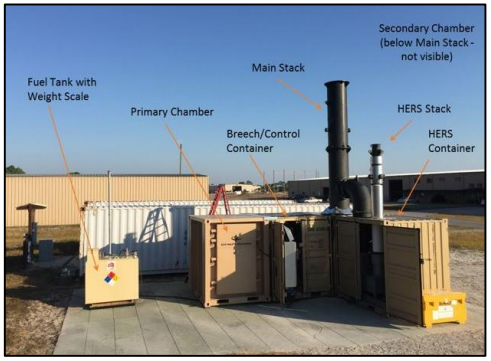
- Determine the state of W2E technology offered by 64 companies with functioning systems for small- and medium-sized contingency bases
- Determine the limitations and potential areas of further research
- Conduct in-depth independent engineering evaluations and site visits of 4 existing leading W2E systems.

Phase 2 (scheduled to complete Dec 2017)

- Characterize the waste at 150 and 600 person contingency bases
- Develop recommended use cases for 150 and 600 person contingency bases
- Develop recommended DoD test standards for W2E systems
- Evaluate potential systems for 150 and 600 person contingency basing applications
- Demonstrate the 3 most promising systems against the DoD test standards.



Advanced Combustion Systems



Eco Waste Solutions

Altex Technologies Corp.

Materiel Solutions

Natick Soldier Research Development and Engineering Center

- **Recent Research and Development**
  - Battalion-scale Waste to Energy Converter (BWEC)
    - Technology: Downdraft gasification and bi-fuel power generation
    - Funding: Alternative Energy Research Increase
    - Status: Ongoing; Army Small Business Innovative Research (SBIR) to mature pre-processor (through 4QFY19)
  - Solid Waste Destruction System (SWDS)
    - Technology 1: Self-powered combustion
    - Technology 2: Rotary pyrolysis and downdraft gasification
    - Funding: Office of the Secretary of Defense (OSD) SBIR
    - Status: Ongoing; OSD SBIR to mature technology (through 4QFY19)
  - Expeditionary Waste Destruction Box (Xw-Box)
    - Technology: Indirectly heated gasifier and black water incinerator
    - Funding: Army Rapid Innovation Fund
    - Status: Gasification proof of concept demonstration complete
      - Numerous technical challenges
      - No follow-on work funded at this time

MSW Power BWEC

MSW Power SWDS

Altex Technologies Corp. SWDS

Leidos Xw-Box

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Defense Logistics Agency Deployable Hazardous Waste (HW) Disposal Study

- **Completed in April 2017**
- **Determined and validated the need for deployable HW capabilities**
- **Identified risks and mitigation factors**
- **Established requirements for a deployable HW disposal system**
- **Examined several categories of technologies**
  - Pyrolysis
  - High Temperature Oxidation
  - Plasma Arc Gasification
  - Lithium Battery recycling
  - Industrial Supercritical Water Oxidation
- **Recommendations**
  - Conduct emissions and operational testing of a pyrolysis gasification system
    - Not all-encompassing; may be cost effective for handling some waste
  - Conduct R&D for deployable lithium battery recycling/disposal
    - Scale down industrial battery recycling technologies
    - Investigate “green” lithium batteries that can be landfilled

Materiel Solutions

Other Initiatives

- **DoD Environmental Security Technology Certification Program**
  - Explore commercially available and emerging technologies for hazardous materials at deployed operations
  - Issued W2E Broad Agency Announcement for contingency operations; 8 technology proposals reviewed for potential funding. Will award 3 projects in CY 2018, with co-funding from OECIF.
- **Air Force Research Lab and Air Force Civil Engineering Center**
  - Developing and demonstrating waste disposal system with established DoD test standards
- **Joint Deployable Waste to Energy (JDW2E) Initiative**
  - Completed demonstration of Micro Auto Gasification System (MAGS) using established DoD test standards
    - Limited testing (8 test runs) due to cost and time constraints
    - Power consumption cannot be directly linked to waste input
    - 10-100x reduction in certain cases of air emissions compared to burn pits
    - Recommend testing using unsorted military waste and perform emissions analysis
- **Naval Facilities Engineering Command**
  - MAGS tested in 2011 and 2013
  - Waste characterization (weight per waste type) for (a) 500 person Seabee unit, and (b) 820-1332 person USMC expeditionary base camp
  - Plasma gasification SBIR Phase II – ongoing

Dynamis Energy System for AF

Terragon's Micro Auto Gasification System (MAGS) for JDW2E

Lessons learned - General

- **Current contingency base solid waste disposal practices are:**
  - Financially expensive
  - Consume land area, energy, and manpower
  - Hazardous to human health and the environment
  - Do not re-use the energy content in waste
  - Cumulatively degrade mission effectiveness

- **Need to consolidate and standardize waste disposal practices to achieve economies of scale and positive ROI**
  - Waste disposal across the spectrum rather than the current siloed approach (camp waste, medical waste, hazardous waste)
  - Coordinate test and evaluation efforts so that the technology is addressing issues prevalent in a contingency operation
  - Consolidate and standardize practices so that units do not see different rules/requirements depending on where they are deployed

Lessons learned – W2E

- **Use improved, consistent DoD test standards**
  - Using standard waste recipes and test methodologies provide better ability to compare results of technologies
  - Focus technology assessments on capacity, fueling, packaging, efficiency, cost, manpower and emissions

- **No single technology can currently address all waste streams**
  - Lithium batteries very problematic

- **If successful, W2E technologies may:**
  - Reduce volume of waste up to 95%
  - Reduce fuel use
    - Minimizes the logistics tail to deliver fuel
    - Minimizes the fully burdened cost of fuel
  - Help protect our people on the base

- **Need for further test and evaluation. Current W2E pitfalls include:**
  - Very complex systems
  - Might prove to be too expensive or time consuming
  - Require too much space and waste throughput to be technically feasible and operationally practical

Conclusion

- **DoD has policies and procedures in place to eliminate the use of burn-pits in contingency operations and to assess and mitigate health risks if a burn pit must be used due to operational constraints.**

- **Contracting solutions may provide better near-term return on investment than W2E technology**
  - There are challenges to overcome

- **However, on-base disposal technology equates to survivability**
  - Not opening up the base for waste removal helps protect those within the base

- **The Department continues to invest in test & evaluation of incinerator and other waste disposal technologies**
  - Collaborating with industry, federal agencies, and other organizations to develop feasible solutions that meet current and future operational requirements
  - Conducting demonstration/validation of W2E technologies in military relevant environments over next 2-3 years

Backup

Past NSRDEC WTE R&D Efforts

- **Past Research and Development**
  - Onsite Packaging and Food Waste Disposal
    - NSRDEC effort
    - Technology: Rijke tube pulse combustion
    - Funding: Army SBIR (topic A99-157)
    - FY99-00
    - Status: Successful Phase I, but not selected for Phase II

  - Mobile Integrated Sustainable Energy Recovery (MISER)
    - NSRDEC agent for DARPA Phase I
    - Technology: Supercritical water gasification
    - Funding: DARPA
    - FY04-06
    - Status: Did not meet objectives for energy recovery

  - Onsite Field-feeding Waste to Energy Converter (OFWEC)
    - NSRDEC effort
    - Technology: Downdraft gasification and bi-fuel power generation
    - Funding: Army SBIR (topic A04−211)
    - FY05-11
    - Status: Successfully demonstrated power generation from field waste at Fort Irwin

  - Solid Waste Preprocessor for Field Waste to Energy Conversion
    - ARL effort, NSRDEC collaboration
    - Technology: Shredder, dryer, pelletizer
    - Funding: Army SBIR (topic A05-037)
    - FY06-09
    - Status: Technology integrated into subsequent GEM, BWEC systems

  - High Energy Density Waste to Energy Converter (HEDWEC)
    - ARL effort, NSRDEC collaboration
    - Technology: Downdraft gasification
    - Funding: Alternative Energy Research Increase
    - FY09-12
    - Status: Did not meet NREL's performance objectives for demonstration at Hickam AFB

JOINT DEPLOYABLE WASTE TO ENERGY (JDW2E) EFFORT

- Defend the Homeland
- Fight Tonight
- Lead Rebalance
- **Drive Activities IAW TCO**
- Operationalize Theater C2
- Organizational Coherence/Climate

PROBLEM STATEMENT:

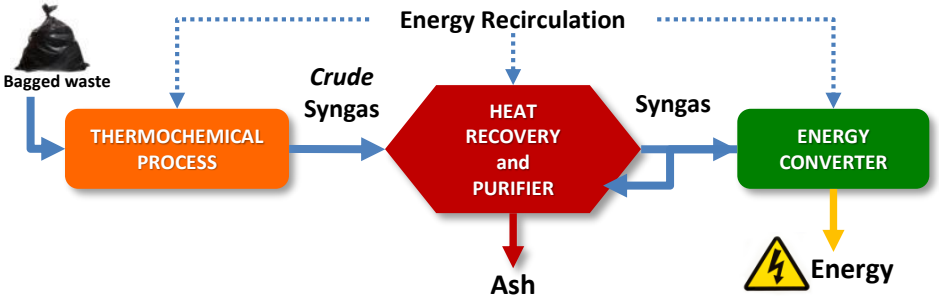
Current contingency base solid waste disposal practices are:

1. Financially expensive
2. Consume land area, energy, and manpower
3. Hazardous to human health and the environs
4. Do not re-use the energy content in waste
5. Cumulatively degrade mission effectiveness

NDAA 2010 §317 and **DoDI 4715.19** issued FEB 2013 prohibit plastic and other "covered waste" from burn pits. Requires Combatant Commanders to use alternate means of disposal or justify the absence of feasible solutions every 180 days for locations with >100pax for >90 days. **GAO-11-63** asserts that current DoD contingency waste disposal practices siphon security personnel from other tasks and pose significant health hazards. The Special Inspector General for Afghanistan Reconstruction (**SIGAR**) reports that current incinerators have been poorly designed and constructed, resulting in their significant underutilization.

MATERIEL SYSTEM DESCRIPTION:

Containerized, deployable, semi-autonomous system that takes bagged, non-hazardous solid and medical waste and reduces volume by over 90%, emits contaminants at or below current contingency base waste disposal practices. Expeditionary system recovers enough energy to power at least 50% of its own operation. Contingency system is able to export power.



REQUIREMENT:

- Materiel: Modular, tiered, interoperable systems to safely and efficaciously dispose of nonhazardous solid waste at U.S. DoD and coalition contingency bases, and re-use energy content and incorporate technological efficiencies at these scales:

Extra-Small	50-300pax	Tricon Size	< 1lb fuel/ 3 lbs waste
Small	300-1,999pax	Multiple Tricon(s)	< 1lb fuel/ 3 lbs waste
Medium	2,000-5,999pax	Multiple 20' CONEX(s)	Export Energy
Large	+ 6,000pax	Installation Size	Export Energy

Non-materiel:

- Joint Concepts of operations (CONOPS)
- Joint Tactics, Techniques, and Procedures (TTPs)
- Joint Planning Factors and Logistics Factor Files (LFF/LOGFACREP) data

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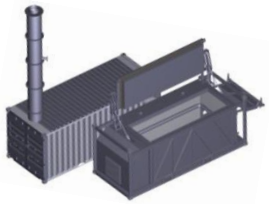
SAMPLE PROTOTYPES:



Dynamis™ for Tyndall AFB 2015

BWEC for FT Benning 2016

Operational Manager: **HQUSPACOM;** Assistant OM**: NAVFAC EXWC**

Technical Manager: **Natick Soldier Research Development and Engineering Center** (NSRDEC)

Transition Managers:

Force Sustainment Systems (PM FSS)

Air Force BEAR Base / Air Force Civil Engineer Center (AFCEC)

Navy Expeditionary Combat Command (NECC)

Defending America's Interests in the Indo-Asia-Pacific