ATTACHMENT 17

OB/OD TREATMENT EFFECTIVENESS, ALTERNATIVE TECHNOLOGIES AND WASTE MINIMIZATION

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1.0 TREATMENT EFFECTIVENESS

1.0.1 The following information is provided to demonstrate the effectiveness of open burning and open detonation (OB/OD) treatment of energetic wastes at the Tooele Army Depot (TEAD).

1.1 List of Candidate Wastes for OB/OD Treatment

1.1.1 TEAD, as a major Army depot, needs the capability to use OB/OD for the demilitarization of most of the conventional munitions (and associated energetics) in the Department of Defense (DoD) inventory. A discussion of candidate wastes and a representative list of candidate munition families and items are provided in Attachment 2 (Waste Analysis Plan), and in the June 1997 TEAD Implementation Plan.

1.2 Chemical and Physical Characteristics of the Waste

1.2.1 Chemical composition summaries for candidate waste munition families and items are provided in the June 1997 TEAD Implementation Plan. All of the candidate energetic wastes for OB/OD treatment at TEAD are in a solid (nonvolatile) form.

1.3 Comparison of the Volume of Waste Treated and the Amount of Residue Generated

1.3.1 Table 1 provides a comparison of gross OD treatment quantities (including donor charges) to shrapnel scrap tonnage from routine range clean-up operations at the OD area based on the latest available TEAD data (i.e., 1996). A typical donor charge NEW to waste NEW of 1:1 is used at TEAD. The collection of scrap shrapnel from the OD area generally occurs after each OD treatment day. Surface exposed shrapnel of 8-9 inches in diameter and larger or 10-15 lbs and heavier (e.g., scrap metal fragments and related items) are recovered from the OB/OD Unit.

Table 1 Comparison of TEAD OD Treatment Quantities and Residue Generated OD, 1996

Operation	Gross wt.	Net explosive wt.
OD Treatment[a]	20	5
Shrapnel recovery	NA[b]	NA[b]

[a] Does not include donor charge quantities. A typical donor charge NEW to waste NEW of 1:1 is used at TEAD

[b] NA = not applicable.

1.3.2 A comparison of the annual OB treatment quantity for TEAD with estimated ash residue amounts is summarized in Table 2. These data are based on OB treatment quantities for 1996 commensurate with the OB treatment data previously described. Two approaches were used to estimate OB ash quantities.

1.3.3 The first approach uses ash generation factors based on OB field tests conducted at Dugway Proving Ground (DPG) (U.S. Army, January 1992). These ash generation factors represent a unitless ratio of quantity of OB ash generated to the OB treatment quantity. Because only bulk propellants are treated by OB at TEAD, the NEW and gross treatment weights are equivalent. Ash generation factors (based on DPG tests and treatment of bulk propellants) ranged from 2.7E-4 to 1.8E-3 with an average of approximately 1.0E-3. The OB treatment quantity multiplied by the ash generation factor yields an estimate of the ash quantity.

1.3.4 The second approach used to estimate ash generation quantities is based on TEAD information. At TEAD, OB ash is usually placed in a 55-gallon drum at a satellite accumulation area. Typically it takes 2-3 years of OB operations to fill the drum. Based on these considerations, approximately 0.1 ton of ash is generated per year of OB treatment operations.

Table 2. Comparison of TEAD OB Treatment Quantities and Residue Generated OB, 1996

Operation	Quantity (tons)
OB Treatment	111[a]
Ash residue recovery	
• Based on DPG generation factor	
+ Range	0.03–0.20
+ Average	0.1
• Based on TEAD observational information	0.1

[a]Because only bulk propellants are treated by OB at TEAD, the NEW and gross treatment rates are equivalent.

1.4 Mass Balance of Treatment Effectiveness

1.4.1 Information presented in the previous sections provides one measure of the effectiveness of treatment. The ratio of the amount of residue generated to the gross treatment quantities for OB and OD is presented in Table 3. The OD results are based on the ratio of total shrapnel to the gross treatment quantity (the quantity of recovered shrapnel was not available). These data indicate a relatively low residue generation rate and, thus, a high level of treatment effectiveness.

Table 3. Summary of Mass Balance of Treatment Effectiveness

Operation	Ratio of residues generated to gross treatment quantity
OB (based on ash generation)	
• Based on DPG ash generation factor	
+ Range	2.7E-4-1.8E-3
+ Average	1.E-3
• Based on TEAD observational information	
OD (based on total shrapnel but does not include donor charges))	7.5E-1

BangBox OB/OD emission test results can also be used to evaluate the treatment effectiveness of OB and OD (U.S. EPA, March 1998). The BangBox study data evaluation report concludes that the low conversion of nitrogen (N) to oxides, the high conversion of carbon (C) to carbon dioxide (CO_2) and carbon monoxide (CO), the absence of emission products with molecular weights larger than those of the energetics treated and the extreme dominance of low molecular weight organic compounds (low toxicity) demonstrate the treatment effectiveness of OB/OD. A summary of C and N conversion factors for OB/ and OD treatment is presented in Table 4.

Table 4. Summary of C and N Conversion Rates for OB/OD Based on BangBox Test Results (U.S. EPA, March 1998)

	Conversion rates	
Treatment type	% C as $CO+CO_2$[a]	% N as $NO+NO_2$[b]
OB		
• Ammonium perchlorate-based propellants	96	1.0
• Organic-based propellants	95	0.3
OD		
• Bulk explosives	104[c]	1.5
• Suppressed (buried) detonations	81	2.4
• Encapsulated explosives	104[c]	3.6

[a]A high rate of C conversion to CO and CO_2 is indicative of a high level of treatment effectiveness.

[b]A low rate of N conversion to NO and NO_2 (which are potential harmful air pollutants) is indicative of a high level of treatment effectiveness.

[c]Values of greater than 100% are attributed to data accuracy limitations.

Particulate (PM-10) average emission factors based on the BangBox results range from 0.016 (for OB treatment of organic-based propellants) to 0.26 for encapsulated explosives (U.S. EPA, March 1998). These data are summarized in Table 5.

Table 5. Summary of Particulate (PM 10) Emission Factors for OB and OD Based on BangBox Test Results (U.S. EPA, March 1998)

Treatment type	PM 10 emission factor (wt. emitted/wt. treated)
OB	
• Ammonium perchlorate-based propellants	0.059
• Organic-based propellants	0.016
OD	
• Bulk explosives	0.060
• Suppressed (buried) detonations	0.110
• Encapsulated explosives	0.260

In general, OB/OD does not destroy constituents. Therefore, we assume that the output quantity of metal emissions/residues is equivalent to input quantity of metals in the waste treated.

1.5 Deactivation Effectiveness

1.5.1 OB/OD soil and shrapnel reactivity tests (using the zero gap test and internal ignition test) have been conducted at TEAD. The test results indicate that OB/OD soils and shrapnel were not explosive. These results were provided in Appendices C.1 and C.2 of the June 1997 TEAD Implementation Plan (see U.S. Army, August 1992; U.S. Army, undated).

1.6 Demonstration of Treatment Effectiveness

1.6.1 Information presented in Section 1 provides various measures of OB/OD treatment effectiveness. The emphasis of this section is on the effectiveness of OB/OD to destroy energetic compounds.

1.7 OB/OD Destruction and Removal Efficiency

1.7.1 Deactivation effectiveness for OB and OD will be based on a destruction and removal efficiency (DRE) factor similar to that used to characterize the performance of hazardous waste incinerators. The DRE values for OB/OD can be calculated as follows:

$$DRE_{Energetics} = (1.0 - EF_{Energetics})\ 100 \qquad \text{Eq.2-1}$$

where

DRE	=	Destruction and removal efficiency for energetics (percent)
$EF_{Energetics}$	=	Total emission factor for energetics based on available OB/OD emission tests (dimensionless)

1.7.2 Soil and shrapnel energetic reactivity tests conducted by TEAD also confirm the effectiveness of OB/OD treatment. These tests included use of the zero gap test and internal ignition test developed by the U.S. Bureau of Mines for explosive reactivity determination. TEAD test results indicated that soils and shrapnel at the OB/OD Unit are not reactive.

1.7.3 A summary of DRE results based on the BangBox OB/OD test (U.S. EPA, March 1998) is presented in Table 6. The available DRE test results indicate a consistent pattern of high DRE values (which approach the performance of a hazardous waste incinerator).

Table 6. Summary of OB/OD Destruction and Removal Efficiency (DRE) Based on BangBox Test Results (U.S. EPA, March 1998)

Treatment type	DRE (percent)
OB	
• Ammonium perchlorate-based propellants	99.9999+
• Organic-based propellants	99.9999+
OD	
• Bulk explosives	99.725
• Suppressed (buried) detonations	99.9999+
• Encapsulated explosives	99.9697

1.8 Non-detection of Energetics

1.8.1 The non-detection of energetics in OB/OD residues can be used as a screening basis to determine treatment effectiveness. However, the detection of energetics in OB/OD residues does not necessarily indicate reactivity. In addition, the non-detection criterion is not applicable since energetic waste is not a listed waste.

1.8.2 Typically, energetic concentrations must be greater than 10% to be considered reactive, based on U.S. Army tests. As discussed in Sections. 1.5 and 2.1, OB/OD soil and shrapnel reactivity tests (using the zero gap test and internal ignition test) have been conducted at TEAD. The test results indicate that OB/OD soils and shrapnel are not reactive. These results were provided in Appendix C of the June 1997 TEAD Implementation Plan (see U.S. Army, August 1992; U.S. Army, undated).

1.9 OB Ash Residue Analysis

1.9.1 Available OB ash analytical data for TEAD are provided in Attachment 2 (Waste Analysis Plan). These analytical results indicate that energetic concentrations are significantly below the 10% reactivity criteria.

1.10 Waste Residues

1.10.1 Retreatment of OD ejecta and OB kickouts is based on visual inspection and generator knowledge of munitions specialists. Similarly, visual inspection and generator knowledge of munition specialists is used to verify that any OD scrap metal that will be shipped off site is nonhazardous. The OB ash residues are subject to the waste analysis test for metals and energetics as specified in Attachment 2 (Waste Analysis Plan) to determine if OB wastes being disposed off-site are hazardous. Because of the low volume of OB ash and waste stream consistency, it is expected that these tests will be conducted every 3 years.

2.0 ALTERNATIVE TECHNOLOGIES

2.0.1 The current alternatives to open burning and open detonation (OB/OD) treatment for the demilitarization of waste munitions in large quantities are rather limited and can be characterized as follows:

- Disassembly of munition items to reduce the gross weight subject to further treatment.
- Removal of the inert portions of munition items prior to treatment or conversely the removal of energetics prior to subsequent treatment. This approach may also involve the application of disassembly technologies.
- Thermal treatment at a deactivation furnace or energetic waste incinerator (EWI).

2.0.2 The available alternatives, however, do not provide a universal substitute for OB/OD treatment at this time. These current technologies all have significant safety, technical, and cost factors, which limit their applicability on a munition-specific and site-specific basis. The configuration of some munition items does not facilitate the disassembly and/or removal of inert portions prior to treatment. The type and energetic content of munitions can also limit the use of deactivation furnaces and EWIs.

2.0.3 TEAD uses alternative technologies to OB/OD whenever technically and economically practical, and worker safety is not jeopardized. These alternatives include disassembly, removal of energetics, and thermal treatment technologies.

2.0.4 Special purpose equipment is needed to support the disassembly of munitions and removal procedures for demilitarization. The equipment needed may have to be designed specifically for various munition types. TEAD designs and manufactures ammunition peculiar equipment (APE) for this purpose. The equipment is used to support on-site as well as Department of Defense (DoD) demilitarization needs at other installations.

2.0.5 A deactivation furnace (APE 1236 furnace) at TEAD is used for the treatment of waste small arms ammunition (up to and including 30 mm) as well as other small items such as fuzes and small quantities of bulk propellants. Use of the furnace is limited by its treatment capability and treatment limits imposed by this Permit. Additional information on the TEAD deactivation furnace is provided elsewhere in this Permit.

2.0.6 The U.S. Army established the Munitions Items Disposition Action System (MIDAS) Program to provide a central source of demilitarization and disposal information for munition items. The system can also be used to identify alternatives to OB and OD treatment. Following are the current five thrust areas for emergency demilitarization technologies derived from the MIDAS Program:

- Destructive technologies (e.g., molten metal technology, contained burns with scrubbers, and pyrotechnic incinerators).
- Disassembly technologies (e.g., advanced munitions cutting and disassembly technologies).
- Resource recovery and recycling (e.g., use of energetic material derived fuels in boilers).
- Removal technologies (e.g., high pressure water washout of large rocket motors).
- Waste stream treatment technologies (e.g., hydrothermal processing of energetic materials).

2.0.7 These emerging technologies, however, are still in the research and development phase and not available as an alternative to routine OB/OD operations at TEAD.

3.0 WASTE MINIMIZATION

3.0.1 Further demilitarization needs of the DoD may result in significant variability of gross waste munitions quantities (especially at major Army Depots such as TEAD). However, TEAD has established a waste minimization program to reduce the relative quantity and associated toxicity of waste that would require OB/OD treatment. This is accomplished by the use of disassembly/removal (pull-apart) technologies as well as the deactivation furnace as appropriate. The decision on the applicability of each of these waste minimization technologies is based on munition specific safety, technical, and cost factors.

3.0.2 TEAD conducts munitions pull-part operations at Building 1375. This facility has about 80,000 square feet of space available with a monorail system. The configuration of the pull-apart operations and APE equipment used varies based on the specific munitions items to be demilitarized. Metal casings and other inert components may be separated (for resource recovery and recycling) from the energetics. Also, in some cases, fuzes and or primers may be removed for thermal treatment in the deactivation furnace. Also, small arms ammunition and small quantities of bulk propellants may also be treated in the deactivation furnace to reduce OB/OD treatment quantities.

3.0.3 In addition, TEAD conducts routine OD shrapnel collection operations as a resource recovery and recycling measure.

3.0.4 A summary of the treatment quantities for OB/OD and waste minimization alternatives is presented in Table 7. This table is based on the latest available TEAD operations data.

Table 7. TEAD Waste Munitions Quantities, 1996

	Quantity (tons)	
Operation	Gross	Net explosive weight
Pull-apart process	396[a]	74
Deactivation furnace	158	4
OB treatment	111	111
OD treatment[b]	20	5
Shrapnel recovery	Not Available	Not applicable

[a] Approximately 160 tons of the total were recovered metals which were used for resale and reuse.

[b] Does not include the donor charge quantities. A typical donor charge NEW to waste NEW of 1:1 is used at TEAD.

4.0 REFERENCES

U.S. Army, January 1992. Final Report: Development of Methodology and Technology for Identifying and Quantifying Emissions Products from Open Burning and Open Detonation Thermal Treatment Methods. U.S. Army Armament, Munitions and Chemical Command, Rock Island, IL.

U.S. Army, August 1992. Explosive Sensitivity of Soils and Metal Fragments at TEAD OB/OD Grounds. Tooele Army Depot, Tooele, UT. (Appendix C.1 of the June 1997 TEAD Implementation Plan.)

U.S. Army, Undated. Detonation Ground Soils & Explosive - Contaminated Metal Have No Reactivity Characteristics Under RCRA Hazardous Waste Regulations. Tooele Army Depot, UT. (Appendix C.2 of the June 1997 TEAD Implementation Plan.)

U.S. EPA, March 1998. Documentation for Validated OB/OD BangBox Emission Factor Database (Draft). U.S. Environmental Protection Agency, Research Triangle Park, NC.