4.7.5 Effectiveness of Treatment

Based on BangBox and full scale field testing, the effectiveness of OB/OD treatment is dependent on a number of factors:

Types of Method: In general, OD results in slightly greater destruction and removal efficiency (DRE) for energetics than OB (although DREs for either type of method exceed 99 percent). The principal reason for this is that OD results in less residue in the unit following treatment. (The mechanism for greater DRE is secondary combustion in the fireball resulting from the detonation as well as ejected material.) For example, the detonation of trinitrotoluene (TNT) results in a DRE of 99.9996 percent with the residue consisting of 2.4-dinitrotoluene and soot. Approximately 2 percent of the OD residue was recovered within 225m of the detonation site. Open burning of propellants containing 2.4-dinitrotoluene result in DREs of between 99.9 and 99.98 percent.

Type of Energetic: Energetic materials with a higher oxygen content resulted in higher DREs. That is, molecules that contained most of the oxygen required for complete combustion have higher conversion efficiencies. For example, OB of propellants containing 2.4-dinitrotoluene resulted in DREs of between 99.9 and 99.98 percent, whereas OB of a triple base propellant containing nitroglycerine and nitroguanidine resulted in DREs of 99.9997 and 99.9998 percent, respectively. In general, propellants have higher oxygen balances and resulting conversion efficiencies than explosives.

Interaction with Soil: The presence of soil interferes with the flame zone for OB or the flow of ambient air into the fireball region of the detonation for OD. For this reason, use of burn pans for OB results in higher flame temperatures and correspondingly higher DREs. Similarly, suspended detonations of explosive result in higher DREs than surface OD. Further evidence of the mechanism of secondary combustion can be found in the higher DREs of fallout material. For example, although the DREs for OB of propellants containing 2.4-

dinitrotoluene is between 99.9 and 99.98 percent, the DREs rise to between 99.9996 and 99.9991 percent in the fallout material, indicating secondary propellant conversion and destruction is occurring in the smoke plume from the burning propellant.

Although OD generally results in less residue in the treatment unit than OB, BangBox testing indicates that OB combustion products are more completely treated or converted than OD combustion products. Open detonation results in 97 percent of the carbon in the explosives being converted to carbon dioxide whereas OB results in greater than 99.6 percent conversion to carbon dioxide. Similarly, higher percentages of carbon monoxide, volatile organize compounds (VOC), semivolatile organic compounds (SVOC), and soot are generated by OD than by OB. (The soot undoubtedly contains "exotic" polynuclear aromatic compounds combustion product such as acenaphthene as well as other high molecular weight compounds.)

Comparison between BangBox and full-scale field test data indicate that the conversion of TNT carbon to carbon dioxide is more efficient under the controlled conditions of the BangBox than in large-scale detonations in the field. Specifically, more VOCs are generated under field conditions than in BangBox Testing . However, SVOC generation appears to be very similar under either BangBox or full-scale testing conditions.

Because combustion products may be present as residues in the treatment unit or ejected soils, the collection and analysis of sample is required to characterize contaminants and determine the concentrations of compounds in the treatment residue for subsequent management and disposal. In general, OB/OD will render energetic materials nonreactive. (The Bureau of Mines reactivity test classifies energetic concentrations of 30,000 mg/kg or less as not reactive.)

The Region 9 Preliminary Remediation Goals (PRGs) present health based criteria for potential contaminants. SW 846 Methods 8320 and 8330 determine the concentrations of 14 energetic

compounds for soil and water. Method 8330 uses ultraviolet detection whereas Method 8320 uses mass spectrometry.

For mechanical units, sampling and analysis of the output streams can be used to demonstrate treatment effectiveness. Permit applicants managing containers in mechanical units such as drum crushers and washers will need to demonstrate that the containers meet the definition of "empty" per 40 CFR §261.7.