TA 16

DEPARTMENT OF ENERGY
National Nuclear Security Administration
Los Alamos Site Office
Los Alamos, New Mexico 87544

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NMED Hazardous Waste Bureau

Mr. John Kieling
Permits Management Program
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6303

Subject: Transmittal of Protocol for Air Dispersion Modeling at Technical Area (TA) 16 and Alternatives Analysis for Open Burning at Los Alamos National Laboratory (LANL)

Dear Mr. Kieling:

This letter transmits information for the open burning units TA-16-388 and 399 at LANL. Enclosure 1 of this submittal includes an air dispersion modeling protocol for the TA-16 open burning units. Enclosure 2 contains a discussion on alternatives to open burning.

Enclosure 1 contains information on emission factor development, air modeling protocol, and risk-based screening values. This submittal was described in a letter from Anthony Grieggs, Los Alamos National Security, LLC (LANS), to you dated March 14, 2007. If no comments on this protocol are received before April 14, 2007, LANL will proceed with the modeling as outlined and submit a full air dispersion modeling package by May 28, 2007.

Enclosure 2 discusses options for open burning of high explosives wastes. This analysis was requested initially in a notice of deficiency for the TA-16 Part B Resource Conservation and Recovery Act (RCRA) Permit Application, dated December 24, 2001. LANL responded to this query with information on a study that had been conducted in 1994. A second notice of deficiency for the TA-16 Part B RCRA Permit Application, received in July 2002, requested an assessment of available literature on alternative technologies and on the feasibility of each method related to the relevant waste streams at LANL. In the August 2002 response to the second notice of deficiency, an assessment of alternatives was included. Enclosure 2 updates and expands on open burning alternatives that were included in the previous responses to the notices of deficiency.

If you have any questions or comments about this submittal please contact me at (505) 667-5794 or Jack Ellvinger, LANS at (505) 667-0633.

Sincerely,

Gene Turner
Environmental Permitting Manager

EO: 2GT-033

Enclosures

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Enclosure 2

Open Burning Alternatives Assessment

LA-UR-07-1904

Approved for public release; distribution is unlimited.

Title: Update to Assessment of Open Burning Alternatives for Los Alamos National Laboratory

Author(s): Water Quality & RCRA Group
Los Alamos National Laboratory

March 2007

Intended for: New Mexico Environment Department- Hazardous Waste Bureau

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Form 836 (7/06)

OPEN BURNING ALTERNATIVES

1.0 INTRODUCTION

Los Alamos National Laboratory (LANL) provided information on alternatives to open burning in the August 2002 Response to Second Notice of Deficiency (NOD). This document provides an update on alternatives LANL has evaluated and/or implemented since the response to the NOD was submitted. Please also refer to the NOD for technologies that have already been reviewed; they are not revisited in this document (e.g., base hydrolysis, supercritical water oxidation, zero-valent iron).

Section 2 describes the alternatives that LANL has been actively implementing. Section 3 describes other technologies, primarily funded by the Joint Demilitarization Technology Program (JDTP).

2.0 RECENT ALTERNATIVE IMPLEMENTATION

LANL chooses alternatives based on the following hierarchy:

- The best waste alternative is to avoid producing the waste (waste minimization).
- Second best is to reclaim/reuse waste materials.
- The least effective alternative is to simply treat it by an alternate method.

Therefore, LANL has expended considerable effort to minimize or reclaim/reuse wastes, making significant progress over the past decade in reducing the amounts of HE wastes treated by open burning. Figure 1 illustrates the success of this effort. This section describes recent alternatives implementation. In keeping with the alternatives hierarchy, they rely heavily on waste elimination and recycle/reuse.

Press to Shape: Nearly half of the waste treated at the TA-16 Burn Ground is currently wet HE waste from machining. Over the past several years, LANL has been developing methods to press explosives lenses to their final complex shape using metal dies instead of machining the HE into the final shape. Explosive lenses constitute about 30 percent of the machining work load. If successful, this project would eliminate approximately 90 percent of the waste from manufacturing lenses.

Solvent Recovery: In 2005, LANL began to operate a solvent recovery system for a process generating the highest quantity of HE-contaminated solvents treated at the TA-16 Burn Ground. This project has eliminated that waste stream. After recovery, the solvents are reused in experimental processes.

Combustibles Waste Minimization: Over the past several years, the TA-16 Burn Ground team has worked extensively with waste generators to better segregate their combustible wastes. Now, generators segregate combustibles contaminated with non-detonable quantities of HE from those with detonable quantities of HE. Non-detonable combustibles are treated at an off-site incinerator as an administrative, non-hazardous

waste. Incineration is not required but is used as a best management practice to ensure that no explosives are disposed in the sanitary landfill. This process has significantly reduced the combustible hazardous waste stream requiring treatment at the TA-16 Burn Ground.

Non-Combustible Waste Minimization: Non-combustible waste is primarily generated during decommissioning of HE buildings and equipment. Generators work with explosives experts to segregate materials into detonable and non-detonable waste. Only the detonable materials are flashed. Non-detonable materials are treated by alternative methods, such as steam cleaning. Segregation has reduced the amount of non-combustibles requiring flashing by thousands of pounds a year.

Bulk HE Waste: The use of recovered/recycled cyclotetramethylenetetranitramine (HMX) in munitions offers the opportunity for substantial savings since its cost is projected to be approximately half of virgin HMX. However, prior to its use in munitions, its safety and sensitivity must be determined along with its ability to be processed in selected formulation. LANL has participated in a JDTP-funded effort to assess changes in particle size distribution and mechanical strength. There are significant differences in these factors that are being further studied by JDTP. LANL will continue to track the progress of this study to determine whether reuse of HMX has potential in the nuclear stockpile.

Off-Site Alternatives: If no way could be found to eliminate or recycle/reuse the waste stream, LANL has searched for off-site alternatives. For example, propellants are now treated at an off-site incinerator. However, LANL rejected the alternative of shipping HE off-site because:

- Greater overall emissions result because the waste would have to be shipped considerable distances, resulting in air emissions from trucks that would carry the waste.
- The HE would be shipped on public roads thereby posing a safety concern for the public.
- Off-site facilities cannot handle all HE waste streams, resulting in continuing need for the TA-16 Burn Ground.

3.0 OTHER ALTERNATIVES

Research on alternatives to open burning and open detonation is funded on a national scale by the JDTP. It is an interagency effort (including both Department of Defense (DoD) and Department of Energy (DOE)) dedicated to the development of safe, efficient, and environmentally acceptable processes for the treatment of munitions. Funding is currently about $10 million per year. JDTP-funded projects have focused on large-scale waste treatment, mainly at Department of Defense (DoD) munitions facilities that treat million of pounds a year of HE waste. These alternative treatment technologies are not completely replacing OB/OD. Rather, they are targeted at specific high throughput waste streams with high environmental risk. For example, Crane Army Ammunition Facility is

using an incinerator for ammunition with high lead content that causes environmental risk. But the bulk of HE treatment is still taking place in OB/OD units.

LANL tracks the development of these alternatives. The most promising of those technologies are discussed in this section. Others, still being tested for their efficacy for treating explosives are being tracked but will not be seriously evaluated until their capabilities and costs are better defined. Some technologies (e.g., ultraviolet treatment, biotreatment, photocatalysis) are targeted at wastewater, a waste stream not treated at the TA-16 Burn Ground. Improvements in bioremediation technologies (e.g., composting and vitrification) are appropriate to environmental restoration. They are not discussed as alternatives to open burning because environmental restoration wastes are not significant waste streams treated at the TA-16 Burn Grounds. Other technologies are specific to DoD ammunition wastes. For example, a number of the projects involve removal of shells (e.g., by metal acid dissolution) or extraction of HE (e.g., trinitrotoluene melting) from shells so that the separated ammunition components can be sent to different treatment facilities. These are not technologies applicable to TA-16 Burn Ground wastes.

When analyzing the candidate alternatives, LANL evaluates the following:

- the types of wastes treated - the more types of wastes the more desirable the technology,
- interferences and/or impediments to treatment, which may render an otherwise acceptable alternative unusable, and
- cost.

Another important consideration is that the technology should not create a waste more difficult to treat than the original waste stream or more toxic to the environment or employees. For example, base hydrolysis (discussed in the NOD) resulted in a waste stream that was still HE contaminated and was highly corrosive. It required burning, burned less efficiently than the original waste stream, emitted pollutants not in the original waste stream, and its corrosivity increased danger to workers during handling. LANL also avoids alternatives that require shipment of detonable wastes on public roads and alternatives that require significant pre-processing of HE before a technology can be applied. For example, some alternatives require that explosives wastes be finely ground to provide sufficient surface area for chemical reactions to occur. Grinding of detonable waste streams is hazardous to workers and facilities.

LANL reviewed the available technologies and identified as potential technologies: conversion of HE to fertilizer, detonation chambers, thermal treatment (incinerators and confined burn facilities), and molten salt. Table 1 summarizes which waste streams the technology can and cannot treat, the possible limitations of the technology, and the qualitative cost (high, medium, or low). Detailed cost estimates are expensive to perform, so very gross cost estimates were obtained verbally from vendors. Vendors could only provide the capitol costs of the equipment. Installation costs will vary by location and facility, usually being high for high capitol cost equipment and low for low capitol cost equipment. Complex equipment would also be expected to have high operating costs. For example, incinerators or rotary furnaces with control equipment

would pose high electrical demands and would require costly electrical upgrades. A small fertilizer conversion unit would have low electrical demand.

3.1 Conversion to Fertilizer

A technology currently under review by JDTP is the Actodemil® technology, which can convert some explosives into a material that can be used as a fertilizer. The key reactant is a proprietary agent. The reaction is carried out in a reaction vessel operating at atmospheric pressure and at a temperature of 160 to 180 $^{\circ}$ Fahrenheit. In theory, following completion of the reaction, the product is neutralized with phosphoric acid and is ready for application as a fertilizer or safe disposal. Unfortunately, this technology has not been tested on plastic-bonded explosives. The manufacturer's concern is that plastics will not degrade and will result in a product too sticky to be used as a fertilizer. Funding to further study this technology is being provided by the JDTP in 2007 and 2008.

If the technology is shown to work on plastic-bonded explosives, this technology may be of interest to LANL: the capitol costs should be <$500,000, it can be installed in existing laboratory space, and the temperatures are low enough that electrical demands are low. The equipment is small and simple, resulting in low operating costs. In addition, as a reclaim/recycle technology, it would rate higher on the LANL hierarchy (reclaim/recycle) than a treatment-only technology. A shortcoming of this technology is that Actodemil® will not handle most of the waste streams currently treated at Burn Ground. Also, if the LANL Press to Shape project is successful, the amount of wet HE remaining may not warrant an alternative technology. Finally, if dissolution of all types of HE is not complete a waste stream similar to the base hydrolysis waste stream may exist, requiring treatment at the TA-16 Burn Grounds. LANL will continue to track the testing of this technology.

3.2 Detonation Chambers

Detonation chambers are being used by DoD to destroy ammunition. It is a system with high capitol, installation, and operating costs. It has limited usefulness because it can treat only dry bulk HE, which is currently a negligible waste stream at the TA-16 Burn Ground. It also requires additional HE as fuel, potentially requiring more pressing of fuel with its attendant wastes. The high cost of this system is not warranted because it cannot treat a significant stream.

3.3 Thermal Treatment Alternatives

Thermal treatment alternatives consist primarily of incinerators, including rotary furnaces, and contained burn units. Incinerators and rotary kilns are being used to demilitarize a wide variety of small arms ammunition and munition components. The capacity of these facilities is limited to reduce impacts from detonations. For example, the Dynasafe Static Kiln has a limit of 4 lb of high explosive per load. The El Dorado Engineering rotary kiln incinerator handles a maximum of 5 lb charges of TNT. Incinerators and rotary furnaces operate at high temperatures, typically above 1500

degrees Centigrade (°C). Capitol costs are high (millions of dollars), as are installation costs. Due to the high temperatures that must be achieved, operating costs are high and the complex equipment requires extensive ongoing maintenance. State and federal environmental requirements (e.g., stack testing and monitoring) also drive up the costs of permitting and operating these units. Due to explosions, the life expectancy of these units is fairly short, requiring refurbishment or replacement. Another significant drawback of this technology is that the public is strongly opposed to incineration. As a result of these factors, this is not considered a viable alternative.

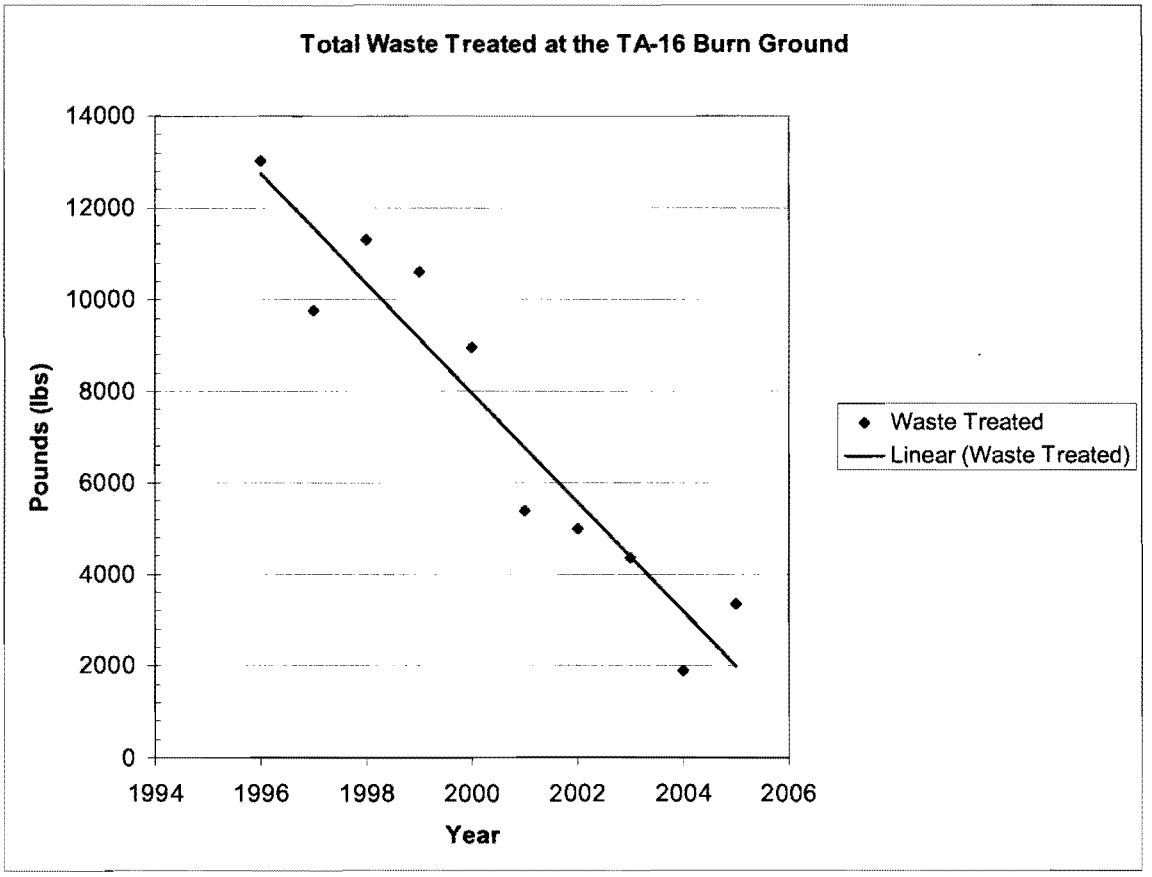
Contained burn technology allows thermal treatment of energetic wastes that do not require external fuel for treatment (e.g., bulk dry HE). The DoD is considering using this technology for burning missile rocket motors. Burns typically take place in a containment vessel or tank with added combustion air. The vessel walls and doors must be designed to withstand the effects of a maximum credible blast. Each item in a contained burn batch must have its own ignition system. After ignition, the waste should burn unassisted. Because there is no "controlled flame device" contained burn facilities can be permitted as RCRA, Subpart X miscellaneous treatment units rather than incinerators. Combustion gases are contained and after pressure and temperature are reduced, they can be routed to an air pollution control system. While contained burn facilities have lower capitol costs and potentially less stringent permitting requirements, they are not an attractive alternative for wastes treated at the TA-16 Burn Ground because most burns require supplemental fuel to optimize burning. The only type of waste they can treat would be bulk HE, not currently a significant waste stream at the TA-16 Burn Ground.

3.4 Molten Salt

The molten salt oxidation process consists of introducing wastes and oxidizing air into a vessel containing a bed of molten salts. The salt oxidizes organic constituents in feed materials to carbon dioxide and water and retains inorganic constituents in the molten salt bed. The molten salt must be maintained at 500 – 1100 °C. The molten salt technology has high capital (millions of dollars) and operating costs. Its main disadvantage is that it can treat only finely divided HE waste streams. It may be able to treat the wet HE without pre-processing but other materials would require significant size reduction (e.g., bulk HE or combustibles) through processes such as grinding before they could be treated, which greatly increases the risk of a detonation. The technology cannot treat non-combustibles. The technology is further limited in use for LANL because the salt is poisoned by chlorine, a common constituent of binders in LANL HE. Based on the high cost and limited usefulness, this technology is not being considered as an alternative.

Table 1. Other Technology Evaluations

Technology	Treatable waste streams	Untreatable waste streams	Limitations	Relative Costs
• Actodemil® Fertilizer Technology	• Wet HE	• Bulk HE • Combustibles • Non-combustibles • Solvents	• Binders may result in product too sticky to use as fertilizer	Low
• Detonation chamber	• Dry HE	• Wet HE • Combustibles • Non-combustibles • Solvents	• Can't treat any of the currently significant waste streams • Requires additional HE for fuel	High
• Incineration	• Combustibles • Solvents • Wet HE • Small bulk HE	• Large bulk HE • Non-combustibles	• Can't treat all wastes • Public opposition to incineration	High
• Contained Burn Technology	• Bulk HE	• Combustibles • Non-combustibles • Solvents • Wet HE • Small bulk HE	• Can't treat any of the currently significant waste streams	High
• Molten Salt	• Wet HE	• Bulk HE • Combustibles • Non-combustibles • Solvents	• Interference of chlorine in binders (converts salt to NaCl)	High



Note - Non-combustible materials are not included in this trend because they do not burn.

Figure 1. Waste Treated at the TA-16 Burn Ground

CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Richard S Watkins

3/27/07

Richard S. Watkins
Associate Director
Associate Directorate Environment, Safety, Health, & Quality
Los Alamos National Laboratory
Operator

Date Signed

Daniel E Glenn

3/29/07

Daniel E. Glenn
Acting Manager, Los Alamos Site Office
National Nuclear Security Administration
U.S. Department of Energy
Owner/Operator

Date Signed

Enclosure 1

TA-16 Burn Ground Air Pathway Assessment Protocol

LA-UR-07-1986

Approved for public release;
distribution is unlimited.

Title: Technical Area (TA) 16 Burn Ground Air Pathway Assessment Protocol

Author(s): Water Quality & RCRA Group

March 2007

Intended for: New Mexico Environment Department- Hazardous Waste Bureau

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Form 836 (7/06)

TA-16 Burn Ground Air Pathway Assessment Protocol

1.0 INTRODUCTION

The Technical Area 16 (TA-16) Burn Ground consists of two units operating under Resource Conservation and Recovery Act (RCRA) interim status:

- the TA-16-399 Burn Tray, which is used to treat bulk dry high explosives (HE) and
- the TA-16-388 Flash Pad, which is used primarily to treat wet HE, combustibles, or other HE-contaminated materials using an external heat source (propane).

The location coordinates of open burn pads are: Universal TransMercator (UTM) Zone 13, UTMH 379740 meter, UTMV 3967730 meter based on NAD 27 projection. The elevation of the facility is 7200 feet (ft) above sea level.

When the TA-16 Part B Permit Renewal Application was submitted in June of 2003, open burning impacts from the treatment of RCRA wastes were covered under New Mexico Environmental Department's Open Burning Regulation (20.2.60 NMAC). The TA-16 RCRA application referenced the air permit as the means of regulating air emissions impacts. The Open Burning regulation changed in 2003, excluded all burning activities covered under RCRA and the Open Burning permit for the TA-16 Burn Ground was withdrawn. Therefore, LANL will be submitting an air quality impacts analysis to support the TA-16 Part B Permit Renewal Application. This modeling protocol discusses how the air quality impacts estimates will be performed in accordance with The Environmental Protection Agency's (EPA's) Draft Final Open Burning/Open Detonation Permitting Guidelines (EPA, 2002b, hhttp://epa.gov/reg3wcmd/OBOD_Guidelines.pdf), referred to hereinafter as the EPA OB/OD Permitting Guidelines and as advised by the New Mexico Environment Department Hazardous Waste Bureau (NMED-HWB).

Section 2 of this document describes the air quality limits to be used to evaluate air quality impacts. Section 3 describes the proposed emission factors and Section 4 explains the selection of the air quality model and its input. Section 5 includes reference for this protocol.

2.0 AIR QUALITY LIMITS

According to the EPA OB/OD Permitting Guidelines, compliance with ambient air quality standards (AAQS) should be evaluated by determining the maximum offsite exposure. The maximum onsite and offsite exposures should be evaluated for toxic air pollutants.

2.1 Ambient Air Quality Standards

The NMED and EPA have ambient air quality standards (AAQS) for total suspended particulate matter (TSP), particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM10), lead, sulfur compounds, carbon monoxide, and nitrogen dioxide. If both NMED and EPA have limits for the same compound, the lowest limit will be used.

Several standards will be eliminated for the following reasons:

- The sulfur compounds with AAQS include sulfur dioxide (SO_2), hydrogen sulfide, and total reduced sulfur. Only SO_2 AAQS were used in this analysis because hydrogen sulfide and total reduced sulfur are not emitted by open burning.

- There is also a federal standard for ozone but the dispersion models for OB sources do not simulate photochemical reactions and ozone formation impacts are not considered significant (EPA, 2002b).

- Two NMED AAQS, the 7-day and 30-day TSP standards, are intended to prevent the nuisance effects from sources of coarse particulate matter (e.g., rock crushers). The New Mexico Air Quality Bureau's (NMAQB) air quality modeling guidance does not require modeling for these two averaging periods. Therefore, they will not be modeled.

2.2 Toxic Air Pollutant Screening Levels

EPA's OB/OD Permitting Guidelines (EPA 2002b) suggest evaluating both long-term (chronic and cancer) and short-term (acute) risk-based impacts:

> Long-term impacts are to be evaluated using the EPA Region 9 Preliminary Remediation Goals (PRGs) (see http://www.epa.gov/region9/waste/sfund/prg/files/prgtable2004.xls under the AIR-H2O worksheet). According to the OB/OD Permitting Guidelines, if modeled impacts do not exceed one tenth (0.1) of the PRGs, then a human health risk assessment for the air pathway is not warranted. If both a chronic and cancer PRG are listed for a pollutant, the cancer PRG will be used because they are lower.
>
> Short-term impacts are to be evaluated using the acute (1 hr) inhalation exposures (AIE) from the Companion Database to EPA's Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities (EPA, 1998a, http://www.epa.gov/Region6/6pd/rcra_c/protocol/protocol.htm). This database includes all of the other acute inhalation sources of information listed in Section 4.1.4 of the OB/OD Permitting Guidelines.

3.0 EMISSION FACTORS FOR OPEN BURNING

This section describes the types of waste streams, the sources of emission factors, and proposed emission factors for each waste stream. The proposed emission factors for pollutants that had air quality limits described above are shown by waste type. No emission factors are shown for pre-treatment and post-treatment emissions such as fugitive dust because no equipment operates off-road, earth-moving operations are not part of the OB/OD activities, and ash generation is negligible.

3.1 Emission Factors for TA-16-399

TA-16-399 burns only HE. The maximum amount of HE that can be burned at this unit is 1000 lb/burn. The types of HE treated at the TA-16 Burn Ground vary depending primarily on research and development (R&D) and stockpile stewardship activities. The primary types of HE treated are cyclotetramethylenetetranitramine (HMX), 1,3,5 triamino 2,4,6 trinitrobenzene (TATB), trinitrotoluene (TNT), and cyclonite (RDX).

Emission factors are not available for all of these explosives. TNT is the least oxygenated and, therefore, the HE that burns less completely ("dirtier") than others treated at the TA-16 Burn Ground. Criteria pollutant emission factors for burning TNT are available in Chapter 6, Section 3, Table 6.3-1 of EPA's Compilation of Air Pollutant Emission Factors (AP-42). The TNT emission factors section can be accessed at http://www.epa.gov/ttn/chief/ap42/ch06/final/c06s03.pdf).

There are no toxic air pollutant emission factors for TNT in AP-42; therefore, the emission factors available from the Open Burn/Open Detonation Dispersion Model (OBODM) User's Guide (EPA, 1998b, http://www.epa.gov/scram001/userg/nonepa/obodmvol1.pdf) for burning types of HE similar to those burned at the TA-16 Burn Ground were reviewed. Emission factors for the detonation of HE are not used because detonation has processes such as fragment formation that do not occur during burning. The types of materials in the EPA document that would be most similar to those treated at LANL are:

- M-43, which contains RDX,
- PBXN-110, which contains HMX, and
- M31A1E1, a mixture of explosives.

These explosives contain a number of contaminants that would not be present in LANL HE; however, no attempt will be made to eliminate non-characteristic emissions from this analysis. Instead, they will be used as published to provide a conservative emissions estimate. The highest pollutant-specific emission factor for any of the three explosives that has a corresponding air quality limit will be used to provide a worst-case emission factor. Table 3-1 summarizes the emission factors used in grams (g) of pollutant per g of waste (g/g) and identifies the HE of origin. The contaminants listed are those that had an emission factor and an AAQS, AIE, and/or PRG.

Table 3-1. Emission Factors for Burning HE

Contaminant	Highest EF (g/g)	Source of EF
Barium	4.20E-07	M31A1E1
Benzene	4.88E-06	PBXN-110
Benzyl alcohol	1.91E-09	M31A1E1
1,3-Butadiene	4.98E-07	PBXN-110
Carbon Monoxide	2.80E-02	TNT
Carbon tetrachloride	6.89E-08	M31A1E1
Chloromethane (methyl chloride)	2.84E-07	M31A1E1
Chromium	3.97E-07	M31A1E1
Cyclohexane	9.07E-08	M31A1E1
Dibutyl phthalate	3.30E-07	M31A1E1
1,1-Dichloroethylene (vinylidene chloride)	2.15E-07	M31A1E1
Diethyl phthalate	6.58E-08	M31A1E1
Ethylbenzene	7.96E-07	PBXN-110
Ethyl chloride	6.89E-08	M31A1E1
Hexane	9.07E-08	M-43
Hydrogen chloride	9.97E-04	M-43
Methylene chloride	7.46E-07	M31A1E1
Nitrogen Dioxide	7.50E-02	TNT
Particulate Matter	9.00E-02	TNT
Styrene	2.57E-07	M31A1E1
1,1,1-Trichloroethane (methyl chloroform)	3.44E-08	M31A1E1
Toluene	5.44E-07	M-43
1,2,4-Trimethylbenzene	4.25E-07	PBXN-110
1,3,5-Trimethylbenzene	2.99E-07	PBXN-110
Vinyl chloride	2.23E-07	PBXN-110
Xylenes	1.67E-06	M31A1E1
Zinc	4.14E-07	M31A1E1

EF = emissions factor

3.2 Emission Factors for TA-16-388

Materials burned at TA-16-388 may consist of pure HE or HE-contaminated combustible solids, liquids, or non-combustibles. The maximum amount of burnable material that can be treated on TA-16-388 is 250 lb/burn. A worst-case emission factor is suggested to represent a combined waste stream. The emission factors suggested for pure HE are shown in Section 3.1. The waste-specific emission factors suggested for the other waste streams are described below. Then, a worst-case combined emission factor is derived from all of the waste streams. Propane is used to burn HE-contaminated materials and its emission factors are shown separately.

3.2.1 Emission Factor for Combustible Solids

Emission factors from the Diesel and Dunnage category in the OBODM's User's Guide (EPA, 1998b, http://www.epa.gov/scram001/userg/nonepa/obodmvol1.pdf) are suggested for this waste category. The Diesel and Dunnage waste consisted of scrap wood, dead branches from trees and shrubs, Styrofoam ™ packing material, other combustibles, and diesel fuel. These emission factors, shown in Table 3-2, should be much higher than for LANL combustibles, which in contrast are characterized by dry waste, no vegetation, no diesel, high heating value from the HE in the waste, and clean supplemental fuel (propane burners).

Table 3-2. Emission Factors for Burning Combustible Solids

Contaminant	EF (g/g)	Contaminant	EF (g/g)
Acenapthene	6.71E-06	Dimethyl phthalate	1.88E-07
Acetophenone	1.74E-07	Ethylbenzene	5.49E-05
Aluminum	7.13E-07	Fluoranthene	7.85E-07
Anthracene	1.02E-07	Hexane	1.60E-05
Barium	1.61E-07	Indeno[1,2,3-cd]pyrene	2.83E-07
Benzene	7.84E-05	Methylcyclohexane	1.56E-04
Benzo[a]anthracene	9.81E-07	Napthalene	8.38E-05
Benzo[b]fluoranthene	7.84E-07	Nitrogen Dioxide	5.07E-05
Benzo[k]fluoranthene	7.46E-07	Particulate matter	5.44E-03
Benzo[a]pyrene	7.42E-07	Phenanthrene	7.17E-06
Benzyl alcohol	3.96E-05	Phenol	1.56E-05
1-3-Butadiene	1.34E-06	Pyrene	7.06E-07
Butyl benzyl phthalate	1.22E-07	Styrene	4.99E-05
Carbon monoxide	2.98E-02	Sulfur Dioxide	1.88E-04
Chrysene	9.33E-07	Toluene	1.22E-04
Cyclohexane	2.67E-05	1,2,4-Trimethylbenzene	2.43E-04
di-n-Octyl phthalate	9.19E-07	1,3,5-Trimethylbenzene	5.57E-04
Dibenz[ah]anthracene	2.00E-07	Xylenes	5.77E-04
Dibutyl phthalate	1.46E-07	Zinc	6.26E-05
Diethyl phthalate	7.00E-08		

EF = emissions factor

3.2.2 Emission Factors for Open Burning of Liquids

This waste stream historically consisted of oils and solvents contaminated with HE. Due to changes in processes and better waste characterization, this waste stream has decreased considerably over the past few years. Oils are not expected to be treated in the future unless they result from a spill that comes into contact with significant quantities of HE. This waste stream is expected to consist primarily of solvents with high HE content (usually greater than 25 percent) from research operations.

No emission factors were identified for burning HE-contaminated liquids. Therefore, the emission factors for burning fuel oil in Emissions of Organic Air Toxics from Open Burning, (EPA,2002a, http://www.epa.gov/nrmrl/pubs/600r02076/600sr02076.pdf) were used. Fuel

oil is not as refined a petroleum product as the solvents used in HE research so the fuel oil emission factors should be conservative. These emission factors did not contain the AAQS pollutants. For these, the emission factors in Booher and Janke (1997) were used.

3.2.3 Non-Combustible Solids

Non-combustible solids contaminated with HE consist primarily of metal piping, equipment, concrete, or soil generated during decommissioning and environmental restoration activities. If these contain HE in sufficient quantities to detonate (e.g., HE present at thicknesses greater than the critical diameter for a specific HE) they must be flashed. Because the non-combustible materials themselves don't burn, the only emissions result from the burning of the HE. The emission factors for this waste stream are the same as those described in Section 2.1.

3.2.4 Dioxin/Furan Emission Factors

Dioxins and furans are formed from burning almost any kind of material, including forest fires, residential wood combustion, and residential oil heating (EPA, 1997a, http://www.epa.gov/ttn/chief/le/dioxin.pdf). Dioxin/furan formation is favored by low excess air and low temperatures (EPA, 1997b, http://www.ejnet.org/dioxin/dioxinpr2.pdf). Because HE burns hot, with considerable oxygen in the fuel and a good air supply from the ambient air, dioxin/furan formation from the TA-16 Burn Ground should be minimal.

No emission factors were identified for dioxin/furan formation from burning HE or HE-contaminated wastes. Recent measurements taken during the detonation of explosives cartridges (AP-42, Section 15, http://www.epa.gov/ttn/chief/ap42/ch15/index.html) show that total dioxin/furan emission factors range from zero to a few parts per billion per pound of material detonated. However, the detonation mechanism is different than burning. To provide a very conservative estimate, the OB/OD User's Guide emission factors for the burning of an Ammonium Perchlorate (AP) Propellant (EPA, 1998b) were used. This waste consisted of 25.87 percent chlorine (EPA, 1998c). AP is not treated at the TA-16 Burn Ground and the amount of chlorine in AP is quite high compared to wastes that are treated at the TA-16 Burn Ground. These emission factors, shown in Table 3-4, were assumed to apply to all waste streams treated, even those with no chlorine.

3.2.5 Emission Factors for Open Burning of Propane

Propane is burned to improve combustion of HE-contaminated waste streams. A typical burn uses two burners at a time for approximately 1 hour. Each burner consumes approximately 25 gal an hour (200 lb). Emissions from burning the propane are additive to the emissions from burning the waste. The emission factors were obtained from Chapter 1.5, Table 1.5-1 of AP-42 (http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s05.pdf). No toxic air pollutant emission factors were located, but propane is a very clean-burning fuel and products of incomplete combustion should be minimal. Emission factors are shown in Table 3-5.

Table 3-3. Emission Factors for Open Burning of Fuel Oil

Contaminant	EF (g/g)	Contaminant	EF (g/g)
Acenaphthene	1.00E-05	Fluoanthene	2.00E-05
Acetaldehyde	6.30E-05	Fluorene	1.00E-06
Acetone	3.50E-05	Formaldehyde	3.03E-04
Acrolein	3.90E-05	Indeno[1,2,3-cd]pyrene	5.00E-06
Anthracene	1.50E-05	Methyl ethyl ketone	1.30E-05
Benzaldehyde	1.04E-04	Methyl isobutyl ketone	1.10E-05
Benzene	1.02E-03	Napthalene	1.62E-04
Benzo[a]anthracene	5.00E-06	Nitrogen dioxide	1.20E-05
Benzo[a]pyrene	5.00E-06	Particulate matter	2.00E-01
Benzo[b&k]fluoanthene	7.00E-06	Pyrene	2.00E-06
Carbon monoxide	9.00E-02	Sulfur dioxide	2.50E-03
Chrysene	9.00E-06	Toluene	4.20E-05
Crotonaldehyde	6.00E-06	1,2,4- Trimethylbenzene	3.20E-05
Ethylbenzene	1.00E-05	Xylenes	2.50E-05

EF = emissions factor

Table 3-4. Emission Factors for Dioxins and Furans

Contaminant	Constituent	EF (g/g)	Total EF (g/g)
Dioxin	1234678-HpCDD	1.49E-12	**1.49E-12**
Furan	Octochlorinated dibenzo-p-dioxin (OCDD)	2.99E-11	**1.25E-10**
	Total heptachlorinated dibenzofurans (HpCDF)	4.55E-11	
	Total hexachlorinated dibenzofurans (HxCDF)	2.53E-11	
	Total pentachlorinated dibenzofurans (PeCDF)	1.64E-11	
	Total tetrachlorinated dibenzofurans (TCDF);	7.47E-12	

EF = emissions factor

Table 3-5. Emission Factors for Propane

Contaminant	EF (lb/1000 gal)	EF (lb/lb = g/g)[b]
Carbon Monoxide	1.9E+00	2.38E-04
Nitrogen Dioxide	1.4E+01	1.75E-03
Sulfur Dioxide[a]	1.80E-02	2.25E-06
Particulate Matter	4.00E-01	5.00E-05

EF= Emissions Factor
[a] Based on a sulfur content of 0.18 grains/100 cubic feet.
[b] Assumes a density of 8 lb/gallon per Ferrell Gas

3.3 Combined Worst-Case Emission Factor

The highest emission factor for each contaminant was selected from all of the wastes burned. Table 3-6 shows the contaminant, the waste type that had the highest emission factor, and the emission factor from the tables above.

Table 3-6. Worst-Case Emission Factors for Combined Wastes

Contaminant	Waste Type	EF (g/g)
Acenaphthene	liquids	1.00E-05
Acetaldehyde	liquids	6.30E-05
Acetone	liquids	3.50E-05
Acrolein	liquids	3.90E-05
Aluminum	combust	7.13E-07
Anthracene	liquids	1.50E-05
Barium	HE	4.20E-07
Benzaldehyde	liquids	1.04E-04
Benzene	liquids	1.02E-03
Benzo[a]anthracene	liquids	5.00E-06
Benzo[a]pyrene	liquids	5.00E-06
Benzo[b&k]fluoanthene	liquids	7.00E-06
Benzyl alcohol	combust	3.96E-05
1-3-Butadiene	combust	1.34E-06
Butyl benzyl phthalate	combust	1.22E-07
Carbon monoxide	Liquids	9.00E-02
Carbon tetrachloride	HE	6.89E-08
Chloromethane (methyl chloride)	HE	2.84E-07
Chromium	HE	3.97E-07
Chrysene	liquids	9.00E-06
Crotonaldehyde	liquids	6.00E-06
Cyclohexane	combust	2.67E-05
Dibenzo[ah]anthracene	combust	2.00E-07
Dibutyl phthalate	HE	3.30E-07
1,1-Dichloroethylene (vinylidene Cl)	HE	2.15E-07
Di-n-octyl phthalate	combust	9.19E-07
Diethylphthalate	combust	7.00E-08
Dimethyl phthalate	combust	1.88E-07
Dioxin	all	1.49E-12
Ethylbenzene	combust	5.49E-05
Ethyl chloride	HE	6.89E-08
Fluoanthene	liquids	2.00E-05
Fluorene	liquids	1.00E-06
Formaldehyde	liquids	3.03E-04
Furan	all	1.25E-10
Hexane	combust	1.60E-05
Hydrogen chloride	HE	9.97E-04
Indeno[1,2,3-cd]pyrene	liquids	5.00E-06
Methylene chloride	HE	7.46E-07
Methylcyclohexane	combust	1.56E-04
Methyl ethyl ketone	liquids	1.30E-05
Methyl isobutyl ketone	liquids	1.10E-05
Napthalene	liquids	1.62E-04
Nitrogen dioxide	HE	7.50E-02
Particulate matter	liquids	2.00E-01
Phenanthrene	Combust	7.17E-06
Phenol	combust	1.56E-05
Pyrene	liquids	2.00E-06
Styrene	combust	4.99E-05
Sulfur dioxide	liquids	2.50E-03
Toluene	combust	1.22E-04
1,1,1-Trichloroethane (methyl chrloroform)	HE	3.44E-08
1,2,4-Trimethylbenzene	combust	2.43E-04
1,3,5-Trimethylbenzene	combust	5.57E-04
Xylenes	liquids	5.77E-04
Vinyl chloride	HE	2.23E-07
Zinc	Combust	6.26E-05

EF = emissions factor
Combust = combustible solids

4.0 DISPERSION MODELING PROTOCOL

This section justifies the dispersion model used and provides information on the source-specific input parameters, the meteorological data set, and receptors.

4.1 Dispersion Models

Two dispersion models have been considered for application to the TA-16 burn permit, the OBODM and CALPUFF. For application to open burn sources at LANL, one must consider the complex terrain of the Pajarito Plateau, the surrounding Jemez Mountains, and the adjacent Class 1 area, Bandelier National Monument. The complex terrain has a dramatic effect on the wind fields, which drive the dispersion of pollutant sources. While the OBODM would seem a logical choice, there are several assumptions and limitations in OBODM that result in CALPUFF being the better model for the TA-16 Burn Ground.

OBODM does not treat complex terrain in a rigorous manner and only allows for a simplistic representation of the local meteorology. OBODM has a complex terrain *screening* procedure, and its limitations are stated in the documentation (Bjorklund et.al. 1998). OBODM treats the terrain in an approximate manner by calculating a "blocking factor" for the wind field and resultant pollutant transport. The basis for this approximation is rooted in stationary industrial stack dispersion analysis. The OBODM model was developed at the US Army Dugway Proving Ground, where the terrain is relatively flat, with isolated hills or small mountains. The terrain at LANL is more complex and thus OBODM is deemed inappropriate to compute the complex wind fields present at LANL. If a model does not produce an accurate wind field, then any dispersion analysis will not be meaningful.

CALPUFF computes the wind fields (streamlines) around the terrain (mountains) and thus the pollutants are transported and deposited in a realistic manner in response to the terrain. There are three different methods to incorporate the terrain in CALPUFF, and we propose using the Complex Terrain algorithm for Sub-Grid scale features (CTSG) methodology. This method imports the Digital Elevation Model (DEM) data directly into the model. The CTSG accepts the flow field produced by the flow model (CALMET), including the wind and temperature structure) in the vicinity of the terrain feature as the incident flow toward that feature. It then proceeds to simulate the changes in the flow and the rate of dispersion that are induced by that terrain feature. At the core of CTSG is the modeling approach adopted in CTDM, the complex terrain model developed in EPA's Complex Terrain Model Development program. CTSG is designed to produce a puff algorithm that contains those elements of the CTDM approach that have the greatest impact on ground-level concentrations. (Scire *et.al.* 2000)

With regard to the buoyant plume rise formulation, both OBODM and CALPUFF are based on the Briggs formulation (Briggs 1970, 1971, 1973, 1975), and are considered equal with respect to capturing the source term buoyancy effects of open burns.

Finally, the Burn Ground does not operate continuously. To provide a conservative estimate of ground level concentrations, we propose simulating 2 1-hour burns per day, 5 days per week. CALPUFF can use full terrain and meteorological input for non-continuous sources. However, the OBODM can only be used in a screening mode for non-continuous operations, not fully able to use on-site terrain and meteorology (Heath et.al., 2006).

Based on the above factors, CALPUFF, version 5.711a, is a better model for determining ambient air quality impacts for the TA-16 Burn Ground than the OBODM.

4.2 Meteorology and Source-Specific Input

Meteorology: The 1995 local meteorological dataset approved by NMAQB for use at LANL will be used to conduct this modeling analysis. The modeling analysis will be conducted using complex terrain modes in the CALPUFF modeling system.

Hours of Operation: The open burning of high explosives only occurs during the workday, 0800-1700 local time in the summer, and 0900-1600 in the winter. The duration of the burn is typically less than 1 hour. For modeling the TA-16 Burn Ground, we will simulate a 1-hour burn.

Source Temperature: Pure high explosives burn without supplemental fuel at about 1000 degrees Centigrade (^{o}C) (1832 degrees Fahrenheit (^{o}F)) to 3000 ^{o}C (5432 ^{o}F). HE-contaminated materials are treated using propane burners to improve burning. The burners are designed to operate at approximately 750 ^{o}C (1300 ^{o}F). To provide a conservative estimate of ground level concentration, LANL proposes using the lower temperature, 750 ^{o}C, in the source term definition. By using the lower temperature the buoyant lofting of the source will be minimized, which will lead to higher ground level concentrations.

Other Sources: LANL will include nearby sources using a data set approved by NMED for previous air permit modeling.

4.2 Receptors

LANL is situated on the Pajarito Plateau of the Jemez Mountain range located in north-central New Mexico. The local geography is rugged with elevations generally declining from 7800 ft near the western boarder to 6800 ft along the eastern boarder. As shown in Figure 1, the plateau is striated with narrow canyons that can be several hundred feet deep. Two residential communities are located at the LANL border, Los Alamos on the north with approximately 11,000 residents and White Rock on the east with approximately 7,000 residents. The nearest residential receptors for most facilities at the laboratory, including the burn pad, live at the Royal Crest Trailer Park, which is located inside of the greater LANL perimeter. Other neighboring lands include Santa Fe National Forest to the west and north, Bandelier National Monument to the south, and the San Ildefonso Pueblo to the east. Recreational access is permitted in most regions of the Santa Fe National Forest and the

Bandelier National Monument. Public access is not allowed in neighboring land belonging to the San Ildefonso Pueblo, and the area is presently unoccupied. Because of open public access to most of the LANL boundary, potential offsite doses to an individual will be reported at all points on or beyond the site boundary where ground-level maximum concentrations are predicted to occur; however, most peak concentrations are expected to remain on site.

The following receptor grids will be used in this study:

- A grid with receptors with 100-meter spacing within the Laboratory property boundary and within 500 meters of the Laboratory fence line
- A medium receptor grid with a resolution of 250 meters extending from (1) to a distance of 3 km
- Additional discrete receptors at public areas such as Royal Crest, hospitals, Bandelier visitor center, Ponderosa Campground, etc.

If any location shows a concentration greater than 75% of an applicable ambient standard, additional receptors with 100-meter spacing will be added in the vicinity of the maximum. For complex terrain modeling analyses, the receptor elevations will be determined from DEM data, as shown in Figure 1.

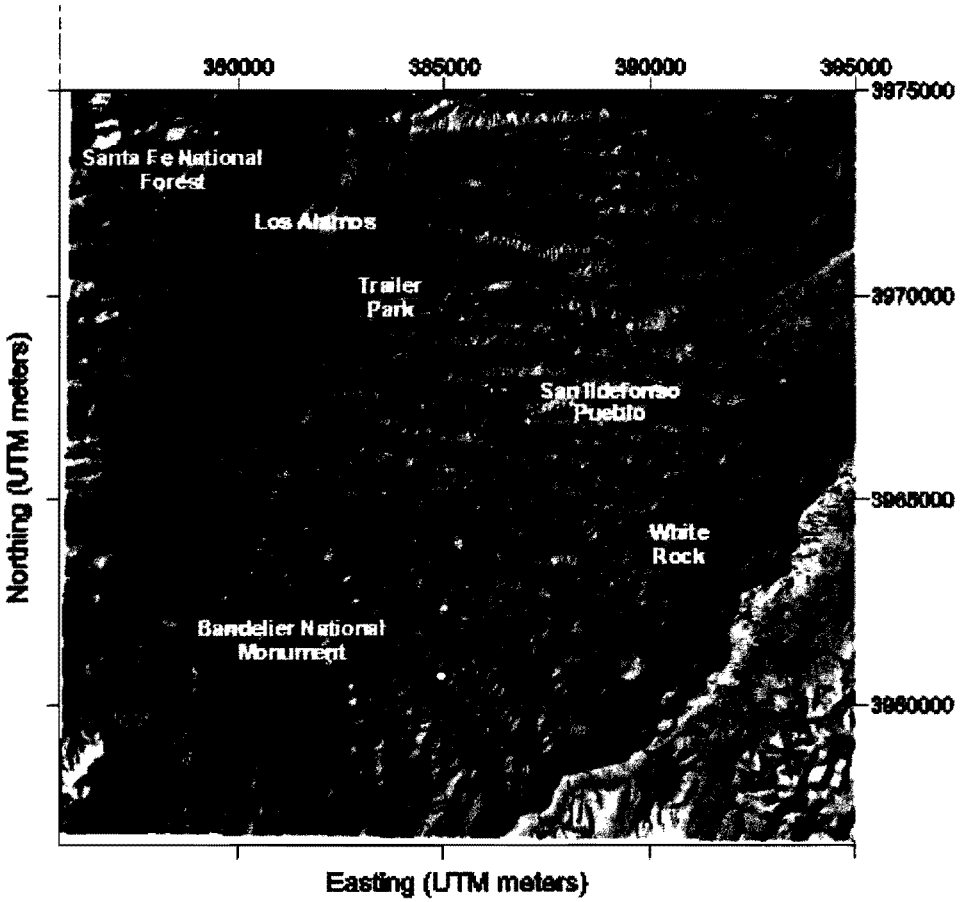

Figure 1: Siting of Los Alamos National Laboratory (green boundary) and burn pad (red box) relative to residential communities and public recreation areas. Four, primary meteorology stations are also shown (red circles).

5.0 REFERENCES

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