Department of Energy
Albuquerque Operations Office
Office of Los Alamos Site Operations
Los Alamos, New Mexico 87544

TA-16

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

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

Dear Mr. Will:

Subject: Response to "Notice of Deficiency; TA-16 Part B Application Revision 3.0, January 31, 2000," Los Alamos National Laboratory, EPA I.D. NM0890010515

The purpose of this letter is to provide the Department of Energy (DOE) and University of California (UC) response to the subject Notice of Deficiency (NOD) issued by the Hazardous Waste Bureau of the New Mexico Environment Department on December 21, 2001. DOE received the NOD on December 26, 2001. The NOD requested additional information regarding a Resource Conservation and Recovery Act (RCRA) Part B permit application submitted to support the renewal of the LANL Hazardous Waste Facility Permit issued on November 8, 1989. The original document contained hazardous waste management plans and information for Technical Area 16 and is entitled "*Los Alamos National Laboratory Technical Area 16 Part B Permit Renewal Document,*" Revision 3.0, January 2000.

This submittal consists of a response to the twelve comments contained in the NOD. It also includes supplemental information attachments as referenced in the comment responses. A certification statement is provided for this document as a revision of the original permit application. Two additional copies of the submittal and an electronic copy of the response have been included. The original submittal date for this document was amended to February 26, 2002 by your letter of January 29, 2002, approving the extension requested by DOE/UC on January 17, 2002.

Please note that DOE and UC are requesting further discussion with your office regarding the issues contained in Comment Nos. 3 and 12 of the NOD. We believe that meeting together after your review of the proposed response would most quickly resolve those issues.

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If you should have any questions or concerns regarding this submittal, please feel free to contact Gene Turner, DOE, at (505) 667-5794 or Gian Bacigalupa, UC, at (505) 667-1579.

Sincerely,

Joseph C. Vozella
Acting Associate Director
Office of Facility Operations

OFO:3GT-021

Enclosure

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LA-UR-02-0890
February 2002

Response to Notice of Deficiency; TA-16 Part B Application Revision 3.0, January 31, 2000

Prepared by:

Los Alamos National Laboratory
Hazardous and Solid Waste Group (ESH-19)
Los Alamos, New Mexico 87545

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ATTACHMENT A

Notice of Deficiency
TA-16 Part B Application Revision 3.0, January 31, 2000

December 21, 2001

Introduction

The following information is the response by Los Alamos National Laboratory (LANL) to a Notice of Deficiency (NOD) sent by the New Mexico Environment Department (NMED) on December 21, 2001. The full title of the NOD is "Notice of Deficiency; TA-16 Part B Application Revision 3.0, January 31, 2000," officially received by the U.S. Department of Energy (DOE) Los Alamos Area Office (LAAO) on December 28, 2001. The NMED required that the comments described in the NOD (Attachment A) be resolved in order for the "Los Alamos National Laboratory Technical Area 16 Part B Permit Renewal Document," Revision 3.0 (LANL, 2000a), submitted to the NMED in January 2000, to be evaluated for technical adequacy. Hereinafter, the permit renewal document will be referred to as "the application".

This document consists of responses to the 12 comments contained in the NOD. As stated in the December 24, 2001, NOD letter to Dr. John C. Browne, Director, LANL, and Mr. David A. Gurulé, Area Manager, DOE LAAO, from James P. Bearzi, Chief, NMED Hazardous Waste Bureau (HWB), the required response was to be submitted to the HWB within 30 days of receipt of the NOD. However, due to the effort necessary to obtain information and develop this response, a letter requesting a 30-day extension was approved by Mr. Carl Will, NMED HWB, on January 29, 2001.

This document includes appendices with information to supplement the individual responses to the numbered comments. NMED's original comments are included in this document as italicized text for ease of review. A copy of the original NOD is also included as Appendix A.

Discussion

This document contains responses to Comment Nos. 3 and 12 that include the suggestion to meet further with the HWB to resolve issues associated with the comments. The resolution of these issues involves comparison of technical factors or regulatory interpretations and the basis for NMED's positions is not included in the comments. It is believed that these issues would be most easily resolved by meeting after LANL's position has been presented in this response due to the complexity of the issues and the need to quickly address potential consequences and resolutions through the regulatory process.

NOD Comments and Responses

1. *Submit the following information to document compliance with 20.4.1.700 NMAC (incorporating 40 CFR Part 265, Subpart P):*

   a. *information regarding the quantity and physical and chemical characteristics specific to TA-16 waste treated at Open Burn units sufficient to determine risk from deposition of air emissions and ash. This information must contain significantly more detail on the waste than that included in the General Part B Permit Application Waste Analysis Plan. Include the halogen content in the waste and concentrations of lead and mercury in the waste [20.4.1.700 NMAC (incorporating 40 CFR § 265.375)];*

Waste Quantities: The quantities of high explosives (HE) and HE-contaminated wastes treated at the Technical Area (TA) 16 Burn Ground vary from year to year, depending on changes in operations and on the types of research conducted. One of the major factors contributing to wastes flashed is decontamination and demolition of old HE-processing buildings. A factor in the amounts and types of bulk HE burned is the retirement of certain weapons. Research and development usually results in only gradual changes in waste types and amounts. Table 1 in Appendix B of this response lists the quantity of wastes treated by structure over the most recent 5-year period for which data have been summarized. Data from 2001 are currently being tabulated and will be provided upon request.

The structures on which wastes are treated have changed over the years. For instance, flashing took place on TA-16-387 and is now conducted on TA-16-388. HE-contaminated oil/solvent burns occurred on TA-16-394, which has been clean closed under the Resource Conservation and Recovery Act (RCRA). These burns now occur on TA-16-388. The amount of combustible waste was reduced to the extent that the industrial incinerator (TA-16-1409) was no longer needed; it has also been clean closed under RCRA. To simplify the following discussion, the wastes are described by the structure on which they are now treated.

Waste Characteristics and Air Emissions: The characteristics of the wastes change for the same reasons that the quantities change. Therefore, in the "Los Alamos National Laboratory General Part B Permit Application", Revision 1.0 (LANL, 1998a), all anticipated hazardous constituents were listed in Table B-6. It was noted in that table that many of the constituents would be present only in trace amounts or might not be present at all. The compositions of wastes treated in the future should be similar, although not identical.

The source used by LANL to determine emission factors for open burning is "Emission Factors for the Disposal of Energetic Materials by Open Burning and

Open Detonation (OB/OD)", *EPA/600/R-98/103* (Environmental Protection Agency [EPA], 1998). A copy of this report is contained in Appendix C of this response. While the types of explosives studied were military, the findings are applicable to the TA-16 Burn Ground operations because the HE components of the waste and the treatment processes are the same or similar. The emissions for each waste type are discussed below.

HE-Contaminated Solid Materials (TA-16-388): Table 2 in Appendix B of this response summarizes materials flashed at TA-16-388 in 2000. This waste stream is very heterogeneous, and quantities and compositions vary from year to year. Some wastes, such as rags used to wipe down oil from HE-machining equipment and cardboard contaminated with HE, are treated every year. Others (such as HE-contaminated soil with polyvinyl chloride [PVC] primer from a spill) occurred and were treated in 2000, but would not typically appear every year.

The TA-16 Burn Ground air permit allows for up to 50 pounds (lbs) of combustibles for each flash burn on TA-16-388 and a total of 36 burns per year, for an annual total of 1,800 lbs (0.90 tons) of combustibles. Plastics included in this total would primarily be polyethylene plastics, which do not contain chlorine. Small amounts of PVC plastics and Lexan could be burned if they became contaminated. However, PVC and Lexan are not often used directly in contact with HE during HE processing and this waste stream is not generated in large quantities. *EPA/600/R-98/103* had no tests that were similar to the TA-16-388 flashing of combustible materials. The most similar waste stream was the Aluminized Propellant Manufacturing Waste Surrogate (AP Waste) Burn. The waste composition of this burn was 65 percent (%) aluminized propellant (AP, containing 19% aluminum, 21% chlorine, 10% carbon, 4% hydrogen, 8% nitrogen, 38% oxygen, and less than 1% phosphorous); 20% plastic material (gloves, polyethylene); 11% paper/wood/cloth; and 4% diesel fuel. No dioxins were detected from this test. Furans were detected and are addressed in LANL's response to Comment No. 6.d. A conservative factor in applying the results from the AP Manufacturer's Waste is that no outside fuel sources, such as the propane burners, were used. As a result, the temperatures were much lower and the chlorine content much higher than would be expected on the TA-16-388 flash pad. The low temperatures and incomplete burning resulted in chlorinated volatile organic compounds (VOC), furans, and semivolatile organic compounds (SVOC). Therefore, the Emission Factors for the Open Burning of Municipal Refuse (Table 2.5-1) and the Polycyclic Aromatic Hydrocarbon Emission Factors from the Open Burning of Agricultural Plastic Film (used plastic, forced air) (Table 2.5-8) in EPA's "Air Pollutant Emission Factors" (EPA, 1995), were used to estimate emissions from burning at TA-16-388. The emission factors and emissions for combustible flashing operations at TA-16-388 are shown in Table 3 of Appendix B in this NOD response. AP-42 is available at http://www.epa.gov/ttn/chief/ap42/index.html.

There are no emission factors available for metals that are flashed. The temperature at the tip of the flame of the propane burners for TA-16-388 is approximately 700 degrees Centigrade (°C). Table 4 in Appendix B of this response shows the melting points and boiling points for toxic metals that may be treated at the TA-16 Burn Ground. The metals for which the boiling point was near 700 °C would be assumed to volatilize and are given an emission factor of 1.0 lb emitted per lb present in the waste. *EPA/600/R-98/103* measured emissions from one open burn with lead, the Double-Based Propellant described in Study 6 of that document. The emission factor provided was 5.3 E-3 lbs lead emitted/lb lead in the material burned at flame temperatures that would have been 2000 °C or greater. This would be an overestimate for higher boiling point metals treated on TA-16-388 at lower temperatures and in more monolithic solids, but was used as a conservative estimate for all of the metals with boiling points greater than 800 °C.

<u>HE-Contaminated Oils/Solvents Treated at TA-16-388</u>: Table 5 in Appendix B of this response provides a summary of the hazardous non-HE constituents in oil/solvent waste treated at TA-16-388 in 2000. The waste profile forms (WPF) from which these data were extracted are presented in the Oil/Solvent Characterization portion of Appendix D of this response. These WPFs represent current documentation of the waste streams and are subject to replacement if generator knowledge changes.

-There are no data on the efficiency of burning oils and solvents at TA-16-388. However, opacity (visible emissions) during burning is so low based upon the operator's observation during burn events that it is likely that combustion efficiency is high. For air emissions of solvents, it was assumed that the burners would have 95% combustion efficiency, with the other 5% being emitted as the parent chemical. The same assumptions for metals were made as described above. Because acids and bases don't "burn," they were assumed to fume and be emitted as the parent acid/base. Emissions calculations, shown in Table 6 of Appendix B in this response, were made using the waste constituents described in Table 5 (see Appendix B of this response).

<u>Bulk HE (TA-16-399, -401, and –406)</u>: Table 7 in Appendix B of this response describes the most common types of bulk HE that may be treated at TA-16-399, -401, and -406. The compounds listed in Table 7 represent the HE that was treated in 2000. HE waste streams generated by research and development operations will vary. LANL will treat waste streams that have a detonation rate greater than 0.33 kilometers per second at sea level and bulk military propellants that can not be otherwise treated safely, as required by the New Mexico Administrative Code, Title 20, Chapter 4, Part 1 (20.4.1 NMAC) § 265.382. The main source of halogens in materials treated at the TA-16 Burn Ground are binders used in explosives. The compositions of binders for explosives are shown in Table 8 of Appendix B in this response. Table 9 in Appendix B of this response summarizes the total halogens in explosives burned in 2000.

The M31A1E1 Triple-Based Propellant Trials described in Study 6 of *EPA/600/R-98/103* is closest to the types of explosives used at LANL. Air emission factors for open burning (OB) of this explosive are summarized in Table 10 of Appendix B in this response. A number of other VOCs were analyzed, including chlorinated VOCs; they were either not detected or detected below background. Importantly, breakdown products of the explosives ring compounds such as toluene, xylene, nitrotoluenes, and nitrobenzenes were not found. The report concluded that for both OB and open detonation (OD), "the emission products from most energetic materials destroyed by OB and OD processes will be adequately represented by the following analytes: CO_2, CO, NO, NO_2, total saturated hydrocarbons (e.g., ethane, propane, butane), acetylene, ethylene, propene, benzene, toluene, and particulate." The report also noted that, consistent with theory, molecules larger than the starting molecules are not formed. Analyses for SVOCs were conducted; none were detected. The extensive target analyte list is contained in Appendix B of the EPA report (see Appendix C of this response). The emission factors shown in Appendix C of the report are a small subset of the analytes; only those with results greater than the detection limits for at least one of the tests are shown. The TA-16 Burn Ground treats explosives with barium, which were not covered by these tests. These metal emissions were based on concentrations of metals found in ash, presented in Table 11 of Appendix B of this response and discussed in LANL's response to Comment No. 6.a. (The WPFs from which the data presented in Table 11 were extracted are presented in the Ash Characterization portion of Appendix D in this response.) The EPA report measured copper at the level of 1.0 E-05 in one of the three M31A1E1 tests. However, copper is not part of the original material managed at LANL, as determined through process knowledge, and the data were not used for the purposes of this response.

The *EPA/600/R-98/103* reference also provided information on the burning of bulk explosives containing chlorine and fluorine. It concluded that the conditions which favor the formation of dioxins and furans are "low temperature (250-400 °C), long residence time (seconds), presence of chlorine and organic materials, and a metal that could serve as a catalyst." These conditions do not exist when burning bulk explosives, which typically burn above 2000 °C and do not involve catalyst metals. The lack of dioxin/furan formation in burning of explosives was confirmed by another test in Study 6, the burning of AP, which has a much higher chlorine content than present in explosives used at LANL. In Chapter 7, Discussion of Results from Burns, the report concludes for the organic-based and AP-based explosives that "dioxins and furans were not detected, despite the extremely sensitive sampling and analysis methods employed." The report further concluded in Chapter 7 that it would be prudent to assume that all the chlorine in AP-based explosives will be released to the environment as HCl. In Chapter 2, the report made the same conclusions for fluorine. The air emissions summarized in Table 10 of Appendix B in this response reflect this finding for HCl and HF.

b. *information documenting that the Permittee will remove all hazardous waste and hazardous waste residues (including but not limited to ash) from the thermal treatment process area or equipment at closure [20.4.1.700 NMAC (incorporating 40 CFR § 265.381)];*

As stated in the TA-16-specific closure plan for the Burn Ground, LANL intends to clean close each site by removal of all hazardous waste and hazardous waste residues. The Closure Plan for the Technical Area 16 Burn Ground Unit was included as Attachment E.2 in the draft "Los Alamos National Laboratory Hazardous Waste Facility Permit, Chapter 5, Technical Area 16 Conditions" (LANL, 2000b), as requested by HWB and described in the June 19, 2000, transmittal letter for the document. In Section E.2.1.1 of the closure plan, LANL indicates that meeting the closure performance standards "will be accomplished by removal of waste from the TA-16 Burn Ground Unit and decontamination, if necessary, of the areas that may have come into contact with wastes. Decontamination activities will ensure the removal of hazardous waste residues from the TA-16 Burn Ground Unit to established cleanup levels."

As indicated in Section E.2.1.9 of the plan, "LANL intends to remove hazardous waste and associated hazardous constituents from the TA-16 Burn Ground Unit (or portion thereof) and to decontaminate structures and equipment contained in the unit or, if decontamination to the cleanup levels approved in the closure plan cannot be achieved, to dispose of or otherwise manage the contaminated structures and equipment (clean closure). If decontamination to these cleanup levels is not achievable, LANL may propose an alternate demonstration of decontamination, as circumstances indicate." Additional information regarding the closure activities and the sampling and analytical procedures to ensure and verify that all hazardous waste and hazardous waste residues are removed is also presented in the closure plan. Section E.2.1.9 goes on to state that "If the TA-16 Burn Ground Unit (or portion thereof) cannot be clean closed, LANL will provide a written post-closure plan."

Finally, in the closure certification discussion in Section E.2.1.6, the closure plan indicates that "a certification that the unit (or portion thereof) has been closed in accordance with the specifications of the closure plan" and that "the certification will be attested to by an independent, registered professional engineer". Such certification will include the waste and residue removal activities in the closure plan.

The information presented in the above-referenced closure plan indicates that LANL intends to remove all hazardous waste and hazardous waste residues (including but not limited to ash) from the thermal treatment process area or equipment at closure to meet the requirements of 20.4.1 NMAC § 265.381.

c. *evidence that all hazardous waste burned at TA-16 has the potential to detonate (including waste with low levels, i.e., less than 10 percent, of high explosives). Acceptable evidence includes test results such as EPA Publication SW 846, Test Method for Evaluating Solid Waste, Subsection 6-2, Definition of Explosive Material, or the Bureau of Mines Gap Test or Deflagration/Detonation Transition Test. RCRA precludes open burning of hazardous waste that is not detonable. [20.4.1.700 NMAC (incorporating 40 CFR § 265.382), 52 FR 46946, 46952 (12/10/87)]; and*

All hazardous waste treated by OB at the TA-16 Burn Ground has the potential to detonate or is a propellant which cannot be safely disposed of through other modes of treatment, pursuant to 20.4.1 NMAC § 265.382. In accordance with 20.4.1 NMAC § 261.33, the HE waste streams containing propellants are capable of detonation if subjected to a strong initiating source or if heated under confinement. The remaining HE waste streams have the potential to detonate because they are Class A explosives as defined in the Code of Federal Regulations, Title 49 (49 CFR), § 173.53, pursuant to 20.4.1 NMAC § 261.23(a)(8). As stated in Chapter 7 of "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (EPA, 1986) (*SW-846*), Section 7.3, the definition of reactivity "is intended to identify wastes that, because of their extreme instability and tendency to react violently or explode, pose a problem at all stages of the waste management process. The definition is to a large extent a paraphrase of the narrative definition employed by the National Fire Protection Association. The Agency chose to rely almost entirely on a descriptive, prose definition of reactivity because most of the available tests for measuring the variegated class of effects embraced by the reactivity definition suffer from a number of deficiencies".

As discussed below, the HE in LANL waste forms treated at the TA-16 Burn Ground do have detonation velocities that exceed the regulatory requirement. In addition, this response discusses the safety-based relation of concentration-based criteria for detonability as opposed to the discrete presence of particulate HE in waste streams.

ESA-Weapon Materials and Manufacturing's High Explosives Team is continually working to minimize, decontaminate, and recycle all HE-contaminated wastes generated from the many critical operations performed. Primary to our mission is the safe handling and treatment of all HE, whether it is intended for national defense or for disposal.

<u>Safety Issues with Small Amounts of HE</u>

All HE engineers, technicians, chemists, and firing-range personnel understand that HE, when accidentally exposed to even small initiating sources such as friction, pinch points, electrical discharge, heat, or impact, has a potential for yielding a detonation. With the knowledge that the HEs typically processed and handled at LANL have detonation velocities averaging 4 to 6 miles per second

and pressures as high as 300,000 times greater than ambient atmospheric pressure for short periods, all HE-containing and HE-contaminated materials are treated with the utmost care. Fickett and Davis explain in their book, "Detonation Theory and Experimentation" (Fickett and Davis, 1979) that a good solid explosive converts energy at a rate of 10^{10} watts per square centimeter at its detonation front.

The DOE Explosives Safety Manual (DOE, 1996) warns most danger is from small ($\leq$ 1 gram) chunks and fine powders of HE. These forms may be deposited on the inside of the bags and boxes that the HE powders and pressed parts are stored in. These HE forms are most dangerous to improperly trained personnel because of the typical belief that the HE can not be accidentally detonated or that there is not enough material to be destructive. Less than a gram of HE, if initiated accidentally, will cause the loss of a hand, one's hearing, one's eyesight, or create irreparable burns to the face or body. Fine HE powders, if suspended, can be initiated very easily and can be life threatening. Therefore, HE waste and HE-contaminated waste are treated by OB to remove the potential for detonation.

HE Waste and HE-Contaminated Waste Treated by OB

LANL does not use a screening level, such as 10% by weight, to determine if a waste is reactive. Instead, each waste's potential for reactivity is evaluated separately. It is our understanding that the U.S. Department of Defense (DoD) obtained approval to ship and possibly not treat HE-contaminated soil unless the soil contained more than 10% by weight HE. Most of the activities and test results that we have seen in that case are based on soil samples that are relatively "homogenous" and have a uniform concentration of HE throughout the soil sample. Most of the contamination found in these studies is based on high levels of trinitrotoluene (TNT), which was the preferred HE used in military applications in the past 50 years. In situations where the materials are relatively homogenous and the concentrations are uniform and typically less than 10% by weight HE, these types of soils do not propagate a detonation when initiated with boosters. However, this example does not address heterogeneous mixtures where chunks or "high HE concentration regions" might be located within a sample being tested. This type of situation could occur with any type of HE-contaminated hazardous waste, whether it be soils, solutions, or combustible wastes. As an example, assume a 5-gallon bucket of dirt weighing ~40 lbs has one or two pieces of HE weighing about two lbs each contained in the dirt. If one determined that the dirt was contaminated and meets the 10% level by the strict application of a weight-based concentration, it could be shipped and classed as a "non-hazardous" material. If one or both of these two-pound pieces were accidentally initiated, considerable damage would result. If the HE pieces detonate with people in close proximately (5 to 10 feet), they would almost certainly be killed.

Most likely, this criterion was established using TNT-contaminated soils and TNT-contaminated waste. TNT is relatively "less hazardous" or somewhat less

sensitive when compared to some of the other types of HE that are routinely processed at S-Site, such as pentaerythritol tetranitrate (PETN), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX).

LANL uses the "Drop Weight Impact" (DWI) test for evaluating the sensitivity, reactivity, or safety of HEs that are processed and handled at S-Site. This is a small-scale test that is used for screening all batches of materials and provides an initial safety screening of these materials. In this test, a 2.5-kilogram weight is dropped onto a powdered sample of HE and the height at which reactions occur 50% of the time is determined. DWI data for many of these HEs exist and can be provided upon request. Previously, HE-contaminated soils from the TA-16-260 outfall (which served the S-Site HE-machining facility) were collected and the drop weight tests run on the soil samples. (Note: this outfall has been closed and safely cleaned up in the past two years.) DWI test results of the HEs such as PETN, RDX, HMX, and TNT are shown in the following table, along with test results of the outfall's HE-contaminated soil samples with various concentrations of HEs.

HE Material	DWI 50 Drop Height, centimeters (cm) (Type 12b tooling)
PETN	14-20
RDX	2-40
HMX	30-36
TNT	>320
Soil (5% HE:RDX/HMX/TNT)	289
Soil (10% HE:RDX/HMX/TNT)	91
Soil (15% HE:RDX/HMX/TNT)	43
Soil (20% HE:RDX/HMX/TNT)	30

NOTE: Maximum height of the DWI apparatus is 320 cm. The soils tested were relatively "homogenous" in HE concentrations.

Based on our interpretation of the above results and on an assessment of the hazards associated with the cleanup of the soils, which was included in the Site-Specific Health and Safety Plan for the 260 Interim Measure (LANL, 2000c), we required the contractor to remotely excavate soils that were contaminated above the 5% level, rather than use the DoD 10% HE-contamination level. As indicated in the DWI data presented above, 5% HE-contaminated soil is more reactive than TNT, and 20% HE-contaminated soil is as reactive as RDX.

A safety-based approach is also used for Class A explosives-bearing liquid waste streams treated at the Burn Ground. No matter what the HE concentration is in our liquid waste streams (0.1% or 10%), our obligation includes ensuring that a detonation does not result. Solvent-bearing liquid waste streams result from HE synthesis work on new and existing Class A explosives. Synthesis techniques

involve putting the HE in a solvent solution. Process knowledge indicates that the HE can and will precipitate out of the solution, leaving a detonable residue. Most HE processing is done wet in order to cool operations and minimize the potential for HE-processing accidents. Through pre-filtering HE-contaminated water prior to treatment at the HE Wastewater Treatment Facility (HEWTF) at TA-16, suspended Class A HE particles can be captured and removed. If the liquid waste spilled and evaporated leaving crystals of HE powders, we know that various types of initiating sources such as impact, friction, and heat could cause a detonation because they remain Class A explosives.

The following list of waste types includes the common waste streams treated at the TA-16 Burn Ground with a discussion of the potential safety-related issues associated with the waste stream. Table 7 in Appendix B of this response includes a listing of the Class A HE types that may be contained in these waste streams, along with detonation rates. The Table 7 detonation rates were taken from the "LLNL Explosives Handbook--Properties of Chemical Explosives and Explosive Stimulants" Dobratz and Crawford, 1985). All applicable rates exceed the regulatory requirement in 20.4.1 NMAC § 265.382. Based upon the previous discussion and as listed below, LANL believes that the detonation rate for the discrete HE type contained in the waste stream is the appropriate determining criteria for the use of OB as treatment.

<u>Detonation Potential by Waste Stream</u>

1. HE-Contaminated Water with Trace Solvents and/or Metals
    a. HE precipitates accumulate during storage and transport, creating a potential for detonation during handling.
    b. Fluid evaporation, leaving HE crystals with the potential for detonation during handling.
    c. Class A explosive.

2. HE-Contaminated Spent Solvent Waste
    a. HE precipitates accumulate during storage and transport, creating a potential for detonation during handling.
    b. Fluid evaporation, leaving HE crystals with the potential for detonation during handling.
    c. Class A explosive.

3. HE-Contaminated Water
    a. HE precipitates accumulate during storage and transport, creating a potential for detonation during handling.
    b. Fluid evaporation, leaving HE crystals with the potential for detonation during handling.
    c. Class A explosive.

4. HE-Contaminated Used Oil
    a. HE precipitates accumulate during storage and transport, creating a potential for detonation during handling.
    b. Fluid evaporation, leaving HE crystals with the potential for detonation during handling.
    c. Class A explosive.

5. Solid and Scrap HE
    a. Chunk HE has a very high potential for detonation when dropped, heated, hit, etc.
    b. Class A explosive.
    c. Capable of detonation or explosive reaction if subject to strong initiating source or if heated under confinement.

6. HE-Contaminated ER Soil and/or Debris
    a. Potential detonation of HE chunks or powders with <10% total HE contamination present.
    b. Class A explosive.
    c. Capable of detonation or explosive reaction if subject to strong initiating source or if heated under confinement.

7. HE-Contaminated Commercial Chemical Products
    a. HE precipitates accumulate during storage and transport, creating a potential for detonation during handling.
    b. Fluid evaporation, leaving HE crystals with the potential for detonation during handling.
    c. Potential detonation of HE chunks or powders with <10% total HE contamination present.
    d. Class A explosive.

8. Wastewater Treatment Residues
    a. HE precipitates accumulate during storage and transport, creating a potential for detonation during handling.
    b. Fluid evaporation, leaving HE crystals with the potential for detonation during handling.
    c. Class A explosive.

9. HE-Contaminated Solid Waste
    a. HE precipitates accumulate during storage and transport, creating a potential for detonation during handling.
    b. Fluid evaporation, leaving HE crystals with the potential for detonation during handling.
    c. Class A explosive.

10. HE-Contaminated Equipment
    a. HE imbedded in cracks, crevices, and threads and that can not be removed has the potential for detonation when bolts, nuts, and screws are twisted or other sources of friction or impact are present.
    b. During transport, friction or impact may result in detonation.
    c. Class A explosive.

11. HE-Contaminated Waste Rags, Wipes, and other Combustibles
    a. Potential detonation of HE chunks or powders with <10% total HE contamination present.
    b. Class A explosive.

12. HE-Contaminated Liquid Acids, Bases, and/or Inorganic Salt Solutions
    a. HE precipitates accumulate during storage and transport, creating a potential for detonation during handling.
    b. Fluid evaporation, leaving HE crystals with the potential for detonation during handling.
    c. Class A explosive.

13. Liquid Process Explosive Waste
    a. HE precipitates accumulate during storage and transport, creating a potential for detonation during handling.
    b. Fluid evaporation, leaving HE crystals with the potential for detonation during handling.
    c. Class A explosive.

d. documentation assuring compliance with the requirements for minimum distance from open burning to the property of others [20.4.1.700 NMAC (incorporating 40 CFR § 265.382)]

As stated in Section H.2.1 of Attachment H in the application, "the closest property not owned by LANL is at a distance greater than one mile from the Burn Ground Unit. Therefore, a safe distance is maintained between the HE burn sites and the property of others, as required in 20 NMAC 4.1, Subpart VI, 265.382 [1-1-97]."

This distance is demonstrated on Map A-8 included in Attachment A of the application. On that map, the measured distance from the Burn Ground Unit to the closest boundary of LANL is approximately 5,425 feet.

As listed in the table of 20.4.1 NMAC §265.382, if 10,001 to 30,000 lbs of waste explosives or propellants are treated by OB, the minimum distance from the OB to the property of others must be 2,260 feet. At the TA-16-388 Flash Pad, the maximum treatment capacity is estimated at 40,000 lbs per burn to

accommodate the weights of large machine tools and other equipment that are contaminated with HE. However, large burns are conducted only when absolutely necessary because it is more difficult to assure the HE is destroyed on all materials treated. Instead, burns of several hundred lbs of HE-contaminated material are usually conducted.

Although the flash pad has a treatment capacity of 40,000 lbs, this weight includes the tools or equipment being treated. The capacity does not mean that 40,000 lbs of waste explosives or propellants are treated. Therefore, LANL complies with the minimum distance requirements in 20.4.1 NMAC § 265.382.

2. *Submit an explanation of why the wastes treated or disposed of by open burning at TA-16 cannot be treated or disposed of by other methods more protective of human health and the environment. Open burning should be used for treatment only when no other option is available that is more protective of human health and the environment [20.4.1.500 NMAC (incorporating 40 CFR § 264.601)].*

OB is the best available treatment for HE and HE-contaminated material due to the serious safety issues inherent to non-treatment, as described in LANL's response to Comment No. 1.c, and the lack of developed alternative technologies. Discussions with waste management personnel at other facilities (e.g., Pantex, Lawrence Livermore National Laboratory [LLNL], and Radian) confirm that they conduct OB. At Pantex and LLNL, HE and HE-contaminated waste is treated by OB, flashing, or OD at treatment facilities permitted by Texas and California, respectively. Radian conducted a study in 1994, which concluded that OB is the best technology for HE treatment. Over the years, numerous oxidation-reduction research and development projects have been proposed for treating hazardous waste and mixed waste. To our knowledge, none of these projects have matured past the research phase.

3. *Submit documentation that the sand filters, unit numbers 401 and 406, meet the regulatory requirements for tanks under 20.4.1.500 NMAC (incorporating 40 CFR Part 264, Subpart J), or submit an explanation of why the sand filters do not meet the definition of a tank at 40 CFR § 260.10.*

Sand Filters 401 and 406 have been proposed to be permitted as OB units under RCRA (Miscellaneous Units, 20.4.1 NMAC §§ 264.600-603) since the November 1988 LANL "RCRA Part B Permit Application", Revision 4.1 (LANL, 1988). This designation has been based upon the similarity of the treatment process with the other stand-alone OB units at TAs 14 and 16. However, the purpose of these filter units is to treat HE-contaminated wastewater and they are directly connected to the TA-16 HEWTF.

If the tank definition is the regulatory factor being applied in this case, LANL believes that these units should not be considered as managed under the LANL

Hazardous Waste Facility Permit. Designated as tanks, Sand Filters 401 and 406 are exempt from regulation under RCRA, pursuant to 20.4.1 NMAC §§ 264.1(g)(6) and 270.1(c)(2)(v). The EPA clarified the federal position regarding the extent of the wastewater treatment unit exemption (53 *FR* 34080, September 2, 1988) as appropriate for a unit when storing or treating hazardous wastewater as a dedicated part of an on-site wastewater treatment facility.

20.4.1 NMAC § 260.10 defines a wastewater treatment unit as "...a device which: (1) Is part of a wastewater treatment facility that is subject to regulation under either Section 402 or 307(b) of the Clean Water Act; and (2) Receives or treats or stores an influent wastewater that is a hazardous waste as defined in § 261.3 of this chapter, or that generates and accumulates a wastewater treatment sludge that is a hazardous waste as defined in § 261.3 of this chapter, or treats or stores a wastewater treatment sludge which is a hazardous waste as defined in § 261.3 of this chapter; and (3) Meets the definition of tank or tank system in § 260.10 of this chapter."

The HEWTF is subject to regulation under Section 402 of the Clean Water Act, and the sand filters are included under LANL's National Pollutant Discharge Elimination System (NPDES) Permit Number NM0028355, as described in the LANL 1998 NPDES Permit Re-Application. As described in Section H.1.3 of the TA-16 Part B permit application, the outflow from the sand filters is directly connected to the HEWTF. As further discussed in that section, the wastes treated in the sand filters include wastewater (in which HE and possibly trace chemicals associated with HE synthesis and degradation are in solution) and particulate HE saturated with water. These units do not process any other waste streams. For the purpose of this discussion, LANL agrees that the sand filters meet the 20.4.1 NMAC § 260.10 tank definition as "a stationary device, designed to contain an accumulation of hazardous waste which is constructed primarily of non-earthen materials...which provide structural support." Details of the steel structure and brick lining are provided as Figure H-7 of the application.

Therefore, Sand Filters 401 and 406 should be withdrawn from the TA-16 permit application. The inclusion of these units as RCRA-regulated treatment units in LANL Part A permit applications may have been inappropriate, given NMED's new permitting approach. LANL believes this situation should be more thoroughly explored with the HWB regarding potential revisions to the application and resulting changes in the Part A and annual unit audits. A meeting to discuss this issue is requested.

4. *Submit the Stormwater Pollution Prevention Plan for TA-16, including details of stormwater sampling conducted at the burn ground.*

The Storm Water Pollution Prevention Plan (SWPPP) for TA-16 is provided as Appendix E of this NOD response. Details of storm water sampling to be conducted at the Burn Ground are in Section 2.3 of the TA-16 SWPPP.

Storm water sampling data conducted in the vicinity of the Burn Ground are included as Appendix F of this response. The map on the first page of Appendix F illustrates the location of the Burn Ground with respect to the sampling location (Station E262) where these data were collected. Station E262, which has been active since April 1999, has provided the storm water sampling data for the watershed. Station E257 is being installed and is expected to be operational by Spring of 2002. The data in Appendix F are from storm water Station E262, located at the southernmost point of the watershed, and are included to demonstrate the type of data that will be collected from Station E257 once it becomes operational.

As indicated in Section 2.3 of the SWPPP, all collection, preservation, and analysis meet the requirements listed in 40 CFR, Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants".

5. *Submit a proposal for remediating groundwater at the site where contaminants have been detected above New Mexico Water Quality Standards, specifically the barium and HE detected at well R-25.*

Pursuant to Module VIII (the Hazardous and Solid Waste Amentments [HSWA] Module) of LANL's existing Hazardous Waste Facility Permit, LANL is currently evaluating both the necessity of groundwater remediation and groundwater remediation alternatives at TA-16 through an NMED-approved RCRA Facility Investigation/Corrective Measures Study (CMS). LANL does not currently believe that the operations at the TA-16 Burn Ground have impacted the waters observed in the R-25 well or any deep groundwaters at TA-16. The R-25 well is hydrologically upgradient from the TA-16 Burn Ground and hydrologically downgradient from the TA-16-260 outfall, which is the most likely source of contaminants observed in this well. In addition, the hydrogeologic regime at the Burn Ground does not facilitate infiltration of water into the vadose zone, and potentially into deep groundwater.

The groundwater at all of TA-16 is being investigated as part of the CMS for Potential Release Site 16-021(c)-99 (the TA-16-260 outfall). Initial groundwater investigations are outlined in the "Addendum to CMS Plan for Potential Release Site 16-021(c)" (LANL, 1998b),which was transmitted to the HWB in September 1998. Since November 2000 when the first round of sampling the R-25 well began, the concentrations of RDX, HMX, TNT, and other HE degradation products in the samples collected from the regional aquifer have decreased. Samples collected from the completed well R-25 showed that RDX concentrations in the regional aquifer ranged from 18 to 28 micrograms per liter (µg/L) in November 2000, but decreased to 8 to 11 µg/L by May 2001. RDX and TNT concentrations in the upper saturated zone were 30 and 1.10 µg/L, respectively, in May 2001. Samples were collected from the completed well R-25 in August 2001, and the analytical data are being validated. A preliminary review

of the data suggests that RDX concentrations in the regional aquifer continue to decrease.

Two deep groundwater wells, CdV-R-15-3 and CdV-R-37-2, have been drilled based on the CMS Addendum, and they do not show any RDX or TNT. LANL has also been working closely with HWB personnel as part of the TA-16-260 high performing team (HPT) to modify that plan as new data become available. Based on the most recent HPT discussions, it is likely that an intermediate depth borehole will be drilled in a location believed to be hydrologically downgradient (east) of the Burn Ground to better determine the extent of contamination in the deep-perched zone observed in well R-25. Any remediation decisions for groundwater at TA-16 will be made in the context of the TA-16-260 CMS investigations once the extent of groundwater contamination is better constrained. It is assumed that these decisions will also be made in close collaboration with the NMED HWB and Groundwater Bureau through the auspices of the HPT.

Barium has not been observed at levels above New Mexico Water Quality (NMWQ) Standards in the R-25 well. The only data that show barium levels above 1 mg/L are from the R-25 borehole as the well was being constructed. Those data, included as Attachment B of the draft "Subject Matter Clarification: Technical Area (TA) 16 Part B Permit Renewal Document, Revision 3.0" (LANL, 2000d), submitted to the NMED in September 2000, show barium concentrations of 1.26 parts per million (ppm) at a depth of 1,137 feet and 1.75 ppm at a depth of 1,286 feet; however, the samples were "total" (i.e., non-filtered) samples, which were turbid and contained suspended solids that typically have higher concentrations of trace elements, such as barium. None of the filtered samples from the borehole or the non-filtered samples from the completed well had barium concentrations exceeding NMWQ Standards or Water Quality Control Commission (WQCC) Standards.

As stated in Section H.3.2 of Attachment H of the TA-16 Part B permit application, "water quality data collected in *Cañon de Valle* since 1994 shows barium and RDX (a form of HE) at levels above New Mexico State Drinking Water standards (*emphasis added*). Barium concentrations are less than 4 parts per million and RDX is less than 200 parts per billion". However, the discussion goes on to clarify that these are surface water data.

There are no explicit NMWQ Standards or WQCC Standards for individual RDX and TNT, nor are they identified as hazardous constituents subject to HSWA. NMWQ and WQCC issues will be considered when well data are evaluated during the CMS review process.

6. *Submit data and analysis that demonstrates compliance with performance standards under 20.4.1.500 NMAC (incorporating 40 CFR §§ 264.601 (a)(7), (a)(8), (a)(9), (b)(10), (b)(11), (c)(1), (c)(2), (c)(6), and (c)(7) for deposition of*

contaminants to soil at the site from ash or entrained particles resulting from the burning of hazardous waste. This submittal shall include submittal of the following information:

a. *summaries of ash sampling results, conducted for the purpose of waste disposal characterization, and an assessment of the potential risk from ash deposition to soil;*

Ash sampling results for 2000 are summarized in Table 11 included in Appendix B of this response. As required by RCRA, the Toxicity Characteristic Leaching Procedure (TCLP) is used to characterize toxic metals to determine whether the metal levels are high enough to classify the ash as RCRA hazardous waste. The "ash" is primarily sand from TA-16-399, -401, and -406. The sand will have metals concentrations typical of background soil. Table 12 in Appendix B of this response shows background levels for soils described in "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments and Bandelier Tuff at Los Alamos National Laboratory" (Ryti et al., 1998). A common conversion used to compare total metal concentrations with TCLP is to divide the total amounts by 20. The table shows this conversion and the amounts of metals detected in the ash samples. The arsenic, lead, mercury, and selenium concentrations appear to be consistent with soil background levels and are not typical constituents of HE or HE-contaminated wastes. The barium concentration is clearly elevated and would be expected to be in the ash because baratol was burned in the OB structures in 2000. The source of the trace levels of cadmium present in the ash from the flash pad is not known. However, emissions were calculated for the cadmium, as well as for the barium.

The TCLP procedure requires 100 grams (g) of waste to be dissolved in 2 liters (L) of solution. The milligram (mg)/L estimates can be converted to grams of metal per gram of ash or pounds of metal per pounds of ash using the following conversion factor:

$$\frac{\text{mg metal}}{\text{L solution}} \times \frac{\text{2 L solution}}{\text{100 g soil}} \times \frac{\text{g metal}}{\text{1000 mg}} = \frac{2 \times 10^{-5}\ \text{g metal}}{\text{g soil}}$$

or 2×10^{-5} lb metal per lb of soil.

The conversion from TCLP to total metals is shown in Table 13 of Appendix B in this response. Because the "ash" primarily consists of sand taken from TA-16-399, -401, and -406, the soil density of 10 lbs per gallon was used to convert the gallons of "ash" disposed to pounds.

The air emissions from ash shown in Table 13 (see Appendix B of this response) used the Table 4 (see Appendix B) assumptions for barium and cadmium. Because so little of the two metals would be emitted (5.3 E-3 for cadmium and 1

E-5 for barium) versus the amount staying in the ash, the amount of metal in the ash did not have to be adjusted for the calculations.

The EPA dispersion model, CALPUFF, was run to estimate deposition to soil from air emissions. The methodology used is described in Appendix G of this response. The deposition rates at the maximum plume impact point are contained in Table 2 of Appendix G. The risks from all air emissions are discussed in the response to Comment No. 6.d.

b. *analysis of possible degradation products of HE that may be generated and the potential risk from levels of the degradation products likely to be found in soil around the burn areas;*

LANL's Air Quality Permit for Open Burning (Permit Number AQB.97.214, effective August 18, 1997) indicates that air emissions (i.e., products of combustion or possible degradation products) for the TA-16 Burn Ground include CO, oxides of nitrogen, particulate matter, nonmethane hydrocarbons, and VOCs. Beginning in 1990, the National Park Service, NMED, and LANL jointly conducted ambient air quality monitoring for these criteria pollutants at the boundary of Bandelier National Monument and TA-49, approximately 15,000 feet south-southeast of the Burn Ground. This 3-year study showed the background air to have only very low levels of pollution. NMED's Air Quality Bureau used this information and the impacts assessment, combined with knowledge of local air quality conditions, to ensure that air quality standards would not be exceeded. Based on the clean condition of ambient air and the low impacts of burning, the Air Quality Bureau has not required monitoring of OB at the TA-16 Burn Ground.

A report published by the EPA (*EPA/600/R-98/103*; EPA, 1998) concluded that emission (i.e., degradation) products from the most energetic materials treated by OB and OD are adequately represented by CO_2, CO, NO, NO_2, total saturated hydrocarbons (e.g., ethane, propane, butane), acetylene, ethylene, propene, benzene, toluene, and particulate. The report also concluded that HMX, RDX, and PETN found in samples collected after OD were present because detonations are not usually 100% efficient. Similar conclusions were not stated in that report for OB.

HEs are formulated so that the combustion source (carbon and nitrogen atoms) are stoichiometrically matched with oxygen (within the same molecule) in order to facilitate complete combustion upon detonation (CO_2, N_2, and H_2O are formed). This formulation aids in a more complete combustion (i.e., CO_2, N_2, and H_2O as products). When the HE is burned, the formation of incomplete combustion products (i.e., nonmethane hydrocarbons, aromatics, and other hydrocarbons) is very minimal. The total air emissions for possible degradation products are presented in Table 10 of Appendix B in this response.

Degradation products from combustion as a result of current OB treatment are not likely to found in the soil around the Burn Ground Unit sites. Intact HE fragments are not found after OB treatment or in the ash residue. If degradation products were to be found in the soil as a result of current OB treatment processes, the likely cause would be from spills or loading practices. Administrative controls at the Burn Ground are in place to prevent the mishandling of HE and HE wastes. Therefore, the potential risk from levels of degradation products that might be found in the soil as a result of OB is low.

c. *information on whether volatile organic compounds (VOCs) are released during burning and the potential quantities of VOCs released;*

The response to Comment No. 1.a includes estimates of the types and quantities of VOCs.

d. *comparison of potential levels of contaminants in soil from ash to HWB human health soil screening levels and LANL ecological screening levels; and*

The response to this comment was expanded from ash impacts to the impacts from all forms of air emissions, particulate or gaseous. However, not all of the emissions described in the response to Comment No. 1 have HWB's Screening Action Levels (SAL) or LANL's Environmental Screening Levels (ESL). The chemicals that had screening levels are summarized in Table 14 of Appendix B in this response. The annual emissions were multiplied by ten to reflect the 10-year duration of the RCRA permit for the TA-16 Burn Ground, and then were multiplied by the deposition conversions from the CALPUFF modeling (see Table 2 of Appendix G). The particulate matter conversion factor was used for metals, the hydrocarbon factor for hydrocarbons, and the gaseous factor for non-hydrocarbons such as nitrates and nitrites. Where classes of air emissions could fit a category (e.g., NO_x could fit either nitrates or nitrites and nitric acid would fit the nitrate category), they are assigned to one or more of the categories. Where there was more than one screening factor for a single metal (e.g., chromium), both are shown in Table 14. Some materials that could be treated at the Burn Ground (e.g., metals and solvents) but were not present in the 2000 calculations were entered into Table 14 with quantities of "-." This showed whether they were typical of other emissions or whether SALs/ESLs were lower for the "missing" chemicals.

As Table 14 of Appendix B in this response shows, the screening levels are orders of magnitude higher than the deposition rates derived from the TA-16 Burn Ground emissions. Therefore, the hazardous constituents in the wastes could be significantly higher without exceeding the risk screening levels.

e. *verification that the open burn units are kept covered when not in use.*

The Burn Ground Unit structures are kept covered when not in use, as indicated in Section 2.2.3 of the application. In Section 2.2.3, it states that "The TA-16-388 Flash Pad has a retractable cover to prevent run-on and to reduce the potential for residues to be blown off the pad by wind". (The Safe Operating Procedure included herein as Appendix H also requires that the cover be returned to cover the flash pad.) In Section 2.2.3 of the application, it also indicates that "The TA-16-388 Burn Tray is covered when a burn is complete to reduce the likelihood of residue dispersion by wind". For the TA-16-399 HE Burn Tray, the same section states that "After a burn is completed, any residue is covered until it can be removed, reducing the likelihood of ash dispersion by wind".

Section 2.2.3 of the application indicates that "When solid HE is present on the sand filter surfaces, the sand filters are covered to ensure that the HE does not become windblown and is not accidentally detonated". As discussed in LANL's response to Comment No. 3, the sand filters are included in LANL's NPDES Permit Number NM0028355 and LANL proposes to meet with the NMED HWB to discuss the regulatory status of Sand Filters 401 and 406.

The information presented above is reiterated and augmented on page F-2 in Attachment F of the draft "Subject Matter Clarification; Technical Area (TA) 16 Part B Permit Renewal Document, Revision 3.0" (LANL, 2000d), submitted to the NMED in September 2000.

In order to verify that the OB units are kept covered when not in use, LANL proposes adding this as an inspection item to the Inspection Plan included as Appendix C of the General Part B. The item will be added to Section C.4.2 of the Inspection Plan.

7. *Move the Application Attachment G, "Container Management," and Attachment H, "TA-16 Burn Ground Unit Management," to the body of the Application, Section 2.0, "Storage and Treatment at Technical Area 16."*

The detailed information in Section 2.0 was provided in the application to meet the facility description requirements of 20.4.1 NMAC § 270.14(b)(1) and is not appropriate for inclusion directly into the permit. This information is more appropriate for use in NMED's development of Modules I, II, and III, as demonstrated in the draft "Los Alamos National Laboratory Hazardous Waste Facility Permit, Chapter 5, Technical Area 16 Conditions" (LANL, 2000b) submitted to the NMED in June 2000.

The information contained in Attachments G and H of the application was provided separately so that the information therein could be tailored by the NMED to become attachments to Chapter 5 of the permit. This format follows the example in LANL's existing Hazardous Waste Facility Permit, where Permit Attachment F discusses Container Management. When developed by NMED, Attachments G and H of permit Chapter 5 should be intended to present

additional permit conditions or information not provided elsewhere in the permit chapter. In addition, the information provided by LANL was included as attachments in accordance with directions provided in NMED correspondence dated February 5, 1998, and signed by Robert S. Dinwiddie. In summary, LANL proposes no changes to the organization of these portions of the application.

8. *Combine and revise Table 1-1, Application page 1-3, and Table H-1, Application page H-21, to accurately and specifically indicate where in the Application 40 CFR § 264.601 performance standards are addressed. For example, Tables 1-1 and H-1 do not include § 270.23, Part B Information requirements for Miscellaneous Units. Table 1-1 indicates that § 264.601 is addressed in the Application Attachment F.2; however § 264.601 describes environmental performance standards for operations, and Attachment F.2 addresses closure only. Table 1-1 states that § 264.602 is addressed in Attachment C, but § 264.602 includes monitoring, analysis, corrective action, and reporting requirements for miscellaneous units, and Attachment C only references facility-wide inspection of operations information included in the General Application. Table H-1 only references Attachment H as addressing all of §§ 264.601 and 602, and should indicate by Application section the location in the Application where specific requirements of § 264.601 are addressed.*

When the application was reformatted at NMED's request for submittal in January 2000, LANL included the two separate tables, which followed the guidance format contained in the "HRMB Standard Operating Procedures Manual, Volume I, External" (NMED, 1998). Table 1-1 follows the Review Checklist for Part B General Requirements (§ 270.14) in the manual, and Table H-1 follows the manual's Review Checklist for Subpart X Miscellaneous Units (§ 264.601). This seemed appropriate, as the two checklists focus on different portions of the regulations and Table H-1 is mainly limited to the information provided in Attachment H. Therefore, LANL proposes to maintain the tables separately. Although not a regulatory requirement or a requirement in the manual, the tables were provided to indicate the location of information required by the two checklists; they were not provided for inclusion in LANL's permit.

LANL has revised the tables to more accurately and specifically indicate where the performance standards are addressed in the application, as stated in NMED's comment. Although not specifically cited in either HRMB checklist, LANL has added the § 270.23 Specific Part B Information Requirements for Miscellaneous Units to Table H-1 because this table addresses miscellaneous units exclusively. The § 264.601 environmental performance standards were further addressed in the subsequent draft Subject Matter Clarification (SMC) document (LANL, 2000d), submitted by LANL to the NMED in September 2000 in response to a draft Technical Request for Supplemental Information for Rev. 3.0, dated July 11, 2000. The revised Table H-1 now references the appropriate section(s) in the SMC, which when combined with the application address the

environmental performance standards. In addition, Table H-1 has also been revised to reference information pertaining to the 20.4.1 NMAC § 264.601 requirements addressed in this NOD response.

Table 1-1 has been revised to more specifically reference document sections that address the requirements of 20.4.1 NMAC § 264.602. However, Table H-1 in the application does include references to Section 2.0 and/or Section 4.0 to address the information requirements of 20.4.1 NMAC §§ 264.601 and 264.602. This table has also been revised to include more detailed section references for the original application (i.e., Rev. 3.0), as well as references to information subsequently provided in the SMC and in this NOD response.

Revised Tables 1-1 and H-1 in redline/strikeout format are provided as Appendix I herein. When the final revision to the application is prepared, they will be included in clean format.

9. *Responses in the draft September 2000 "Subject Matter Clarification" reference Closure Plans in Attachments E-1 and E-2 of the draft June 2000 LANL Hazardous Waste Facility Permit, Chapter 5, submitted by the Permittee to NMED in June 2000. If the Permittee intends those Closure Plans to be the TA-16 specific Closure Plans then the Application must be revised to include those Closure Plans.*

When the final revision to the application is produced, LANL will include the TA-16-specific closure plans from the draft June 2000 LANL Hazardous Waste Facility Permit, Chapter 5, in the application. The TA-16-specific closure plans in the January 2000 application were revised for inclusion in the June 2000 draft Chapter 5. Any additional revisions to the TA-16-specific closure plans made in response to other NMED comments in this NOD will also be included in the revised application, when produced.

10. *In the Closure Plan for the open burn (OB) units, the Permittee shall provide a sampling and analysis plan (SAP) including sampling locations, number of samples, depths and analytes for each OB unit. In the SAP, include analyses for VOCs, semivolatile organic compounds (SVOCs), perchlorate,. and all explosives compounds treated at the OB units during closure, including the following compounds, unless a demonstration can be made that these compounds were not treated at the OB units:*

    RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine), HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine), TNT (2,4,6-Trinitrotoluene), DNT (2,4- and 2,6-Dinitrotoluene), DNB (1,3-Dinitrobenzene), HCE (Hexachloroethane), Tetryl (Methyl-2,4,6-trinitrophenylnitramine), TNB (1,3,5-Trinitrobenzene, Nitrocellulose, TNG (Trinitroglycerol [nitroglycerin]), PETN (Pentaerythritol tetranitrate), Nitroglycerin,

NQ (Nitroguanidine), WP (White phosphorus) and EGDN (Ethylene glycoldinitrate).

20.4.1 NMAC § 264.112(a)(1) requires that a closure plan containing the elements listed in 20.4.1 NMAC § 264.112(b) be submitted and approved by the NMED. 20.4.1 NMAC § 264.112(b)(4) requires a description of sampling and analytical methods but does not require the submittal of a sampling and analysis plan (SAP). Because treatment operations are ongoing, it is difficult to select appropriate sampling locations, number of samples, and sample depths at this time. Past closure activities at TA-16 have involved the preparation of more detailed closure sampling and analysis procedures subject to NMED approval prior to the initiation of closure activities unless LANL proceeds "at risk". Closure of the TA-16 OB sites is not scheduled to occur within the timeframe of the renewed Hazardous Waste Facility Permit. These factors and the probability that sampling and analytical methodology may improve before closure indicate that the development of a detailed SAP containing procedures beyond those already included in the closure plan is not necessary at this point. Therefore, LANL will not include a SAP as part of the closure plan.

The proposed analytes for the OB sites were presented in Table E.2-2 of the Closure Plan for the Technical Area 16 Burn Ground Unit included as Attachment E.2 of the draft June 2000 LANL Hazardous Waste Facility Permit, Chapter 5 (LANL, 2000b). As stated in that table, LANL intends to analyze for ignitability, corrosivity, toxicity characteristic metals, VOCs, SVOCs, and total RCRA metals. For explosive compounds treated at the OB sites, LANL will add *SW-846* Methods 8330, 8332, 8015b, 7580 , and 314.0 to this table. The revised table in redline/strikeout format is included as Appendix J herein.

11. *The Closure Plan for the OB units shall describe what measures will be taken if a closed OB unit is impacted by an active OB unit.*

The likelihood that emissions from an active OB site will impact a closed OB site in the vicinity is low, as discussed in LANL's response to Comment No. 6.b. If a clean closed OB site is impacted in the future by an active OB site, characterization and potential remediation of the area of the closed OB site will be addressed under a corrective action program at LANL.

12. *Revise the Closure Plan for the closure of container storage units to include the sampling of potential contaminated areas using swipe sampling rather than sampling the rinse water to determine if a release has occurred and to determine if contamination has been remediated.*

LANL does not believe that the use of swipe sampling is the best or only method for closure decontamination determinations, particularly to the extent of replacing rinse water sampling for that purpose. Swipe samples are not approved methodology for hazardous waste constituent sampling, their use may not be

appropriate for some analytes and circumstances, and rinse water sampling has been established by precedence during other closures at LANL.

The only approved sampling methodologies that LANL has been able to identify that use direct swipe sampling are for polychlorinated biphenyl (PCB) decontamination determination (as discussed in "Verification of PCB Spill Cleanup by Sampling and Analysis" *EPA-560/5-85-026* [EPA, 1985], and as included in Attachment A of *SW-846*, Method 8290A) and for Occupational Safety and Health Administration (OSHA) surface contamination sampling (OSHA, 1999). The first use is limited to sampling for PCBs, a non-volatile and normally somewhat viscous compound. The technical intent of this sampling method is also limited to establishing the presence of the compound at a concentration of 10 ppm or higher, a relatively gross level of contamination compared to the risk-based concentration limits required for closure determinations. The second method limits the use of swipe sampling to act as a quality control to ensure that a cleaning procedure is being implemented effectively. The method states specifically that this type of sampling is not attempting to assess health risk resulting from contamination. However, the decontamination criteria used in the most recent relevant LANL container storage area closures (TA-21-61, TA-50-37) have been the U.S. EPA Risk-Based Concentration Limits as stipulated by the NMED. Those criteria are specifically health based. The use of these sampling methodologies has not been expressly extended or approved beyond the stated purpose or context, although swipe samples are commonly used as a screening tool.

Swipe sampling may not be the best or most appropriate method of sampling for other types of contaminants. Materials that have hardened, that reside in relatively rougher surface features (e.g., cracks, surface irregularities), or that will not go into solution with the type of wetting agent used or the conditions for the swipe may not be successfully collected using this method. Swipe sampling is dependent upon the efficiency of the contact between the analyte and the collection medium. The reproducibility of the obtained results is also affected. There are two areas in which rinse water sample collection may be superior. Using the decontamination rinse water (water and decontamination agent) to collect the analyte potentially increases the solubility because there is a higher potential that an acknowledged decontamination agent such as Alconox will solubilize the range of closure plan-specified analyzed compounds versus a compound-specific material (see *SW-846* Method 8290A). In addition, the total surface area contacted is probably higher when the area is decontaminated by the rinse water rather than randomly sampled by the swipe. Therefore, it is believed that swipe sampling does not necessarily represent an improvement over rinse water sampling in collection ability.

Swipe sampling, by nature, does not involve the collection of samples from the entire surface being tested. Therefore, the method relies upon a statistical random sampling approach to determine decontamination. A large number of

samples (with associated costs) is necessary to assure that a sufficiently high confidence level has been achieved to assure decontamination. A significant advantage of the rinse water sampling approach is that the entire area of the surface being tested has been sampled.

LANL has minimized the potential problem of rinse water dilution in past LANL closure activities. Minimization is accomplished by limiting the amount used for the sample collection portion of the decontamination and by utilizing low analytical detection levels and/or concentration techniques. .

Finally, LANL has used the rinse water sampling approach, when appropriate, for all past closure activities conducted in container storage areas. This approach has never been previously questioned by NMED permit writers or inspectors and is currently included in approved container storage area closure plans in LANL's Hazardous Waste Facility Permit. Additionally, NMED has usually required prior approval of detailed sampling and decontamination activities prior to the start of the closure process unless LANL proceeds "at risk" (i.e., subject to changes made by NMED). Rinse water sampling has not been identified as a problem in previous closure plan reviews and approvals. The requirement to replace the methodology with another without supporting scientific basis appears arbitrary and restricts LANL's closure options.

LANL proposes modifying the closure plan to allow the use of any sampling methodology (including rinse water sampling or the use of swipe sampling) determined to be appropriate and approved at the time of closure. Most container storage area closures at LANL will not occur soon and this approach will allow the use of sampling methods that may be developed or improved in future. LANL also proposes meeting with the HWB to further discuss this issue.

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APPENDIX A

COPY OF "NOTICE OF DEFICIENCY; TA-16 PART B APPLICATION REVISION 3.0, JANUARY 31, 2000"

ENVIRONMENT DEPARTMENT
Hazardous Waste Bureau
2905 Rodeo Park Drive East Building 1
Santa Fe, New Mexico 87505-6303
Telephone (505) 428-2500
Fax (505) 428-2567
www.nmenv.state.nm.us

GARY E. JOHNSON
GOVERNOR

PETER MAGGIORE
SECRETARY

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

December 24, 2001

John C. Browne, Director
Los Alamos National Laboratory
P.O. Box 1663, Mail Stop A100
Los Alamos, New Mexico 87545

David A. Gurulé, Area Manager
Department of Energy
Los Alamos Area Office
528 35th Street, Mail Stop A316
Los Alamos, New Mexico 87544

SUBJECT: NOTICE OF DEFICIENCY:
TECHNICAL REVIEW OF THE JANUARY 31, 2000, TA-16 PART B
RCRA PERMIT APPLICATION, REVISION 3.0
LOS ALAMOS NATIONAL LABORATORY (LANL)
EPA ID# NM 0890010515
HWB-LANL-00-002

Dear Dr. Browne and Mr. Gurulé:

The New Mexico Environment Department (NMED) has reviewed the above-referenced document submitted by LANL and the United States Department of Energy (the Permittee) for technical adequacy as required under NMAC 20.4.2.201.3.2. NMED issued a draft Request for Supplemental Information (RSI), dated July 5, 2000 to the Permittee as part of informal permit application discussions. The Permittee responded to the RSI with a draft "Subject Matter Clarification Technical Area (TA) 16 Part B Permit Renewal Document, Revision 3.0" in September of 2000.

Based on our review of the original submittal and the subsequent discussions, NMED has determined that the Permit Application is deficient. NMED requires that the issues described in Attachment A of this letter be resolved in order for the Permit Application to be evaluated for technical adequacy. Any remaining outstanding items from NMED's July 5, 2000 draft RSI not addressed in this Notice must be addressed by facility-wide requirements in the General Permit Chapter.

You are required to respond to this Notice within thirty days of receipt of this letter. If the receipt is not signed, you must respond within thirty days of the date of this letter. Please submit your response electronically using Microsoft Word 2000 or earlier version and also in hard copy.

If you have questions regarding this letter, please contact Lee Winn of my staff at 505-428-2533

Sincerely,

James P. Bearzi
Chief
Hazardous Waste Bureau

JPB:lw

cc: J. Kieling, NMED HWB
D. Cobrain, NMED HWB
C. Will, NMED HWB
P. Allen, NMED HWB
L. Winn, NMED HWB
A. Ortiz, NMED OGC
D. Neleigh, EPA, 6PD-N
J. Ellvinger, LANL ESH-19, MS K490
G. Bacigalupa, LANL ESH-19, MS K490
G. Turner, DOE LAAO, MS A316

File: Reading and Red LANL TA-16 2001

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TA-16 NOD Support

ATTACHMENT A
Notice of Deficiency
TA-16 Part B Application Revision 3.0, January 31, 2000

December 21, 2001

1. Submit the following information to document compliance with 20.4.1.700 NMAC (incorporating 40 CFR Part 265, Subpart P):

   a. information regarding the quantity and physical and chemical characteristics specific to TA-16 waste treated at Open Burn units sufficient to determine risk from deposition of air emissions and ash. This information must contain significantly more detail on the waste than that included in the General Part B Permit Application Waste Analysis Plan. Include the halogen content in the waste and concentrations of lead and mercury in the waste [20.4.1.700 NMAC (incorporating 40 CFR § 265.375)];

   b. information documenting that the Permittee will remove all hazardous waste and hazardous waste residues (including but not limited to ash) from the thermal treatment process area or equipment at closure [20.4.1.700 NMAC (incorporating 40 CFR § 265.381)];

   c. evidence that all hazardous waste burned at TA-16 has the potential to detonate (including waste with low levels, i.e., less than 10 percent, of high explosives). Acceptable evidence includes test results such as EPA Publication SW 846, Test Method for Evaluating Solid Waste, Subsection 6-2, Definition of Explosive Material, or the Bureau of Mines Gap Test or Deflagration/Detonation Transition Test. RCRA precludes open burning of hazardous waste that is not detonable. [20.4.1.700 NMAC (incorporating 40 CFR § 265.382), 52 FR 46946, 46952 (12/10/87)]; and

   d. documentation assuring compliance with the requirements for minimum distance from open burning to the property of others [20.4.1.700 NMAC (incorporating 40 CFR § 265.382)].

2. Submit an explanation of why the wastes treated or disposed of by open burning at TA-16 cannot be treated or disposed of by other methods more protective of human health and the environment. Open burning should be used for treatment only when no other option is available that is more protective of human health and the environment [20.4.1.500 NMAC (incorporating 40 CFR § 264.601)].

3. Submit documentation that the sand filters, unit numbers 401 and 406, meet the regulatory requirements for tanks under 20.4.1.500 NMAC (incorporating 40 CFR Part 264, Subpart J), or submit an explanation of why the sand filters do not meet the definition of a tank at 40 CFR § 260.10.

4. Submit the Stormwater Pollution Prevention Plan for TA-16, including details of stormwater sampling conducted at the burn ground.

5. Submit a proposal for remediating groundwater at the site where contaminants have been detected above New Mexico Water Quality Standards, specifically the barium and HE detected at well R-25.

6. Submit data and analysis that demonstrates compliance with performance standards under 20.4.1.500 NMAC (incorporating 40 CFR §§ 264.601(a)(7), (a)(8), (a)(9), (b)(10), (b)(11), (c)(1), (c)(2), (c)(6), and (c)(7)) for deposition of contaminants to soil at the site from ash or entrained particles resulting from the burning of hazardous waste. This submittal shall include submittal of the following information:

a. summaries of ash sampling results, conducted for the purpose of waste disposal characterization, and an assessment of the potential risk from ash deposition to soil;
b. analysis of possible degradation products of HE that may be generated and the potential risk from levels of the degradation products likely to be found in soil around the burn areas;
c. information on whether volatile organic compounds (VOCs) are released during burning and the potential quantities of VOCs released;
d. comparison of potential levels of contaminants in soil from ash to HWB human health soil screening levels and LANL ecological screening levels; and
e. verification that the open burn units are kept covered when not in use.

7. Move the Application Attachment G, "Container Management," and Attachment H, "TA-16 Burn Ground Unit Management," to the body of the Application, Section 2.0, "Storage and Treatment at Technical Area 16."

8. Combine and revise Table 1-1, Application page 1-3, and Table H-1, Application page H-21, to accurately and specifically indicate where in the Application 40 CFR § 264.601 performance standards are addressed. For example, Tables 1-1 and H-1 do not include § 270.23, Part B Information requirements for Miscellaneous Units. Table 1-1 indicates that § 264.601 is addressed in the Application Attachment F.2; however § 264.601 describes environmental performance standards for operations, and Attachment F.2 addresses closure only. Table 1-1 states that § 264.602 is addressed in Attachment C, but § 264.602 includes monitoring, analysis, corrective action, and reporting requirements for miscellaneous units, and Attachment C only references facility-wide inspection of operations information included in the General Application. Table H-1 only references Attachment H as addressing all of §§ 264.601 and 602, and should indicate by Application section the location in the Application where specific requirements of § 264.601 are addressed.

9. Responses in the draft September 2000 "Subject Matter Clarification" reference Closure Plans in Attachments E-1 and E-2 of the draft June 2000 LANL Hazardous Waste Facility Permit, Chapter 5, submitted by the Permittee to NMED in June 2000. If the Permittee intends those Closure Plans to be the TA-16 specific Closure Plans then the Application must be revised to include those Closure Plans.

10. In the Closure Plan for the open burn (OB) units, the Permittee shall provide a sampling and analysis plan (SAP) including sampling locations, number of samples, depths and analytes for each OB unit. In the SAP, include analyses for VOCs, semivolatile organic compounds (SVOCs), perchlorate, and all explosives compounds treated at the OB units during closure, including the following compounds, unless a demonstration can be made that these compounds were not treated at the OB units:

> RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine), HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine), TNT (2,4,6-Trinitrotoluene), DNT (2,4- and 2,6-Dinitrotoluene), DNB (1,3-Dinitrobenzene), HCE (Hexachloroethane), Tetryl (Methyl-2,4,6-trinitrophenylnitramine), TNB (1,3,5-Trinitrobenzene), Nitrocellulose, TNG (Trinitroglycerol [nitroglycerin]), PETN (Pentaerythritol tetranitrate), Nitroglycerin, NQ (Nitroguanidine), WP (White phosphorus) and EGDN (Ethylene glycoldinitrate).

11. The Closure Plan for the OB units shall describe what measures will be taken if a closed OB unit is impacted by an active OB unit.

12. Revise the Closure Plan for the closure of container storage units to include the sampling of potential contaminated areas using swipe sampling rather than sampling the rinse water to determine if a release has occurred and to determine if contamination has been remediated.

APPENDIX B

TECHNICAL AREA 16 BURN GROUND DATA AND SUMMARY TABLES

Table 1. HE and HE-Contaminated Materials Treated at the TA-16 Burn Ground in 2000

Structure	Year	Quantity of Waste Treated (pounds)
HE-Contaminated Materials Flashed at TA-16-388	1996	91000
	1997	63000
	1998	31600
	1999	5220
	2000	2350
HE-Contaminated Solvents/Oils Burned at TA-16-388	1996	1099
	1997	1650
	1998	1900
	1999	3080
	2000	1040
Bulk HE Burned at TA-16-399, TA-16-401, and TA-16-406	1996	8360
	1997	6100
	1998	6950
	1999	7510
	2000	5650
HE-Contaminated Trash Incinerated at TA-16-1409	1996	2280
	1997	250
	1998	280
	1999+	0

Table 2. Materials Flashed at TA-16-388 in 2000

BURN DATE	AMOUNT (LBS)	MATERIAL	EPA HAZARDOUS WASTE NUMBERS
01/04/2000	50	FIBER & WOODEN HE BOXES & PACKING	D003, D030
02/16/2000	50	CARDBOARD HE BOXES AND PACKING	D003, D030
02/16/2000	10	HE-CONTAMINATED RAGS	D003, D030
02/18/2000	50	CARDBOARD HE BOXES AND PACKING	D003
02/22/2000	150	HE-CONTAMINATED SOIL	D003, D035
03/01/2000	50	HE-CONTAMINATED CARDBOARD BOXES AND PACKING.	D003
03/07/2000	50	HE CARDBOARD BOXES/PACKING	D003
03/13/2000	50	HE CARDBOARD/PACKING MATERIAL	D003
03/24/2000	35	HE-CONTAMINATED RAGS, WIPES, GLOVES	D003, D030
04/19/2000	50	HE- CONTAMINATED RAGS	D003, D030
05/01/2000	355	HE- CONTAMINATED SCRAP METAL, SHOT DEBRIS	D003
08/22/2000	50	HE-CONTAMINATED RAGS, PAPER, PLASTIC	D003, D030
08/23/2000	50	HE- CONTAMINATED RAGS	D003, D030
09/19/2000	50	HE-CONTAMINATED RAGS, PAPER, PLASTIC	D003, D030
10/17/2000	50	HE-CONTAMINATED RAGS, PAPER, PLASTIC	D003, D030
11/02/2000	50	HE-CONTAMINATED TRASH FROM S-SITE	D003
11/06/2000	50	PBX CONT. BURLAP BAGS, SCRAP METAL	D003
11/27/2000	1000	SCRAP METAL & FIRE BRICK	D003
12/14/2000	150	HE-CONTAMINATED RAGS	D003, D030

Table 3. Emissions for Combustible TA-16-388 Flashing Operations

Air Pollutant	Emission Factor (lbs/ton burned)	Emissions (lbs/yr) for Maximum Combustibles (0.9 tons/yr)
Particulate Matter	16	14
Nitrogen Oxides	6	5
Sulfur Oxides	1	1
Carbon Monoxide	85	77
Methane	13	12
Non-Methane Hydrocarbons	30	35
Anthracene	8 E-07	7 E-07
Benzo(b)fluoranthene	2 E-06	2 E-06
Benzo(a)anthracene	2 E-06	2 E-06
Chrysene	2 E-06	2 E-06
Fluoranthene	8 E-05	7 E-06
Phenanthrene	2 E-05	2 E-06
Pyrene	1 E-05	1 E-05
Retene	6 E-06	5 E-06

Table 4. Melting and Boiling Points for Toxic Metals Treated at the Burn Ground

Metal	Melting Point (°C)	Boiling Point (°C)	Emission Factor
Arsenic (As)	817	613 (sublimes)	1.0
Barium (Ba)	725	1140	5.3 E-03
Cadmium (Cd)	321	765	1.0
Chromium (Cr)	1857	2672	5.3 E-03
Lead (Pb)	328	1740	5.3 E-03
Mercury (Hg)	-39	357	1.0
Selenium (Se)	217	685	1.0
Silver (Ag)	962	2212	5.3 E-03

Table 5. Hazardous Constituents (Other than HE) and Quantities of Oil/Solvent Waste Treated at TA-16-388 in 2000

WPF Number	20661	22776	24158	25278	29515	30280	30508	30824	31709	31722	31845	31846	32117	32124	
Amount of Waste	1 gal	15 gal	5 gal	15 gal	1 gal	15 gal	15 gal	6 gal	0.5 gal	10gal	1 gal	2.5 gal	10 ml	25	
Weight of Waste (lbs)	12	125	42	125	8	125	125	50	4	83	8	21	0.02	208	
Constituents (lbs)															Total (lbs)
Acetone							3	6		12		8		5	34
Acetonitrile		19					9								28
Ammonium hydroxide					1										1
BDNPF ether	12														12
Butyl acetate										4					4
Butyl nitrite													0.02		0.02
Chloroform				3											3
Chromium			0.03												0.03
DMSO											1				1
Ethyl acetate										4				31	35
Ethanol						38				6					44
1,2-dichloroethane		12		12			12								36
2,4-dinitrotoluene				6											6
Hydrogen chloride			1												1
Isopropyl alcohol		1					9								10
Mercury			0.02												0.02
Methanol		27		106			41					11			185
Methylene chloride		2					3								5
Methyl ethyl ketone										0.8					0.8
Nitric acid			1												1
Potassium hydroxide			1												1
Pump oil									22						22
Sodium hydroxide			3		1										4
Sulfuric acid			5												5
Tetrahydrafuran		2					3								5
Toluene								22	0.2						22.2
Trichloroethylene							9								9

Table 6. TA-16-388 Oil/Solvent Emissions

Constituent	Air Emissions (lbs/yr)
Acetone	1 E+00
Acetonitrile	1 E+00
Ammonium hydroxide	1 E+00
BDNPF ether	6 E-01
Butyl acetate	2 E-01
Butyl nitrite	1.E-03
Chloroform	2 E-01
Chromium	2 E-04
DMSO	5 E-02
1,2-dichloroethane	2 E+00
Ethyl acetate	2 E+00
Ethanol	2 E+00
1,2-trichloroethane	2 E+00
2,4-dinitrotoluene	3 E-01
Hydrogen chloride	1.E+00
Isopropyl alcohol	5.E-01
Mercury	2.E-02
Methanol	9 E+00
Methylene chloride	3 E-01
Methyl ethyl ketone	4 E-02
Nitric acid	1.E+00
Potassium hydroxide	1 E+00
Pump oil	2 E-01
Sodium hydroxide	4 E+00
Sulfuric acid	5 E+00
Tetrahydrafuran	3 E-01
Toluene	1 E-00
Trichloroethylene	5 E-01

Table 7. Composition of High Explosives Treated at the TA-16 Burn Ground in 2000

Explosive	Explosive Name and Compositions	Detonation Rate (km/sec)	Chemical Formula
ANFO	95% wt% Ammonium nitrate, 5 wt% fuel oil	4.80	$NH_4NO_3 + CH_3(CH2)_{10}CH_3$
Baratol	24 wt% TNT, 76 wt% barium nitrate	4.87	$C_{0.74}H_{0.53}N_{0.90}O_{2.38}Ba_{0.29}$
Boracitol	46 wt% TNT, 60 wt% boric acid	4.86	$C1_{1.23}H_{3.79}N_{0.53}O_{3.97}B_{0.97}$
DAAF	Diaminoazoxy furazan	7.98	$C_4H_4N_8O_3$
HMX	Cyclotetramethylenetetranitramine (Octohydro-1,3,5,7 tetranitro-1,3,5,7 tetrazocine)	9.11	$C_4H_8N_8O_8$
LX02	73.5 wt% PETN, 17.6 wt% butyl rubber, 6.9 wt% acetyltributyl citrate, 2.0 wt% Cabosil	7.37	$C_{2.77}H_{4.86}N_{0.93}O_{2.99}Si_{0.03}$
LX07	90 wt% HMX, 10 wt% Viton A	8.64	$C_{1.48}H_{2.62}N_{2.43}O_{2.43}F_{0.35}$
NC	Nitrocellulose	7.30	$C_6H_{7.29}N_{2.71}O_{10.41}$
NG	Nitroglycerine (1,2,3- Propanetriol trinitrate)	7.70	$C_3H_5N_3O_9$
NTO	1,2,4-nitro-triazole-5-one	7.65	$C_2H_2N_4O_3$
PBX 9404	94 wt% HMX, 3 wt% Nitrocellulose, 3 wt% CEF	8.80	$C_{1.4}H_{2.75}N_{2.57}O_{2.69}Cl_{0.03}P_{0.01}$
PBX 9407	94% wt% RDX, 6 wt% FPC 461	7.91	$C_{1.41}H_{2.66}N_{2.54}O_{2.54}Cl_{0.07}F_{0.09}$
PBX-9501	95 wt% HMX, 2.5 wt% Estane, 2.5 wt% BDNPA-F	8.83	$C_{1.47}H_{2.86}N_{2.60}O_{2.69}$
PBX-9502	95 wt% TATB, 5 wt% Kel-F 800	7.71	$C_{2.30}H_{2.23}N_{2.21}O_{2.21}Cl_{0.038}F_{0.13}$
PETN	Pentaerythrioltetranitrate (2,2-Bis[(nitroxy)methyl]-1,3-propanediol dinitrate)	8.26	$C_5H_8N_4O_{12}$
RDX	Cyclonite (Hexahydro-1,3,5-Trinitro-1,3,5-triazine)	8.70	$C_3H_6N_6O_6$
TATB	1,3,5 Triamino 2,4,6 Trinitrobenzene	7.76	$C_6H_6N_6O_6$
Tetryl	Trinitro 2,4,6 Phenylmethylnitramine	7.85	$C_7H_5N_5O_8$
TNT	2,4,6, Trinitrotoluene (aka 2-Methly-1,3,5-Trinitrobenzene)	6.93	$C_7H_5N_3O_6$
XTX 8003	80 wt% PETN, 20 wt% Silicone Rubber	7.30	$C_{1.8}H_{3.64}N_{1.01}O_{3.31}Si_{0.27}$
XTX 8004	XTX 8004 (80 wt% RDX, 20 wt% SYLGARD182)	7.22	$C_{1.62}H_{3.78}N_{2.16}O_{2.43}Si_{0.27}$

Sources:

- LLNL Explosives Handbook Properties of Chemical Explosives and Explosive Stimulants, UCRL-52997-CHG.2c.1
- DAAF and NTO detonation velocities from personal communication with Dareen Naud, DX-2

Table 8. Compositions of Binders for Explosives Treated at TA-16-399, -401, and –406 in 2000

Binder	Composition
BDNPA-F	Bis(2,2-dinitropropyl) acetal/Bis(2,2-dinitropropyl) formal, 50/50 wt%
Cab-O-Sil (gelling agent):	Amorphous Silicon Oxide (SiO_2)
CEF	Chloroethyl phosphate ($C_6H_{12}Cl_3O_4P$)
Estane	Trade designation for a polyester containing urethane, adipic acid, 1,4-butanediol ($C_{5.14}H_{7.5}N_{.19}O_{1.76}$)
FPC 461 (aka Exon 461)	Vinyl chloride-trifluorochloroethylene copolymer ($C_5H_{4.5}Cl_{2.5}F_3$)
Kel-F 800:	Chlorotrifluoroethylene/vinylidene fluoide copolymer; Trade designation for fluorocarbon resin ($C_8H_2Cl_3F_{11}$)
Sylgard 182	Trade designation for dimethylpolysiloxane resin (C_2H_6OSi)
Viton A	Vinylidine Fluoride/hexafluoropropylene Copolymer, 60/40 wt% ($C_5H_{3.5}F_{6.5}$)

Table 9. Halogens from the Burning of Bulk HE in 2000

	Pounds of Cl and F by Type of HE		Total Cl and F
	9502	9404	
Pounds of HE	1512	406	
Weight % of Binder	5	3	
Pounds of Binder	76	12	
Weight % of Cl in Binder	26	37	
Weight % of F in Binder	51	0	
Pounds of Cl	19	4.5	23.5
Pounds of F	38	0	38

Table 10. Air Emissions from the Burning of Explosives

Compound	Average Emission Factor (lb analyte/lb material burned)	Emissions (lbs/yr) Using Maximum 1996-2000 HE Treated (8364 lbs)
Carbon monoxide (CO)	1.3 E-04	1.1
Carbon dioxide (CO2)	5.9 E-01	4935
Nitric oxide	1.2 E-03	10
Nitrogen dioxide	1.0 E-04	1
Particulate matter (PM-10)	9.1 E-01	7611
Sulfur dioxide ($S0_2$)	1.2 E-03	10
Total aromatics	5.0 E-05	0.42
Non-methane hydrocarbons	1.0 E-04	0.84
Total unidentified hydrocarbons	2.0 E-05	0.17
HCl (HE with Cl binders)	100 % conversion of Cl	25
HF (HE with F binders)	100 % conversion of F	42

Table 11. Chemical Constituents of Ash Collected in 2000

Waste Profile Number	Sample Number	Constituent Concentration (mg/L)							
		As	Ba	Cd	Cr	Ag	Pb	Hg	Se
32054	00DS017	ND	10.6	ND	ND	ND	ND	0.0013	ND
33362	00DS771	ND	1.3	0.09	ND	ND	ND	0.0004	ND
32542	00DS209	ND	12.6	ND	ND	ND	ND	ND	ND
33267	00D676	ND	8500	ND	ND	ND	ND	ND	ND
32400	00DS164	0.1	2.4	ND	ND	ND	ND	0.0005	ND
30489	99DS076	ND	1.4	0.225	ND	ND	ND	0.0007	0.06
30085	98SD639	ND	1.8	ND	ND	ND	ND	0.007	ND
32053	99DS581	ND	3.2	ND	ND	ND	ND	0.0006	ND
30919	99DS285	ND	7.5	ND	ND	ND	0.08	0.004	ND
30487	99DSO77	ND	1.4	0.225	ND	ND	ND	0.0007	0.06
Maximum		0.10	8500	0.225	ND	ND	0.08	0.007	0.06
Minimum		ND	ND	ND	ND	0	0.08	0.0004	ND

Table 12. Background Metal Concentrations in Soil

Metal	Background (mg/kg)	TCLP (ug/L)	Maximum "ash" TCLP (ug/L)
Arsenic	8.17	0.4	0.1
Barium	295	15	8500
Cadmium	0.4	0.02	0.225
Chromium	19.3	0.07	ND
Lead	22.3	1.1	0.08
Mercury	0.1	0.01	0.007
Selenium	1.42	0.07	0.06
Silver	1	0.05	ND

Table 13. Quantities of Metals Released from Burning

Waste Profile Number	Amount of Ash Disposed (lbs)	Constituent (lb)			
		Ba in Ash	Ba Emitted	Cd in Ash	Cd Emitted
32054	1100	0.2332	1.24E-03	0	0.00E+00
33362	2200	0.0572	1.24E-03	0.004	4.00E-03
32542	900	0.2268	1.20E-03	0	0.00E+00
33267	550	93.5	4.96E-01	0	0.00E+00
32400	550	0.0264	1.40E-04	0	0.00E+00
30489	1650	0.0462	2.45E-04	0.0074	7.40E-03
30085	550	0.0198	1.05E-04	0	0.00E+00
32054	2200	0.1408	7.46E-04	0	0.00E+00
30919	1100	0.165	8.75E-04	0	0.00E+00
30487	1100	0.0308	1.63E-04	0.005	5.00E-03
TOTAL			5.01E-01		1.64E-02

Table 14. Comparison of 2000 Emissions with SALs and ESLs

Constituent	Air Emissions (lbs/yr)	Air Emissions (g/yr)	Deposition over 10 years (mg/kg)	SAL for Industrial Soil (mg/kg)	ESL (mg/kg)
Aluminum	-	-	-	1.0 E+5	5.0 E+0
Acetone	1 E+00	4 E+02	3 E-05		3.7 E+00
Anthracene	7 E-07	3 E-04	2 E-11	3.4 E+04	2.0 E+02
Barium	5 E-01	2 E-02	6 E-05	1.5 E+04	2.4 E+00
Benzo(b)flouranthene	2 E-06	9 E-04	6 E-11	2.6 E+01	1.8 E+01
Benzo(a)anthracene	2 E-06	9 E-04	6 E-11	2.6 E+01	
Benzene	-	-	-	5.6 E+00	5.5 E-01
Cadmium	2 E-02	7 E+00	2 E-06	1.9 E+02	1.0 E-01
Carbon tetrachloride	-	-	-	1.3 E+00	
Chloroform	2 E-01	1 E+02	6 E-06	3.0 E-01	2.8 E+01
Chrysene	2 E-06	9 E-04	6 E-11	2.5 E+03	2.5 E+00
Chromium	2 E-04	7 E-02	2 E-08	1.0 E+05 (III) 6.6 E+02 (VI)	1.4 E+00 (TOTAL) 2.0 E-01 (VI)
Copper	-	-	-	8.5 E+03	1.0 E+01
1,2-dichloroethane	2 E+00	9 E+02	6 E-05	7.2 E+00	
2.4-dinitrotoluene	3 E-01	1 E+02	9 E-06	3.0 E+02	1.0 E+0
Fluoranthene	7 E-06	3 E-03	2 E-10	5.3 E+03	2.6 E+01
Fluoride	4 E+01	2 E+04	3 E-04	8.9 E+03	3.1 E+01
Iron	-	-	-	6.9 E+04	N/A
Lead	-	-	-	1.0 E+03	5.6 E+01
Mercury, elemental	2 E-02	9 E+00	2 E-06	2.0 E+01	5.0 E-02
Methylene chloride	3 E-01	1 E+02	9 E-06		7.0 E+00
Nickel	-	-	-	4.4 E+03	2.0E+01
Nitrate (use HNO_3 and NO_x and NO)	6 E+00	3 E+03	4 E-05	1.0 E+05	
Nitrite (use NO_x and	2 E+01	7 E+03	1 E-04	1.5 E+04	
Phenanthrene	2 E-06	9 E-04	6 E-11	4.4 E+03	1.1 E+01
Phenol	-	-	-	8.9 E+04	7.9 E-01
Pyrene	1 E-05	4 E-03	3 E-10	4.3 E+03	1.5 E+01
Selenium	-	-	-	1.2 E+03	1.0 E-01
Silver	-	-	-	1.2 E+03	5.0 E-02
Toluene	1 E-00	5 E+02	3 E-5	1.8 E+02	7.1 E+01
Trichloroethylene	5 E-01	2 E+02	1 E-5	1.8 E+01	1.9 E+00
Xylenes	-	-	-	6.3 E+00	1.1 E+01
Zinc	-	-	-	6.9 E+04	1.0 E+01

APPENDIX C

COPY OF "EMISSION FACTORS FOR THE DISPOSAL OF ENERGETIC MATERIALS BY OPEN BURNING AND OPEN DETONATION (OB/OD)"

EPA/600/R-98/103

Emission Factors for the Disposal of Energetic Materials by Open Burning and Open Detonation (OB/OD)

By

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AUGUST 1998

This emission factor database was created using data collected by the U.S. Department of Defense

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Disclaimer

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Abstract

This report contains a validated database of pollutant emission factors applicable to the disposal of energetic-containing materials through open-air burning (in burn pans) and unconfined detonation processes (OB/OD). The emission factors in the database were compiled using data from studies, which measured the quantities of particles, semivolatile organic compounds, polychlorinated dibenzo-p-dioxins and furans, toxic metals, volatile organic compounds, and inorganic gases released when 0.22 kg of energetic materials were detonated and 2.2 kg of these materials were burned in 930 m^3 chambers, called BangBoxes. Air samples from the chamber were analyzed for over 275 analytes. The actions taken in validating the database are also described along with the minimum quantification limits for each pollutant measurement system. Summary statistics were calculated and compared to the results from smaller (0.02 kg)and larger (250-3,200 kg) scale detonations and burns of energetic materials. These comparisons confirm and expand upon results from earlier studies which determined that emission factors derived from chamber-based results can be used to predict the emission products that would be released from much larger scale detonations and burns, that is, the results are scalable. These comparisons also indicate that OB- and OD-based processes can be environmentally friendly ways to dispose of many of the energetic materials in the demil inventories of the world.

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List Of Abbreviations And Terms

Abbreviations

DPG: Dugway Proving Ground, UT

LLNL: Lawrence Livermore National Laboratories

SNL: Sandia National laboratories

Definition of Terms

Blast effect: the high pressure generated by the explosion.

Brisance: the ability of an explosive to provide shock waves to shatter the target. After shattering the target, the shock wave can continue moving through the target. In this respect, brisance differs from blast effect. The blast itself can not transmit the energy through solid material without moving the target, but shock waves can.

Composite Explosive: A solid propellant comprised of an oxidizer (e.g., ammonium perchlorate) and a metallic fuel (e.g., aluminum powder) held together by a polymeric substance (e.g., polybutadiene).

Double-base Propellant: A solid propellant comprised of nitrocellulose (NC) and nitroglycerin (NG).

Emission Factor: The mass of an analyte released by a detonation or burn normalized to the energetic mass of the material (MEM) detonated. In the database, the emission factors are in terms of Kg analyte/kg MEM.

Encapsulated Energetic: An assembled energetic-containing material, such as a mine or a fuze.

Energetic: A substance, either a pure compound or a mixture of compounds, capable of undergoing a very rapid chemical change, releasing large quantities of heat and large volumes of hot gases. Includes high explosives, low explosives (propellants and pyrotechnics), incendiaries, fuse powders and thermites.

Explosive: A chemical compound or mixture which, when subjected to heat, impact, friction, shock or other suitable stimulous, undergoes a very rapidchemical reaction with the evolution of large volumes of heated gases that exert high pressures in the surrounding medium. Explosives are a subset of energetics, excluding those which do not produce large volumes of hot gases (e.g., incendiaries, fuse powders and thermites).

High Explosive: An energetic material in which the decomposition process (detonation) proceeds through the entire material at supersonic speed. The rate at which the decomposition process passes through the explosive is determined by the velocity of the shock wave.
TNT, RDX and PETN are examples of high explosives.

Low Explosive: An energetic material in which the decomposition process (deflagration) occurs at subsonic speed. The decomposition occurs on the surface of the explosive only; there is no shock wave.
Propellants and pyrotechnics are examples of low explosives.

Single -base Propellant: A solid propellant containing only

nitrocellulose (NC) as the primary energetic material.

Target Analytes: The chemical species sought in the emissions from the detonations and burns, e.g., Pb, Al, acetylene. The target analytes are identified in Appendix C.

Triple-base Propellants: A solid propellant comprised of nitrocellulose (NC), nitroglycerin (NG) and nitroguanidine (NQ).

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Executive Summary

A database of emission factors applicable to the open burning (in burn pans, OB) and open detonation (OD) practices routinely used to destroy surplus or unserviceable energetic materials has been constructed and validated using emissions data from 16 energetic materials which were burned and 23 materials which were detonated in a 930 m^3 chamber called a BangBox. Both high and low explosives in bulk and assembled (encapsulated) form were detonated, but only low explosives in bulk and encapsulated forms were burned.

The database also contains emission factors from the burning of two surrogate materials, dunnage and an energetic-containing waste. The waste simulated one that would result from cleaning the processing equipment after an aluminized ammonium perchlorate (Al-AP) waste had been manufactured. The burns of these surrogate materials were initiated with diesel fuel.

A comparison of the emission factors in the database to those generated in other chamber studies and in large scale, unconfined field tests showed that all test results conformed to detonation theory. This finding indicates strongly that it should be possible to classify energetic materials into broad categories for the purpose of predicting the emission products and confirmed that chambers can be used to derive emission factors for use in predicting the emissions from unconfined detonations and burns.

Significant findings from these comparisons follow.

Findings Applicable To Both OB and OD

(1) Unconfined detonations, lightly-confined detonations and burns yield similar emission products, but the mix of products is different. If the energetic materials do not contain toxic metals, chlorine, plastic, wood or diesel fuel, the emission products will be CO_2, H_2O and N_2 along with small quantities of NOx and light hydrocarbons. Consistent with detonation theory, molecules larger than the starting molecules are not formed, even when the detonation is partially confined.

(2) The following four parameters are statistically the same across all the items detonated and burned in an unconfined state: %C as COx, %CO/COx, %N as NOx, and %NO/NOx.

(3) The emission products from most energetic materials destroyed by OB and OD processes will be adequately represented by the following analytes: CO_2, CO, NO, NO_2, total saturated hydrocarbons (e.g., ethane, propane, butane), acetylene, ethylene, propene, benzene, toluene, and particulate.

(4) Low recoveries of aluminum, lead, sulfur and chlorine were common across all detonation and burn studies used in these comparisons. In all studies 98 to 99% of the chlorine recovered was determined to be HCl. The high reactivity of chlorine is a likely explanation for the low recoveries. The reasons for the low recoveries for sulfur and the

metals still need to be determined to more fully characterize the environmental safety of OB and OD practices.

(5) Because most of the emission products from OB and OD operations are all species commonly found in the environment, it is particularly difficult to correct for contamination of metals and semi-volatile organic compounds (SVOCs)released from the walls of the chamber or the soil by the blast wave or the rapid movement of heated air. To compensate for the sample contamination from these sources when measuring the emission products from OB and OD activities, background samples should be collected by sampling the emissions from burning or detonating a material that would not be expected to release SVOC's or metals, e.g., detonation cord and nitrocellulose.

Findings Applicable to OD Only

(1) For the unconfined detonations, the median % recovery of carbon as carbon oxides (CO_2 + CO) was 98.5%; only 1.6% of the carbon was recovered as CO. The median % recovery of nitrogen as NOx was 1.2%. The remaining nitrogen was likely converted to N_2 in conformance with detonation theory and the results from large scale detonations conducted in the tunnels at the Nevada Test Site.

(2) Detonation-based processes can be an environmentally-safe way to dispose of bulk energetic materials, particularly for those which have been recovered from assembled munitions and for which there is no commercial or military use. This is especially applicable when: (1) the detonation occurs in an unconfined or lightly-confined state; (2) the detonation goes high order; (3) the soil particles released to the atmosphere are not hazardous in their own right; and (4) the toxic metals in the energetic materials are either at concentrations low enough not to endanger the health of humans or ecosystems or, their release to the environment can be kept below these levels. Coupling OB with phytoremediation techniques could be particularly rewarding in terms of protecting human health and the environment in both the short term and long term.

(3) It is also possible that many assembled munitions could be destroyed in an environmentally safe manner using detonation-based processes, provided research can provide a better understanding on how the following variables affect the emission products: donor charge placement, stacking geometry, mass of energetic material, degree of blast confinement and the type of casing.

(4) Compared to an unconfined detonation of the same material, detonating an energetic under a soil cover (buried detonation), or under other conditions which inhibit the formation of a fireball, will cause a decrease in CO_2 and an increase in soot (free carbon), CO, light saturated hydrocarbons, acetylene, ethylene, propene, benzene and toluene. It will very likely also increase the quantities of undegraded or partially degraded energetic starting materials. Placing an oxygen source next to a buried energetic material will not automatically ensure that detonation will convert all the carbon in the energetic to carbon oxides.

(5) Buried detonations should be avoided whenever possible. For

those situations where OB is not acceptable and blast noise control is needed, numerous, small scale detonations in chambers should be considered as an alternate to buried detonations.

Findings Applicable to OB Only

(1) The median % recovery of carbon as carbon oxides (CO_2 + CO) from the materials burned was 98.5%; only 0.2% of the carbon was recovered as CO. The median % recovery of nitrogen as NOx was 0.9%. The remaining nitrogen was likely converted to N_2 in conformance with detonation theory and the results from large scale detonations conducted in the tunnels at the Nevada Test Site.

(2) Open burning is an environmentally-safe means to dispose of single, double and triple base (organic-based) propellants when the propellants do not contain significant amounts of other combustible materials, such as diesel fuel, wood and chlorinated plastics or toxic metals. OB may be particularly appropriate for destroying energetic materials which result from steamout, water jet cutting and other demilitarization processes. Coupling OB with phytoremediation techniques could be particularly rewarding in terms of protecting human health and the environment in both the short term and long term.

(3) Open burning may also be appropriate for energetic materials containing AP, if the HCl and any metals in the energetic released could be prevented from entering the environment in quantities which could endanger the health of humans or ecosystems. Pollution control technologies that could accomplish this are available, although their suitability for this application needs to be established.

(4) Burning energetics containing plastics and chlorine in the presence of diesel fuel and wood may produce dioxins and furans.

Chapter 1
Introduction

U.S. EPA Regulations For the Disposal of Energetic Materials

During the Cold War, the United States of America, its allies and the former Soviet Union accumulated over 9,000,000 tons of energetic materials. With the ending of the Cold War, the United States, as well as these other countries, are now faced with disposing of large inventories of these materials in an environmentally sound manner. For example, in 1997, the U.S. Department of Defense (DoD) had 450,000 tons in its "demil inventory" and the inventory has been increasing by 40,000 to 50,000 tons per year.

The four methods commonly used to dispose of unneeded energetic materials are: (1) incineration; (2) disassembly, recovery and recycling (DRC); (3) burning in pans in an open area (OB); and (4) detonating either at ground level (OD) or under a soil cover (buried OD).

Although incineration and DRC are the environmentally-preferred methods of disposal, for the following reasons, they are not suitable for disposing of many of the items already in the demil inventory or likely to enter the inventory in the near future. First, the composition of many of the materials is either unknown, unstable, obsolete or has degraded. Second, the materials cannot be safely disassembled. Third, the financial and environmental expense of developing a recovery and reuse technology for them cannot be justified based on the quantity in the demil inventory or the commercial value of the material that would be recovered. For these materials, OB and OD are the only disposal techniques currently available and, thus, they continue to be an integral part of this nation's demil programs.

In the U.S., as elsewhere, there are concerns about the impact of OB and OD-based practices on human health and the environment. In the U.S., the disposal of energetic materials by OB and OD has been regulated under the Resource Conservation and Recovery Act (Subpart X of 40CFR264)[1], since 1984. One of the major concerns is the degree to which the energetic and its associated packing or containment materials are converted to innocuous chemicals. Other concerns relate to the toxicities and dispersion in the environment of the ash, soil and chemical pollutants released and the impact of the blast waves and sound waves released.

Because of these concerns the Subpart X permits that have been issued are very restrictive in terms of the conditions under which OB and OD can be carried out and the quantities that can be destroyed at one time, and over selected periods. To obtain a Subpart X permit, a facility must, at a minimum, provide the following information to the regulatory agency. First, the identity and quantities of pollutants and debris that will be released per event and over time. Second, the intensity of the blast waves and sound waves that will be generated. Third, a description of how these pollutants, debris, blast waves and sound waves will be distributed in the environment. Fourth, the degree to which the health of humans and the environment may be endangered in the short term (event basis) and over the lifetime of the OB and OD program.

The Detonation Process

Explosives are the class of energetic materials normally disposed of by OB and OD procedures. Explosives fall into two general classes: high and low[2]. High explosives are energetic materials in which the decomposition process (detonation) proceeds through the entire material at supersonic speed. The rate at which the decomposition process passes through the explosive is determined by the velocity of the shock wave and not by the rate of heat transfer. Low explosives (propellants and pyrotechnics) are energetic materials in which the decomposition process (deflagration) occurs at subsonic speed. The decomposition occurs on the surface of the explosive only and there is no shock wave. The rate determining factors in the deflagration process are the rate of heat transfer into the propellant itself from the burning surface and the rate of decomposition of the propellant formulation. The rate of the heat transfer is affected by the pressure of the combustion products.

The amount of energy released by propellant burning is comparable to that released when a high explosive of that same mass is detonated; the difference is in the rate at which the energy is released. In high explosives, a fast reaction produces a very high pressure shock in the surrounding medium. This shock is capable of shattering objects. In propellants (low explosives), a lower pressure is produced that extends over a longer period of time. High explosives produce peak pressure of 36,000 to 360,000 atmospheres in less than 4 microseconds; this pressure wave radiates through the material at a velocity (detonation velocity) between 2,500 and 10,200 m/s. The detonation also produces a 2-10 second fireball (afterburn) which has initial dimensions 1.2 to 1.5 times the dimensions of the material detonated. Propellants on the other hand, seldom produce peak pressures in excess of 3,500 atmospheres. TNT, RDX, Comp B are examples of high explosives and nitrocellulose (NC) and nitroguanidine (NQ) are examples of low explosives. Nitroglycerin (NG) by itself is a high explosive, but when added to NC, it becomes part of a low explosive. For both types of explosives, the initial release of energy results from adiabatic, oxidation reduction processes, which involve oxidant (e.g., $-ONO_2$, $-NO_2$, $-NHNO_2$) and reductant (e.g., C_xH_y) radicals within the energetic material.

Cook[3] and Ornellas[4,5] have published extensively regarding the mechanisms involved when explosives are detonated and burned. The information presented in this section was taken primarily from their publications.

Cook's publication provides a very lucid, comprehensive description of how explosives are made and how their performance is modified by the addition of accelerators and retardants. Ornellas's publications, on the other hand, describe results from experiments conducted to derive thermodynamic codes for use in predicting the explosive performance of C,H,N,O,Al-based explosives. These studies primarily assessed the effect the following factors had on the efficiency and effectiveness of the detonation process: explosive density, purity, and particle size; degree of confinement; and type of initiating charge. One of his reports[4] presents a comprehensive summary of the results obtained from detonating 25g cylindrical pellets (6.4 to 12.7 mm diameter, 114 mm

long) of 43 energetic materials in a 5.3L bomb calorimeter at Lawrence Livermore National Laboratories (LLNL). Most of the detonations were done with the calorimeter evacuated, but a few were done when the calorimeter was pressurized with either CO_2 or O_2. Some of the detonations were done with the energetic simply suspended by a string (unconfined detonation), others were done with the energetic encased in glass or metal cylinders; sometimes the ends of the cylinders were open (partially-confined detonation), but at other times they were closed (fully-confined detonation). Approximately 90 minutes after the detonation, gas samples were taken from the bomb calorimeter and analyzed for N_2, CO, CO_2, H_2, H_2O, CH_4, NO, NO_2, HCN, HCl, HF, C_2H_2, C_2H_4 C_2H_6, and CH_2O, as appropriate. The calorimeter itself was also rinsed out and the rinse analyzed for solid carbon (C_S), HCl, HF Al_2O_3, and Zr_2O_3, as appropriate.

Ornellas's studies determined the following:

(1) The major reaction products from an unconfined detonation are primarily the fully oxidized, thermodynamically-stable compounds: N_2, CO_2, and H_2O. The detonation also produces small quantities of incompletely-oxidized, combustible products such as elemental carbon (C_S or soot), CO, H_2, CH_4, NO, NO_2, HCN, HCl, HF, C_2H_2, C_2H_4, C_2H_6, and CH_2O, but, as the fireball expands all or most all of these latter products react with O_2 in the air or with each other to form CO_2, N_2, and H_2O. The oxidation (afterburn) of these initial products releases energy which helps support additional combustion. After the burning gaseous mass cools to about 1800^0 K, the reaction rates fall to a point where further chemical change takes hours or longer to occur.

(2) The actual composition of initial detonation products depends on a variety of factors; one of the most important of these is the amount and form of oxygen in the energetic molecule. If the energetic is oxygen-balanced or only slightly oxygen-deficient, most of the carbon is converted to CO_2 and most of the hydrogen is converted to H_2O at the instant of detonation. As the oxygen-balance becomes more negative, the amount of soot, CO and other incompletely oxidized products formed increases and the fireball must occur if the incompletely oxidized products formed by the detonation are to converted to CO_2, N_2, and H_2O.

(3) Generally, at least 97% of the nitrogen in the energetic is released as N_2; almost all the rest is released as NO and NO_2.

(4) As noted above, the initial release of energy by an explosive results from an adiabatic oxidation reduction mechanism. This was dramatically demonstrated by Ornellas using a 20:80 blend (by weight) of ammonium nitrate (AN) and TNT. In his experiments, Ornellas used unlabeled AN (contains 99.8% $_{14}N$), labeled AN (contains 99.1% $_{15}N$ isotope) and unlabeled TNT (contains 99.8% $_{14}N$). In one of the experiments he made a slurry of TNT and AN in toluene, dried the slurry, blended it, sieved it through a 30-mesh screen and pressed the resulting powder into 12.7 mm diameter pellets, which he then detonated in the calorimeter. In the other experiment he detonated a 12.7 mm diameter AN pellet containing a 6.4 mm diameter core of labeled AN and an annulus of unlabeled AN. After each detonation, Ornellas measured the isotopic content of the N_2 formed, i.e., $_{14}N_{14}N$, $_{14}N_{15}N$, and $_{15}N_{15}N$. The two experiments yielded similar results, i.e., only about 13% of the

nitrogen in the TNT and the AN mixed.

(5) If the oxygen in the energetic is bonded with nitrogen, the energy released upon detonation is much greater than that which is released when the oxygen is bonded to hydrogen.

(6) The composition of the initial detonation products is not greatly affected by the degree of confinement, but, the composition of the final products is affected. The more oxygen-deficient the energetic, the more the degree of confinement affects the final product mix.

(7) If an oxygen-deficient energetic is detonated in an oxygen-enriched environment, the final products will be CO_2, N_2 and H_2O. On the other hand, the products formed by detonating an energetic in an inert atmosphere (e.g., CO_2) will be essentially the same as those formed when the energetic is detonated in a vacuum, regardless of the degree the energetic is oxygen-balanced (Table 1-1). The oxygen-rich atmosphere will also yield a much higher total energy release (Table 1-1), because of the heat released when the incompletely oxidized radicals are oxidized by the oxygen.

(8) Generally, less than 20% of the Cl and F in the energetics detonated in the bomb calorimeter was recovered, but all of the Cl and F recovered was in the form of HCl and HF. The missing Cl and F were assumed to have reacted with the steel walls of the calorimeter, because they were not found in the rinse of the calorimeter.

(9) Al and Zr in the energetic were usually not quantitatively recovered, but the portion recovered was all in the oxide form.

(10) The packing density has a profound influence on the ratios of initial products formed from a detonation. For example, free-flowing loose granules do not explode as efficiently as cast explosives.

(11) As the density of a high explosive is increased, the detonation pressure and temperature also increases. On the other hand, when the density of a propellant is increased the detonation pressure decreases, even though the reaction (deflagration) temperature increases.

(12) A trace impurity can substantially increase or decrease the efficiency with which the detonation will occur.

(13) The manner in which the charges are placed, the priming method, and the placement of the initiating charge can influence the effectiveness of the detonation in destroying all of the energetic. The most desirable circumstance would be to assure that the explosive detonates ideally. An explosive stack with an irregular shape will usually impact much more force in the direction of the longest dimension.

The studies described above were conducted to improve the in-use performance of energetic materials. The nature of the emissions and the impact of these emission products on the health of humans and

ecosystems when surplus or unserviceable energetic materials are destroyed by OB and OD processes were not addressed. These latter energetic materials frequently contain degraded or below specification grade energetics and other materials, such as asphalt, resinous shell linings, binders, cardboard, wood, metal foil, etc., which could adversely impact the efficiency of the detonation and burning processes.

Also, real world OD processes are usually not truly adiabatic, because the fireball and plume encounter a myriad of heat sinks which prematurely quench the fireball or cool the plume and therefore can hinder the oxidation of the incompletely oxidized products released by the detonation. For example, even in a truly spherical fireball having the lowest possible ratio of surface to mass of any geometrical form, the outermost layer of the expanding fireball will be in direct contact with the ambient air. Also, the expanding gases penetrate the earth under the cloud, where they are both cooled by conduction and denied access to air for further oxidation until below equilibrium maintaining temperature. Further, for noise control purposes, at many facilities the detonations are conducted under a soil cover.

Studies To Assess The Environmentally Important Emissions From OB and OD Activities

In response to public concerns about the ability of OB and OD processes to convert degraded energetics into innocuous products, the Department of Defense (DOD) began its first comprehensive study to characterize the emissions from OB and OD activities in 1984. The DOD hoped to demonstrate that OB and OD would yield emission products which were similar to those from energetics when used for their intended purpose.

In this study, helicopters equipped with commonly-used air pollutant sampling equipment measured the pollutants in the plumes released when 900 to 5000 kg quantities of energetic materials were open burned and open detonated at DPG, UT. The results were inconclusive.[6] Few of the target compounds (analytes) were detected, but it wasn't clear if this was because they weren't present or because they were present at concentrations which were below the detection limits of the sampling equipment. Also, it was subsequently established that the helicopter frequently sampled only the outer portion of the plume and that the plume volume measurement technique was not reliable.

In 1988, the United States Army initiated a second study which had two major objectives: (1) to determine if toxic or hazardous pollutants were released when energetic materials were detonated or burned; and (2) to determine if emission factors produced by detonating and burning small quantities of energetic materials in large chambers containing ambient air would provide emission factors equivalent to those determined when large quantities of energetic materials were open-detonated and open-burned in the ambient air in the unconfined state.

Detonating and burning the energetic materials in large chambers provided DOD the opportunity to: (1) characterize ten or more energetic materials at a cost comparable to conducting field tests on one energetic material; (2) collect sufficient sample to meet the minimum quantification limits of the pollution measurement systems; (3) study

the decay rates of the primary and secondary products released from detonations and burns; (4) minimize testing delays due to adverse weather conditions; and (5) obtain the minimum number of detonations and burns required to calculate statistically valid emission factors on each type of PEP material under repeatable and controlled conditions.

In this second study, 225 g quantities of flaked TNT were detonated and 2 kg quantities of two types of propellants were burned in a 930 m^3 hemispherical chamber (BangBox) at Sandia National Laboratories (SNL) in Albuquerque, NM and the emission products were measured with state-of-the-art air sampling equipment. This sampling equipment was then installed in a twin-engine, turboprop aircraft and used to sample the plumes released when 900 kg quantities of four explosives (reclaimed TNT, PBXN, Explosive D and Composition B) contained in treated wood boxes were detonated on the ground and 2,000-3100 kg quantities of four bulk propellants (M1, M6, M30 and a composite propellant) were burned in steel pans in the open at Dugway Proving Ground (DPG), UT.[7,8] Three, 2000-kg TNT detonations were also conducted with the TNT in iron cages suspended 10 m above the ground.

Based on their review of the test results, the U.S. Army concluded that the emission factors derived from the BangBox tests were: (1) more reliable and reproducible than those from the field tests; (2) were statistically equivalent to those determined from the field tests; and (3) supported the original assumption that the detonations and burns were producing emission products consistent with detonation theory. For example, the CO_2 and CO emission factors derived from the TNT-BangBox detonations (TNT block suspended 1 m above the floor) were the same as those from the 2000-kg, suspended, reclaimed-TNT detonation, but both were substantially higher than those from the 2000-kg surface reclaimed-TNT detonatio.n[8] In this latter detonation, the expanding gases likely penetrated the earth under the detonating TNT and some of the energy released by the detonation was lost (transferred) to the soil. The resultant "cooling" of the fireball in combination with the reduced access to O_2 prevented the complete oxidation of the incompletely-oxidized products which were released by the detonation of the severely oxygen-deficient TNT molecules.

In their test reports the Army also noted the similarity of the emission products from the BangBox and field tests across all the materials tested, i.e., the emission products were primarily: N_2 (assumed), H_2O and CO_2; particles and metals; and small quantities of CO, NO, NO_2, low molecular weight volatile organic compounds (VOCs)and a few semivolatile organic compounds (SVOCs) commonly found in the ambient air. The report also noted: (1) that the soil at DPG had a high organic content and that the soil could have been the primary source for the SVOC's associated with the detonations; and (2) that the % C Recovered as CO_2 followed detonation theory, i.e., 99% for the 900 kg suspended field detonations (no detonation energy losses to soil), 97.5% for the 0.2 kg detonation in the BangBox and 95% for the 900 kg surface field detonations.[8]

In 1992, the U.S. EPA concurred with the Army's conclusion and agreed to accept BangBox derived emission factors for energetic materials as representative of those that would be derived through ground level, open-air tests. The Army then installed a BangBox at DPG identical to

the one at SNL and initiated a program to characterize the compounds released when a wide variety of bulk and assembled munitions representative of those in the demil inventory were destroyed by OB and OD.

BangBox Study Results Used To Construct Database

Seven studies to characterize the emissions from the detonation and burning of energetic materials have now been conducted in BangBoxes. In these studies, 16 energetic materials have been burned and 23 have been detonated under conditions representing standard, unconfined OB and OD disposal practices. Since the seven studies used similar sampling and analysis procedures and had extensive documentation on what was done, it was possible to develop and validate the database of emission factors described in this report.

The database also includes the results from two special experiments. One experiment involved burning a surrogate dunnage to determine the contribution the burning dunnage makes to the emissions when it is used to initiate or support burning of an energetic material.

The other experiment involved using bags of water to suppress the detonations of two, TNT-based energetic materials, amatol and tritonal. These suppressed detonations were done primarily to assess how detonating an energetic under a soil cover could change the emission products compared to detonating the same weight of the energetic material on the ground. (As mentioned above, buried detonations are frequently used in the U.S. to mitigate the sound and blast waves released by the detonation.) Amatol and tritonal were selected for this experiment because they represent two extremes in the oxygen content of commonly used explosives. When detonated, amatol, an oxygen-balanced explosive, contains sufficient oxygen to convert its C and H to CO_2 and H_2O, whereas tritonal contains only 20% of the oxygen required to convert all its carbon to CO2 and H_2O.

These suppressed detonation experiments were also done to provide some robust emission factors for a blast and noise suppression technology developed in the U.S.[9], but refined in Europe[10,11] and South Africa [12]. The technology involves detonating munitions in contact with plastic bags containing water. This technology reduces the blast noise by more than 90% when compared to an equivalent unrestricted detonation[10]. However, the water also quenches the fireball which, based on the amount of sooty particulate found after the detonation, reduces the overall destruction efficiency of the detonation process.

Table 1-1. Distribution of Carbon in Emission Products from Detonating TNT in Different Atmospheres in Bomb Calorimeter[a].

	Calorimeter Atmosphere		
	Vacuum	CO_2 (1.66 Atm.)	O_2 (2.46 Atm.)
Total Energy Released (kcal/mol)	1093	1116	3575
% C Recovered as CO_2	18	17	97
% C Recovered as CO	28	29	5
% C Recovered as (soot)	52	52	Not Detected
Total % Carbon Recovered	98	98	102

a.) Data taken from Table 44 on page 77 of Reference 4.

Table 1-2. Heats of Reaction (kcal/mol) for Selected Gas Phase Reactions at 1 Atmosphere and 298° K

REACTANTS		PRODUCTS	HEATS OF REACTION
$C + \frac{1}{2} O_2$	=	CO	-26
$C + O_2$	=	CO_2	-94
$CO + \frac{1}{2} O_2$	=	CO_2	-68
$2\ CO$	=	$CO_2 + C$	-41
$CH_4 + \frac{1}{2} O_2$	=	$CO_2 + H_2O$ (gas)	-192
$H_2 + \frac{1}{2} O_2$	=	H_2O (gas)	-58
$H_2 + CO$	=	$C + H_2O$ (gas)	-31
$\frac{1}{2} N_2 + \frac{1}{2} O_2$	=	NO	+22
$NO + \frac{1}{2} O_2$	=	NO_2	-14
$3/2\ H_2 + \frac{1}{2} N_2$	=	NH_3	-11
$NH_3 + 3/4\ O_2$	=	$\frac{1}{2} N_2 + 3/2\ H_2O$ (gas)	-78
$NH_3 + 3/2\ NO$	=	$5/4\ N_2 + 3/2\ H_2O$ (gas)	-108
$4/3\ NH_3 + NO_2$	=	$7/6\ N_2 + 2\ H_2O$ (gas)	-108
$CH_4 + 2\ NO_2$	=	$N_2 + 2\ H_2O$ (gas) $+ CO_2$	-208
$S + O_2$	=	SO_2	-71
$SO_2 + \frac{1}{2} O_2$	=	SO_3	-23
$H_2 + S$	=	H_2S	-5

Chapter 2
Methods and Materials

Composition of the Energetic Materials Characterized

Table 2-1 identifies the materials detonated and burned in the seven studies. Table 2-1 also presents: the abbreviation used for each material in the other tables in this paper; the total weight (mass) of each energetic material (MEM) tested; and the number of times (trials) each material was detonated or burned. MEM includes the weight of all supplemental energetic materials such as blasting caps, donor charge, smokeless powder, etc. used in initiating the detonation or burn.

Tables 2-2 and 2-3 present the weights of the energetic components and Pb and Al in each material detonated and burned to the extent information is available. The abbreviations used in these tables represent the following compounds: TNT (2,4,6 trinitrotoluene); RDX (1,3,5-trinitro-1,3,5-triazacyclohexane); PETN (pentaeyrthritol tetranitrate); TETRYL (2,4,6, N-tetranitro-N-methylaniline); NC (nitrocellulose); NG (nitroglycerin); NQ (nitroguanidine); HMX (1,3,5,7-tetranitro-1,3,5,7-tetraazacyclooctane); AP (ammonium perchlorate); and AN (ammonium nitrate), KN (potassium nitrate); zinc powder (Zn) and aluminum powder (Al).

Appendix A contains detailed descriptions of the compositions of each energetic material.

Description of the BangBoxes

Each BangBox sits on a concrete pad and is divided into two sections: an inflatable, 930 m^3, 16.5 m diameter hemispherical test chamber made from a flexible polyvinyl-coated polyester fabric and a 5.5 x 2.1 x 2.5 m building (airlock) with a plywood front and a wood frame covered with the same material as the BangBox. The test chamber is kept inflated by two high-capacity blowers; six fans spaced 60^0 apart circulate the air in the test chamber to produce a homogeneous pollutant mix that is sampled with instruments in the chamber and the attached air lock. The energetic materials are burned in stainless steel burn pans placed on a steel pad located in the center of the test chamber and detonated in a 1 m^3 steel-lined pit after the steel cover is removed. The test chamber is purged with air for at least 60 minutes (two air volume exchanges) between trials.

When detonations and burns are initiated, a known quantity of SF_6 is released in the chamber. The concentration of the SF_6 is then measured over the time air pollutant samples are taken and used to establish the actual volume of the chamber and the dilution of the emission products which occurred (due to the chamber blowers) between initiation of the burn/detonation and completion of sample collection. This information is used to calculate the initial concentrations of the compounds released by the burn/detonation. (The SF_6 was collected in 0.85 L Summa canisters and analyzed by a gas chromatograph equipped with a flame photometric detector (GC/FPD).

Sampling and Analysis Procedures Used in the DPG BangBox

The following sampling equipment was located in the test chamber: (1) high volume samplers (Hi-Vol) for measuring particle mass, metals, and EPA SW846 Method 8270 semivolatile organic compounds (SVOCs); (2) Hi-Vol-based PM-10 sampler for measuring particles and metals in the respirable range; (3) EPA PS-1 samplers for measuring Method 8270 SVOCs and chlorinated dioxins and furans; (4) EPA Method 26 samplers for HCl and Cl_2.

The following sampling equipment for gases was located in the airlock attached to the chamber: (1) continuous emission monitors (CEMs) for CO_2, CO, NO, NO_2, O_3, and HCl; and (2) canisters for measuring volatile organic compounds (VOCs), CO_2, and CO.

Background samples were collected in the test chamber at the beginning of every test day, analyzed in a manner identical to the test samples, and the results used to correct the emission factors for any contribution background levels of the target compounds (analytes) made to the measured (uncorrected) emission factors.

The sampling equipment used in each study was selected based on the composition of the materials being tested and the objective(s) of the study. Table 2-4 identifies the sampling systems used in each study.

Appendix B contains a more detailed description of the actual sampling systems used and Appendix C delineates the target analytes used in the seven studies.

Sampling and Analysis Procedures Used in the SNL BangBox

The procedures used at SNL were similar to those used at DPG. The differences are: (1) particle mass was determined from the PS-1 filter; (2) the extract from the PS-1 sampler was analyzed by selective-ion SFC/MS as well as by the full scan GC/MS procedure used for the DPG BangBox samples; (3) the PS-1 samplers for dioxins and furans contained polyurethane foam rather than XAD-2; (4) samples for metals were collected on Teflon filters and analyzed using x-ray fluorescence; (5) individual VOC compounds from the canister analyses were not reported except for acetylene and benzene; and (6) two, PS-1 SVOC, two PS-1 dioxins/furans samples, two metals samples and five VOC canister samples were collected during each detonation or burn.

Table 2-1. Energetic Materials Burned and Detonated in the BangBoxes

Study	Item	Abbreviation	MEM (g)	OB Trials	OD Trials
1	TNT (block)	TNT-SNL	230		1
	TNT (block)	TNT-SNL	230		1
	TNT (block)	TNT-SNL	230		1
	Foam-suppressed TNT OD	TNT-foam	225		1
	Double-based Propellant	Dbl-base-SNL	471	1	
	MK-6 Propellant	MK-6	448	1	
2	PBXN-110	PBXN	1064	1	
	MK-23	MK-23	1030	1	
	M-43-LOVA	M-43	1060	1	
	Smokeless Powder	Smkles-pwdr	454	1	
	Smokey Sam	Smky-sam	273	1	
3	TNT (flake)	TNT-ACC1	230		3
	20 mm HEI cartridge	20 mm	189		3
	40 mm HEI cartridge	40 mm	158		3
	M18A1 Claymore mine	Claymore	229		3
	T45E7 Adapter Booster	T45E7	193		3
4	M-9 Propellant in Bags	M-9	2406	3	
	M-1 Propellant in M-3 Bag	M-1	2273	3	
5	TNT (block)	TNT-ACC2	230		1
	Detonation Train	Det. train	178		3
	M187 Impulse Cartridge	ARD-446	215		3
	BBU-36B Impulse Cartridge	BBU-36	144		3
	Gas Generator GCU-2A	GGU-2A.	139		3
	MK-107 Impulse Cartridge	MK-107	208		3
	Signal, Red Star, M-158	M-158	239		3
	Fuze, Tail Bomb, FMU-54	FMU-54	210		3

Table 2-1. Continued.

Study	Item	Abbreviation	MEM (g)	OB Trials	OD Trials
5	IR Flare, M-206	M-206	241		3
	Fuze, Tail Bomb, FMU-139	FMU-139	172		3
	Signal, Red Star, M43A2	M43A2	260		3
6	M31A1E1 Propellant	M31A1E1	2276	3	
	Double-based Propellant	Dbl-base-DPG	2227	2	
	Ammonium Perchlorate	AP	2270	2	
	Aluminized AP Propellant	Al-AP	1183	2	
7	Detonation Cord	Det cord	205		3
	Tritonal	Tritonal	235		3
	Tritonal With Wax	Tritonal-wax	235		3
	Amatol	Amatol	235		3
	Composition B	Comp B	235		3
	Composition B With Alum.	HBX	220		3
	H_2O-Suppressed Tritonal	Tritonal-H_2O	235		3
	Manufacturing Waste	AP-waste	1139	3	
	H_2O-Suppressed Amatol	Amatol-H_2O	235		3
	Diesel Fuel/Dunnage	Dunnage	913	3	

Table 2-2. Weights (grams) of Energetic Materials in Items Detonated

Item	TNT	RDX	TETRYL	PETN	Al	KNO_3	AN	NC	NG
TNT	227	2							
Tritonal	182	8			46				
Tritonal-wax	173	8			43				
Amatol	114	8					113		
Comp B	86	136							
HBX	72	111			39				
FMU-139		28	126	17					
FMU-54		28	163	18					
T45E7		28	177						
ARD-446		54		32		50		53	15
BBU-36		54		32		45		28	8
MK-107		54		32		6		87	25
Det train		108		65					
M43A2		54		32					
M-158		54		32		44			
M-206		54		32					
Claymore		229							
20 mm		79						100	10
40 mm		145						7	2
Det cord				203					
GCU-2A[a]		26		15					

a Energetic composition and weight classified.

Table 2-3. Weights (grams) of Energetic Materials in Items Burned

Item	RDX	AP	Al	Zn	KNO_3	NC	NG	NQ	HMX
Dbl-base-SNL						240	184		
M-1						1815			
M-9					36	1387	960		
Dbl-base-DPG						(a)	(a)		
M31A1E1						493	410	1245	
PBXN						16	1		924
M-43	775					38	2		
Smkles pwdr						435	23		
MK-6		381	1						
AP[b]		1946							
Al-AP[b]		821	226			4	0.2		
MK-23		800	20			28	2		
Smky-sam[b]		110		100		22	1		
AP-waste		738	140			4			

a Actual weights classified

b. Identity and weights of other energetic materials either classified or not available

Table 2-4. Sampling Systems Used in Each Study[a]

System	Analyte	Study 1	Study 2	Study 3	Study 4	Study 5	Study 6	Study 7
CEM	CO2	S	S	NA	NS	S	S	S
	CO	S	S	NA	NS	S	S	S
	NO/NO2	S	S	NA	NS	S	S	S
	SO2	S	S	NA	NS	S	S	S
	O3	S	S	NA	NS	S	S	S
	HCl	S	NS	S	NS	NS	S	S
Bubbler	HCl/Cl2	S	NS	NS	NS	NS	S	S
Canister	VOC	S	S	S	S	S	S	S
	CO/CO2	S	S	S	S	S	S	S
Hi-Vol	Mass	NS	NA	S	S	S	S	S
	SVOC/GCMS	NS	NA	S	S	S	S	S
	SVOC/SFCMS	S	NA	S	S	S	NA	NA
	Metals	S	NA	S	S	S	S	S
PM-10	Mass	NS	S	S	S	S	S	S
	Metals	NS	NS	S	S	S	S	S
PS-1	Mass	S	NS	NS	NS	NS	NS	NS
	SVOC/GCMS	S	NA	S	S	S	S	S
	SVOC/SFCMS	S	NS	NS	NS	NS	NS	NS
	Dioxins/Furans	S	NS	NS	NS	S	S	S
Teflon filter	Metals	S	NS	NS	NS	NS	NS	NS

a. S = sample taken; NS = no sample taken; NA = sample taken, results not valid or not available.

Chapter 3
Construction and Validation of the Database

Construction of the Raw Database

A matrix was developed to accommodate all the emission factors that could exist if every study had used the complete suite of sampling systems available. This matrix was then completed using data from each study's documentation file, e.g., test design plans, final reports, field notes, calibration data, laboratory reports, QA and QC reports, etc. Instances where data were missing were identified and the reason(s) determined. Some of these reasons were: (1) no sample collected; (2) sample collected, but no emission factor calculated because the sample was determined to be invalid; and (3) only those target compounds (analytes) actually detected were specifically identified in the final report. In this latter case, the Experimental Section of that final report listed all the target analytes and, if a target analyte was not mentioned in the Results Section of that report, then the reader was to assume that it was not detected. This latter situation was common for the VOC and SVOC analytes.

In addition to the previously reported results, previously unreported results were converted to emission factors and placed in the database, except when the analyte had not been detected in any study. There were a large number of analytes in the not detected category, e.g., 103 of the 108 Method 8270 analytes and 65% of the VOCs. **Thus, if an analyte is listed in Appendix C, but is not in the database, the user of the database can safely assume that it was never detected, or if it was detected, it was not above the concentration in the associated background sample.**

After all quantitative values had been put into the database, the matrix was filled in using the following codes: (1) NS (no sample collected); (2) ND (sample collected, but analyte either not detected or not detected above background concentration); and (3) NA (sample was supposed to have been collected, but either no results were found or result had been invalidated). The emission factors were then examined to assure that the total mass of the energetic material (MEM) detonated/burned had been used in calculating each emission factor. When this was not the case, the emission factors were recalculated using the correct MEM and the corrected emission factors were then entered into the database.

The emission factors from the seven studies had been adjusted to compensate for the concentrations of the analyte in the background sample(s) taken the day of the test, hereafter designated as (EF_{BC}). The uncorrected emission factors were not reported. Since it is helpful to know the extent to which an emission factor has been adjusted for the background concentration, the concentration of each analyte measured in each background sample was converted to the equivalent emission factor for that test (EF_B) and entered in the database. In Studies 1, 5, 6, and 7 (Table 2-1), the actual volume of gas sampled was used for this calculation. Because the original sampling volumes were not available for the other three studies, the average volume of gas collected by the sampling systems used in Studies 5, 6 and 7 was used instead.

Two additional types of emission factors were also calculated, the minimum quantitation limit (MQL) emission factors (EF_{MQL}), which are shown in Table 3-1, and the "uncorrected (for background)" emission factors (EF_{UC}). Each EF_{MQL} was calculated by entering the laboratory-determined MQL for the analyte (expressed in units of mass/m^3) into the pollutant concentration term of the emission factor equation. Each EF_{UC} was calculated by adding the average background-corrected emission factor (EF_{BC}) to the associated background emission factor (EF_B).

After these additional types of emission factors were added to the database, statistical outlier tests were done to identify anomalous values. The records associated with these values were examined to determine if there was an explanation for them being identified as an anomalous value, e.g., transcription error, misspelled word, etc. Values that could not be rejected for scientifically-defendable reasons were left in the database.

After these outlier tests were completed, it was clear that most of the uncorrected Method 8270 SVOC emission factors were considerably less than the corresponding MQL emission factors. A subsequent investigation showed that in the actual test report, these SVOC emission factors were identified as qualitative or tentative in nature; thus, they were not useful in calculating quantitative emission factors. To address this situation, it was decided to change the uncorrected emission factor (EF_{UC}) and the associated background-corrected emission factor (EF_{BC}) to ND if the EF_{BC} was less than 30% of the associated MQL emission factor.

Because Hg, As, Ni and Be were never detected above background levels, they were not included in the validated database. It was also apparent that the PM-10 mass emission factors for metals were less reproducible and sometimes were larger than the corresponding Hi-Vol values. Much of this variation likely occurred because each PM-10 mass emission factor represented a single measurement whereas each Hi-Vol value represented the average of three measurements. Also, most of the uncorrected PM-10 mass emission factors were at or below the EF_{MQL}. For the above reasons, the PM-10 mass emission factors for metals were not included in the "raw database". The PM-10 emission factors themselves, however, were included, because there wasn't an alternative source for these emission factors.

At this point, the raw database contained approximately 100,000 values. However, 80% of these values were identified as either ND, NS or NA. To facilitate the validation and statistical analysis of the database using SAS , all NS and NA values were changed to "." and all ND values were changed to "0.0E+00".

Validation of the Database

Adjustment of the Emission Factors for Metals from the Floor

Bulk explosives which did not contain any metals still yielded emission factors above the MQL emission factors for: Al, Ba, Cu, Pb, Ti and Zn. These "emission factors" likely came from metals in or on the concrete floor of the BangBox, since dust from the floor was commonly found on Hi-Vol filters collected after detonations. Thus, it was decided to use the emission factors from the bulk explosives to derive the detonation-related, background emission factors for these six metals rather than use the pre-test background samples. These detonation-related, background emission factors were calculated by averaging the emission factors for the following five bulk explosives : TNT-DPG1; TNT-DPG2; Amatol; Comp B; and Det. train. These calculations yielded the following background emission factors (g analyte/g MEM): Al (7.2E-04); Ba (3.7E-04); Cu (4.8E-04); Zn (3.8E-04) and Pb (5.9E-04). The averages were then subtracted from the individual and average trial emission factors and the uncorrected emission factors to obtain the corrected emission factors.

Comparisons Between Sampling Systems

As part of the validation effort and to remove redundant data from the database, the following comparisons were done using the average emission factor for each analyte: (1) CO/CO_2 (CEM vs canister); (2) VOC (GC/FID vs GC/MS); and (3) PS-1/GCMS vs Hi-Vol GCMS vs Hi-Vol/SFCMS. These comparisons yielded the following results.

Canister vs CEM for CO and CO_2: The CEM CO emission factors are statistically equivalent to the corresponding canister values at the 95% confidence level (based on a comparison of 53 paired values). In contrast, the CEM CO_2 emission factors are on the average 5% higher than the corresponding canister emission factors (based on a comparison of 48 paired values) and the CEM mean difference is statistically different from the canister mean value at the 95% confidence level. Because the canisters were also used to measure the VOC emissions, it was decided to include the canister-derived CO and CO_2 emission factors in the validated database and to include the CEM-derived values if the canister-derived values were not available.

GC/FID vs GC/MS for VOCs: The GC/FID emission factors for (o,m,p)-xylene, are statistically equivalent to the corresponding GC/MS values, but for the seven other VOCs (measured by GC/FID and GC/MS) the emission factors are statistically different at the 95% confidence level. For 1,3-butadiene, the GC/FID mean emission factor is 66% of the GC/MS value (based on a comparison of 12 paired values), but for the other six VOCs, the GC/FID mean values are larger than the GC/MS values. The magnitudes of these mean differences are: benzene (34% larger, 51 paired values); ethylbenzene (21% larger, 38 paired values); styrene (102% larger, 19 paired values); toluene (39% larger, 38 paired values); and 1,3,5-trimethylbenzene (130% larger, 9 paired values). On an absolute basis, however, the mean differences are small, i.e., benzene (0.00002); ethylbenzene (0.0000006); styrene (0.000002); toluene (0.000004); and 1,3,5-trimethylbenzene (0.000001). Since the GC/FID emission factors were larger than the GC/MS values for most compounds and GC/FID was also used

for all the other VOC compounds, it was decided to include the GC/FID-derived emission factors in the validated database and to include the GC/MS-derived values only when the GC/FID values were not available.
PS-1/GCMS vs Hi-Vol/GCMS vs Hi-Vol/SFCMS: The PS-1 sampling system yielded non-zero emission factors for 5 of the 108 Method 8270 (non-energetic SVOC) target compounds. These compounds and the energetic materials they were associated with are: acenaphthalene (AP-waste); fluoranthene (AP-waste); phenol AP-waste); 2-chlorophenol (AP-waste) and diethylphthalate (BBU-36, FMU-139, MK-107, GGU and M-9).

(1) Phenol: The PS-1 sampler detected phenol only in the first of the two AP-waste burns; it also detected phenol in the background sample (at a concentration only slightly less than that measured in the burn sample) taken in the BangBox before this burn. The Hi-Vol/SFCMS system also detected phenol for only the first burn and the emission factor (3.8E-05) is essentially the same as that from the PS-1 sampling system (3.4E-05). The phenol emission factors for the AP-waste burn were excluded from the validated database for three reasons. First, it was a common component of background samples in the concentration levels equivalent to the emission factors calculated from the burn. Second, it was in the background sample for the surrogate waste burn. Third, phenol was not found in the samples from the second burn. The Hi-Vol/SFCMS sampling system did detect phenol in the detonation products from the following four energetic-containing items: ARD-446 (1.9E-06); MK-107 (8.4E-07); FMU-54 (4.7E-06); and 40mm (1.5E-06). These emission factors are very close to the MQL emission factor (2.9E-06), and, as noted above, phenol was a common constituent of the ambient air in the BangBox. Also, the PS-1 sampling system detected phenol in the background samples associated with these four items at levels which would have yielded emission factors of the same magnitude reported for these four items. Therefore, these latter phenol emission factors were not included in the validated database.

(2) Acenaphthalene and Fluoranthene: The Hi-Vol GC/MS sampling system yielded emission factors for only two of the 108 EPA-8270 compounds (acenaphthalene and fluoranthene) and both compounds were associated only with the AP-waste burn. These two compounds are normally released when diesel fuel and wood, two of the materials in the AP-waste material, are burned. These two compounds were also found by the corresponding PS-1 sampler. For acenaphthalene the average PS-1 emission factor was 1.0E-04 and the corresponding Hi-vol emission factor was 1.6E-04. Similarly, for fluoranthene the PS-1 emission factor was 2.0E-04 and the Hi-Vol value was 1.0E-04. Since it is highly likely that these are valid emission factors, the PS-1 derived emission factors were included in the validated database.

(3) 2-Chlorophenol: This compound was detected only by the PS-1 sampler during the two AP propellant burns conducted July 31, 1995. Both trials yielded the same emission factor (1.0E-05), a value approximately 30% of the MQL. Since 2-chlorophenol was not found in the associated background samples and it was not a common background contaminant, the 2-chlorophenol emission factors were included in the validated database.

(4) Diethylphthalate: Non-zero emission factors for

diethylphthalate came only from the PS-1 sampler. They were associated with the four items which were detonated (BBU-36,MK-107,FMU-139 and GGU-2A) and one item which was burned (M-9). For the following reasons the emission factors associated with the four items detonated (BBU-36, MK-107; FMU-139, and GGU-2A) were included in the validated database. First, diethylphthalate was not detected in the background samples associated with these energetic materials. Second, the MQL emission factor (2.1E-04) associated with the four materials is less than the average emission factors reported for these materials. Third, it was found in almost all samples.

The emission factor from the single M-9 propellant burn was excluded from the validated database for the following reasons. First, the MQL for diethylphthalate is higher than the emission factor from the M-9 propellant burn. Second, although diethylphthalate was not found in the background sample associated with this burn, it was frequently found in background samples at levels tenfold greater than the M-9 emission factor.

Mass Balance Assessments for C, N, S, Cl, Al and Pb

Carbon Mass Balance

The carbon mass balance was conducted by calculating the total mass (weight) of carbon in the material (MEM) detonated or burned and comparing it to the mass of carbon found using the sum of the average emission factors for CO_2 and CO (expressed as their carbon equivalent values). Sufficient composition data was available to conduct the mass balance calculation for 23 of the materials detonated and burned. Only the detonation cord gave a % Conversion (210%) which differed by more than 18% from the value of 100% that was expected if all the carbon had been converted to CO and CO_2. The extremely high % Conversion value for the det. cord was unexpected because each of the three trials involved detonating 203 g of PETN with an electric blasting cap and because the emission factors for the three trials agreed so closely. A subsequent review of the raw data also showed that this material had an usually large difference between the CEM and canister values for both CO_2 and CO. It also showed that PETN was not detected in the emission from any of the three detonations. This was particularly unusual, because, when much lower quantities of PETN had been detonated (as part of donor charges), measurable quantities of PETN had been detected. For the above reasons all emission factors for the det. cord were excluded from the validated database.

Nitrogen Mass Balance

Although N was not measured directly in the BangBox studies, there is solid scientific evidence from detonation and burn experiments on explosives where the N_2 emissions were measured directly.[4,5,13,14] The experiments described in references 13 and 14 are particularly relevant here because they involved detonating M107, 155 mm artillery rounds (965 - 2260 kg) and burning NIKE rocket motors in a 4,100 m^3 chamber. More than 99.8% of the N in the Comp B in the M107 rounds and 99.7% of the N in the NIKE's double base propellant were converted to N_2. These low %N Conversion are particularly striking when compared to those for other

CHNO-based materials. For example, the percentages of N (in the fuel) converted to NOx in utility boilers firing residual fuel oil, distillate oil and coal are: 50-60%, 60-80% and 20-25%, respectively[15,16].

The N mass balance calculations used the NO and NO_2 emission factors (expressed as N) to determine how much of the N in the energetic material was converted to nitrogen oxides. Sufficient chemical composition data was available to conduct the assessment on 25 of the materials detonated and burned. The AP-waste burn, which had a % Conversion of N to nitrogen oxides of 17%, was the only material with a % Conversion of N value greater than 6%. Since all the % Conversion of N values are reasonable based on the work of Cook[3] and Ornellas[4], all the NO and NO_2 emission factors were included in the validated database.

Chlorine Mass Balance

Percent recoveries for Cl could be calculated for five energetic materials. These materials and the associated % recoveries are: AP (85%), Al-AP (102%), MK-23 (99%), MK-6 (37%) and AP-waste (60%). Since these % Recoveries are reasonable based on the work of Ornellas[4], all HCl and Cl_2 emission factors were included in the validated database.

Sulfur Mass Balance

Four of the materials detonated contained known quantities of S. These materials and their associated % Conversion to SO_2 are: M31A1E1 (28%), HBX (5%), M43A2 (5%), and M158(1%). Because no literature references on recovery of S from detonations was found, the SO_2 emission factors were included in the validated database.

Lead Mass Balance

The two materials known to contain Pb (Dbl-SNL and Dbl-DPG) yielded % Recoveries of 37% ((Dbl-DPG) and 128% (Dbl-SNL). The reason for the low % Recovery for Dbl-DPG burn is not known. (Pb was found in the residue from this latter burn, but, the quantity in the residue was not reported.) Because Pb is one of the most likely toxic compounds potentially released from OB and OD activities, the Pb emission factors were included in the validated database.

Aluminum Mass Balance

The six materials known to contain measurable quantities of Al yielded a wide range of % Recoveries. These materials and the associated % Recoveries are: tritonal (6%), tritonal-wax (9%), HBX (5%), Al-AP (7%), AP-waste (29%) and MK-6 (60%). Although Al was found in the residue from the three burns and observed on the floor of the BangBox for the three detonations, the actual amount was never determined. Because Ornellas[4] also reported low recoveries for Al, all the Al emission factors were included in the validated database.

Energetic Material Mass Balance

The database contained non-zero emission factors for only four of the original energetic compounds: NG, HMX, RDX and PETN; all were associated with detonations. The other target energetics (including TETRYL and TNT) were never detected. However, it should be noted that sampling results for energetics were only available for the energetic materials detonated

and burned in Studies 1,3,4 and 5. Air samples for energetics were also taken in Studies 6 and 7, but the samples were not analyzed because the SFC/MS unit was broken and it was not repaired until six months after the samples had been extracted. (The analytical method specified that the extract must be analyzed within 60 days after extraction). Thus, it is possible that additional energetic emission factors would have resulted had these latter samples been analyzed.

NG was associated only with detonations of energetic materials which did not contain NG and it was found in the background samples associated with these detonations. Therefore, the NG emission factors were not included in the validated database.

The PETN and RDX emission factors were included in the validated database, because they were associated only with detonations in which materials containing these energetics were used to initiate the detonation.

The emission factors for HMX were included in the validated database because: (1) the HMX was consistently detected only when RDX was also detected in the emission products; (2) military grades of RDX contain between 4 to 15% HMX by weight; and (3) with one exception, the HMX emission factors were 3 to 24% of the corresponding RDX emission factor.

Validation of Chlorinated Dioxins and Furans Results

The validation of the dioxin and furan data was difficult because of the excellent MQL_{EF} (E-10 to E-11) and the ubiquitous nature of these compounds in all environmental media[17]. Dioxin and furan samples were collected during four burns (AP propellant, aluminized AP propellant, AP-waste and diesel fuel and dunnage) and after the detonations of the M-158, M43A2 and M-206 flares.

Furans were detected only in the emissions from the AP waste burn. The five isomers (octochlorinated dibenzo-p-furan (OCDF), 1234678 HpCDF, 1234789 HpCDF, 123478 HxCDF and 123678 HxCDF) were detected at levels 100 to 1,000 times larger than the MQL emission factor (2.6E-11) and therefore, were included in the validated database. No total furan values (e.g., total HxCDF) were reported.

Octochlorinated dibenzo-p-dioxin (OCDD) was detected in the emissions from the detonation of the M43A2 flare and the burning of the diesel fuel and dunnage surrogate. The OCDD emission factor for the M43A2 was included in the validated database, because: (1) it was not found in the background sample; and (2) was found at levels 4 to 10 times larger than the EF_{MQL} (2.1E-10) for the three trials (detonations).

The OCDD emission factor for the dunnage burn was not included because: (1) it was found for only one of the three trials; (2) the background emission factor accounted for 70% of the corrected emission factor; and (3) the uncorrected emission factor was only 30% larger than the MQL emission factor (2.1E-10). A total HpCDD emission factor was also reported for the M43A2 detonation. It was included in the validated database, because it was found in each of the three trials (detonations) at levels which were 1.3, 2.5 and 5 times the EF_{MQL} (2.1E-10). No other dioxins were reported for any of the items tested.

Table 3-1. Representative MQL Emission Factors (kg.analyte/kg MEM)

Analyte	MQL for Detonations	MQL for Burns
HCl	9.2E-05	1.2E-05
Cl_2	4.6E-05	6.0E-06
CO_2	4.3E-07	5.5E-08
CO	4.3E-07	5.5E-08
NO	3.1E-05	3.9E-06
NO_2	4.7E-05	6.0E-06
SO_2	2.2E-05	2.8E-06
SVOCs	2.0E-04	2.6E-05
Dioxins & Furans	2.0E-10	2.6E-11
RDX, PETN & HMX	2.9E-07	3.7E-08
VOCs	4.3E-07	5.5E-08
Al	2.7E-04	3.5E-05
Sb & Ba	6.7E-04	8.6E-05
Cd	3.9E-05	4.9E-06
Cu	8.7E-05	1.1E-05
Pb	3.6E-04	4.6E-05
Ti	1.1E-05	1.4E-06
Zn	9.0E-04	1.2E-05

Chapter 4
Overview of the Validated Database

Appendices D and E contain printouts of the BangBox-derived emission factor databases for burns and detonations, respectively. These emission factors apply to the disposal of energetic materials through OB in a pan and through unconfined, surface detonations (OD) with the following exceptions: dunnage burn; AP-manufacturing waste burn; gas generator detonation; and water-suppressed tritonal and amatol detonations. The reasons these latter materials were designated as exceptions is discussed below.

The validated database contains emission factors for 83 analytes: 7 inorganic gases; total nonmethane hydrocarbons (TNMHC); total unidentified hydrocarbons; 22 unsaturated hydrocarbons (including a total unsaturated hydrocarbons); 16 saturated hydrocarbons (including total unsaturated hydrocarbons); 10 aromatics (including total aromatics); 8 chlorinated hydrocarbons; 8 metals; 5 chlorinated furans; 1 chlorinated dioxin; 4 non-energetics SVOCs; and 3 energetic SVOCs. Most of the analytes are nonhazardous compounds commonly found in ambient air. If an analyte is listed in Appendix C, but is not in the database, the user of the database can safely assume that it was never detected, or if it was detected, it was not above the concentration in the associated background sample.

The many similarities between the emission products from detonations and burns reported earlier[7,8] are also present in the expanded database. For example, ethane, propane and isobutane were associated with almost every energetic material tested and their emission factors were usually much greater than those for the other saturated hydrocarbons. Also, almost every energetic material tested released ethylene, propene and acetylene and these three compounds represented a very substantial part of the emission factor for total unsaturated compounds.

Chapter 5
Discussion of Results from Unsuppressed Detonations

The materials detonated in the BangBoxes without water suppression, were placed into two categories: BangBox bulk explosives and BangBox assembled (encapsulated) explosives, e.g., fuzes, flares and impulse cartridges. A third category (DPG field bulk explosives) was also created using the emission factors from the 900-kg surface detonations (TNT-Phase A, TNT-Phase B, TNT-Phase C, Comp B, Explosive D and PBXN) and the 900-kg suspended detonations conducted at DPG in 1989 and 1990.[8] The mean emission factors and associated standard deviations were then calculated for the following analytes within each category (if the data were available): total saturated hydrocarbons; ethylene, propene, acetylene, and (total of) other unsaturated hydrocarbons; benzene, toluene and (total of)other aromatics; and PM-10 (Table 5.1). The mean %C and %N converted to the corresponding oxides (COx, NOx) and the ratios $\%CO/CO_2$ and $\%NO/NO_2$ and the associated standard deviations were also calculated (Table 5.2).

These analytes were selected because they are found in the emissions from most of the materials detonated. Emission factors for individual saturated hydrocarbon compounds, such as ethane, propane and butane, were excluded for two reasons. First, these compounds are environmentally benign. Second, the background concentrations of these saturated hydrocarbons averaged approximately 50 percent of the concentrations found in the samples collected after the detonations (compared to average values of 10% and 30% for the unsaturated hydrocarbons and aromatic hydrocarbons, respectively.

The means were then subjected to a Student's t-test to determine if the means for the same ratio or analyte were statistically the same across at least two of the three categories. These t-tests determined that the means were statistically equivalent across all three categories for %C Converted to COx; %CO/COx and PM-10 mass and therefore the individual values could be combined to create larger data sets (Table 5.3).

No other means were equivalent. However, because the absolute differences between the mean values for the %N Converted to NOx were small across the three categories, the individual values were ranked from highest to lowest to see if they were sufficiently intermixed across the three data sets to justify combining them into one large data set. For this exercise, the BangBox bulk detonations, the DPG field detonations, and the BangBox encapsulated detonations were designated by the numbers 1, 2 and 3, respectively.

This ranking exercise, which is shown below, demonstrated that for all practical purposes, there is sufficient overlap of values across the three categories to rationalize combining them (Table 5.3).

%N as NOx: 3, 1, 3, 3, 3, 1, 1, 3, 1, 3, 3, 3, 1, 2, 1, 1, 2, 2, 1, 2, 2, 2, 2, 2

As shown below, a similar ranking exercise performed on the %NO/NOx ratios also yielded results which justified combining the three data sets into one large data set (Table 5.3).

%NO/NOx: 1, 1, 1, 1, 1, 3, 1, 3, 3, 3, 3, 3, 2, 2, 3, 3, 2, 2, 2, 2, 1, 2, 2, 3, 3.

Users of the database who are estimating the emissions from a variety of energetic materials should consider using the data in Table 5.3 rather than the average CO_2, CO, NO and NO_2 emission factors in the validated database. Users should also assume that BangBox-derived PM-10 mass emission factors will likely underestimate the PM-10 emissions from detonations, since they do not include the soil particles that are entrained in the plume by the surface detonations.

On the other hand, the differences between the means for the organic analytes were too large to rationalize combining them into larger data sets. The means in Table 5.1 are normalized to the mass of the energetic material (MEM) detonated, but for some applications, having the emission factors normalized to the carbon content of the material detonated might be more appropriate. Users who need the organic analytes normalized to the carbon content of the material detonated will find this information in Table 5.4.

Other VOC Compounds

Other than benzene and toluene, styrene, a common air pollutant, was the only other aromatic found at high levels. It was found after the detonation of the Claymore mines (average emission factor of 1.7E-03) and the T-45E7 adapter boosters (average emission factor of 1.2E-04). These emission factors are likely valid, because both materials contained polystyrene (the casing of the Claymore mine contained 150g and the T45E7 contained a 31g polystyrene plug).

Sulfur and Aluminum

The low and variable recoveries for S and Al should be investigated further. It is possible that the S was converted to compounds, such as SO_3, H_2SO_4, H_2S, metallic sulfates or even free $S(S_8)$; none of which were target analytes. The low recovery of Al may be completely, or at least partly, explained by the silvery-gray residue observed on the floor after each detonation of an Al-containing material. Unfortunately, the identity and mass of this residue was never determined. However, Ornellas[4] also reported low recoveries of Al for some materials. Until the reasons for the low recoveries are determined, it would be prudent to assume that all the Al (and any other metal in the explosive detonated) is released to the environment.

Method 8270 Compounds (SVOCs)

Diethylphthalate was the only Method 8270 compound found in the detonation samples and it was associated with items which were either known to contain phthalates or were likely to contain them. Consistent with detonation theory, no SVOC's attributable to molecular rearrangement reactions of the energetic molecule were found.

Dioxins and Furans

Furans were not detected, despite the extremely sensitive sampling and analysis method employed (MQL emission factor of 2.0E-10). One dioxin, OCDD (octochlorinated dibenzo-p-dioxin) was found (average emission factor of 1.8E-09) in the samples from the detonation of the M43A2 flare and likely resulted from the reaction of the chloride-containing compound(s) and the plastic materials in the flare.

Residual Energetics

The presence of HMX, RDX and PETN in some of the air samples collected after detonations is expected, because detonations are usually not 100.0% efficient. However, it must be noted that for most of these detonations, the ratio of the donor charge mass to the total mass (MEM) detonated was two to four times greater than that used in a routine OD activities. The emission factors in the validated database are calculated based on the total MEM detonated, rather than the actual mass of PETN and RDX used. Table 5.5 compares these original emission factors to those which result when the actual mass of PETN and RDX detonated is used to calculate the emission factors.

As noted in Chapter 3, HMX is an accepted contaminant in RDX; military-grade RDX contains between 4 to 15% HMX by weight. If the percentage of HMX in the RDX being used is known, one should consider using an emission factor for HMX derived by multiplying the RDX emission factor by the percentage of HMX in the RDX rather than using the values in the database.

Table 5.1 Mean Emission Factors (kg Analyte/kg MEM) for Selected Analytes for Detonations

Analyte	Category	MEM (kg)	No. Of Values	Mean	Std. Dev.
PM-10	BB, Encapsulated	0.2	12	0.30	0.26
	BB, Bulk	0.2	8	0.13	0.13
Total Saturated HC	BB, Encapsulated	0.2	11	55E-06	59E-06
	BB, Bulk	0.2	7	11E-06	11E-06
Ethylene	BB, Encapsulated	0.2	11	256E-06	132E-06
	BB, Bulk	0.2	8	69E-06	130E-06
Propene	BB, Encapsulated	0.2	11	50E-06	40E-06
	BB, Bulk	0.2	8	14E-06	24E-06
Acetylene	BB, Encapsulated	0.2	11	300E-06	171E-06
	BB, Bulk	0.2	8	56E-06	70E-06
Other Unsaturated HC	BB, Encapsulated	0.2	11	61E-06	NM
	BB, Bulk	0.2	8	11E-06	NM
Benzene	BB, Encapsulated	0.2	11	69E-06	41E-06
	BB, Bulk	0.2	8	9E-06	9E-06
	Field, Bulk	900	6	69E-06	37E-06
Toluene	BB, Encapsulated	0.2	11	26E-06	12E-06
	BB, Bulk	0.2	8	4E-06	2E-06
Other Aromatics	BB, Encapsulated	0.2	11	42E-06	NM
	BB, Bulk	0.2	8	10E-06	NM

Table 5.2 % Recoveries of C and N as the Oxides for Detonations

Parameter	Category	MEM (kg)	No. Of Values	Mean	Std. Dev.
%C as COx	BB, Encapsulated	0.2	5	100%	10%
	BB, Bulk	0.2	9	102%	10%
	Field, Bulk	900	8	96%	2%
%CO/COx	BB, Encapsulated	0.2	13	6.6%	16%
	BB, Bulk	0.2	9	0.6%	4%
	Field, Bulk	900	8	3.4%	2.0%
%N as NOx	BB, Encapsulated	0.2	8	2.9%	2.0%
	BB, Bulk	0.2	8	1.9%	1.4%
	Field, Bulk	900	8	0.6%	0.3%
%NO/NOx	BB, Encapsulated	0.2	9	69%	20%
	BB, Bulk	0.2	8	92%	18%
	Field, Bulk	900	8	55%	8.1%

Table 5.3 Emission Factor Averages Across Categories for Detonations

Parameter	No. Of Values	Median	Mean	Std. Dev.
%C as COx	22	98.55	99.6%	8.40%
%CO/COx	30	1.60%	3.96%	11.1%
%N as NOx	24	1.20%	1.78%	1.57%
%NO / NOx	25	66.0%	71.0%	22.3%
PM-10	20	0.21	0.230	0.180

Table 5.4 Mean Emission Factors (kg Analyte/kg C in Energetic) for Selected Analytes for Detonations

Analyte	Category	No. Of Values	Mean
Total Saturated HC	BB, Encapsulated	5	117E-06
	BB, Bulk	8	14E-06
Ethylene	BB, Encapsulated	5	1302E-06
	BB, Bulk	8	239E-06
Propene	BB, Encapsulated	5	209E-06
	BB, Bulk	8	47E-06
Acetylene	BB, Encapsulated	5	1267E-06
	BB, Bulk	8	187E-06
Other Unsaturated HC	BB, Encapsulated	5	6700E-06
	BB, Bulk	8	38E-06
Benzene	BB, Encapsulated	5	231E-06
	BB, Bulk	8	32E-06
	Field, Bulk	6	244E-06
Toluene	BB, Encapsulated	5	95E-06
	BB, Bulk	8	12E-06
Other Aromatics	BB, Encapsulated	5	137E-06
	BB, Bulk	8	33E-06

Table 5.5 Original and Adjusted Emission Factors for PETN and RDX

	PETN Emission Factors		RDX Emission Factors	
	Original	Adjusted	Original	Adjusted
FMU-139	1.7E-05	1.7E-04	3.4E-04	2.1E-03
FMU-54	9.6E-06	1.1E-04	9.0E-05	6.4E-04
T45E7	PETN Not Used	PETN Not Used	2.4E-04	1.6E-03
ARD-446	0	0	8.4E-04	3.3E-03
BBU-36	5.8E-04	2.6E-03	0	0
MK-107	5.1E-05	3.4E-03	0	0
Det. Train	5.6E-04	1.5E-03	7.4E-03	1.2E-02
M43A2	1.2E-05	1.5E-03	1.9E-04	9.1E-04
M-158	8.4E-06	6.2E-05	5.5E-05	2.4E-04
M-206	1.6E-06	1.0E-05	6.0E-05	2.5E-04
GGU-2A	4.9E-05	4.5E-04	1.4E-04	7.4E-04
Claymore	PETN Not Used	PETN Not Used	9.9E-06	1.0E-05
20-mm	PETN Not Used	PETN Not Used	1.2E-05	2.7E-05
40-mm	PETN Not Used	PETN Not Used	3.7E-05	4.0E-05
Number of Values	10	10	14	14
Median	1.45E-05	2.55E-04	1.7E-04	7.4E-04
Mean	1.28E-04	6.74E-04	6.84E-04	1.61E-03
Standard dev.	2.33E-04	8.87E-04	1.94E-03	3.14E-03

Chapter 6
Results for Water-Suppressed Detonations

Tables 6.1 and 6.2 compare the emission factors derived from the water-suppressed detonations of amatol and tritonal to those derived from the unsuppressed detonations of these materials. The suppressed detonations were done primarily to assess in a robust manner the impact that detonating oxygen balanced (amatol) and severely oxygen-deficient (tritonal) explosives under a soil or water-blanket cover might have on the emissions. Amatol, an oxygen balanced explosive comprised of a mixture of TNT and AN, contains sufficient oxygen to convert its C and H to CO_2 and H_2O, whereas tritonal contains only 20% of the oxygen required. The water quenched the fireball (afterburn) required by the tritonal to convert its C, N and H to COx, NOx, and H_2O.

These experiments were also done to provide some robust emission factors for a blast and noise suppression technology developed in the U.S.[9], but refined in Europe[10,11] and South Africa[12]. This technology involves detonating munitions in contact with plastic bags containing water. This technology reduces the blast noise by more than 90% when compared to an equivalent unrestricted detonation[11]. However, the water also quenches the fireball which, based on the amount of sooty particulate found after the detonation, reduces the overall destruction efficiency of the detonation process.

The data in Tables 6.1 and 6.2 are consistent with the results from Ornellas.[4,5] That is, quenching the afterburn significantly increases the emissions of incompletely-oxidized species such as soot and the hydrocarbons, and sharply decreases the emissions of CO_2. The results also are in general agreement with detonation theory.[3,4,5] For example, the increase in hydrocarbons is limited to molecules which are smaller than the starting energetic molecules (Table 6.2), i.e., rearrangement into larger molecules did not occur.

The decrease in the CO_2 and increase in the CO and hydrocarbon emissions for the water-suppressed detonation of amatol (an oxygen-balanced energetic) may seem surprising, but conforms to detonation theory. That is, the oxygen balance in amatol is achieved by mixing a strong oxidizer (AN) with the oxygen-deficient TNT. Thus, for the optimum energy release from amatol, the oxidant and reductant radicals formed behind the shock wave must diffuse between two molecules in order to react with each other. In contrast, when the redox reaction occurs within the same molecule, the affect of fireball-suppression on the emissions is less severe.

The results show that placing an oxygen source in contact with the explosive molecule will not ensure an efficient detonation when it is conducted under a soil or water blanket cover. Unfortunately, there is no information on the TNT emissions which might have resulted from the water suppressed detonations, because the air samples collected for the energetic analytes were not analyzed (SFC/MS unit was broken).

Table 6.1. Comparison of Emission Factors for Unsuppressed and Water-Suppressed Detonations of Tritonal and Amatol.

Analyte	Tritonal-H_2O (T-H_2O)	Tritonal (T)	(T-H_2O) / (T)	Amatol-H_2O (A-H_2O)	Amatol (A)	(A-H_2O) / (A)
CO_2	0.28	1.2	0.23	0.3	0.7	0.43
CO	2700E-04	29E-04	93	2.3E-04	97E-04	0.24
NO	40E-04	59E-04	0.68	77E-04	180E-04	0.43
NO_2	2.7E-04	0.3E-04	9	2.4E-04	1.2E-04	2
Ethane	120E-06	0.4E-06	300	1100E-06	4.1E-06	268
Propane	55E-06	0.7E-06	78	190E-06	0.1E-06	1900
Butane	15E-06	0.3E-06	50	52E-06	0.6E-06	87
Other Saturated HC	30E-06	8E-06	4	158E-06	135E-06	1
Ethylene	1100E-06	25E-06	44	980E-06	31E-06	32
Propene	160E-06	5E-06	32	360E-06	5.5E-06	65
Acetylene	4400E-06	43E-06	102	140E-06	1.0E-06	140
Other Unsaturated HC	240E-06	87E-06	6	20E-06	103E-06	5
Benzene	200E-06	1.5E-06	133	270E-06	23E-06	12
Toluene	73E-06	1.8E-06	40	120E-06	6.7E-06	18
Other Aromatics	87E-06	11E-06	8	0.0E+00	13E-06	NM

Table 6.2. Distribution of C and N Across Selected Analyte Classes for Tritonal and Amatol Detonations

Analyte Class	Tritonal-H_2O	Tritonal	Amatol-H_2O	Amatol
%C as COx	65%	106%	98%	104%
%CO/COx	49%	0.2%	0.07%	1.3%
%N as NOx	2.7%	0.95	2.2%	5.0%
%NO/NOx	94%	99%	97%	99%
%(E+P+B)/Total Saturated HC[a]	86%	14%	100%	30%
%(E+P+A)/Total Unsaturated HC[b]	96%	46%	99%	27%
%(B+T)/Total Aromatics[c]	76%	24%	100%	55%

a. (Ethane + propane + butane) emission factors/total saturated HC emission factor.

b. (Ethylene + propene + acetylene) emission factors/total unsaturated HC emission factor.

c. (Benzene + toluene)/total aromatic HC emission factor.

Chapter 7
Discussion of Results from Burns

AP-Waste Burn Results

This surrogate waste was supposed to simulate the mix of AP-contaminated plastic gloves, cotton rags, Kimwipes, wood towel rods and similar materials that result from the clean-up of the vessels used to manufacture AP-based propellants. These materials are usually disposed of by open burning in pans or by incineration. The original plan was to bring an actual AP-based manufacturing waste to DPG for the experiment, however, this was prohibited because DPG did not have a permit for destroying this type of waste. In hindsight, the surrogate waste burned was not truly representative of a real manufacturing waste. The chemical composition was appropriate, i.e., 65% aluminized AP (69% AP, 19% aluminum), 20% plastic material (polyethylene gloves), 11% paper/wood/cloth and 4% diesel fuel; the problem lies with the manner in which the propellant was placed in contact with the combustible materials. That is, 1-in. cubes randomly dispersed on top of the combustible materials. In an actual waste, the propellant would be dispersed on the combustible materials as a fine powder.

Also, because the first burn resulted in a hole in the bottom of the pan, the second and third burns were done with the surrogate waste sitting on top of a 7.6 cm layer of pea gravel. At the completion of each of these last two burns, holes were found in the side of the burn pan, and melted plastic was found in the pea gravel. Approximately 110g of ash remained in the burn pan after the first burn, 40g of ash after the second burn and 65g of ash after the third burn. It was difficult to determine the weight of ash remaining when the pea gravel was used. The weight of waste surrogate burned in the three trials was 1,139g, including the 4g of Hercules Unique Smokeless Powder used to initiate each burn.

The unique mix of emission products, the melted plastic and the 17% conversion of N to NOx observed for the surrogate AP-manufacturing waste demonstrates that this burn was very different from all other burns which involved energetic materials. Most of the emission factors for chlorinated VOC's, those for the five furans, and two of those for the SVOCs are associated only with this material. There were also notable quantities of diesel-fuel-related VOCs in the emissions.

These results are consistent with a combination deflagration (AP) and incineration type burn (melting of polyvinyl gloves and charring of the wood dowel sticks by the heat released from the deflagration). This environment would have provided the conditions which favor the formation of SVOCs and dioxins and furans. These conditions are[17]: low temperature (250-400^{0}C), long residence time (seconds), presence of Cl and organic materials and a metal that could serve as a catalyst. Additional work should be done on this type of material.

Dunnage Burn Results

The dunnage burn is unique in that it did not involve any energetic-containing materials. Not surprising, almost all of the emission factors in the database for C_7 and higher saturated hydrocarbons are associated

with the diesel fuel used in this burn and the AP-waste burn. These emission factors could be useful for predicting the VOC emissions from diesel fuel-initiated or supported burns of energetic-containing materials.

Smokey Sam Burn Results

The smokey sam is an HC-type obscurant (Chemical Agent, Group B Class). Its energetic composition is: 110.0g AP, 100.2g Zn, 30g hydroxyl-terminated polybutadiene and 7.5g dioctyl adipate. It was the only encapsulated propelling material burned in the BangBox. In use, its purpose is to provide a screening smoke of $ZnCl_2$ particles. The burn was very dirty; the BangBox airlock was filled with a pungent, noxious odor and the BangBox test chamber was filled with a dense fog. In comparison to the other AP-based propellant burns, its CO emissions were very high (17%) relative to its CO_2 emissions. Although the emission factors are included in the database, this item is sufficiently unique to justify not using it to calculate summary statistics for bulk propellants.

Discussion of Results for Other Energetic Materials

The other materials burned in the BangBoxes were placed into two categories: BangBox organic-based propellants and BangBox AP-based propellants. A third category (DPG field organic-based propellants) was also created using the emission factors from the 2000-3100 kg propellant burns conducted at DPG in 1989 and 1990.[8] The mean emission factors and associated standard deviations were then calculated for the following analytes within each category (if the data were available): total saturated hydrocarbons; ethylene; propene; acetylene; (total of) other unsaturated hydrocarbons; benzene; toluene; (total of) other aromatics; and PM - 10 (Table 7.1). The mean %C and %N converted to the corresponding oxides (COx, NOx) and the ratios $\%CO/CO_2$ and $\%NO/NO_2$ and the associated standard deviations were also calculated (Table 7.2).

The means were then subjected to a Student's t-test to determine if the means for the same ratio or analyte were statistically the same across at least two of the three categories. These t-tests determined that the means were statistically equivalent across all three categories for %C Converted to COx, %CO/COx, %N Converted to NOx, %NO/NOx and PM-10 mass, and, therefore the individual values could be combined to create larger data sets (Table 7.3).

Users of the database should consider using the data in Table 7.3 rather than the average CO_2, CO, NO and NO_2 emission factors in the validated database. Also, in contrast to the detonation PM-10 data, the BangBox-derived PM-10 mass emission factors likely provide reasonable estimates of the emissions from the open burning of propellants.
Analogous to the detonation data, the differences between the means for the organic analytes are too large to permit combining them into larger data sets. The means in Table 7.1 are normalized to the mass of the energetic material (MEM) burned. While it would be desirable for some applications to have these emission factors normalized to the carbon content of the material burned, this could not be done because the information necessary to do the calculations was available for too few materials.

Other VOC Compounds
No other VOC compounds were found at notable levels for the bulk propellant burns. This is consistent with the theory of propellant burns.[4,5]

HCl and Cl_2
The mean, median and standard deviation of the mean % Recoveries for the five Cl-containing materials burned in the BangBox are: 68%, 73% and 32.8%, respectively. For the four materials for which both HCl and Cl_2 values were available, at least 98% of the Cl was found as HCl, regardless of the amount of total Cl recovered. These results are similar to those obtained by Ornellas for AP-based explosive materials.[5] At this time, it would be prudent to assume that all the Cl in an AP-based propellant will be released to the environment as HCl.

Lead and Aluminum
The low and variable recoveries for Pb and Al were not expected and should be investigated further. It is possible that some of the Pb is converted to a chemical form which is not collected by a quartz fiber filter. Until the reasons for the low recoveries are determined, it would be prudent to assume that all the Pb and Al not accounted for in the ash, was released to the environment.

Method 8270 Compounds (SVOCs)
No Method 8270 SVOC compounds were found for the bulk propellant burns. This is consistent with detonation theory.

Dioxins and Furans
Dioxins and furans were not detected, despite the extremely sensitive sampling and analysis method employed (MQL emission factor of 2.6E-11).

Residual Energetics
No residual energetics were detected for any of the bulk propellant burns. However, as mentioned earlier, the air samples collected for energetic analyses in the last two studies were not be analyzed because the SFC/MS unit was broken.

Table 7.1. Mean Emission Factors (kg Analyte/kg MEM) for Selected Burn Analytes

Analyte	Category	MEM (kg)	No. Of Values	Mean	Std.. Dev.
PM-10	BB, AP-Based	0.2	4	0.15	0.19
	BB, Organic-Based	0.2	7	0.28	0.36
Total Saturated HC	BB, AP-Based	0.2	4	0.0E+00	NM
	BB, Organic-Based	0.2	7	4.7E-06	9.7E-06
Ethylene	BB, AP-Based	0.2	4	0.0E+00	NM
	BB, Organic-Based	0.2	7	3.7E-06	3.5E-06
Propene	BB, AP-Based	0.2	4	0.0E+00	NM
	BB, Organic-Based	0.2	7	1.0E-06	1.1E-06
Acetylene	BB, AP-Based	0.2	4	9.0E-06	9.0E-06
	BB, Organic-Based	0.2	7	4.6E-06	5.0E-06
Other Unsaturated HC	BB, AP-Based	0.2	4	26E-06	NM
	BB, Organic-Based	0.2	7	3E-06	NM
Benzene	BB, AP-Based	0.2	4	1.5E-06	3.0E-06
	BB, Organic-Based	0.2	7	3.0E-06	3.6E-06
Toluene	BB, AP-Based	0.2	3	0.0E+00	NM
	BB, Organic-Based	0.2	7	0.8E-06	1.3E-06
Other Aromatics	BB, AP-Based	0.2	4	0.0E+00	NM
	BB, Organic-Based	0.2	7	8E-06	NM

NC = not calculable

Table 7.2. % Conversion of C and N to the Oxides from Burns

Parameter	Category	MEM (kg)	No. Of Values	Mean	Std. Dev.
%C as COx	BB, AP-Based	02	4	99%	14%
	BB, Organic-Based	0.2	3	91%	8%
	Field, Organic-Based	3200	3	100%	2%
%CO/COx	BB, AP-Based	0.2	4	0.55%	0.32%
	BB, Organic-Based	0.2	7	0.27%	0.37%
	Field, Organic-Based	3200	3	0.007%	0.01%
%N as NOx	BB, AP-Based	0.2	2	1.8%	1.0%
	BB, Organic-Based	0.2	4	0.5%	0.4%
	Field, Organic-Based	3200	3	0.9%	0.4%
%NO/NOx	BB, AP-Based	0.2	3	75%	16%
	BB, Organic-Based	0.2	4	72%	46%
	Field, Organic-Based	3200	3	75%	6%

Table 7.3. Emission Factor Averages Across Categories for Burns

Parameter	No of Values	Median	Mean	Std. Dev
%C as COx	10	98.5%	95.0%	9.87%
%CO/COx	14	0.20%	0.300%	0.366%
%N as NOx	9	0.90%	0.89%	0.74%
%NO/NOx	10	77.0%	73.9%	25.6%
PM-10	10	0.019	0.233	0.300

Chapter 8
Suggestions For Using the Database

Detonation Emission Factors

Rather than using all the emission factors, user's of the database should consider using the means and medians in Tables 5.1, 5.3 and 5.4 as the starting point for predicting the emissions from OD-based processes and adjust the data for their own situation using commonly accepted information on detonation theory and processes, such as that presented in Chapter 1 and the information presented in Chapters 5 and 6 of this document.

For example, a database user attempting to estimate the emissions at a facility which surface-detonated a wide variety of bulk and assembled energetic-containing materials, could calculate an average emission factor for each analyte which covers both bulk and encapsulated energetic materials. On the other hand, if the detonations are to be conducted under a soil cover, one should consider the likelihood that the fireball will be suppressed and use either the data in Tables 6.1 and 6.2 or select the uppermost part of the ranges for %CO/COx and hydrocarbons species in Tables 5.3 and 5.4.

Unfortunately, if the energetic contains Pb or Al, at this time, one has to assume that all the Pb and Al is released to the atmosphere. More research is needed on these release of these and other metals from OD activities. The low and variable % recoveries for Cl and S observed in all the studies also needs to be studied further to more fully characterize the environmental safety of OD practices. At this time, one has to assume that all the metals, S and Cl enter the environment and attempt to estimate how they will disperse in the environment.

The most difficult emissions to estimate are those for PM-10 and undegraded energetic starting materials. It would be reasonable to assume that the PM-10 emission factors in Table 5.1 and 5.3 underestimate the PM-10 emissions for a surface detonation, but how low is the estimate? Also, if the mass of the energetic being detonated is small and the ratio "donor charge to total energetic mass," is large, one can assume that some amount of undegraded energetic will be released to the environment. But again, how much?

Open Burning Emission Factors

Users should apply the data in Tables 7.1, 7.2 and 7.3 and the other information presented in Chapter 7 in a manner analogous to that recommended above for the detonation emission factors, e.g., one has to assume that all Pb, Al Cl and S in the energetic material being burned will be released to the environment, except for whatever was recovered in the burn pan ash. However, for burns, one can assume that

undegraded energetic emissions would be low and that the PM-10 emission factors in Tables 7.1 and 7.3 are reasonable estimates of the PM-10

emissions expected.

Chapter 9
Recommendations for Future Work

The low and variable % recoveries for metals and for Cl and S observed in all studies reviewed needs to be determined to more fully characterize the environmental safety of OB and OD practices. At this time, one has to assume that all the metals, S and Cl enter the environment.

All emission products studies to date have used relatively clean energetic materials. Recovered high and low explosives should be burned and detonated in chambers to confirm the representativeness of these earlier studies.

Existing knowledge on the affect that accelerators and retardants have on the rate of energetic processes should be applied to OB and OD technologies to see if the environmental safety of OB and OD can be improved further.

Buried detonations should be avoided until the impact that burial and partial confinement have on the emission is established through rigorous research testing. Computer simulations using computational fluid dynamic techniques followed by experimental confirmation should be an integral part of these studies, because of the large number of factors which could affect the emissions. Other noise suppression techniques which do not inhibit the formation of the fireball, such as detonating in chambers, should also be developed and evaluated.

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Appendix A
Detailed Descriptions of the Energetic Materials

Description of Materials Used in Study 1

This study, which was funded by the United States Army Matériel Command (AMCCOM), was conducted in the SNL Bang Box between January 30 and February 16, 1989. In this study TNT blocks were detonated while suspended approximately 1 m above the concrete floor and two propellants were burned in stainless steel pans 103 cm in diameter and 12.7 cm deep. During the propellant burns, the pan was covered with a coarse stainless steel screen to prevent pieces of the propellant from sputtering out of the pan during the burn. The propellants were ignited with an Atlas electric match.

TNT Block

TNT blocks weighing 227g were detonated on January 31, February 2 and February 6, 1989. The TNT was obtained by removing the Mylar film from TNT demolition block and cutting the TNT into the shape and weight desired. The TNT block was made from pressed TNT grains ranging in size from 35 to 65 mesh; graphite (used to facilitate the pressing process) was the only other component in the block. An RP-83 initiator, which consisted of PETN and RDX encased in an aluminum alloy casing, was used as the initiator.

Foam Suppressed TNT Block Detonation

The suspended TNT block was encased in a glycol-based foam which had an expansion ratio of 130:1. The foam contained glycol ether, a 5-carbon alcohol, xanthin biopolymer, formaldehyde, a sulfonate surfactant and C_{12} - C_{14} fatty acids. The foam blanket was held in place with polyethylene sheeting. The diameter of the foam to that of the block was approximately 17:1. The TNT block was detonated on February 13, 1989 in the same manner as the bare TNT blocks had been detonated. This test was done to determine the capability of foam to reduce the blast wave and improve the environmental safety of OD activities. It was found that the foam did not substantially reduce the blast wave to the degree expected and that it impaired the efficiency of the detonation (as evident by the sharp reduction of the CO_2 emissions and the free carbon in the residue left on the floor after the detonation). **The results from this single test were not included in the database because of the uniqueness of the test.**

Double-base Propellant-NOSIH-AA2

The MEM burned was 471g. The major constituents of the propellant were: 240g NC, 184g NG, 26.6g ethyl cellulose, 12.3g triacetin, 9.1g of di-n-propyl adipate and 4.5g lead. A single burn was conducted on February 9, 1989.

Composite Propellant MK-6, 88 P-217

The MEM burned was 448g. The major energetic constituents of the propellant were: 381g AP, 35.9g hydroxy-terminated polybutadiene, 20.2g dioctyl sebacate and 4.5g aluminum oxide.

Description of Materials Used in Study 2

This Navy-funded study, which was conducted from January 19 to January

21, 1993, was the first study conducted in the DPG BangBox. Its objective was to collect emissions data for use in designing a confined-burn facility for propellants. Five propellants were burned in stainless steel pans and the dimensions of the pans were not recorded in the final report. The burn pans were placed at the center of the BangBox on the steel plate covering the 1 x 1 x 1 m detonation pit. The burns were ignited using Hercules Unique Smokeless Powder, which is a mixture of NC (95%) and NG (5%). A single burn was done on each material.

PBXN-110 Propellant
The MEM burned on January 19, 1993 was 1064g, which included 14g of smokeless powder. The major energetic components of the 1050g of PBXN-110 burned were: 924.1g HMX, 53g hydroxyl-terminated polybutadiene, and 53g isodecyl pelargonate.

MK-23 CTBN Propellant
The MEM of energetic material burned on January 19, 1993 was 1030g, including 30g Hercules smokeless powder. The major energetic components of the 1000g of MK-23 propellant burned were 800g AP, 142g carboxyl-terminated polybutadiene and 20 g Al.

MK-43 LOVA Propellant, MIL-P-70818
The MEM of energetic material burned on January 20, 1993 was 1060g, including 40g Hercules smokeless powder. The energetic composition of the MK-43 propellant burned was: 775g RDX, 41g NC, 122g cellulose acetate butyrate (CAB) and 78g of a mix of bis(2,2-dinitropropyl)acetal and bis(2,2-dinitropropyl)formal (BDNPA/F).

Hercules Unique Smokeless Powder
The MEM burned on January 21, 1993 was 454g; it was comprised only of smokeless powder (431.3g NC and 22.7g NG).

Smokey Sam (Obscurant)
The MEM of energetic material burned on January 21, 1993 was 273g, including 23g of Hercules smokeless powder. One smokey sam was burned in each trial. The energetic components of the smokey sam were: 110.0g AP, 100.2g Zn, 30g hydroxyl-terminated polybutadiene and 7.5g dioctyl adipate. The burn was very dirty; the BangBox airlock was filled with a pungent, noxious odor and the BangBox test chamber was filled with a dense fog.

Description of Materials Used in Study 3

Study 3 was funded by the United States Air Force (USAF) and was conducted from February 8 to February 12, 1993. Its objective was to obtain emissions data for a Subpart X permit application for a USAF base. Four USAF items were detonated in the BangBox; the detonations were initiated using C-4 and an electric blasting cap (EBC). (C-4 is the donor charge used in the routine detonation of the four USAF items.) The four items and the TNT block (used to verify that the BangBox pollutant measurement systems were operating properly) were detonated approximately 30 cm above the floor of the 1 x 1 x 1 m, steel-lined detonation pit in the center of the Bang Box test chamber. Sixteen gauge iron wire was used to suspend the TNT block and test items. Three

detonations were conducted on each of the four USAF items; a single trial was conducted on the TNT block. The C-4 used for the donor charges was obtained by removing the Mylar film from standard C-4 demolition blocks. It was shaped to the size and weight needed for the test and then wrapped in a 12.7 cm x 30 cm sheet of polyethylene (weighing 1.9g) to prevent C-4 particles from falling to the floor of the BangBox before the detonation was initiated.

Bare-TNT Charge

The MEM of energetic material detonated on February 8, 1993 was 227g, including 6g for the EBC. The 221g of TNT detonated was flaked TNT.

20mm High Explosive Incinerary (HEI) Cartridge, M56A4, NSN 1305-01-118-9928

The MEM detonated in each trial on February 9, 1993 was 189g, including 60g of C-4 with an EBC. Three, 20mm cartridges were placed on the C-4 strip and tied in place with 16 gauge iron wire for each detonation. Each cartridge contained 8.8 g RDX (explosive charge); 39.2g of WC870 propellant (major energetic constituents: 33g NC and 3.3g NG); and trace quantities (mg) of barium, tin, potassium chlorate and lead. The cartridge has a thin steel casing.

40mm HEI Cartridge, M384, NSN 1310-00-039-1254

The MEM detonated in each trial on February 10, 1993 was 158g, including 40g of C-4 with an EBC. Two 40mm cartridges were placed on the C-4 strip and tied in place with 16 gauge iron wire for each detonation. Each cartridge contained 54.4g of composition A5 explosive (comprised of 53.3g RDX, and 1.1g stearic acid); 4.6g of M-2 propellant (major energetic constituents: 3.5g NC, 0.9g NG) and trace quantities (mg) of barium, tin cadmium and lead. The cartridge has a thin steel casing.

M18A1 Antipersonnel Mine (Claymore), K143, NSN 1345-00-710-6964

The MEM detonated in each trial on February 11, 1993 was 227g. Because the mine contained 681g of C-4, it was necessary to remove 454 g of the C-4 before detonating it in the BangBox, which has a detonation MEM limit of approximately 230g. The mine was opened and the 700, 22-caliber steel balls and 454g of C-4 were removed from the 360 fiberglass resin case. The case was a 50:50 composite of fiberglass and a polystyrene/polybutadiene resin. The mine was suspended in the detonation pit, an EBC inserted in the 227g of C-4 remaining and the mine was detonated.

Adapter-booster, T45E7, NSN 1325-00-827-3851

The MEM detonated in each trial on February 12, 1993 was 193g, which included 10g of C4 with an EBC. One adapter booster was detonated in each of the three trials. The adapter-booster contained 182g of TETRYL, a booster pellet and a hollow bursted well which was closed with a steel plug and housed in a steel cylinder 17.3 cm long and 7.2 cm in diameter. It also contained two 7.5g pressed wool wafers to protect the booster casing and milligram quantities of cadmium. To reduce the chance for the blast pulse to become focused, a steel wool plug was placed in the large end of the bursted well and the end was closed with a 31g plastic plug. A 1.6 cm diameter x 25 cm long steel rod was screwed into the fuze well and a 2.5 cm thick x 23 cm diameter steel disk was fastened to the

other end of the rod. This assembly was suspended horizontally in the detonation pit. A 10g charge of C-4 with an EBC initiated the detonation. However, significant focusing of the blast still occurred as noted by: 1) the hole punched through the 1.25 cm steel plate lining the pit and the charred paper on the fiberglass insulation behind the steel plate; and 2) the charred wood on the "witness shield" approximately 3 meters above the pit (1 m above the top of the metal, shrapnel-containment cage (suppressive shield) covering the pit. When this charring occurred, i.e., during which trial(s), is not recorded, but, it could explain the higher than expected result obtained when the average CO_2 emission factor was used to conduct a carbon mass balance.

Description of Materials Used in Study 4

Study 4 was funded by the United States Army and the National Guard and it was conducted on March 16 and 17, 1993. It's objective was to assess the pollutants that troops are exposed to during training activities associated with the burning of propellant bags. In this study, M-1 and M-9 propellants were burned in stainless steel pans using 4g of Hercules Unique Smokeless Powder as the initiator. Three burns were conducted on each propellant.

M-9 Propellant

Two hundred and thirty two (232) unopened bags of M-9 propellant were placed in the burn pans and the propellant ignited using 4g of smokeless powder and two electric squibs. Each bag weighed 11.5g and contained approximately 10.4g of M-9 propellant. Three M-9 propellant burns were conducted on March 16, 1993. The MEM used in each burn was 2405g, including 4g of smokeless powder. The energetic composition of the 2,401g of M-9 propellant burned was: 1,387g NC, 960g NG, 36g potassium nitrate and 18g diphenylamine. The propellant bags were identical to those used to fire the 181 mm mortar, but their chemical composition was not given in the final report. Based on 1.1g per bag, the total mass of the 232 bags was 255g.

M-1 Propellant In M-3 Propellant Bags

The MEM burned in each trial was 2,273g, including 4g of smokeless powder and 113g of reducer charge. The M-1 propellant was contained in Number 4 and Number 5 M-3 propellant bags; the composition is not given in the final report. The Number 4 bag weighed 15g and the Number 5 bag weighed 19.5g. Two Number 4 bags and two Number 5 bags were burned during each trial. Each Number 4 bag contained 428g of M-1 propellant and 29g of reducer charge and each Number 5 bag contained 650g of M-1 propellant and 27.5g of reducer charge. The composition of the reducer charge was not given in the final report. The major energetic constituents of the 2,156g of M-1 propellant burned were: 1,815g NC, 213g dinitrotoluene, 106g dibutylphthalate and 22g diphenylamine. The three M-1 propellant burns were conducted on March 17 and 18, 1993; each burn was conducted under different temperature and humidity conditions. These conditions were generated using electric heaters and pans containing water. The first burn was conducted at low humidity and at a temperature above ambient temperature; the second burn was conducted early in the morning of March 18 under conditions of cool temperature and high relative humidity, and the third burn was conducted at ambient temperature. Unfortunately, the specific temperatures and humidities used are not given in the final report. Because the three trials gave

emission factors which were essentially the same, the emission factors are identified in the database as M-1 propellant burn without referencing the environmental conditions under which each burn was done.

Description of Materials Used in Study 5

This study, which was funded by the USAF, was conducted from February 23 to March 9, 1995. Its objective was to obtain emissions data for a Subpart X permit application at a USAF base. During this study, the emission from 10 USAF items were characterized when these materials were detonated. C-4, detonation cord and an EBC assembly (detonation train) were use to initiate each detonation. Three detonations were conducted for each item. Each item detonated was suspended either 1 m or 0.5 m above the floor of the 1 x 1 x 1 m detonation pit. The C-4 was obtained by removing the Mylar film from M112 demolition charges; it was shaped to the size and weight needed for the test and then wrapped in a 12.7 cm x 30 cm sheet of polyethylene (weighing 1.9g) to prevent C-4 particles from falling to the floor of the BangBox before the detonation was initiated.

TNT Block

To ensure that the pollutant measurement instruments and other BangBox equipment was operating properly, three TNT blocks with a total MEM of 222g were tied together with 16 gauge iron wire, wrapped with 1.9g of polyethylene sheeting and detonated (using an EBC inserted in the bottom of the assembly) on February 23, 1995.

Detonation Train

This item represents the detonation train used to initiate the detonation of the other nine items used in the study. It was detonated to determine the effect that its detonation could have on the emissions measured from the other nine items. Each detonation train contained 57g C-4, 32g detonation cord (PETN), and an EBC. The C-4 was shaped into blocks weighing 57g with dimensions approximately 7.7 x 2.5 x 2.5 cm and the detonation cord was cut into 3 m lengths and coiled around the polyethylene-wrapped C-4. For this test, two detonation train assemblies were tied together with 16 gauge iron wire, wired in parallel to the firing line and detonated above the floor of the detonation pit using one EBC on each detonation train. The MEM used in each of the three detonations conducted on February 24, 1995 was 178g.

Cartridge, Impulse, M187 Mod 0, ARD446-1, NSN 1377-00-516-9924

This item has a MEM of 12.5g. For each trial, ten ARD446's were wrapped together in polyethylene sheeting and detonated using one detonation train. The MEM of the assembly was 216g, including 91g from the detonation train. Each cartridge was stated to contain 0.9g charcoal, 0.9g sulfur and 5.0g potassium nitrate and approximately 8g of smokeless powder. It is assumed that the smokeless powder was 70% NC and 20% NG and 10% ethyl centralite. Three detonations were done on February 25, 1995.

Cartridge, Impulse, BBU 36B, NSN 1377-01-037-8650, Lot T0592A002012

This item deploys chaff from aircraft and contains a pyrotechnic filler which readily burns when initiated. Each cartridge has a MEM of 875mg.

Sixty cartridges were used in each of the three detonations conducted on February 27, 1995. In each detonation, 42 cartridges were clustered around a 57g block of C-4 and 18 cartridges were placed on the sides of a 0.5 m length of detonation cord which had been folded into a 0.25 m length. In trial 1, the two assemblies were hung separately with one end of the detonation cord inserted in the block of C-4. An EBC was used to detonate the C-4. In trials 2 and 3, the C-4 and detonation cord assemblies were bound together using 16 gauge iron wire. The MEM of the assemblies detonated was 144g, including 91g from the detonation train. The energetic composition of the cartridge is not fully known; it did contain 0.1g potassium nitrate, 0.1g charcoal 0.7g NC, 0.2g NG and 0.06g amorphous boron.

Generator, Gas Pressure, Propellant Actuated, GCU-2/A, NSN-1336-00-420-2980

This item, which is used in the LGM30 minuteman missile, has a MEM of 95.3g; its energetic composition is classified. The item was prepared for detonation by removing the outer metal jacket to expose the solid propellant which is cast as a short hollow cylinder. Twenty-eight and a half grams of C-4 was packed into the hollow cylinder and the cylinder wrapped in polyethylene sheeting. This assembly was then wrapped with 1.5 m of detonation cord and the gas generator's plastic shipping plug was taped on top of the detonation cord. The gas generator was then oriented with its steel plug facing into the detonation pit and detonated with an EBC. One gas generator was used in each detonation; three detonations were done on March 1, 1995. The MEM of each assembly detonated was 139g.

Cartridge, Impulse, MK107, Mod 01, NSN-1377-00-779-2601

This cartridge has a MEM of 24.5g. Five cartridges were placed around a 57g block of C-4. Tney were parallel to each other, but alternated tip to base. This assembly was wrapped with 3 m of detonation cord and detonated over the detonation pit using an EBC. The MEM of each assembly was 208g, including 91g for the detonation train. The energetic composition of the MK107 cartridge was 17.4g NC, 5.0g NG, 1g barium nitrate and 1.2g of potassium nitrate. Three detonations were conducted on March 3, 1995.

Signal, Illumination, Ground, Red Star, M158 NSN 1370-00-490-7363

This flare has a MEM of 36.8g. Four flares along with their bandoliers were used in each detonation. Two flares were placed on one side of a 57g block of C-4 and two were placed on the opposite side. This assembly was wrapped in polyethylene sheeting; 3 m of detonation cord was then wrapped around the assembly and secured with 16 gauge iron wire. This final assembly was detonated with the flare-releasing end pointed down into the pit. An EBC was used to initiate each of the three detonations conducted on March 4, 1995. The MEM of each assembly was 239g, including 91g from the detonation train. The complete energetic composition of the item is unknown. It did contain 2.5g of black powder, 5.2g of strontium nitrate, 2.5g magnesium, 11g potassium nitrate, 2.5g charcoal and milligram quantities of cadmium and zinc.

Fuze, Tail Bomb, Fuze Mechanical Unit (FMU) 54A/B, NSN-1325-00-613-0484

This fuze, which contains 163g of TETRYL, initiates the longitudinal detonator cast into general purpose (GP) air-dropped bombs such as the

M117 and MK82. The MEM of the fuze is 163.3g. One fuze was used in each of the three detonations conducted on March 6, 1995. Each fuze was prepared for detonation as follows. A 28.5g block of C-4 was taped to the side of the fuze near its main explosive charge and the assembly wrapped in polyethylene sheeting. 1.5 m of detonation cord was then wrapped around the fuze and the fuze was screwed onto a threaded shaft. (The opposite end of the shaft was attached to a 1.9 cm thick by 30.5 cm diameter steel plate. The purpose of the steel plate was to break up any focused blast effect resulting from the detonation.) The fuze was detonated 0.5 m above the floor of the detonation pit using an EBC. The MEM was 209g, including 46g from the detonation train.

Flare, Countermeasure, Aircraft, M206, NSN-1370-01-0482138
This flare is used to decoy heat-seeking missiles away from aircraft. Each flare has a MEM of 150.2g and contains 102g powered magnesium, 1g potassium nitrate, 5g NC and 13g rubber. The flare, which had an aluminum case, was prepared for detonation as follows. A 57g block of C-4 was cut in half lengthwise and the two halves placed on the long axis of the flare such that two halves remained in contact. This assembly was wrapped in polyethylene sheeting and then 3 m of detonating cord was wrapped around the assembly starting at the end opposite the C-4. The plastic plug in the forward end of the flare was left in place and the final assembly suspended 0.5 m above the floor of the detonation pit. The pit cover was partially extended over the pit when the flare was detonated using an EBC to initiate the detonation. The MEM of the final assembly was 241g, including 91g from the detonation train. Three detonations were done on March 7, 1995.

Fuze, Tail Bomb, Fuze Mechanical Unit, 139A/B, NSN 1325-01-214-7311
This fuze contains 126g of TETRYL; it initiates the longitudinal detonation cast into GP air-dropped bombs. The MEM of the fuze is 126g. One fuze was detonated in each of the three detonations conducted on March 8, 1997. The procedure employed was similar to that used for the FMU 54 A/B fuzes detonated on March 6, 1995. The MEM of the each assembly detonated was 172g, including 46g from the detonation train.

Signal, Illumination, Aircraft, Red Star M43A2, NSN-1370-00-618-5790
This flare has a MEM of 56.8g with 56.6g of this MEM in the illuminating charge. The illuminating charge contains 10.2g magnesium powder, 13.6g potassium perchlorate, 24.9g strontium nitrate, 3.4g hexachlorobenzene, 4g asphaltum and mg quantities of cadmium, barium, and lead. Three flares along with their bandoliers were used in each of the three detonations conducted on March 9, 1997. The three flares were tied to a 57g block of C-4 and detonated employing a procedure similar to that used for the M158 flares detonated on March 4, 1995. The MEM of each assembly detonated was 260g, including 91g from the detonation train.

Description of Materials Used in Study 6

Study 6 was a R&D study funded by the Strategic Environmental Research and Development Program (SERDP); its objective was to determine the emissions released when double-based and AP-based propellants were burned. The testing was conducted from July 26 to August 3, 1995. The four propellants burned were placed in stainless steel pans and ignited with an electric squib and 4g of Hercules Unique Smokeless Powder.

M31A1E1, Triple Based Propellant, NSN 1376-01-213-5669
During the first burn, the stick propellant was burned in an upright position, which resulted in extensive propellant kickout. To reduce propellant kickout, for the second and third burns, the propellant sticks were placed horizontally in the pan. For these latter burns, four propellant sticks were broken into fourths (18.4 cm) and placed in the pan. Then additional propellant sticks were broken in half (36.8 cm) and placed crosswise on top of the other propellant sticks. The MEM (including the 4g of smokeless powder) used in the three burns conducted on July 26, 1995 were 2,284g, 2,280g and 2,264g, for the first, second and third burns, respectively. The major energetic constituents of the M31A1E1 propellant burned were: 492g NC, 410g NG, 1,245g NQ, 34g ethyl centralite and 1g of charcoal.

Double-Based Propellant
Other than the following elemental composition, no information is available for this cast propellant which was burned on July 27, 1995: 20.36% C, 2.97% H, 28.73% N, 46.14% O, 0.89% Pb, 0.89% Zr and 0.02% Sn. The MEM of propellant burned in each of the two burns was 2,227g, including 4g of smokeless powder. Each propellant burn would potentially release 19.8g of Pb.

Ammonium Perchlorate (AP) Propellant
Other than the following elemental composition, no information is available for this propellant which was burned on July 31, 1995: 25.87% Cl, 11.32% C, 4.31% H, 10.35% N, 47.31%O, and 0.89% Zr. This formulation implies that the propellant was 85% AP. The MEM burned in each of the two trials was 2,270g, including the 4g of smokeless powder used to initiate each burn. Based on the above elemental composition, the 2,270g of propellant burned contained: 1946g AP, 300g of a material or materials with the elemental formula of $C_{21}H_{32}$, 3.8g NC, 0.2g NG and 20g Zr.

Aluminized Ammonium Perchlorate (AP) Propellant
Other than the following elemental composition, no information is available for this propellant which was burned on August 3, 1995: 19% Al, 20.8% Cl, 10.09% C, 3.7% H, 8.3% N, 38.1% O and 0.008% P. This formulation implies that the propellant contained 69% AP by weight. The MEM (including 4g of smokeless powder) for the first and second burns were 1,216g and 1,159g, respectively for an average MEM of 1192g (821g AP, 226g Al, 141g of a material or materials with an elemental composition of $C_{20}H_{34}O$, 3.8g NC and 0.2g NG).

Description of Materials Used in Study 7
Study 7 was a SERDP-funded R & D project designed to determine the emissions released when TNT-based explosives are detonated at ground level and underground. This study was also done to obtain information on the emissions released to the atmosphere when waste from an aluminized AP propellant manufacturing process and diesel fuel-soaked dunnage are burned. All detonations and burns were done in triplicate. Except as indicated below, all detonations were done using an M-6 EBC and a 6.5g block of C-4 cut from an M112 demolition charge. The detonations were done with the material suspended 1 m above the floor of the BangBox.

Detonating Cord
Twenty-one and three tenths (21.3) meters of PETN-based detonating cord were shaped into a 61 cm diameter coil and the coil suspended over the detonating pit such that a 2.5 cm space existed between each successive turn of the coil. The MEM used in each of the three detonations conducted on August 15, 1995 was 205g, including the M6 EBC used to detonate the detonation cord. **For the reasons discussed in Chapter 3, all the detonation cord results were determined to be invalid and, therefore, were not included in the validated database.**

Tritonal Surrogate
Low density tritonal is used in 750 lb. air-dropped bombs; it consists of 80% TNT and 20% Al by weight. There is no commercial or military use for tritonal recovered from these out-of-date bombs. A tritonal surrogate was prepared using crushed TNT block and aluminum powder. These components were placed in a jar and mixed until the mixture appeared to be homogeneous. This mix contained 1274g TNT and 431g Al. Three, 227g portions of this mix were placed in thin polyethylene bags and the bags closed with cotton string. One bag was used in each detonation; the detonations were done with the bags suspended approximately 1 m above the concrete floor of the Bang Box. In the first two trials, a single M-6 EBC was used to initiate the detonation. It was apparent from the noise of the blast and the residues on the floor that the two detonations did not go high order. To ensure that the third detonation went high order, the EBC was inserted into a 6.5g block of C-4 for this detonation. The MEM of the material detonated in the three detonations was 229g for the first two detonations and 235g for the last detonation. Because they were not high order detonations, the results from the first two detonations are not included in the database. The detonations were done on August 16, 1995.

Tritonal Surrogate with 2.5% Calcium Stearate
The calcium stearate served as a surrogate for the organic materials associated with tritonal when it is steamed out of 750 lb. bombs. Three detonations were done on August 17, 1995; a 6.4g block of C-4 and an EBC were used to initiate each detonation. The tritonal/calcium stearate mixes detonated were contained in thin polyethylene bags in a manner identical to the tritonal surrogate detonations. Each bag contained 216g of the tritonal surrogate mix prepared earlier and 11g of calcium stearate. The MEM of the material detonated was 226g, including 8g from the C-4/EBC.

Water-Suppressed Tritonal Surrogate Detonation
The purpose of these water-suppressed detonations was to obtain a preliminary comparison between the emissions from unconfined, surface and buried detonations. The purpose of the water was to quench the fireball that forms when an energetic material is detonated. This fireball is important for ensuring that the molecular fragments of the energetic materials formed in the detonation are converted to CO and CO_2. Three, water-suppressed detonations of tritonal were done on August 22, 1995 using 227g of tritonal surrogate, 1,362g of water, a 6.5g block of C-4 and an EBC. For the first two detonations, the tritonal was in contact with three bags each of which contained 454g of

water. (The four bags (3 water, 1 tritonal) were in a larger bag which was tied with cotton string such that the water bags remained in contact with the tritonal bag.) For the third detonation the 1,362g of water was divided equally among five polyethylene bags to increase the tritonal surface area covered by the water. In this latter detonation, three of the water bags were in the same plane as the tritonal bag, one was on top of the tritonal bag and the last was underneath the tritonal bag. The six bags were held in a larger bag which was tied with cotton string to keep the water bags in contact with the tritonal bag. The MEM detonated in each trial was 235g, including 8g from the C-4/EBC.

Amatol Surrogate

Amatol is a secondary explosive comprised of TNT and ammonium nitrate (AN). It is used in a wide variety of munitions. Three detonations of an amatol surrogate containing 113.5g of TNT and 113.5g AN were done on August 18, 1995. The amatol was prepared by mixing crushed TNT block with AN powder in a manner similar to that used to prepare the tritonal surrogate. The amatol surrogate was placed in the polyethylene bags and detonated in the same manner as the tritonal surrogate. The MEM of the material detonated in each of the three trials was 235g, including 8g from the C-4/EBC.

Water-suppressed Amatol Surrogate Detonation

Three detonations of 227g amatol surrogate in contact with 5 bags containing a total of 1362g of water were done on August 28, 1995. The five water bags were distributed around the amatol surrogate bag in a manner similar to that used for the third water-suppressed tritonal detonation on August 22, 1995. The MEM detonated was 235g, including 8g from the C-4/EBC.

Low-Density Composition B Surrogate

Composition B, a secondary explosive found in a wide variety of bombs and artillery projectiles, is a combination of RDX and TNT. The Composition B surrogate detonated on August 19, 1995 was prepared by mixing crushed TNT block with C-4. Three, 227g mixtures of the Composition B surrogate in thin polyethylene bags were detonated. The energetic composition of this composition B was 128g RDX, 86.3g TNT and 12.7g of mineral oil/polyisobutylene (from the C-4). The MEM detonated was 235g, including 8g from the C-4/EBC.

HBX Surrogate

HBX is an aluminized form of Composition B; it is used in a variety of bombs, depth charges and torpedoes. The HBX surrogate was prepared by mixing aluminum powder with Composition B surrogate. Two hundred and twenty seven gram quantities of the HBX surrogate were placed in thin polyethylene bags and detonated on August 21, 1995. Three detonations were done. The energetic composition of the HBX surrogate detonated was: 109g RDX, 72g TNT, 7.8g mineral oil/polyisobutylene and 38.5g Al. The MEM of the material detonated was 235g, including 8g from the C-4/EBC.

Aluminized Propellant Manufacturing Waste Surrogate

This surrogate waste simulated the mix of plastic gloves, cotton rags, kimwipes, wood towel rods and similar materials that result from the clean-up of the vessels used to manufacture propellants; it is usually

disposed of by open burning. The composition of the surrogate waste burned in the stainless steel pans on August 23, 1995 was: 65% aluminized AP (69% AP, 19% aluminum), 20% plastic material (gloves, anti-static polyethylene), 11% paper/wood/cloth and 4% diesel fuel. The propellant in one inch cubes was randomly dispersed in the combustible materials. Because the first burn resulted in a hole in the bottom of the pan, the second and third burns were done with the surrogate waste sitting on top of a 7.6 cm layer of pea gravel. At the completion of each of these last two burns, holes were found in the side of the burn pan, and melted plastic was found in the pea gravel. Approximately 110g of ash remained in the burn pan after the first burn, 40g of ash after the second burn and 65g of ash after the third burn. It was difficult to determine the weight of ash remaining when the pea gravel was used. The weight of waste surrogate burned in the three trials was 1,139g, including the 4g of Hercules Unique Smokeless Powder used to initiate each burn. Since this burn was done to characterize the emissions from the waste itself, the mass of the material burned (1,139g), rather than the mass of energetic burned (741.8g) was used to calculate the emission factors.

Diesel Fuel and Dunnage Surrogate

Scrap wood from ammunition boxes, dead branches from bushes/trees, styrofoam packing materials and other combustible materials (dunnage) are sometimes used with diesel fuel or other flammable liquid to assist in the open burning of munitions and other energetic materials found on training ranges, battlefields, etc. A surrogate diesel fuel-soaked dunnage was burned on August 29, 1995 to determine the emissions released when dunnage is burned. Three burns were done in unlined stainless steel pans using 909g of the surrogate material and 4g of smokeless powder. The composition of the surrogate material, which was prepared using styrofoam, pasteboard and irregularly shaped pieces of wood, was: 87.5% cellulose (795.4g), and 12.5% plastic/diesel fuel (114g). Since this burn was done to characterize the emissions from the diesel fuel and dunnage mixture itself, i.e., the mixture did not contain any energetic materials, the mass of the material burned (909g) was used to calculate the emission factors.

Appendix B
Sampling and Analysis Methodologies Used

Continuous Emission Monitors (CEMs)

Thermo Environmental (TECO) CEMs were used to measure the concentrations of CO_2, CO, NO, NO_2, SO_2, O_3 and HCl in the test chamber for a minimum of 25 minutes after a detonation or burn was initiated. The CEMs were located in the airlock and connected to the test chamber via a passivated stainless steel sampling manifold; their output voltages were recorded by a calibrated data acquisition system (DAS) comprised of five computers and a LAN. The pollutant concentrations measured before the detonation/burn was initiated were used to correct the pollutant concentrations measured after the detonation/burn was initiated. The model numbers and measurement principles of the TECO analyzers are: CO_2 (Model 41H, gas filter correlation); CO (Model 48, gas filter correlation); NO/NO_2 (Model 42, chemiluminescence); SO_2 (Model 43A, pulsed fluorescence); O_3 (Model 49, UV absorption); and HCl (Model 15, gas filter correlation). The analyzers were calibrated at least once each test day using NIST-traceable gas standards.

EPA Method 26 Sampling System for HCl and Cl_2.

Two EPA Method 26 samplers, located in the test chamber, were used to measure Cl_2 and HCl concentrations when chlorine-containing propellants were burned. This sampler uses a set of Midget impingers connected in series to collect HCl and Cl_2. The second and third impingers, which contain 0.1N H_2SO_4, remove HCl from the sampled gas stream, and the forth impinger, which contains 0.1 N NaOH, removes Cl_2. The impinger contents are analyzed for Cl by ion chromatography. The sampling flow rate is 1 L/min.

Evacuated Canisters for CO, CO_2, and SF_6

Evacuated canisters were used to measure the CO_2, CO and SF_6 concentrations in the test chamber. Generally, three CO_2/CO samples and five SF_6 samples were collected from the sampling manifold in the airlock during each trial. These samples were taken at 5 to 10 minute intervals and spanned the time during which the other pollutant samples were being collected/measured. Depending on the concentration of the gases, the CO and CO_2 analyses were done using a GC equipped with either a flame ionization detector (GC/FID) or a thermal conductivity detector (GC/TCD) and the SF6 analyses were done using an electron capture detector (GC/ECD).

Evacuated Canisters for Volatile Organic Compounds (VOCs)

Three, 6-L canister samples were collected from the test chamber via the sampling manifold during each burn/detonation event. The first sample was taken approximately 5 min after the burn/detonation was initiated, the second was taken 5 to 10 minutes later and the third was taken 5 to 10 minutes after the second. Each sample was taken over a 1 to 3-min. period. The canister samples were analyzed for total non-methane hydrocarbons using EPA Method TO-12 (GC/FID) and for over 200 individual compounds using GC/FID and GC/MS. Most of these compounds were quantified by GC/FID; approximately 20 were quantified by GC/MS. Ten of these latter compounds were also quantified by GC/FID. The VOC target analytes are listed in Appendix C.

High Volume Sampler

This sampler collected samples for determination of: (1) particle mass; (2) metals; (3) EPA SW-846 Method 8270 SVOC compounds (Soxhlet extraction with analysis by GC/MS); and (4) remnants of the energetic materials (e.g., TNT, PETN, RDX, NG, NC, etc.) and other thermally-labile analytes. Three samplers, equipped with 20.3 x 30.8 cm quartz filters, were used for each detonation/burn event. They collected test chamber samples for 20 to 30 minutes after a detonation/burn was initiated. Although the initial flow rate was 1.1 m^3 /min, the flow rate generally decreased over the sampling period. Sometimes the filters were recovered after each trial; at other times they were recovered after the last trial had been done (composite samples). The filters were processed in the laboratory as follows.

Particle Mass and Metals

The weight gain of each filter was determined using a laboratory balance, and then two, 6.5-cm^2 sections were taken from each filter, combined, acid extracted and the extract analyzed using inductively coupled plasma atomic emission spectrometry (ICP) for Al, Sb, Ba, Be, Cd, Cr, Cu, Pb, Ni, Ti; and Zn. A portion of each filter was also analyzed for mercury using EPA SW-846 Method 7000. In some studies all filter sections from the same detonation/burn were combined, but in others, all filters from the same sampler were combined.

Method 8270 SVOCs

The composited filters were Soxhlet-extracted with 700 ml of acetonitrile, the extract was concentrated to 1 to 2 ml via rotary evaporation, and an aliquot analyzed using a HP Model 5890/5970 GC/MS operated in the full scan GC/MS mode. In some studies all filters from the same detonation/burn were combined before the Soxhlet extraction was done, but in other studies all filters from the same sampler were combined before the extraction was done. The Method 8270 target compounds are listed in Appendix C.

Energetic and Other Thermally-labile Compounds

To determine if these compounds were present, an aliquot from the above SVOC extract was analyzed by SFC/MS (supercritical fluid chromatography/MS) and, at times by SFC/TEA using a modified Lee Scientific Model 600/ Finnigan-Mat Incos 50. Two complementary SFC/MS analyses were performed: (1) negative chemical ionization for nitroaromatics, nitramines, nitrate esters and nitroso compounds; and (2) positive chemical ionization for polynuclear aromatic hydrocarbons, their nitrogen and oxygen heterocyclic counterparts, amines, and nitrosoamines. The SFC unit was run in the selected ion mode, rather than full scan mode. Extracts from some studies were also analyzed using full scan, SFC/TEA to seek out untargeted nitroso and nitro compounds and nitrate esters. The target energetic compounds are listed in Appendix C.

PM-10 Sampler (General Metals Works, Model GUV-10H)

This sampler is essentially a high volume sampler equipped with an inlet which prevents particles with aerodynamic size diameters larger than 10 microns from reaching the 20.3 by 30.8 cm, quartz filter; provided the sampling flow rate is maintained at 1.1 m^3/min. Only one PM-10 sampler was used in the BangBox; it was located in the test chamber. The filter samples were recovered after each detonation/burn, weighed, and analyzed for metals in a manner analogous

to that used for the high volume samples.

PS-1 Sampler (General Metal Works, Inc. Model PS-1)

This sampler was used to collect air samples for determination of Method 8270 SVOCs and chlorinated dioxins and furans. (See Appendix A.) Separate samplers were used for the SVOCs and the dioxins/furans, because the extraction solvent for the SVOCs (methylene chloride) was not the same as that used for the dioxins/furans (toluene). Three SVOC samplers were used for each detonation/burn, but no more than two dioxins/furans samplers were used in any detonation or burn. The PS-1 samplers contained 65 to 75 g of XAD-2 resin in either a glass or aluminum cartridge. The cartridge had an internal diameter of 6 cm and was 12.5 cm in length; it contained a 10-cm diameter quartz fiber filter in its inlet. This filter was replaced after each detonation/burn, but the XAD-2 resin was not recovered until all detonation/burn trials planned for the test item had been accomplished. All filters from the same sampler were combined with the corresponding XAD-2 cartridge, extracted and analyzed using either full-scan GC/MS (SVOCs) or selective-ion-mode high resolution gas chromatography/high resolution MS (HRGC/HRMS).

Floor and Burn Pan Samples

In some studies, floor sweepings and burn pan residues were analyzed for metals, Method 8270 SVOC compounds, and dioxins and furans using procedures similar to those used for the air samplers. Unfortunately, the total mass of the metal in the ash/residue was not reported.

APPENDIX C
TARGET ANALYTES

VOCs

The individual target VOC compounds were:

acetaldehyde; acetone; acetonitrile;
acetylene; acrylonitrile; allyl chloride
benzaldehyde; benzene; benzyl chloride;
bromochloromethane; bromodichloromethane; bromoform;
bromomethane; 1,3-butadiene; n-butane;
1-butanol; 2-butanone; 1-butene;
cis-2-butene; trans-2-butene; butylacrylate;
n-butylbenzene; tert-butylbenzene; butylaldehyde;
carbon tetrachloride; chlorobenzene; chlorodifluoromethane;
chloroethane; chloroform; chloromethane;
chloroprene; (o,m,p)-chlorotoluene; cyclohexane;
cyclohexene; cyclopentane; cyclopentene;
n-decane; 1-decene; dibromochloromethane;
dichloromoethane; (o,m,p)-dichlorobenzene; dichlorodifluoromethane;
1,1-dichloroethane; 1,2-dichloroethane; 1,1-dichloroethene;
cis-1,2-dichloroethene; trans-1,2-dichloroethene; trichlorofluoromethane;
1,2-dichloropropane; cis-1,3-dichloropropene; diethyl ether;
trans-1,3-trichloropropene; (m, p)-diethylbenzene; 2,3-dimethylbutane;
2,2-dimethylheptane; 2,3-dimethylhexane; 2,5-dimethylhexane;
2,3-dimethylpentane; 2,4-dimethylpentane; 1,4-dioxane;
ethane; ethanol; ethylbenzene;
2-ethyl-1-butene; ethyl chloride; 3-ethylhexane;
ethylene; (o,m,p)-ethyltoluene; heptanal;
n-heptane; 1-heptene; hexachloro-1,3-butadiene;
hexanal; n-hexane; 1-hexene;
cis-2-hexene; trans-2-hexene; cis-3-hexene;
indan; indene; isobutane;
isobutene; isobutylbenzene; isoheptane;
isohexane; isopentane; isoprene;
isopropylbenzene; p-isopropyltoluene; methane;
methyl bromide; methyl tert-butyl ether; 2-methylpentane;
2-methyl-1-butene; 2-methyl-2-butene; 3-methyl-1-butene;
2-methyl-1-pentene; 4-methyl-1-pentene; 2-methyl-2-pentene;
cis-3-methyl-2-pentene; methylcyclohexane cis-4-methyl-2-pentene;
trans-4-methyl-2-pentene; methylcyclohexane; 1-methylcyclohexene;
methylcyclopentane; methylcyclopentene; methylene chloride;
2-methylheptane; 3-methylheptane; 3-methylhexane;
methylisobutylketone; 3-methylpentane naphthalene;
neohexane; neopentane; n-nonane;
1-nonene; 4-nonene; n-octane;
1-octene; cis-2-octene; n-pentane;
1-pentene; cis-2-pentene; trans-2-pentene;
alpha-pinene; beta-pinene; propane;
1-propanol; 2-propanol; n-propylbenzene;
propylene; styrene; Tetrachloroethene;
1,1,2,2-tetrachloroethane; toluene; 1,2,4-trichlorobenzene;
1,1,1-trichloroethane; 1,1,2-trichloroethane; trichloroethene;
trichloroethylene; trichlorofluoromethane; 1,2,3-trimethylbenzene;
1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; 2,2,4-trimethylhexane;
2,2,4-trimethylpentane; 2,3,4-trimethylpentane; 2,2,5-trimethylhexane 2,4,4-
trimethyl-1-pentene; 2,4,4-trimethyl-2-pentene; 2,2,3-trimethylpentane;
n-undecane; 1-undecene; vinyl acetate;
(o,m,p)-xylene; vinylidine chloride; vinyl chloride.

In addition to the above individual compounds, the following classes of VOC compounds were also measured and converted to emission factors:

Total Alkanes (saturated hydrocarbos) = sum of all alkanes measured in the sample,

including non-target alkanes;

Total Alkenes (unsaturated hydrocarbons) = sum of all alkenes measured in the sample, including non-target alkenes and acetylene

Total Aromatics = sum of all aromatic compounds measured in the sample, including non-target aromatics;

Total Non-methane Hydrocarbons (TNMHC) = sum of total alkanes, total alkenes, total aromatics, and all other chromatographic peaks which did not contain halogen compounds;

Total Unidentified Hydrocarbons (TUHC) = sum of all chromatographic peaks known to be hydrocarbon compounds but not identified.

Method 8270 Analytes (Hi-Vol and PS-1 Sampling Systems)

Acenaphthylene; acetophenone; 2-acetylmninofluorene;
4-aminobiphenyl; aniline; anthracene;
benz(a)anthracene; benz(a)pyrene; benzidine;
benzo(b)fluoranthene; benzo(g,h,i)perylene; benzoic acid;
benzo(k)fluoranthene; benzyl alcohol; biphenyl;
bromophenylphenylether; butylbenzylphthalate; p-chloroaniline;
chlorobenzilate; bis(2-chloroethoxy)methane; bis(2-chloroethyl)ether;
bis(2-chloroisopropylether; 4-chloro-3-methylphenol; 2-chloronaphthalene;
2-chlorophenol; 4-chlorophenylphenyl ether; chrysene;
diallate; dibenz(a,h)anthracene; dibenzofuran;
1,2-dichlorobenzene; 1,3-dichlorobenzene; 1,4-dichlorobenzene;
3,3'-dichlorobenzidine; 2,4-dichlorophenol; 2,6-dichlorophenol;
diethylphthalate; p-dimethylaminoazobenzene; dimethylbenz(a)anthracene; 3,3'-dimethylbenzidine; dimethylphenethylamine; 2,4-dimethylphenol;
dimethylphthalate; di-n-butylphthalate; 1,3-dinitrobenzene;
4,6-dinitro-2-methylphenol; 2,4-dinitrophenol; 2,4-dinitrotoluene;
2,6-dinitrotoluene; di-n-octylphthalate; 1,4-diphenylamine;
1,2 diphenylhydrazine; bis(2-ethylhexyl)phthallate; N-nitrosodiphenylamine;
ethyl methanesulfonate; fluoranthene; fluorene;
hexachlorobenzene; hexachlorobutadiene; hexachlorocyclopentadiene;
hexachloroethane; hexachloropropene; indeno(1,2,3-cd)pyrene;
isophoron; isosafrole; kepone;
methapyrilene; 3-methylcholanthrene; methyl methanesulfonate;
2-methylnaphthalene; 2-methylphenol; 4-methylphenol;
3-methylphenol; naphthalene; 1,4-naphthoquinone;
1-naphthylamine; 2-naphthylamine; 2-nitroaniline;
3-nitroaniline; 4-nitroaniline; nitrobenzene;
5-nitro-o-toluidine; 2-nitrophenol; 4-nitrophenol;
4-nitroquinoline-1-oxide; N-nitrosodiethylamine; N-nitrosodimethylamine;
N-nitroso-di-n-butylamine; N-nitroso-di-n-propylamine; N-nitrosomethylethylamine;
N-nitrosomorpholine; N-nitrosopiperidine; N-nitrosopyrrolidine;
pentachlorobenzene; pentachloroethane; pentachloronitrobenzene;
pentachlorophenol; perylene; phenacetin;
phenanthrene; phenol; 2-picoline;
pronamide; pyrene; pyridine;
safrole; 1,2,4,5-tetrachlorobenzene; 2,3,4,6-tetrachlorophenol;
o-toluidine; 1,2,4-trichlorobenzene; 2,4,5-trichlorophenol;
2,4,6-trichlorophenol; triethylphosphorothioate; 1,3,5-trinitrobenzene.

Energetic Target Analytes

Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX);
hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX);
methyl-2,4,5-trinitrophenylnitramine (TETRYL);
2,6 dichlorphenol;
nitrobenzene;
2,4,6-trinitrotoluene (TNT);
2-amino-4,6-dinitrotoluene;
2,4-dinitrotoluene;
2-nitronaphthalene;
dibenzofuran;
2,6-dichlorophenol;
1,3,5-trinitrobenzene;
1,3-dinitrobenzene;
2-nitrodiphenylamine;
4-amino-2,6-dinitrotoluene;
2,6-dinitrotoluene;
2-methylnaphthalene;
naphthalene;

1-nitropyrene;
4-nitrotoluene ;
nitroglycerin (NG);
nitrocellulose (NC);
pentaerythritol tetranitrate (PETN);
phenol.

2-nitrotoluene;
3-nitrotoluene;
nitroguanidine (NQ);
Benz(A)pyrene;
benz(a)anthracene;

Polychlorinated dibenzo-p-furan Analytes (Furans)

Total chlorinated dibenz-p-dioxin (TCDD);
Total pentachlorinated dibenzo-p-dioxin (PeCDD);
Total hexachlorinated dibenzo-p-dioxin (HxCDD);
Total heptachlorinated dibenzo-p-dioxin (HpCDD);
Octachlorinated dibenzo-p-dioxin (OCDD);
2378-TCDD; 1234678-HpCDD.

Polychorinated dibenzo-p-dioxin Analytes (Dioxins)

Total tetrachlorinated dibenzofurans (TCDF);
Total pentachlorinated dibenzofurans (PeCDF);
Total hexachlorinated dibenzofurans (HxCDF);
Total heptachlorinated dibenzofurans (HpCDF);
Octachlorinated dibenzofuran (OCDF);

2378-TCDF;	12378-PeCDF;	23478-PeCDF;
123478-HxCDF;	123678-HxCDF;	234678-HxCDF;
1234678-HpCDF;	1234789-HpCDF.	

Appendix D
Emission Factors for Burns

SPECIAL NOTES:

The emission factors in this database apply to the open burning of energetic materials in a burn pan. A value of 0.00e+00 means that the compound (analyte) was either not detected, or, was detected at only the background level. Values of 0.00e+00 were not used in calculating the average (AVG) emission factors in the database. A blank cell means that either no sample was collected or that the sample collected was either lost or not valid.

The emission factors in this table are unitless. The user can convert them to any mass units desired (e.g., grams compound per gram NEW). A value e-06 means that the quantity in the numerator is to be multiplied by 10 to the -6 power. For example, 1.1 e-06 could be written as either 1.1×10^{-6} g/g NEW or 1 microgram/g NEW.

COMPOUND	ITEM	EMISSION FACTORS				
		TRIAL 1	TRIAL 2	TRIAL 3	AVERAGE	UNCORR
cis-2-Pentene	diesel furel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	Manufacturer's waste - aluminized propellant with diesel	3.80e-07	3.10e-07	1.00e-06	5.60e-07	6.60e-07
cis-2-Pentene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	Propellant, M-43 (USN)	9.10e-08			9.10e-08	9.10e-08
cis-2-Pentene	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	Propellant, MK-23	0.00e+00			0.00e+00	9.80e-08
cis-2-Pentene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	Propellant, PBXN-110	0.00e+00			0.00e+00	1.00e-07
cis-2-Pentene	Propellant, Smokey Sam	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Butane	Diesel fuel and dunnage	0.00e+00	1.20e-06	0.00e+00	1.20e-06	1.40e-06
i-Butane	Manufacturer's waste - aluminized propellant with diesel	2.30e-07	1.80e-06	2.10e-06	1.40e-06	2.30e-06
i-Butane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Butane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Butane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Butane	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.80e-06
i-Butane	Propellant, M-43 (USN)	0.00e+00			0.00e+00	1.80e-07
i-Butane	Propellant, M-9	4.30e-08			4.30e-08	8.50e-08
i-Butane	Propellant, MK-23	0.00e+00			0.00e+00	2.00e-07
i-Butane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Butane	Propellant, PBXN-110	0.00e+00			0.00e+00	2.00e-07
i-Butane	Propellant, Smokey Sam	0.00e+00			0.00e+00	7.80e-07
i-Butane	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	9.60e-07
i-Butene	Diesel fuel and dunnage	0.00e+00	1.70e-06	2.30e-06	2.00e-06	2.00e-06
i-Butene	Manufacturer's waste - aluminized propellant with diesel	1.30e-05	2.10e-06	2.60e-06	5.80e-06	5.80e-06
i-Butene	Propellant, ammonium perchlorate, aluminized	1.00e-05	0.00e+00		1.00e-05	1.00e-05
i-Butene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Butene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Butene	Propellant, M-3	7.90e-07	0.00e+00	0.00e+00	7.90e-07	8.00e-07
i-Butene	Propellant, M-43 (USN)	5.40e-07			5.40e-07	5.40e-07
i-Butene	Propellant, M-9	2.60e-07			2.60e-07	2.60e-07
i-Butene	Propellant, MK-23	4.90e-07			4.90e-07	4.90e-07
i-Butene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

i-Butene	Propellant, PBXN-110	1.30e-06			1.30e-06	1.30e-06
i-Butene	Propellant, Smokey Sam	2.40e-06			2.40e-06	2.40e-06
i-Butene	Smokeless Powder (Hercules Unique)	9.60e-07			9.60e-07	9.60e-07
i-Pentane	Diesel fuel and dunnage	0.00e+00	6.90e-06	1.10e-05	8.90e-06	1.00e-05
i-Pentane	Manufacturer's waste - aluminized propellant with diesel	0.00e+00	0.00e+00	2.30e-05	2.30e-05	1.80e-05
i-Pentane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Pentane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Pentane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Pentane	Propellant, M-3	3.00e-08	0.00e+00	0.00e+00	3.00e-08	1.80e-07
i-Pentane	Propellant, M-43 (USN)	9.10e-08			9.10e-08	3.60e-07
i-Pentane	Propellant, M-9	0.00e+00			0.00e+00	8.50e-08
i-Pentane	Propellant, MK-23	0.00e+00			0.00e+00	6.90e-07
i-Pentane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Pentane	Propellant, PBXN-110	0.00e+00			0.00e+00	1.00e-06
i-Pentane	Propellant, Smokey Sam	7.80e-07			7.80e-07	2.70e-06
i-Pentane	Smokeless Powder (Hercules Unique)	1.20e-06			1.20e-06	3.80e-06
m-Ethyltoluene	Diesel fuel and dunnage	1.10e-04	1.40e-04	1.40e-04	1.30e-04	4.60e-04
m-Ethyltoluene	Manufacturer's waste - aluminized propellant with diesel	2.20e-06	1.50e-06	4.10e-06	2.60e-06	6.90e-05
m-Ethyltoluene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
m-Ethyltoluene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
m-Ethyltoluene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
m-Ethyltoluene	Propellant, M-3	5.00e-08	0.00e+00	1.40e-07	9.70e-08	5.50e-07
m-Ethyltoluene	Propellant, M-43 (USN)	0.00e+00			0.00e+00	3.60e-07
m-Ethyltoluene	Propellant, M-9	4.30e-08			4.30e-08	6.00e-07
m-Ethyltoluene	Propellant, MK-23	3.00e-07			3.00e-07	9.80e-07
m-Ethyltoluene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
m-Ethyltoluene	Propellant, PBXN-110	2.00e-07			2.00e-07	7.00e-07
m-Ethyltoluene	Propellant, Smokey Sam	2.00e-06			2.00e-06	5.90e-06
m-Ethyltoluene	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	2.20e-06
n-Butane	Diesel fuel and dunnage	1.30e-06	6.80e-06	5.70e-06	4.60e-06	5.40e-06
n-Butane	Manufacturer's waste - aluminized propellant with diesel	5.50e-06	2.40e-06	2.00e-05	9.30e-06	1.80e-05
n-Butane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Butane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Butane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Butane	Propellant, M-3	9.00e-08	1.80e-07	0.00e+00	1.50e-07	5.60e-07
n-Butane	Propellant, M-43 (USN)	9.10e-08			9.10e-08	5.40e-07
n-Butane	Propellant, M-9	4.30e-08			4.30e-08	3.40e-07
n-Butane	Propellant, MK-23	0.00e+00			0.00e+00	5.90e-07
n-Butane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

n-Butane	Propellant, PBXN-110	1.00e-07			1.00e-07	6.00e-07
n-Butane	Propellant, Smokey Sam	0.00e+00			0.00e+00	2.70e-06
n-Butane	Smokeless Powder (Hercules Unique)	4.80e-07			4.80e-07	3.80e-06
n-Decane	Diesel fuel and dunnage	1.50e-03	0.00e+00	2.00e-03	1.80e-03	1.80e-03
n-Decane	Manufacturer's waste - aluminized propellant with diesel	9.20e-06	1.10e-05	2.30e-05	1.40e-05	3.10e-05
n-Decane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Decane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Decane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Decane	Propellant, M-3	4.20e-07	8.70e-07	1.40e-07	5.90e-07	1.90e-06
n-Decane	Propellant, M-43 (USN)	8.20e-07			8.20e-07	3.70e-06
n-Decane	Propellant, M-9	0.00e+00			0.00e+00	1.30e-06
n-Decane	Propellant, MK-23	0.00e+00			0.00e+00	3.20e-06
n-Decane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Decane	Propellant, PBXN-110	1.30e-06			1.30e-06	4.40e-06
n-Decane	Propellant, Smokey Sam	5.90e-06			5.90e-06	2.20e-05
n-Decane	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	8.60e-06
n-Heptane	Diesel fuel and dunnage	3.10e-05	8.00e-05	6.60e-05	5.90e-05	6.00e-05
n-Heptane	Manufacturer's waste - aluminized propellant with diesel	3.50e-06	2.40e-06	8.30e-06	4.70e-06	7.30e-06
n-Heptane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Heptane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Heptane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Heptane	Propellant, M-3	2.70e-07	5.10e-07	9.40e-08	3.10e-07	1.60e-06
n-Heptane	Propellant, M-43 (USN)	9.10e-08			9.10e-08	2.70e-07
n-Heptane	Propellant, M-9	0.00e+00			0.00e+00	1.10e-06
n-Heptane	Propellant, MK-23	0.00e+00			0.00e+00	4.90e-07
n-Heptane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Heptane	Propellant, PBXN-110	0.00e+00			0.00e+00	8.00e-07
n-Heptane	Propellant, Smokey Sam	2.00e-06			2.00e-06	3.10e-06
n-Heptane	Smokeless Powder (Hercules Unique)	7.20e-07			7.20e-07	1.20e-06
n-Hexane	Diesel fuel and dunnage	6.40e-06	2.30e-05	1.90e-05	1.60e-05	1.70e-05
n-Hexane	Manufacturer's waste - aluminized propellant with diesel	2.70e-06	1.50e-06	6.70e-06	3.70e-06	5.70e-06
n-Hexane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Hexane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Hexane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Hexane	Propellant, M-3	1.60e-05	1.40e-05	4.90e-06	1.90e-05	9.00e-05
n-Hexane	Propellant, M-43 (USN)	9.10e-08			9.10e-08	3.60e-07
n-Hexane	Propellant, MK-23	0.00e+00			0.00e+00	7.90e-07
n-Hexane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Hexane	Propellant, PBXN-110	0.00e+00			0.00e+00	1.30e-06

n-Hexane	Propellant, Smokey Sam	2.70e-06			2.70e-06	3.90e-06
n-Hexane	Smokeless Powder (Hercules Unique)	9.60e-07			9.60e-07	2.20e-06
n-Nonane	Diesel fuel and dunnage	8.00e-04	1.20e-03	1.10e-03	1.00e-03	1.00e-03
n-Nonane	Manufacturer's waste - aluminized propellant with diesel	1.10e-05	7.60e-06	2.10e-05	1.30e-05	2.40e-05
n-Nonane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Nonane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Nonane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Nonane	Propellant, M-3	7.80e-08	1.40e-07	0.00e+00	1.20e-07	2.30e-07
n-Nonane	Propellant, M-43 (USN)	0.00e+00			0.00e+00	9.10e-08
n-Nonane	Propellant, M-9	0.00e+00			0.00e+00	1.70e-07
n-Nonane	Propellant, MK-23	0.00e+00			0.00e+00	2.00e-07
n-Nonane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Nonane	Propellant, PBXN-110	2.00e-07			2.00e-07	5.00e-07
n-Nonane	Propellant, Smokey Sam	1.20e-06			1.20e-06	1.60e-06
n-Nonane	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	4.80e-07
n-Octane	Diesel fuel and dunnage	1.50e-04	3.20e-04	2.80e-04	2.50e-04	2.50e-04
n-Octane	Manufacturer's waste - aluminized propellant with diesel	6.30e-06	4.20e-06	1.20e-05	7.60e-06	1.30e-05
n-Octane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Octane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Octane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Octane	Propellant, M-3	2.90e-07	6.40e-07	1.90e-07	4.30e-07	1.60e-06
n-Octane	Propellant, M-43 (USN)	9.10e-08			9.10e-08	2.70e-07
n-Octane	Propellant, M-9	0.00e+00			0.00e+00	1.10e-06
n-Octane	Propellant, MK-23	0.00e+00			0.00e+00	2.00e-07
n-Octane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Octane	Propellant, PBXN-110	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Octane	Propellant, Smokey Sam	1.20e-06			1.20e-06	1.60e-06
n-Octane	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	4.80e-07
n-Pentane	Diesel fuel and dunnage	2.00e-06	1.30e-05	1.20e-05	9.10e-06	1.00e-05
n-Pentane	Manufacturer's waste - aluminized propellant with diesel	2.60e-06	1.10e-06	9.00e-06	4.30e-06	7.20e-06
n-Pentane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Pentane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Pentane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Pentane	Propellant, M-3	5.30e-07	1.50e-06	4.20e-07	8.60e-07	3.30e-06
n-Pentane	Propellant, M-43 (USN)	0.00e+00			0.00e+00	3.60e-07
n-Pentane	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Pentane	Propellant, MK-23	0.00e+00			0.00e+00	7.90e-07
n-Pentane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
n-Pentane	Propellant, PBXN-110	0.00e+00			0.00e+00	1.10e-06

n-Pentane	Propellant, Smokey Sam	7.80e-07			7.80e-07	2.70e-06
n-Pentane	Smokeless Powder (Hercules Unique)	9.60e-07			9.60e-07	2.60e-06
p-Ethyltoluene	Diesel fuel and dunnage	1.20e-04	1.70e-04	1.70e-04	1.50e-04	1.60e-04
p-Ethyltoluene	Manufacturer's waste - aluminized propellant with diesel	5.40e-06	2.90e-06	6.70e-06	5.00e-06	8.10e-06
p-Ethyltoluene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
p-Ethyltoluene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
p-Ethyltoluene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
p-Ethyltoluene	Propellant, M-3	5.60e-07	3.20e-07	2.20e-06	9.80e-07	2.10e-06
p-Ethyltoluene	Propellant, M-43 (USN)	1.80e-07			1.80e-07	9.10e-07
p-Ethyltoluene	Propellant, M-9	4.00e-06			4.00e-06	5.50e-06
p-Ethyltoluene	Propellant, MK-23	0.00e+00			0.00e+00	1.10e-06
p-Ethyltoluene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
p-Ethyltoluene	Propellant, PBXN-110	3.00e-07			3.00e-07	1.40e-06
p-Ethyltoluene	Propellant, Smokey Sam	7.10e-06			7.10e-06	1.10e-05
p-Ethyltoluene	Smokeless Powder (Hercules Unique)	4.80e-07			4.80e-07	2.40e-06
p-Ethyltoluene	Diesel fuel and dunnage	1.20e-04	6.60e-06	6.90e-07	4.10e-05	4.20e-05
p-Ethyltoluene	Manufacturer's waste - aluminized propellant with diesel	2.00e-06	2.00e-06	0.00e+00	2.00e-06	5.30e-06
p-Ethyltoluene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
p-Ethyltoluene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
p-Ethyltoluene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
p-Ethyltoluene	Propellant, M-3	0.00e+00	2.00e-07	2.80e-08	3.70e-08	5.70e-07
p-Ethyltoluene	Propellant, M-43 (USN)	0.00e+00			0.00e+00	3.90e-07
p-Ethyltoluene	Propellant, M-9	0.00e+00			0.00e+00	7.20e-07
p-Ethyltoluene	Propellant, MK-23	0.00e+00			0.00e+00	4.20e-07
p-Ethyltoluene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
p-Ethyltoluene	Propellant, PBXN-110	4.30e-07			4.30e-07	8.50e-07
p-Ethyltoluene	Propellant, Smokey Sam	1.70e-06			1.70e-06	3.30e-06
p-Ethyltoluene	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	1.00e-06
trans-2-Butene	Diesel fuel and dunnage	3.60e-06	1.80e-06	3.30e-06	2.90e-06	2.90e-06
trans-2-Butene	Manufacturer's waste - aluminized propellant with diesel	2.70e-05	1.40e-05	2.10e-05	2.10e-05	2.10e-05
trans-2-Butene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Butene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Butene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Butene	Propellant, M-3	1.90e-07	0.00e+00	0.00e+00	1.90e-07	1.90e-07
trans-2-Butene	Propellant, M-43 (USN)	1.80e-07			1.80e-07	1.80e-07
trans-2-Butene	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Butene	Propellant, MK-23	2.00e-07			2.00e-07	2.00e-07
trans-2-Butene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Butene	Propellant, PBXN-110	4.00e-07			4.00e-07	4.00e-07

trans-2-Butene	Propellant, Smokey Sam	2.40e-06			2.40e-06	2.40e-06
trans-2-Butene	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Hexene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Hexene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	Diesel fuel and dunnage	0.00e+00	0.00e+00	1.10e-06	1.10e-06	1.10e-06
trans-2-Pentene	Manufacturer's waste - aluminized propellant with diesel	0.00e+00	3.80e-07	1.50e-06	9.60e-07	1.20e-06
trans-2-Pentene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	Propellant, M-43 (USN)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	Propellant, MK-23	0.00e+00			0.00e+00	9.80e-08
trans-2-Pentene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	Propellant, PBXN-110	0.00e+00			0.00e+00	2.00e-07
trans-2-Pentene	Propellant, Smokey Sam	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Acetylene	Diesel fuel and dunnage	1.20e-04	7.30e-05	9.10e-05	9.50e-05	9.60e-05
Acetylene	Manufacturer's waste - aluminized propellant with diesel	1.80e-03	1.30e-03	1.50e-03	1.60e-03	1.60e-03
Acetylene	Propellant, ammonium perchlorate, aluminized	1.00e-05	0.00e+00		1.00e-05	1.00e-05
Acetylene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Acetylene	Propellant, composite (MK-6) (Sandia)	2.10e-05			2.10e-05	
Acetylene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Acetylene	Propellant, double base (Sandia)	2.00e-04			2.00e-04	
Acetylene	Propellant, M-3	7.70e-06	1.50e-05	1.90e-05	1.30e-05	7.90e-06
Acetylene	Propellant, M-43 (USN)	5.90e-06			5.90e-06	6.40e-06
Acetylene	Propellant, M-9	9.00e-06			9.00e-06	9.20e-06
Acetylene	Propellant, MK-23	5.50e-06			5.50e-06	6.20e-06
Acetylene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Acetylene	Propellant, PBXN-110	3.10e-06			3.10e-06	3.70e-06
Acetylene	Propellant, Smokey Sam	8.30e-04			8.30e-04	8.30e-04
Acetylene	Smokeless Powder (Hercules Unique)	1.20e-06			1.20e-06	3.60e-06
Acenaphthalene	Manufacturer's waste - aluminized propellant with diesel	1.10e-04	5.00e-04	3.20e-04	1.60e-04	0.00e+00
Aluminum	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.50e-06
Aluminum	Manufacturer's waste - aluminized propellant with diesel	6.10e-03	8.50e-03	9.30e-02	3.60e-02	3.60e-02
Aluminum	Propellant, ammonium perchlorate, aluminized	9.40e-03	1.20e-02		1.10e-02	1.10e-02
Aluminum	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.00e-05
Aluminum	Propellant, composite (MK-6) (Sandia)	1.30e-03			1.30e-03	
Aluminum	Propellant, M-3	6.80e-07	8.50e-07	1.40e-05	5.10e-06	5.10e-06
Aluminum	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Barium	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Manufacturer's waste - aluminized propellant with diesel	1.60e-05	2.00e-05	2.20e-04	8.60e-05	8.90e-05
Barium	Propellant, ammonium perchlorate, aluminized	1.00e-05	1.00e-05		1.00e-05	1.00e-05
Barium	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Propellant, composite (MK-6) (Sandia)	1.60e-06			1.60e-06	
Barium	Propellant, double base (Sandia)	0.00e+00			0.00e+00	
Barium	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Benzene	Diesel fuel and dunnage	1.00e-04	5.20e-05	8.10e-05	7.80e-05	8.00e-05
Benzene	Manufacturer's waste - aluminized propellant with diesel	6.40e-04	2.90e-04	4.10e-04	4.50e-04	4.50e-04
Benzene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Benzene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Benzene	Propellant, composite (MK-6) (Sandia)	5.70e-05			5.70e-05	
Benzene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Benzene	Propellant, double base (Sandia)	1.20e-04			1.20e-04	
Benzene	Propellant, M-3	6.40e-06	1.10e-05	1.40e-05	1.00e-05	7.70e-06
Benzene	Propellant, M-43 (USN)	1.70e-06			1.70e-06	2.30e-06
Benzene	Propellant, M-9	3.20e-06			3.20e-06	4.20e-06
Benzene	Propellant, MK-23	0.00e+00			0.00e+00	2.00e-06
Benzene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Benzene	Propellant, PBXN-110	4.90e-06			4.90e-06	7.70e-06
Benzene	Propellant, Smokey Sam	6.60e-05			6.60e-05	7.00e-05
Benzene	Smokeless Powder (Hercules Unique)	1.20e-06			1.20e-06	3.10e-06
Carbon tetrachloride	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.90e-07
Carbon tetrachloride	Manufacturer's waste - aluminized propellant with diesel	3.30e-06	6.30e-06	7.30e-06	5.60e-06	6.00e-06
Carbon tetrachloride	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Carbon tetrachloride	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Carbon tetrachloride	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Carbon tetrachloride	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Carbon tetrachloride	Propellant, M-43 (USN)	0.00e+00			0.00e+00	5.00e-07
Carbon tetrachloride	Propellant, M-9	2.30e-07			2.30e-07	2.30e-07
Carbon tetrachloride	Propellant, MK-23	1.10e-06			1.10e-06	1.60e-06
Carbon tetrachloride	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Carbon tetrachloride	Propellant, PBXN-110	0.00e+00			0.00e+00	5.50e-07
Carbon tetrachloride	Propellant, Smokey Sam	0.00e+00			0.00e+00	2.20e-06
Carbon tetrachloride	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	1.30e-06
Chloroform	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Manufacturer's waste - aluminized propellant with diesel	2.20e-06	2.40e-06	2.30e-06	2.30e-06	2.50e-06

Chloroform	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Propellant, M-43 (USN)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Propellant, MK-23	4.20e-07			4.20e-07	4.20e-07
Chloroform	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Propellant, PBXN-110	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Propellant, Smokey Sam	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Manufacturer's waste - aluminized propellant with diesel	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Propellant, ammonium perchlorate, aluminized	1.00e-05	1.00e-05		1.00e-05	1.00e-05
Chromium	Propellant, ammonium perchlorate, nonaluminized	1.00e-05	1.00e-05		1.00e-05	1.00e-05
Chromium	Propellant, composite (MK-6) (Sandia)	4.80e-05			4.80e-05	
Chromium	Propellant, double base (Sandia)	0.00e+00			0.00e+00	
Chromium	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cl2	Manufacturer's waste - aluminized propellant with diesel	2.80e-04	1.50e-05	1.60e-04	2.00e-04	
Cl2	Propellant, ammonium perchlorate, aluminized	5.00e-03	4.20e-03		4.60e-03	
Cl2	Propellant, ammonium perchlorate, nonaluminized	1.10e-02	8.20e-03		9.20e-03	
Copper	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Copper	Manufacturer's waste - aluminized propellant with diesel	1.50e-05	0.00e+00	0.00e+00	1.50e-05	1.90e-05
Copper	Propellant, ammonium perchlorate, nonaluminized	5.00e-05	1.00e-04		8.00e-05	8.00e-05
Copper	Propellant, double base	0.00e+00	3.20e-04		1.60e-04	1.60e-04
Copper	Propellant, double base (Sandia)	3.70e-02			3.70e-02	
Copper	Propellant, M-3	3.40e-06	8.30e-06	2.50e-06	4.40e-06	2.90e-05
Copper	Propellant, M-9	6.50e-06			6.50e-06	4.60e-05
Copper	Propellant, M31A1E1	1.00e-05			1.00e-05	
Cyclohexane	Diesel fuel and dunnage	1.30e-05	3.80e-05	3.00e-05	2.70e-05	2.70e-05
Cyclohexane	Manufacturer's waste - aluminized propellant with diesel	1.70e-06	9.20e-07	3.30e-06	2.00e-06	3.40e-06
Cyclohexane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	Propellant, M-3	1.30e-07	1.40e-07	0.00e+00	1.50e-07	5.00e-07
Cyclohexane	Propellant, M-43 (USN)	9.10e-08			9.10e-08	1.80e-07
Cyclohexane	Propellant, M-9	0.00e+00			0.00e+00	4.70e-07

Cyclohexane	Propellant, MK-23	0.00e+00			0.00e+00	3.90e-07
Cyclohexane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	Propellant, PBXN-110	0.00e+00			0.00e+00	8.00e-07
Cyclohexane	Propellant, Smokey Sam	1.20e-06			1.20e-06	2.00e-06
Cyclohexane	Smokeless Powder (Hercules Unique)	4.80e-07			4.80e-07	9.60e-07
Cyclopentane	Diesel fuel and dunnage	0.00e+00	1.50e-06	1.40e-06	1.50e-06	1.50e-06
Cyclopentane	Manufacturer's waste - aluminized propellant with diesel	1.50e-07	7.60e-08	5.40e-07	2.50e-07	4.30e-07
Cyclopentane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.70e-08
Cyclopentane	Propellant, M-43 (USN)	0.00e+00			0.00e+00	9.10e-08
Cyclopentane	Propellant, M-9	4.30e-08			4.30e-08	8.50e-08
Cyclopentane	Propellant, MK-23	0.00e+00			0.00e+00	9.80e-08
Cyclopentane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	Propellant, PBXN-110	0.00e+00			0.00e+00	2.00e-07
Cyclopentane	Propellant, Smokey Sam	0.00e+00			0.00e+00	3.90e-07
Cyclopentane	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	2.40e-07
Cyclopentene	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentene	Manufacturer's waste - aluminized propellant with diesel	9.80e-07	7.60e-07	1.10e-06	9.40e-07	9.40e-07
Cyclopentene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentene	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentene	Propellant, M-43 (USN)	9.10e-08			9.10e-08	9.10e-08
Cyclopentene	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentene	Propellant, MK-23	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentene	Propellant, PBXN-110	1.00e-07			1.00e-07	1.00e-07
Cyclopentene	Propellant, Smokey Sam	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentene	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
CO	Diesel fuel and dunnage	7.40e-03	4.70e-03	6.00e-03	6.00e-03	
CO	Manufacturer's waste - aluminized propellant with diesel	2.20e-02	1.90e-02	1.90e-02	2.00e-02	
CO	Propellant, ammonium perchlorate, aluminized	2.10e-03	3.50e-04		1.20e-03	
CO	Propellant, ammonium perchlorate, nonaluminized	1.30e-04	1.50e-04		1.40e-04	
CO	Propellant, composite (MK-6) (Sandia)	4.20e-03			4.20e-03	
CO	Propellant, double base	1.50e-03	1.50e-03		1.50e-03	
CO	Propellant, double base (Sandia)	9.50e-04			9.50e-04	
CO	Propellant, M-3	1.60e-02	1.60e-02	1.80e-02	1.40e-02	
CO	Propellant, M-43 (USN)	6.60e-04			6.60e-04	
CO	Propellant, M-9	2.70e-03			2.70e-03	

CO	Propellant, MK-23	2.70e-04			2.70e-04	
CO	Propellant, M31A1E1	1.40e-04	1.10e-04	1.30e-04	1.30e-04	
CO	Propellant, PBXN-110	1.20e-03			1.20e-03	
CO	Propellant, Smokey Sam	7.20e-02			7.20e-02	
CO	Smokeless Powder (Hercules Unique)	1.60e-03			1.60e-03	
CO2	Diesel fuel and dunnage	1.50e+00	1.50e+00	1.50e+00	1.50e+00	
CO2	Manufacturer's waste - aluminized propellant with diesel	1.10e+00	1.10e+00	1.20e+00	1.10e+00	
CO2	Propellant, ammonium perchlorate, aluminized	3.10e-01	3.20e-01		3.20e-01	
CO2	Propellant, ammonium perchlorate, nonaluminized	3.70e-01	3.70e-01		3.70e-01	
CO2	Propellant, composite (MK-6) (Sandia)	4.20e-01			4.20e-01	
CO2	Propellant, double base	6.70e-01	6.70e-01		6.70e-01	
CO2	Propellant, double base (Sandia)	9.70e-01			9.70e-01	
CO2	Propellant, M-3	1.20e+00	1.20e+00	1.20e+00	1.20e+00	
CO2	Propellant, M-43 (USN)	7.70e-01			7.70e-01	
CO2	Propellant, M-9	9.40e-01			9.40e-01	
CO2	Propellant, MK-23	5.40e-01			5.40e-01	
CO2	Propellant, M31A1E1	5.40e-01	5.60e-01	6.80e-01	5.90e-01	
CO2	Propellant, PBXN-110	1.00e+00			1.00e+00	
CO2	Propellant, Smokey Sam	4.20e-01			4.20e-01	
CO2	Smokeless Powder (Hercules Unique)	8.70e-01			8.70e-01	
Ethane	Diesel fuel and dunnage	0.00e+00	7.20e-06	1.20e-05	9.30e-06	1.00e-05
Ethane	Manufacturer's waste - aluminized propellant with diesel	1.80e-05	3.80e-06	6.90e-06	9.50e-06	1.00e-05
Ethane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethane	Propellant, M-3	1.10e-06	1.20e-06	2.80e-07	1.30e-06	1.50e-06
Ethane	Propellant, M-43 (USN)	1.80e-07			1.80e-07	1.50e-06
Ethane	Propellant, M-9	5.60e-07			5.60e-07	1.40e-06
Ethane	Propellant, MK-23	0.00e+00			0.00e+00	9.80e-07
Ethane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethane	Propellant, PBXN-110	1.00e-06			1.00e-06	2.10e-06
Ethane	Propellant, Smokey Sam	0.00e+00			0.00e+00	5.50e-06
Ethane	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	2.60e-06
Ethylbenzene	Diesel fuel and dunnage	4.30e-05	6.20e-05	6.10e-05	5.50e-05	5.70e-05
Ethylbenzene	Manufacturer's waste - aluminized propellant with diesel	2.30e-06	1.30e-06	3.50e-06	2.40e-06	4.20e-06
Ethylbenzene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethylbenzene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethylbenzene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethylbenzene	Propellant, M-3	3.00e-07	0.00e+00	1.40e-07	2.60e-07	1.00e-06

Ethylbenzene	Propellant, M-43 (USN)	0.00e+00			0.00e+00	3.60e-07
Ethylbenzene	Propellant, M-9	0.00e+00			0.00e+00	8.50e-07
Ethylbenzene	Propellant, MK-23	0.00e+00			0.00e+00	6.90e-07
Ethylbenzene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethylbenzene	Propellant, PBXN-110	8.00e-07			8.00e-07	1.60e-06
Ethylbenzene	Propellant, Smokey Sam	1.20e-06			1.20e-06	2.70e-06
Ethylbenzene	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	1.20e-06
Ethylene	Diesel fuel and dunnage	6.60e-05	7.20e-05	8.50e-05	7.40e-05	7.50e-05
Ethylene	Manufacturer's waste - aluminized propellant with diesel	3.10e-04	1.60e-04	2.30e-04	2.30e-04	2.30e-04
Ethylene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethylene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethylene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethylene	Propellant, M-3	5.80e-06	8.80e-06	3.30e-06	7.80e-06	5.90e-06
Ethylene	Propellant, M-43 (USN)	4.80e-06			4.80e-06	5.00e-06
Ethylene	Propellant, M-9	6.50e-06			6.50e-06	6.60e-06
Ethylene	Propellant, MK-23	9.80e-07			9.80e-07	1.20e-06
Ethylene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethylene	Propellant, PBXN-110	6.70e-06			6.70e-06	6.80e-06
Ethylene	Propellant, Smokey Sam	7.20e-05			7.20e-05	7.30e-05
Ethylene	Smokeless Powder (Hercules Unique)	2.40e-07			2.40e-07	1.40e-06
Fluoranthene	Manufacturer's waste - aluminized propellant with diesel	5.00e-05	0.00e+00	3.60e-04	2.00e-04	2.00e-04
HCl	Propellant, ammonium perchlorate, aluminized	2.10e-01	2.10e-01		2.10e-01	2.10e-01
HCl	Propellant, ammonium perchlorate, nonaluminized	2.10e-01	2.15e-01		2.15e-01	2.15e-01
HCl	Propellant, composite (MK-6) (Sandia)	9.40e-02			9.40e-02	
HCl	Propellant, M-43 (USN)	1.00e-03			1.00e-03	1.00e-03
HCl	Propellant, MK-23 .	1.90e-03			1.90e-03	1.90e-03
HCl	Propellant, PBXN-110	1.80e-04			1.80e-04	1.80e-04
HCl	Propellant, Smokey Sam	2.90e-02			2.90e-02	2.90e-02
HCl	Manufacturer's waste - aluminized propellant with diesel	8.50e-02	7.70e-02	8.80e-02	8.30e-02	
Lead	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Lead	Manufacturer's waste - aluminized propellant with diesel	0.00e+00	7.30e-05	4.90e-04	2.80e-04	2.80e-04
Lead	Propellant, ammonium perchlorate, aluminized	4.00e-05			4.00e-05	4.00e-05
Lead	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Lead	Propellant, double base	5.80e-03	5.50e-03		5.60e-03	5.60e-03
Lead	Propellant, double base (Sandia)	1.30e-02			1.30e-02	
Lead	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Lead	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methyl chloride	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methyl chloride	Manufacturer's waste - aluminized propellant with diesel	2.70e-05	1.40e-05	1.90e-05	2.00e-05	2.00e-05

Methyl chloride	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methyl chloride	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methyl chloride	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methyl chloride	Propellant, M-3	1.60e-07	0.00e+00	1.10e-07	1.40e-07	4.50e-07
Methyl chloride	Propellant, M-43 (USN)	0.00e+00			0.00e+00	1.60e-07
Methyl chloride	Propellant, M-9	1.50e-07			1.50e-07	3.10e-07
Methyl chloride	Propellant, MK-23	7.10e-07			7.10e-07	8.90e-07
Methyl chloride	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methyl chloride	Propellant, PBXN-110	1.80e-07			1.80e-07	1.80e-07
Methyl chloride	Propellant, Smokey Sam	5.70e-06			5.70e-06	6.40e-06
Methyl chloride	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	4.30e-07
Methylcyclohexane	Diesel fuel and dunnage	8.40e-05	2.10e-04	1.70e-04	1.60e-04	1.60e-04
Methylcyclohexane	Manufacturer's waste - aluminized propellant with diesel	7.30e-06	4.40e-06	1.20e-05	8.00e-06	1.40e-05
Methylcyclohexane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclohexane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclohexane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclohexane	Propellant, M-3	9.90e-08	0.00e+00	4.70e-08	5.80e-08	4.30e-07
Methylcyclohexane	Propellant, M-43 (USN)	0.00e+00			0.00e+00	1.80e-07
Methylcyclohexane	Propellant, M-9	0.00e+00			0.00e+00	4.70e-07
Methylcyclohexane	Propellant, MK-23	0.00e+00			0.00e+00	3.90e-07
Methylcyclohexane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclohexane	Propellant, PBXN-110	0.00e+00			0.00e+00	5.00e-07
Methylcyclohexane	Propellant, Smokey Sam	7.80e-07			7.80e-07	1.60e-06
Methylcyclohexane	Smokeless Powder (Hercules Unique)	4.80e-07			4.80e-07	9.60e-07
Methylcyclopentane	Diesel fuel and dunnage	4.20e-06	1.40e-05	1.10e-05	9.90e-06	1.00e-05
Methylcyclopentane	Manufacturer's waste - aluminized propellant with diesel	7.60e-08	3.80e-07	2.70e-06	1.10e-06	2.00e-06
Methylcyclopentane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclopentane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclopentane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclopentane	Propellant, M-3	2.10e-06	2.00e-06	6.60e-07	2.50e-06	1.10e-05
Methylcyclopentane	Propellant, M-43 (USN)	0.00e+00			0.00e+00	1.80e-07
Methylcyclopentane	Propellant, M-9	0.00e+00			0.00e+00	1.70e-06
Methylcyclopentane	Propellant, MK-23	0.00e+00			0.00e+00	4.90e-07
Methylcyclopentane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclopentane	Propellant, PBXN-110	0.00e+00			0.00e+00	7.00e-07
Methylcyclopentane	Propellant, Smokey Sam	1.60e-06			1.60e-06	2.00e-06
Methylcyclopentane	Smokeless Powder (Hercules Unique)	7.20e-07			7.20e-07	1.20e-06
Methylenechloride	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylenechloride	Manufacturer's waste - aluminized propellant with diesel	1.50e-05	9.80e-06	0.00e+00	1.20e-05	1.10e-05

Methylenechloride	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylenechloride	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylenechloride	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylenechloride	Propellant, M-3	5.60e-06	0.00e+00	5.20e-05	2.30e-05	5.80e-05
Methylenechloride	Propellant, M-43 (USN)	0.00e+00			0.00e+00	1.10e-06
Methylenechloride	Propellant, M-9	0.00e+00			0.00e+00	4.30e-05
Methylenechloride	Propellant, MK-23	6.00e-07			6.00e-07	6.00e-07
Methylenechloride	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylenechloride	Propellant, PBXN-110	0.00e+00			0.00e+00	9.00e-07
Methylenechloride	Propellant, Smokey Sam	1.20e-06			1.20e-06	4.70e-06
Methylenechloride	Smokeless Powder (Hercules Unique)	7.20e-07			7.20e-07	7.20e-07
NO	Diesel fuel and dunnage	6.30e-04	8.90e-04	8.80e-04	8.00e-04	
NO	Manufacturer's waste - aluminized propellant with diesel	9.30e-04	8.80e-04	1.20e-03	1.00e-03	
NO	Propellant, ammonium perchlorate, aluminized	2.20e-03	1.60e-03		1.90e-03	
NO	Propellant, ammonium perchlorate, nonaluminized	4.10e-03	3.90e-03		4.00e-03	
NO	Propellant, composite (MK-6) (Sandia)	2.10e-03			2.10e-03	
NO	Propellant, double base	1.70e-03	1.70e-03		1.70e-03	
NO	Propellant, double base (Sandia)	2.40e-02			2.40e-02	
NO	Propellant, M-43 (USN)	6.30e-03			6.30e-03	
NO	Propellant, M31A1E1		1.10e-03	1.20e-03	1.20e-03	
NO	Propellant, PBXN-110	2.60e-03			2.60e-03	
NO	Propellant, Smokey Sam	1.10e-02			1.10e-02	
NO2	Diesel fuel and dunnage	0.00e+00	5.10e-05	3.20e-05	4.20e-05	
NO2	Manufacturer's waste - aluminized propellant with diesel	4.40e-07	9.80e-06	9.70e-06	6.60e-06	
NO2	Propellant, ammonium perchlorate, aluminized	2.10e-04	7.00e-05		1.40e-04	
NO2	Propellant, ammonium perchlorate, nonaluminized	4.30e-03	4.70e-04		2.40e-03	
NO2	Propellant, composite (MK-6) (Sandia)	1.00e-03			1.00e-03	
NO2	Propellant, double base	9.00e-05	1.00e-04		1.00e-04	
NO2	Propellant, double base (Sandia)	2.80e-03			2.80e-03	
NO2	Propellant, M-43 (USN)	4.70e-04			4.70e-04	
NO2	Propellant, M31A1E1		1.00e-04	1.00e-04	1.00e-04	
NO2	Propellant, PBXN-110	2.80e-04			2.80e-04	
NO2	Propellant, Smokey Sam	2.70e-04			2.70e-04	
OCDD	Diesel fuel and dunnage	1.00e-11	0.00e+00	0.00e+00	1.00e-11	3.20e-11
OCDF	Manufacturer's waste - aluminized propellant with diesel	4.00e-08			4.00e-08	
Propane	Diesel fuel and dunnage	1.40e-06	2.20e-06	3.10e-06	2.20e-06	2.50e-06
Propane	Manufacturer's waste - aluminized propellant with diesel	4.20e-06	2.80e-06	6.50e-06	4.50e-06	5.00e-06
Propane	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Propane	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Propane	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Propane	Propellant, M-3	3.30e-07	5.10e-07	5.20e-07	5.00e-07	7.20e-07
Propane	Propellant, M-43 (USN)	0.00e+00			0.00e+00	9.10e-07
Propane	Propellant, M-9	0.00e+00			0.00e+00	3.40e-07
Propane	Propellant, MK-23	4.90e-07			4.90e-07	1.30e-06
Propane	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Propane	Propellant, PBXN-110	3.00e-07			3.00e-07	1.00e-06
Propane	Propellant, Smokey Sam	1.60e-06			1.60e-06	4.30e-06
Propane	Smokeless Powder (Hercules Unique)	2.40e-07			2.40e-07	3.40e-06
Propene	Diesel fuel and dunnage	1.00e-05	1.30e-05	1.60e-05	1.30e-05	1.30e-05
Propene	Manufacturer's waste - aluminized propellant with diesel	2.50e-05	2.10e-05	3.20e-05	2.60e-05	2.60e-05
Propene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Propene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Propene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Propene	Propellant, M-3	1.40e-06	2.00e-06	2.10e-06	2.00e-06	1.50e-06
Propene	Propellant, M-43 (USN)	1.10e-06			1.10e-06	1.20e-06
Propene	Propellant, M-9	7.30e-07			7.30e-07	8.10e-07
Propene	Propellant, MK-23	1.70e-06			1.70e-06	1.80e-06
Propene	Propellant, PBXN-110	3.00e-06			3.00e-06	3.10e-06
Propene	Propellant, Smokey Sam	2.70e-06			2.70e-06	2.70e-06
Propene	Smokeless Powder (Hercules Unique)	2.40e-07			2.40e-07	7.20e-07
PM10	Diesel fuel and dunnage	4.70e-03	4.90e-03	6.80e-03	5.40e-03	
PM10	Manufacturer's waste - aluminized propellant with diesel	3.80e-01	4.40e-01	4.90e+00	1.90e+00	
PM10	Propellant, ammonium perchlorate, aluminized	4.10e-01	4.30e-01		4.20e-01	
PM10	Propellant, ammonium perchlorate, nonaluminized	1.10e-02	1.80e-02		1.50e-02	
PM10	Propellant, double base	1.90e-02	1.90e-02		1.90e-02	
PM10	Propellant, M-3	8.80e-03	8.70e-03	8.20e-03	8.60e-03	
PM10	Propellant, M-43 (USN)	1.20e-03			1.20e-03	
PM10	Propellant, M-9	1.60e-02			1.60e-02	
PM10	Propellant, MK-23	5.90e-02			5.90e-02	
PM10	Propellant, M31A1E1	8.90e-01	9.30e-01	9.10e-01	9.10e-01	
PM10	Propellant, PBXN-110	4.90e-01			4.90e-01	
PM10	Propellant, Smokey Sam	2.60e-01			2.60e-01	
PM10	Smokeless Powder (Hercules Unique)	1.80e-03			1.80e-03	
Styrene	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Manufacturer's waste - aluminized propellant with diesel	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Propellant, M-43 (USN)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Styrene	Propellant, M-9	4.70e-07			4.70e-07	4.70e-07
Styrene	Propellant, MK-23	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Propellant, M31A1E1	0.00e+00			0.00e+00	1.00e-05
Styrene	Propellant, PBXN-110	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Propellant, Smokey Sam	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
SO2	Diesel fuel and dunnage	2.10e-04	7.90e-05	2.80e-04	1.90e-04	
SO2	Manufacturer's waste - aluminized propellant with diesel	8.60e-04	8.40e-04	8.80e-04	8.60e-04	
SO2	Propellant, ammonium perchlorate, aluminized	6.00e-05	4.00e-05		5.00e-05	
SO2	Propellant, ammonium perchlorate, nonaluminized	1.10e-04	1.10e-04		1.10e-04	
SO2	Propellant, composite (MK-6) (Sandia)	1.10e-03			1.10e-03	
SO2	Propellant, double base	3.00e-05	2.00e-05		3.00e-05	
SO2	Propellant, double base (Sandia)	3.20e-03			3.20e-03	
SO2	Propellant, M-43 (USN)	1.20e-04			1.20e-04	
SO2	Propellant, M31A1E1	1.00e-03	1.20e-03		1.20e-03	
SO2	Propellant, PBXN-110	3.50e-04			3.50e-04	
SO2	Propellant, Smokey Sam	1.50e-04			1.50e-04	
SO2	Smokeless Powder (Hercules Unique)	6.10e-04			6.10e-04	
Tetrachloroethylene	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Manufacturer's waste - aluminized propellant with diesel	0.00e+00	1.60e-06	1.80e-06	1.70e-06	1.70e-06
Tetrachloroethylene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Propellant, M-43 (USN)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Propellant, MK-23	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Propellant, PBXN-110	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Propellant, Smokey Sam	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Toluene	Diesel fuel and dunnage	8.00e-05	1.50e-04	1.40e-04	1.20e-04	1.30e-04
Toluene	Manufacturer's waste - aluminized propellant with diesel	3.40e-05	1.50e-05	3.40e-05	2.80e-05	3.90e-05
Toluene	Propellant, ammonium perchlorate, aluminized	0.00e+00			0.00e+00	1.00e-05
Toluene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00			0.00e+00	1.00e-05
Toluene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Toluene	Propellant, M-3	1.80e-06	2.00e-06	8.90e-07	1.80e-06	6.60e-06
Toluene	Propellant, M-43 (USN)	5.40e-07			5.40e-07	1.80e-06
Toluene	Propellant, M-9	0.00e+00			0.00e+00	5.40e-06
Toluene	Propellant, MK-23	0.00e+00			0.00e+00	2.90e-06
Toluene	Propellant, M31A1E1	0.00e+00			0.00e+00	3.00e-05

Toluene	Propellant, PBXN-110	0.00e+00			0.00e+00	4.50e-06
Toluene	Propellant, Smokey Sam	8.60e-06			8.60e-06	1.50e-05
Toluene	Smokeless Powder (Hercules Unique)	3.40e-06			3.40e-06	7.40e-06
Total Alkanes (Paraffins)	Diesel fuel and dunnage	2.70e-03	3.90e-03	3.90e-03	3.50e-03	3.50e-03
Total Alkanes (Paraffins)	Manufacturer's waste - aluminized propellant with diesel	9.40e-05	5.80e-05	2.30e-04	1.30e-04	2.30e-04
Total Alkanes (Paraffins)	Propellant, ammonium perchlorate, aluminized	0.00e+00			0.00e+00	2.00e-05
Total Alkanes (Paraffins)	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00		0.00e+00	1.00e-05
Total Alkanes (Paraffins)	Propellant, composite (MK-6) (Sandia)	5.90e-05			5.90e-05	
Total Alkanes (Paraffins)	Propellant, double base	0.00e+00				1.00e-05
Total Alkanes (Paraffins)	Propellant, double base (Sandia)	2.20e-04			2.20e-04	
Total Alkanes (Paraffins)	Propellant, M-3	3.00e-05	2.10e-05	7.40e-06	2.60e-05	1.30e-04
Total Alkanes (Paraffins)	Propellant, M-43 (USN)	5.40e-07			5.40e-07	1.00e-05
Total Alkanes (Paraffins)	Propellant, M-9	0.00e+00			0.00e+00	2.30e-05
Total Alkanes (Paraffins)	Propellant, MK-23	0.00e+00			0.00e+00	1.40e-05
Total Alkanes (Paraffins)	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Total Alkanes (Paraffins)	Propellant, PBXN-110	0.00e+00			0.00e+00	2.00e-05
Total Alkanes (Paraffins)	Propellant, Smokey Sam	2.30e-05			2.30e-05	7.20e-05
Total Alkanes (Paraffins)	Smokeless Powder (Hercules Unique)	6.70e-06			6.70e-06	4.20e-05
Total Alkenes (Olefins)	Diesel fuel and dunnage	2.00e-04	1.70e-04	2.10e-04	1.90e-04	2.00e-04
Total Alkenes (Olefins)	Manufacturer's waste - aluminized propellant with diesel	2.20e-03	1.50e-03	1.90e-03	1.90e-03	1.90e-03
Total Alkenes (Olefins)	Propellant, ammonium perchlorate, aluminized	3.00e-05	1.00e-05		2.00e-05	2.00e-05
Total Alkenes (Olefins)	Propellant, ammonium perchlorate, nonaluminized	1.00e-05	1.00e-05		1.00e-05	1.00e-05
Total Alkenes (Olefins)	Propellant, composite (MK-6) (Sandia)	1.00e-04			1.00e-04	
Total Alkenes (Olefins)	Propellant, double base	0.00e+00	1.00e-05		1.00e-05	1.00e-05
Total Alkenes (Olefins)	Propellant, double base (Sandia)	7.30e-04			7.30e-04	
Total Alkenes (Olefins)	Propellant, M-3	3.60e-05	2.80e-05	2.50e-05	2.90e-05	3.70e-05
Total Alkenes (Olefins)	Propellant, M-43 (USN)	1.30e-05			1.30e-05	1.40e-05
Total Alkenes (Olefins)	Propellant, M-9	1.70e-05			1.70e-05	1.80e-05
Total Alkenes (Olefins)	Propellant, MK-23	1.10e-05			1.10e-05	1.30e-05
Total Alkenes (Olefins)	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.00e-05
Total Alkenes (Olefins)	Propellant, PBXN-110	1.60e-05			1.60e-05	1.80e-05
Total Alkenes (Olefins)	Propellant, Smokey Sam	9.10e-04			9.10e-04	9.20e-04
Total Alkenes (Olefins)	Smokeless Powder (Hercules Unique)	2.20e-06			2.20e-06	7.40e-06
Total Aromatics	Diesel fuel and dunnage	1.60e-03	2.70e-03	2.60e-03	2.30e-03	2.30e-03
Total Aromatics	Manufacturer's waste - aluminized propellant with diesel	7.80e-04	3.60e-04	5.60e-04	5.70e-04	6.20e-04
Total Aromatics	Propellant, ammonium perchlorate, aluminized	0.00e+00				2.00e-05
Total Aromatics	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00		0.00e+00	2.00e-05
Total Aromatics	Propellant, composite (MK-6) (Sandia)	1.60e-04			1.60e-04	
Total Aromatics	Propellant, double base	0.00e+00	0.00e+00		0.00e+00	1.00e-05

Total Aromatics	Propellant, double base (Sandia)	4.40e-04			4.40e-04	
Total Aromatics	Propellant, M-3	1.60e-05	1.10e-05	1.90e-05	1.40e-05	3.50e-05
Total Aromatics	Propellant, M-43 (USN)	2.80e-06			2.80e-06	1.30e-05
Total Aromatics	Propellant, M-9	5.40e-06			5.40e-06	2.70e-05
Total Aromatics	Propellant, MK-23	0.00e+00			0.00e+00	1.70e-05
Total Aromatics	Propellant, M31A1E1	6.00e-05	7.00e-05	3.00e-05	5.00e-05	9.00e-05
Total Aromatics	Propellant, PBXN-110	7.10e-06			7.10e-06	2.80e-05
Total Aromatics	Propellant, Smokey Sam	1.00e-04			1.00e-04	1.50e-04
Total Aromatics	Smokeless Powder (Hercules Unique)	6.20e-06			6.20e-06	3.50e-05
Total Non-methane Hydrocarbons	Diesel fuel and dunnage	9.90e-03	1.30e-02	1.30e-02	1.20e-02	1.20e-02
Total Non-methane Hydrocarbons	Manufacturer's waste - aluminized propellant with diesel	3.50e-03	2.20e-03	3.10e-03	2.90e-03	3.20e-03
Total Non-methane Hydrocarbons	Propellant, ammonium perchlorate, aluminized	6.00e-05	3.00e-05		5.00e-05	1.10e-04
Total Non-methane Hydrocarbons	Propellant, ammonium perchlorate, nonaluminized	5.00e-05	4.00e-05		4.00e-05	7.00e-05
Total Non-methane Hydrocarbons	Propellant, double base	1.00e-05	1.00e-05		1.00e-05	4.00e-05
Total Non-methane Hydrocarbons	Propellant, M-3	1.10e-04	9.50e-05	5.30e-05	9.30e-05	3.00e-04
Total Non-methane Hydrocarbons	Propellant, M-43 (USN)	4.10e-05			4.10e-05	1.10e-04
Total Non-methane Hydrocarbons	Propellant, M-9	1.50e-05			1.50e-05	1.30e-04
Total Non-methane Hydrocarbons	Propellant, MK-23	0.00e+00			0.00e+00	1.40e-04
Total Non-methane Hydrocarbons	Propellant, M31A1E1	1.00e-04	9.00e-05	1.20e-04	1.00e-04	1.70e-04
Total Non-methane Hydrocarbons	Propellant, PBXN-110	5.10e-05			5.10e-05	1.80e-04
Total Non-methane Hydrocarbons	Propellant, Smokey Sam	1.10e-03			1.10e-03	1.60e-03
Total Non-methane Hydrocarbons	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	2.30e-04
Total Unidentified Hydrocarbons	Diesel fuel and dunnage	5.50e-03	6.00e-03	6.60e-03	6.00e-03	6.20e-03
Total Unidentified Hydrocarbons	Manufacturer's waste - aluminized propellant with diesel	4.10e-04	2.30e-04	4.20e-04	3.50e-04	4.70e-04
Total Unidentified Hydrocarbons	Propellant, ammonium perchlorate, aluminized	2.00e-05	3.00e-05		2.50e-05	4.00e-05
Total Unidentified Hydrocarbons	Propellant, ammonium perchlorate, nonaluminized	3.00e-05	2.00e-05		2.50e-05	3.00e-05
Total Unidentified Hydrocarbons	Propellant, double base	0.00e+00	0.00e+00		0.00e+00	1.00e-05
Total Unidentified Hydrocarbons	Propellant, M-3	2.80e-05	3.50e-05	1.70e-06	2.40e-05	9.10e-05
Total Unidentified Hydrocarbons	Propellant, M-43 (USN)	2.50e-05			2.50e-05	7.40e-05
Total Unidentified Hydrocarbons	Propellant, M-9	0.00e+00			0.00e+00	5.80e-05
Total Unidentified Hydrocarbons	Propellant, MK-23	2.90e-06			2.90e-06	9.10e-05
Total Unidentified Hydrocarbons	Propellant, M31A1E1	3.00e-05	1.00e-05	2.00e-05	2.00e-05	4.00e-05
Total Unidentified Hydrocarbons	Propellant, PBXN-110	4.40e-05			4.40e-05	1.10e-04
Total Unidentified Hydrocarbons	Propellant, Smokey Sam	7.50e-05			7.50e-05	4.30e-04
Total Unidentified Hydrocarbons	Smokeless Powder (Hercules Unique)	0.00e+00			0.00e+00	1.40e-04
Vinyl chloride	Diesel fuel and dunnage	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Manufacturer's waste - aluminized propellant with diesel	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Vinyl chloride	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Propellant, M-43 (USN)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Propellant, MK-23	1.50e-06			1.50e-06	1.50e-06
Vinyl chloride	Propellant, PBXN-110	2.20e-07			2.20e-07	2.20e-07
Vinyl chloride	Propellant, Smokey Sam	8.80e-07			8.80e-07	8.80e-07
Vinyl chloride	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Diesel fuel and dunnage	6.40e-05	6.50e-05	5.90e-05	6.30e-05	6.40e-05
Zinc	Manufacturer's waste - aluminized propellant with diesel	1.60e-04	1.10e-04	1.40e-03	5.70e-04	5.80e-04
Zinc	Propellant, ammonium perchlorate, aluminized	6.00e-05	2.00e-05		4.00e-05	4.00e-05
Zinc	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Propellant, double base	0.00e+00	1.00e-05		1.00e-05	1.00e-05
Zinc	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Butene	Diesel fuel and dunnage	0.00e+00	4.70e-06	4.60e-06	4.70e-06	4.70e-06
1-Butene	Manufacturer's waste - aluminized propellant with diesel	1.10e-05	5.70e-06	8.00e-06	8.30e-06	8.30e-06
1-Butene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Butene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Butene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Butene	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Butene	Propellant, M-43 (USN)	2.70e-07			2.70e-07	2.70e-07
1-Butene	Propellant, M-9	2.60e-07			2.60e-07	2.60e-07
1-Butene	Propellant, MK-23	5.90e-07			5.90e-07	5.90e-07
1-Butene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Butene	Propellant, PBXN-110	6.00e-07			6.00e-07	6.00e-07
1-Butene	Propellant, Smokey Sam	1.20e-06			1.20e-06	1.20e-06
1-Butene	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Hexene	Diesel fuel and dunnage	1.10e-06	2.70e-06	2.80e-06	2.20e-06	2.20e-06
1-Hexene	Manufacturer's waste - aluminized propellant with diesel	1.10e-06	6.10e-07	1.30e-05	4.80e-06	4.80e-06
1-Hexene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Hexene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Hexene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Hexene	Propellant, M-3	1.80e-07	0.00e+00	0.00e+00	1.80e-07	1.80e-07
1-Hexene	Propellant, M-43 (USN)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Hexene	Propellant, M-9	2.10e-07			2.10e-07	2.10e-07
1-Hexene	Propellant, MK-23	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Hexene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Hexene	Propellant, PBXN-110	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

1-Hexene	Propellant, Smokey Sam	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Hexene	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Pentene	Diesel fuel and dunnage	0.00e+00	1.70e-06	0.00e+00	1.70e-06	1.80e-06
1-Pentene	Manufacturer's waste - aluminized propellant with diesel	4.80e-06	3.30e-06	7.00e-06	5.10e-06	5.30e-06
1-Pentene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Pentene	Propellant, ammonium perchlorate, nonaluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Pentene	Propellant, double base	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Pentene	Propellant, M-3	1.60e-07	0.00e+00	0.00e+00	1.60e-07	2.20e-07
1-Pentene	Propellant, M-43 (USN)	9.10e-08			9.10e-08	9.10e-08
1-Pentene	Propellant, M-9	4.30e-08			4.30e-08	8.50e-08
1-Pentene	Propellant, MK-23	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Pentene	Propellant, M31A1E1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Pentene	Propellant, PBXN-110	1.00e-07			1.00e-07	2.00e-07
1-Pentene	Propellant, Smokey Sam	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Pentene	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1,3-Butadiene	Diesel fuel and dunnage	0.00e+00	1.30e-06	9.80e-07	1.20e-06	1.20e-06
1,3-Butadiene	Manufacturer's waste - aluminized propellant with diesel	5.40e-06	4.20e-06	2.40e-06	4.00e-06	4.00e-06
1,3-Butadiene	Propellant, ammonium perchlorate, aluminized	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1,3-Butadiene	Propellant, M-3	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1,3-Butadiene	Propellant, M-43 (USN)	9.10e-08			9.10e-08	9.10e-08
1,3-Butadiene	Propellant, M-9	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1,3-Butadiene	Propellant, MK-23	2.00e-07			2.00e-07	2.00e-07
1,3-Butadiene	Propellant, PBXN-110	5.00e-07			5.00e-07	5.00e-07
1,3-Butadiene	Propellant, Smokey Sam	1.20e-06			1.20e-06	1.20e-06
1,3-Butadiene	Smokeless Powder (Hercules Unique)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1234678-HpCDF	Manufacturer's waste - aluminized propellant with diesel	3.40e-08			3.40e-08	
123478-HxCDF	Manufacturer's waste - aluminized propellant with diesel	2.00e-08			2.10e-08	
1234789-HpCDF	Manufacturer's waste - aluminized propellant with diesel	7.90e-09			7.90e-09	
123678-HxCDF	Manufacturer's waste - aluminized propellant with diesel	9.50e-09			9.50e-09	
2-Chlorophenol	Propellant, ammonium perchlorate, nonaluminized	1.00e-05	1.00e-05		1.00e-05	1.00e-05

Appendix E
Emission Factors for Detonations

SPECIAL NOTES:

The emission factors in this database apply primarily to unconfined, ground level detonations of bulk and assembled energetic materials. They do not apply confined or otherwise suppressed detonations, except for the emission factors for the water-suppressed detonations of tritonal and amatol.

A value of 0.00e+00 means that the compound (analyte) was either not detected, or, was detected at only the background level. Values of 0.00e+00 were not used in calculating the average (AVG) emission factors in the database. A blank cell means that either no sample was collected or that the sample collected was either lost or not valid.

The emission factors in this table are unitless. The user can convert them to any mass units desired (e.g., grams compound per gram NEW). A value e-06 means that the quantity in the numerator is to be multiplied by 10 to the -6 power. For example, 1.1e-06 could be written as either 1.1×10^{-6} g/g NEW or 1 microgram/g NEW.

COMPOUND	ITEM	EMISSION FACTORS				
		TRIAL 1	TRIAL 2	TRIAL 3	AVERAGE	UNCORR
cis-2-Pentene	Amatol	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	Amatol surrogate with water	6.30e-06	1.10e-05	7.80e-06	8.50e-06	9.10e-06
cis-2-Pentene	Cartridge, Impulse, ARD 446-1	7.80e-07	2.60e-07	5.00e-07	5.10e-07	8.70e-07
cis-2-Pentene	Cartridge, Impulse, BBU-36/B	2.70e-07	2.80e-07	5.60e-07	3.70e-07	9.00e-07
cis-2-Pentene	Cartridge, Impulse, MK 107	2.60e-07	2.60e-07	2.60e-07	2.60e-07	2.60e-07
cis-2-Pentene	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	Detonating train	5.80e-07	3.00e-07	3.00e-07	3.90e-07	9.10e-07
cis-2-Pentene	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	3.40e-07	3.40e-07	3.40e-07
cis-2-Pentene	Fuze, Tail Bomb FMU-139 A/B	4.90e-07	9.70e-07	4.80e-07	6.50e-07	6.50e-07
cis-2-Pentene	Fuze, Tail Bomb FMU-54 A/B	5.90e-07	8.90e-07	0.00e+00	7.40e-07	9.30e-07
cis-2-Pentene	Gas Generator, GGU-2/A	5.90e-07	1.20e-06	6.10e-07	7.90e-07	9.90e-07
cis-2-Pentene	HBX surrogate	3.70e-07	4.10e-07	0.00e+00	3.90e-07	3.80e-07
cis-2-Pentene	Mine, Claymore, M18A1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	Signal, Illumination, Red Star AN-M43A2	3.50e-07	3.50e-07	3.50e-07	3.50e-07	3.50e-07
cis-2-Pentene	Signal, Illumination, Red Star M158	3.50e-07	3.50e-07	0.00e+00	3.50e-07	3.50e-07
cis-2-Pentene	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.70e-07
cis-2-Pentene	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	3.60e-07
cis-2-Pentene	Tritonal surrogate with water	2.30e-06	3.70e-06	3.40e-06	3.10e-06	3.30e-06
cis-2-Pentene	TNT (ACC1)	4.60e-07	0.00e+00	0.00e+00	4.60e-07	4.60e-07
cis-2-Pentene	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
cis-2-Pentene	T45E7 Adapter Booster	3.00e-06	2.40e-06	2.90e-06	2.70e-06	2.70e-06
cis-2-Pentene	20 mm HEI Cartridge	0.00e+00	0.00e+00	6.80e-07	6.80e-07	6.80e-07
cis-2-Pentene	40 mm HEI Cartridge	8.30e-07	0.00e+00	0.00e+00	8.30e-07	3.30e-06
i-Butane	Amatol surrogate	7.50e-07	7.50e-07	3.70e-07	6.20e-07	6.20e-07
i-Butane	Amatol surrogate with water	6.70e-06	6.30e-06	6.30e-06	6.40e-06	7.50e-06
i-Butane	Cartridge, Impulse, ARD 446-1	0.00e+00	2.60e-07	2.50e-06	1.40e-06	5.10e-06
i-Butane	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.10e-06
i-Butane	Cartridge, Impulse, MK 107	0.00e+00	1.10e-06	0.00e+00	1.10e-06	1.90e-06
i-Butane	Composition B surrogate	3.70e-07	3.70e-07	0.00e+00	3.70e-07	3.70e-07
i-Butane	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.00e-06
i-Butane	Flare, IR Countermeasure M206	6.60e-07	0.00e+00	0.00e+00	6.60e-07	5.00e-06
i-Butane	Fuze, Tail Bomb FMU-139 A/B	2.00e-06	3.90e-06	9.70e-07	2.30e-06	3.90e-06
i-Butane	Fuze, Tail Bomb FMU-54 A/B	3.00e-07	3.00e-07	0.00e+00	3.00e-07	3.70e-06
i-Butane	Gas Generator, GGU-2/A	1.20e-06	5.90e-07	0.00e+00	8.80e-07	9.50e-06

i-Butane	HBX surrogate	7.30e-07	0.00e+00	3.70e-07	5.50e-07	9.20e-07
i-Butane	Mine, Claymore, M18A1	4.90e-07	9.80e-07	0.00e+00	7.30e-07	2.40e-06
i-Butane	Signal, Illumination, Red Star AN-M43A2	3.50e-07	3.50e-07	0.00e+00	3.50e-07	3.10e-06
i-Butane	Signal, Illumination, Red Star M158	2.10e-06	1.80e-06	6.90e-07	1.50e-06	5.70e-06
i-Butane	Tritonal surrogate	7.40e-07	0.00e+00	3.60e-07	5.50e-07	5.50e-07
i-Butane	Tritonal surrogate with calcium stearate		0.00e+00	7.30e-07	7.30e-07	9.10e-07
i-Butane	Tritonal surrogate with water	4.10e-06	4.40e-06	4.10e-06	4.20e-06	4.60e-06
i-Butane	TNT (ACC1)	4.60e-07	0.00e+00	0.00e+00	4.60e-07	4.60e-07
i-Butane	TNT (ACC2)	0.00e+00			0.00e+00	5.20e-06
i-Butane	T45E7 Adapter Booster	0.00e+00	1.20e-06	2.30e-06	1.70e-06	3.50e-06
i-Butane	20 mm HEI Cartridge	7.00e-07	1.40e-06	2.00e-06	1.40e-06	3.90e-06
i-Butane	40 mm HEI Cartridge	0.00e+00	0.00e+00	1.60e-06	1.60e-06	2.90e-06
i-Butene	Amatol surrogate	2.30e-06	0.00e+00	7.40e-07	1.50e-06	1.50e-06
i-Butene	Amatol surrogate with water	1.50e-05	3.10e-05	1.30e-05	2.00e-05	2.00e-05
i-Butene	Cartridge, Impulse, ARD 446-1	2.50e-05	2.00e-05	2.20e-05	2.20e-05	3.20e-05
i-Butene	Cartridge, Impulse, BBU-36/B	2.00e-05	2.10e-05	2.60e-05	2.20e-05	2.20e-05
i-Butene	Cartridge, Impulse, MK 107	6.80e-06	0.00e+00	2.90e-06	4.90e-06	4.90e-06
i-Butene	Composition B surrogate	3.70e-07	7.40e-07	1.80e-06	9.80e-07	9.80e-07
i-Butene	Detonating train	1.00e-05	3.10e-05	3.00e-05	2.40e-05	3.60e-05
i-Butene	Flare, IR Countermeasure M206	2.30e-06	2.40e-06	2.70e-06	2.50e-06	2.50e-06
i-Butene	Fuze, Tail Bomb FMU-139 A/B	5.40e-06	5.30e-06	5.30e-06	5.30e-06	5.50e-06
i-Butene	Fuze, Tail Bomb FMU-54 A/B	4.40e-06	5.60e-06	4.30e-06	4.80e-06	4.80e-06
i-Butene	Gas Generator, GGU-2/A	0.00e+00	2.90e-06	0.00e+00	2.90e-06	2.90e-06
i-Butene	HBX surrogate	3.70e-06	2.50e-06	4.50e-06	3.50e-06	3.50e-06
i-Butene	Mine, Claymore, M18A1	3.40e-06	3.40e-06	4.20e-06	3.70e-06	5.10e-06
i-Butene	Signal, Illumination, Red Star AN-M43A2	0.00e+00	2.80e-06	3.50e-06	3.10e-06	3.30e-06
i-Butene	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	4.50e-06	4.50e-06	4.50e-06
i-Butene	Tritonal surrogate	3.00e-06	3.70e-07	7.30e-07	1.40e-06	1.40e-06
i-Butene	Tritonal surrogate with calcium stearate		2.60e-06	1.50e-06	2.00e-06	2.00e-06
i-Butene	Tritonal surrogate with water	1.30e-05	0.00e+00	0.00e+00	1.30e-05	1.30e-05
i-Butene	TNT (ACC1)	3.70e-06	3.40e-06	3.80e-06	3.60e-06	3.60e-06
i-Butene	TNT (ACC2)	1.50e-06			1.50e-06	1.50e-06
i-Butene	T45E7 Adapter Booster	7.30e-05	8.20e-06	1.30e-05	3.10e-05	3.10e-05
i-Butene	20 mm HEI Cartridge	4.10e-05	9.40e-06	1.70e-05	2.20e-05	2.20e-05
i-Butene	40 mm HEI Cartridge	1.20e-05	9.00e-06	4.90e-06	8.80e-06	8.80e-06
i-Pentane	Amatol surrogate	1.50e-06	1.50e-06	0.00e+00	1.50e-06	1.50e-06
i-Pentane	Amatol surrogate with water	1.50e-06	1.10e-05	5.60e-06	6.20e-06	3.70e-05
i-Pentane	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.90e-06
i-Pentane	Cartridge, Impulse, BBU-36/B	0.00e+00	5.60e-07	1.40e-06	9.70e-07	4.10e-06

i-Pentane	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.20e-06
i-Pentane	Composition B surrogate	3.70e-07	0.00e+00	0.00e+00	3.70e-07	7.40e-07
i-Pentane	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.10e-06
i-Pentane	Flare, IR Countermeasure M206	0.00e+00	3.40e-07	0.00e+00	3.40e-07	2.10e-06
i-Pentane	Fuze, Tail Bomb FMU-139 A/B	0.00e+00	4.80e-07	0.00e+00	4.80e-07	1.10e-06
i-Pentane	Fuze, Tail Bomb FMU-54 A/B	2.70e-06	0.00e+00	0.00e+00	2.70e-06	1.00e-05
i-Pentane	Gas Generator, GGU-2/A	0.00e+00	5.90e-07	0.00e+00	5.90e-07	1.10e-05
i-Pentane	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.70e-06
i-Pentane	Mine, Claymore, M18A1	3.90e-06	0.00e+00	0.00e+00	3.90e-06	3.10e-06
i-Pentane	Signal, Illumination, Red Star AN-M43A2	3.50e-07	0.00e+00	0.00e+00	3.50e-07	5.80e-07
i-Pentane	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.20e-06
i-Pentane	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.10e-06
i-Pentane	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	4.20e-06
i-Pentane	Tritonal surrogate with water	3.70e-07	3.70e-07	3.70e-07	3.70e-07	4.70e-06
i-Pentane	TNT (ACC1)	1.40e-06	0.00e+00	0.00e+00	1.40e-06	1.20e-06
i-Pentane	TNT (ACC2)	7.40e-07			7.40e-07	1.50e-06
i-Pentane	T45E7 Adapter Booster	1.20e-06	2.90e-06	1.40e-05	6.20e-06	1.10e-05
i-Pentane	20 mm HEI Cartridge	0.00e+00	1.10e-05	1.20e-05	1.20e-05	1.50e-05
i-Pentane	40 mm HEI Cartridge	9.10e-06	0.00e+00	0.00e+00	9.10e-06	1.80e-05
i-Propylbenzene	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Propylbenzene	Amatol surrogate with water	1.90e-06	3.20e-06	0.00e+00	2.50e-06	3.20e-06
i-Propylbenzene	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.50e-07
i-Propylbenzene	Cartridge, Impulse, BBU-36/B	8.20e-07	1.10e-06	8.40e-07	9.20e-07	9.20e-07
i-Propylbenzene	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	5.20e-07	5.20e-07	5.20e-07
i-Propylbenzene	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Propylbenzene	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Propylbenzene	Flare, IR Countermeasure M206	0.00e+00	6.80e-07	1.00e-06	8.50e-07	8.50e-07
i-Propylbenzene	Fuze, Tail Bomb FMU-139 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Propylbenzene	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	3.00e-07	0.00e+00	3.00e-07	7.90e-07
i-Propylbenzene	Gas Generator, GGU-2/A	1.20e-06	0.00e+00	0.00e+00	1.20e-06	8.80e-07
i-Propylbenzene	HBX surrogate	7.30e-07	0.00e+00	3.70e-07	5.50e-07	1.50e-06
i-Propylbenzene	Mine, Claymore, M18A1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Propylbenzene	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Propylbenzene	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Propylbenzene	Tritonal surrogate	7.40e-07	0.00e+00	1.10e-06	6.10e-07	1.70e-06
i-Propylbenzene	Tritonal surrogate with calcium stearate		0.00e+00	7.30e-07	7.30e-07	7.30e-07
i-Propylbenzene	Tritonal surrogate with water	0.00e+00	0.00e+00	1.10e-06	1.10e-06	1.90e-06
i-Propylbenzene	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Propylbenzene	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

i-Propylbenzene	T45E7 Adapter Booster	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Propylbenzene	20 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
i-Propylbenzene	40 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
m-Ethyltoluene	Amatol surrogate	0.00e+00	3.70e-07	0.00e+00	3.70e-07	1.50e-05
m-Ethyltoluene	Amatol surrogate with water	1.50e-06	1.90e-06	1.50e-06	1.60e-06	3.80e-05
m-Ethyltoluene	Cartridge, Impulse, ARD 446-1	5.20e-07	2.60e-07	7.50e-07	5.10e-07	3.00e-06
m-Ethyltoluene	Cartridge, Impulse, BBU-36/B	1.10e-06	1.40e-06	5.60e-07	1.00e-06	4.20e-06
m-Ethyltoluene	Cartridge, Impulse, MK 107	0.00e+00	7.90e-07	5.20e-07	6.60e-07	1.20e-06
m-Ethyltoluene	Composition B surrogate	0.00e+00	3.70e-07	3.60e-07	3.70e-07	1.90e-05
m-Ethyltoluene	Detonating train	0.00e+00	3.00e-07	3.00e-07	3.00e-07	3.20e-06
m-Ethyltoluene	Flare, IR Countermeasure M206	3.30e-07	0.00e+00	3.40e-07	3.40e-07	7.90e-07
m-Ethyltoluene	Fuze, Tail Bomb FMU-139 A/B	9.70e-07	9.70e-07	0.00e+00	9.70e-07	1.30e-06
m-Ethyltoluene	Fuze, Tail Bomb FMU-54 A/B	3.00e-07	3.00e-07	6.10e-07	4.00e-07	1.30e-06
m-Ethyltoluene	Gas Generator, GGU-2/A	0.00e+00	5.90e-07	0.00e+00	5.90e-07	2.80e-06
m-Ethyltoluene	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.50e-05
m-Ethyltoluene	Mine, Claymore, M18A1	6.80e-06	3.40e-06	6.60e-06	5.60e-06	6.60e-06
m-Ethyltoluene	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.80e-07
m-Ethyltoluene	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	3.50e-07	3.50e-07	8.10e-07
m-Ethyltoluene	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.20e-05
m-Ethyltoluene	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	3.70e-05
m-Ethyltoluene	Tritonal surrogate with water	1.50e-06	0.00e+00	7.50e-07	1.10e-06	4.70e-05
m-Ethyltoluene	TNT (ACC1)	0.00e+00	4.80e-07	4.80e-07	4.80e-07	1.70e-06
m-Ethyltoluene	TNT (ACC2)	0.00e+00			0.00e+00	1.10e-06
m-Ethyltoluene	T45E7 Adapter Booster	1.80e-06	2.90e-06	2.90e-06	2.50e-06	2.50e-06
m-Ethyltoluene	20 mm HEI Cartridge	1.40e-06	4.30e-06	5.40e-06	3.70e-06	7.10e-06
m-Ethyltoluene	40 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.80e-06
n-Butane	Amatol surrogate	7.50e-07	7.50e-07	3.70e-07	6.20e-07	6.20e-07
n-Butane	Amatol surrogate with water	3.80e-05	6.80e-05	4.90e-05	5.20e-05	6.30e-05
n-Butane	Cartridge, Impulse, ARD 446-1	1.50e-06	2.30e-06	2.70e-06	2.20e-06	4.80e-06
n-Butane	Cartridge, Impulse, BBU-36/B	5.40e-06	3.60e-06	5.30e-06	4.80e-06	4.80e-06
n-Butane	Cartridge, Impulse, MK 107	0.00e+00	5.30e-07	7.90e-07	6.60e-07	3.10e-06
n-Butane	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.70e-07
n-Butane	Detonating train	3.80e-06	3.30e-06	2.10e-06	3.10e-06	1.00e-05
n-Butane	Flare, IR Countermeasure M206	3.30e-07	6.80e-07	6.80e-07	5.70e-07	5.10e-06
n-Butane	Fuze, Tail Bomb FMU-139 A/B	9.70e-07	1.90e-06	4.40e-06	2.40e-06	5.20e-06
n-Butane	Fuze, Tail Bomb FMU-54 A/B	3.00e-06	2.10e-06	0.00e+00	2.50e-06	1.90e-05
n-Butane	Gas Generator, GGU-2/A	3.50e-06	2.90e-06	0.00e+00	3.20e-06	3.50e-05
n-Butane	HBX surrogate	7.30e-07	4.10e-07	3.70e-07	5.00e-07	8.90e-07
n-Butane	Mine, Claymore, M18A1	2.90e-06	1.50e-06	9.40e-07	1.80e-06	6.60e-06

n-Butane	Signal, Illumination, Red Star AN-M43A2	2.80e-06	2.40e-06	1.40e-06	2.20e-06	4.10e-06
n-Butane	Signal, Illumination, Red Star M158	3.50e-07	2.10e-06	0.00e+00	1.20e-06	7.10e-06
n-Butane	Tritonal surrogate	1.90e-06	0.00e+00	3.60e-07	1.30e-06	1.40e-06
n-Butane	Tritonal surrogate with calcium stearate		0.00e+00	3.60e-07	3.60e-07	9.20e-07
n-Butane	Tritonal surrogate with water	8.60e-06	1.80e-05	1.80e-05	1.50e-05	1.60e-05
n-Butane	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.30e-06
n-Butane	TNT (ACC2)	0.00e+00			0.00e+00	7.40e-07
n-Butane	T45E7 Adapter Booster	5.30e-06	6.50e-06	1.60e-05	9.10e-06	1.60e-05
n-Butane	20 mm HEI Cartridge	2.10e-06	7.20e-06	1.30e-05	7.40e-06	1.40e-05
n-Butane	40 mm HEI Cartridge	1.70e-06	8.20e-07	1.60e-06	1.40e-06	1.10e-05
n-Decane	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.70e-07
n-Decane	Amatol surrogate with water	1.10e-06	1.30e-06	1.90e-06	1.40e-06	3.50e-06
n-Decane	Cartridge, Impulse, ARD 446-1	2.60e-07	5.10e-07	2.50e-07	3.40e-07	8.70e-07
n-Decane	Cartridge, Impulse, BBU-36/B	3.50e-06	3.90e-06	5.30e-06	4.20e-06	9.10e-06
n-Decane	Cartridge, Impulse, MK 107	2.60e-07	2.60e-07	2.60e-07	2.60e-07	6.40e-07
n-Decane	Composition B surrogate	0.00e+00	0.00e+00	3.60e-07	3.60e-07	4.90e-07
n-Decane	Detonating train	0.00e+00	9.00e-07	3.00e-07	6.00e-07	1.80e-06
n-Decane	Flare, IR Countermeasure M206	3.30e-07	3.40e-07	3.40e-07	3.40e-07	4.50e-07
n-Decane	Fuze, Tail Bomb FMU-139 A/B	9.70e-07	9.70e-07	1.50e-06	1.10e-06	1.30e-06
n-Decane	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.00e-07
n-Decane	Gas Generator, GGU-2/A	5.90e-07	5.90e-07	6.10e-07	6.00e-07	1.20e-06
n-Decane	HBX surrogate	3.70e-07	0.00e+00	0.00e+00	3.70e-07	6.40e-07
n-Decane	Mine, Claymore, M18A1	3.90e-06	1.00e-05	1.60e-05	1.00e-05	1.30e-05
n-Decane	Signal, Illumination, Red Star AN-M43A2	3.50e-07	7.00e-07	0.00e+00	5.20e-07	4.60e-07
n-Decane	Signal, Illumination, Red Star M158	7.00e-07	3.50e-07	6.90e-07	5.80e-07	8.10e-07
n-Decane	Tritonal surrogate	0.00e+00	3.70e-07	3.60e-07	3.70e-07	6.10e-07
n-Decane	Tritonal surrogate with calcium stearate		0.00e+00	3.60e-07	3.60e-07	5.50e-07
n-Decane	Tritonal surrogate with water	0.00e+00	0.00e+00	1.10e-06	1.10e-06	1.70e-06
n-Decane	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.00e-05
n-Decane	TNT (ACC2)	0.00e+00			0.00e+00	3.70e-07
n-Decane	T45E7 Adapter Booster	1.20e-06	0.00e+00	0.00e+00	1.20e-06	1.40e-05
n-Decane	20 mm HEI Cartridge	4.90e-06	5.00e-06	9.50e-06	6.50e-06	2.90e-05
n-Decane	40 mm HEI Cartridge	5.00e-06	2.50e-06	8.20e-06	5.20e-06	4.20e-05
n-Heptane	Amatol surrogate	1.10e-06	3.70e-07	7.40e-07	7.50e-07	1.60e-06
n-Heptane	Amatol surrogate with water	5.90e-06	1.30e-05	7.40e-06	8.70e-06	1.20e-05
n-Heptane	Cartridge, Impulse, ARD 446-1	1.50e-06	1.50e-06	2.20e-06	1.80e-06	4.30e-06
n-Heptane	Cartridge, Impulse, BBU-36/B	1.60e-06	1.70e-06	1.10e-06	1.50e-06	4.70e-06
n-Heptane	Cartridge, Impulse, MK 107	1.00e-06	1.10e-06	1.00e-06	1.00e-06	1.90e-06
n-Heptane	Composition B surrogate	0.00e+00	3.70e-07	1.10e-06	7.30e-07	1.20e-06

n-Heptane	Detonating train	8.70e-07	1.50e-06	1.80e-06	1.40e-06	5.00e-06
n-Heptane	Flare, IR Countermeasure M206	3.30e-07	3.40e-07	6.80e-07	4.50e-07	1.00e-06
n-Heptane	Fuze, Tail Bomb FMU-139 A/B	4.90e-07	9.70e-07	4.80e-07	6.50e-07	1.10e-06
n-Heptane	Fuze, Tail Bomb FMU-54 A/B	5.90e-07	5.90e-07	0.00e+00	5.90e-07	1.50e-06
n-Heptane	Gas Generator, GGU-2/A	5.90e-07	5.90e-07	1.20e-06	8.00e-07	2.80e-06
n-Heptane	HBX surrogate	7.30e-07	0.00e+00	3.70e-07	5.50e-07	3.30e-06
n-Heptane	Mine, Claymore, M18A1	2.90e-06	3.40e-06	4.70e-06	3.70e-06	5.60e-06
n-Heptane	Signal, Illumination, Red Star AN-M43A2	3.50e-07	1.10e-06	3.50e-07	5.80e-07	1.00e-06
n-Heptane	Signal, Illumination, Red Star M158	1.10e-06	7.00e-07	1.00e-06	9.30e-07	1.60e-06
n-Heptane	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	4.30e-06
n-Heptane	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	4.20e-06
n-Heptane	Tritonal surrogate with water	2.30e-06	1.80e-06	5.60e-06	3.20e-06	9.50e-06
n-Heptane	TNT (ACC1)	4.60e-07	1.40e-06	0.00e+00	9.50e-07	5.50e-06
n-Heptane	TNT (ACC2)	3.70e-07			3.70e-07	1.50e-06
n-Heptane	T45E7 Adapter Booster	3.60e-06	1.80e-06	4.60e-06	3.30e-06	8.00e-06
n-Heptane	20 mm HEI Cartridge	2.10e-06	5.00e-06	8.90e-06	5.30e-06	1.50e-05
n-Heptane	40 mm HEI Cartridge	5.00e-06	0.00e+00	0.00e+00	5.00e-06	2.20e-05
n-Hexane	Amatol surrogate	0.00e+00	3.70e-07	7.40e-07	5.60e-07	9.90e-07
n-Hexane	Amatol surrogate with water	7.10e-06	1.50e-05	1.10e-05	1.10e-05	1.60e-05
n-Hexane	Cartridge, Impulse, ARD 446-1	1.50e-06	1.50e-06	1.50e-06	1.50e-06	4.00e-06
n-Hexane	Cartridge, Impulse, BBU-36/B	1.60e-06	1.40e-06	2.20e-06	1.70e-06	5.40e-06
n-Hexane	Cartridge, Impulse, MK 107	2.60e-07	7.90e-07	5.20e-07	5.30e-07	1.40e-06
n-Hexane	Composition B surrogate	0.00e+00	7.40e-07	3.60e-07	5.50e-07	1.20e-06
n-Hexane	Detonating train	1.50e-06	1.50e-06	2.40e-06	1.80e-06	5.80e-06
n-Hexane	Flare, IR Countermeasure M206	6.60e-07	6.80e-07	6.80e-07	6.80e-07	1.20e-06
n-Hexane	Fuze, Tail Bomb FMU-139 A/B	4.90e-07	9.70e-07	4.80e-07	6.50e-07	1.10e-06
n-Hexane	Fuze, Tail Bomb FMU-54 A/B	3.00e-07	5.90e-07	0.00e+00	4.40e-07	1.30e-06
n-Hexane	Gas Generator, GGU-2/A	1.20e-06	1.20e-06	6.10e-07	9.90e-07	3.20e-06
n-Hexane	HBX surrogate	7.30e-07	0.00e+00	3.70e-07	5.50e-07	4.70e-06
n-Hexane	Mine, Claymore, M18A1	2.00e-06	1.50e-06	4.70e-07	1.30e-06	3.20e-06
n-Hexane	Signal, Illumination, Red Star AN-M43A2	6.90e-07	1.10e-06	6.90e-07	8.10e-07	1.30e-06
n-Hexane	Signal, Illumination, Red Star M158	1.40e-06	1.10e-06	6.90e-07	1.10e-06	1.90e-06
n-Hexane	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.00e-06
n-Hexane	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	6.80e-06
n-Hexane	Tritonal surrogate with water	1.90e-06	1.50e-06	4.50e-06	2.60e-06	1.30e-05
n-Hexane	TNT (ACC1)	1.40e-06	4.80e-07	0.00e+00	9.30e-07	3.30e-06
n-Hexane	TNT (ACC2)	0.00e+00			0.00e+00	1.10e-06
n-Hexane	T45E7 Adapter Booster	3.00e-06	4.70e-06	9.80e-06	5.80e-06	9.90e-06
n-Hexane	20 mm HEI Cartridge	1.40e-06	3.60e-06	5.40e-06	3.50e-06	1.30e-05

n-Hexane	40 mm HEI Cartridge	1.90e-05	0.00e+00	0.00e+00	1.90e-05	3.50e-05
n-Nonane	Amatol surrogate	3.70e-07	3.70e-07	0.00e+00	3.70e-07	3.70e-07
n-Nonane	Amatol surrogate with water	2.20e-06	4.40e-06	3.00e-06	3.20e-06	3.70e-06
n-Nonane	Cartridge, Impulse, ARD 446-1	2.60e-07	7.70e-07	7.50e-07	5.90e-07	1.40e-06
n-Nonane	Cartridge, Impulse, BBU-36/B	2.70e-06	3.60e-06	3.30e-06	3.20e-06	6.90e-06
n-Nonane	Cartridge, Impulse, MK 107	0.00e+00	2.60e-07	7.90e-07	5.20e-07	9.60e-07
n-Nonane	Composition B surrogate	2.20e-06	3.70e-07	0.00e+00	1.30e-06	1.20e-06
n-Nonane	Detonating train	5.80e-07	9.00e-07	9.00e-07	7.90e-07	2.00e-06
n-Nonane	Flare, IR Countermeasure M206	6.60e-07	6.80e-07	6.80e-07	6.80e-07	9.00e-07
n-Nonane	Fuze, Tail Bomb FMU-139 A/B	4.90e-07	4.80e-07	0.00e+00	4.90e-07	7.30e-07
n-Nonane	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	1.20e-06	1.20e-06	9.40e-07
n-Nonane	Gas Generator, GGU-2/A	5.90e-07	5.90e-07	0.00e+00	5.90e-07	1.20e-06
n-Nonane	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.20e-07
n-Nonane	Mine, Claymore, M18A1	4.90e-07	1.50e-06	1.90e-06	1.30e-06	1.80e-06
n-Nonane	Signal, Illumination, Red Star AN-M43A2	1.00e-06	3.50e-07	0.00e+00	7.00e-07	9.30e-07
n-Nonane	Signal, Illumination, Red Star M158	1.10e-06	7.00e-07	1.00e-06	9.30e-07	1.30e-06
n-Nonane	Tritonal surrogate	3.40e-06	0.00e+00	3.60e-07	1.20e-06	1.60e-06
n-Nonane	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	5.50e-07
n-Nonane	Tritonal surrogate with water	0.00e+00	7.30e-07	7.50e-07	7.40e-07	1.50e-06
n-Nonane	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.40e-06
n-Nonane	TNT (ACC2)	0.00e+00			0.00e+00	3.70e-07
n-Nonane	T45E7 Adapter Booster	1.80e-06	5.90e-07	1.70e-06	1.40e-06	2.50e-06
n-Nonane	20 mm HEI Cartridge	7.00e-07	0.00e+00	6.80e-07	6.90e-07	3.60e-06
n-Nonane	40 mm HEI Cartridge	1.70e-06	1.70e-06	2.50e-06	1.90e-06	4.80e-06
n-Octane	Amatol surrogate	0.00e+00	3.70e-07	3.70e-07	3.70e-07	6.20e-07
n-Octane	Amatol surrogate with water	3.30e-06	7.00e-06	4.40e-06	4.90e-06	5.80e-06
n-Octane	Cartridge, Impulse, ARD 446-1	5.20e-07	1.00e-06	0.00e+00	7.70e-07	1.40e-06
n-Octane	Cartridge, Impulse, BBU-36/B	1.40e-06	2.80e-07	1.90e-06	1.20e-06	4.00e-06
n-Octane	Cartridge, Impulse, MK 107	5.30e-07	5.30e-07	2.60e-07	4.40e-07	7.70e-07
n-Octane	Composition B surrogate	3.70e-07	3.70e-07	3.60e-07	3.70e-07	7.40e-07
n-Octane	Detonating train	0.00e+00	1.50e-06	0.00e+00	1.50e-06	2.70e-06
n-Octane	Flare, IR Countermeasure M206	1.00e-06	3.40e-07	0.00e+00	6.70e-07	7.80e-07
n-Octane	Fuze, Tail Bomb FMU-139 A/B	4.90e-07	4.80e-07	0.00e+00	4.90e-07	9.70e-07
n-Octane	Fuze, Tail Bomb FMU-54 A/B	3.00e-07	3.00e-07	6.10e-07	4.00e-07	1.10e-06
n-Octane	Gas Generator, GGU-2/A	0.00e+00	0.00e+00	1.20e-06	1.20e-06	1.80e-06
n-Octane	HBX surrogate	1.10e-06	0.00e+00	3.70e-07	7.30e-07	1.80e-06
n-Octane	Mine, Claymore, M18A1	2.00e-06	7.80e-06	1.20e-05	7.20e-06	9.10e-06
n-Octane	Signal, Illumination, Red Star AN-M43A2	3.50e-07	3.50e-07	0.00e+00	3.50e-07	5.80e-07
n-Octane	Signal, Illumination, Red Star M158	1.40e-06	1.10e-06	6.90e-07	1.10e-06	1.40e-06

n-Octane	Tritonal surrogate	3.70e-07	0.00e+00	3.60e-07	3.70e-07	1.70e-06
n-Octane	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	1.50e-06
n-Octane	Tritonal surrogate with water	1.50e-06	1.50e-06	2.20e-06	1.70e-06	3.70e-06
n-Octane	TNT (ACC1)	0.00e+00	2.90e-06	0.00e+00	2.90e-06	1.00e-05
n-Octane	TNT (ACC2)	0.00e+00			0.00e+00	7.40e-07
n-Octane	T45E7 Adapter Booster	2.40e-06	0.00e+00	1.20e-06	1.80e-06	8.80e-06
n-Octane	20 mm HEI Cartridge	4.90e-06	7.90e-06	1.60e-05	9.50e-06	2.50e-05
n-Octane	40 mm HEI Cartridge	2.50e-06	8.20e-07	7.40e-06	3.60e-06	2.90e-05
n-Pentane	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.20e-07
n-Pentane	Amatol surrogate with water	1.30e-05	2.30e-05	1.50e-05	1.70e-05	2.40e-05
n-Pentane	Cartridge, Impulse, ARD 446-1	7.80e-07	1.30e-06	1.30e-06	1.10e-06	4.00e-06
n-Pentane	Cartridge, Impulse, BBU-36/B	1.10e-06	1.10e-06	1.40e-06	1.20e-06	5.20e-06
n-Pentane	Cartridge, Impulse, MK 107	0.00e+00	2.60e-07	2.60e-07	2.60e-07	1.50e-06
n-Pentane	Composition B surrogate	3.70e-07	0.00e+00	3.60e-07	3.70e-07	7.40e-07
n-Pentane	Detonating train	5.80e-07	1.20e-06	1.20e-06	1.00e-06	6.10e-06
n-Pentane	Flare, IR Countermeasure M206	0.00e+00	6.80e-07	3.40e-07	5.10e-07	1.50e-06
n-Pentane	Fuze, Tail Bomb FMU-139 A/B	9.70e-07	1.50e-06	4.80e-07	9.70e-07	1.90e-06
n-Pentane	Fuze, Tail Bomb FMU-54 A/B	3.00e-07	5.90e-07	0.00e+00	4.40e-07	3.70e-06
n-Pentane	Gas Generator, GGU-2/A	1.20e-06	1.20e-06	0.00e+00	1.20e-06	4.80e-06
n-Pentane	HBX surrogate	7.30e-07	0.00e+00	7.40e-07	7.40e-07	2.30e-06
n-Pentane	Mine, Claymore, M18A1	4.40e-06	8.80e-06	1.40e-05	9.10e-06	1.30e-05
n-Pentane	Signal, Illumination, Red Star AN-M43A2	3.50e-07	7.00e-07	6.90e-07	5.80e-07	1.20e-06
n-Pentane	Signal, Illumination, Red Star M158	7.00e-07	7.00e-07	3.50e-07	5.80e-07	2.10e-06
n-Pentane	Tritonal surrogate	0.00e+00	0.00e+00	7.30e-07	7.30e-07	3.80e-06
n-Pentane	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	3.30e-06
n-Pentane	Tritonal surrogate with water	1.10e-06	0.00e+00	6.70e-06	3.90e-06	5.50e-06
n-Pentane	TNT (ACC1)	1.80e-06	4.80e-06	0.00e+00	3.30e-06	1.10e-05
n-Pentane	TNT (ACC2)	3.70e-07			3.70e-07	1.90e-06
n-Pentane	T45E7 Adapter Booster	3.60e-06	1.80e-06	9.80e-06	5.00e-06	1.60e-05
n-Pentane	20 mm HEI Cartridge	5.60e-06	1.20e-05	2.20e-05	1.30e-05	3.20e-05
n-Pentane	40 mm HEI Cartridge	1.30e-05	0.00e+00	0.00e+00	1.30e-05	5.20e-05
p-Ethyltoluene	Amatol surrogate	0.00e+00	6.00e-06	9.30e-06	7.60e-06	1.10e-05
p-Ethyltoluene	Amatol surrogate with water	2.00e-05	4.00e-05	3.70e-05	3.20e-05	3.80e-05
p-Ethyltoluene	Cartridge, Impulse, BBU-36/B	4.90e-06	5.60e-07	1.40e-06	2.30e-06	9.40e-06
p-Ethyltoluene	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
p-Ethyltoluene	Composition B surrogate	7.40e-07	7.40e-07	1.50e-06	9.80e-07	3.30e-06
p-Ethyltoluene	Detonating train	8.70e-07	1.50e-06	1.20e-06	1.20e-06	8.20e-06
p-Ethyltoluene	Flare, IR Countermeasure M206	0.00e+00	3.40e-07	6.80e-07	5.10e-07	2.20e-06
p-Ethyltoluene	Fuze, Tail Bomb FMU-139 A/B	2.00e-06	4.80e-07	9.70e-07	1.10e-06	2.30e-06

p-Ethyltoluene	Fuze, Tail Bomb FMU-54 A/B	5.90e-07	5.90e-07	4.60e-06	1.90e-06	4.70e-06
p-Ethyltoluene	Gas Generator, GGU-2/A	0.00e+00	0.00e+00	0.00e+00	0.00e+00	6.80e-06
p-Ethyltoluene	HBX surrogate	7.30e-07	0.00e+00	0.00e+00	7.30e-07	5.50e-06
p-Ethyltoluene	Mine, Claymore, M18A1	1.50e-05	7.30e-06	2.80e-05	1.70e-05	1.90e-05
p-Ethyltoluene	Signal, Illumination, Red Star AN-M43A2	0.00e+00	7.00e-07	0.00e+00	7.00e-07	1.60e-06
p-Ethyltoluene	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.70e-06
p-Ethyltoluene	Tritonal surrogate	7.40e-06	4.10e-06	1.50e-06	4.30e-06	9.20e-06
p-Ethyltoluene	Tritonal surrogate with calcium stearate		0.00e+00	7.30e-07	7.30e-07	4.60e-06
p-Ethyltoluene	Tritonal surrogate with water	3.90e-05	1.50e-05	2.80e-05	2.70e-05	3.40e-05
p-Ethyltoluene	TNT (ACC1)	4.60e-07	1.90e-06	0.00e+00	1.20e-06	7.70e-06
p-Ethyltoluene	TNT (ACC2)	0.00e+00			0.00e+00	2.60e-06
p-Ethyltoluene	T45E7 Adapter Booster	1.10e-05	9.40e-06	1.20e-05	1.10e-05	1.10e-05
p-Ethyltoluene	20 mm HEI Cartridge	0.00e+00	1.10e-05	1.60e-05	1.40e-05	2.60e-05
p-Ethyltoluene	40 mm HEI Cartridge	7.50e-06	4.10e-06	4.10e-06	5.20e-06	2.60e-05
p-Ethyltoluene	Amatol surrogate	3.70e-07	0.00e+00	0.00e+00	3.70e-07	1.60e-06
p-Ethyltoluene	Amatol surrogate with water	2.20e-06	2.20e-06	1.90e-06	2.10e-06	4.10e-06
p-Ethyltoluene	Cartridge, Impulse, ARD 446-1	1.10e-06	1.10e-06	1.10e-06	1.10e-06	4.20e-06
p-Ethyltoluene	Cartridge, Impulse, BBU-36/B	2.30e-06	1.20e-06	1.20e-06	1.60e-06	5.40e-06
p-Ethyltoluene	Cartridge, Impulse, MK 107	0.00e+00	1.10e-06	1.10e-06	1.10e-06	1.10e-06
p-Ethyltoluene	Composition B surrogate	7.40e-07	3.70e-07	1.10e-06	7.40e-07	2.60e-06
p-Ethyltoluene	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.90e-06
p-Ethyltoluene	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.50e-06
p-Ethyltoluene	Fuze, Tail Bomb FMU-139 A/B	2.10e-06	0.00e+00	0.00e+00	2.10e-06	2.10e-06
p-Ethyltoluene	Fuze, Tail Bomb FMU-54 A/B	1.30e-06	2.60e-06	1.30e-06	1.70e-06	2.90e-06
p-Ethyltoluene	Gas Generator, GGU-2/A	2.50e-06	5.10e-06	0.00e+00	3.80e-06	4.20e-06
p-Ethyltoluene	HBX surrogate	3.70e-07	0.00e+00	7.40e-07	5.60e-07	4.80e-06
p-Ethyltoluene	Mine, Claymore, M18A1	4.20e-06			4.20e-06	4.20e-06
p-Ethyltoluene	Signal, Illumination, Red Star AN-M43A2	0.00e+00	1.50e-06	0.00e+00	1.50e-06	1.50e-06
p-Ethyltoluene	Signal, Illumination, Red Star M158	0.00e+00	1.50e-06	0.00e+00	1.50e-06	1.50e-06
p-Ethyltoluene	Tritonal surrogate	0.00e+00	0.00e+00	3.60e-07	3.60e-07	3.30e-06
p-Ethyltoluene	Tritonal surrogate with calcium stearate		3.70e-07	0.00e+00	3.70e-07	4.20e-06
p-Ethyltoluene	Tritonal surrogate with water	1.10e-06	0.00e+00	0.00e+00	1.10e-06	4.70e-06
p-Ethyltoluene	TNT (ACC1)	0.00e+00			0.00e+00	2.00e-06
p-Ethyltoluene	TNT (ACC2)	0.00e+00			0.00e+00	1.60e-06
p-Ethyltoluene	T45E7 Adapter Booster	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
p-Ethyltoluene	20 mm HEI Cartridge	0.00e+00			0.00e+00	4.10e-06
p-Ethyltoluene	40 mm HEI Cartridge	0.00e+00			0.00e+00	9.50e-06
trans-2-Butene	Amatol surrogate	0.00e+00	0.00e+00	1.50e-06	1.50e-06	1.50e-06
trans-2-Butene	Amatol surrogate with water	2.40e-05	4.60e-05	3.40e-05	3.50e-05	3.50e-05

trans-2-Butene	Cartridge, Impulse, ARD 446-1	1.00e-05	7.70e-06	7.20e-06	8.30e-06	8.30e-06
trans-2-Butene	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Butene	Cartridge, Impulse, MK 107	1.00e-05	8.20e-06	7.10e-06	8.40e-06	8.40e-06
trans-2-Butene	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Butene	Detonating train	4.70e-06	2.70e-06	4.80e-06	4.00e-06	4.00e-06
trans-2-Butene	Flare, IR Countermeasure M206	3.00e-06	2.70e-06	2.70e-06	2.80e-06	2.80e-06
trans-2-Butene	Fuze, Tail Bomb FMU-139 A/B	1.20e-05	1.30e-05	1.40e-05	1.30e-05	1.30e-05
trans-2-Butene	Fuze, Tail Bomb FMU-54 A/B	5.90e-06	9.50e-06	7.90e-06	7.80e-06	1.10e-05
trans-2-Butene	Gas Generator, GGU-2/A	1.40e-05	1.50e-05	1.60e-05	1.50e-05	1.50e-05
trans-2-Butene	HBX surrogate	4.00e-06	2.50e-06	7.10e-06	4.50e-06	4.50e-06
trans-2-Butene	Mine, Claymore, M18A1	1.50e-05	1.90e-05	2.10e-05	1.80e-05	1.80e-05
trans-2-Butene	Signal, Illumination, Red Star AN-M43A2	6.90e-06	9.10e-06	7.30e-06	7.80e-06	7.80e-06
trans-2-Butene	Signal, Illumination, Red Star M158	5.30e-06	6.00e-06	4.80e-06	5.40e-06	5.40e-06
trans-2-Butene	Tritonal surrogate	0.00e+00	1.90e-06	1.10e-06	1.50e-06	1.50e-06
trans-2-Butene	Tritonal surrogate with calcium stearate		2.90e-06	7.30e-07	1.80e-06	1.80e-06
trans-2-Butene	Tritonal surrogate with water	4.10e-05	2.80e-05	4.60e-05	3.80e-05	3.80e-05
trans-2-Butene	TNT (ACC1)	9.20e-07	9.60e-07	9.60e-07	9.50e-07	9.50e-07
trans-2-Butene	TNT (ACC2)	7.40e-07			7.40e-07	7.40e-07
trans-2-Butene	T45E7 Adapter Booster	2.60e-05	1.80e-05	1.60e-05	2.00e-05	2.00e-05
trans-2-Butene	20 mm HEI Cartridge	1.10e-05	7.20e-06	1.00e-05	9.50e-06	9.50e-06
trans-2-Butene	40 mm HEI Cartridge	2.50e-06	1.70e-06	1.60e-06	1.90e-06	1.90e-06
trans-2-Pentene	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	Amatol surrogate with water	8.50e-06	1.70e-05	1.20e-05	1.20e-05	1.30e-05
trans-2-Pentene	Cartridge, Impulse, ARD 446-1	5.20e-07	7.70e-07	5.00e-07	6.00e-07	1.20e-06
trans-2-Pentene	Cartridge, Impulse, BBU-36/B	8.20e-07	5.60e-07	5.60e-07	6.40e-07	1.40e-06
trans-2-Pentene	Cartridge, Impulse, MK 107	2.60e-07	2.60e-07	2.60e-07	2.60e-07	2.60e-07
trans-2-Pentene	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	Detonating train	1.50e-06	9.00e-07	3.00e-07	8.80e-07	2.00e-06
trans-2-Pentene	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.40e-07
trans-2-Pentene	Fuze, Tail Bomb FMU-139 A/B	9.70e-07	3.90e-06	9.70e-07	1.90e-06	1.90e-06
trans-2-Pentene	Fuze, Tail Bomb FMU-54 A/B	5.90e-07	1.20e-06	9.20e-07	9.00e-07	1.60e-06
trans-2-Pentene	Gas Generator, GGU-2/A	2.40e-06	1.20e-06	6.10e-07	1.40e-06	2.00e-06
trans-2-Pentene	HBX surrogate	3.70e-07	0.00e+00	0.00e+00	3.70e-07	3.80e-07
trans-2-Pentene	Mine, Claymore, M18A1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	Signal, Illumination, Red Star AN-M43A2	3.50e-07	7.00e-07	3.50e-07	4.60e-07	4.60e-07
trans-2-Pentene	Signal, Illumination, Red Star M158	7.00e-07	1.40e-06	3.50e-07	8.20e-07	9.30e-07
trans-2-Pentene	Tritonal surrogate	3.70e-07	3.70e-07	0.00e+00	3.70e-07	8.60e-07
trans-2-Pentene	Tritonal surrogate with calcium stearate		0.00e+00	3.60e-07	3.60e-07	7.30e-07
trans-2-Pentene	Tritonal surrogate with water	2.30e-06	3.30e-06	3.70e-06	3.10e-06	3.60e-06

trans-2-Pentene	TNT (ACC1)	4.60e-07	0.00e+00	0.00e+00	4.60e-07	4.60e-07
trans-2-Pentene	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
trans-2-Pentene	T45E7 Adapter Booster	4.20e-06	4.10e-06	4.00e-06	4.10e-06	4.10e-06
trans-2-Pentene	20 mm HEI Cartridge	0.00e+00	1.40e-06	1.40e-06	1.40e-06	1.40e-06
trans-2-Pentene	40 mm HEI Cartridge	5.00e-06	0.00e+00	0.00e+00	5.00e-06	1.10e-05
Acetylene	Amatol surrogate	1.90e-04	4.60e-05	5.40e-05	9.60e-05	9.70e-05
Acetylene	Amatol surrogate with water	7.60e-05	1.30e-04	2.20e-04	1.40e-04	1.40e-04
Acetylene	Cartridge, Impulse, ARD 446-1	2.80e-04	1.90e-04	1.80e-04	2.20e-04	3.20e-04
Acetylene	Cartridge, Impulse, BBU-36/B	1.50e-04	1.30e-04	1.70e-04	1.50e-04	3.00e-04
Acetylene	Cartridge, Impulse, MK 107	2.80e-04	2.50e-04	1.90e-04	2.40e-04	3.50e-04
Acetylene	Composition B surrogate	6.70e-06	8.90e-06	2.70e-05	1.40e-05	1.50e-05
Acetylene	Detonating train	1.80e-04	7.30e-05	1.40e-04	1.30e-04	2.10e-04
Acetylene	Flare, IR Countermeasure M206	2.60e-04	3.10e-04	2.80e-04	2.90e-04	2.90e-04
Acetylene	Fuze, Tail Bomb FMU-139 A/B	5.40e-04	6.60e-04	6.60e-04	6.20e-04	6.20e-04
Acetylene	Fuze, Tail Bomb FMU-54 A/B	3.00e-04	5.70e-04	5.00e-04	4.60e-04	6.10e-04
Acetylene	Gas Generator, GGU-2/A	5.50e-04	6.30e-04	7.30e-04	6.40e-04	6.40e-04
Acetylene	HBX surrogate	1.80e-05	1.80e-05	5.20e-05	2.90e-05	3.00e-05
Acetylene	Mine, Claymore, M18A1	7.70e-04	1.10e-03	1.10e-03	9.80e-04	9.80e-04
Acetylene	Signal, Illumination, Red Star AN-M43A2	2.80e-04	3.50e-04	2.90e-04	3.10e-04	3.10e-04
Acetylene	Signal, Illumination, Red Star M158	2.80e-04	2.80e-04	2.30e-04	2.70e-04	2.70e-04
Acetylene	Tritonal surrogate	2.00e-04	1.30e-04	4.30e-05	1.20e-04	1.30e-04
Acetylene	Tritonal surrogate with calcium stearate		2.10e-05	1.60e-05	1.90e-05	2.00e-05
Acetylene	Tritonal surrogate with water	4.30e-03	4.40e-03	4.50e-03	4.40e-03	4.40e-03
Acetylene	TNT (ACC1)	2.20e-05	1.60e-05	1.40e-05	1.70e-05	1.80e-05
Acetylene	TNT (ACC2)	1.60e-05			1.60e-05	1.70e-05
Acetylene	TNT (Sandia)	5.00e-06	2.40e-06	8.50e-06	5.30e-06	
Acetylene	T45E7 Adapter Booster	7.50e-04	4.50e-04	3.60e-04	5.20e-04	5.30e-04
Acetylene	20 mm HEI Cartridge	2.20e-04	1.30e-04	1.90e-04	1.80e-04	2.50e-04
Acetylene	40 mm HEI Cartridge	5.20e-05	4.30e-05	3.20e-05	4.20e-05	6.40e-05
Allylchloride	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	Cartridge, Impulse, BBU-36/B	5.20e-06	1.10e-05	1.10e-05	9.30e-06	9.30e-06
Allylchloride	Cartridge, Impulse, MK 107	1.00e-05	2.90e-06	2.10e-06	5.10e-06	5.10e-06
Allylchloride	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	Flare, IR Countermeasure M206	2.10e-05	1.60e-05	1.80e-05	1.80e-05	1.80e-05
Allylchloride	Fuze, Tail Bomb FMU-139 A/B	3.00e-05	3.30e-05	2.80e-05	3.00e-05	3.00e-05
Allylchloride	Fuze, Tail Bomb FMU-54 A/B	2.10e-05	8.30e-06	0.00e+00	1.50e-05	1.50e-05

Allylchloride	Gas Generator, GGU-2/A	9.20e-05	8.80e-05	1.60e-04	1.10e-04	1.10e-04
Allylchloride	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	Mine, Claymore, M18A1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	Signal, Illumination, Red Star AN-M43A2	1.60e-05	1.40e-05	2.30e-05	1.80e-05	1.80e-05
Allylchloride	Signal, Illumination, Red Star M158	2.20e-05	1.10e-05	1.40e-05	1.60e-05	1.60e-05
Allylchloride	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	Tritonal surrogate with calcium stearate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	T45E7 Adapter Booster	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	20 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Allylchloride	40 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Aluminum	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Aluminum	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Aluminum	Cartridge, Impulse, ARD 446-1	3.90e-03	3.40e-03	4.30e-03	3.90e-03	6.00e-03
Aluminum	Cartridge, Impulse, BBU-36/B	8.40e-03	1.20e-02	1.30e-02	1.10e-02	2.30e-02
Aluminum	Cartridge, Impulse, MK 107	8.70e-03	9.70e-03	1.00e-02	9.50e-03	1.40e-02
Aluminum	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Aluminum	Detonating train	0.00e+00	9.20e-05	0.00e+00	0.00e+00	3.00e-04
Aluminum	Flare, IR Countermeasure M206	1.90e-02	1.40e-02	1.20e-02	1.50e-02	1.50e-02
Aluminum	Fuze, Tail Bomb FMU-139 A/B	4.00e-02	3.20e-02	3.20e-02	3.40e-02	3.50e-02
Aluminum	Fuze, Tail Bomb FMU-54 A/B	1.00e-02	1.30e-02	1.30e-02	1.20e-02	1.60e-02
Aluminum	Gas Generator, GGU-2/A	6.30e-03	5.60e-03	4.30e-03	5.40e-03	5.80e-03
Aluminum	HBX surrogate	6.10e-03	8.90e-03	1.10e-02	8.60e-03	8.60e-03
Aluminum	Mine, Claymore, M18A1	6.20e-03			6.20e-03	8.60e-04
Aluminum	Signal, Illumination, Red Star AN-M43A2	1.90e-02	1.70e-02	2.10e-02	1.90e-02	1.90e-02
Aluminum	Signal, Illumination, Red Star M158	2.80e-03	1.80e-03	1.80e-03	2.10e-03	2.70e-03
Aluminum	Tritonal surrogate	4.20e-02	1.80e-02	1.60e-02	2.50e-02	2.50e-02
Aluminum	Tritonal surrogate with calcium stearate		1.60e-02	1.70e-02	1.70e-02	1.70e-02
Aluminum	Tritonal surrogate with water	3.10e-03	7.00e-03	8.00e-03	6.00e-03	6.00e-03
Aluminum	TNT (ACC1)	0.00e+00			0.00e+00	0.00e+00
Aluminum	TNT (ACC2)	1.30e-03			1.30e-03	1.30e-03
Aluminum	T45E7 Adapter Booster	8.80e-03			8.80e-03	1.70e-03
Aluminum	20 mm HEI Cartridge	9.60e-04			9.60e-04	7.10e-05
Aluminum	40 mm HEI Cartridge	1.50e-02			1.50e-02	3.90e-03
Antimony	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Cartridge, Impulse, ARD 446-1	1.80e-04	1.60e-04	2.00e-04	1.80e-04	1.80e-04

Antimony	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Fuze, Tail Bomb FMU-139 A/B	2.90e-04	2.20e-04	1.50e-04	2.20e-04	2.20e-04
Antimony	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Gas Generator, GGU-2/A	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Mine, Claymore, M18A1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Tritonal surrogate with calcium stearate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	TNT (Sandia)	3.20e-07	7.00e-07	1.00e-06	6.70e-07	
Antimony	T45E7 Adapter Booster	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	20 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Antimony	40 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Amatol surrogate	0.00e+00	2.40e-05	3.20e-05	6.00e-06	8.00e-06
Barium	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.00e-06
Barium	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Cartridge, Impulse, MK 107	0.00e+00	2.50e-05	3.70e-05	1.60e-05	1.90e-04
Barium	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Flare, IR Countermeasure M206	1.50e-04	3.10e-04	2.60e-04	2.40e-04	2.40e-04
Barium	Fuze, Tail Bomb FMU-139 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Gas Generator, GGU-2/A	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Barium	Mine, Claymore, M18A1	0.00e+00			0.00e+00	0.00e+00
Barium	Signal, Illumination, Red Star AN-M43A2	7.80e-05	7.70e-05	1.80e-04	1.10e-04	1.10e-04
Barium	Signal, Illumination, Red Star M158	2.10e-04	1.60e-04	1.40e-04	1.70e-04	2.60e-04
Barium	Tritonal surrogate	4.70e-04	0.00e+00	1.60e-04	1.60e-04	1.60e-04
Barium	Tritonal surrogate with calcium stearate		3.10e-04	4.10e-04	3.60e-04	3.60e-04
Barium	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Barium	TNT (ACC1)	1.10e-04			1.10e-04	1.10e-04
Barium	TNT (ACC2)	3.60e-04			3.60e-04	3.70e-04
Barium	TNT (Sandia)	7.90e-03	7.70e-03	8.90e-03	8.20e-03	
Barium	T45E7 Adapter Booster	6.10e-04			6.10e-04	6.10e-04
Barium	20 mm HEI Cartridge	0.00e+00			0.00e+00	0.00e+00
Barium	40 mm HEI Cartridge	0.00e+00			0.00e+00	0.00e+00
Benzene	Amatol surrogate	4.20e-05	1.00e-05	1.60e-05	2.30e-05	2.50e-05
Benzene	Amatol surrogate with water	1.90e-04	3.60e-04	2.70e-04	2.70e-04	2.80e-04
Benzene	Cartridge, Impulse, ARD 446-1	7.70e-05	6.30e-05	6.10e-05	6.70e-05	1.00e-04
Benzene	Cartridge, Impulse, BBU-36/B	2.10e-05	1.90e-05	2.30e-05	2.10e-05	4.70e-05
Benzene	Cartridge, Impulse, MK 107	6.90e-05	6.70e-05	5.50e-05	6.40e-05	9.60e-05
Benzene	Composition B surrogate	2.20e-06	2.20e-06	3.30e-06	2.60e-06	5.00e-06
Benzene	Detonating train	2.40e-05	2.30e-05	2.60e-05	2.50e-05	4.60e-05
Benzene	Flare, IR Countermeasure M206	4.60e-05	3.90e-05	5.00e-05	4.50e-05	4.80e-05
Benzene	Fuze, Tail Bomb FMU-139 A/B	1.10e-04	1.20e-04	1.30e-04	1.20e-04	1.20e-04
Benzene	Fuze, Tail Bomb FMU-54 A/B	6.40e-05	1.70e-04	1.00e-04	1.10e-04	1.50e-04
Benzene	Gas Generator, GGU-2/A	1.10e-04	1.30e-04	1.50e-04	1.30e-04	1.40e-04
Benzene	HBX surrogate	6.60e-06	4.50e-06	1.00e-05	7.20e-06	1.40e-05
Benzene	Mine, Claymore, M18A1	5.50e-04	9.40e-04	9.30e-04	8.10e-04	8.10e-04
Benzene	Signal, Illumination, Red Star AN-M43A2	3.00e-05	3.60e-05	3.50e-05	3.40e-05	3.60e-05
Benzene	Signal, Illumination, Red Star M158	3.00e-05	3.40e-05	2.60e-05	3.00e-05	3.30e-05
Benzene	Tritonal surrogate	1.20e-05	3.30e-06	1.50e-06	5.70e-06	1.60e-05
Benzene	Tritonal surrogate with calcium stearate		4.40e-06	1.80e-06	3.10e-06	1.40e-05
Benzene	Tritonal surrogate with water	2.90e-04	1.20e-04	2.10e-04	2.00e-04	2.20e-04
Benzene	TNT (ACC1)	4.60e-06	4.80e-06	2.90e-06	4.10e-06	8.80e-06
Benzene	TNT (ACC2)	4.10e-06			4.10e-06	7.40e-06
Benzene	TNT (Sandia)	1.40e-06	3.30e-06	4.20e-06	3.00e-06	
Benzene	T45E7 Adapter Booster	1.60e-04	1.40e-04	8.00e-05	1.30e-04	1.30e-04
Benzene	20 mm HEI Cartridge	1.50e-04	8.90e-05	9.90e-05	1.10e-04	1.70e-04
Benzene	40 mm HEI Cartridge	2.80e-05	0.00e+00	0.00e+00	2.80e-05	4.90e-05
Cadmium	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cadmium	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cadmium	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cadmium	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cadmium	Cartridge, Impulse, MK 107	1.00e-03	1.80e-03	1.40e-03	1.40e-03	1.40e-03
Cadmium	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cadmium	Detonating train	1.10e-05	1.40e-05	7.00e-06	1.10e-05	1.10e-05
Cadmium	Flare, IR Countermeasure M206	4.90e-05	3.00e-05	2.30e-05	3.40e-05	3.50e-05
Cadmium	Fuze, Tail Bomb FMU-139 A/B	2.40e-03	2.10e-03	2.20e-03	2.30e-03	2.30e-03

Cadmium	Fuze, Tail Bomb FMU-54 A/B	1.80e-04	1.50e-04	5.90e-04	3.10e-04	4.10e-04
Cadmium	Gas Generator, GGU-2/A	4.50e-05	2.10e-04	4.90e-05	1.00e-04	1.00e-04
Cadmium	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cadmium	Mine, Claymore, M18A1	2.40e-04			2.40e-04	2.40e-04
Cadmium	Signal, Illumination, Red Star AN-M43A2	1.30e-04	7.00e-05	6.10e-05	8.80e-05	9.00e-05
Cadmium	Signal, Illumination, Red Star M158	1.30e-03	9.40e-04	1.10e-03	1.10e-03	1.30e-03
Cadmium	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cadmium	Tritonal surrogate with calcium stearate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cadmium	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cadmium	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cadmium	TNT (ACC2)	4.00e-05			4.00e-05	4.00e-05
Cadmium	TNT (Sandia)	2.90e-06	2.50e-06	2.80e-06	2.70e-06	
Cadmium	T45E7 Adapter Booster	5.80e-03			5.80e-03	5.80e-03
Cadmium	20 mm HEI Cartridge	8.60e-04			8.60e-04	4.00e-04
Cadmium	40 mm HEI Cartridge	3.20e-05			3.20e-05	3.20e-05
Carbon tetrachloride	Amatol surrogate	3.70e-07	0.00e+00	0.00e+00	3.70e-07	2.10e-06
Carbon tetrachloride	Amatol surrogate with water	3.70e-07	3.70e-07	3.70e-07	3.70e-07	2.20e-06
Carbon tetrachloride	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Carbon tetrachloride	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Carbon tetrachloride	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Carbon tetrachloride	Composition B surrogate	0.00e+00	0.00e+00	3.60e-07	3.60e-07	2.20e-06
Carbon tetrachloride	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Carbon tetrachloride	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.90e-06
Carbon tetrachloride	Fuze, Tail Bomb FMU-139 A/B	0.00e+00	2.70e-06	0.00e+00	2.70e-06	2.70e-06
Carbon tetrachloride	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.20e-06
Carbon tetrachloride	Gas Generator, GGU-2/A	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.30e-06
Carbon tetrachloride	HBX surrogate	0.00e+00	4.10e-07	3.70e-07	3.90e-07	2.30e-06
Carbon tetrachloride	Mine, Claymore, M18A1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Carbon tetrachloride	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.90e-06
Carbon tetrachloride	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.90e-06
Carbon tetrachloride	Tritonal surrogate	0.00e+00	3.70e-07	0.00e+00	3.70e-07	2.00e-06
Carbon tetrachloride	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	1.80e-06
Carbon tetrachloride	Tritonal surrogate with water	3.70e-07	3.70e-07	7.50e-07	4.80e-07	2.40e-06
Carbon tetrachloride	TNT (ACC1)	0.00e+00			0.00e+00	2.50e-06
Carbon tetrachloride	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Carbon tetrachloride	T45E7 Adapter Booster	3.20e-06			3.20e-06	6.50e-06
Carbon tetrachloride	20 mm HEI Cartridge	7.60e-06			7.60e-06	1.60e-05
Carbon tetrachloride	40 mm HEI Cartridge	4.50e-06			4.50e-06	1.20e-05
Chloroform	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.70e-07

Chloroform	Amatol surrogate with water	3.70e-07	3.70e-07	0.00e+00	3.70e-07	7.40e-07
Chloroform	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.70e-07
Chloroform	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Fuze, Tail Bomb FMU-139 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Gas Generator, GGU-2/A	2.50e-06	2.50e-06	2.60e-06	2.60e-06	2.60e-06
Chloroform	HBX surrogate	3.70e-07	4.10e-07	3.70e-07	3.80e-07	7.60e-07
Chloroform	Mine, Claymore, M18A1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	Tritonal surrogate	0.00e+00	0.00e+00	3.60e-07	3.60e-07	7.40e-07
Chloroform	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	3.70e-07
Chloroform	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	T45E7 Adapter Booster	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	20 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chloroform	40 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Cartridge, Impulse, BBU-36/B	2.00e-05	0.00e+00	2.50e-05	2.20e-05	2.20e-05
Chromium	Cartridge, Impulse, MK 107	4.30e-05	2.90e-05	2.80e-05	3.30e-05	3.30e-05
Chromium	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Flare, IR Countermeasure M206	1.40e-04	1.70e-04	1.60e-04	1.60e-04	1.60e-04
Chromium	Fuze, Tail Bomb FMU-139 A/B	1.60e-04	1.20e-04	1.30e-04	1.40e-04	1.40e-04
Chromium	Fuze, Tail Bomb FMU-54 A/B	5.50e-05	3.50e-05	2.80e-05	3.90e-05	5.50e-05
Chromium	Gas Generator, GGU-2/A	5.30e-05	9.70e-05	1.40e-04	9.60e-05	9.60e-05
Chromium	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Mine, Claymore, M18A1	3.80e-05			3.80e-05	3.80e-05
Chromium	Signal, Illumination, Red Star AN-M43A2	6.60e-05	5.20e-05	5.30e-05	5.70e-05	5.80e-05
Chromium	Signal, Illumination, Red Star M158	1.30e-04	1.50e-04	1.50e-04	1.50e-04	1.50e-04
Chromium	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Chromium	Tritonal surrogate with calcium stearate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.10e-06

Chromium	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.20e-06
Chromium	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.00e-06
Chromium	TNT (ACC2)	2.30e-05			2.30e-05	2.50e-05
Chromium	TNT (Sandia)	1.30e-06	3.50e-06	2.50e-06	2.40e-06	
Chromium	T45E7 Adapter Booster	9.40e-05			9.40e-05	9.40e-05
Chromium	20 mm HEI Cartridge	3.50e-05			3.50e-05	3.50e-05
Chromium	40 mm HEI Cartridge	8.80e-05			8.80e-05	8.80e-05
Copper	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Copper	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Copper	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.50e-05
Copper	Cartridge, Impulse, BBU-36/B	8.80e-04	1.40e-03	1.40e-03	1.20e-03	2.90e-03
Copper	Cartridge, Impulse, MK 107	1.30e-03	1.50e-03	1.50e-03	1.40e-03	2.40e-03
Copper	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Copper	Detonating train	0.00e+00	4.70e-04	0.00e+00	0.00e+00	2.60e-04
Copper	Flare, IR Countermeasure M206	6.50e-05	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Copper	Fuze, Tail Bomb FMU-139 A/B	7.70e-03	6.60e-03	5.90e-03	6.80e-03	6.80e-03
Copper	Fuze, Tail Bomb FMU-54 A/B	4.40e-04	4.50e-04	6.40e-04	5.10e-04	8.60e-04
Copper	Gas Generator, GGU-2/A	6.60e-04	7.00e-04	5.50e-04	6.40e-04	7.10e-04
Copper	HBX surrogate	1.90e-03	4.50e-03	3.10e-03	3.20e-03	3.20e-03
Copper	Mine, Claymore, M18A1	4.70e-03			4.70e-03	7.10e-04
Copper	Signal, Illumination, Red Star AN-M43A2	6.90e-04	2.00e-04	2.30e-04	3.70e-04	3.90e-04
Copper	Signal, Illumination, Red Star M158	0.00e+00	1.80e-03	0.00e+00	0.00e+00	0.00e+00
Copper	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Copper	Tritonal surrogate with calcium stearate		1.00e-04	0.00e+00	4.40e-05	7.50e-05
Copper	Tritonal surrogate with water	9.20e-04	7.70e-04	9.60e-04	8.80e-04	9.10e-04
Copper	TNT (ACC1)	3.00e-04			3.00e-04	0.00e+00
Copper	TNT (ACC2)	5.00e-04			5.00e-04	5.20e-04
Copper	T45E7 Adapter Booster	2.70e-03			2.70e-03	3.20e-04
Copper	20 mm HEI Cartridge	2.60e-02			2.60e-02	1.20e-02
Copper	40 mm HEI Cartridge	8.90e-03			8.90e-03	2.30e-03
Cyclohexane	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	Amatol surrogate with water	7.40e-07	0.00e+00	0.00e+00	7.40e-07	1.50e-06
Cyclohexane	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	Cartridge, Impulse, BBU-36/B	0.00e+00	5.60e-07	0.00e+00	5.60e-07	1.70e-06
Cyclohexane	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	Detonating train	8.70e-07	0.00e+00	6.00e-07	7.30e-07	1.80e-06
Cyclohexane	Flare, IR Countermeasure M206	3.30e-07	0.00e+00	0.00e+00	3.30e-07	3.30e-07
Cyclohexane	Fuze, Tail Bomb FMU-139 A/B	4.90e-07	0.00e+00	0.00e+00	4.90e-07	4.90e-07

Cyclohexane	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	Gas Generator, GGU-2/A	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	5.80e-07
Cyclohexane	Mine, Claymore, M18A1	2.00e-06	4.90e-07	1.40e-06	1.30e-06	1.80e-06
Cyclohexane	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.40e-07
Cyclohexane	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	7.30e-07
Cyclohexane	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.80e-06
Cyclohexane	TNT (ACC1)	2.30e-06	9.60e-07	0.00e+00	1.60e-06	3.00e-06
Cyclohexane	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclohexane	T45E7 Adapter Booster	1.80e-06	1.20e-06	4.00e-06	2.30e-06	4.70e-06
Cyclohexane	20 mm HEI Cartridge	7.00e-07	0.00e+00	6.80e-07	6.90e-07	6.50e-06
Cyclohexane	40 mm HEI Cartridge	7.50e-06	0.00e+00	0.00e+00	7.50e-06	1.60e-05
Cyclopentane	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	Amatol surrogate with water	2.20e-06	4.40e-06	2.20e-06	3.00e-06	3.50e-06
Cyclopentane	Cartridge, Impulse, ARD 446-1	0.00e+00	2.60e-07	0.00e+00	2.60e-07	7.50e-07
Cyclopentane	Cartridge, Impulse, BBU-36/B	2.70e-07	2.80e-07	2.80e-07	2.80e-07	9.00e-07
Cyclopentane	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	Detonating train	0.00e+00	0.00e+00	3.00e-07	3.00e-07	6.10e-07
Cyclopentane	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	Fuze, Tail Bomb FMU-139 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	Gas Generator, GGU-2/A	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	HBX surrogate	0.00e+00	0.00e+00	1.10e-06	1.10e-06	7.50e-07
Cyclopentane	Mine, Claymore, M18A1	0.00e+00	9.80e-07	4.70e-07	7.20e-07	7.20e-07
Cyclopentane	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	Tritonal surrogate	3.70e-07	3.70e-07	3.60e-07	3.70e-07	7.40e-07
Cyclopentane	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	5.50e-07
Cyclopentane	Tritonal surrogate with water	0.00e+00	1.50e-06	7.50e-07	1.10e-06	1.90e-06
Cyclopentane	TNT (ACC1)	4.60e-07	4.80e-07	0.00e+00	4.70e-07	4.70e-07
Cyclopentane	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentane	T45E7 Adapter Booster	0.00e+00	5.90e-07	5.80e-07	5.80e-07	9.70e-07
Cyclopentane	20 mm HEI Cartridge	0.00e+00	7.20e-07	6.80e-07	7.00e-07	1.60e-06
Cyclopentane	40 mm HEI Cartridge	1.70e-06	0.00e+00	0.00e+00	1.70e-06	3.30e-06
Cyclopentene	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentene	Amatol surrogate with water	4.10e-06	2.00e-05	0.00e+00	1.20e-05	1.20e-05

Cyclopentene	Cartridge, Impulse, ARD 446-1	2.10e-06	5.10e-06	2.00e-06	3.10e-06	3.10e-06
Cyclopentene	Cartridge, Impulse, BBU-36/B	2.70e-06	0.00e+00	2.80e-06	2.70e-06	2.70e-06
Cyclopentene	Cartridge, Impulse, MK 107	1.00e-06	7.90e-07	1.00e-06	9.70e-07	9.70e-07
Cyclopentene	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentene	Detonating train	3.80e-06	3.90e-06	3.30e-06	3.70e-06	3.70e-06
Cyclopentene	Flare, IR Countermeasure M206	6.60e-07	6.80e-07	1.00e-06	7.90e-07	7.90e-07
Cyclopentene	Fuze, Tail Bomb FMU-139 A/B	9.70e-07	9.70e-07	4.80e-07	8.10e-07	8.10e-07
Cyclopentene	Fuze, Tail Bomb FMU-54 A/B	1.20e-06	1.50e-06	1.20e-06	1.30e-06	1.30e-06
Cyclopentene	Gas Generator, GGU-2/A	4.10e-06	1.80e-06	4.90e-06	3.60e-06	3.60e-06
Cyclopentene	HBX surrogate	3.70e-07	4.10e-07	0.00e+00	3.90e-07	5.70e-07
Cyclopentene	Mine, Claymore, M18A1	4.90e-07	0.00e+00	0.00e+00	4.90e-07	4.90e-07
Cyclopentene	Signal, Illumination, Red Star AN-M43A2	1.00e-06	1.70e-06	1.00e-06	1.30e-06	1.30e-06
Cyclopentene	Signal, Illumination, Red Star M158	3.50e-06	2.10e-06	1.70e-06	2.50e-06	2.50e-06
Cyclopentene	Tritonal surrogate	0.00e+00	0.00e+00	7.30e-07	7.30e-07	7.30e-07
Cyclopentene	Tritonal surrogate with calcium stearate		0.00e+00	3.60e-07	3.60e-07	3.60e-07
Cyclopentene	Tritonal surrogate with water	0.00e+00	0.00e+00	2.60e-06	2.60e-06	2.60e-06
Cyclopentene	TNT (ACC1)	4.60e-07	0.00e+00	0.00e+00	4.60e-07	4.60e-07
Cyclopentene	TNT (ACC2)	3.70e-07			3.70e-07	3.70e-07
Cyclopentene	T45E7 Adapter Booster	4.20e-06	4.10e-06	2.90e-06	3.70e-06	3.70e-06
Cyclopentene	20 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Cyclopentene	40 mm HEI Cartridge	8.30e-07	0.00e+00	0.00e+00	8.30e-07	1.70e-06
CO	Amatol surrogate	9.80e-03	8.60e-03	1.10e-02	9.70e-03	
CO	Amatol surrogate with water	1.90e-01	3.10e-01	1.90e-01	2.30e-01	
CO	Cartridge, Impulse, ARD 446-1	1.40e-02	1.20e-02	1.30e-02	1.30e-02	
CO	Cartridge, Impulse, BBU-36/B	8.10e-03	8.10e-03	9.00e-03	8.40e-03	
CO	Cartridge, Impulse, MK 107	1.40e-02	1.50e-02	1.30e-02	1.40e-02	
CO	Composition B surrogate	3.40e-03	4.70e-03	4.40e-03	4.20e-03	
CO	Detonating train	1.30e-02	7.90e-03	7.40e-03	9.40e-03	
CO	Flare, IR Countermeasure M206	7.40e-03	9.50e-03	7.90e-03	8.30e-03	
CO	Fuze, Tail Bomb FMU-139 A/B	2.10e-02	2.40e-02	2.50e-02	2.30e-02	
CO	Fuze, Tail Bomb FMU-54 A/B	1.50e-02	2.40e-02	1.70e-02	1.80e-02	
CO	Gas Generator, GGU-2/A	2.70e-02	2.80e-02	3.00e-02	2.80e-02	
CO	HBX surrogate	4.40e-03	4.20e-03	7.00e-03	5.20e-03	
CO	Mine, Claymore, M18A1	2.90e-02	3.20e-02	3.00e-02	3.00e-02	
CO	Signal, Illumination, Red Star AN-M43A2	1.70e-02	2.10e-02	2.80e-02	2.20e-02	
CO	Signal, Illumination, Red Star M158	1.10e-02	1.10e-02	1.20e-02	1.20e-02	
CO	Tritonal surrogate	5.60e-03	5.60e-03	2.90e-03	4.70e-03	
CO	Tritonal surrogate with calcium stearate		3.30e-03	2.00e-03	2.70e-03	
CO	Tritonal surrogate with water	2.80e-01	2.40e-01	2.80e-01	2.70e-01	

CO	TNT (ACC1)	9.50e-03	1.30e-02	9.30e-03	1.00e-02	
CO	TNT (ACC2)	6.70e-03			6.70e-03	
CO	T45E7 Adapter Booster	3.10e-02	3.10e-02	2.60e-02	2.90e-02	
CO	20 mm HEI Cartridge	1.20e-01	9.10e-02	1.10e-01	1.10e-01	
CO	40 mm HEI Cartridge	2.30e-02	2.30e-02	1.80e-02	2.10e-02	
CO2	Amatol surrogate	5.10e-01	7.80e-01	8.00e-01	7.00e-01	
CO2	Amatol surrogate with water	2.30e-01	4.50e-01	2.40e-01	3.10e-01	
CO2	Cartridge, Impulse, ARD 446-1	4.80e-01	4.60e-01	5.00e-01	4.80e-01	
CO2	Cartridge, Impulse, BBU-36/B	5.00e-01	4.80e-01	5.30e-01	5.00e-01	
CO2	Cartridge, Impulse, MK 107	8.40e-01	8.50e-01	8.60e-01	8.50e-01	
CO2	Composition B surrogate	1.10e+00	1.20e+00	1.10e+00	1.10e+00	
CO2	Detonating train	5.70e-01	1.10e+00	1.10e+00	9.10e-01	
CO2	Flare, IR Countermeasure M206	7.70e-01	8.10e-01	8.50e-01	8.10e-01	
CO2	Fuze, Tail Bomb FMU-139 A/B	1.50e+00	1.40e+00	1.50e+00	1.40e+00	
CO2	Fuze, Tail Bomb FMU-54 A/B	9.20e-01	9.10e-01	9.80e-01	9.40e-01	
CO2	Gas Generator, GGU-2/A	4.40e-01	4.30e-01	4.80e-01	4.50e-01	
CO2	HBX surrogate	9.70e-01	9.40e-01	1.10e+00	1.00e+00	
CO2	Mine, Claymore, M18A1	4.90e+00	5.10e+00	5.00e+00	5.00e+00	
CO2	Signal, Illumination, Red Star AN-M43A2	1.00e+00	1.10e+00	1.10e+00	1.10e+00	
CO2	Signal, Illumination, Red Star M158	5.00e-01	5.30e-01	5.10e-01	5.10e-01	
CO2	Tritonal surrogate	5.00e-01	2.20e-01	1.20e+00	6.40e-01	
CO2	Tritonal surrogate with calcium stearate		1.30e+00	1.30e+00	1.30e+00	
CO2	Tritonal surrogate with water	2.50e-01	3.30e-01	2.60e-01	2.80e-01	
CO2	TNT (ACC1)	1.40e+00	1.50e+00	1.50e+00	1.50e+00	
CO2	TNT (ACC2)	1.40e+00			1.40e+00	
CO2	TNT (Sandia)	1.30e+00			1.30e+00	
CO2	T45E7 Adapter Booster	5.10e+00	4.60e+00	4.70e+00	4.80e+00	
CO2	20 mm HEI Cartridge	2.30e+00	2.20e+00	1.90e+00	2.10e+00	
CO2	40 mm HEI Cartridge	9.10e-01	8.70e-01	8.80e-01	8.90e-01	
Diethyl phthalate	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.40e-05
Diethyl phthalate	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.80e-06
Diethyl phthalate	Cartridge, Impulse, BBU-36/B	4.40e-05	6.70e-04	4.90e-04	4.00e-04	7.80e-04
Diethyl phthalate	Cartridge, Impulse, MK 107	3.00e-04	0.00e+00	0.00e+00	3.00e-04	4.40e-04
Diethyl phthalate	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	Fuze, Tail Bomb FMU-139 A/B	1.40e-03	1.70e-03	1.50e-03	1.50e-03	1.50e-03
Diethyl phthalate	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Diethyl phthalate	Gas Generator, GGU-2/A	2.30e-04	0.00e+00	1.60e-03	8.90e-04	0.00e+00
Diethyl phthalate	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	Mine, Claymore, M18A1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	Signal, Illumination, Red Star M158	0.00e+00	7.70e-05	0.00e+00	7.70e-05	7.70e-05
Diethyl phthalate	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	Tritonal surrogate with calcium stearate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.40e-06
Diethyl phthalate	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	T45E7 Adapter Booster	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	20 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Diethyl phthalate	40 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethane	Amatol surrogate	0.00e+00	2.20e-06	6.00e-06	4.10e-06	5.20e-06
Ethane	Amatol surrogate with water	8.70e-04	1.50e-03	1.00e-03	1.10e-03	1.10e-03
Ethane	Cartridge, Impulse, ARD 446-1	3.00e-05	1.20e-05	2.90e-05	2.40e-05	3.90e-05
Ethane	Cartridge, Impulse, BBU-36/B	1.40e-06	5.60e-07	8.40e-06	3.40e-06	1.30e-05
Ethane	Cartridge, Impulse, MK 107	5.30e-07	2.60e-06	1.60e-06	1.60e-06	9.50e-06
Ethane	Composition B surrogate	1.90e-06	0.00e+00	7.30e-07	1.30e-06	4.70e-06
Ethane	Detonating train	1.70e-06	1.80e-06	9.60e-06	4.40e-06	1.40e-05
Ethane	Flare, IR Countermeasure M206	1.00e-06	0.00e+00	1.00e-06	1.00e-06	7.60e-06
Ethane	Fuze, Tail Bomb FMU-139 A/B	0.00e+00	9.20e-06	0.00e+00	9.80e-06	1.90e-05
Ethane	Fuze, Tail Bomb FMU-54 A/B	9.80e-06	1.20e-05	0.00e+00	1.10e-05	1.90e-05
Ethane	Gas Generator, GGU-2/A	2.50e-05	3.70e-05	3.00e-05	3.00e-05	3.90e-05
Ethane	HBX surrogate	0.00e+00	1.60e-06	1.50e-06	1.60e-06	4.90e-06
Ethane	Mine, Claymore, M18A1	8.80e-06	1.50e-06	5.60e-06	5.30e-06	7.20e-06
Ethane	Signal, Illumination, Red Star AN-M43A2	9.00e-06	0.00e+00	9.00e-06	9.00e-06	1.30e-05
Ethane	Signal, Illumination, Red Star M158	1.50e-05	2.40e-05	0.00e+00	2.00e-05	2.60e-05
Ethane	Tritonal surrogate	0.00e+00	0.00e+00	3.60e-07	3.60e-07	2.60e-06
Ethane	Tritonal surrogate with calcium stearate		7.40e-07	0.00e+00	7.40e-07	4.40e-06
Ethane	Tritonal surrogate with water	5.00e-05	1.10e-04	2.10e-04	1.20e-04	1.30e-04
Ethane	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.70e-06
Ethane	TNT (ACC2)	7.40e-07			7.40e-07	4.10e-06
Ethane	T45E7 Adapter Booster	2.80e-05	2.40e-05	2.40e-05	2.50e-05	3.90e-05
Ethane	20 mm HEI Cartridge	1.10e-04	7.60e-05	9.90e-05	9.40e-05	1.40e-04
Ethane	40 mm HEI Cartridge	2.90e-05	3.60e-05	2.50e-05	3.00e-05	4.60e-05
Ethyl chloride	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Ethyl chloride	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Detonating train	0.00e+00	6.90e-07	6.90e-07	6.90e-07	6.90e-07
Ethyl chloride	Flare, IR Countermeasure M206	3.90e-06	3.20e-06	2.40e-06	3.10e-06	3.10e-06
Ethyl chloride	Fuze, Tail Bomb FMU-139 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Gas Generator, GGU-2/A	2.70e-06	4.10e-06	7.10e-06	4.70e-06	4.70e-06
Ethyl chloride	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Mine, Claymore, M18A1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Tritonal surrogate with calcium stearate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	T45E7 Adapter Booster	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	20 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethyl chloride	40 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Ethylbenzene	Amatol surrogate	7.50e-07	1.10e-06	1.90e-06	1.20e-06	4.00e-06
Ethylbenzene	Amatol surrogate with water	1.20e-05	2.20e-05	1.50e-05	1.60e-05	2.10e-05
Ethylbenzene	Cartridge, Impulse, ARD 446-1	1.00e-06	2.10e-06	2.70e-06	1.90e-06	8.10e-06
Ethylbenzene	Cartridge, Impulse, BBU-36/B	2.70e-06	2.50e-06	1.90e-06	2.40e-06	1.00e-05
Ethylbenzene	Cartridge, Impulse, MK 107	7.90e-07	1.10e-06	1.00e-06	9.70e-07	2.90e-06
Ethylbenzene	Composition B surrogate	1.10e-06	1.90e-06	2.90e-06	2.00e-06	5.30e-06
Ethylbenzene	Detonating train	2.90e-07	6.00e-07	9.00e-07	6.00e-07	9.30e-06
Ethylbenzene	Flare, IR Countermeasure M206	2.70e-06	1.70e-06	2.70e-06	2.40e-06	4.10e-06
Ethylbenzene	Fuze, Tail Bomb FMU-139 A/B	3.40e-06	3.40e-06	2.90e-06	3.20e-06	4.50e-06
Ethylbenzene	Fuze, Tail Bomb FMU-54 A/B	1.50e-06	3.30e-06	2.40e-06	2.40e-06	6.00e-06
Ethylbenzene	Gas Generator, GGU-2/A	5.90e-07	1.80e-06	1.20e-06	1.20e-06	9.10e-06
Ethylbenzene	HBX surrogate	1.50e-06	1.60e-06	2.20e-06	1.80e-06	8.80e-06
Ethylbenzene	Mine, Claymore, M18A1	3.10e-05	4.10e-05	4.20e-05	3.80e-05	3.90e-05
Ethylbenzene	Signal, Illumination, Red Star AN-M43A2	6.90e-07	3.50e-07	3.50e-07	4.60e-07	1.90e-06
Ethylbenzene	Signal, Illumination, Red Star M158	7.00e-07	7.00e-07	0.00e+00	7.00e-07	2.20e-06
Ethylbenzene	Tritonal surrogate	1.50e-06	2.60e-06	3.30e-06	2.50e-06	1.10e-05
Ethylbenzene	Tritonal surrogate with calcium stearate		7.40e-07	2.60e-06	1.60e-06	9.90e-06
Ethylbenzene	Tritonal surrogate with water	8.20e-06	3.30e-06	7.50e-06	6.30e-06	1.50e-05
Ethylbenzene	TNT (ACC1)	4.60e-07	4.80e-07	0.00e+00	4.70e-07	2.70e-06

Ethylbenzene	TNT (ACC2)	0.00e+00			0.00e+00	3.30e-06
Ethylbenzene	T45E7 Adapter Booster	1.00e-05	7.70e-06	9.80e-06	9.20e-06	1.00e-05
Ethylbenzene	20 mm HEI Cartridge	2.80e-06	5.00e-06	6.10e-06	4.60e-06	1.00e-05
Ethylbenzene	40 mm HEI Cartridge	2.50e-06	0.00e+00	0.00e+00	2.50e-06	9.60e-06
Ethylene	Amatol surrogate	4.40e-05	2.00e-05	2.90e-05	3.10e-05	3.20e-05
Ethylene	Amatol surrogate with water	7.30e-04	1.30e-03	8.80e-04	9.80e-04	9.80e-04
Ethylene	Cartridge, Impulse, ARD 446-1	3.90e-04	3.10e-04	3.10e-04	3.30e-04	4.90e-04
Ethylene	Cartridge, Impulse, BBU-36/B	2.60e-04	2.50e-04	3.00e-04	2.70e-04	5.30e-04
Ethylene	Cartridge, Impulse, MK 107	2.00e-04	1.80e-04	1.60e-04	1.80e-04	2.60e-04
Ethylene	Composition B surrogate	1.20e-05	1.20e-05	1.70e-05	1.40e-05	1.50e-05
Ethylene	Detonating train	4.20e-04	4.10e-04	3.50e-04	3.90e-04	6.00e-04
Ethylene	Flare, IR Countermeasure M206	1.30e-04	7.70e-05	1.40e-04	1.20e-04	1.20e-04
Ethylene	Fuze, Tail Bomb FMU-139 A/B	2.40e-04	4.00e-04	3.80e-04	3.40e-04	3.40e-04
Ethylene	Fuze, Tail Bomb FMU-54 A/B	1.60e-04	2.60e-04	1.70e-04	1.90e-04	2.60e-04
Ethylene	Gas Generator, GGU-2/A	6.00e-04	5.80e-04	6.70e-04	6.10e-04	6.20e-04
Ethylene	HBX surrogate	2.80e-05	2.50e-05	4.30e-05	3.20e-05	3.30e-05
Ethylene	Mine, Claymore, M18A1	1.80e-04	2.30e-04	3.00e-04	2.40e-04	2.40e-04
Ethylene	Signal, Illumination, Red Star AN-M43A2	2.10e-04	2.20e-04	2.20e-04	2.20e-04	2.20e-04
Ethylene	Signal, Illumination, Red Star M158	2.30e-04	3.50e-04	1.00e-04	2.30e-04	2.30e-04
Ethylene	Tritonal surrogate	2.70e-05	1.30e-05	2.50e-05	2.20e-05	2.30e-05
Ethylene	Tritonal surrogate with calcium stearate		3.20e-05	1.80e-05	2.50e-05	2.60e-05
Ethylene	Tritonal surrogate with water	1.20e-03	9.00e-04	1.30e-03	1.10e-03	1.10e-03
Ethylene	TNT (ACC1)	3.00e-05	2.90e-05	8.60e-06	2.20e-05	2.30e-05
Ethylene	TNT (ACC2)	1.60e-05			1.60e-05	1.60e-05
Ethylene	T45E7 Adapter Booster	6.50e-04	5.60e-04	4.90e-04	5.70e-04	5.70e-04
Ethylene	20 mm HEI Cartridge	3.30e-04	2.40e-04	3.00e-04	2.90e-04	4.00e-04
Ethylene	40 mm HEI Cartridge	8.90e-05	9.00e-05	6.50e-05	8.10e-05	1.10e-04
Lead	Amatol surrogate	0.00e+00	3.20e-05	9.70e-05	3.30e-05	3.30e-05
Lead	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Lead	Cartridge, Impulse, ARD 446-1	3.60e-04	2.10e-04	3.60e-04	3.10e-04	3.10e-04
Lead	Cartridge, Impulse, BBU-36/B	1.20e-05	1.00e-04	8.80e-05	6.80e-05	6.80e-05
Lead	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Lead	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Lead	Detonating train	2.80e-05	2.20e-04	2.90e-04	1.80e-04	1.80e-04
Lead	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Lead	Fuze, Tail Bomb FMU-139 A/B	2.80e-03	2.40e-03	2.50e-03	2.60e-03	2.60e-03
Lead	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Lead	Gas Generator, GGU-2/A	4.10e-04	4.10e-04	2.80e-04	3.70e-04	3.70e-04
Lead	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Lead	Mine, Claymore, M18A1	0.00e+00			0.00e+00	0.00e+00
Lead	Signal, Illumination, Red Star AN-M43A2	2.10e-04	0.00e+00	2.80e-05	7.00e-05	7.00e-05
Lead	Signal, Illumination, Red Star M158	7.00e-05	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Lead	Tritonal surrogate	1.90e-03	7.20e-04	6.70e-04	1.10e-03	1.10e-03
Lead	Tritonal surrogate with calcium stearate		9.10e-04	9.30e-04	9.20e-04	9.20e-04
Lead	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Lead	TNT (ACC1)	0.00e+00			0.00e+00	0.00e+00
Lead	TNT (ACC2)	9.00e-06			9.00e-06	9.00e-06
Lead	TNT (Sandia)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	
Lead	T45E7 Adapter Booster	1.80e-04			1.80e-04	1.80e-04
Lead	20 mm HEI Cartridge	7.00e-04			7.00e-04	8.00e-06
Lead	40 mm HEI Cartridge	3.70e-04			3.70e-04	3.70e-04
Methyl chloride	Amatol surrogate	1.10e-06	7.50e-07	3.70e-07	7.50e-07	7.50e-07
Methyl chloride	Amatol surrogate with water	2.20e-06	1.80e-06	2.60e-06	2.20e-06	2.20e-06
Methyl chloride	Cartridge, Impulse, ARD 446-1	1.90e-06	9.20e-07	9.00e-07	1.20e-06	2.00e-06
Methyl chloride	Cartridge, Impulse, BBU-36/B	4.90e-07	1.50e-06	1.00e-06	1.00e-06	3.00e-06
Methyl chloride	Cartridge, Impulse, MK 107	1.90e-06	4.80e-07	4.70e-07	9.60e-07	1.60e-06
Methyl chloride	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methyl chloride	Detonating train	1.10e-06	5.30e-07	5.30e-07	7.00e-07	1.90e-06
Methyl chloride	Flare, IR Countermeasure M206	1.20e-06	6.00e-07	1.20e-06	1.00e-06	1.60e-06
Methyl chloride	Fuze, Tail Bomb FMU-139 A/B	4.50e-06	6.10e-06	3.50e-06	4.70e-06	5.30e-06
Methyl chloride	Fuze, Tail Bomb FMU-54 A/B	1.10e-06	2.20e-06	6.20e-06	3.10e-06	4.90e-06
Methyl chloride	Gas Generator, GGU-2/A	5.30e-06	7.60e-06	3.60e-05	1.60e-05	1.70e-05
Methyl chloride	HBX surrogate	3.70e-07	4.10e-07	1.10e-06	6.30e-07	1.00e-06
Methyl chloride	Mine, Claymore, M18A1	4.40e-06			4.40e-06	4.40e-06
Methyl chloride	Signal, Illumination, Red Star AN-M43A2	1.90e-06	1.20e-06	1.80e-06	1.70e-06	2.10e-06
Methyl chloride	Signal, Illumination, Red Star M158	0.00e+00	1.30e-06	1.30e-06	1.30e-06	1.10e-06
Methyl chloride	Tritonal surrogate	7.40e-07	3.70e-07	0.00e+00	5.60e-07	5.60e-07
Methyl chloride	Tritonal surrogate with calcium stearate		3.70e-07	3.60e-07	3.70e-07	3.70e-07
Methyl chloride	Tritonal surrogate with water	3.70e-06	3.70e-06	4.10e-06	3.80e-06	3.80e-06
Methyl chloride	TNT (ACC1)	0.00e+00			0.00e+00	1.70e-06
Methyl chloride	TNT (ACC2)	0.00e+00			0.00e+00	6.70e-07
Methyl chloride	T45E7 Adapter Booster	2.20e-06			2.20e-06	3.20e-06
Methyl chloride	20 mm HEI Cartridge	1.30e-06			1.30e-06	3.50e-06
Methyl chloride	40 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methyl chloroform	Amatol surrogate	3.70e-07	3.70e-07	0.00e+00	3.70e-07	1.70e-06
Methyl chloroform	Amatol surrogate with water	3.70e-07	0.00e+00	3.70e-07	3.70e-07	1.70e-06
Methyl chloroform	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	1.20e-06	1.20e-06	1.80e-06
Methyl chloroform	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.60e-06

Methyl chloroform	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.80e-06
Methyl chloroform	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methyl chloroform	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.20e-06
Methyl chloroform	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.60e-06
Methyl chloroform	Fuze, Tail Bomb FMU-139 A/B	1.20e-05	1.80e-05	1.80e-05	1.60e-05	1.90e-05
Methyl chloroform	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.90e-06
Methyl chloroform	Gas Generator, GGU-2/A	0.00e+00	0.00e+00	0.00e+00	0.00e+00	2.90e-06
Methyl chloroform	HBX surrogate	3.70e-07	4.10e-07	3.70e-07	3.80e-07	1.90e-06
Methyl chloroform	Mine, Claymore, M18A1	2.30e-06			2.30e-06	4.60e-06
Methyl chloroform	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.60e-06
Methyl chloroform	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.70e-06
Methyl chloroform	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	1.60e-06
Methyl chloroform	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	1.80e-06
Methyl chloroform	Tritonal surrogate with water	3.70e-07	0.00e+00	3.70e-07	3.70e-07	1.70e-06
Methyl chloroform	TNT (ACC1)	0.00e+00			0.00e+00	6.60e-06
Methyl chloroform	TNT (ACC2)	0.00e+00			0.00e+00	1.80e-06
Methyl chloroform	T45E7 Adapter Booster	0.00e+00			0.00e+00	5.60e-06
Methyl chloroform	20 mm HEI Cartridge	3.30e-06			3.30e-06	1.40e-05
Methyl chloroform	40 mm HEI Cartridge	0.00e+00			0.00e+00	2.10e-05
Methylcyclohexane	Amatol surrogate	7.50e-07	2.20e-06	4.50e-06	2.50e-06	4.40e-06
Methylcyclohexane	Amatol surrogate with water	4.50e-06	1.20e-05	7.40e-06	8.00e-06	1.10e-05
Methylcyclohexane	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclohexane	Cartridge, Impulse, BBU-36/B	5.40e-07	2.80e-07	0.00e+00	4.10e-07	1.60e-06
Methylcyclohexane	Cartridge, Impulse, MK 107	7.90e-07	0.00e+00	2.60e-07	5.20e-07	9.60e-07
Methylcyclohexane	Composition B surrogate	2.20e-06	3.00e-06	1.80e-06	2.30e-06	4.10e-06
Methylcyclohexane	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclohexane	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	3.40e-07	3.40e-07	6.80e-07
Methylcyclohexane	Fuze, Tail Bomb FMU-139 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclohexane	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclohexane	Gas Generator, GGU-2/A	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclohexane	HBX surrogate	4.40e-06	7.00e-06	7.10e-06	6.10e-06	1.00e-05
Methylcyclohexane	Mine, Claymore, M18A1	5.40e-06	5.90e-06	4.70e-06	5.30e-06	6.30e-06
Methylcyclohexane	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Methylcyclohexane	Signal, Illumination, Red Star M158	3.50e-07	0.00e+00	0.00e+00	3.50e-07	7.00e-07
Methylcyclohexane	Tritonal surrogate	4.80e-06	5.90e-06	1.00e-05	7.00e-06	1.40e-05
Methylcyclohexane	Tritonal surrogate with calcium stearate		0.00e+00	4.40e-06	4.40e-07	6.20e-06
Methylcyclohexane	Tritonal surrogate with water	4.90e-06	5.10e-06	9.40e-06	6.50e-06	1.10e-05
Methylcyclohexane	TNT (ACC1)	9.20e-06	9.60e-07	0.00e+00	5.10e-06	4.30e-06
Methylcyclohexane	TNT (ACC2)	0.00e+00			0.00e+00	3.70e-07

Methylcyclohexane	T45E7 Adapter Booster	2.40e-06	2.90e-06	3.50e-06	2.90e-06	4.10e-06
Methylcyclohexane	20 mm HEI Cartridge	1.40e-06	2.90e-06	4.10e-06	2.80e-06	5.80e-06
Methylcyclohexane	40 mm HEI Cartridge	2.50e-06	0.00e+00	0.00e+00	2.50e-06	1.40e-05
Methylcyclopentane	Amatol surrogate	0.00e+00	0.00e+00	3.70e-07	1.90e-07	5.00e-07
Methylcyclopentane	Amatol surrogate with water	4.80e-06	1.20e-05	3.00e-06	6.60e-06	8.90e-06
Methylcyclopentane	Cartridge, Impulse, ARD 446-1	1.00e-06	2.60e-07	5.00e-07	6.00e-07	1.70e-06
Methylcyclopentane	Cartridge, Impulse, BBU-36/B	0.00e+00	1.10e-06	0.00e+00	1.10e-06	1.90e-06
Methylcyclopentane	Cartridge, Impulse, MK 107	0.00e+00	5.30e-07	0.00e+00	5.30e-07	7.70e-07
Methylcyclopentane	Composition B surrogate	0.00e+00	0.00e+00	3.60e-07	3.60e-07	4.90e-07
Methylcyclopentane	Detonating train	2.90e-07	0.00e+00	0.00e+00	2.90e-07	1.70e-06
Methylcyclopentane	Flare, IR Countermeasure M206	0.00e+00	3.40e-07	0.00e+00	3.40e-07	4.50e-07
Methylcyclopentane	Fuze, Tail Bomb FMU-139 A/B	4.90e-07	0.00e+00	0.00e+00	4.90e-07	4.90e-07
Methylcyclopentane	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	3.00e-07	0.00e+00	3.00e-07	8.00e-07
Methylcyclopentane	Gas Generator, GGU-2/A	2.40e-06	5.90e-07	0.00e+00	1.50e-06	1.80e-06
Methylcyclopentane	HBX surrogate	3.70e-07	8.20e-07	7.40e-07	6.40e-07	2.40e-06
Methylcyclopentane	Mine, Claymore, M18A1	1.40e-05	1.50e-05	1.80e-05	1.60e-05	1.70e-05
Methylcyclopentane	Signal, Illumination, Red Star AN-M43A2	0.00e+00	3.50e-07	0.00e+00	3.50e-07	7.00e-07
Methylcyclopentane	Signal, Illumination, Red Star M158	1.10e-06	0.00e+00	0.00e+00	1.10e-06	8.20e-07
Methylcyclopentane	Tritonal surrogate	7.40e-07	3.70e-07	0.00e+00	5.60e-07	3.50e-06
Methylcyclopentane	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	2.90e-06
Methylcyclopentane	Tritonal surrogate with water	0.00e+00	0.00e+00	7.50e-07	7.50e-07	4.70e-06
Methylcyclopentane	TNT (ACC1)	9.20e-07	4.80e-07	0.00e+00	7.00e-07	1.60e-06
Methylcyclopentane	TNT (ACC2)	3.70e-07			3.70e-07	7.40e-07
Methylcyclopentane	T45E7 Adapter Booster	1.20e-06	2.90e-06	4.60e-06	2.90e-06	4.70e-06
Methylcyclopentane	20 mm HEI Cartridge	7.00e-07	2.90e-06	4.80e-06	2.80e-06	7.70e-06
Methylcyclopentane	40 mm HEI Cartridge	9.10e-06	0.00e+00	0.00e+00	9.10e-06	1.60e-05
Methylenechloride	Amatol surrogate	1.50e-04	2.00e-04	1.10e-04	1.50e-04	2.00e-04
Methylenechloride	Amatol surrogate with water	2.10e-04	2.00e-04	2.20e-04	2.10e-04	2.60e-04
Methylenechloride	Cartridge, Impulse, ARD 446-1	1.30e-05	3.20e-05	1.10e-04	5.00e-05	1.90e-04
Methylenechloride	Cartridge, Impulse, BBU-36/B	8.20e-06	3.00e-04	2.10e-04	1.70e-04	1.10e-03
Methylenechloride	Cartridge, Impulse, MK 107	6.30e-04	3.10e-05	2.00e-05	2.30e-04	9.30e-04
Methylenechloride	Composition B surrogate	0.00e+00	3.70e-07	2.80e-04	1.40e-04	1.90e-06
Methylenechloride	Detonating train	0.00e+00	5.00e-05	3.50e-05	4.20e-05	5.60e-04
Methylenechloride	Flare, IR Countermeasure M206	4.80e-04	3.80e-04	3.80e-04	4.10e-04	1.90e-03
Methylenechloride	Fuze, Tail Bomb FMU-139 A/B	1.20e-04	1.60e-04	5.50e-05	1.10e-04	8.60e-04
Methylenechloride	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	7.10e-04	7.80e-04	7.40e-04	2.40e-03
Methylenechloride	Gas Generator, GGU-2/A	2.80e-04	7.00e-05	2.30e-03	8.70e-04	2.90e-03
Methylenechloride	HBX surrogate	0.00e+00	0.00e+00	2.70e-04	2.70e-04	2.80e-04
Methylenechloride	Mine, Claymore, M18A1	1.10e-04			1.10e-04	1.10e-04

Methylenechloride	Signal, Illumination, Red Star AN-M43A2	0.00e+00	8.10e-06	0.00e+00	8.10e-06	3.30e-04
Methylenechloride	Signal, Illumination, Red Star M158	1.00e-04	9.60e-05	1.00e-04	1.00e-04	3.20e-04
Methylenechloride	Tritonal surrogate	3.40e-06	4.80e-05	2.50e-06	1.80e-05	1.80e-05
Methylenechloride	Tritonal surrogate with calcium stearate		6.30e-06	3.10e-04	1.60e-04	1.60e-04
Methylenechloride	Tritonal surrogate with water	0.00e+00	8.80e-06	1.10e-06	5.00e-06	6.70e-06
Methylenechloride	TNT (ACC1)	1.80e-04			1.80e-04	2.40e-04
Methylenechloride	TNT (ACC2)	0.00e+00			0.00e+00	2.70e-04
Methylenechloride	T45E7 Adapter Booster	5.00e-04			5.00e-04	5.90e-04
Methylenechloride	20 mm HEI Cartridge	4.50e-04			4.50e-04	9.00e-04
Methylenechloride	40 mm HEI Cartridge	8.70e-04			8.70e-04	1.40e-03
NO	Amatol surrogate	2.20e-04	1.40e-02	1.70e-02	1.80e-02	
NO	Amatol surrogate with water	7.60e-03	7.50e-03	8.00e-03	7.70e-03	
NO	Cartridge, Impulse, ARD 446-1	6.50e-03	6.20e-03	6.50e-03	6.40e-03	
NO	Cartridge, Impulse, BBU-36/B	5.30e-03	3.50e-03	3.30e-03	4.00e-03	
NO	Cartridge, Impulse, MK 107	1.70e-02	1.40e-02	1.30e-02	1.50e-02	
NO	Composition B surrogate	9.20e-03	8.90e-03	9.70e-03	9.30e-03	
NO	Detonating train	6.80e-03	3.60e-03	4.30e-03	4.90e-03	
NO	Flare, IR Countermeasure M206	4.90e-03	6.00e-03	5.10e-03	5.30e-03	
NO	Fuze, Tail Bomb FMU-139 A/B	9.80e-03	1.00e-02	9.80e-03	9.90e-03	
NO	Fuze, Tail Bomb FMU-54 A/B	7.30e-03	6.90e-03	6.90e-03	7.00e-03	
NO	Gas Generator, GGU-2/A	1.50e-03	1.30e-03	1.90e-03	1.60e-03	
NO	HBX surrogate	9.30e-03	9.80e-03	1.00e-02	9.90e-03	
NO	Signal, Illumination, Red Star AN-M43A2	1.20e-02	1.50e-02	1.10e-02	1.30e-02	
NO	Signal, Illumination, Red Star M158	2.60e-03	2.70e-03	2.70e-03	2.60e-03	
NO	Tritonal surrogate	1.30e-03	1.70e-02	5.90e-03	8.20e-03	
NO	Tritonal surrogate with calcium stearate		6.50e-03	6.70e-03	6.60e-03	
NO	Tritonal surrogate with water	4.30e-03	3.90e-03	3.80e-03	4.00e-03	
NO	TNT (ACC2)	9.20e-03			9.20e-03	
NO	TNT (Sandia)	9.80e-03	1.00e-02	9.20e-03	9.70e-03	
NO2	Amatol surrogate	3.40e-04	1.80e-04	4.20e-04	1.20e-04	
NO2	Amatol surrogate with water	2.00e-04	2.10e-04	2.90e-04	2.40e-04	
NO2	Cartridge, Impulse, ARD 446-1	1.90e-03	1.60e-03	1.70e-03	1.70e-03	
NO2	Cartridge, Impulse, BBU-36/B	1.50e-03	1.70e-03	1.30e-03	1.50e-03	
NO2	Cartridge, Impulse, MK 107	7.70e-04	5.40e-04	5.30e-04	6.10e-04	
NO2	Composition B surrogate	1.10e-04	1.70e-04	3.00e-04	1.90e-04	
NO2	Detonating train	8.10e-03	3.30e-03	1.90e-03	4.40e-03	
NO2	Flare, IR Countermeasure M206	2.60e-03	3.10e-03	2.80e-03	2.80e-03	
NO2	Fuze, Tail Bomb FMU-139 A/B	1.70e-02	1.70e-02	1.70e-02	1.70e-02	
NO2	Fuze, Tail Bomb FMU-54 A/B	2.40e-03	2.50e-03	2.60e-03	2.50e-03	

NO2	Gas Generator, GGU-2/A	2.60e-03	2.40e-03	2.30e-03	2.40e-03	
NO2	HBX surrogate	5.90e-05	4.00e-05	3.40e-05	4.40e-05	
NO2	Signal, Illumination, Red Star AN-M43A2	9.80e-04	1.30e-03	1.00e-03	1.10e-03	
NO2	Signal, Illumination, Red Star M158	1.40e-03	1.60e-03	1.60e-03	1.50e-03	
NO2	Tritonal surrogate	2.50e-04	1.90e-04	1.80e-05	1.50e-04	
NO2	Tritonal surrogate with calcium stearate		3.00e-05	5.90e-05	4.50e-05	
NO2	Tritonal surrogate with water	2.60e-04	1.50e-04	3.90e-04	2.70e-04	
NO2	TNT (ACC2)	6.60e-05			6.60e-05	
NO2	TNT (Sandia)	3.90e-04	9.60e-04	9.20e-04	7.60e-04	
OCDD	Signal, Illumination, Red Star AN-M43A2	8.30e-10	1.60e-09	2.90e-09	1.80e-09	1.80e-09
Propane	Amatol surrogate	1.10e-06	7.50e-07	1.10e-06	1.00e-06	1.40e-06
Propane	Amatol surrogate with water	1.40e-04	2.40e-04	1.70e-04	1.90e-04	1.90e-04
Propane	Cartridge, Impulse, ARD 446-1	6.20e-06	5.40e-06	5.50e-06	5.70e-06	1.00e-05
Propane	Cartridge, Impulse, BBU-36/B	2.70e-06	3.90e-06	3.90e-06	3.50e-06	8.50e-06
Propane	Cartridge, Impulse, MK 107	0.00e+00	1.30e-06	1.60e-06	1.40e-06	5.20e-06
Propane	Composition B surrogate	7.40e-07	0.00e+00	7.30e-07	7.40e-07	1.40e-06
Propane	Detonating train	4.70e-06	4.50e-06	4.80e-06	4.70e-06	1.10e-05
Propane	Flare, IR Countermeasure M206	0.00e+00	6.80e-07	2.00e-06	1.40e-06	3.90e-06
Propane	Fuze, Tail Bomb FMU-139 A/B	4.40e-06	3.40e-06	3.90e-06	3.90e-06	7.90e-06
Propane	Fuze, Tail Bomb FMU-54 A/B	8.90e-07	1.80e-06	1.80e-06	1.50e-06	6.00e-06
Propane	Gas Generator, GGU-2/A	7.70e-06	7.10e-06	8.50e-06	7.70e-06	1.10e-05
Propane	HBX surrogate	1.50e-06	4.10e-07	7.40e-07	8.70e-07	2.20e-06
Propane	Mine, Claymore, M18A1	3.40e-06	4.40e-06	2.80e-06	3.60e-06	9.80e-06
Propane	Signal, Illumination, Red Star AN-M43A2	1.70e-06	3.50e-06	2.40e-06	2.60e-06	4.60e-06
Propane	Signal, Illumination, Red Star M158	6.00e-06	5.30e-06	3.10e-06	4.80e-06	8.00e-06
Propane	Tritonal surrogate	0.00e+00	7.40e-07	7.30e-07	7.30e-07	1.20e-06
Propane	Tritonal surrogate with calcium stearate		0.00e+00	3.60e-07	3.60e-07	2.20e-06
Propane	Tritonal surrogate with water	5.20e-05	5.00e-05	6.30e-05	5.50e-05	5.70e-05
Propane	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	9.50e-07
Propane	TNT (ACC2)	3.70e-07			3.70e-07	1.50e-06
Propane	T45E7 Adapter Booster	1.50e-05	8.20e-06	8.60e-06	1.10e-05	2.10e-05
Propane	20 mm HEI Cartridge	9.10e-06	6.50e-06	2.40e-05	1.30e-05	2.30e-05
Propane	40 mm HEI Cartridge	1.70e-06	5.00e-06	4.90e-06	3.80e-06	1.50e-05
Propene	Amatol surrogate	6.70e-06	3.40e-06	6.30e-06	5.50e-06	5.80e-06
Propene	Amatol surrogate with water	2.60e-04	4.90e-04	3.40e-04	3.60e-04	3.60e-04
Propene	Cartridge, Impulse, ARD 446-1	6.70e-05	5.50e-05	5.70e-05	6.00e-05	8.70e-05
Propene	Cartridge, Impulse, BBU-36/B	4.30e-05	4.60e-05	5.80e-05	4.90e-05	9.70e-05
Propene	Cartridge, Impulse, MK 107	2.80e-05	2.60e-05	2.40e-05	2.60e-05	3.80e-05
Propene	Composition B surrogate	3.70e-06	1.10e-06	4.40e-06	3.10e-06	4.10e-06

Propene	Detonating train	7.50e-05	7.10e-05	7.10e-05	7.30e-05	1.10e-04
Propene	Flare, IR Countermeasure M206	2.20e-05	2.00e-05	2.60e-05	2.20e-05	2.30e-05
Propene	Fuze, Tail Bomb FMU-139 A/B	5.90e-05	6.30e-05	5.50e-05	5.90e-05	5.90e-05
Propene	Fuze, Tail Bomb FMU-54 A/B	3.80e-05	5.20e-05	3.90e-05	4.30e-05	4.30e-05
Propene	Gas Generator, GGU-2/A	6.90e-05	6.80e-05	7.80e-05	7.20e-05	7.30e-05
Propene	HBX surrogate	8.40e-06	7.80e-06	1.20e-05	9.40e-06	9.90e-06
Propene	Mine, Claymore, M18A1	2.10e-05	2.70e-05	2.60e-05	2.40e-05	2.50e-05
Propene	Signal, Illumination, Red Star AN-M43A2	3.20e-05	3.90e-05	3.40e-05	3.50e-05	3.50e-05
Propene	Signal, Illumination, Red Star M158	6.00e-05	5.80e-05	5.00e-05	5.60e-05	5.60e-05
Propene	Tritonal surrogate	2.60e-06	1.50e-06	5.40e-06	3.20e-06	3.60e-06
Propene	Tritonal surrogate with calcium stearate		8.10e-06	4.00e-06	6.10e-06	6.60e-06
Propene	Tritonal surrogate with water	1.70e-04	1.20e-04	1.80e-04	1.60e-04	1.60e-04
Propene	TNT (ACC1)	7.80e-06	8.10e-06	5.80e-06	7.20e-06	7.70e-06
Propene	TNT (ACC2)	4.10e-06			4.10e-06	4.10e-06
Propene	T45E7 Adapter Booster	2.00e-04	1.60e-04	1.30e-04	1.60e-04	1.60e-04
Propene	20 mm HEI Cartridge	6.20e-05	4.00e-05	5.00e-05	5.10e-05	7.20e-05
Propene	40 mm HEI Cartridge	1.80e-05	1.70e-05	1.20e-05	1.60e-05	2.40e-05
PETN	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
PETN	Cartridge, Impulse, BBU-36/B	0.00e+00	9.30e-04	2.30e-04	5.80e-04	5.80e-04
PETN	Cartridge, Impulse, MK 107	2.30e-05	1.10e-04	1.80e-05	5.10e-05	7.60e-05
PETN	Detonating train	5.60e-04	7.30e-04	4.10e-04	5.60e-04	8.80e-04
PETN	Flare, IR Countermeasure M206	2.40e-06	1.90e-06	4.00e-07	1.60e-06	2.10e-06
PETN	Fuze, Tail Bomb FMU-139 A/B	2.60e-05	1.50e-05	8.90e-06	1.70e-05	1.90e-05
PETN	Fuze, Tail Bomb FMU-54 A/B	1.20e-05	1.10e-05	5.80e-06	9.60e-06	1.40e-05
PETN	Gas Generator, GGU-2/A	1.10e-04	2.90e-05	1.10e-05	4.90e-05	6.30e-05
PETN	Signal, Illumination, Red Star AN-M43A2	1.70e-05	8.20e-06	1.10e-05	1.20e-05	1.20e-05
PETN	Signal, Illumination, Red Star M158	1.30e-05	5.60e-06	6.10e-06	8.40e-06	8.40e-06
PETN	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
PM10	Amatol surrogate	1.50e-02	2.10e-02	2.00e-02	1.90e-02	
PM10	Amatol surrogate with water	2.40e-02	3.10e-02	4.00e-02	3.20e-02	
PM10	Cartridge, Impulse, ARD 446-1	8.30e-02	1.20e-01	8.60e-02	8.30e-02	
PM10	Cartridge, Impulse, BBU-36/B	1.60e-01	1.90e-01	1.90e-01	1.80e-01	
PM10	Cartridge, Impulse, MK 107	2.40e-01	2.60e-01	2.50e-01	2.50e-01	
PM10	Composition B surrogate	1.00e-02	1.10e-02	1.50e-02	1.20e-02	
PM10	Detonating train	3.60e-02	4.00e-02	3.20e-02	3.60e-02	
PM10	Flare, IR Countermeasure M206	4.90e-01	5.90e-01	5.80e-01	5.50e-01	
PM10	Fuze, Tail Bomb FMU-139 A/B	6.50e-01	5.60e-01	5.90e-01	6.00e-01	
PM10	Fuze, Tail Bomb FMU-54 A/B	3.10e-01	3.40e-01	3.40e-01	3.30e-01	
PM10	Gas Generator, GGU-2/A	9.80e-02	9.20e-02	8.90e-02	9.30e-02	

PM10	HBX surrogate	6.80e-02	3.70e-02	4.40e-01	1.80e-01	
PM10	Mine, Claymore, M18A1	2.40e-01	2.30e-01	2.10e-01	2.30e-01	
PM10	Signal, Illumination, Red Star AN-M43A2	4.30e-01	4.50e-01	4.80e-01	4.50e-01	
PM10	Signal, Illumination, Red Star M158	9.20e-02	8.30e-02	7.20e-02	8.20e-02	
PM10	Tritonal surrogate	6.30e-01	2.50e-01	2.20e-01	3.70e-01	
PM10	Tritonal surrogate with calcium stearate		2.30e-01	3.00e-01	2.60e-01	
PM10	Tritonal surrogate with water	1.10e-01	2.20e-01	2.30e-01	1.90e-01	
PM10	TNT (ACC1)	7.20e-02	7.30e-02	7.50e-02	7.30e-02	
PM10	TNT (ACC2)	9.30e-02			9.30e-02	
PM10	T45E7 Adapter Booster	2.40e-01	2.70e-01	2.70e-01	2.60e-01	
PM10	40 mm HEI Cartridge	4.70e-01	4.80e-01	4.50e-01	4.70e-01	
RDX	Cartridge, Impulse, ARD 446-1	2.30e-03	1.20e-02	1.10e-02	8.40e-04	1.20e-03
RDX	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.10e-04
RDX	Cartridge, Impulse, MK 107	1.70e-04	1.80e-04	1.50e-04	1.70e-04	2.40e-04
RDX	Detonating train	1.10e-02	7.90e-03	3.70e-03	7.40e-03	1.20e-02
RDX	Flare, IR Countermeasure M206	8.70e-05	5.40e-05	3.80e-05	6.00e-05	6.20e-05
RDX	Fuze, Tail Bomb FMU-139 A/B	3.50e-04	3.80e-04	3.00e-04	3.40e-04	3.40e-04
RDX	Fuze, Tail Bomb FMU-54 A/B	9.70e-05	9.20e-05	8.00e-05	9.00e-05	1.30e-04
RDX	Gas Generator, GGU-2/A	2.10e-04	1.10e-04	1.00e-04	1.40e-04	1.60e-04
RDX	Mine, Claymore, M18A1	1.00e-05	6.50e-07	1.90e-05	9.90e-06	1.20e-05
RDX	Signal, Illumination, Red Star AN-M43A2	1.50e-04	2.00e-04	2.30e-04	1.90e-04	1.90e-04
RDX	Signal, Illumination, Red Star M158	5.20e-05	5.40e-05	6.00e-05	5.50e-05	6.70e-05
RDX	TNT (ACC1)	1.40e-06	1.30e-06	9.70e-07	1.20e-06	2.10e-06
RDX	TNT (ACC2)	9.60e-06			9.60e-06	1.00e-05
RDX	T45E7 Adapter Booster	2.50e-04	2.90e-04	1.80e-04	2.40e-04	2.80e-04
RDX	20 mm HEI Cartridge	1.30e-05	1.50e-05	7.10e-06	1.20e-05	3.00e-05
RDX	40 mm HEI Cartridge	2.60e-05	3.30e-05	5.20e-05	3.70e-05	3.20e-05
Styrene	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Cartridge, Impulse, ARD 446-1	6.70e-06	4.10e-06	5.20e-06	5.40e-06	5.40e-06
Styrene	Cartridge, Impulse, BBU-36/B	2.40e-06	2.80e-06	5.60e-06	3.60e-06	3.60e-06
Styrene	Cartridge, Impulse, MK 107	9.50e-06	9.50e-06	9.20e-06	9.40e-06	1.40e-05
Styrene	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Detonating train	4.10e-06	3.00e-06	5.10e-06	4.10e-06	4.10e-06
Styrene	Flare, IR Countermeasure M206	7.60e-06	4.10e-06	9.50e-06	7.10e-06	7.80e-06
Styrene	Fuze, Tail Bomb FMU-139 A/B	3.20e-05	2.70e-05	3.00e-05	2.90e-05	3.10e-05
Styrene	Fuze, Tail Bomb FMU-54 A/B	5.60e-06	9.80e-06	7.90e-06	7.80e-06	1.10e-05
Styrene	Gas Generator, GGU-2/A	7.70e-06	8.80e-06	8.50e-06	8.30e-06	9.10e-06
Styrene	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Styrene	Mine, Claymore, M18A1	2.10e-03	1.40e-03	1.50e-03	1.70e-03	1.70e-03
Styrene	Signal, Illumination, Red Star AN-M43A2	6.20e-06	4.90e-06	2.40e-06	4.50e-06	5.40e-06
Styrene	Signal, Illumination, Red Star M158	2.10e-06	3.50e-06	1.00e-06	2.20e-06	2.60e-06
Styrene	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Tritonal surrogate with calcium stearate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Styrene	TNT (ACC2)	1.50e-06			1.50e-06	1.50e-06
Styrene	T45E7 Adapter Booster	2.30e-04	7.40e-05	3.70e-05	1.20e-04	1.30e-04
Styrene	20 mm HEI Cartridge	0.00e+00	3.60e-06	0.00e+00	3.60e-06	3.60e-06
Styrene	40 mm HEI Cartridge	4.20e-05	0.00e+00	0.00e+00	4.20e-05	4.20e-05
SO2	Amatol surrogate	3.20e-04	2.10e-04	2.50e-04	2.60e-04	
SO2	Amatol surrogate with water	1.10e-04	1.70e-04	1.10e-04	1.30e-04	
SO2	Cartridge, Impulse, ARD 446-1	2.30e-04	2.30e-04	2.60e-04	2.40e-04	
SO2	Cartridge, Impulse, BBU-36/B	3.80e-04	4.00e-04	4.20e-04	4.00e-04	
SO2	Cartridge, Impulse, MK 107	3.00e-04	2.40e-04	2.30e-04	2.60e-04	
SO2	Composition B surrogate	1.40e-04	1.40e-04	1.10e-04	1.30e-04	
SO2	Detonating train	6.70e-04	3.20e-04	3.70e-04	4.60e-04	
SO2	Flare, IR Countermeasure M206	5.80e-04	1.20e-03	1.30e-03	1.00e-03	
SO2	Fuze, Tail Bomb FMU-139 A/B	1.40e-03	1.30e-03	1.40e-03	1.40e-03	
SO2	Fuze, Tail Bomb FMU-54 A/B	4.80e-04	3.60e-04	3.80e-04	4.10e-04	
SO2	Gas Generator, GGU-2/A	3.40e-04	4.50e-04	3.90e-04	4.00e-04	
SO2	HBX surrogate	1.00e-04	1.10e-03	1.90e-03	1.10e-03	
SO2	Signal, Illumination, Red Star AN-M43A2	1.30e-02	1.30e-02	1.30e-02	1.30e-02	
SO2	Signal, Illumination, Red Star M158	2.70e-04	2.40e-05	4.10e-05	1.10e-04	
SO2	Tritonal surrogate	1.20e-04	2.80e-04	7.80e-05	1.60e-04	
SO2	Tritonal surrogate with calcium stearate		1.80e-04	6.70e-05	1.20e-04	
SO2	Tritonal surrogate with water	2.60e-05	5.70e-05	5.90e-05	4.70e-05	
SO2	TNT (ACC2)	1.40e-04			1.40e-04	
SO2	TNT (Sandia)	1.90e-04	1.20e-04	1.10e-04	1.40e-04	
Tetrachloroethylene	Amatol surrogate	3.70e-07	3.70e-07	0.00e+00	3.70e-07	3.70e-07
Tetrachloroethylene	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Cartridge, Impulse, ARD 446-1	2.20e-05	5.90e-05	2.80e-05	3.60e-05	8.30e-05
Tetrachloroethylene	Cartridge, Impulse, BBU-36/B	3.20e-06	1.60e-06	0.00e+00	2.40e-06	6.40e-06
Tetrachloroethylene	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Composition B surrogate	2.10e-05	1.90e-05	1.40e-05	1.80e-05	3.50e-05
Tetrachloroethylene	Detonating train	1.20e-05	1.20e-05	1.00e-05	1.10e-05	3.40e-05
Tetrachloroethylene	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Fuze, Tail Bomb FMU-139 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Tetrachloroethylene	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Gas Generator, GGU-2/A	7.00e-06	7.00e-06	3.60e-06	5.90e-06	5.90e-06
Tetrachloroethylene	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Mine, Claymore, M18A1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	Tritonal surrogate	1.90e-06	3.30e-06	2.90e-06	2.70e-06	4.10e-06
Tetrachloroethylene	Tritonal surrogate with calcium stearate		3.70e-07	3.60e-07	3.70e-07	7.30e-07
Tetrachloroethylene	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	T45E7 Adapter Booster	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	20 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Tetrachloroethylene	40 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	
Titanium	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Fuze, Tail Bomb FMU-139 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Gas Generator, GGU-2/A	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Mine, Claymore, M18A1	1.30e-04			1.30e-04	0.00e+00
Titanium	Signal, Illumination, Red Star AN-M43A2	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Titanium	TNT (ACC1)	0.00e+00			0.00e+00	0.00e+00
Titanium	TNT (ACC2)	0.00e+00			0.00e+00	0.00e+00
Titanium	T45E7 Adapter Booster	8.70e-05			8.70e-05	8.70e-05
Titanium	20 mm HEI Cartridge	0.00e+00			0.00e+00	0.00e+00
Titanium	40 mm HEI Cartridge	0.00e+00			0.00e+00	0.00e+00
Toluene	Amatol surrogate	1.10e-05	3.70e-06	5.20e-06	6.70e-06	2.00e-05
Toluene	Amatol surrogate with water	8.10e-05	1.60e-04	1.20e-04	1.20e-04	1.60e-04

Toluene	Cartridge, Impulse, ARD 446-1	1.50e-05	1.50e-05	2.00e-05	1.70e-05	5.40e-05
Toluene	Cartridge, Impulse, BBU-36/B	1.30e-05	7.90e-06	6.40e-06	9.10e-06	4.70e-05
Toluene	Cartridge, Impulse, MK 107	8.40e-06	9.70e-06	8.90e-06	9.00e-06	2.00e-05
Toluene	Composition B surrogate	4.80e-06	3.70e-06	9.50e-06	6.00e-06	2.10e-05
Toluene	Detonating train	1.70e-06	3.60e-06	7.20e-06	4.20e-06	5.70e-05
Toluene	Flare, IR Countermeasure M206	3.10e-05	2.30e-05	3.00e-05	2.80e-05	4.10e-05
Toluene	Fuze, Tail Bomb FMU-139 A/B	2.30e-05	2.20e-05	2.50e-05	2.30e-05	3.00e-05
Toluene	Fuze, Tail Bomb FMU-54 A/B	2.00e-05	4.30e-05	3.20e-05	3.20e-05	5.70e-05
Toluene	Gas Generator, GGU-2/A	5.90e-06	1.90e-05	1.30e-05	1.30e-05	5.40e-05
Toluene	HBX surrogate	4.80e-06	8.20e-07	4.50e-06	3.30e-06	5.30e-05
Toluene	Mine, Claymore, M18A1	1.90e-04	2.50e-04	3.10e-04	2.50e-04	2.60e-04
Toluene	Signal, Illumination, Red Star AN-M43A2	2.90e-05	2.90e-05	3.00e-05	3.00e-05	4.30e-05
Toluene	Signal, Illumination, Red Star M158	2.50e-05	2.40e-05	2.70e-05	2.50e-05	3.90e-05
Toluene	Tritonal surrogate	1.90e-06	0.00e+00	1.80e-06	1.80e-06	6.30e-05
Toluene	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	6.40e-05
Toluene	Tritonal surrogate with water	1.10e-04	3.40e-05	7.90e-05	7.30e-05	1.60e-04
Toluene	TNT (ACC1)	6.50e-06	3.80e-06	0.00e+00	5.10e-06	1.20e-05
Toluene	TNT (ACC2)	1.50e-06			1.50e-06	2.10e-05
Toluene	T45E7 Adapter Booster	5.50e-05	4.50e-05	5.60e-05	5.20e-05	7.40e-05
Toluene	20 mm HEI Cartridge	2.80e-05	3.40e-05	2.90e-05	3.00e-05	6.40e-05
Toluene	40 mm HEI Cartridge	2.60e-05	0.00e+00	0.00e+00	2.60e-05	6.40e-05
Total Alkanes (Paraffins)	Amatol surrogate	1.00e-05	1.60e-05	2.10e-05	1.60e-05	4.10e-05
Total Alkanes (Paraffins)	Amatol surrogate with water	1.10e-03	1.10e-03	1.40e-03	1.20e-03	1.40e-03
Total Alkanes (Paraffins)	Cartridge, Impulse, ARD 446-1	5.20e-05	4.10e-05	6.10e-05	5.10e-05	1.30e-04
Total Alkanes (Paraffins)	Cartridge, Impulse, BBU-36/B	3.30e-05	3.60e-05	4.60e-05	3.80e-05	1.40e-04
Total Alkanes (Paraffins)	Cartridge, Impulse, MK 107	2.90e-06	1.00e-05	7.60e-06	6.90e-06	3.90e-05
Total Alkanes (Paraffins)	Composition B surrogate	1.30e-05	6.30e-06	1.50e-05	1.10e-05	4.30e-05
Total Alkanes (Paraffins)	Detonating train	1.80e-05	2.80e-05	3.80e-05	2.80e-05	1.50e-04
Total Alkanes (Paraffins)	Flare, IR Countermeasure M206	8.00e-06	0.00e+00	1.20e-05	9.90e-06	3.80e-05
Total Alkanes (Paraffins)	Fuze, Tail Bomb FMU-139 A/B	1.30e-05	2.60e-05	5.30e-06	1.50e-05	4.20e-05
Total Alkanes (Paraffins)	Fuze, Tail Bomb FMU-54 A/B	2.20e-05	2.30e-05	0.00e+00	2.20e-05	8.90e-05
Total Alkanes (Paraffins)	Gas Generator, GGU-2/A	4.50e-05	5.80e-05	2.70e-05	4.30e-05	1.70e-04
Total Alkanes (Paraffins)	HBX surrogate	2.50e-05	8.20e-07	1.70e-05	1.40e-05	1.50e-04
Total Alkanes (Paraffins)	Mine, Claymore, M18A1	6.50e-05	6.80e-05	8.10e-05	7.10e-05	1.20e-04
Total Alkanes (Paraffins)	Signal, Illumination, Red Star AN-M43A2	2.30e-05	9.10e-06	1.20e-05	1.50e-05	3.60e-05
Total Alkanes (Paraffins)	Signal, Illumination, Red Star M158	3.70e-05	4.10e-05	4.10e-06	2.70e-05	6.70e-05
Total Alkanes (Paraffins)	Tritonal surrogate	3.70e-06	0.00e+00	1.60e-05	1.00e-05	2.10e-04
Total Alkanes (Paraffins)	Tritonal surrogate with calcium stearate		0.00e+00	0.00e+00	0.00e+00	2.00e-04
Total Alkanes (Paraffins)	Tritonal surrogate with water	1.40e-04	1.60e-04	3.70e-04	2.20e-04	5.40e-04

Total Alkanes (Paraffins)	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	7.50e-05
Total Alkanes (Paraffins)	TNT (ACC2)	3.30e-06			3.30e-06	4.00e-05
Total Alkanes (Paraffins)	TNT (Sandia)	1.20e-05	8.50e-06	5.40e-06	8.60e-06	
Total Alkanes (Paraffins)	T45E7 Adapter Booster	5.60e-05	6.70e-05	1.40e-04	8.70e-05	2.10e-04
Total Alkanes (Paraffins)	20 mm HEI Cartridge	1.20e-04	1.40e-04	2.40e-04	1.70e-04	3.90e-04
Total Alkanes (Paraffins)	40 mm HEI Cartridge	1.60e-04	0.00e+00	0.00e+00	1.60e-04	4.70e-04
Total Alkenes (Olefins)	Amatol surrogate	2.50e-04	7.20e-05	9.60e-05	1.40e-04	1.40e-04
Total Alkenes (Olefins)	Amatol surrogate with water	1.30e-03	1.40e-03	1.70e-03	1.50e-03	1.50e-03
Total Alkenes (Olefins)	Cartridge, Impulse, ARD 446-1	8.10e-04	6.20e-04	6.10e-04	6.80e-04	1.00e-03
Total Alkenes (Olefins)	Cartridge, Impulse, BBU-36/B	5.10e-04	5.00e-04	6.20e-04	5.40e-04	1.10e-03
Total Alkenes (Olefins)	Cartridge, Impulse, MK 107	5.60e-04	4.90e-04	4.10e-04	4.80e-04	7.10e-04
Total Alkenes (Olefins)	Composition B surrogate	2.50e-05	2.30e-05	5.30e-05	3.40e-05	3.80e-05
Total Alkenes (Olefins)	Detonating train	7.70e-04	6.40e-04	6.60e-04	6.90e-04	1.10e-03
Total Alkenes (Olefins)	Flare, IR Countermeasure M206	4.40e-04	4.30e-04	4.80e-04	4.50e-04	4.60e-04
Total Alkenes (Olefins)	Fuze, Tail Bomb FMU-139 A/B	9.20e-04	1.20e-03	1.20e-03	1.10e-03	1.10e-03
Total Alkenes (Olefins)	Fuze, Tail Bomb FMU-54 A/B	5.40e-04	9.30e-04	7.50e-04	7.40e-04	9.90e-04
Total Alkenes (Olefins)	Gas Generator, GGU-2/A	1.30e-03	1.40e-03	1.60e-03	1.40e-03	1.50e-03
Total Alkenes (Olefins)	HBX surrogate	8.00e-05	6.70e-05	1.30e-04	9.40e-05	9.90e-05
Total Alkenes (Olefins)	Mine, Claymore, M18A1	1.00e-03	1.40e-03	1.50e-03	1.30e-03	1.30e-03
Total Alkenes (Olefins)	Signal, Illumination, Red Star AN-M43A2	5.50e-04	6.50e-04	5.90e-04	6.00e-04	6.00e-04
Total Alkenes (Olefins)	Signal, Illumination, Red Star M158	6.40e-04	7.80e-04	4.50e-04	6.20e-04	6.30e-04
Total Alkenes (Olefins)	Tritonal surrogate	2.40e-04	1.50e-04	8.30e-05	1.60e-04	1.70e-04
Total Alkenes (Olefins)	Tritonal surrogate with calcium stearate		7.60e-05	4.70e-05	6.10e-05	6.90e-05
Total Alkenes (Olefins)	Tritonal surrogate with water	5.90e-03	5.50e-03	6.10e-03	5.90e-03	5.90e-03
Total Alkenes (Olefins)	TNT (ACC1)	7.70e-05	6.50e-05	3.90e-05	6.00e-05	6.40e-05
Total Alkenes (Olefins)	TNT (ACC2)	4.20e-05			4.20e-05	4.40e-05
Total Alkenes (Olefins)	TNT (Sandia)	5.00e-06	1.70e-05	1.70e-05	1.30e-05	
Total Alkenes (Olefins)	T45E7 Adapter Booster	1.80e-03	1.30e-03	1.10e-03	1.40e-03	1.40e-03
Total Alkenes (Olefins)	20 mm HEI Cartridge	6.80e-04	4.60e-04	6.10e-04	5.80e-04	8.20e-04
Total Alkenes (Olefins)	40 mm HEI Cartridge	2.00e-04	1.50e-04	1.10e-04	1.50e-04	2.40e-04
Total Aromatics	Amatol surrogate	5.80e-05	2.80e-05	4.20e-05	4.30e-05	8.30e-05
Total Aromatics	Amatol surrogate with water	3.30e-04	3.70e-04	4.80e-04	3.90e-04	4.70e-04
Total Aromatics	Cartridge, Impulse, ARD 446-1	1.00e-04	9.50e-05	1.00e-04	1.00e-04	2.40e-04
Total Aromatics	Cartridge, Impulse, BBU-36/B	7.40e-05	6.20e-05	5.70e-05	6.40e-05	2.10e-04
Total Aromatics	Composition B surrogate	1.70e-05	1.80e-05	3.60e-05	2.40e-05	7.10e-05
Total Aromatics	Detonating train	3.40e-05	4.00e-05	4.40e-05	3.90e-05	2.00e-04
Total Aromatics	Flare, IR Countermeasure M206	9.10e-05	7.00e-05	9.70e-05	8.60e-05	1.20e-04
Total Aromatics	Fuze, Tail Bomb FMU-139 A/B	1.80e-04	1.80e-04	2.00e-04	1.90e-04	2.10e-04
Total Aromatics	Fuze, Tail Bomb FMU-54 A/B	9.90e-05	2.40e-04	1.70e-04	1.70e-04	2.70e-04

Total Aromatics	Gas Generator, GGU-2/A	1.20e-04	1.70e-04	1.80e-04	1.60e-04	2.80e-04
Total Aromatics	HBX surrogate	0.00e+00	1.10e-05	3.10e-05	2.10e-05	1.50e-04
Total Aromatics	Mine, Claymore, M18A1	3.10e-03	3.00e-03	3.10e-03	3.00e-03	3.10e-03
Total Aromatics	Signal, Illumination, Red Star AN-M43A2	7.00e-05	7.80e-05	6.80e-05	7.20e-05	1.00e-04
Total Aromatics	Signal, Illumination, Red Star M158	6.30e-05	6.70e-05	5.80e-05	6.30e-05	9.60e-05
Total Aromatics	Tritonal surrogate	3.40e-05	2.20e-05	2.30e-05	2.70e-05	1.70e-04
Total Aromatics	Tritonal surrogate with calcium stearate		0.00e+00	1.40e-05	1.40e-05	1.60e-04
Total Aromatics	Tritonal surrogate with water	4.70e-04	1.80e-04	3.60e-04	3.40e-04	5.20e-04
Total Aromatics	TNT (ACC1)	1.70e-05	1.50e-05	0.00e+00	1.60e-05	6.10e-05
Total Aromatics	TNT (ACC2)	3.00e-06			3.00e-06	6.00e-05
Total Aromatics	TNT (Sandia)	2.70e-06	9.90e-06	1.20e-05	8.20e-06	
Total Aromatics	T45E7 Adapter Booster	5.10e-04	3.20e-04	2.50e-04	3.60e-04	4.20e-04
Total Aromatics	20 mm HEI Cartridge	2.10e-04	2.10e-04	2.30e-04	2.10e-04	3.80e-04
Total Aromatics	40 mm HEI Cartridge	1.00e-04	0.00e+00	0.00e+00	1.00e-04	2.60e-04
Total HpCDD	Signal, Illumination, Red Star AN-M43A2	2.60e-10	5.70e-10	1.00e-09	6.10e-10	6.10e-10
Total Non-methane Hydrocarbons	Amatol surrogate	7.50e-04	3.40e-04	2.60e-04	4.50e-04	5.90e-04
Total Non-methane Hydrocarbons	Amatol surrogate with water	3.60e-03	3.80e-03	4.00e-03	3.80e-03	4.20e-03
Total Non-methane Hydrocarbons	Cartridge, Impulse, ARD 446-1	1.10e-03	9.10e-04	9.10e-04	9.80e-04	1.70e-03
Total Non-methane Hydrocarbons	Cartridge, Impulse, BBU-36/B	7.50e-04	7.10e-04	8.40e-04	7.70e-04	1.70e-03
Total Non-methane Hydrocarbons	Cartridge, Impulse, MK 107	7.30e-04	6.50e-04	5.60e-04	6.40e-04	1.00e-03
Total Non-methane Hydrocarbons	Composition B surrogate	5.50e-05	1.30e-04	1.50e-04	1.10e-04	3.00e-04
Total Non-methane Hydrocarbons	Detonating train	9.20e-04	8.10e-04	8.30e-04	8.50e-04	1.60e-03
Total Non-methane Hydrocarbons	Flare, IR Countermeasure M206	5.80e-04	5.60e-04	6.90e-04	6.10e-04	7.10e-04
Total Non-methane Hydrocarbons	Fuze, Tail Bomb FMU-139 A/B	1.20e-03	1.50e-03	1.50e-03	1.40e-03	1.50e-03
Total Non-methane Hydrocarbons	Fuze, Tail Bomb FMU-54 A/B	7.10e-04	1.30e-03	9.80e-04	9.90e-04	1.50e-03
Total Non-methane Hydrocarbons	Gas Generator, GGU-2/A	1.60e-03	1.70e-03	2.00e-03	1.80e-03	2.10e-03
Total Non-methane Hydrocarbons	HBX surrogate	2.00e-04	7.70e-05	2.70e-04	1.80e-04	5.80e-04
Total Non-methane Hydrocarbons	Mine, Claymore, M18A1	4.70e-03	4.80e-03	5.20e-03	4.90e-03	5.10e-03
Total Non-methane Hydrocarbons	Signal, Illumination, Red Star AN-M43A2	6.80e-04	8.50e-04	7.10e-04	7.40e-04	8.40e-04
Total Non-methane Hydrocarbons	Signal, Illumination, Red Star M158	7.90e-04	9.50e-04	5.70e-04	7.70e-04	8.80e-04
Total Non-methane Hydrocarbons	Tritonal surrogate	3.90e-04	2.60e-04	1.80e-04	2.80e-04	7.50e-04
Total Non-methane Hydrocarbons	Tritonal surrogate with calcium stearate		2.80e-05	5.10e-05	4.00e-05	5.40e-04
Total Non-methane Hydrocarbons	Tritonal surrogate with water	7.00e-03	6.50e-03	7.90e-03	7.10e-03	7.80e-03
Total Non-methane Hydrocarbons	TNT (ACC1)	0.00e+00	2.80e-05	0.00e+00	2.80e-05	5.50e-04
Total Non-methane Hydrocarbons	TNT (ACC2)	4.00e-05			4.00e-05	2.10e-04
Total Non-methane Hydrocarbons	T45E7 Adapter Booster	2.70e-03	1.60e-03	1.40e-03	1.90e-03	2.60e-03
Total Non-methane Hydrocarbons	20 mm HEI Cartridge	1.30e-03	9.20e-04	1.30e-03	1.20e-03	2.60e-03
Total Non-methane Hydrocarbons	40 mm HEI Cartridge	6.50e-04	0.00e+00	9.00e-06	3.30e-04	2.40e-03
Total Unidentified Hydrocarbons	Amatol surrogate	4.40e-04	2.30e-04	1.00e-04	2.50e-04	3.30e-04

Total Unidentified Hydrocarbons	Amatol surrogate with water	8.10e-04	8.50e-04	4.30e-04	7.00e-04	8.00e-04
Total Unidentified Hydrocarbons	Cartridge, Impulse, ARD 446-1	1.50e-04	1.50e-04	1.30e-04	1.40e-04	2.80e-04
Total Unidentified Hydrocarbons	Cartridge, Impulse, BBU-36/B	1.30e-04	1.20e-04	1.20e-04	1.20e-04	3.10e-04
Total Unidentified Hydrocarbons	Cartridge, Impulse, MK 107	7.20e-05	6.00e-05	6.50e-05	6.60e-05	1.30e-04
Total Unidentified Hydrocarbons	Composition B surrogate	3.70e-07	8.60e-05	5.00e-05	4.50e-05	1.50e-04
Total Unidentified Hydrocarbons	Detonating train	1.00e-04	1.00e-04	8.20e-05	9.60e-05	2.40e-04
Total Unidentified Hydrocarbons	Flare, IR Countermeasure M206	3.80e-05	6.50e-05	9.50e-05	6.60e-05	9.00e-05
Total Unidentified Hydrocarbons	Fuze, Tail Bomb FMU-139 A/B	9.60e-05	1.30e-04	8.30e-05	1.00e-04	1.40e-04
Total Unidentified Hydrocarbons	Fuze, Tail Bomb FMU-54 A/B	5.10e-05	8.00e-05	7.00e-05	6.70e-05	1.20e-04
Total Unidentified Hydrocarbons	Gas Generator, GGU-2/A	1.40e-04	1.20e-04	1.80e-04	1.50e-04	2.10e-04
Total Unidentified Hydrocarbons	HBX surrogate	7.30e-05	0.00e+00	8.40e-05	7.90e-05	1.80e-04
Total Unidentified Hydrocarbons	Mine, Claymore, M18A1	5.10e-04	4.00e-04	5.60e-04	4.90e-04	6.30e-04
Total Unidentified Hydrocarbons	Signal, Illumination, Red Star AN-M43A2	3.30e-05	1.10e-04	4.20e-05	6.10e-05	1.00e-04
Total Unidentified Hydrocarbons	Signal, Illumination, Red Star M158	4.10e-05	6.80e-05	5.80e-05	5.60e-05	9.10e-05
Total Unidentified Hydrocarbons	Tritonal surrogate	1.20e-04	9.60e-05	5.40e-05	9.00e-05	2.00e-04
Total Unidentified Hydrocarbons	Tritonal surrogate with calcium stearate		0.00e+00	3.60e-06	3.60e-06	1.20e-04
Total Unidentified Hydrocarbons	Tritonal surrogate with water	4.70e-04	6.00e-04	1.10e-03	7.10e-04	8.70e-04
Total Unidentified Hydrocarbons	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	3.50e-04
Total Unidentified Hydrocarbons	T45E7 Adapter Booster	3.10e-04	0.00e+00	0.00e+00	3.10e-04	5.70e-04
Total Unidentified Hydrocarbons	20 mm HEI Cartridge	3.00e-04	1.20e-04	2.40e-04	2.20e-04	1.00e-03
Total Unidentified Hydrocarbons	40 mm HEI Cartridge	1.80e-04	0.00e+00	2.00e-04	1.90e-04	1.40e-03
Vinyl chloride	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Cartridge, Impulse, BBU-36/B	6.10e-07	2.50e-06	1.90e-06	1.70e-06	1.70e-06
Vinyl chloride	Cartridge, Impulse, MK 107	2.40e-06	0.00e+00	0.00e+00	2.40e-06	2.40e-06
Vinyl chloride	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Detonating train	1.30e-06	0.00e+00	0.00e+00	1.30e-06	1.30e-06
Vinyl chloride	Flare, IR Countermeasure M206	1.50e-06	1.50e-06	1.50e-06	1.50e-06	1.50e-06
Vinyl chloride	Fuze, Tail Bomb FMU-139 A/B	2.20e-06	2.20e-06	1.10e-06	1.80e-06	1.80e-06
Vinyl chloride	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	6.70e-07	6.90e-07	6.80e-07	6.80e-07
Vinyl chloride	Gas Generator, GGU-2/A	2.50e-05	2.80e-05	7.70e-05	4.40e-05	4.40e-05
Vinyl chloride	HBX surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Mine, Claymore, M18A1	1.10e-06			1.10e-06	1.10e-06
Vinyl chloride	Signal, Illumination, Red Star AN-M43A2	2.30e-06	2.30e-06	2.30e-06	2.30e-06	2.30e-06
Vinyl chloride	Signal, Illumination, Red Star M158	8.00e-07	1.60e-06	7.80e-07	1.10e-06	1.10e-06
Vinyl chloride	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Tritonal surrogate with calcium stearate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00

Vinyl chloride	TNT (ACC1)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	TNT (ACC2)	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	T45E7 Adapter Booster	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	20 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Vinyl chloride	40 mm HEI Cartridge	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Amatol surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Cartridge, Impulse, BBU-36/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Cartridge, Impulse, MK 107	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Detonating train	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Flare, IR Countermeasure M206	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Fuze, Tail Bomb FMU-139 A/B	8.20e-03	5.40e-03	5.00e-03	6.20e-03	6.30e-03
Zinc	Fuze, Tail Bomb FMU-54 A/B	0.00e+00	0.00e+00	0.00e+00	0.00e+00	8.20e-05
Zinc	Gas Generator, GGU-2/A	1.60e-04	2.40e-04	1.50e-04	1.80e-04	2.10e-04
Zinc	HBX surrogate	0.00e+00	2.10e-04	2.60e-04	1.40e-04	1.40e-04
Zinc	Mine, Claymore, M18A1	1.60e-03	0.00e+00	0.00e+00	1.60e-03	8.00e-05
Zinc	Signal, Illumination, Red Star AN-M43A2	5.80e-04	2.70e-04	1.80e-04	3.40e-04	3.50e-04
Zinc	Signal, Illumination, Red Star M158	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Tritonal surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	Tritonal surrogate with calcium stearate		1.60e-04	0.00e+00	7.00e-05	7.70e-05
Zinc	Tritonal surrogate with water	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
Zinc	TNT (ACC1)	0.00e+00			0.00e+00	0.00e+00
Zinc	TNT (ACC2)	1.00e-05			1.00e-05	2.00e-05
Zinc	T45E7 Adapter Booster	2.90e-03			2.90e-03	4.20e-04
Zinc	20 mm HEI Cartridge	1.60e-02			1.60e-02	7.40e-03
Zinc	40 mm HEI Cartridge	1.10e-03			1.10e-03	2.80e-04
1-Butene	Amatol surrogate	1.90e-06	0.00e+00	1.50e-06	1.70e-06	1.70e-06
1-Butene	Amatol surrogate with water	8.10e-05	1.50e-04	7.90e-05	1.00e-04	1.00e-04
1-Butene	Cartridge, Impulse, ARD 446-1	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Butene	Cartridge, Impulse, BBU-36/B	6.00e-06	6.40e-06	9.40e-06	7.30e-06	7.30e-06
1-Butene	Cartridge, Impulse, MK 107	1.10e-05	1.00e-05	8.60e-06	1.00e-05	1.00e-05
1-Butene	Composition B surrogate	7.40e-07	0.00e+00	1.80e-06	1.30e-06	1.10e-06
1-Butene	Detonating train	3.10e-05	0.00e+00	0.00e+00	3.10e-05	3.10e-05
1-Butene	Flare, IR Countermeasure M206	7.30e-06	6.20e-06	1.10e-05	8.10e-06	8.10e-06
1-Butene	Fuze, Tail Bomb FMU-139 A/B	1.70e-05	1.60e-05	1.60e-05	1.60e-05	1.60e-05
1-Butene	Fuze, Tail Bomb FMU-54 A/B	9.80e-06	1.30e-05	9.50e-06	1.10e-05	1.10e-05
1-Butene	Gas Generator, GGU-2/A	4.10e-05	3.90e-05	4.60e-05	4.20e-05	4.20e-05

1-Butene	HBX surrogate	8.00e-06	4.50e-06	6.30e-06	6.30e-06	6.30e-06
1-Butene	Mine, Claymore, M18A1	5.90e-06	9.80e-06	7.10e-06	7.60e-06	7.60e-06
1-Butene	Signal, Illumination, Red Star AN-M43A2	1.30e-05	1.20e-05	1.00e-05	1.20e-05	1.20e-05
1-Butene	Signal, Illumination, Red Star M158	2.40e-05	2.60e-05	1.90e-05	2.30e-05	2.30e-05
1-Butene	Tritonal surrogate	0.00e+00	1.50e-06	2.50e-06	2.00e-06	2.00e-06
1-Butene	Tritonal surrogate with calcium stearate		5.50e-06	1.80e-06	3.70e-06	3.70e-06
1-Butene	Tritonal surrogate with water	2.80e-05	1.90e-05	2.70e-05	2.50e-05	2.50e-05
1-Butene	TNT (ACC1)	1.80e-06	1.90e-06	1.90e-06	1.90e-06	1.90e-06
1-Butene	TNT (ACC2)	1.50e-06			1.50e-06	1.50e-06
1-Butene	T45E7 Adapter Booster	0.00e+00	4.50e-05	5.40e-05	4.90e-05	4.90e-05
1-Butene	20 mm HEI Cartridge	0.00e+00	2.20e-05	2.70e-05	2.40e-05	2.40e-05
1-Butene	40 mm HEI Cartridge	6.60e-06	5.00e-06	3.30e-06	5.00e-06	5.00e-06
1-Hexene	Amatol surrogate	2.60e-06	1.50e-06	1.90e-06	2.00e-06	2.00e-06
1-Hexene	Amatol surrogate with water	3.50e-05	7.40e-05	4.50e-05	5.10e-05	5.20e-05
1-Hexene	Cartridge, Impulse, ARD 446-1	1.90e-05	1.80e-05	1.70e-05	1.80e-05	1.80e-05
1-Hexene	Cartridge, Impulse, BBU-36/B	1.60e-05	1.80e-05	2.30e-05	1.90e-05	1.90e-05
1-Hexene	Cartridge, Impulse, MK 107	7.30e-06	6.60e-06	7.30e-06	7.10e-06	7.10e-06
1-Hexene	Composition B surrogate	1.50e-06	1.90e-06	1.50e-06	1.60e-06	1.60e-06
1-Hexene	Detonating train	2.30e-05	2.20e-05	2.80e-05	2.40e-05	2.40e-05
1-Hexene	Flare, IR Countermeasure M206	5.60e-06	5.50e-06	6.80e-06	6.00e-06	6.00e-06
1-Hexene	Fuze, Tail Bomb FMU-139 A/B	8.80e-06	9.20e-06	8.20e-06	8.70e-06	8.70e-06
1-Hexene	Fuze, Tail Bomb FMU-54 A/B	6.50e-06	8.60e-06	6.40e-06	7.20e-06	7.20e-06
1-Hexene	Gas Generator, GGU-2/A	1.20e-05	1.10e-05	1.20e-05	1.20e-05	1.20e-05
1-Hexene	HBX surrogate	2.20e-06	2.50e-06	3.30e-06	2.70e-06	3.00e-06
1-Hexene	Mine, Claymore, M18A1	2.40e-06	2.50e-06	2.40e-06	2.40e-06	2.40e-06
1-Hexene	Signal, Illumination, Red Star AN-M43A2	9.00e-06	1.10e-05	8.60e-06	9.50e-06	9.50e-06
1-Hexene	Signal, Illumination, Red Star M158	1.90e-05	1.80e-05	1.60e-05	1.70e-05	1.70e-05
1-Hexene	Tritonal surrogate	2.60e-06	1.10e-06	2.50e-06	2.10e-06	2.50e-06
1-Hexene	Tritonal surrogate with calcium stearate		2.90e-06	2.60e-06	2.80e-06	3.10e-06
1-Hexene	Tritonal surrogate with water	1.80e-05	1.90e-05	2.60e-05	2.10e-05	2.20e-05
1-Hexene	TNT (ACC1)	2.30e-06	2.40e-06	1.90e-06	2.20e-06	2.20e-06
1-Hexene	TNT (ACC2)	1.50e-06			1.50e-06	1.50e-06
1-Hexene	T45E7 Adapter Booster	3.40e-05	2.80e-05	2.30e-05	2.80e-05	2.80e-05
1-Hexene	20 mm HEI Cartridge	4.90e-06	4.30e-06	4.10e-06	4.40e-06	4.40e-06
1-Hexene	40 mm HEI Cartridge	1.70e-06	8.20e-07	1.60e-06	1.40e-06	4.10e-06
1-Pentene	Amatol surrogate	1.10e-06	1.90e-06	7.40e-07	1.20e-06	1.20e-06
1-Pentene	Amatol surrogate with water	3.30e-05	6.80e-05	4.80e-05	4.90e-05	5.00e-05
1-Pentene	Cartridge, Impulse, ARD 446-1	9.50e-06	8.70e-06	8.20e-06	8.90e-06	1.30e-05
1-Pentene	Cartridge, Impulse, BBU-36/B	9.00e-06	9.80e-06	1.20e-05	1.00e-05	1.00e-05

1-Pentene	Cartridge, Impulse, MK 107	4.50e-06	4.20e-06	4.50e-06	4.40e-06	4.40e-06
1-Pentene	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1-Pentene	Detonating train	1.20e-05	1.40e-05	1.60e-05	1.40e-05	2.20e-05
1-Pentene	Flare, IR Countermeasure M206	4.00e-06	2.70e-06	3.70e-06	3.50e-06	3.50e-06
1-Pentene	Fuze, Tail Bomb FMU-139 A/B	5.80e-06	7.30e-06	5.30e-06	6.10e-06	6.10e-06
1-Pentene	Fuze, Tail Bomb FMU-54 A/B	5.30e-06	6.20e-06	3.60e-06	5.10e-06	7.00e-06
1-Pentene	Gas Generator, GGU-2/A	5.90e-06	5.30e-06	6.70e-06	6.00e-06	6.00e-06
1-Pentene	HBX surrogate	1.10e-06	1.60e-06	1.90e-06	1.50e-06	1.70e-06
1-Pentene	Mine, Claymore, M18A1	9.70e-07	1.50e-06	1.90e-06	1.40e-06	1.40e-06
1-Pentene	Signal, Illumination, Red Star AN-M43A2	0.00e+00	5.90e-06	5.20e-06	5.60e-06	5.60e-06
1-Pentene	Signal, Illumination, Red Star M158	9.80e-06	1.20e-05	8.60e-06	1.00e-05	1.00e-05
1-Pentene	Tritonal surrogate	1.50e-06	1.50e-06	1.50e-06	1.50e-06	1.70e-06
1-Pentene	Tritonal surrogate with calcium stearate		3.70e-07	1.50e-06	9.10e-07	9.10e-07
1-Pentene	Tritonal surrogate with water	1.50e-05	1.50e-05	2.40e-05	1.80e-05	1.80e-05
1-Pentene	TNT (ACC1)	1.80e-06	1.40e-06	9.60e-07	1.40e-06	1.40e-06
1-Pentene	TNT (ACC2)	7.40e-07			7.40e-07	7.40e-07
1-Pentene	T45E7 Adapter Booster	2.40e-05	1.90e-05	1.50e-05	1.90e-05	1.90e-05
1-Pentene	20 mm HEI Cartridge	2.80e-06	5.80e-06	2.00e-06	3.50e-06	5.90e-06
1-Pentene	40 mm HEI Cartridge	1.70e-06	0.00e+00	8.20e-07	1.20e-06	3.30e-06
1,3-Butadiene	Amatol surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1,3-Butadiene	Amatol surrogate with water	3.70e-06	8.90e-06	6.30e-06	6.30e-06	6.30e-06
1,3-Butadiene	Cartridge, Impulse, ARD 446-1	8.80e-06	6.70e-06	4.70e-06	6.70e-06	6.70e-06
1,3-Butadiene	Cartridge, Impulse, BBU-36/B	2.70e-06	2.50e-06	3.10e-06	2.80e-06	6.30e-06
1,3-Butadiene	Cartridge, Impulse, MK 107	2.10e-06	2.10e-06	1.80e-06	2.00e-06	2.00e-06
1,3-Butadiene	Composition B surrogate	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
1,3-Butadiene	Detonating train	5.50e-06	8.70e-06	1.30e-05	9.00e-06	9.00e-06
1,3-Butadiene	Flare, IR Countermeasure M206	3.70e-06	2.70e-06	2.70e-06	3.00e-06	3.00e-06
1,3-Butadiene	Fuze, Tail Bomb FMU-139 A/B	2.70e-05	1.70e-05	1.90e-05	2.10e-05	2.10e-05
1,3-Butadiene	Fuze, Tail Bomb FMU-54 A/B	3.30e-06	4.70e-06	5.50e-06	4.50e-06	4.50e-06
1,3-Butadiene	Gas Generator, GGU-2/A	2.20e-05	2.60e-05	3.30e-05	2.70e-05	2.70e-05
1,3-Butadiene	HBX surrogate	1.50e-06	8.20e-07	1.90e-06	1.40e-06	1.40e-06
1,3-Butadiene	Mine, Claymore, M18A1	3.90e-06	2.50e-06	1.90e-06	2.70e-06	2.70e-06
1,3-Butadiene	Signal, Illumination, Red Star AN-M43A2	2.40e-06	2.10e-06	1.00e-06	1.90e-06	1.90e-06
1,3-Butadiene	Signal, Illumination, Red Star M158	1.30e-05	1.30e-05	1.10e-05	1.20e-05	1.20e-05
1,3-Butadiene	Tritonal surrogate	3.70e-07	0.00e+00	1.50e-06	9.10e-07	9.10e-07
1,3-Butadiene	Tritonal surrogate with calcium stearate		1.80e-06	7.30e-07	1.30e-06	1.30e-06
1,3-Butadiene	Tritonal surrogate with water	1.70e-05	3.90e-05	3.30e-05	3.00e-05	3.00e-05
1,3-Butadiene	TNT (ACC1)	3.20e-06	9.60e-07	9.60e-07	1.70e-06	1.70e-06
1,3-Butadiene	TNT (ACC2)	3.70e-07			3.70e-07	3.70e-07

1,3-Butadiene	T45E7 Adapter Booster	4.30e-05	1.50e-05	1.30e-05	2.30e-05	2.30e-05
1,3-Butadiene	20 mm HEI Cartridge	5.60e-06	4.30e-06	5.40e-06	5.10e-06	5.10e-06
1,3-Butadiene	40 mm HEI Cartridge	4.20e-06	8.20e-07	8.20e-07	1.90e-06	1.90e-06

APPENDIX D

COPIES OF WASTE PROFILE FORMS

TA-16-388 OIL/SOLVENT WASTE CHARACTERIZATON

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 22776

12-Dec-1999 10:00 PM (Version: 5)

Generator :	KING, WAYNE F	MS :	C920	PH :	71694	Z#:	085294
WMC :	JIO, GORDON	MS :	C920	PH :	74325	Z#:	093700
Contact :							
RCRA Rev :	NOLL, MONICA D.	MS :	J595	PH :	75999	Z#:	115370
Status :	ACTIVE	Activation Date :	21-Dec-1995	Expiration Date:	21-Dec-2000		
Group :	DX2	TA :	09	Bldg :	000021	Room:	131

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Satellite Accumulation Area Site ID# 1369**

Method of Char : **Acceptable Knowledge Documentation** **Number: DX-2 CHEMICAL HYGIENE PLAN**

Waste Type : **Process Waste/Spent Chemical/Other**

Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**

Waste Category: **Organic**
Solvent
Explosive process

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Non-aqueous**

Matrix Type : **Homogeneous**

Waste/Proc Desc : WASTE GENERATED FROM LIQUID CHROMATOGRAPHY OF SAMPLES CONTINUING HIGH EXPLOSIVES CPDS.

Ignitability : **<73 F <22.3 C**

Corrosivity : **6.1 - 9.0**

Reactivity : **Explosive**

Boiling Point : **< = 95 F < = 35 C**

Toxicity Characteristic Metals : N/A

Toxicity Characteristic Organic Compounds:

Contaminant	Method	Limit	Min	Max	Unit
1,2-DICHLOROETHANE			**5**	**15**	**%**
2,4-DINITROTOLUENE		**Y**			**ppm**
NITROBENZENE		**Y**			**ppm**

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	WATER	**30**	**40**	**%**
	METHANOL	**15**	**30**	**%**
	ACETONITRILE	**10**	**20**	**%**
	1,2-DICHLORETHANE	**5**	**15**	**%**
	TETRAHYDRAFURAN	**0**	**5**	**%**
	ISOPROPYL ALCOHOL	**5**	**15**	**%**

METHYLENE CHLORIDE 0 3 %

LDR and Underlying Hazardous Constituents Information

Non-Wastewater/Wastewater Category: **Non Wastewater**

Notification of California List Applicability:

A D001 thru D043 waste containing Halogenated Organic Compounds (HOCs) listed in 40 CFR 268, Appendix III, at 1000 ppm or greater.

Notification Of Underlying Hazardous Constituents:

Constituents

Acetonitrile
1,2-Dichloroethane
Methanol
Methylene chloride

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **HAZARDOUS WASTE**

Misc. Category : N/A

Waste Classification : **HAZARDOUS WASTE**

EPA Hazardous Waste Code : **F003 D001 D003 F004 F002 D028**

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 24158

28-Feb-2000 05:40 PM (Version: d) 61

Generator :	ARCHULETA, JOSE GIL	MS :	C920	PH :	76361	Z#:	079834
WMC :	JIO, GORDON	MS :	C920	PH :	74325	Z#:	093700
Contact :							
RCRA Rev :	MATZKE, JIM	MS :	J595	PH :	58300	Z#:	096260
Status :	ACTIVE	Activation Date :	13-Jun-1996		Expiration Date :		13-Jun-2000
Group :	DX2	TA :	09	Bldg :	000021	Room :	121

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : Satellite Accumulation Area Site ID# 431
Method of Char : Knowledge of Process

Waste Type : Process Waste/Spent Chemical/Other
Waste Classes: RCA Waste - Not RCA Waste
RAD Waste - Non-rad

Waste Category: Solvent
Degreaser
Explosive process

Waste Sources : Research/Development/Testing

Waste Matrix : Aqueous

Matrix Type : Heterogeneous

Waste/Proc Desc : THE WASTE IS SPENT CAUSTIC AND SPENT ACID USED IN THE CLEANING AND DEGREASING OF GLASSWARE. INORGANIC REAGENTS FROM OTHER ANALYSIS ARE INCLUDED. PRECIPITATES OCCASIONALLY FORM A SOLID RESIDUE ON BOTTOM OF THE CARBOY. WASTE FROM BASIC HYDROLYSIS EXPERIMENTS IS ALSO INCLUDED. THE WASTE IS GENERALLY SENT TO THE S-SITE BURN GROUNDS.

Ignitability : Not ignitable

Corrosivity : 2.1 - 4.0

Reactivity : Explosive

Boiling Point : > 95 F > 35 C

Toxicity Characteristic Metals :

Contaminant	Method	Limit	Min	Max	Unit
CHROMIUM	TOTA		500	1000	PPM
MERCURY	TOTA		200	500	PPM

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	H2O	0	55	%
	H2SO4	0	12	%
	HCL	0	3	%
	HGSO4 - dilute see Hg [illegible] above	0	1	%

HNO3	0	5	%
K2CR4O2/NA.CR2 O2 – dilute solution see Cr atm	0	2	%
KOH	0	5	%
NAOH	0	15	%
HIGH EXPLOSIVES	0	2	%

LDR and Underlying Hazardous Constituents Information

Non-Wastewater/Wastewater Category: **Non Wastewater**

Notification of California List Applicability: **N/A**

Notification Of Underlying Hazardous Constituents:

Constituents

Chromium (Total)
Mercury - All Others
Sulfide

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **HAZARDOUS WASTE**

Misc. Category : **ADMIN CONTROLLED WASTE**

Waste Classification : **HAZARDOUS WASTE**

EPA Hazardous Waste Code : **D003 D007 D009**

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 25278

Generator :	KING, WAYNE F	MS :	C920	PH :	71694	Z#:	085294
WMC :	JIO, GORDON	MS :	C920	PH :	74325	Z#:	093700
Contact :							
RCRA Rev :	NOLL, MONICA D.	MS :	J595	PH :	75999	Z#:	115370
Status :	ACTIVE	Activation Date :	02-Dec-1996	Expiration Date:	02-Dec-2000		
Group :	DX2	TA :	09	Bldg :	000021	Room:	131

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Satellite Accumulation Area Site ID# 1369**

Method of Char : **Acceptable Knowledge Documentation** **Number: DX-2 CHEMICAL HYGIENE PLAN**

Waste Type : **Process Waste/Spent Chemical/Other**

Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**

Waste Category: **Organic**
Solvent
Explosive process

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Non-aqueous**

Matrix Type : **Homogeneous**

Waste/Proc Desc : THE WASTE IS A MIXTURE OF DICHLOROETHANE AND CHLOROFORM FROM LIQUID CHROMOTOGRAPHY ANALYSIS OF TEST FORMULATIONS AND ORGANIC BINDERS AS WELL AS SOIL EXTRACTIONS. THE WASTE WILL GO TO THE S-SITE BURNING GROUNDS AS TRACE AMOUNTS OF HIGH EXPLOSIVE AND ALSO PRESENT. METHANOL IS ALSO PRESENT (80%)

Ignitability : **<73 F <22.8 C**

Corrosivity : **Non-aqueous**

Reactivity : **Explosive**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals : N/A

Toxicity Characteristic Organic Compounds:

Contaminant	Method	Limit	Min	Max	Unit
CHLOROFORM	**TOTA**		**0**	**5**	**%**
1,2-DICHLOROETHANE	**TOTA**		**5**	**15**	**%**
2,4-DINITROTOLUENE	**TOTA**		**0**	**1**	**PPM**

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	METHANOL	**80**	**90**	**%**

LDR and Underlying Hazardous Constituents Information

Non-Wastewater/Wastewater Category: **Non Wastewater**

Notification of California List Applicability:

A D001 thru D043 waste containing Halogenated Organic Compounds (HOCs) listed in 40 CFR 268, Appendix III, at 1000 ppm or greater.

Notification Of Underlying Hazardous Constituents:

Constituents

Chloroform
1,2-Dichloroethane
Methanol

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category :	**NON-RAD**
RCRA Category :	**HAZARDOUS WASTE**
Misc. Category :	**ADMIN CONTROLLED WASTE**
Waste Classification :	**HAZARDOUS WASTE**
EPA Hazardous Waste Code :	**F003 D022 D028 D030 D003 D001**

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM

WPF #: 29515

30-Sep-1998 10:00 PM (Version: 1.1) p.1

Generator :	BISHOP, ROBERT	MS :	C920	PH :	52742	Z#:	117863
WMC :	JIO, GORDON	MS :	C920	PH :	74325	Z#:	093700
Contact :							
CSR :	RIVERA, ROBERT	MS :	J595	PH :	54000	Z#:	122062
Status :	ACTIVE	Activation Date :	29-SEP-98			Expiration Date:	29-SEP-99
Group :	DX2	TA :	09	Bldg :	000021	Room:	135

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to EM-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Satellite Accumulation Area Site ID# 428**

Method of Char : **Acceptable Knowledge Documentation** **Number: SOP #5.11**

Waste Type : **Process Waste/Spent Chemical/Other**

Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Explosive process**

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Aqueous**

Matrix Type : **Heterogeneous**

Waste/Proc Desc : CHEMICAL DESTRUCTION OF ENERGETIC MATERIALS. WASTE TO GO TO BURN GROUNDS. TO REPLACE WPF#22025

Ignitability : **Not ignitable**

Corrosivity : **> = 12.5**

Reactivity : **Explosive - DOT Div. 1.1D**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals : N/A

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	AMMONIUM SALTS [AMMONIUM HYDROXIDE]	0 7.5	15	%
	CARBONATE SALTS	0 7.5	15	%
	SODIUM SALTS [SODIUM HYDROXIDE]	0 7.5	15	%
	EXPLOSIVE RESIDUE (HMX, RDX, NQ, NC, PETN, TATB, NTO) TNT)	0 0.5	1	%
	WATER	85	99	%

LDR and Underlying Hazardous Constituents Information

Non-Wastewater/Wastewater Category: **Non Wastewater**

Notification of California List Applicability:

Notification Of Underlying Hazardous Constituents:

Constituents

No Underlying Hazardous Constituents in this waste stream

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **HAZARDOUS WASTE**

Misc. Category : **ADMIN CONTROLLED WASTE**

Waste Classification : **HAZARDOUS WASTE**

EPA Hazardous Waste Code : **D002 D003**

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM

WPF #: 30280

24-Mar-1999 10:00 PM (Version: 1.1) p.1

Generator :	LEE, KIEN YIN	MS :	C920	PH :	77131	Z#:	087572
WMC :	JIO, GORDON	MS :	C920	PH :	74325	Z#:	093700
Contact :							
RCRA Rev :	STANTON, JAMES K.	MS :	J595	PH :	56411	Z#:	111489
Status :	ACTIVE	Activation Date :	24-Mar-1999	Expiration Date:	24-Mar-2000		
Group :	DX2	TA :	09	Bldg :	000021	Room:	130

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to EM-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Satellite Accumulation Area Site ID# 420**

Method of Char : **Acceptable Knowledge Documentation** **Number: K-YLEE NB1**

Waste Type : **Process Waste/Spent Chemical/Other**

Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Explosive process**

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Aqueous**

Matrix Type : **Homogeneous**

Waste/Proc Desc : TRACE AMOUNT OF TATB, HMX IN WATER FROM PARTICLE SIZE ANALYSIS.

Ignitability : **<73 F <22.8 C**

Corrosivity : **6.1 - 9.0**

Reactivity : **Explosive - DOT Div. 1.1D**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals : N/A

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	WATER	**10**	**60**	**%**
	TATB	**1**	**2**	**%**
	HMX	**1**	**2**	**%**
	ETHANOL	**10**	**50**	**%**

LDR and Underlying Hazardous Constituents Information

Non-Wastewater/Wastewater Category: **Non Wastewater**

Notification of California List Applicability:

Notification Of Underlying Hazardous Constituents:

Constituents

No Underlying Hazardous Constituents in this waste stream

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **HAZARDOUS WASTE**

Misc. Category : **ADMIN CONTROLLED WASTE**

Waste Classification : **HAZARDOUS WASTE**

EPA Hazardous Waste Code : **D001 D003**

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 30508

01-Apr-1999 10:00 PM (Version: 1.1) p.1

Generator:	KING, WAYNE F	MS :	C920	PH :	71694	Z#:	085294
WMC:	JIO, GORDON	MS :	C920	PH :	74325	Z#:	093700
Contact:							
RCRA Rev:	ELICIO, ANDY	MS :	J595	PH :	57557	Z#:	118692
Status :	ACTIVE	Activation Date :	01-Apr-1999	Expiration Date:	01-Apr-2000		
Group :	DX2	TA :	09	Bldg :	000021	Room:	131

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to EM-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Satellite Accumulation Area Site ID# 1369**

Method of Char : **Acceptable Knowledge Documentation** **Number: DX-2 chemical hygiene plan**

Waste Type : **Process Waste/Spent Chemical/Other**

Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**
Volatile Organics > = 500 ppm
Solvent
Explosive process

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Aqueous**

Matrix Type : **Homogeneous**

Waste/Proc Desc : WASTE GENERATED FROM LIQUID CHROMATOGRAPHY OF SAMPLES CONTAINING HIGH EXPLOSIVES CPDS. REPLACES WASTE PROFILE #30102

Ignitability : **<73 F <22.8 C**

Corrosivity : **6.1 - 9.0**

Reactivity : **Explosive - DOT Div. 1.1D**

Boiling Point : **< = 95 F < = 35 C**

Toxicity Characteristic Metals : N/A

Toxicity Characteristic Organic Compounds:

Contaminant	Method	Limit	Min	Max	Unit
1,2-DICHLOROETHANE	**AK**		**50000**	**150001**	**PPM**
TRICHLOROETHYLENE	**AK**		**5000**	**10000**	**PPM**

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	WATER	**10**	**45**	**%**
	METHANOL	**10**	**55**	**%**
	ACETONITRILE	**5**	**10**	**%**
	ACETONE	**.1**	**5**	**%**
	TETRAHYDRAFURAN	**.1**	**15**	**%**

1,2 DICHLOROETHANE	**5**	**15**	**%**
METHYLENE CHLORIDE	**.1**	**5**	**%**
ISOPROPYL ALCOHOL	**.5**	**1**	**%**
TRICHLOROETHYLENE	**.5**	**1**	**%**
HIGH EXPLOSIVES	**1**	**5**	**%**

Additional Information: METHANOL IS ALWAYS MIXED WITH WATER THEREFORE WOULD NOT CARRY EPA WASTE CODE F003.

LDR and Underlying Hazardous Constituents Information

Non-Wastewater/Wastewater Category: **Non Wastewater**

Notification of California List Applicability:

A D001 thru D043 waste containing Halogenated Organic Compounds (HOCs) listed in 40 CFR 268, Appendix III, at 1000 ppm or greater.

Notification Of Underlying Hazardous Constituents:

Constituents

Acetone
Acetonitrile
1,2-Dichloroethane
Methanol
Methylene chloride
Trichloroethylene

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **HAZARDOUS WASTE**

Misc. Category : **ADMIN CONTROLLED WASTE**

Waste Classification : **HAZARDOUS WASTE**

EPA Hazardous Waste Code : **D001 D003 D028 F002 F003**

Los Alamos
National Laboratory

WASTE PROFILE FORM

WPF #: 30824
(Version: 1.2)

18-Apr-2000 07:05 AM

Generator:	SULLIVAN, GREGG DX2	MS : C920
WMC:	JIO, GORDON DX	MS : C920
FROM:	FWO-SWO	MS : J595/5-4000

WASTE PROFILE (WPF) EXTENSION QUESTIONNAIRE

Our files indicate that your WPF#: 30824 was submitted approximately one year ago. Please review the attached copy and answer the following questions concerning your waste stream to determine whether to renew or void your WPF. Please return the completed questionnaire to FWO-SWO at the address listed below. If your waste stream remains the same, your WPF will be extended for another year. If the original generator is no longer with the generating group or generating this waste, a new WPF will need to be filled out with a new generator. Upon receipt of this questionnaire with a signed Extension Certification, we will send you a return receipt indicating that your WPF is valid for another year. If there are changes in your waste stream, a new WPF will need to be completed.

Are you currently producing the same type of waste as indicated on your WPF#: 30824
YES _____ NO _____
If yes, please sign the Extension Certification below
If no, will you be producing the same type of waste in the near future?
YES _____ NO _____
If yes, please sign the Extension Certification below
If no, will you be producing a different type of waste?
YES _____ NO _____
If no, sign the Void Approval below to indicate that your WPF should be voided
If yes, please submit a new WPF, along with this memo. We will then void your previous WPF and process a new one

Extension Certification

I am producing or will produce the same type of waste as indicated in WPF# 30824

Based on my knowledge of the waste and/or chemical/physical analysis, I certify that the information on this form is correct. I understand that this information will be made available to regulatory agencies and that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Extension-> Signed Gregg Sullivan Date 4-26-00

Void Approval

I will no longer be generating or will be producing a different type or composition (a new WPF will be submitted) of waste as indicated in WPF# 30824

Void-> Signed _____ Date _____

NOTE: PLEASE FOLD AND STAPLE THE FORM TO THE LINE BELOW AND RETURN TO ADDRESS PROVIDED

TO: FWO-SWO ***MS: J595*** ***PHONE: 5-4000***

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 30824

29-Feb-2000 12:30 PM (Version: 2.2) p.1

Generator :	SULLIVAN, GREGG	MS :	C920	PH :	55072	Z#:	150812
WMC :	JIO, GORDON	MS :	C920	PH :	74325	Z#:	093700
Contact :							
RCRA Rev :	NOLL, MONICA D.	MS :	J595	PH :	75999	Z#:	115370
Status :	ACTIVE	Activation Date :	19-May-1999	Expiration Date:	19-May-2000		
Group :	DX2	TA :	09	Bldg :	000021	Room:	139

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Satellite Accumulation Area Site ID# 1625**

Method of Char : **Acceptable Knowledge Documentation** **Number: HCP Not Yet Approved**

Waste Type : **Process Waste/Spent Chemical/Other**

Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Solvent**
Explosive process

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Aqueous**

Matrix Type : **Heterogeneous**

Waste/Proc Desc : TOLUENE, ACETONE, WATER, RDX, PBX 9407, EXON 461 FROM EXPLOSIVE PROCESSING WASTE TO GO TO BURN GROUNDS. THIS WILL INCLUDE SOME SPECIAL FORMULATIONS WITH BDNPA/F ADDED TO THE 9407.

Ignitability : **<73 F <22.8 C**

Corrosivity : **6.1 - 9.0**

Reactivity : **Explosive - DOT Div. 1.1D**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals : N/A

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
108-88-3	TOLUENE	30	60	%
7732-18-5	WATER	75	100	%
121-82-4	RDX	1	5	%
	PBX 9407	1	5	%
	EXON 461	1	5	%
67-64-1	ACETONE	5	20	%
	BDNPA/P	0	5	%

LDR and Underlying Hazardous Constituents Information

Non-Wastewater/Wastewater Category: **Non Wastewater**

Notification of California List Applicability: N/A
Notification Of Underlying Hazardous Constituents:

Constituents
Acetone
Toluene

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **HAZARDOUS WASTE**

Misc. Category : **N/A**

Waste Classification : **HAZARDOUS WASTE**

EPA Hazardous Waste Code : **D001 D003 F003 F005**

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 31709

29-Oct-1999 03:34 PM (Version: 1.1)

Generator :	SULLIVAN, GREGG	MS :	C920	PH :	55072	Z#:	150812
WMC :	JIO, GORDON	MS :	C920	PH :	74325	Z#:	093700
Contact :							
RCRA Rev :	ELICIO, ANDY	MS :	J595	PH :	57557	Z#:	118692
Status :	ACTIVE	Activation Date :	22-Oct-1999	Expiration Date:	22-Oct-2000		
Group :	DX2	TA :	09	Bldg :	000021	Room:	139

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Satellite Accumulation Area Site ID# 1625**
Method of Char : **Acceptable Knowledge Documentation** **Number: HCP 99-165 99-215 99-247**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Explosive process**

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Non-aqueous**

Matrix Type : **Heterogeneous**

Waste/Proc Desc : VACUUM PUMP OIL WITH HIGH EXPLOSIVES AND SOLVENTS FROM SMALL SCALE SLURRY VESSEL. VACUUM PUMP FOLLOWS 2 CONDENSERS AND A SOLVENT & SO LITTLE WATER OR SOLVENT IS LIKELY TO BE PRESENT IN OIL. ALSO IT IS EXTREMELY UNLIKELY HE IS PRESENT IN OIL, BUT IT CANNOT BE EXCLUDED WITH CERTAINTY.

Ignitability : **<73 F <22.8 C**

Corrosivity : **Non-aqueous**

Reactivity : **Explosive - DOT Div. 1.1D**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals : N/A

Toxicity Characteristic Organic Compounds:

Contaminant	Method	Limit	Min	Max	Unit
METHYL ETHYL KETONE	**AK**		**0**	**1000**	**PPM**

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	HMX (CYCLOTETRAMETHYLENETETRANITRAMINE)	**0**	**1**	**%**
	PBX 9407	**0**	**1**	**%**
121-82-4	**RDX (CYCLOTRIMETHYLENETRINITRAMINE)**	**0**	**1**	**%**
	PBX 9501	**0**	**1**	**%**
	EXON 461	**0**	**1**	**%**
	ESTANE	**0**	**1**	**%**

	BDNPA/F	**0**	**1**	**%**
7732-18-5	**WATER**	**0**	**1**	**%**
	VACUUM PUMP OIL	**90**	**100**	**%**
108-88-3	**TOLUENE**	**0**	**1**	**%**

Additional Information: TO BE DISPOSED OF AT THE BURNGROUND.

LDR and Underlying Hazardous Constituents Information

Non-Wastewater/Wastewater Category: **Non Wastewater**

Notification of California List Applicability: N/A

Notification Of Underlying Hazardous Constituents:

Constituents
Methyl ethyl ketone
Toluene

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **HAZARDOUS WASTE**

Misc. Category : **ADMIN CONTROLLED WASTE**

Waste Classification : **HAZARDOUS WASTE**

EPA Hazardous Waste Code : **D001 D003**

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 31722

29-Oct-1999 03:54 PM (Version: 1.1)

Generator :	SULLIVAN, GREGG	MS :	C920	PH :	55072	Z#:	150812
WMC :	JIO, GORDON	MS :	C920	PH :	74325	Z#:	093700
Contact :							
RCRA Rev :	ELICIO, ANDY	MS :	J595	PH :	57557	Z#:	118692
Status :	ACTIVE	Activation Date :	28-Oct-1999	Expiration Date:	28-Oct-2000		
Group :	DX2	TA :	09	Bldg :	000021	Room:	139

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Satellite Accumulation Area Site ID# 1625**
Method of Char : **Acceptable Knowledge Documentation** **Number: HCP 99-247**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Solvent**
Explosive process

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Aqueous**

Matrix Type : **Heterogeneous**

Waste/Proc Desc : ETHYL ACETATE, BUTYL ACETATE, MEK, ACETONE, ETHANOL, WATER, HMX, PBX 9501 FROM EXPLOSIVE PROCESSING. WASTE TO GO TO BURN GROUNDS. REPLACES WPF# 30250

Ignitability : **<73 F <22.8 C**

Corrosivity : **6.1 - 9.0**

Reactivity : **Explosive - DOT Div. 1.1D**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals : N/A

Toxicity Characteristic Organic Compounds:

Contaminant	Method	Limit	Min	Max	Unit
METHYL ETHYL KETONE	**AK**		**10000**	**100000**	**PPM**

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
141-78-6	**ETHYL ACETATE**	**0**	**10**	**%**
123-86-4	**BUTYL ACETATE**	**0**	**10**	**%**
	WATER	**50**	**75**	**%**
	HMX	**5**	**10**	**%**
	PBX 9501	**5**	**10**	**%**
	ACETONE	**10**	**20**	**%**
	ETHYL ALCOHOL	**5**	**10**	**%**

LDR and Underlying Hazardous Constituents Information

Non-Wastewater/Wastewater Category: **Non Wastewater**

Notification of California List Applicability: N/A

Notification Of Underlying Hazardous Constituents:

Constituents

Acetone

Ethyl acetate

Methyl ethyl ketone

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **HAZARDOUS WASTE**

Misc. Category : **ADMIN CONTROLLED WASTE**

Waste Classification : **HAZARDOUS WASTE**

EPA Hazardous Waste Code : **D001 D003 F003 F005**

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 31845

Generator :	BISHOP, ROBERT	MS :	C920	PH :	52742	Z#:	117863
WMC :	JIO, GORDON	MS :	C920	PH :	74325	Z#:	093700
Contact :							
RCRA Rev :	ELICIO, ANDY	MS :	J595	PH :	57557	Z#:	118692
Status :	ACTIVE	Activation Date :	13-Dec-1999	Expiration Date:	13-Dec-2000		
Group :	DX2	TA :	09	Bldg :	000021	Room:	135

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Satellite Accumulation Area Site ID# 1393**
Method of Char : **Acceptable Knowledge Documentation** **Number: 5.11 sop**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**
Explosive process

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Suspended Solids / Aqueous**

Matrix Type : **Heterogeneous**

Waste/Proc Desc : DIAMINO AZ0 FURAZAN DISSOLVED IN DMSO AND WATER

Ignitability : **140 - 200 F 60.0 - 99.3 C**

Corrosivity : **6.1 - 9.0**

Reactivity : **Explosive - DOT Div. 1.1D**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals : N/A

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	DMSO	**10**	**20**	**%**
	WATER	**80**	**90**	**%**
	DIAMINO AZ0 FURAZAN	**0**	**5**	**%**

LDR and Underlying Hazardous Constituents Information
Non-Wastewater/Wastewater Category: **Non Wastewater**
Notification of California List Applicability: N/A
Notification Of Underlying Hazardous Constituents:
Constituents
No Underlying Hazardous Constituents in this waste stream

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **HAZARDOUS WASTE**

Misc. Category : **ADMIN CONTROLLED WASTE**

Waste Classification : **HAZARDOUS WASTE**

EPA Hazardous Waste Code : **D003**

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 31846

06-Dec-1999 10:00 PM (Version: 1.1)

Generator:	BISHOP, ROBERT	MS:	C920	PH:	52742	Z#:	117863
WMC:	JIO, GORDON	MS:	C920	PH:	74325	Z#:	093700
Contact:							
RCRA Rev:	ELICIO, ANDY	MS:	J595	PH:	57557	Z#:	118692
Status:	ACTIVE	Activation Date:	06-Dec-1999	Expiration Date:	06-Dec-2000		
Group:	DX2	TA:	09	Bldg:	000021	Room:	135

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu: **Satellite Accumulation Area Site ID# 1393**
Method of Char: **Acceptable Knowledge Documentation** **Number: 5.11 sop**

Waste Type: **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**
Solvent
Explosive process

Waste Sources: **Research/Development/Testing**

Waste Matrix: **Suspended Solids / Aqueous**

Matrix Type: **Heterogeneous**

Waste/Proc Desc: ACETONE, METHANOL, WATER, PLUS DIAMINO AZO FURAZAN.

Ignitability: **<73 F <22.8 C**

Corrosivity: **6.1 - 9.0**

Reactivity: **Explosive - DOT Div. 1.1D**

Boiling Point: **Not applicable**

Toxicity Characteristic Metals: N/A

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants:

CAS NO	Constituent	MIN	MAX	UOM
	ACETONE	25	50	%
	METHANOL	50	60	%
	WATER	1	10	%
	DAAZF (DIAMINO AZO FURAZAN)	1	2	%

LDR and Underlying Hazardous Constituents Information
Non-Wastewater/Wastewater Category: **Non Wastewater**
Notification of California List Applicability: N/A
Notification Of Underlying Hazardous Constituents:

Constituents
Acetone

Methanol

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category :	**NON-RAD**
RCRA Category :	**HAZARDOUS WASTE**
Misc. Category :	**ADMIN CONTROLLED WASTE**
Waste Classification :	**HAZARDOUS WASTE**
EPA Hazardous Waste Code :	**D001 D003 F003**

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 32117

10-Feb-2000 10:00 PM (Version: 1.1)

Generator :	HISKEY, MICHAEL A	MS :	C920	PH :	74592	Z#:	105406
WMC :	JIO, GORDON	MS :	C920	PH :	74325	Z#:	093700
Contact :							
RCRA Rev :	RAEL, MICHELLE	MS :	J595	PH :	54000	Z#:	120950
Status :	ACTIVE	Activation Date :	10-Feb-2000	Expiration Date:	10-Feb-2001		
Group :	DX2	TA :	09	Bldg :	000021	Room:	125

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Satellite Accumulation Area Site ID# 720**
Method of Char : **Acceptable Knowledge Documentation** **Number: SOP 3.1.1**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**
Volatile Organics > = 500 ppm

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Non-aqueous**

Matrix Type : **Homogeneous**

Waste/Proc Desc : DISPOSED OF 10ML 1-BUTYL NITRITE

Ignitability : **<73 F <22.8 C**

Corrosivity : **Non-aqueous**

Reactivity : **Shock Sensitive**

Boiling Point : **< = 95 F < = 35 C**

Toxicity Characteristic Metals : N/A

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	1-BUTYL NITRITE	**100**	**100**	**%**

LDR and Underlying Hazardous Constituents Information
Non-Wastewater/Wastewater Category: **Non Wastewater**
Notification of California List Applicability:
Notification Of Underlying Hazardous Constituents:
Constituents
No Underlying Hazardous Constituents in this waste stream

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **HAZARDOUS WASTE**

Misc. Category : N/A

Waste Classification : **HAZARDOUS WASTE**

EPA Hazardous Waste Code : **D001 D003**

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 32124

16-Feb-2000 10:00 PM (Version: 1.3)

Generator :	**SULLIVAN, GREGG**	MS :	**C920**	PH :	**55072**	Z#:	**150812**
WMC :	**JIO, GORDON**	MS :	**C920**	PH :	**74325**	Z#:	**093700**
Contact :							
RCRA Rev :	**ELICIO, ANDY**	MS :	**J595**	PH :	**57557**	Z#:	**118692**
Status :	**ACTIVE**	Activation Date :	**16-Feb-2000**	Expiration Date:	**16-Feb-2001**		
Group :	**DX2**	TA :	**09**	Bldg :	**000021**	Room:	**139**

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Satellite Accumulation Area Site ID# 1625**
Method of Char : **Acceptable Knowledge Documentation** **Number: HCP 00-013**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Solvent**
Explosive process

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Aqueous**

Matrix Type : **Heterogeneous**

Waste/Proc Desc : ACETONE, TATB, ETHYL ACETATE, WATER, KEL-F 800, PBX 9502 FROM EXPLOSIVES PROCESSING. WASTE TO GO TO BURN GROUNDS.

Ignitability : **<73 F <22.8 C**

Corrosivity : **6.1 - 9.0**

Reactivity : **Explosive - DOT Div. 1.1D**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals : N/A

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
67-64-1	**ACETONE**	**0**	**5**	**%**
3058-38-6	**TATB (TRIAMINOTRINITROBENZENE)**	**0**	**5**	**%**
141-78-6	**ETHYL ACETATE**	**10**	**20**	**%**
7732-18-5	**WATER**	**50**	**75**	**%**
9010-75-7	**KEL-F 800**	**0**	**5**	**%**
	PBX 9502	**0**	**5**	**%**

LDR and Underlying Hazardous Constituents Information
Non-Wastewater/Wastewater Category: **Non Wastewater**
Notification of California List Applicability: N/A
Notification Of Underlying Hazardous Constituents:
Constituents

Acetone
Ethyl acetate

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category :	**NON-RAD**
RCRA Category :	**HAZARDOUS WASTE**
Misc. Category :	**ADMIN CONTROLLED WASTE**
Waste Classification :	**HAZARDOUS WASTE**
EPA Hazardous Waste Code :	**D001 F003 D003**

ASH CHARACTERIZATION

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 30085

12-Jan-1999 10:00 PM (Version: 1)

Generator :	GARCIA, ROBERT F	MS :	C930	PH :	76891	Z#:	076368
WMC :	STADELMAIER, AL	MS :	C928	PH :	79746	Z#:	095169
Contact :							
RCRA Rev :	STANTON, JAMES K.	MS :	J595	PH :	56411	Z#:	111489
Status :	ACTIVE	Activation Date :	12-Jan-1999	Expiration Date:	12-Jan-2000		
Group :	ESAWMM	TA :	16	Bldg :	000386	Room:	0

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Waste Accumu : **Less-than-90-days Storage Area** **Site ID# 80**
Method of Char : **Analysis/Documents Attached**
Chemical/Physical Analysis **Number: 98DS639**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Powder/Ash**

Matrix Type : **Heterogeneous**

Waste/Proc Desc : ASH FROM VESSEL 401 BURN TRAY #399. ATT:NEW MEXICO SPECIAL WASTE

Ignitability : **Not ignitable**

Corrosivity : **Non-aqueous**

Reactivity : **Non-reactive**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals :

Contaminant	Method	Limit	Min	Max	Unit
BARIUM	**TCLP**	**Y**			**PPM**
MERCURY	**TCLP**	**Y**			**PPM**

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	ASH	**99**	**100**	**%**

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **NON-HAZARDOUS WASTE**

Misc. Category : **NEW MEXICO SPECIAL WASTE**

Waste Classification : **NEW MEXICO SPECIAL WASTE**

EPA Hazardous Waste Code : N/A

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* explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

LOS ALAMOS NATIONAL LABS
attn: **DUSTIE STEPHENS**
MAIL STOP K491/ESH-19
LOS ALAMOS, NM 87545

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **LOS ALAMOS NATIONAL LABS**
Project: **9810122 TA-16 BURN 8M02CR2000000000**

Karen Balstrn G
William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID: ***98DS639*** Sample Matrix: ***ASH*** Sample Collected: ***10/14/98 09:00:00***

[illegible]ion	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	Run Date
			Test: TCLP SW846-6010 ICP							
9810122-01A	M98886	7440-38-2	Arsenic	ND	mg / L	1	0.1		MW.1998.1540-81	12/01/98
	M98886	7440-39-3	Barium	1.8	mg / L	1	0.1		MW.1998.1540-81	
	M98886	7440-43-9	Cadmium	ND	mg / L	1	0.02		MW.1998.1540-81	
	M98886	7440-47-3	Chromium	ND	mg / L	1	0.02		MW.1998.1540-81	
	M98886	7439-92-1	Lead	ND	mg / L	1	0.05		MW.1998.1540-81	
	M98886	7782-49-2	Selenium	ND	mg / L	1	0.05		MW.1998.1540-81	
	M98886	7440-22-4	Silver	ND	mg / L	1	0.04		MW.1998.1540-81	
			Test: TCLP SW846-7470							
9810122-01A	M98974	7439-97-6	Mercury	0.007	mg / L	1	0.002		MW.1998.1605-16	12/14/98

**** Sample specific analytical Detection Limit is determined by multiplying the sample Dilution Factor by the listed method Detection Limit. ****
**** Results relate only to the items tested. ****

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LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 30487

Generator :	GARCIA, ROBERT F	MS :	C930	PH :	76891	Z#:	076368
WMC :	STADELMAIER, AL	MS :	C928	PH :	79746	Z#:	095169
Contact :							
RCRA Rev :	STANTON, JAMES K.	MS :	J595	PH :	56411	Z#:	111489
Status :	ACTIVE	Activation Date :	29-Mar-1999	Expiration Date:	29-Mar-2000		
Group :	ESAWMM	TA :	16	Bldg :	000386	Room:	NA

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Waste Accumu : **None of the Above Site ID#**
Method of Char : **Analysis/Documents Attached**
Chemical/Physical Analysis **Number: 99DS077**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Powder/Ash**

Matrix Type : **Homogeneous**

Waste/Proc Desc : ASH FROM BURN TRAY #399 AND FILTER VESSEL #406. SAMPLE 99DS077 ATT: THIS IS A NEW MEXICO SPECIAL WASTE.

Ignitability : **Not ignitable**

Corrosivity : **Non-aqueous**

Reactivity : **Non-reactive**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals :

Contaminant	Method	Limit	Min	Max	Unit
BARIUM	**TCLP**	**Y**			**PPM**
MERCURY	**TCLP**	**Y**			**PPM**

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	ASH	**99**	**100**	**%**

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **NON-HAZARDOUS WASTE**

Misc. Category : **NEW MEXICO SPECIAL WASTE**

Waste Classification : **NEW MEXICO SPECIAL WASTE**

EPA Hazardous Waste Code : N/A

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LOS ALAMOS NATIONAL LABS
attn: **DUSTIE STEPHENS**
MAIL STOP K491/ESH-19
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* explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **LOS ALAMOS NATIONAL LABS**
Project: **9902185**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID ***99DS076*** Sample Matrix ***MS*** Sample Collected ***02/19/99***

ion	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	Run Date
			Test: SW846 1311/3010A/6010A ICP TCLP							
9902185-01A	M99234	7440-38-2	Arsenic	ND	mg / L	1	0.1		MW.1999.245-22	03/03/99
	M99234	7440-39-3	Barium	1.4	mg / L	1	0.1		MW.1999.245-22	
	M99234	7440-43-9	Cadmium	0.225	mg / L	1	0.02		MW.1999.245-22	
	M99234	7440-47-3	Chromium	ND	mg / L	1	0.02		MW.1999.245-22	
	M99234	7782-49-2	Selenium	0.06	mg / L	1	0.05		MW.1999.245-22	
	M99234	7440-22-4	Silver	ND	mg / L	1	0.04		MW.1999.245-22	
			Test: SW846 1311/3010A/7000 series AA-FL TCLP							
9902185-01A	M99234	7439-92-1	Lead	ND	mg / L	1	0.1		MW.1999.257-13	03/04/99
			Test: SW846 1311/7470 CVAA TCLP							
9902185-01A	M99235	7439-97-6	Mercury	0.0007	mg / L	1	0.0002		MT.1999.453-5	02/26/99

Client Sample ID ***99DS077*** Sample Matrix ***MS*** Sample Collected ***02/19/99***

Fraction	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	Run Date
			Test: SW846 1311/3010A/6010A ICP TCLP							
9902185-02A	M99234	7440-38-2	Arsenic	ND	mg / L	1	0.1		MW.1999.245-23	03/03/99
	M99234	7440-39-3	Barium	3.7	mg / L	1	0.1		MW.1999.245-23	
	M99234	7440-43-9	Cadmium	ND	mg / L	1	0.02		MW.1999.245-23	
	M99234	7440-47-3	Chromium	ND	mg / L	1	0.02		MW.1999.245-23	

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Certificate of Analysis

Client: **LOS ALAMOS NATIONAL LABS**

Project: **9902185**

9902185-02A	M99234	7782-49-2	Selenium	ND	mg / L	1	0.05		MW.1999.245-23	03/03/99
	M99234	7440-22-4	Silver	ND	mg / L	1	0.04	1	MW.1999.245-23	
			Test: SW846 1311/3010A/7000 series AA-FL TCLP							
9902185-02A	M99234	7439-92-1	Lead	ND	mg / L	1	0.1		MW.1999.257-14	03/04/99
			Test: SW846 1311/7470 CVAA TCLP							
9902185-02A	M99235	7439-97-6	Mercury	0.0005	mg / L	1	0.0002		MT.1999.453-6	02/26/99

**** Sample specific analytical Detection Limit is determined by multiplying the sample Dilution Factor by the listed method Detection Limit. ****
**** Results relate only to the items tested. ****

footnote [1] This sample was utilized for the matrix spike and duplicate. Please note that the recoveries were outside of QC criteria, suggesting matrix interference problems. This should be taken into account when reviewing the data.

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 30489

29-Mar-1999 10:00 PM (Version: 1.1)

Generator :	GARCIA, ROBERT F	MS :	C930	PH :	76891	Z#:	076368
WMC :	STADELMAIER, AL	MS :	C928	PH :	79746	Z#:	095169
Contact :							
RCRA Rev :	STANTON, JAMES K.	MS :	J595	PH :	56411	Z#:	111489
Status :	ACTIVE	Activation Date :	29-Mar-1999	Expiration Date:	29-Mar-2000		
Group :	ESAWMM	TA :	16	Bldg :	000386	Room:	NA

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Waste Accumu : **None of the Above Site ID#**
Method of Char : **Analysis/Documents Attached**
Chemical/Physical Analysis **Number: 99DS076**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Powder/Ash**

Matrix Type : **Homogeneous**

Waste/Proc Desc : ASH FROM FLASH PAD. SAMPLE# 99DS076 ATT: THIS IS A NEW MEXICO SPECIAL WASTE.

Ignitability : **Not ignitable**

Corrosivity : **Non-aqueous**

Reactivity : **Non-reactive**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals :

Contaminant	Method	Limit	Min	Max	Unit
BARIUM	**TCLP**	**Y**			**PPM**
CADMIUM	**TCLP**	**Y**			**PPM**
MERCURY	**TCLP**	**Y**			**PPM**
SELENIUM	**TCLP**	**Y**			**PPM**

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	ASH	**95**	**100**	**%**

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **NON-HAZARDOUS WASTE**

Misc. Category : **NEW MEXICO SPECIAL WASTE**

Waste Classification : **NEW MEXICO SPECIAL WASTE**

EPA Hazardous Waste Code : N/A

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* explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

LOS ALAMOS NATIONAL LABS
attn: **DUSTIE STEPHENS**
MAIL STOP K491/ESH-19
LOS ALAMOS, NM, 87545

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **LOS ALAMOS NATIONAL LABS**
Project: **9902185**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID **99DS076** Sample Matrix **MS** Sample Collected **02/19/99**

on	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	Run Date
			Test: SW846 1311/3010A/6010A ICP TCLP							
9902185-01A	M99234	7440-38-2	Arsenic	ND	mg / L	1	0.1		MW.1999.245-22	03/03/99
	M99234	7440-39-3	Barium	1.4	mg / L	1	0.1		MW.1999.245-22	
	M99234	7440-43-9	Cadmium	0.225	mg / L	1	0.02		MW.1999.245-22	
	M99234	7440-47-3	Chromium	ND	mg / L	1	0.02		MW.1999.245-22	
	M99234	7782-49-2	Selenium	0.06	mg / L	1	0.05		MW.1999.245-22	
	M99234	7440-22-4	Silver	ND	mg / L	1	0.04		MW.1999.245-22	
			Test: SW846 1311/3010A/7000 series AA-FL TCLP							
9902185-01A	M99234	7439-92-1	Lead	ND	mg / L	1	0.1		MW.1999.257-13	03/04/99
			Test: SW846 1311/7470 CVAA TCLP							
9902185-01A	M99235	7439-97-6	Mercury	0.0007	mg / L	1	0.0002		MT.1999.453-5	02/26/99

Client Sample ID **99DS077** Sample Matrix **MS** Sample Collected **02/19/99**

Fraction	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	Run Date
			Test: SW846 1311/3010A/6010A ICP TCLP							
9902185-02A	M99234	7440-38-2	Arsenic	ND	mg / L	1	0.1		MW.1999.245-23	03/03/99
	M99234	7440-39-3	Barium	3.7	mg / L	1	0.1		MW.1999.245-23	
	M99234	7440-43-9	Cadmium	ND	mg / L	1	0.02		MW.1999.245-23	
	M99234	7440-47-3	Chromium	ND	mg / L	1	0.02		MW.1999.245-23	

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Client: **LOS ALAMOS NATIONAL LABS**

Project: **9902185**

9902185-02A	M99234	7782-49-2	Selenium	ND	mg / L	1	0.05		MW.1999.245-23	03/03/99
	M99234	7440-22-4	Silver	ND	mg / L	1	0.04	1	MW.1999.245-23	

Test: SW846 1311/3010A/7000 series AA-FL TCLP

9902185-02A	M99234	7439-92-1	Lead	ND	mg / L	1	0.1		MW.1999.257-14	03/04/99

Test: SW846 1311/7470 CVAA TCLP

9902185-02A	M99235	7439-97-6	Mercury	0.0005	mg / L	1	0.0002		MT.1999.453-6	02/26/99

**** Sample specific analytical Detection Limit is determined by multiplying the sample Dilution Factor by the listed method Detection Limit. ****
**** Results relate only to the items tested. ****

footnote 1 This sample was utilized for the matrix spike and duplicate. Please note that the recoveries were outside of QC criteria, suggesting matrix interference problems. This should be taken into account when reviewing the data.

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 30919

13-Jun-1999 10:00 PM (Version: 1.1)

Generator :	GARCIA, ROBERT F	MS :	C930	PH :	76891	Z#:	076368
WMC :	STADELMAIER, AL	MS :	C928	PH :	79746	Z#:	095169
Contact :							
RCRA Rev :	RAEL, MICHELLE	MS :	J595	PH :	54000	Z#:	120950
Status :	ACTIVE	Activation Date :	11-Jun-1999	Expiration Date:	11-Jun-2000		
Group :	ESAWMM	TA :	16	Bldg :	000386	Room:	NA

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Waste Accumu : **Less-than-90-days Storage Area Site ID# 80**
Method of Char : **Analysis/Documents Attached**
Chemical/Physical Analysis **Number: 99DS285**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Powder/Ash**

Matrix Type : **Heterogeneous**

Waste/Proc Desc : ASH FROM 401 FILTER VESSEL.

Ignitability : **Not ignitable**

Corrosivity : **Non-aqueous**

Reactivity : **Non-reactive**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals :

Contaminant	Method	Limit	Min	Max	Unit
BARIUM	**TCLP**	**Y**			**PPM**
LEAD	**TCLP**	**Y**			**PPM**
MERCURY	**TCLP**	**Y**			**PPM**

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	ASH	**95**	**100**	**%**

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **NON-HAZARDOUS WASTE**

Misc. Category: **NEW MEXICO SPECIAL WASTE**

Waste Classification : **NEW MEXICO SPECIAL WASTE**

EPA Hazardous Waste Code : N/A

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* explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
	tentatively identified compound
	subcontracted
	see footnote

LOS ALAMOS NATIONAL LABS
attn: **DUSTIE STEPHENS**
MAIL STOP K491/ESH-19
LOS ALAMOS, NM 87545

Al
C Stadelmaier
filter vessel
401

Client: **LOS ALAMOS NATIONAL LABS**
Project: **9904237 TA-16 STADELMAIER**

...tical Laboratories, Inc.

Client Sample ID ***99DS285***

Sample Collected ***04/28/99 14:30:00***

...on	QC Group	CAS #							*	Sequence	Run Date
			Test: SW846 1311/3010A/6010A								
9904237-01B	M99525	7440-38-2	Arsenic	ND	mg / L	1	0.1			MW.1999.536-99	05/12/99
	M99525	7440-39-3	Barium	7.5	mg / L	1	0.1			MW.1999.536-99	
	M99525	7440-43-9	Cadmium	ND	mg / L	1	0.02			MW.1999.536-99	
	M99525	7440-47-3	Chromium	ND	mg / L	1	0.02			MW.1999.536-99	
	M99525	7439-92-1	Lead	0.08	mg / L	1	0.05			MW.1999.555-67	05/18/99
	M99525	7782-49-2	Selenium	ND	mg / L	1	0.05			MW.1999.536-99	05/12/99
	M99525	7440-22-4	Silver	ND	mg / L	1	0.04		1	MW.1999.536-99	
			Test: SW846 1311/7470 CVAA TCLP								
9904237-01B	M99521	7439-97-6	Mercury	0.0040	mg / L	1	0.0002			MT.1999.983-22	05/06/99

**** Sample specific analytical Detection Limit is determined by multiplying the sample Dilution Factor by the listed method Detection Limit. ****
**** Results relate only to the items tested. ****

footnote [1] This sample was utilized for the matrix spike and duplicate. Please note that the recoveries were outside of QC criteria, suggesting matrix interference problems. This should be taken into account when reviewing the data.

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LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 32053

24-Jan-2000 10:00 PM (Version: 1.1)

Generator :	GARCIA, ROBERT F	MS :	C930	PH :	76891	Z#:	076368
WMC :	STADELMAIER, AL	MS :	C928	PH :	79746	Z#:	095169
Contact :							
RCRA Rev :	RAEL, MICHELLE	MS :	J595	PH :	54000	Z#:	120950
Status :	ACTIVE	Activation Date :	24-Jan-2000	Expiration Date:	24-Jan-2001		
Group :	ESAWMM	TA :	16	Bldg :	000386	Room:	NA

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Less-than-90-days Storage Area Site ID# 80**
Method of Char : **Analysis/Documents Attached**
Chemical/Physical Analysis **Number: 99DS581**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Powder/Ash**

Matrix Type : **Homogeneous**

Waste/Proc Desc : ASH FROM 38[illegible] FLASH PAD. ATT: NEW MEXICO SPECIAL WASTE

Ignitability : **Not ignitable**

Corrosivity : **Non-aqueous**

Reactivity : **Non-reactive**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals :

Contaminant	Method	Limit	Min	Max	Unit
BARIUM	**TCLP**	**Y**			**PPM**
MERCURY	**TCLP**	**Y**			**PPM**

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	ASH	**98**	**100**	**%**

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **NON-HAZARDOUS WASTE**

Misc. Category : **NEW MEXICO SPECIAL WASTE**

Waste Classification : **NEW MEXICO SPECIAL WASTE**

EPA Hazardous Waste Code : N/A

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127 Eastgate Drive, 212-C • Los Alamos, New Mexico 87544 • (505) 662-2558

Explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

LOS ALAMOS NATIONAL LABS
attn: **DUSTIE STEPHENS**
MAIL STOP K491/ESH-19
LOS ALAMOS, NM 87545

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **LOS ALAMOS NATIONAL LABS**
Project: **9909A02 TA-16 STAD 8M02CR2024000000**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID ***99DS581*** Sample Matrix ***ASH*** Sample Collected *09/14/99 09:30:00*

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
9909219-02B		**SW846 1311/3010A/6010A ICP TCLP**							
M991092	MW.1999.1135-62	7440-38-2	Arsenic	ND	mg / L	1	0.1	2	09/30/99
M991092	MW.1999.1135-62	7440-43-9	Cadmium	ND	mg / L	1	0.02		09/30/99
M991092	MW.1999.1135-62	7440-47-3	Chromium	ND	mg / L	1	0.02		09/30/99
M991092	MW.1999.1135-62	7439-92-1	Lead	ND	mg / L	1	0.05		09/30/99
M991092	MW.1999.1135-62	7782-49-2	Selenium	ND	mg / L	1	0.05		09/30/99
M991092	MW.1999.1135-62	7440-22-4	Silver	ND	mg / L	1	0.04	2	09/30/99
9909219-02B		**SW846 1311/3010A/7000 series AA-FL TCLP**							
M991101	MW.1999.1141-12	7440-39-3	Barium	3.2	mg / L	1	0.5		10/01/99
9909219-02B		**SW846 1311/7470 CVAA TCLP**							
M991098	MT.1999.2361-5	7439-97-6	Mercury	0.0006	mg / L	1	0.0002		10/01/99

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ct: 9909A02 TA-16 STAD 8M02CR2024000000

**** Sample specific Detection Limit is determined by multiplying the sample Dilution Factor by the listed Reporting Detection Limit. ****

**** ND = Not detected: less than the sample specific Detection Limit. Results relate only to the items tested. ****

footnote [2] This sample was utilized for the matrix spike and duplicate. Please note that the recoveries were outside of QC criteria, suggesting matrix interference problems. This should be taken into account when reviewing the data.

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 32054

Generator :	GARCIA, ROBERT F	MS :	C930	PH :	76891	Z#:	076368
WMC :	STADELMAIER, AL	MS :	C928	PH :	79746	Z#:	095169
Contact :							
RCRA Rev :	RAEL, MICHELLE	MS :	J595	PH :	54000	Z#:	120950
Status :	ACTIVE	Activation Date :	24-Jan-2000	Expiration Date:	24-Jan-2001		
Group :	ESAWMM	TA :	16	Bldg :	000387	Room:	NA

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Waste Accumu : **Less-than-90-days Storage Area Site ID# 80**
Method of Char : **Analysis/Documents Attached**
Chemical/Physical Analysis **Number: 00DS017**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**

Waste Sources : **Materials Processing/Production**

Waste Matrix : **Powder/Ash**

Matrix Type : **Homogeneous**

Waste/Proc Desc : ASH FROM 401 FILTER VESSEL. ATT: NEW MEXICO SPECIAL WASTE

Ignitability : **Not ignitable**

Corrosivity : **Non-aqueous**

Reactivity : **Non-reactive**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals :

Contaminant	Method	Limit	Min	Max	Unit
BARIUM	**TCLP**	**Y**			**PPM**

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	ASH	**95**	**100**	**%**

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **NON-HAZARDOUS WASTE**

Misc. Category : **NEW MEXICO SPECIAL WASTE**

Waste Classification : **NEW MEXICO SPECIAL WASTE**

EPA Hazardous Waste Code : N/A

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127 Eastgate Drive, 212-C • Los Alamos, New Mexico 87544 • (505) 662-2558

Explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

LOS ALAMOS NATIONAL LABS
attn: **DUSTIE STEPHENS**
MAIL STOP K491/ESH-19
LOS ALAMOS, NM 87545

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **LOS ALAMOS NATIONAL LABS**
Project: **0001173** **TA-16 STAD XAHV 0300 0000 0000**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID ***00DS017*** Sample Matrix ***MS*** Sample Collected ***01/18/00 12:30:00***

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0001173-01B		**SW846 1311/3010A/6010A ICP TCLP**							
M0061	MW.2000.80-36	7440-38-2	Arsenic	ND	mg / L	1	0.1		01/19/00
M0061	MW.2000.80-36	7440-39-3	Barium	10.6	mg / L	1	0.1		01/19/00
M0061	MW.2000.80-36	7440-43-9	Cadmium	ND	mg / L	1	0.02		01/19/00
M0061	MW.2000.80-36	7440-47-3	Chromium	ND	mg / L	1	0.02		01/19/00
M0061	MW.2000.80-36	7439-92-1	Lead	ND	mg / L	1	0.05		01/19/00
M0061	MW.2000.80-36	7782-49-2	Selenium	ND	mg / L	1	0.05		01/19/00
M0061	MW.2000.80-36	7440-22-4	Silver	ND	mg / L	1	0.04		01/19/00
0001173-01B		**SW846 1311/7471 CVAA TCLP**							
M0063	MW.2000.86-11		Mercury	0.0013	mg / L	1	0.0002		01/20/00

Client Sample ID ***00DS018*** Sample Matrix ***MS*** Sample Collected ***01/18/00 12:30:00***

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0001173-02B		**SW846 1311/3010A/6010A ICP TCLP**							
M0061	MW.2000.80-38	7440-38-2	Arsenic	ND	mg / L	1	0.1		01/19/00
M0061	MW.2000.80-38	7440-39-3	Barium	5.6	mg / L	1	0.1		01/19/00
M0061	MW.2000.80-38	7440-43-9	Cadmium	ND	mg / L	1	0.02		01/19/00
M0061	MW.2000.80-38	7440-47-3	Chromium	ND	mg / L	1	0.02		01/19/00
M0061	MW.2000.80-38	7439-92-1	Lead	ND	mg / L	1	0.05		01/19/00

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lient: **LOS ALAMOS NATIONAL LABS**

ject: **0001173** **TA-16 STAD XAHV 0300 0000 0000**

M0061	MW.2000.80-38	7782-49-2	Selenium	ND	mg / L	1	0.05		01/19/00
M0061	MW.2000.80-38	7440-22-4	Silver	ND	mg / L	1	0.04		01/19/00

0001173-02B **SW846 1311/7471 CVAA TCLP**

M0063	MW.2000.86-12		Mercury	0.0009	mg / L	1	0.0002		01/20/00

**** Sample specific Detection Limit is determined by multiplying the sample Dilution Factor by the listed Reporting Detection Limit. ****

**** ND = Not detected: less than the sample specific Detection Limit. Results relate only to the items tested. ****

LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 32400

Generator :	GARCIA, ROBERT F	MS :	C930	PH :	76891	Z#:	076368
WMC :	STADELMAIER, AL	MS :	C928	PH :	79746	Z#:	095169
Contact :							
RCRA Rev :	ELICIO, ANDY	MS :	J595	PH :	76956	Z#:	118692
Status :	ACTIVE	Activation Date :	11-Apr-2000	Expiration Date:	11-Apr-2001		
Group :	ESAWMM	TA :	16	Bldg :	000387	Room:	NA

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Less-than-90-days Storage Area Site ID# 1217**
Method of Char : **Analysis/Documents Attached**
Chemical/Physical Analysis **Number: DS164**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**

Waste Sources : **Materials Processing/Production**

Waste Matrix : **Powder/Ash**

Matrix Type : **Heterogeneous**

Waste/Proc Desc : ASH FROM 401 FILTER VESSEL ATT: NEW MEXICO SPECIAL WASTE

Ignitability : **Not ignitable**

Corrosivity : **Non-aqueous**

Reactivity : **Non-reactive**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals :

Contaminant	Method	Limit	Min	Max	Unit
ARSENIC	**TCLP**	**Y**			**PPM**
BARIUM	**TCLP**	**Y**			**PPM**
MERCURY	**TCLP**	**Y**			**PPM**

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	ASH AND SAND	**99**	**100**	**%**

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **NON-HAZARDOUS WASTE**

Misc. Category : **NEW MEXICO SPECIAL WASTE**

Waste Classification : **NEW MEXICO SPECIAL WASTE**

EPA Hazardous Waste Code : N/A

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Explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

LOS ALAMOS NATIONAL LABS
attn: **DUSTIE STEPHENS**
MAIL STOP K491/ESH-19
LOS ALAMOS, NM 87545

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **LOS ALAMOS NATIONAL LABS**
Project: **0003022** **TA-16 8M02CRF100000000**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID ***00DS164*** Sample Matrix ***ASH/SAND*** Sample Collected ***03/01/00 08:45:00***

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0[illegible]2-01B		SW846 1311/3010A/6010A ICP TCLP							
M00236	MW.2000.349-33	7440-38-2	Arsenic	0.1	mg / L	1	0.1		03/13/00
M00236	MW.2000.313-67	7440-39-3	Barium	2.4	mg / L	1	0.1		03/07/00
M00236	MW.2000.349-33	7440-43-9	Cadmium	ND	mg / L	1	0.02		03/13/00
M00236	MW.2000.313-67	7440-47-3	Chromium	ND	mg / L	1	0.02		03/07/00
M00236	MW.2000.313-67	7439-92-1	Lead	ND	mg / L	1	0.05		03/07/00
M00236	MW.2000.313-67	7782-49-2	Selenium	ND	mg / L	1	0.05		03/07/00
M00236	MW.2000.313-67	7440-22-4	Silver	ND	mg / L	1	0.04		03/07/00
0003022-01B		SW846 1311/7470 CVAA TCLP							
M00284	MW.2000.354-16		Mercury	0.0005	mg / L	1	0.0002		03/14/00

*** Sample specific Detection Limit is determined by multiplying the sample Dilution Factor by the listed Reporting Detection Limit. ***
*** ND = Not detected: less than the sample specific Detection Limit. Results relate only to the items tested. ***

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LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 32542

Generator :	GARCIA, ROBERT F	MS :	C930	PH :	76891	Z#:	076368
WMC :	STADELMAIER, AL	MS :	C928	PH :	79746	Z#:	095169
Contact :							
RCRA Rev :	RAEL, MICHELLE	MS :	J595	PH :	54000	Z#:	120950
Status :	ACTIVE	Activation Date :	01-Jun-2000	Expiration Date:	01-Jun-2001		
Group :	ESAWMM	TA :	16	Bldg :	000387	Room:	NA

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Waste Accumu : **Less-than-90-days Storage Area Site ID# 1217**
Method of Char : **Analysis/Documents Attached**
Chemical/Physical Analysis **Number: 00DS209**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Powder/Ash**

Matrix Type : **Homogeneous**

Waste/Proc Desc : BURNGROUND ASH FROM 401 FILTER VESSEL. ATT: NEW MEXICO SPECIAL WASTE.

Ignitability : **Not ignitable**

Corrosivity : **Non-aqueous**

Reactivity : **Non-reactive**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals :

Contaminant	Method	Limit	Min	Max	Unit
BARIUM	**TCLP**	**Y**			**PPM**

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	ASH	**98**	**100**	**%**

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **NON-HAZARDOUS WASTE**

Misc. Category : **NEW MEXICO SPECIAL WASTE**

Waste Classification : **NEW MEXICO SPECIAL WASTE**

EPA Hazardous Waste Code : N/A

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Explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

LOS ALAMOS NATIONAL LABS
attn: **DUSTIE STEPHENS**
MAIL STOP K491/ESH-19
LOS ALAMOS, NM 87545

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **LOS ALAMOS NATIONAL LABS**
Project: **0004053 TA-16 STADELMAIER**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID ***00DS209*** Sample Matrix ***MS*** Sample Collected ***04/05/00 11:10:00***

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0[illegible]3-01B		**SW846 1311/3010A/6010A ICP TCLP**							
M00383	MW.2000.520-64	7440-38-2	Arsenic	ND	mg / L	1	0.1		04/11/00
M00383	MW.2000.520-64	7440-39-3	Barium	12.6	mg / L	1	0.1		04/11/00
M00383	MW.2000.520-64	7440-43-9	Cadmium	ND	mg / L	1	0.02		04/11/00
M00383	MW.2000.520-64	7440-47-3	Chromium	ND	mg / L	1	0.02		04/11/00
M00383	MW.2000.520-64	7439-92-1	Lead	ND	mg / L	1	0.05		04/11/00
M00383	MW.2000.589-24	7782-49-2	Selenium	ND	mg / L	1	0.05		04/19/00
M00383	MW.2000.520-64	7440-22-4	Silver	ND	mg / L	1	0.04		04/11/00
0004053-01B		**SW846 1311/7470 CVAA TCLP**							
M00411	MW.2000.560-46		Mercury	ND	mg / L	1	0.0002		04/17/00

**** Sample specific Detection Limit is determined by multiplying the sample Dilution Factor by the listed Reporting Detection Limit. ****
**** ND = Not detected: less than the sample specific Detection Limit. Results relate only to the items tested. ****

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LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 33267

Generator :	GARCIA, ROBERT F	MS :	C930	PH :	76891	Z#:	076368
WMC :	STADELMAIER, AL	MS :	C928	PH :	79746	Z#:	095169
Contact :							
RCRA Rev :	CORIZ, MICHELLE	MS :	J595	PH :	54000	Z#:	120950
Status :	ACTIVE	Activation Date :	30-Nov-2000	Expiration Date:	30-Nov-2001		
Group :	ESAWMM	TA :	16	Bldg :	000386	Room:	NA

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Waste Accumu : **Less-than-90-days Storage Area Site ID# 80**
Method of Char : **Chemical/Physical Analysis** **Number: See Attached**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Powder/Ash**

Matrix Type : **Heterogeneous**

Waste/Proc Desc : ASH FROM BURN TRAY #399, SAMPLE NUMBER #00DS676

Ignitability : **Not ignitable**

Corrosivity : **Non-aqueous**

Reactivity : **Non-reactive**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals :

Contaminant	Method	Limit	Min	Max	Unit
BARIUM	**TCLP**		**0**	**8500**	**PPM**

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	ASH	**99**	**100**	**%**

LDR and Underlying Hazardous Constituents Information
Non-Wastewater/Wastewater Category: **Non Wastewater**
Notification of California List Applicability: N/A
Notification Of Underlying Hazardous Constituents:

Constituents
Barium

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **HAZARDOUS WASTE**

Misc. Category : N/A

Waste Classification : **HAZARDOUS WASTE**

•EPA Hazardous Waste Code : **D005**

ASSAIGAI
ANALYTICAL
LABORATORIES, INC.
7300 Jefferson, NE • Albuquerque, New Mexico 87109 • (505) 345-8964 • FAX (505) 345-7259
3332 Wedgewood Dr., Suite N • El Paso, Texas 79925 • (915) 593-6000 • FAX (915) 593-7820
127 Eastgate Drive, 212-C • Los Alamos, New Mexico 87544 • (505) 662-2558

Explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

LOS ALAMOS NATIONAL LABS
attn: **DUSTIE STEPHENS**
MAIL STOP K491/ESH-19
LOS ALAMOS, NM 87545

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **LOS ALAMOS NATIONAL LABS**
Project: **0009253 J2ER 2000 0000 0000**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID ***00DS676*** Sample Matrix ***ASH*** Sample Collected ***09/18/00 13:15:00***

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0009253-01B		**SW846 1311/3010A/6010A ICP TCLP**							
M001082	MW.2000.1413-58	7440-38-2	Arsenic	ND	mg / L	1	0.1		09/27/00
M001082	MW.2000.1476-15	7440-39-3	Barium	8500	mg / L	100	0.1		10/05/00
M001082	MW.2000.1413-58	7440-43-9	Cadmium	ND	mg / L	1	0.02		09/27/00
M001082	MW.2000.1413-58	7440-47-3	Chromium	ND	mg / L	1	0.02		09/27/00
M001082	MW.2000.1413-58	7439-92-1	Lead	ND	mg / L	1	0.05		09/27/00
M001082	MW.2000.1413-58	7782-49-2	Selenium	ND	mg / L	1	0.05		09/27/00
M001082	MW.2000.1413-58	7440-22-4	Silver	ND	mg / L	1	0.04		09/27/00
0009253-01B		**SW846 1311/7470 CVAA TCLP**							
M001142	MW.2000.1533-24	7439-97-6	Mercury	ND	mg / L	1	0.0002		10/17/00

**** Sample specific Detection Limit is determined by multiplying the sample Dilution Factor by the listed Reporting Detection Limit. ****
**** ND = Not detected: less than the sample specific Detection Limit. Results relate only to the items tested. ****

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LOS ALAMOS NATIONAL LABORATORY
WASTE PROFILE SYSTEM
WPF #: 33362

Generator :	GARCIA, ROBERT F	MS :	C930	PH :	76891	Z#:	076368
WMC :	STADELMAIER, AL	MS :	C928	PH :	79746	Z#:	095169
Contact :							
RCRA Rev :	CORIZ, MICHELLE	MS :	J595	PH :	54000	Z#:	120950
Status :	ACTIVE	Activation Date :	17-Jan-2001	Expiration Date:	17-Jan-2002		
Group :	ESAWMM	TA :	16	Bldg :	000386	Room:	NA

You are required to keep a copy of the WPF(s) in your files for at least three years. This WPF(s) is valid for one year or as long as the composition of the waste you have characterized remains the same and the generator remains the same. Should your waste or generator change, please submit a new WPF to FWO-SWO Customer Service, and attach a copy of the WPF which is being replaced.

Waste Accumu : **Less-than-90-days Storage Area Site ID# 80**
Method of Char : **Analysis/Documents Attached**
Chemical/Physical Analysis **Number: Attached**

Waste Type : **Process Waste/Spent Chemical/Other**
Waste Classes: RCA Waste - **Not RCA Waste**
RAD Waste - **Non-rad**
Classif/Sensi - **N**

Waste Category: **Organic**

Waste Sources : **Research/Development/Testing**

Waste Matrix : **Powder/Ash**

Matrix Type : **Homogeneous**

Waste/Proc Desc : ASH FROM #388 FLASH PAD #00DS0070 AND FROM #399 BURN TRAY #00DS0071.

Ignitability : **Not ignitable**

Corrosivity : **Non-aqueous**

Reactivity : **Non-reactive**

Boiling Point : **Not applicable**

Toxicity Characteristic Metals :

Contaminant	Method	Limit	Min	Max	Unit
BARIUM	**TCLP**	**Y**			**PPM**
CADMIUM	**TCLP**	**Y**			**PPM**
MERCURY	**TCLP**	**Y**			**PPM**

Toxicity Characteristic Organic Compounds: N/A

Additional Chemical Constituents and Contaminants :

CAS NO	Constituent	MIN	MAX	UOM
	ASH	**98**	**100**	**%**

WASTE CHARACTERIZATION INFORMATION

Radioactivity Category : **NON-RAD**

RCRA Category : **NON-HAZARDOUS WASTE**

Misc. Category : N/A

Waste Classification : **NON-HAZARDOUS WASTE**

EPA Hazardous Waste Code : N/A

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127 Eastgate Drive, 212-C • Los Alamos, New Mexico 87544 • (505) 662-2558

Explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

LOS ALAMOS NATIONAL LABS
attn: DUSTIE STEPHENS
MAIL STOP K491/ESH-19
LOS ALAMOS, NM 87545

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: LOS ALAMOS NATIONAL LABS
Project: 0011082 8M02 XF70 0000 0000

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID: 00DS771 — Sample Matrix: ASH — Sample Collected: 11/08/00 13:00:00

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
1082-01B		SW846 1311/3010A/6010A ICP TCLP							
M001233	MW.2000.1663-27	7440-38-2	Arsenic	ND	mg / L	1	0.1		11/14/00
M001233	MW.2000.1663-27	7440-39-3	Barium	1.3	mg / L	1	0.1		11/14/00
M001233	MW.2000.1663-27	7440-43-9	Cadmium	0.090	mg / L	1	0.02		11/14/00
M001233	MW.2000.1663-27	7440-47-3	Chromium	ND	mg / L	1	0.02		11/14/00
M001233	MW.2000.1663-27	7439-92-1	Lead	ND	mg / L	1	0.05		11/14/00
M001233	MW.2000.1663-27	7782-49-2	Selenium	ND	mg / L	1	0.05		11/14/00
M001233	MW.2000.1663-27	7440-22-4	Silver	ND	mg / L	1	0.04		11/14/00
0011082-01B		SW846 1311/7470 CVAA TCLP							
M001239	TT.2000.1317-6	7439-97-6	Mercury	0.0004	mg / L	1	0.0002		11/15/00

Client Sample ID: 00DS772 — Sample Matrix: ASH — Sample Collected: 11/08/00 13:00:00

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0011082-02A		SW846-8270C Dioxin Scan							
00.1300	TT.2000.1300-1		2,3,7,8-Tetrachlorodibenzo-p-dioxin	ND	ug/Kg	1	50		11/13/00

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APPENDIX E

COPY OF "STORM WATER POLLUTION PREVENTION PLAN PREPARED FOR TECHNICAL AREA 16 BURN GROUND UNIT"

STORM WATER POLLUTION PREVENTION PLAN

prepared for:

TECHNICAL AREA 16
BURN GROUND UNIT

Los Alamos National Laboratory

In fulfillment of the requirements for the:

NPDES Multi-Sector General Permit for Storm Water Discharges Associated with Industrial Activity

September 2001

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APPENDICES

Appendix A- Pollution Prevention Team
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PREFACE

Storm Water Pollution Prevention Plans (SWPPPs) must be developed in accordance with the provisions of the Clean Water Act (33 U.S.C. 1251 et seq.) and the regulations established by the U.S. Environmental Protection Agency (U.S. EPA) for the National Pollutant Discharge Elimination System (NPDES) Multi-Sector General Permit for Storm Water Discharges Associated with Industrial Activity (U.S. EPA, 1992c at 41235). The applicable Storm Water Discharge Permit is EPA Multi-Sector General Permit Number NMR05A509.

This SWPPP applies to discharges of storm water discharges associated with industrial activities from the hazardous waste treatment, storage or disposal facilities at the Technical Area (TA) 16 Burn Ground. This Storm Water Pollution Prevention Plan addresses the active structures at the TA-16 Burn Ground Unit. The structures undergoing closure by LANL/s Environmental Restoration Program (MDA-P and TA-16-387) and are covered under different SWPPPs.

GENERAL 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 gathered and evaluated 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."

D A Hopkins for RVO

Date 9/26/01

Ricardo Ortiz
Group Leader
ESA Division Weapon Materials and Manufacturing (WMM) Group

Date 9/26/01

Robert Grace
Group Leader
ESA Division Facilities Management (FM) Group

1.0 STORM WATER POLLUTION PREVENTION TEAM

This Storm Water Pollution Prevention Plan (SWPPP) is applicable to operations at Technical Area 16 (TA-16) Burn Ground at S-Site, Los Alamos National Laboratory, Los Alamos County, New Mexico. The Burn Ground is under the control of Engineering Sciences and Applications (ESA) Division, Weapon Materials and Manufacturing (WMM) Group, which is responsible for the safe treatment and handling of high-explosives (HE)-contaminated waste material generated by the HE processing facilities.

The Pollution Prevention Team consists of personnel appointed by ESA-WMM. The members are selected on the basis of their familiarity with operations, equipment, and facilities at TA-16 Burn Ground. The list of current team members, included in Appendix A, will be revised whenever a member is added to or removed from the team. The duties of each team member are also described in the Appendix.

2.0 DESCRIPTION OF POTENTIAL POLLUTANT SOURCES

This section of the SWPPP provides a description of the following information:

- the drainage patterns at the Burn Ground (Section 2.1),
- the types of materials handled at the site and areas of legacy contamination and spills which may impact storm water quality (Section 2.2), and
- the storm water sampling program (Section 2.3).

2.1 Drainage Patterns

The drainage pattern map is included as Appendix B. The map indicates:

- the predicted direction of flow based on topography,
- active structures, where materials may be exposed to storm water,
- solid waste management units (SWMUs) where legacy contamination may exist, and
- best management practices, including check dams and other structures.

2.2 Inventory of Exposed Materials, Risk Identification, and Management of Run-On/Runoff

This section covers materials that may be exposed to storm water for current activities (Section 2.2.1), legacy contaminants (Section 2.2.2), spills and leaks that have occurred since the inception of this plan (Section 2.2.3), and non-storm water discharges (Section 2.2.4).

2.2.1 Current Activities

This section provides a general description of the structures at the Burn Ground, types of materials handled, and residues generated that may be exposed to storm water. A facility site plan showing these structures is located in Appendix B. The materials exposed to storm water and the practices used to minimize exposure to runon/runoff are summarized in Table 2-1. In the past, another structure, the TA-16-387 flash pad, was included in this SWPPP. However, this structure is being closed by Environmental Restoration as part of the closure of MDA-P and is covered under that project's SWPPP.

TA-16-388 Flash Pad

Flashing operations are conducted at TA-16-388 to remove HE from equipment/ materials. The structure consists of a concrete pad on which racks or trays are placed on which the materials to be flashed are staged. Propane burners are used to heat the materials to a temperature where the HE degrades.

TA-16-388 and -394 Oil/Solvent Burn Trays

TA-16-388 oil/solvent burning operations are conducted in a cylindrical kettle or in a tray on the TA-16-388 flash pad. The kettle/tray and their secondary containment are located on cement pads. Propane-fueled burners are used to evaporate then burn vapors.

The activities at the -394 burn tray have been relocated to the newly constructed -388 tray and TA-16-394 is underging closure in accordance with 20 NMAC 4.1 Subpart V (3-1-97) requirements. On-site closure activities were completed in FY01, and the closure is now pending NMED approval. Since there are no materials being treated at this structure, there is no entry for it in Table 2-1.

TA-16-399 HE Burn Tray

This burn pad consists of an elevated metal tray lined with firebrick and sand for burning HE solids. Burning will destroy the HE. However, if inerts contaminated with HE are also burned, there may be some barium-contaminated residue.

TA-16-401 and –406 Filter Vessels Treatment Operations

These filter vessels are constructed of welded steel and lined with firebricks. Liquid passes through the sand/gravel filter bed into a fluid drain at the base of the filter vessel and through carbon adsorption units at the HE Wastewater Treatment Facility (HEWTF) located near the filter vessels. Solids collected on the surface of the sand are burned to destroy the HE. Since these filters are piped directly to the HEWTF, any storm water that came into contact with these materials would be treated at the HEWTF prior to release. It would then be considered treated industrial water and not storm water. Sand is removed after a burn and treated at the TA-16-388 Flash Pad. Clean sand piles used to replenish the filters are located adjacent to the filters. A new sand pile will be located across the asphalt drive from the filter vessels. The site is curbed on the upslope side, which will prevent runon. The pile will be bermed on the downslope side to prevent runoff.

TA-16-1409 Incinerator

The incinerator was removed in FY00 and the site is undergoing closure in accordance with 20 NMAC 4.1 Subpart V (3-1-97) requirements. Closure is pending NMED approval. Since there is no activity at this structure, there are no materials that are exposed to stormwater. Since there are no materials being treated at this structure, there is no entry for it in Table 2-1.

TA-16-389 Control Building

TA-16-389 is the control building for burning operations. There are no materials associated with this structure that are exposed to stormwater. Therefore, it is not listed in Table 2-1.

TA-16-363HE Wastewater Treatment Facility

TA-16-363 is the old HEWTF. It was replaced by TA-16-1508. There are no materials associated with this building that are exposed to storm water. Therefore, it is not listed in Table 2-1.

TA-16-1508 HE Wastewater Treatment Facility
TA-16-1508 is the new HEWTF. The facility is totally enclosed and there are no materials exposed to stormwater. Therefore, it is not listed in Table 2-1.

Other

A covered <90 day storage area (TA-16-386) is maintained at the Burn Ground. Materials stored in this area are already packaged in drums and are placed on a covered concrete pad. Therefore, there are no materials exposed to storm water and it is not listed in Table 2-1.

Vehicles are used to deliver and stage material at the burn structures. These vehicles are not resident and there have been no historical releases from them. Staging materials and packaging of residues do not occur during precipitation events. Therefore, there has been no exposure of materials during loading and unloading. There are two resident pump trucks used to transport HE-contaminated wastewater to the HEWTF. They may be parked near the HEWTF. However, they are not serviced at the Burn Ground. They are well maintained and there has been no history of oil or gasoline leaks from them.

2.2.2 Solid Waste Management Units (SWMUs)

The Laboratory's 1990 Solid Waste Management Units Report and subsequent documents identified areas with possible legacy contamination (referred to as SWMUs) at the TA-16 Burn Ground. These SWMUs are shown on the figure in Appendix B. Table 2-2 describes the TA-16 Burn Ground SWMUs. If the SWMUs still have ongoing processes, the storm water measures and controls for current activities are covered in Section 2.2.1. This section lists only legacy use, legacy contaminants, and covers only measures and controls for legacy contamination. The TA-16-387 Flash Pad (SWMU 16-010(b)) is no longer operational. It has been transferred to MDA-P for closure and is covered in that project's SWPPP. SWMU 16-008(b) is not included because it has already undergone closure and significant contaminants no longer exist.

2.2.3 Spills and Leaks

Review of ESA-WMM, ESA-FM and ESH-18 records and Group ESA-WMM operations indicate one reportable spill/leak has occurred at the Burn Ground in the past 5 years; none were recorded in FY00. Information on the one spill/leak follows:

- Release of potable water was discovered during AP 4.5/SPCC inspection on 7/25/97. The potable water discharge was from the TA-16 Burn Ground underground water system. The release flowed through a SWMU before reaching a straw bale best management practice. The BMP successfully worked to remove an oily sheen noticed before the straw bales. No water reached the stream course. No erosion occurred at the SWMU. The leak was fixed 7/30/97 and the discharge ceased.
- *15-Day Written Notification of a Release from PRS 16-010(j) (Former OU 1082)* was submitted to Mr. Benito Garcia, NMED-HRMB, from Jorg Jansen, Program Manager for LANL/ER Project, on August 8, 1997.

2.2.4 Non-Storm Water Discharges

In June 1993, Santa Fe Engineering conducted a Wastewater Stream Characterization (WSC) of the Burn Ground. The characterization included interviews, review of engineering drawings, and dye test studies of all piping discharging into the environment from buildings. WSC Report #11 details the characterization for the Burn Ground. The non-storm water discharge assessment and certification form, included in Appendix C, certifies that all storm water outfalls have been evaluated for the presence of non-storm water discharges. Sources of non-storm water discharges at the Burn Ground include:

- testing of the fire hydrants,
- the NPDES-permitted discharge from the HE Wastewater Treatment Facility (outfall 05a055), and
- the septic tank serving the TA-16-389 control building restroom.

2.3 Storm Water Sampling

The Laboratory's Multi-Sector General Permit requires sampling for Treatment Storage and Disposal Facilities. The TA-16 Burn Grounds falls into this category thus requiring quarterly analytical monitoring. Stormwater monitoring is conducted directly from the site at Station E257 Canon del Valle tributary at S-Site. A station, E256 Canon del Valle below MDA-P, also exists on the other side of the drainage to collect possible runoff draining in this direction. The map included in the plan as Figure 2-1 shows the stormwater station locations relative to the regulated activity for this site. All stormwater compliance monitoring related to this site is conducted by ESH-18 Water Quality and Hydrology Group. All collection, preservation, and analysis meets the requirements listed in Title 40, Part 136.

Figure 2-1
TA-16 Burn Grounds Stormwater Stations

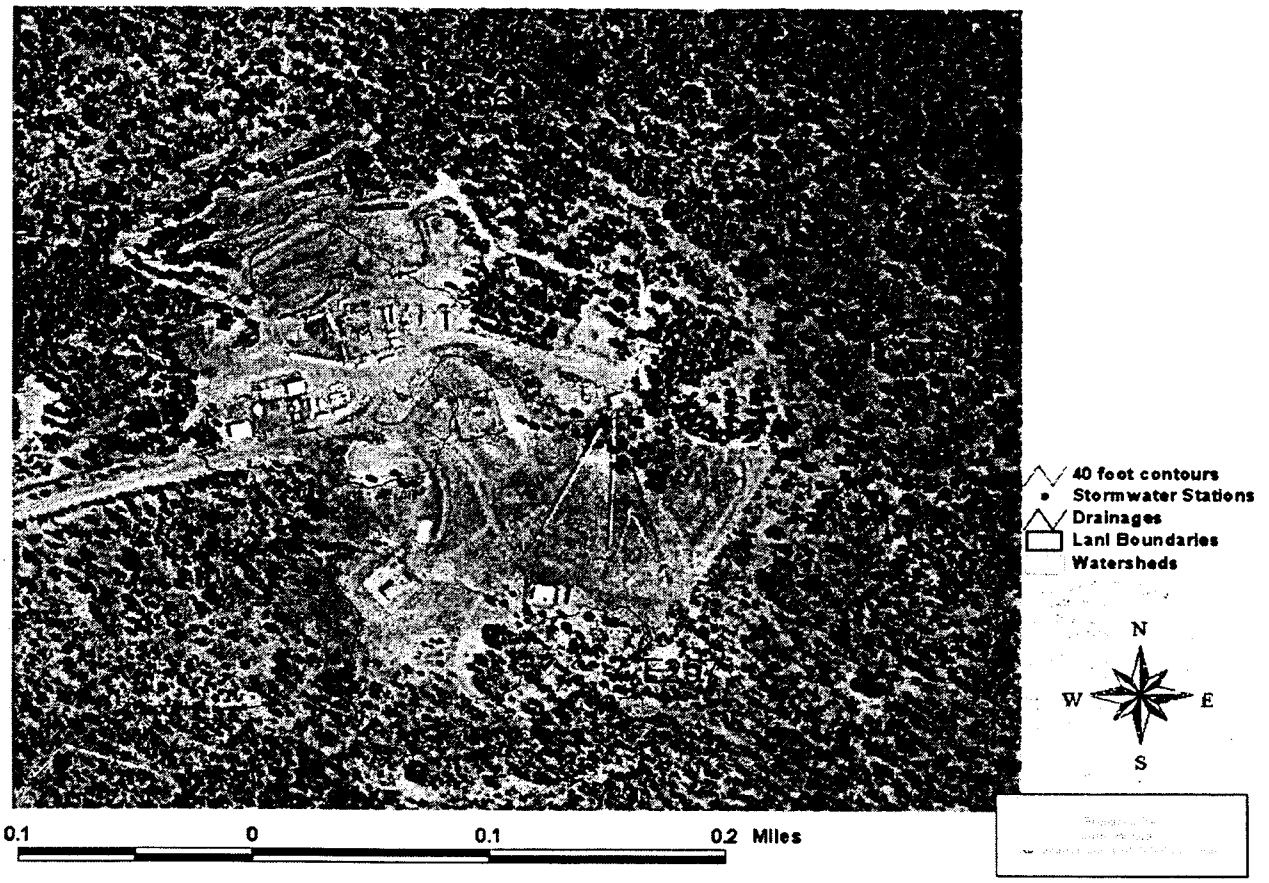


Table 2.-1.
Materials Management and Storm Water Exposure Minimization Practices for Materials Subject to Runon/Runoff

Description of Exposed Significant Materials	Period of Exposure	Materials Management Practices	Storm Water Minimization Practices
Ash from 388 Flash Pad	Periodic	After the burn, ash is sampled and placed in barrels, which are stored in a covered <90 day storage area until analytical results are available Depending on the analytical results, the ash is shipped to an appropriate disposal or treatment location.	A retractable cover prevents storm water runon/runoff except during burning. The flash pad has secondary containment.
HE-contaminated materials and equipment at 388 Flash Pad.	Periodic	After flashing, equipment is be disposed as NMED special waste or salvaged.	A retractable cover prevents storm water run-on/runoff except during burning. The flash pad has secondary containment.
Oil/solvent at 388 Burn Tray or Flash Pad	Constant	Oil/solvents are staged the day of burning. Residues are sampled, barrelled, stored, and disposed in the same manner as described for the 388 ash.	A retractable cover prevents storm water run-on/runoff except during burning. The burn tray has secondary containment.
Oil leakage from equipment awaiting flashing on 388 Flash Pad	Periodic	Oil is drained from hydraulic equipment before it is transported to the Burn Ground; residual could leak. Any residual oil is burned during flashing.	A retractable cover prevents storm water run-on/runoff except during burning. The flash pad has secondary containment.
HE materials at 399 Burn Tray	Periodic	HE is staged just before burning and never when there is precipitation. After the burn, residues (if any are present) are sampled, barreled, stored, and disposed in the same manner as described for the 388 ash.	A cover is used after burning to prevent residue dispersal and runon/runoff. The pad area is bermed.
Sand/ash mixtures at 401/406	Periodic	Ash (and unburned residues) and a small amount of sand are removed after each burn. If any sand/ash is spilled during drumming, it is immediately cleaned up and added to the drummed material. The ash and sand are sampled, drummed, stored, and disposed as described above for the 388 ash.	Any runoff from the filters is routed to and treated by the HEWTF.
Sand piles at 401/406	Periodic	Clean sand is stored on the ground at TA-16-401/406. When the sand in the filters becomes clogged, it is replaced with clean sand.	The clean sand is stored at a high point that is not subject to drainage.
Outdoor vehicle and equipment storage/parking	Periodic	Vehicles and cranes are used to transport materials for burning to the Burn Ground. After staging the structures, the vehicles are removed from the site. Tanker trucks used to transport HE-contaminated water to the HEWTF are stored at the Burn Grounds. During periods of inactivity, they may be stored in a garage.	Loading and unloading activities are not conducted during storm water events. Vehicles used for loading/unloading the burn structures are not resident at the Burn Ground. The pump trunks used to transport HE-contaminated wastewater are well-maintained and not serviced on-site.

Table 2-2. Burn Ground SWMUs

SWMU and Legacy Use	Structure No.	Legacy Contaminants	Storm Water Measures and Controls
16-005(g) Sand Filter for Basket Wash	TA-16-393	Decommissioned	NA
16-006(e) Septic System	TA-16-385	Unknown	NA
16-010(c) HE Burn Tray	TA-16-388	HE, Barium	See Section 3.4 for BMP remedial actions for this site
16-010(d) HE Burn Tray	TA-16-399	HE, Barium	Tray area bermed Rock check dams in drainage
16-010(e,f) Sand filters for Basket Wash Facility	TA-16-401 TA-16-406	Same as 16-010(k-n)	Old sand filters removed and new sand filters installed with drainage to HEWTF
16-010(h) Basket Wash Facility	TA-16-390	See data in Appendix E	Drains from basket wash closed - no longer any drainage to environment
16-010(i) Filter Bed for Basket Wash Facility and Burn Pad	TA-16-392	See data in Appendix E	Vegetated slopes Rock check dams
16-010(j) Filter Bed for Basket Wash facility	TA-16-394	See data in Appendix E	Drain plugged Vegetated slopes
16-010(k,l,m,n) Basket Wash Facility Troughs	TA-16-1129 TA-16-1134 TA-16-1135 TA-16-1136	See data in Appendix E	Vegetated slopes Rock check dams
16-028(a) South Drainage from Burn Ground	None	See data in Appendix E	Rock check dams

3.0 MEASURES AND CONTROLS

In addition to the material management practices and storm water controls documented in Section 2, the programs described in this section are used to minimize storm water impacts.

3.1 Good Housekeeping

All waste management, storage, and operational areas are maintained in a clean and orderly state. Burn Ground personnel perform inspections of the active structures at least weekly and document the condition of the materials being handled, any poor housekeeping, spills, and other problems on the *Hazardous and Mixed Waste Facility Inspection Record Form*. These forms are also used to document when remedial action is taken. The original forms are kept at the Burn Ground and copies are provided to ESH-19.

3.2 Preventative Maintenance and Inspections

The preventative maintenance involves timely inspection and maintenance of storm water management devices (containment, earthen berms, etc.). Burn Ground personnel inspect the structures daily when in use and weekly when not in use. A *Hazardous and Mixed Waste Facility Inspection Record Form* is completed for each inspection. Conditions such as spills, deterioration, leaks, and the condition of controls are noted. The need for corrective action is noted on the forms and tracked until complete.

A Comprehensive Site Compliance Evaluation Report for storm water pollution is conducted annually by ESA-WMM, with assistance by ESH-18. This consists of an checklist for a walk-through inspection of the Burn Ground area. Evaluation of erosion and erosion damage is included. The checklist includes specific measures and responsibilities to correct findings from the inspections. The Site Compliance Evaluation is included in this report (see Appendix D), and a copy is provided to ESH-18.

3.3 Sediment and Erosion Control

In addition to the existing run-on/runoff controls described in Section 2, a slope stabilization project was undertaken in FY00 for the TA-16-388 Flash Pad/Burn Tray. The project involved: exess soil removal; construction of a retaining wall on the uphill slope of the burn pad to retain the slope and prevent further erosion; installation of an inerceptor trench above the retaining wall; extension of the asphalt on the east side of the pad/tray; and stabilization of the culvert on the east side using rock. This project was completed in FY01.

3.4 Spill Prevention and Response Procedures

The steps taken to prevent spills are described in Section 3.4.1. Emergency response to spills is described in Section 3.4.2.

3.4.1 Spill Prevention

Containment is used to prevent releases during waste staging, burning, and residue management, as described below:

- The TA-16-388 Flash Pad is located on a concrete pad with walls on the back and on two sides. The pad is sloped toward the back wall, so that any releases will be contained on the pad and can be removed and properly treated or disposed. The flash pad has a retractable cover, mainly used to prevent run-on. However, the cover also acts as containment to ensure that residues are not blown off the pad by wind.

- The TA-16-388 Burn Tray sits in a larger tray, which provides secondary containment for spills that may occur during waste handling. The burn tray is covered when a burn is complete to reduce the likelihood of residue dispersion by wind.

- The TA-16-399 HE Burn Tray is installed on a concrete pad that is surrounded by earthen berms. Wastes are staged on this pad just before a burn, so releases during staging are highly unlikely. After a burn is completed, any residue is covered until it can be removed, reducing the likelihood of dispersion of ash by wind.

- The TA-16-401 and TA-16-406 Sand Filters are contained in steel tanks. Any liquids introduced into the tanks are piped directly into the HE Wastewater Treatment Facility, where they are treated. When solid HE is present on the surface, the sand filters are covered to ensure that the HE does not become windblown and is not accidentally detonated.

- The transport and handling of solid HE and HE-contaminated equipment is designed to ensure that none is spilled. HE is transported in trucks specifically designed not to release HE or permit an explosion in the case of accidents. Solids are unloaded directly onto the appropriate burn structures.

3.4.2 Emergency Response

The Emergency Management & Response (EM&R) Office has been appointed by the Laboratory Director as the organization responsible for emergency management at the Laboratory. In the event of a spill, the EM&R Office must be notified calling **667-6211**. EM&R will then determine appropriate cleanup procedures. If fire or explosion is present, or if the potential for such exists, the situation must be reported by dialing 911 from a non-cellular phone or by activating a fire pull box. Facility spill response procedures are also contained in each Building Emergency Plan. The equipment available for emergency response is listed in Table 3-1.

The completion of a spill report is also required in the event of a spill. Such reporting consists of either internal spill record keeping and external agency notification. The determination for the type of reporting will be made by the EM&R Office and ESH-18 in accordance with Laboratory and DOE policies, and federal and state regulatory reporting requirements. Copies of internal spill reports will be kept by ESH-18 and the responsible organization. External agency

notification may consist of verbal or written notification to the National Response Center, Environmental Protection Agency Region VI, or the New Mexico Environment Department.

3.5 Employee Training

Employee training is essential for effective SWPP Plan implementation and maintenance. The objective of the training program is to instill in employees an understanding of the purpose of the SWPP Plan; to help them recognize situations that could lead to potential storm water contamination; and to provide instruction in proper spill prevention and response, good housekeeping, and material management practices.

Workers responsible for storm water management will receive storm water pollution prevention training. To accomplish this, ESA maintains a Storm Water Pollution Prevention Self Study, which includes sections on the following topics:

- Goals of the Storm Water Pollution Prevention Plan.
- Spill response and cleanup.
- Conducting inspections.
- Good housekeeping and material management practices to prevent storm water pollution.
- Site-specific structures, equipment and procedures designed to minimize erosion and storm water pollution.
- Goals and procedures resulting from the annual Comprehensive Site Compliance Evaluation.
- Any changes in facilities or procedures that are to be implemented as a results of the most recent Comprehensive Site Compliance Evaluation.

ESH-18 will notify ESA if changes in requirements or procedures require further training. ESH-18 will provide such training, as needed. Training records are maintained in the Employee Development System (EDS), the official training database for LANL.

3.6 Recordkeeping and Reporting

The records required to be included in the SWPPP, their location in the plan, and the responsible party are described in Table 3-2.

Table 3-1
Emergency Equipment near the
Technical Area (TA) 16 Burn Ground

FIRE CONTROL EQUIPMENT
Fire extinguishers are located at or in:

Tank-truck garage (TA-16-1507)
Control Building (TA-16-389)
High Explosives Wastewater Treatment Facility (HEWTF) (TA-16-1508)
Each truck used to transport high explosives

Four fire hydrants are located within the TA-16 Burn Ground Unit.
Three additional fire hydrants are located at the TA-16 Burn Ground.
A fire alarm pull station is located at the HEWTF.

SPILL CONTROL
Portable berms to contain spills are stored in an all-weather cabinet near the center of the TA-16 Burn Ground, at the less-than-90-day storage area (TA-16-386), and beside the Control Building.

COMMUNICATION EQUIPMENT
Telephones are available at the Control Building, at the TA-16-401 Sand Filter, at the HEWTF, and at the railroad gate at the entrance to the Burn Ground.

DECONTAMINATION EQUIPMENT
Eyewash stations are located in the tank-truck garage and in the HEWTF.

PERSONNEL PROTECTION EQUIPMENT
Respirators, coveralls, and safety glasses are available for TA-16 personnel during waste-handling operations.
All vehicles are equipped with first-aid kits.

Table 3-2
Recordkeeping Requirements

Requirement	Method of Compliance	Responsible Party
Description of Incidents	Spills are recorded in Section 2.2.3	ESA-WMM
Storm water quality/quantity	Watershed Monitoring Station Network	ESH-18
Inspections and maintenance activities	Comprehensive Site Evaluation Report - see Appendix D	ESA-WMM
	Hazardous and Mixed Waste Facility Inspection Record Form	ESA-WMM

4.0 COMPLIANCE EVALUATION AND PLAN REVISION

EPA regulations require the completion of an annual Comprehensive Site Compliance Evaluation. In accordance with EPA guidelines, the individual performing the Site Compliance Evaluation will do the following:

- Inspect storm water drainage areas for evidence of potential contaminants.
- Evaluate the effectiveness of BMPs.
- Observe structural measures, sediment controls and other storm water BMPs.
- Revise the description of potential pollutants and pollution prevention measures/controls, as needed, within two weeks of the inspection;
- Begin to implement the above changes within 12 weeks of the inspection.
- Prepare a report summarizing inspection results and follow-up actions.
- Sign the report and keep it with the Plan.

4.1 Evaluation Procedures

During the annual Comprehensive Site Compliance Evaluation, the Pollution Prevention Team Coordinator will examine all operational areas for conditions that may contribute to the presence of contaminants in runoff from the facility. The Team Coordinator will use a Site Compliance Evaluation Checklist to ensure that significant areas, structures and conditions are not overlooked during the inspection.

Areas inspected in detail will include material storage areas, recycling areas, waste disposal and storage sites, loading and unloading areas, equipment and vehicle storage areas, and areas affected by non-storm water discharges. Specific items to be evaluated during the inspection of each of these areas include:

- Exposed materials or wastes that may contribute to contamination of storm water runoff.
- Any evidence of spills that may have occurred in the operational areas, and their potential for contributing contamination to runoff.
- Evidence of erosion and sediment transport.
- Areas that may have been altered by construction or other activities so as to change the direction of storm water runoff.
- Condition and effectiveness of storm water management structures.
- Effectiveness of BMPs such as good housekeeping and spill prevention and response measures.
- Any other factors that may require modification of either operating procedures or the contents of the SWPP Plan.

All observations made during the inspection will be documented on the Site Compliance Evaluation Checklist.

4.2 Report on Results of the Site Compliance Evaluation

Within two weeks of the performance of the annual Comprehensive Site Compliance Evaluation, the Pollution Prevention Team Leader will prepare a report describing the results of the inspection. The report will include, as a minimum, the following items:

- Date(s) on which the inspection was performed.
- The personnel who performed the inspection.
- A copy of the Site Compliance Evaluation Checklist.
- A written summary of major observations relating to implementation of the SWPP Plan.
- A summary of all changes made to the SWPP Plan in accordance with Section 4.3 below.
- A description of any incidents of non-compliance with the SWPP Plan that were noted during the inspection.Actions that should be taken to correct noted deficiencies.

The report must also include:

- A certification, signed by the responsible line manager, stating that the facility is, to the best of his or her knowledge, in compliance with the SWPP Plan.

4.3 Revision of Storm Water Pollution Prevention Plan

Amendments to the SWPP Plan will be made, as needed, following the annual Comprehensive Site Compliance Evaluation. This includes reviewing the current plan for accuracy and updating Appendix D to include the newest Site Compliance Evaluation. The Plan should also be amended to reflect:

- Changes in members or duties of the Pollution Prevention Team;
- Significant changes in operational procedures that affect storm water;
- Significant changes in the type of materials handled at the facility;
- Construction changes affection drainage or runoff;
- Changes in control structures; and
- Spills.

The Pollution Prevention Team is responsible for timely amendment of the SWPP Plan. Required revisions (changes in pollutants and measures/controls) to SWPP Plan sections must be made within two weeks after the need for the change is reported to the Pollution Prevention Team. Other changes will be made in a timely manner, as the information becomes available. It is the responsibility of each Pollution Prevention Team member to bring to the attention of the Team Coordinator any changes in facility conditions or operations that require the revision or incorporation of new material to the SWPP Plan.

APPENDIX A

Pollution Prevention Team

TA-16 BURN GROUND

POLLUTION PREVENTION TEAM MEMBER ROSTER

Team Member: Robert Garcia SWPPP Team Coordinator
Phone: 667-6891

Responsibilities: Responsibilities: Supervise all operations at the Burn Ground. Ensure Best Management Practice implementation. Ensure operators receive training specified in SWPPP for storm water pollution prevention. Ensure that SWPPP is implemented and spills are properly reported. Appoints SWPPP team members. Identify when the SWPPP needs to be revised.

Perform TA-16 Burn Ground operations in accordance with the SWPPP. Complete weekly inspections and forward to ESH-19. Complete required training for SWPPP. Ensure that preventive maintenance and scheduled inspections are completed and documented. Implement Best Management Practices identified in the SWPPP.

Team Member: Ann Sherrard or Yvonne Ellington Title: ESH Generalist
Phone: 665-7226 or 667-4462

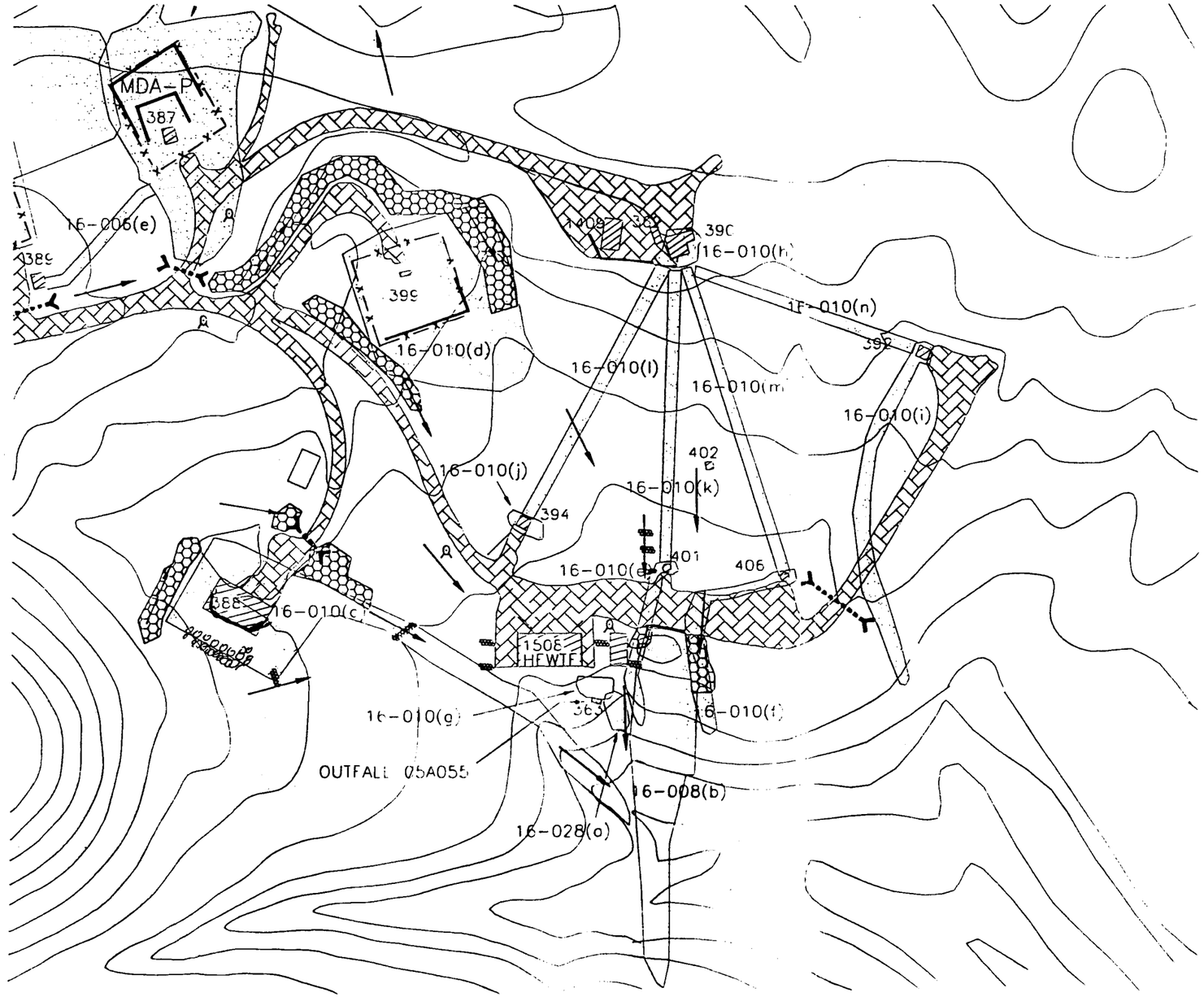
Responsibilities: Revise Storm Water Pollution Prevention Plan, as needed. Conduct the annual Comprehensive Site Compliance Evaluation with assistance of other Storm Water Pollution Prevention Team Member(s). Ensure that annual inspection report is submitted to ESH-18 and included in the SWPPP.

Team Member: Chris McLean Title: Water Quality Specialist
Contact Number: 667-4503

Responsibilities: Site Compliance Evaluation

Appendix B

TA-16 Burn Grounds Site Plan



SYMBOLS LEGEND	
→	DIRECTION OF STORM WATER FLOW
	FIRE HYDRANT
	PAVED ROAD
	EXISTING BUILDING
	CULVERT
	FENCE
	PRS AREA
	BERM OR CURB
	RIP RAP
	ROCK CHECK DAM

N

NO.	DATE	CLASS REV.	REVISIONS	DWN	DES	CHKD	SUB	APP

MERRICK
Engineers & Architects
600 Sixth Street, Los Alamos, New Mexico, 87544, USA
(505) 662-0006, Fax (505) 662-3051

TA-16 BURN GROUNDS SWPP PLAN

SITE PLAN

BLDG. TA-

DRAWN	JCF
DESIGN	
CHECKED	
DATE	1/7/00

SUBMITTED

APPROVED FOR RELEASE

Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

SHEET 1 OF 1

CLASSIFICATION REVIEWER DATE

PROJECT ID

DRAWING NO.

REV. 10

Appendix C

Non-Storm Water Discharge Assessment and Certification

NON-STORM WATER DISCHARGE
ASSESSMENT AND CERTIFICATION

Completed by: Ann Sherrard
Title: ESH Generalist
Date: 2/24/00

Date of Evaluation	Outfall Directly Observed During the Test (Location)	Identify Potential Significant Sources of Non- Storm Water	Method Used to Test or Evaluate Discharge	Is Non-Storm Water Present?	How Often?	Results from Test for Non-Storm Water Discharge
May-92	see Wastewater Stream Characterization Report 11	Discharge for tests of fire hydrants	Visual	No	monthly	see Wastewater Stream Characterization Report
May-92	see Wastewater Stream Characterization Report 11	TA-16-389 Control Building Septic System	Visual	No	daily	see Wastewater Stream Characterization Report
May-92	see Wastewater Stream Characterization Report 11	HEWTF outfall (05a055) Covered under NPDES Permit NM0028355	Visual	Yes - industrial only, permitted	weekly	see Wastewater Stream Characterization Report

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 completed. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name & Official Title: _____

Signature: _____ Date Signed: 10/17/00

Appendix D

Annual Comprehensive
Site Compliance Evaluation Report

COMPREHENSIVE SITE COMPLIANCE EVALUATION REPORT

Name of Facility: TA16 Burn Grounds **Date of Inspection:** 9/20/2001

Describe Specific Evaluation Location (if only evaluating part of the facility):

Frequency of Inspection:

☐ Monthly ☐ Quarterly ☐ Semi-Annual ☒ Annual ☐ Other

Name of Inspector(s): Chris McLean ESH-18, Ann Sherrard ESA, Robert Garcia ESA

Inspector Qualifications: Members of SWPPP Team

Scope:

This comprehensive site compliance evaluation shall include the inspection of all areas where industrial materials or activities are exposed to storm water, areas where spills and leaks have occurred within the past 3 years, and areas where storm water discharges have the potential to impact down gradient activities such as critical habitat and National Historic Preservation sites. Such inspections include, but are not limited to, identification of:

I. Industrial material, residues, or trash on the ground that could contaminate or be washed away in storm water
II. Leaks or spills
III. Off-site vehicle tracking
IV. Migration of raw, final, or waste material to areas exposed to storm water
V. Evidence of, or the potential for, pollutants entering the facility's storm drain system
VI. Effectiveness of storm water management measures and other BMPs identified in the plan

In addition, the completeness and implementation of the SWPP Plan shall also be evaluated.

Major Observations: Site is well vegetated. No significant erosion noted on site. Rocks in center of ripraped drainage were removed to allow better drainage and keep culvert from backing up and filling with sediment. Stream channel is well vegetated on other side of riprap area below culvert. Facility is planning to move sand piles located on pavement to vegetated area next to HE liquid waste treatment area. Plan is to put down plastic to stockpile sand. Recommend berming the sand pile to mitigate transport of sand off site.

Follow-up Actions Required: None

Incidents of Non-compliance: None found-no pictures needed to document any problems

Noteworthy Accomplishments: Removal of rock in channel to allow drainage through culvert TA-16 394 has been removed and on site closure activities were completed

Comments:

Following the completion of the inspection, answer the following questions with Yes/No:

yes Must the SWPPP be updated?

no Are New BMPs or Modifications of BMPs Required?

no Is a report for follow-up action required?

COMPREHENSIVE SITE COMPLIANCE EVALUATION

Certification Statement

This facility, TA-16 Burn Ground, was inspected on , 9/20/2001, and there were no observed incidents of non-compliance with the Storm Water Pollution Prevention Plan. I am certifying that this facility is in compliance with its Storm Water Pollution Prevention Plan and the General Permit.

AND

"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 gathered and evaluated 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."

Name: Ricardo V. Ortiz

Title: ESA-WMM Group Leader

Signature: for RVO Date: 9/26/01

COMPREHENSIVE SITE COMPLIANCE EVALUATION CHECKLIST OF AREAS REQUIRED TO BE EVALUATED

Please use the enclosed list to ensure that each area is thoroughly inspected. Place a checkmark in each box as the corresponding topic is observed. Record major observations related to the implementation of the SWPP Plan, actions taken, incidents of non-compliance, and noteworthy accomplishments in their appropriate places above. Throughout the evaluation, consider the results of both visual and analytical monitoring done during the year.

SWPP PLAN EVALUATION

Ensure that all necessary procedures are described in the SWPP. Evaluate the effectiveness of existing programs or procedures to reduce pollutant loadings into storm water discharges, ensure these programs and procedures are implemented correctly, and determine whether additional programs or procedures are needed. The following programs should be evaluated:

Good Housekeeping

☒ Check that plan describes good housekeeping procedures (storage practices, material inventory, routine area cleanup, organized work areas, operation/maintenance of equipment, and routine inspections for leaks and the condition of storage containers)

Preventive Maintenance

☒ Check that there is an active preventive maintenance program to comply with the SWPPP

☒ Make sure that the current PM program includes periodic inspections and testing, as well as records of inspections and of maintenance on equipment and systems

Visual and Analytical Monitoring

☒ Ensure that there is an existing quarterly storm water visual inspection program

☒ Ensure that there is an existing annual non-storm water visual inspection program

☒ Check that inspections are documented in the SWPPP

☒ Check that there are follow-up procedures

Employee Training

☒ Check that training is provided on spill response, good housekeeping, material management, preventive maintenance, and components and goals of the SWPPP

☒ Make sure there is a schedule for periodic training

SWPPP EVALUATION *(Continued)*

Review and Revisions

- ☒ Check for procedures describing the review and revision of the Plan
- ☒ Check that Pollution Prevention Team Members are current
- ☒ Ensure that the description of potential pollutant sources is still accurate
- ☒ Make sure that the spills table has been updated
- ☒ Check that the site maps are current
- ☒ Check that the plan is certified by the person designated in the signatory letter
- ☒ Review the plan to see that it has been revised to reflect the October 2000 permit. Make sure that it includes a copy of the regulations and a new permit number. (This is a one-time check.)

SITE EVALUATION

Observe structural control measures, erosion control measures and/or other pollution prevention measures identified in the Plan to ensure that they are adequate and functioning correctly. Also look for general cleanliness and evidence of spills, leaks, tracking of materials, and potential pollutants. The following programs should be evaluated:

I. Storage and handling of industrial material, residues, and trash

- ☒ Check that all trash containers, storage areas, and loading docks are orderly and are regularly cleaned
- ☒ Check that there are no industrial materials, residue, or trash on the ground that could contaminate storm water
- ☒ Note that all other areas are clean and orderly

II. Leaks or Spills

- ☒ Look for new spills or leaks since the last inspection. Pay close attention to industrial equipment; drums, barrels, tanks and other similar containers; chemicals usage locations and any other susceptible locations
- ☒ Look for new high-risk areas
- ☒ Look for new non-storm water discharges

III. Vehicle Tracking

- ☒ Look for evidence of offsite tracking of industrial materials or sediment where vehicles enter or exit the site

IV. Migration of Raw, Final, or Waste Material

- ☒ Look for areas where raw, final, or waste material has been blown, tracked, or carried from areas of no exposure to areas exposed to storm water

SITE EVALUATION *(Continued)*

V. Evidence of, or the Potential for, Pollutants Entering the Drainage System

Look for pollutants and potential pollutants in new areas, materials or physical features including

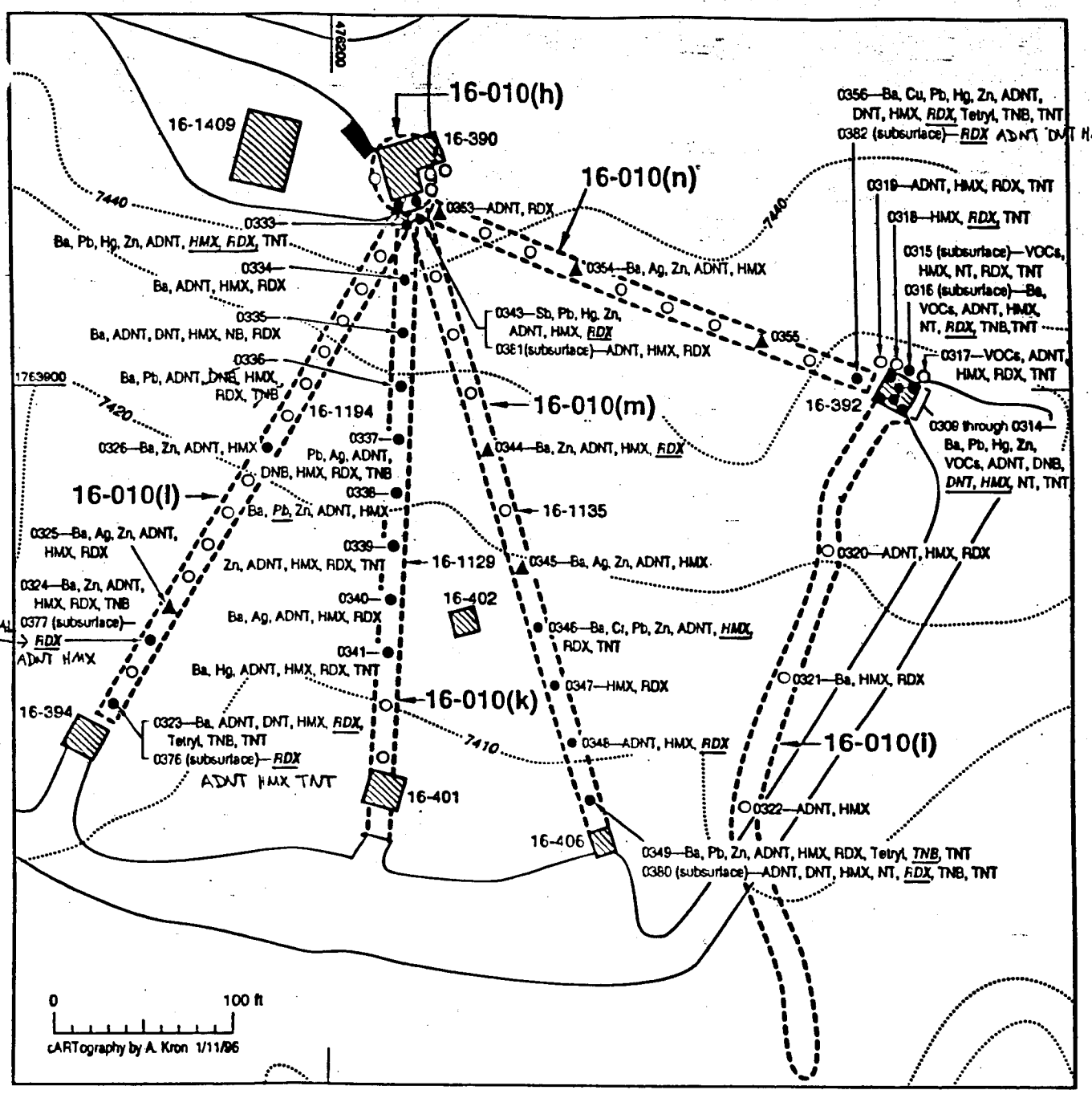
- ☒ Loading/unloading areas
- ☒ Outdoor storage
- ☒ Outdoor manufacturing or processing
- ☒ Dust or particulate generating processes
- ☒ On-site waste disposal activities
- ☒ Transportation or conveyance activities
- ☒ SWMUs
- ☒ Other areas, please describe: **None**

VI. Storm Water Management Measures

- ☒ Look for new areas of erosion or the potential for erosion
- ☒ Make sure erosion controls are provided for storm water and other discharges
- ☒ See that runoff control structures are in place
- ☒ Ensure that vegetated areas are maintained
- ☒ Inspect discharge points, where accessible, to see whether BMPs are effective in preventing significant impacts to receiving waters. Where discharge locations are inaccessible, inspect downstream locations.
- ☒ Note locations of BMPs that require maintenance or have proven inadequate. Also note any locations where additional BMPs are needed.
- ☒ Look for areas where storm water discharges have the potential to impact down gradient activities such as critical habitat and National Historic Preservation sites
- ☒ Note any other observations about storm water management and sediment and erosion control

Appendix E

Sampling data for SWMU's



Permanent structure

Temporary structure

Paved road

PRS boundary

Contour interval = 10 ft

○ HE screening sample (no elevated levels found)

● HE analytical sample (elevated HE levels found)

▲ Analytical sample (elevated barium levels found)

0323 Sample number (all samples collected at surface except where otherwise noted). Note: all sample numbers have prefix 0316-95-. Analytes listed exceed background levels. Analytes in bold italic face and underlined exceed SALs.

Abbreviations:

Sb—antimony	VOCs—volatile organic compounds
Ba—barium	ADNT—2-amino-4,6-dinitrotoluene and 4-amino-2,6-dinitrotoluene
Cr—chromium	DNB—1,3-dinitrobenzene
Cu—copper	DNT—2,4-dinitrotoluene and 2,6-dinitrotoluene
Ni—nickel	HMX—cyclotetramethylenetetranitramine
Pb—lead	NB—nitrobenzene
Hg—mercury	RDX—cyclonite
Ag—silver	TNB—1,3,5-tinitrobenzene
Zn—zinc	TNT-2,4,6-tinitrotoluene

Sampling locations for PRSs 16-010(i, k, l, m, n).

16-010(h) Table (inorganics)									
SAMPLE ID	DEPTH (ft)	BARIUM (mg/kg)	LEAD (mg/kg)	MERCURY (mg/kg)	ZINC (mg/kg)				
LANL UTL	N/A	315	23.3	0.1	50.8				
SAL	N/A	5340	400	23	23,004				
0316-95-0303	0-0.5	196	800	<0.053	1070				
0316-95-0304	sub	42	51.1	<0.05	115				
0316-95-0305	0-0.5	80.5	12.1	<0.054	46.7				
0316-95-0306	sub	75.3	12.3	<0.054	47.1				
0316-95-0307	0-0.5	121	44.2	0.058	96.7				
0316-95-0308	sub	35.8	8.48	<0.06	53.9				
Bold indicates values above SAL.									
SWMU 16-010(h) TABLE 5.1.6-1									
SAMPLE ID	DEPTH (ft)	2-Amino-4,6-dinitrotoluene (mg/kg)	4-Amino-2,6-dinitrotolene (mg/kg)	2,4-Dinitrotoluene (mg/kg)	HMX (mg/kg)	Nitrobenzene (mg/kg)	RDX (mg/kg)	1,3,5-Trinitrobenzene (mg/kg)	2,4,6-Trinitrotoluene (mg/kg)
SAL	N/A	NC	NC	0.65	3259	32.6	4.0	3.3	48.4
0316-95-0303	0-0.5	<0.077	<0.091	<0.057	0.623	<0.091	0.178	<0.085	<0.084
0316-95-0305	0-0.5	0.658	0.447	0.083	727	0.199	1250	0.143	0.123
0316-95-0306	sub	<0.082	<0.085	<0.057	18.3	<0.091	189	<0.093	<0.09
0316-95-0307	0-0.5	0.169	0.214	0.233	732	<0.091	124	<0.093	3.37
0316-95-0308	sub	0.172	0.138	<0.057	37.1	<0.09	65.1	<0.092	<0.089

16-010(i) Table (inorganics)

SAMPLE ID	DEPTH (ft)	BARIUM (mg/kg)	LEAD (mg/kg)	MERCURY (mg/kg)	ZINC (mg/kg)
LANL UTL	N/A	315	23.3	0.1	50.8
SAL	N/A	5340	400	23	23,004
0316-95-0309	0-0.5	345	45.5	<0.044	23.3
0316-95-0310	sub	831	54.7	0.065	39.4
0316-95-0311	0-0.5	291	19.1	0.173	28.8
0316-95-0312	sub	339	32.4	0.188	27.7
0316-95-0313	0-0.5	880	46.8	0.331	118
0316-95-0314	sub	652	14.4	0.087	48.5
0316-95-0316	1.6	571	12.1	<0.049	36.7
0316-95-0321	**0-0.5**	**318**	**7.9**	**<0.052**	**25.4**

Bold indicates values above SAL.

SWMU 16-010(i) HE

SAMPLE ID	DEPTH (ft)	2-Amino-4,6-dinitrotoluene (mg/kg)	4-Amino-2,6-dinitrotolene (mg/kg)	1,3-Dinitrobenzene (mg/kg)	2,4-Dinitrotoluene (mg/kg)	HMX (mg/kg)	2-Nitrotoluene (mg/kg)	3-Nitrotoluene (mg/kg)	4-Nitrotoluene (mg/kg)	RDX (mg/kg)	1,3,5-Trinitrobenzene (mg/kg)	2,4,6-Trinitrotoluene (mg/kg)
SAL	N/A	NC	NC	6.52	0.65	3259	652.0	652.0	652.0	4.0	3.3	48.4
0316-95-0309	0-0.5	2.32	1.87	0.09	0.348	764	0.434	<0.158	<0.19	39.2	0.095	1.53
0316-95-0310	sub	3.02	2.2.4	0.111	0.318	339	0.694	<0.158	0.255	58.7	0.353	24
0316-95-0311	0-0.5	7.14	5.83	<0.064	0.651	77.7	<0.157	<0.156	<0.187	5.75	0.105	35.1
0316-95-0312	sub	19.9	14.7	<0.064	3.02	152	0.248	<0.155	<0.187	19.2	0.241	63.3
0316-95-0313	0-0.5	4.07	4.01	0.208	0.857	4830	1.56	<0.165	4.51	10700	0.791	230
0316-95-0314	sub	2.28	<0.086	0.102	0.635	2610	3.03	<0.157	<0.189	8160	1.03	2060
0316-95-0315	1.1	<0.091	<0.094	<0.071	<0.063	8.05	2.87	1.1	<0.207	3.32	<0.103	0.241
0316-95-0316	1.6	2.1	3.66	<0.069	<0.062	64.8	0.351	<0.167	0.947	23	0.217	4.06
0316-95-0317	1.1	<0.076	0.104	<0.068	<0.056	42.4	<0.155	<0.154	<0.185	1.31	<0.084	0.101
0316-95-0318	1.1	<0.077	<0.092	<0.069	<0.057	5.3	<0.156	<0.155	<0.187	10.6	<0.085	1.02
0316-95-0319	0-0.5	0.102	0.115	<0.068	<0.057	1.73	<0.155	<0.154	<0.185	2.3	<0.084	0.142
0316-95-0320	0-0.5	0.211	0.167	<0.075	<0.067	0.273	<0.184	<0.183	<0.22	0.216	<0.011	<0.106
0316-95-0321	0-0.5	<0.077	<0.091	<0.069	<0.065	0.435	<0.156	<0.154	<0.186	2.14	<0.084	<0.09
0316-95-0322	0-0.5	<0.094	0.125	<0.073	<0.057	0.35	<0.178	<0.177	<0.213	<0.2	<0.106	<0.103

SWMU 16-010(i) VOLATILES												
SAMPLE ID	DEPTH (ft)	ACETONE (mg/kg)	p-ISOPROPYLTOLUENE (mg/kg)	METHYLENE CHLORIDE (mg/kg)	TRICHLOROFLUOROMETHANE (mg/kg)	TOLUENE (mg/kg)						
SAL	N/A	2000	NC	11	710	1,900						
0316-95-0314	sub	0.014	<0.005	<0.005	<0.005	0.017						
0316-95-0315	0-0.5	0.014	0.022	<0.0055	<0.0055	<0.0055						
0316-95-0316	1.6	<0.0011	0.012	<0.0054	<0.0054	<0.0055						
0316-95-0317	1.1	<0.001	<0.0052	0.063	0.013	<0.0052						

16-010(k) Table (Inorganics)

SAMPLE ID	DEPTH (ft)	BARIUM (mg/kg)	LEAD (mg/kg)	MERCURY (mg/kg)	SILVER (mg/kg)	ZINC (mg/kg)
LANL UTL	N/A	315	23.3	0.1	not available	50.8
SAL	N/A	5340	400	23	383	23,004
0316-95-0333	0-0.5	1 820	169	0.295	<0.578	63.7
0316-95-0334	0-0.5	480	17.4	<0.054	<0.536	28.1
0316-95-0335	0-0.5	633	15	0.058	<0.547	34
0316-95-0336	0-0.5	456	49.4	0.058	<0.53	20.6
0316-95-0337	0-0.5	289	85.7	<0.053	0.52	43.1
0316-95-0338	0-0.5	401	489	<0.051	<0.507	71.4
0316-95-0339	0-0.5	301	14.3	<0.054	<0.522	54.6
0316-95-0340	0-0.5	610	10.7	<0.06	0.89	44.9
0316-95-0341	0-0.5	337	8.81	0.122	<0.537	37
0316-95-0378	1-1.5	76.1	4.51	<0.06	<0.6	33.5
0316-95-0379	0-0.5	126	5.31	<0.059	<0.582	32.7
0316-95-2018	1-1.5	73.5	6.38	<0.058	<0.579	41.1

Bold indicates values above SAL.

SWMU 16-010(k) TABLE 5.1.6-1

SAMPLE ID	DEPTH (ft)	2-Amino-4,6-dinitrotoluene (mg/kg)	4-Amino-2,6-dinitrotolene (mg/kg)	1,3-Dinitrobenzene (mg/kg)	2,4-Dinitrotoluene (mg/kg)	2,6-Dinitrotoluene (mg/kg)	HMX (mg/kg)	Nitrobenzene (mg/kg)	RDX (mg/kg)	1,3,5-Trinitrobenzene (mg/kg)	2,4,6-Trinitrotoluene (mg/kg)
SAL	N/A	NC	NC	6.52	0.65	0.65	3259	32.6	4.0	3.3	48.4
0316-95-0333	0-0.5	1.29	0.882	<0.407	<0.337	<0.475	12100	<0.537	6.93	<0.501	0.848
0316-95-0334	0-0.5	0.155	0.159	<0.074	<0.061	<0.086	2.84	<0.098	0.96	<0.091	<0.097
0316-95-0335	0-0.5	0.544	0.266	<0.077	<0.064	0.121	91.3	0.464	0.621	<0.095	<0.101
0316-95-0336	0-0.5	0.134	0.142	<0.076	<0.063	<0.089	78.6	<0.101	0.887	<0.094	<0.1
0316-95-0337	0-0.5	0.453	0.416	0.221	<0.061	<0.085	588	<0.096	1.24	0.189	<0.096
0316-95-0338	0-0.5	0.225	0.215	<0.070	<0.058	<0.082	6.95	<0.093	<0.179	<0.087	<0.092
0316-95-0339	0-0.5	1.51	1.07	<0.078	0.066	<0.091	885	<0.103	1.83	<0.096	0.484
0316-95-0340	0-0.5	0.573	0.435	<0.082	<0.068	<0.088	801	<0.108	0.865	<0.1	<0.107
0316-95-0341	0-0.5	0.542	0.584	<0.076	<0.063	<0.095	388	<0.1	0.485	<0.093	0.164
0316-95-0378	1-1.5	<0.077	0.216	<0.069	<0.057	<0.08	116	<0.091	<0.175	<0.085	<0.09
0316-95-0379	0-0.5	0.105	0.13	<0.069	<0.057	<0.08	162	<0.091	0.286	<0.085	<0.09
0316-95-2018	1-1.5	0.52	0.421	<0.069	<0.057	<0.08	69.1	<0.091	<0.175	<0.085	<0.09

16-010(I) Table (inorganics)

SAMPLE ID	DEPTH (ft)	BARIUM (mg/kg)	SILVER (mg/kg)	ZINC (mg/kg)
LANL UTL	N/A	315	NC	50.8
SAL	N/A	5340	383	23,004
0316-95-0323	0-0.5	475	<0.567	33.4
0316-95-0324	0-0.5	387	<0.555	55.1
0316-95-0325	0-0.5	902	1.09	125
0316-95-0326	0-0.5	489	<0.513	86.3
0316-95-0376	2-2.5			
0316-95-0377	3-3.5			

Samples not in FIMAD or hard copy; values < 25% SAL

Bold indicates values above SAL.

SWMU 16-010(I) TABLE 5.1.6-1

SAMPLE ID	DEPTH (ft)	2-Amino-4,6-dinitrotoluene (mg/kg)	4-Amino-2,6-dinitrotolene (mg/kg)	2,4-Dinitrotoluene (mg/kg)	2,6-Dinitrotoluene (mg/kg)	HMX (mg/kg)	RDX (mg/kg)	Tetryl (mg/kg)	1,3,5-Trinitrobenzene (mg/kg)	2,4,6-Trinitrotoluene (mg/kg)
SAL	N/A	NC	NC	0.65	3259	3259	4.0	NC	3.3	48.4
0316-95-0323	0-0.5	21.7	15.2	0.481	0.178	259	2540	0.321	0.421	23
0316-95-0324	0-0.5	0.465	0.295	<0.062	<0.088	1	0.476	<0.103	0.123	<0.099
0316-95-0325	0-0.5	1.07	0.789	<0.057	<0.08	352	2.38	<0.093	<0.084	<0.089
0316-95-0326	0-0.5	0.081	<0.091	<0.057	<0.08	0.176	<0.174	<0.093	<0.084	<0.089
0316-95-0376	2-2.5	2.61	2.05	<0.065	<0.092	45.7	594	<0.114	<0.113	30.9
0316-95-0377	3-3.5	0.425	0.267	<0.078	<0.11	20.2	2.29	<0.137	<0.135	<0.123

16-010(m) Table (inorganics)

SAMPLE ID	DEPTH (ft)	ANTIMONY (mg/kg)	BARIUM (mg/kg)	CHROMIUM (mg/kg)	LEAD (mg/kg)	MERCURY (mg/kg)	SILVER (mg/kg)	ZINC (mg/kg)		
LANL UTL	N/A	1	315	19.3	23.3	0.1	NC	50.8		
SAL	N/A	30.7	5340	211	400	23	383	23,004		
0316-95-0343	0-0.5	12.1	273	3.85	102	0.154	<0.561	76.6		
0316-95-0344		<1.07	380	5.39	9.3	<0.05	<0.534	53.4		
0316-95-0345	0-0.5	<1.07	577	6.85	9.97	<0.051	0.735	106		
0316-95-0346		<5.69	316	25.6	192	<0.057	<0.569	66.1		
0316-95-0347	0-0.5	<5.59	188	3.03	16.9	<0.058	<0.559	25.2		
0316-95-0348		<5.63	272	3.58	9.34	<0.056	<0.563	30.8		
0316-95-0349	1.6	<5.25	545	11.7	87.6	0.062	<0.559	120		
0316-95-0380	0-0.5	<6.02	241	9.2	46.8	<0.06	<0.602	39.4		
0316-95-0381	1.6	<6.05	44.9	2.28	31.3	<0.059	<0.605	37.8		
0316-95-2019	0-0.5	<1.23	212	8.88	16.1	0.106	<0.598	56.7		

Bold indicates values above SAL.

SWMU 16-010(m) TABLE 5.1.6-1

SAMPLE ID	DEPTH (ft)	2-Amino-4,6-dinitrotoluene (mg/kg)	4-Amino-2,6-dinitrotolene (mg/kg)	2,4-Dinitrotoluene (mg/kg)	HMX (mg/kg)	2-Nitrotoluene (mg/kg)	RDX (mg/kg)	Tetryl (mg/kg)	1,3,5-Trinitrobenzene (mg/kg)	2,4,6-Trinitrotoluene (mg/kg)
SAL	N/A	NC	NC	0.65	3259	652.0	4.0	NC	3.3	48.4
0316-95-0343	0-0.5	0.433	0.427	<0.068	2420	<0.185	**27.8**	<0.111	<0.101	<0.107
0316-95-0344		0.457	0.247	<0.057	8.34	<0.155	**2050**	<0.093	<0.084	<0.089
0316-95-0345	0-0.5	0.649	0.315	<0.057	5.6	<0.155	<0.174	<0.093	<0.084	<0.089
0316-95-0346		1.18	1.14	<0.334	18700	<0.914	0.39	<0.55	<0.496	**1.74**
0316-95-0347	0-0.5	<0.088	<0.104	<0.065	0.905	<0.178	0.404	<0.107	<0.096	<0.102
0316-95-0348		0.131	0.17	<0.064	1630	<0.175	**40.7**	<0.105	<0.095	<0.101
0316-95-0349	1.1	2.99	2.44	<0.064	603	<0.176	**2.3**	0.262	**3.36**	**22.9**
0316-95-0380	1.6	1.8	1.7	0.117	204	0.634	**3170**	<0.099	0.128	**37.3**
0316-95-0381	1.1	<0.082	0.086	<0.057	205	<0.155	3.03	<0.099	<0.092	<0.089
0316-95-2019	1.1	1.8	1.76	<0.057	153	<0.156	**2160**	0.154	1.08	**59.5**

16-010(n) Table (inorganics)

SAMPLE ID	DEPTH (ft)	BARIUM (mg/kg)	COPPER (mg/kg)	LEAD (mg/kg)	MERCURY (mg/kg)	SILVER (mg/kg)	ZINC (mg/kg)		
LANL UTL	N/A	315	19.3	23.3	0.1	NC	50.8		
SAL	N/A	5340	211	400	23	383	23,004		
0316-95-0354	0-0.5	494	8.01	19.1	<0.053	0.536	162		
0316-95-0356	0-0.5	545	35	87.6	0.573	<0.525	166		
0316-95-0382	0.7-1.1								
Sample results not in FIMAD or hard copy; no values > SAL									
Bold indicates values above SAL.									
SWMU 16-010(n) TABLE 5.1.6-1									
SAMPLE ID	DEPTH (ft)	2-Amino-4,6-dinitrotoluene (mg/kg)	4-Amino-2,6-dinitrotolene (mg/kg)	2,4-Dinitrotoluene (mg/kg)	HMX (mg/kg)	RDX (mg/kg)	Tetryl (mg/kg)	1,3,5-Trinitrobenzene (mg/kg)	2,4,6-Trinitrotoluene (mg/kg)
SAL	N/A	NC	NC	0.65	3259	4.0	NC	3.3	48.4
0316-95-0353	0-0.5	0.251	0.271	<0.056	<0.165	0.955	<0.093	<0.084	<0.089
0316-95-0354	0-0.5	<0.078	0.094	<0.057	0.321	<0.176	<0.095	<0.085	<0.091
0316-95-0356	0-0.5	1.55	1.56	0.116	1890	4980	0.275	0.097	3.66
0316-95-0382	0.7-1.1	1.07	0.985	0.075	748	2430	<0.112	<0.111	2.83

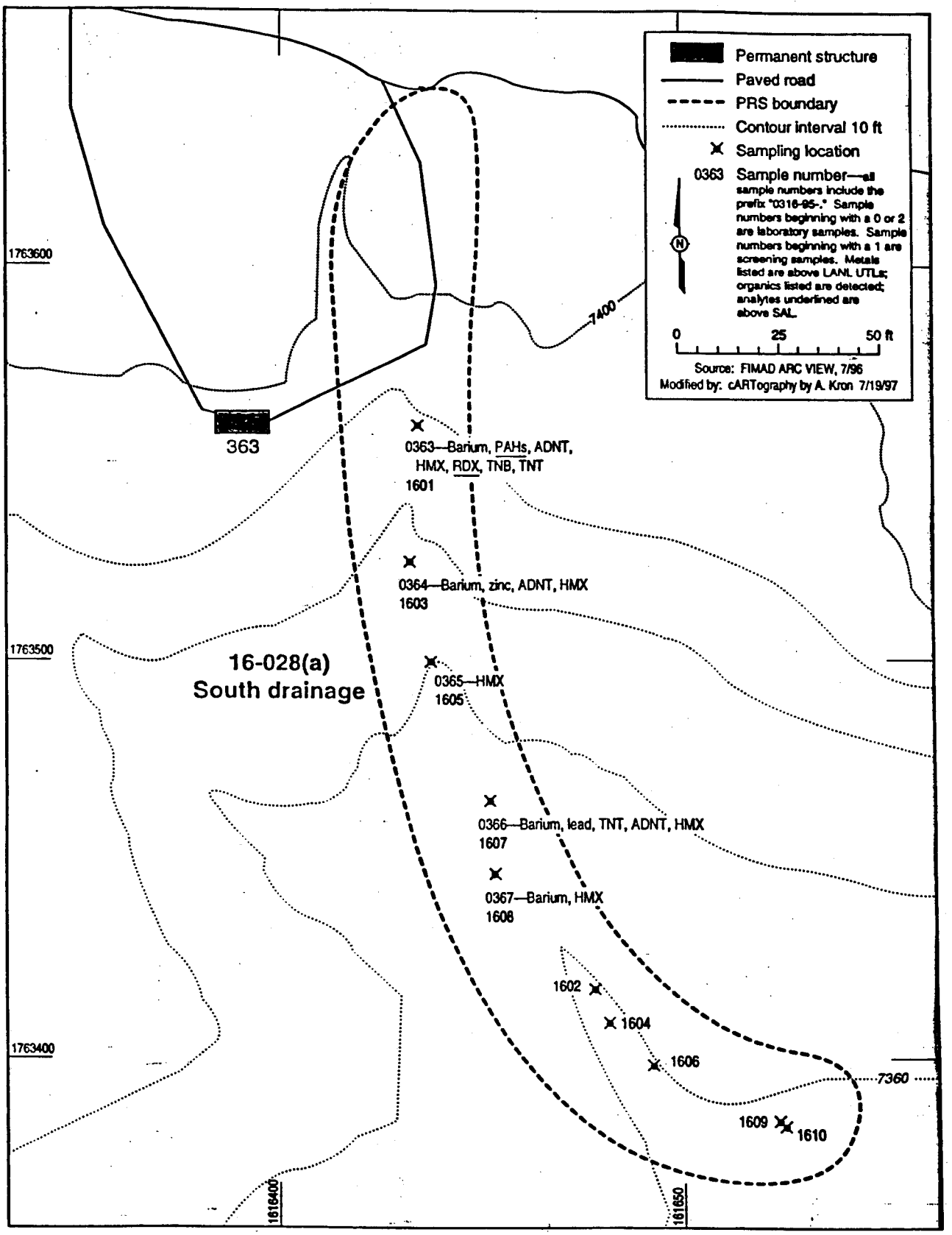


Figure 5.14.4-1. Sample locations at PRS 16-028(a).

5.14.5 Evaluation of Inorganic Chemicals

Table 5.14.5-1 shows the metals present at levels above UTLs. Barium, a component of many explosives, was above its UTL but well below its SAL.

TABLE 5.14.5-1

INORGANICS WITH CONCENTRATIONS GREATER THAN BACKGROUND UTLs FOR PRS 16-028(a)

SAMPLE ID	DEPTH (ft)	BARIUM (mg/kg)	LEAD (mg/kg)	ZINC (mg/kg)
LANL UTL (all soil)	N/A	315	23.3	50.8
SAL	N/A	5 300	400	23 000
0316-95-0363	0-0.5	321	7.9	35.1 (P)
0316-95-0364	0-0.5	588	5.5	170 (P)
0316-95-0366	0-0.5	501	76.6	37.8 (P)
0316-95-0367	0-0.5	368	6.3	30.1 (P)

5.14.6 Evaluation of Radionuclides

Radionuclides were not present at levels above UTLs at this PRS.

5.14.7 Evaluation of Organic Chemicals

PAHs were found at levels less than 0.3 mg/kg in one sample (Table 5.14.7-1). All the PAH data were qualified as being estimated concentrations. Benzo(a)pyrene was present at a level slightly greater than its SAL. No other PAHs were above SALs.

TABLE 5.14.7-1

PRS 16-028(a) SOIL CONCENTRATIONS FOR DETECTED ORGANIC ANALYTES

SAMPLE ID	DEPTH (ft)	ANTHRACENE (mg/kg)	BENZO (a) ANTHRACENE (mg/kg)	BENZO (a) PYRENE (mg/kg)	BENZO (b) FLUORANTHENE (mg/kg)	BENZO (k) FLUORANTHENE (mg/kg)	CHRYSENE (mg/kg)	FLUORANTHENE (mg/kg)	PHENANTHRENE (mg/kg)	PYRENE (mg/kg)
SAL	N/A	18 000	0.61	0.061	0.61	6.1	61	2 600	NC	19 000
EQL	N/A	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
0316-95-0363	0-0.5	0.042 (J)	0.095 (J)	0.09 (J)	0.11 (J)	0.056 (J)	0.11 (J)	0.26 (J)	0.2 (J)	0.22 (J)

HE was found in a number of samples. Table 5.14.7-2 presents the analytical results for samples containing HE. Only sample 0316-95-0363 contained HE (RDX only) at a levels above SAL. All other samples showed that HE contamination dropped off significantly with distance from the burning ground, with only very low levels of HMX detected at the farthest downgradient point.

TABLE 5.14.7-2

PRS 16-028(a) SOIL CONCENTRATIONS FOR DETECTED HE ANALYTES

SAMPLE ID	DEPTH (ft)	2-ADNT (mg/kg)	4-ADNT (mg/kg)	HMX (mg/kg)	RDX (mg/kg)	1,3,5-TNB (mg/kg)	TNT (mg/kg)
SAL	N/A	NC	NC	3 300	4	3.3	15
EQL	N/A	0.26	ND	2.2	1	0.25	0.25
0316-95-0363	0-0.5	0.093	0.097	8.22	5.33	2.33	0.139
0316-95-0364	0-0.5	0.081 (U)	0.12	1.04	0.174 (U)	0.092 (U)	0.089 (U)
0316-95-0365	0-0.5	0.081 (U)	0.084 (U)	0.34	0.174 (U)	0.092 (U)	0.089 (U)
0316-95-0366	0-0.5	0.171	0.247	0.644	0.175 (U)	0.093 (U)	0.301
0316-95-0367	0-0.5	0.081 (U)	0.084 (U)	0.432	0.174 (U)	0.092 (U)	0.089 (U)

5.14.8 Risk-Based Screening Assessment

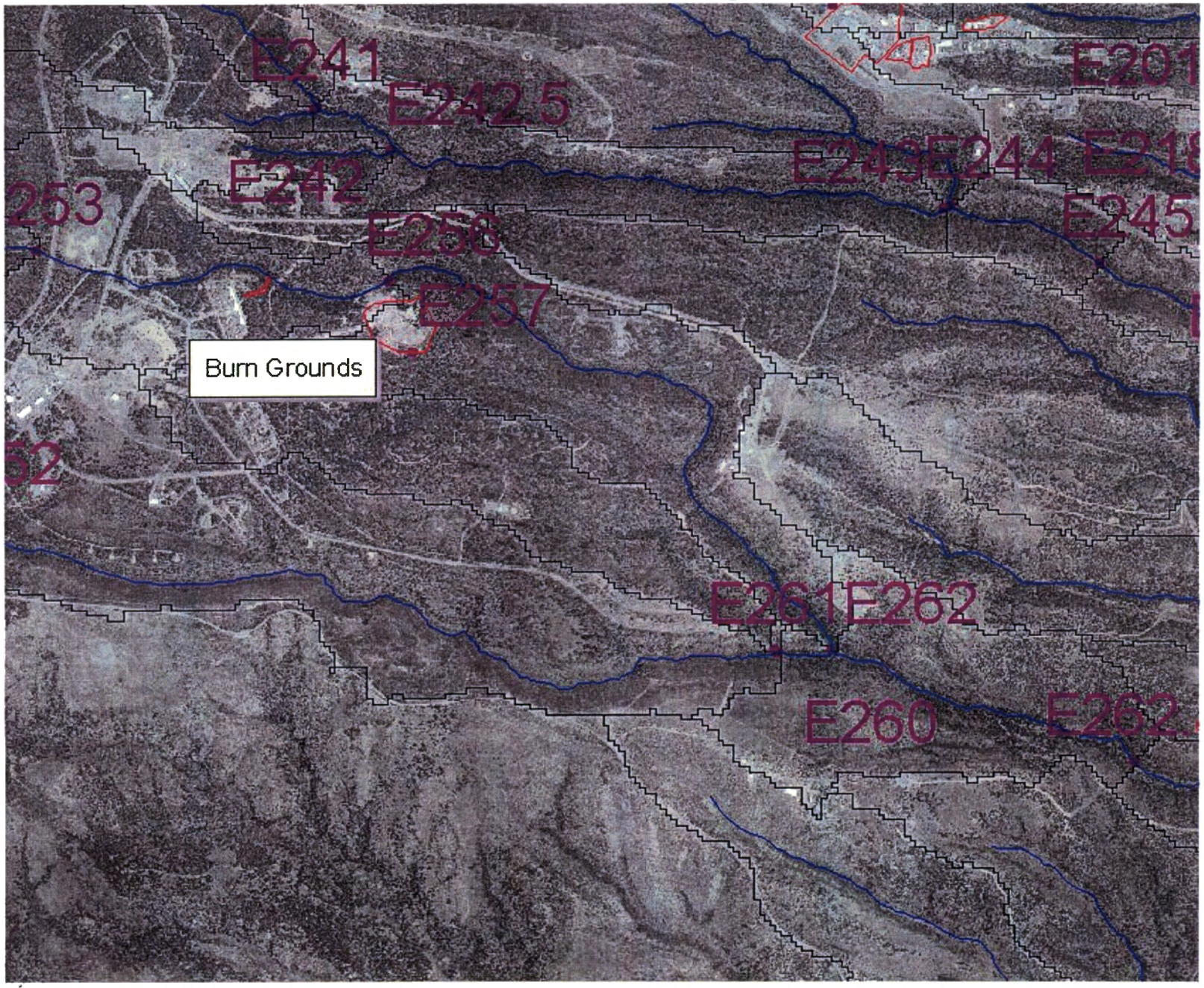
Three inorganic and two organic chemicals were carried forward from the background comparison and organic constituent evaluation. As described in Chapter 3 of this report, analytes are divided into three classes for the screening assessment (noncarcinogens, carcinogens, and radionuclides), depending on which toxicological effect forms the basis of their SAL. This separation is required to evaluate possible additive effects within each class of chemical.

RDX and Benzo(a)pyrene exceed their SALs in only one sample. These two constituents will be retained as COPCs for further evaluation. Sample results that exceeded SAL values are highlighted in black squares in the previous tables.

An MCE calculation was performed using the sum of the maximum concentrations at this PRS. The MCE results for noncarcinogens and chemical carcinogens 1.0 and 0.2, respectively. The MCE value for noncarcinogenic compounds is greater than unity; therefore, a potential human health risk based on additive effects has been identified for this class of chemicals. The noncarcinogenic COPCs that have a normalized value of more than 0.1 in the MCE at this PRS are barium, lead, and 1,3,5-Trinitrobenzene. These compounds are, therefore, retained as COPCs for further evaluation. The MCE value for carcinogenic compounds is less than the target value of 1, indicating that multiple constituents are not present at levels that pose a risk when combined. The MCE calculations are presented in Table 5.14.8-1.

APPENDIX F

STATION E262 STORMWATER DATA



0.6 0 0.6 1.2 Miles

Industrial coverage
Drainage
Stormwater Stations
Station Watersheds

N
W E
S

Watershed Delineation by Station

Station E262 Stormwater Data

E#	Location Name	Sample Date	Analyte	Symbol	Result	Units
E262	Canon de Valle at Mouth	08/05/01	Po-210		265	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Am-241		1.18	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Pu-238		0.26	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Pu-239,240		3.15	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ra-228		11.5	pCi/L
E262	Canon de Valle at Mouth	08/05/01	U-235,236		3.31	pCi/L
E262	Canon de Valle at Mouth	08/05/01	U-238		53.9	pCi/L
E262	Canon de Valle at Mouth	08/05/01	GROSSA		337	pCi/L
E262	Canon de Valle at Mouth	08/05/01	GROSSB		539	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Pb-210		1.01	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Th-228		91.4	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Th-230		64	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Th-232		61.9	pCi/L
E262	Canon de Valle at Mouth	08/05/01	U-234		51.5	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Tl-208	<	3.19	pCi/L
E262	Canon de Valle at Mouth	08/05/01	U-235,236	<	-5.61	pCi/L
E262	Canon de Valle at Mouth	08/05/01	U-238	<	9.38	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Y-88	<	3.07	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Zn-65	<	9.7	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Zr-95	<	2.28	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Se-75	<	0.833	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Sn-113	<	-2.09	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Sr-85	<	-23.7	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Th-227	<	8.14	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Th-231	<	2.96	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Th-234	<	9.38	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Rn-219	<	0	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ru-103	<	-0.208	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ru-106	<	-30.2	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Sb-124	<	-0.11	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Sb-125	<	-4.83	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Pb-214	<	4.45	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ra-223	<	36.6	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ra-224	<	0	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ra-226	<	3.78	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ra-228	<	26.4	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Rh-106	<	-11.1	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Pa-231	<	55.8	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Pa-233	<	8.46	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Pa-234M	<	427	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Pb-211	<	52.2	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Pb-212	<	7.27	pCi/L
E262	Canon de Valle at Mouth	08/05/01	K-40	<	66.2	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Mn-54	<	-0.302	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Na-22	<	0.204	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Nb-95	<	3.16	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Np-237	<	10.8	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Np-239	<	5.08	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Eu-152	<	-5.15	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Eu-154	<	-2.57	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Fe-59	<	-2.5	pCi/L

Station E262 Stormwater Data

E#	Location Name	Sample Date	Analyte	Symbol	Result	Units
E262	Canon de Valle at Mouth	08/05/01	Hg-203	<	1.25	pCi/L
E262	Canon de Valle at Mouth	08/05/01	I-133	<	-2630000000	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ce-144	<	10.5	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Co-57	<	2.85	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Co-60	<	0.762	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Cr-51	<	37.3	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Cs-134	<	-0.202	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Cs-137		0.801	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Bi-214	<	3.78	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Cd-109	<	32.2	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ce-139	<	0.628	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ce-141	<	-3.01	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Am-241	<	3.24	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Be-7		109	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Bi-211	<	12.8	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Bi-212	<	44.3	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Sr-90		14.1	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ac-228	<	26.4	pCi/L
E262	Canon de Valle at Mouth	08/05/01	SPGR			
E262	Canon de Valle at Mouth	08/05/01	SPEC_CONDC		317	uS/cm
E262	Canon de Valle at Mouth	08/05/01	TKN		1.59	mg/L
E262	Canon de Valle at Mouth	08/05/01	NH3-N		1.16	mg/L
E262	Canon de Valle at Mouth	08/05/01	pH			
E262	Canon de Valle at Mouth	08/05/01	TSS		27700	mg/L
E262	Canon de Valle at Mouth	08/05/01	TSS		27100	mg/L
E262	Canon de Valle at Mouth	08/05/01	LOI		2520	mg/L
E262	Canon de Valle at Mouth	08/05/01	COD		113	mg/L
E262	Canon de Valle at Mouth	08/05/01	NO3+NO2-N		1.84	mg/L
E262	Canon de Valle at Mouth	08/05/01	P		7.9	mg/L
E262	Canon de Valle at Mouth	08/05/01	Zn		1880	ug/L
E262	Canon de Valle at Mouth	08/05/01	Ba		29800	ug/L
E262	Canon de Valle at Mouth	08/05/01	Fe		300000	ug/L
E262	Canon de Valle at Mouth	08/05/01	Mn		38700	ug/L
E262	Canon de Valle at Mouth	08/05/01	Hg	<	0.073	ug/L
E262	Canon de Valle at Mouth	08/05/01	Ni		301	ug/L
E262	Canon de Valle at Mouth	08/05/01	Se		14.9	ug/L
E262	Canon de Valle at Mouth	08/05/01	Sn		3.5	ug/L
E262	Canon de Valle at Mouth	08/05/01	Sr		2210	ug/L
E262	Canon de Valle at Mouth	08/05/01	V		384	ug/L
E262	Canon de Valle at Mouth	08/05/01	Co		199	ug/L
E262	Canon de Valle at Mouth	08/05/01	Cr		259	ug/L
E262	Canon de Valle at Mouth	08/05/01	Cu		380	ug/L
E262	Canon de Valle at Mouth	08/05/01	Mg		84.9	mg/L
E262	Canon de Valle at Mouth	08/05/01	Mo		1.66	ug/L
E262	Canon de Valle at Mouth	08/05/01	Ag		301	ug/L
E262	Canon de Valle at Mouth	08/05/01	Al		494000	ug/L
E262	Canon de Valle at Mouth	08/05/01	As		79.4	ug/L
E262	Canon de Valle at Mouth	08/05/01	B		59.3	ug/L
E262	Canon de Valle at Mouth	08/05/01	Be		36.3	ug/L
E262	Canon de Valle at Mouth	08/05/01	Cd		13.3	ug/L
E262	Canon de Valle at Mouth	08/05/01	Pb		543	ug/L

Station E262 Stormwater Data

E#	Location Name	Sample Date	Analyte	Symbol	Result	Units
E262	Canon de Valle at Mouth	08/05/01	Sb		0.435	ug/L
E262	Canon de Valle at Mouth	08/05/01	Tl		4.73	ug/L
E262	Canon de Valle at Mouth	08/05/01	U		28.9	ug/L
E262	Canon de Valle at Mouth	08/05/01	TSS		27200	mg/L
E262	Canon de Valle at Mouth	08/05/01	Ba-133	<	0.979	pCi/L
E262	Canon de Valle at Mouth	08/05/01	Ra-226		9.83	pCi/L
E262	Canon de Valle at Mouth	08/05/01	TSS(m)		30800	mg/L
E262	Canon de Valle at Mouth	08/05/01	TSS(m)		27100	mg/L
E262	Canon de Valle at Mouth	08/09/01	Hg	<	0.073	ug/L
E262	Canon de Valle at Mouth	08/09/01	Cd		12.1	ug/L
E262	Canon de Valle at Mouth	08/09/01	Sb		0.219	ug/L
E262	Canon de Valle at Mouth	08/09/01	Tl		5.14	ug/L
E262	Canon de Valle at Mouth	08/09/01	U		39.7	ug/L
E262	Canon de Valle at Mouth	08/09/01	Pb		684	ug/L
E262	Canon de Valle at Mouth	08/09/01	Ag		267	ug/L
E262	Canon de Valle at Mouth	08/09/01	Al		468000	ug/L
E262	Canon de Valle at Mouth	08/09/01	As		91.9	ug/L
E262	Canon de Valle at Mouth	08/09/01	B		132	ug/L
E262	Canon de Valle at Mouth	08/09/01	Be		33.2	ug/L
E262	Canon de Valle at Mouth	08/09/01	Co		172	ug/L
E262	Canon de Valle at Mouth	08/09/01	Cr		265	ug/L
E262	Canon de Valle at Mouth	08/09/01	Cu		403	ug/L
E262	Canon de Valle at Mouth	08/09/01	Mg		75.5	mg/L
E262	Canon de Valle at Mouth	08/09/01	Mo		3.32	ug/L
E262	Canon de Valle at Mouth	08/09/01	Ni		318	ug/L
E262	Canon de Valle at Mouth	08/09/01	Se		24.4	ug/L
E262	Canon de Valle at Mouth	08/09/01	Sn		9.48	ug/L
E262	Canon de Valle at Mouth	08/09/01	Sr		1670	ug/L
E262	Canon de Valle at Mouth	08/09/01	V		420	ug/L
E262	Canon de Valle at Mouth	08/09/01	Zn		1690	ug/L
E262	Canon de Valle at Mouth	08/09/01	Ba		24300	ug/L
E262	Canon de Valle at Mouth	08/09/01	Fe		360000	ug/L
E262	Canon de Valle at Mouth	08/09/01	Mn		29600	ug/L
E262	Canon de Valle at Mouth	08/09/01	CN (amen)	<	0.00289	mg/L
E262	Canon de Valle at Mouth	08/09/01	CN(TOTAL)		0.0172	mg/L
E262	Canon de Valle at Mouth	08/09/01	TKN		2.54	mg/L
E262	Canon de Valle at Mouth	08/09/01	P		5.2	mg/L
E262	Canon de Valle at Mouth	08/09/01	NH3-N		0.96	mg/L
E262	Canon de Valle at Mouth	08/09/01	COD		139	mg/L
E262	Canon de Valle at Mouth	08/09/01	ClO4	<	4.79	ug/L
E262	Canon de Valle at Mouth	08/09/01	pH		7.24	
E262	Canon de Valle at Mouth	08/09/01	NO3+NO2-N		1.05	mg/L
E262	Canon de Valle at Mouth	08/09/01	LOI		3720	mg/L
E262	Canon de Valle at Mouth	08/09/01	TSS		20700	mg/L
E262	Canon de Valle at Mouth	08/09/01	TSS		20100	mg/L
E262	Canon de Valle at Mouth	08/09/01	SPGR		1.02	
E262	Canon de Valle at Mouth	08/09/01	SPEC_CONDC		184	uS/cm
E262	Canon de Valle at Mouth	08/09/01	H-3		26.7	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Pb-210		63.8	pCi/L
E262	Canon de Valle at Mouth	08/09/01	U-234		47.9	pCi/L
E262	Canon de Valle at Mouth	08/09/01	U-235,236		2.65	pCi/L

Station E262 Stormwater Data

E#	Location Name	Sample Date	Analyte	Symbol	Result	Units
E262	Canon de Valle at Mouth	08/09/01	U-238		50.6	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Th-228		93.2	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Th-230		51.2	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Th-232		74.1	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Sr-90		9.56	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ra-226		9.79	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ra-228		10.9	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Po-210		133	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ac-228	<	17.5	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Am-241	<	-9.7	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ba-133	<	0.211	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Be-7		99.4	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Bi-211	<	21.6	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Bi-212	<	-5.88	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Bi-214	<	13.6	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Cd-109	<	56.9	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ce-139	<	1.66	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ce-141	<	2.66	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ce-144	<	8.89	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Co-57	<	-0.193	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Co-60		9.6	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Cr-51	<	56.5	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Cs-134	<	-1.58	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Cs-137		9.57	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Eu-152	<	-5.83	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Eu-154	<	-0.523	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Fe-59	<	1.69	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Hg-203	<	-0.538	pCi/L
E262	Canon de Valle at Mouth	08/09/01	I-133	<	-305000000	pCi/L
E262	Canon de Valle at Mouth	08/09/01	K-40		74.4	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Mn-54	<	3.24	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Na-22	<	-0.227	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Nb-95	<	1.74	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Np-237	<	-1.83	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Np-239	<	16.1	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Pa-231	<	-107	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Pa-233	<	0.462	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Pa-234M	<	657	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Pb-211	<	25.8	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Pb-212		17.6	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Pb-214	<	7.51	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ra-223	<	32.4	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ra-224	<	45	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ra-226		13.6	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ra-228	<	17.5	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Rh-106	<	13.3	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Rn-219	<	-24.5	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ru-103	<	2.43	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Ru-106	<	26.7	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Sb-124	<	-2.03	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Sb-125	<	-2.85	pCi/L

Station E262 Stormwater Data

E#	Location Name	Sample Date	Analyte	Symbol	Result	Units
E262	Canon de Valle at Mouth	08/09/01	Se-75	<	1.63	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Sn-113	<	2.63	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Sr-85	<	-18.2	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Th-227	<	-20.5	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Th-231	<	12.1	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Th-234	<	191	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Tl-208	<	4.44	pCi/L
E262	Canon de Valle at Mouth	08/09/01	U-235,236	<	22.4	pCi/L
E262	Canon de Valle at Mouth	08/09/01	U-238	<	191	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Y-88	<	2.05	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Zn-65	<	1.83	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Zr-95	<	2.98	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Am-241		0.49	pCi/L
E262	Canon de Valle at Mouth	08/09/01	GROSSA		545	pCi/L
E262	Canon de Valle at Mouth	08/09/01	GROSSB		786	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Pu-238		0.251	pCi/L
E262	Canon de Valle at Mouth	08/09/01	Pu-239,240		1.04	pCi/L
E262	Canon de Valle at Mouth	08/09/01	TSS(m)		27200	mg/L
E262	Canon de Valle at Mouth	08/09/01	TSS(m)		29700	mg/L

APPENDIX G

DEPOSITION MODELING FOR THE TA-16 BURN GROUND

Deposition Modeling for the TA-16 Burn Ground

Keith W. Jacobson 1/22/02

Introduction

The Air Quality Group at LANL applied the CALPUFF modeling system for the modeling of toxics deposition in regards to the burn grounds located at TA-16. This new set of tools is considered by the Environmental Protection Agency (EPA) to be suitable for complex and rugged terrain conditions. Because of the terrain, Los Alamos surface winds often vary dramatically with time of day, location, and height above ground (Bowen, 1990). The computer-modeling package known as CALPUFF consists of a meteorological program with both diagnostic and prognostic wind-field calculations (CALMET), a non-steady state dispersion model (CALPUFF), and a post-processing program (CALPOST). The CALPUFF package was developed and intended for regulatory use in air quality programs, and is considered a "guideline" model by the EPA (EPA, 2000). Presented are estimates of the range of deposition rates as calculated for various pollutant species evaluated using the CALPUFF system at LANL.

In addition to incorporating the influences of terrain in dispersion modeling, the CALPUFF system has many other capabilities; one important aspect being that it is a non-steady state model or "puff" trajectory model. Therefore, output results incorporate downwind changes in dispersion conditions with time, on an hour-by-hour basis. The CALPUFF system is suitable for modeling domains from tens of meters to hundreds of kilometers. Predictions for averaging times can range from one hour to one year (Scire, 2000).

The purpose of the CALPUFF analysis is to derive conversion values, that when multiplied by the estimated annual emissions rate of a particular pollutant (in g/year) results in a soil concentration level that could be compared to the soil screening action levels (in mg-pollutant/Kg-soil).

Methods

The first step was a screening calculation to obtain a rough estimate and upper bound on the potential soil concentration. The hand-calculation assumed that 1) deposition occurred over an area with a 1 km radius centered on the source, 2) the active layer of the soil was 0.02m, and 3) the bulk density of the soil is 1200 Kg/m3. The resultant active soil mass using these assumptions is 7.5×10^7 Kg. Thus for example, if the amount of a toxic pollutant released per year is 1000 g, the resultant concentration of the pollutant in the soil is about 0.01 mg/Kg. This value will serve as a screening value to compare to the final results of the modeling.

For the air dispersion modeling, we used a 3Km x 3Km modeling domain. The release sites were centered approximately within the modeling domain. Terrain data was supplied to the model from digitized topography data obtained from the USGS.

For the modeling, a unit release rate was used in order to preclude having to run the model for each specific pollutant. The air concentration and deposition are directly

proportional to the emission rate and likewise can be adjusted to specific values by using the estimated emission rate for each pollutant (EPA, 1999).

Pollutant emissions can occur as particles, vapors, and gases. The CALPUFF model, in addition to containing species specific data for the primary air pollutants, includes some toxic pollutants in the species library such as toluene and xylene. For the modeling we used the selection of PM10 to represent particulate emissions, the selection TOLUENE to represent hydrocarbon emissions, the selection of NO to represent gaseous emissions. Both air concentration and deposition rates were modeled with CALPUFF.

Results

For screening calculations, air concentrations can be converted to deposition rates by applying the value of 0.02 m/s (CEPA, 2000), (ARB, 1989). By applying this screening value for deposition velocity, a deposition rate can be obtained to compare against and validate the output from the CALPUFF deposition modeling. Shown in Figure 1 are the resultant ground level air-concentration values. The overall maximum air concentration calculated by CALPUFF was about 4.5×10^{-8} g/cm3 (for a unit release rate of 1g/s) for all pollutant types. The ground level concentration contours are shown in the following figure.

The overall deposition rates were calculated by CALPUFF and are presented in the following table along with the screening value discussed above. The CALPUFF deposition flux for gases/vapors is shown in figure 2.

Estimating Soil Concentrations

To determine the estimated annul input to soil concentration per year of operation, the expected annual emissions (in g/year) for all burning activities at TA-16 could be summed for each pollutant type. That value is then multiplied by the value chosen from Table 2. The calculation assumed that the soil active layer is 0.02 m, and the soil density is 1200 Kg per cubic meter, the unit release rate was 1g/s, and the deposition rate is taken from Table 1. The output units are in mg/Kg, the most common unit of soil screening action levels. Note that the CALPUFF derived values are smaller but similar to the screening value, as would be expected. For example, if the estimated release rate of toluene is 1000 g per year, then the CALPUFF derived value for the maximum soil concentration is $1000 * 6.3 \times 10^{-09}$, or 6.3×10^{-6} (mg/Kg). This value can then be compared to the screening action level for toluene. Note this value is well within the screening soil concentration value that was calculated as the first step.

Figure 1. CALPUFF Annual Air Concentration Values (g/m**3) per Unit Release Rate (g/s) for TA16 Open Burning Sites

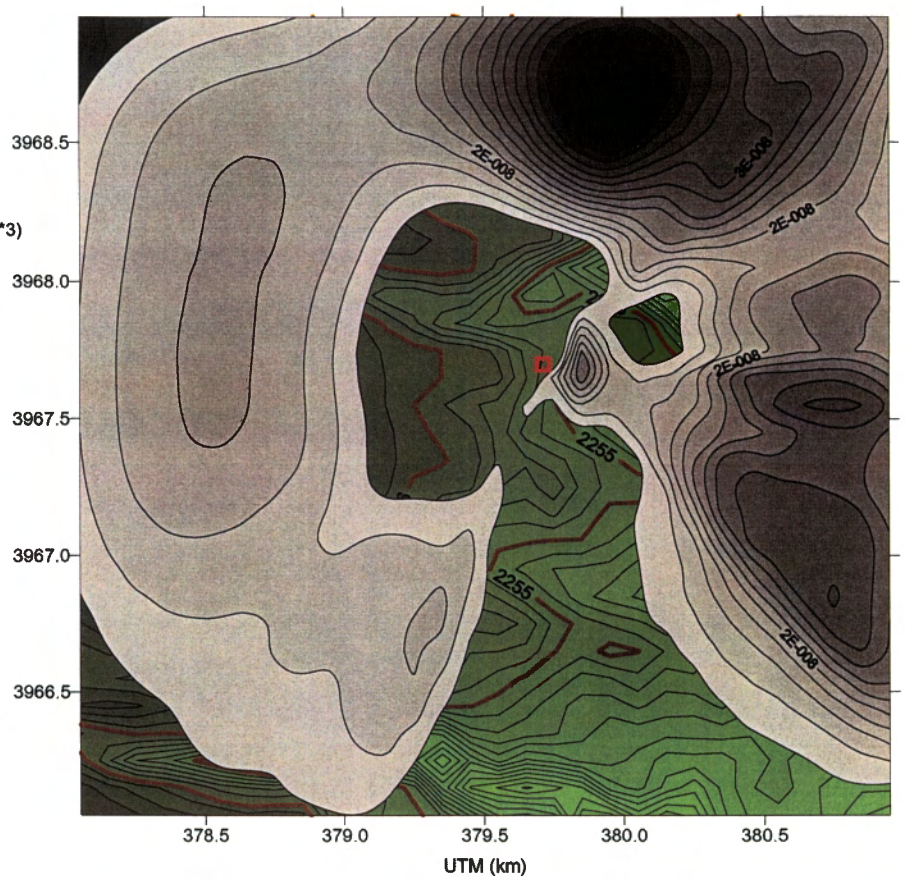


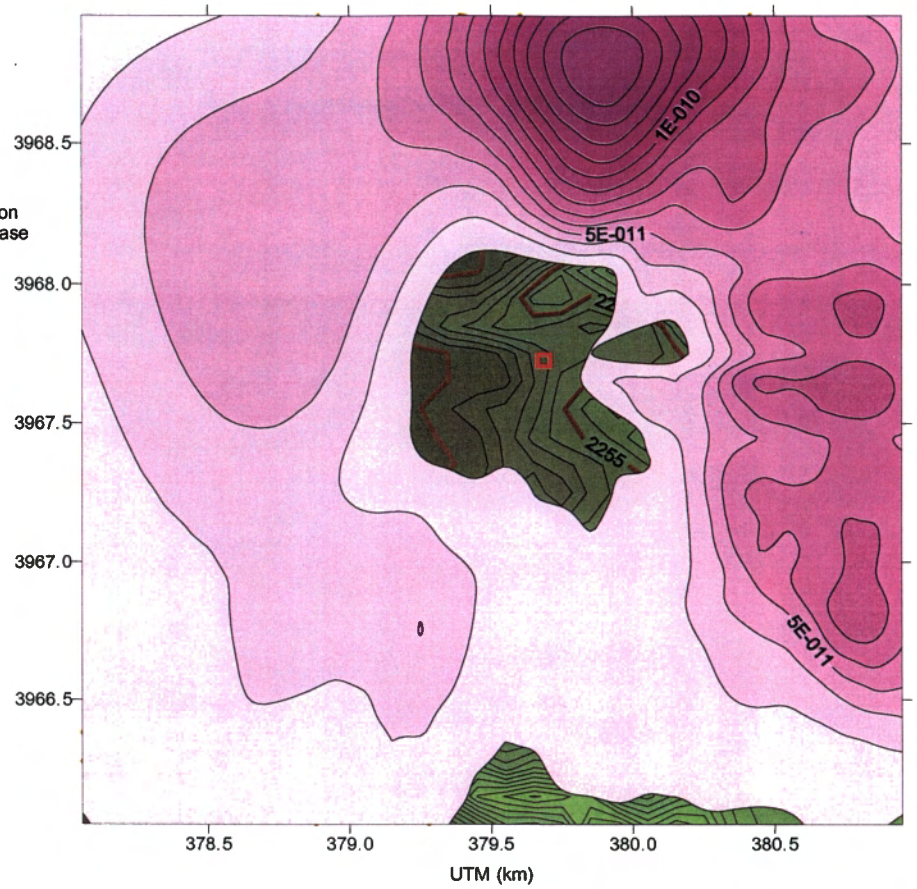
Table 1. Deposition Rate for Pollutants Emitted During Open Burns at TA16 Burn Grounds.

Variable	Rate (g/m2/s)
Screening value pollutant deposition Rate	9.0×10^{-10}
CALPUFF derived particle deposition rate	6.2×10^{-10}
CALPUFF derived hydrocarbon deposition rate	1.5×10^{-10}
CALPUFF derived gas deposition rate	3.8×10^{-11}

Table 2. Values for Converting Pollutant Emissions In "g/yr" To Soil Concentration Levels in "mg/Kg"

Variable	Conversion value
Screening Value for emissions	3.8×10^{-08}
Particulate emission type from CALPUFF	2.6×10^{-08}
Hydrocarbon emission type from CALPUFF	6.3×10^{-09}
Gaseous emissions type from CALPUFF	1.6×10^{-09}

Figure 2. CALPUFF Deposition Flux (g/m**2/s) per Unit Release Rate (g/s) for Toluene TA16 Open Burning Sites



References

(Bowen, 1990) Bowen, B. M. "Los Alamos Climatology" Los Alamos National Laboratory report LA-11735-MS, 1990

(EPA, 2000) EPA, 40 CFR 51 "Requirements of Preparation, Adoption, and Submittal of State Implementation Plans, Guideline on Air Quality Models – Proposed Rule" Federal Register, April 21, 2000

(Scire, 2000) Scire, J.S., Stimanitis D. G., and Yamartino R.J. "A Users Guide for the CALPUFF Dispersion Model" Earth Tech. Inc. January 2000.

(EPA, 1999) Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Peer Review Draft, EPA530-D-99-001A, EPA Region 6, August 1999

(CEPA, 2000) Air Toxics Hot Spots Program Risk Assessment Guidelines, The California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, Oakland, CA, September 2000

(ARB, 1989) "Screening Deposition Velocities", California Air Resource Board, Internal memorandum from A. Ranzieri to G. Shiroma dated 8/17/89

APPENDIX H

COPY OF "WEAPON MATERIALS & MANUFACTURING SAFE OPERATING PROCEDURE FOR TREATMENT OF HE-CONTAMINATED WASTE AT TA-16-388, THE BURNING GROUND FLASHPAD"

WEAPON MATERIALS & MANUFACTURING SAFE OPERATING PROCEDURE

FOR

TREATMENT OF HE-CONTAMINATED WASTE AT TA-16-388, THE BURNING GROUND FLASHPAD

Prepared By: _____ Date 3/13/2001
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Reviewed By: _____ Date 3-14-2001
Robert Garcia, ESA-WMM HE Disposal Supervisor

Approved By: _____ Date 2/26/01
David Hayden, ESA-WMM HE Processing Team Leader

Approved By: _____ Date 3/15/01
Ricardo (Tino) Ortiz, ESA-WMM Group Leader

Approved By: _____ Date 4/19/01
ESA-FM Safety Representative

ESA-WMM
ES&H Review: _____
Debbie Trujillo

LOS ALAMOS
National Laboratory
ESA-WMM

CONTROLLED DOCUMENT

Users have the ultimate responsibility to ensure that they are working with the latest revision of the controlled document. Uncontrolled if coversheet is not printed in red.

1.0 SCOPE

Wastes contaminated with High Explosives (HE), are treated at the TA-16-388, S-Site Burning Ground using various process operations as described in this SOP to remove their reactive characteristic of HE (RCRA Waste Code D003). This reduces the safety risks in handling this waste during final disposal or salvage.

This procedure is under the jurisdiction of the ESA-WMM HE Processing Team and is supervised by the HE Disposal Supervisor. The hazards associated with these operations present an initial **Medium** risk and a **Low** mitigated risk.

2.0 LIMITS

2.1 Personnel

- Minimum of 2, Maximum of 4 people under normal disposal operations of HE contaminated materials.

2.2 Explosives

- The flash pad can treat HE contaminated items or explosives suspended in liquids or dispersed in solids below 10 weight percent. No bulk or solid-chunk explosives will be treated at the flash pad.

3.0 ALLOWABLE EXPLOSIVES

Any explosive material listed in ESA SOP 1.1.0, Tables 1 and 2 and any experimental explosives/components listed in active High Explosives Development Procedures and Authorizations (HEDs).

4.0 FLASHPAD DESCRIPTION

The flash pad (see page 9) consists of a 22-ft by 22-ft concrete pad set on a polypropylene-lined secondary containment. The pad is slightly slanted lower toward the back. One-ft in from the edge of the concrete pad along the two sides and back is a 3-ft high, 8-in thick impervious concrete wall. The entire flash pad is covered with a retractable steel roof when the pad is inactive. Storm water that falls on the flash pad cannot escape. These collect in the back of the pad where they can evaporate or be collected with spill-kits or with the Burning Ground vacuum tank truck.

The heat sources for the flash pad are three 5-ft.-long forced-air propane burners with adjustable mounts. A burner is mounted outside the walls on each side and back of the pad. One, two, or three burners can be used, depending on the amount

and configuration of the material to be flashed. Each burner has a thermal output of 2,500,000 BTU per hour that is used to heat or ignite the material being flashed to temperatures sufficient to destroy all HE contamination, above 800°F or above 400°C.

4.1 Tray on Flashpad

The waste to be treated is set on a steel tray, 8-ft long, 4-ft wide and 1-ft high. The bottom is covered with sand, and the walls are protected with firebricks. The tray is both confinement for the residue of the treatment process and protection for the concrete pad. The tray was constructed to hold liquids. For large non-combustible objects that cannot be placed in the tray, four 4-ft by 4-ft flat steel pallets are available to replace the tray. Both the tray and the pallets can be readily moved with a forklift.

4.2 Remote Monitoring

Television cameras are mounted above the front of the pad allowing remote supervision of operations at the flash pad. The monitor and the lockout key for the power to operate the flash pad are located at the office/control building, TA-16-389. The key is carried and controlled by the HE Disposal Supervisor. Once the flash pad has been set-up for treatment, the road is barricaded to prevent traffic from approaching, and HE Processing personnel return to –389 to make the notifications designated in Section 10 of this SOP. The burners are operated remotely from –389 using a computer monitor display.

5.0 FLASHPAD OPERATION PROCEDURE

The operation of the flash pad is described in Operating Procedure (OP-050). Below are several items that must be completed at the flashpad and propane tank pad before treatment can begin.

5.1 The Air Quality Group, ESH-17, must be notified at least 24 hours before any treatment operations at the flash pad. They must notify the state air quality officials so that the state officials have an opportunity to prohibit or inspect the operation. The Disposal Supervisor or the HE Processing Team Leader will perform LANL notifications. After any operation on the flash pad, the type and amount of material treated must be reported by FAX to ESH-17, along with the amount of propane consumed in units of BTUs.

5.2 The key to the switch box that disables the burners at the 388 flash pad are kept locked in the keybox at TA-16-389. That key must be carried by

flashpad personnel when working or setting up for a treatment at the flashpad.

5.3 Check the level of the propane tank to assure sufficient fuel is on hand.

5.4 Check all valves between the propane tank and the burners for proper position.

5.5 The vaporizer must be switched on for all flashpad operations.

5.6 The control panel on the propane tank pad must be checked for any "fail" light displays. Any "fail" light will prevent the flash pad from operating. The Equipment Services Unit must be called to check the flash pad if a "fail" light is displayed.

5.7 The roof for the flashpad must be fully retracted. First, check to see that all tie-downs are uncoupled at the flash pad. Second, pull out the emergency stop button for the roof retraction power and push the retraction button. When the roof is fully retracted, push in the emergency stop button.

5.8 Assure personnel limits are in compliance.

5.9 The key switches on the side of the control panel are checked to see if they are switched on for the proper burners.

5.10 Proceed to TA-16-389, adjust the TV monitors for the treatment, then, with the key, turn the disabling switch to the "ON" position, and begin operations from the computer display as described in Operating Procedure (OP-050).

5.11 The cover must remain retracted for all flashing operations. Wait a minimum of 30 minutes after the completion of the burn before covering the flashpad with the retractable roof.

5.12 After burning and/or other work is finished for the day, the cover must be returned to cover the flash pad.

6.0 WASTE TYPES AND FLASHPAD TREATMENT PROCEDURES

6.1 HE-CONTAMINATED METAL WASTE

The majority of non-combustible wastes are metal items, which are handled manually.

- Items that weigh up to a nominal 50 lb (22.7 kg) and can be securely gripped may be handled by one operator, provided the individual is comfortable lifting the given weight.

- Items that weigh up to a nominal 100 lb (45.4 kg) may be handled by two operators provided that the object can be firmly gripped and the weight is equally distributed.

- Items exceeding 100 lbs, shall not be handled manually. These items will be maneuvered with the boom truck.

After a minimum of 12 hours cooling, the items can be reoriented for additional treatment. As described above, items too large for the tray are placed on steel pallets. Authorized Burning Ground personnel shall use thermocouples to verify that the required temperatures have been reached. After the metal items are treated and ESA-FM deems them HE decontaminated, they are salvaged by ESA-FM.

6.2 HE-CONTAMINATED SOLID COMBUSTIBLES

Cardboard HE storage containers, cloth and paper used to clean HE, packing material for HE, wooden HE packing crates, rags used to mop-up oil from around HE processing machines are some of the common combustible materials that must be treated. These materials are stacked on the steel tray and covered with chain-linked fencing. The burners are used to ignite and thoroughly burn the material. When the burning subsides, the residue is inspected for thorough combustion. After treatment, the cooled residue is placed in a 55 or 5 gallon DOT approved container for testing and final disposal by ESA-FM.

6.3 HE-CONTAMINATED LIQUID WASTES

The steel tray combined with smaller steel trays are used to contain small batches of water-solvent solutions, oils and acids or bases that must be treated. These wastes are received in 5 gallon or smaller carboys. The contents are poured into the 2-ft. by 3-ft. by several inch deep trays that are set on a steel stand in the middle of the large 4-ft. by 8-ft lined tray. After treatment, the cooled residue is placed in a 55 or 5 gallon DOT approved container for testing and final disposal by ESA-FM.

6.4 HE-CONTAMINATED NON-COMBUSTIBLE PARTICULATES

Soil contaminated with explosives, contaminated sands from the sand filters -401 and -406, small batches of HE contaminated activated carbon, and

similar contaminated non-combustible particulate matter are treated in the same manner as liquids. Thermocouples are set in the middle of the waste to monitor the temperature. After treatment, the cooled residue is placed in a 55 or 5 gallon DOT approved container for testing and final disposal by ESA-FM.

7.0 WASTE ACCEPTANCE CRITERIA

Before wastes can be accepted for treatment, the Disposal Supervisor must receive a **TA-16 Burning Ground Treatment Request Form** accompanied by a **Los Alamos National Laboratory Waste Profile Form** with its assigned number. These documents describe the type and amount of wastes, the location, other chemicals involved and their hazards, and the type of explosives involved. The Disposal Supervisor and the HE Processing Team Leader must review these documents and, if a decision is made to accept the waste, the Team Leader must sign the request.

8.0 WASTE DISPOSAL

The ESA-FM-ESH Waste coordinator shall be contacted immediately to dispose of waste for clean up. This waste is moved to 90 day storage and labeled "**Pending Testing**". After testing is performed an analysis is made and the containers are re-labeled either "**Special Waste**" or "**Hazardous Waste**". ESA-FM is then contacted for final disposal.

9.0 TRAINING AND SAFETY APPAREL

9.1 Personnel who are both qualified and authorized per the High Explosive Disposal Operations and Waste Water Treatment Facility Operation, Hazard Control Plan (HCP 99-008), and individual Training Plans may engage in explosive disposal activities which include: handling, transporting, and disposing of explosives and other hazardous materials

9.2 All personnel involved in disposal and hazardous waste operations shall be instructed in, and are required to follow all WWTF requirements as defined in LANL/ESA-WMM official documents (noted under HCP 99-008).

9.3 Operators or staff who are engaged in disposal operations at the flash pad shall wear coveralls, industrial safety shoes, goggles, and leather work-gloves.

9.4 When working with hazardous wastes Operators must wear Personal Protective Equipment (PPE) based on the wastes' MSDSs, including rubber gloves, spill apron, face shield, and appropriate respiratory apparatus as prescribed by the Industrial Hygiene and Safety Group (ESH-5).

10.0 FLASH PAD TRAY NOTIFICATIONS

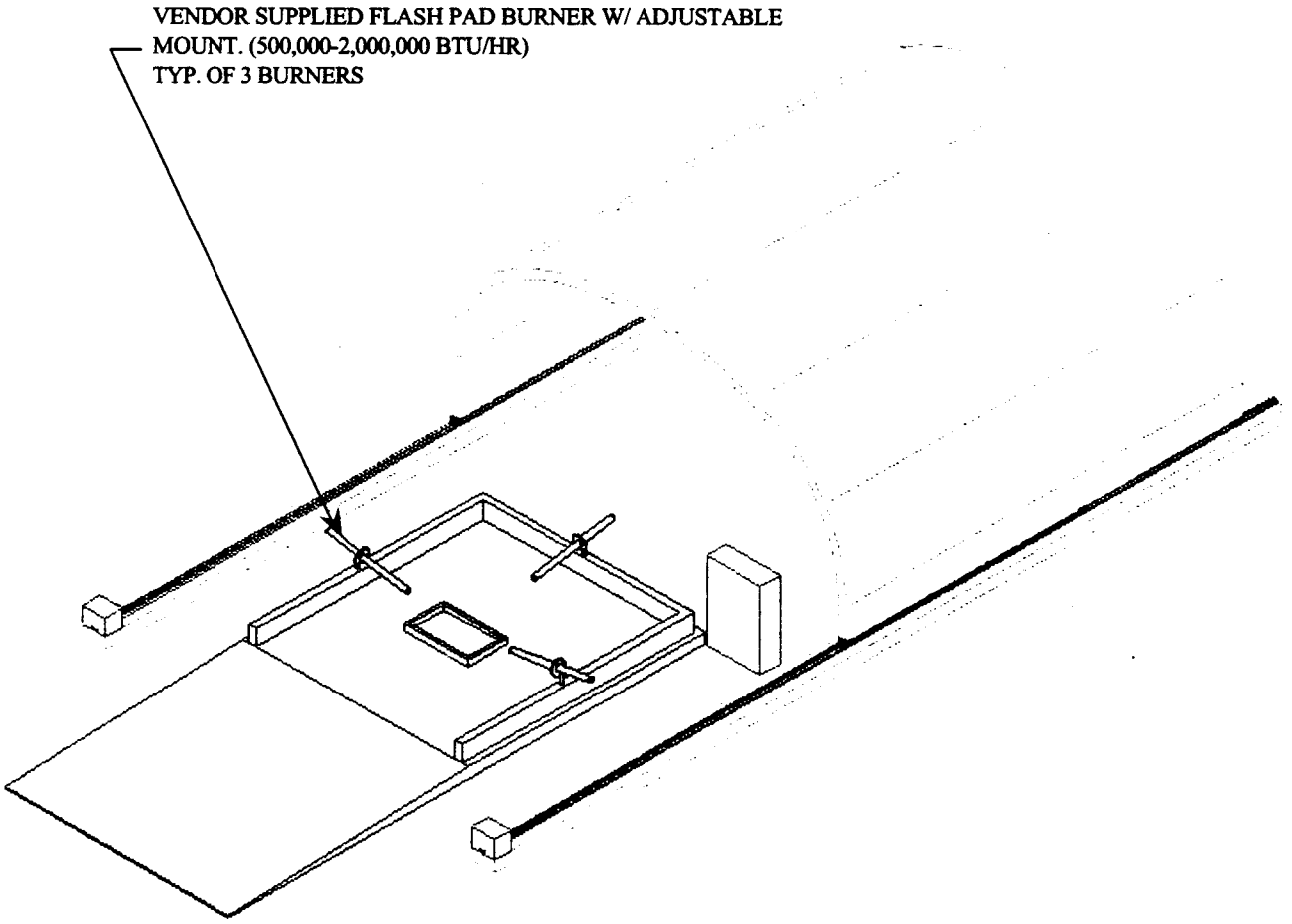
The operation of the flash pad requires the following notifications be given.

Flashpad Operations

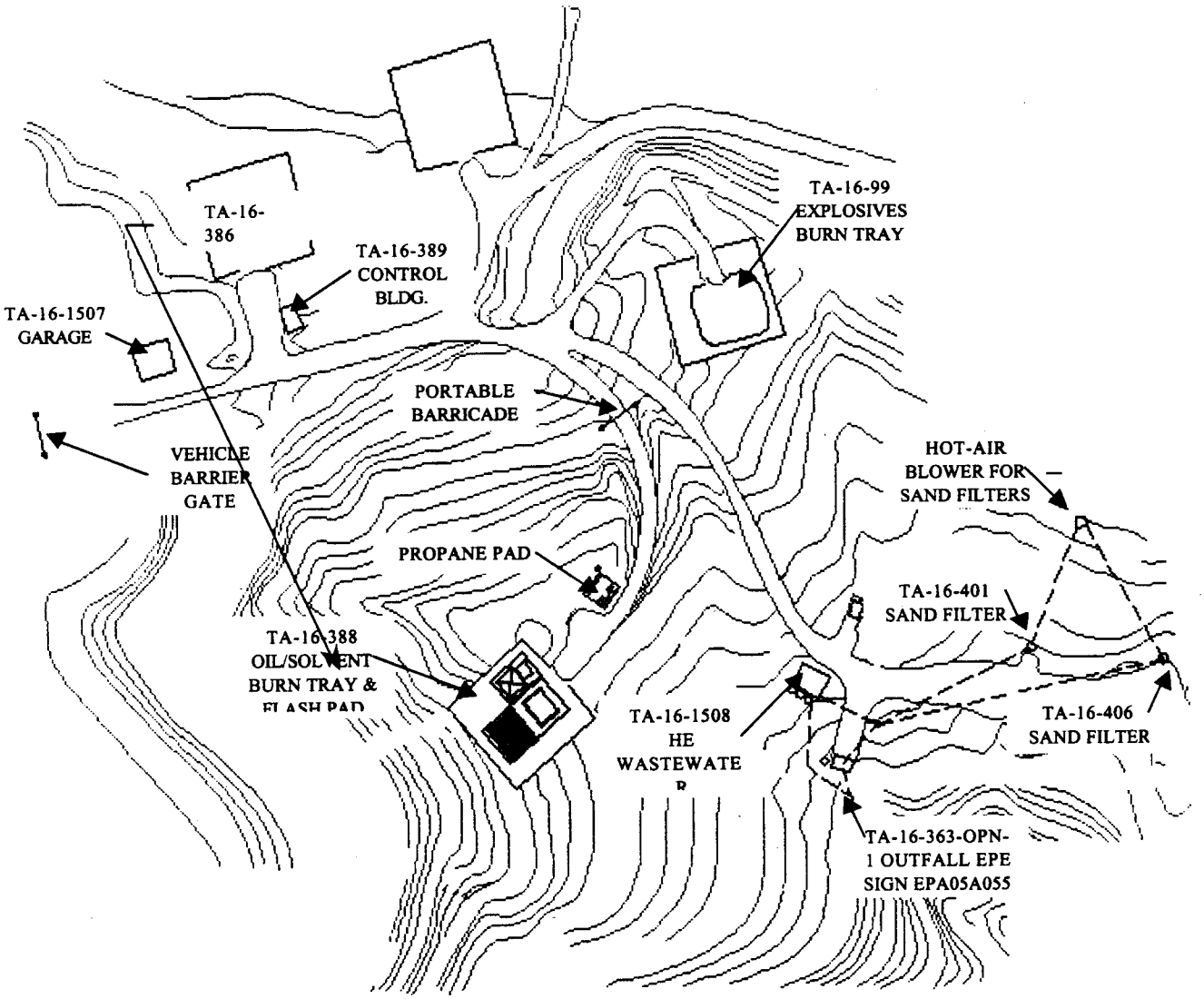
Contact	Time Frame
HE Processing Team Leader	24 hours prior to burn
Air Quality (ESH-17)	24 hours prior to burn
New Mexico Env. Dept. (NMED)	Contacted by ESH-17
* Access Control Office (ACO)	Before/After each flashing
Local Fire Department	Before/After each flashing

*** Prohibit access to Burning Grounds while flashing is being conducted.**

In order to communicate and address all concerns, employees are encouraged to recommend changes be made to this document. Employees are always encouraged to raise any questions or concerns to their Team Leader, and make suggestions for improvements in the over all safety of operations.


VENDOR SUPPLIED FLASH PAD BURNER W/ ADJUSTABLE
MOUNT. (500,000-2,000,000 BTU/HR)
TYP. OF 3 BURNERS

FLASH PAD



TA-16-BURN GROUND
S.O.P. SITE PLAN

APPENDIX I

REVISED TABLES 1-1 AND H-1
(from the "Los Alamos National Laboratory Technical Area 16 Part B Permit Renewal Document", Revision 3.0, January 2000)
IN REDLINE/STRIKEOUT FORMAT

Table 1-1

Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Document	Location in SMC	Location in NOD Response
§270.14(b)(1)	General facility description	Attachment A[a]	–	–
§270.14(b)(2)	Chemical and physical analyses	Attachment B[a]	Process Operations – Ask Management, Attachment A (Sections H.2.3 and H.4	Nos. 1,6
§270.14(b)(3)	Waste analysis plan	Attachment B[a]	–	–
§264.13(b)	Development and implementation of waste analysis plan	Attachment B[a]	–	–
§264.13(c)	Off-site waste analysis requirements	Attachment B[a]	–	–
§270.14(b)(4)	Security procedures and equipment	Attachments G and H	Attachment A (Section H.2.6)	–
§264.14	Security	Attachments G and H	Attachment A (Section H.2.6)	–
§270.14(b)(5)	General inspection requirements	Attachment C[a]	–	No. 6
§264.15(b)	General inspection requirements	Attachment C[a]	–	No. 6
§264.174	Container inspections	Attachment C[a]	–	–
§264.193(i)	Tank inspections	NA[b]	NA	NA
§264.195	Overfill control inspections	NA	NA	NA
§264.226	Surface impoundments monitoring and inspection	NA	NA	NA
§264.254	Waste pile monitoring and inspection	NA	NA	NA
§264.273	Land treatment design and operating requirements	NA	NA	NA
§264.303	Landfill monitoring and inspection	NA	NA	NA
§264.347	Incinerator monitoring and inspection	NA	NA	NA

Table 1-1
(Continued)
Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Document	Location in SMC	Location in NOD Response
§264.602	Miscellaneous units (monitoring, testing, analytical data, inspection, response, reporting, corrective action)	Attachment C[a], Sections 2.3 and 4.3	Process Operations – Ash Management, Environmental Data, Attachments A and E	No. 4
§264.1033	Process vent standards	NA	NA	NA
§264.1052	Equipment leak air emission standards	NA	NA	NA
§264.1053	Compressor standards	NA	NA	NA
§264.1058	Standards for pumps, valves, pressure relief devices, flanges and connections	NA	NA	NA
§264.1088	Subpart CC inspection and monitoring requirements	NA	NA	NA
§270.14(b)(6)	Request for waiver from preparedness and prevention requirements of 264 Subpart C	NA	NA	NA
§270.14(b)(7)	Contingency plan requirements under 264 Subpart D	Attachment E[a]	Miscellaneous – Contingency Plan	–
§264, Subpart D	Contingency plan and emergency procedures	Attachment E[a]	Miscellaneous – Contingency Plan	–
§264.227	Surface impoundment emergency repairs; contingency plans	NA	NA	NA
§264, Subpart C	Preparedness and prevention	Sections 2.1.12 and 2.2.7, Attachments G (G.2.4) and H (H.2.7)	Attachment A (Section H.2.7)	–
§270.14(b)(8)	Preparedness and prevention	Sections 2.1.12 and 2.2.7, Attachments G (G.2.4) and H (H.2.7)	Attachment A (Section H.2.7)	–
§270.14(b)(8)(i)	Prevention of hazards in unloading operations (ramps and special forklifts)	Attachments G (G.2.4.1) and H (H.2.7.6)	Attachment A (Section H.2.7.6)	–
§270.14(b)(8)(ii)	Runoff prevention with berms, trenches, and dikes	2.0 (2.1.12 and 2.2.7)	Attachment A (Section H.2.7.6)	–

Table 1-1
(Continued)
Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Document	Location in SMC	Location in NOD Response
§270.14(b)(8)(iii)	Prevention of contamination of water supplies	Attachments G (G.2.4.3) and H (H.2.7.6)	Attachment A (Sections H.2.7.6, H.3.2, H.3.3)	No. 5
§270.14(b)(8)(iv)	Mitigation effects of equipment failure and power outages	Attachments G (G.2.4.4) and H (H.2.7.6)	Attachment A (Section H.2.7.6)	–
§270.14(b)(8)(v)	Prevention of undue exposure of personnel by use of personal protective equipment	Attachments G (G.2.4.5) and H (H.2.7.6)	Attachment A (Section H.2.7.6)	–
§270.14(b)(8)(vi)	Prevention of release to the atmosphere	Attachments G (G.2.4.6) and H (H.2.7.6)	Attachment A (Section H.2.7.6)	Nos. 1,6, Appendix G
§270.14(b)(9)	Prevention of accidental ignition or reaction	2.0[a], (Sections 2.1.10 and 2.2.5), Attachments G (G.2.5) and H (H.2.7.7)	Attachment A (Section H.2.7.7)	No. 1
§264.17	General requirements for ignitable, reactive, or incompatible wastes	2.0[a], (Sections 2.1.10 and 2.2.5), Attachments G (G.2.5) and H (H.2.7.7)	Attachment A (Section H.2.7.7)	–
§264.17(c)	Documentation of compliance with 264.17 (general requirements for ignitable, reactive, or incompatible wastes)	2.0[a], (Sections 2.1.10 and 2.2.5), Attachments G (G.2.5) and H (H.2.7.7)	Process Operations – Temperature Levels and Necessary Time to Achieve HE Degradation, Attachment A (Section H.2.7.7)	–
§270.14(b)(10)	Traffic pattern, volume, and controls	Attachment A[a]	–	–
	Identification of turn lanes	NA	–	–
	Identification of traffic/stacking lanes	NA	–	–
	Description of road surface	Attachment A[a]	–	–
	Description of road load-bearing capacity	Attachment A[a]	–	–
	Identification of type and number of traffic controls	Attachment A	–	–

Table 1-1
(Continued)
Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Document	Location in SMC	Location in NOD Response
§270.14(b)(11)	Facility/unit location information	Attachment A	–	–
§264.18	Location standards	Attachment A	–	–
§270.14(b)(11)(i)	Seismic standard applicability [264.18(a)]	Attachment A	–	–
§270.14(b)(11)(ii)	Seismic standard requirements	Attachment A	–	–
§270.14(b)(11)(ii)(A)	No fault within 3,000 feet (ft) with displacement in Holocene time	NA	–	–
§270.14(b)(11)(ii)(A)(1)	Published geological studies	NA	–	–
§270.14(b)(11)(ii)(A)(2)	Aerial reconnaissance of a five-mile radius from the facility	NA	–	–
§270.14(b)(11)(ii)(A)(3)	Analysis of aerial photographs covering 3,000-ft radius from the facility/unit	NA	–	–
§270.14(b)(11)(ii)(A)(4)	Reconnaissance based on walking portions of the area within 3,000 ft of the facility	NA	–	–
§270.14(b)(11)(ii)(B)	If faults which have displacement in Holocene time are present within 3,000 ft, no faults pass within 200 ft of portions of the facility where treatment, storage, or disposal will be conducted	NA	–	–
§270.14(b)(11)(iii)	100-year floodplain standard	Attachment A[a]	–	–
§270.14(b)(11)(iv)	If facility is within 100-year floodplain	NA	–	–
§270.14(b)(11)(iv)(A)	Engineering analyses of hydrostatic forces expected in a 100-year flood	NA	–	–
§270.14(b)(11)(iv)(B)	Structural engineering studies for flood protection to prevent washout	NA	–	–
§270.14(b)(11)(iv)(C)	Detailed description of procedures to remove hazardous waste to safety before flood reaches the waste	NA	–	–
§270.14(b)(11)(iv)(C)(1)	Timing of removal	NA	–	–

Table 1-1
(Continued)
Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Document	Location in SMC	Location in NOD Response
§270.14(b)(11)(iv)(C)(2)	Location to be moved to	NA	–	–
§270.14(b)(11)(iv)(C)(3)	Dedicated equipment and personnel to ensure removal	NA	–	–
§270.14(b)(11)(iv)(C)(4)	Potential for accidental discharge during movement	NA	–	–
§270.14(b)(11)(v)	Plan to show how the facility will be brought into compliance with 264.18(b)	NA	–	–
§270.14(b)(12)	Personnel training program	Attachment D[a]	–	–
§270.14(b)(13)	Closure and post-closure plans	Attachments F.1 and F.2[a]	Miscellaneous – Closure Plan	Nos. 9-12
§264.112	Amendment of closure plan	Attachments F.1 and F.2[a]	–	–
§264.118	Post-closure plan; amendment of plan	Attachments F.1 and F.2[a]	–	–
§264.178	Closure/containers	Attachment F.1[a]	–	No. 12
§264.197	Closure/tanks	NA	–	–
§264.228	Closure/post-closure/surface impoundments	NA	–	–
§264.258	Closure/post-closure/waste piles	NA	–	–
§264.280	Closure/post-closure/land treatment	NA	–	–
§264.310	Closure/post-closure/landfills	NA	–	–
§264.351	Closure/incinerators	NA	–	–
§264.601	Miscellaneous units	Section 2.2, Attachment F.2[a], Attachment H (Sections H.1 and H.2)	Process Operations, Environmental Data, Attachments A, E, and F	Nos. 1-12
§264.603	Post-Closure care	Attachments F.1 and F.2[a]	Miscellaneous-Closure Plan	No. 11
§270.14(b)(14)	Post-closure notices (264.119)	Attachments F.1 and F.2[a]	–	–
§270.14(b)(15)	Closure cost estimate (264.142)	Attachments F.1 and F.2[a]	–	–

Table 1-1
(Continued)
Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Document	Location in SMC	Location in NOD Response
	Financial assurance (264.143)	Attachments F.1 and F.2[a]	–	–
§270.14(b)(16)	Post-closure cost estimate (264.144)	Attachments F.1 and F.2[a]	–	–
	Post-closure care financial assurance (264.145)	Attachments F.1 and F.2[a]	–	–
§270.14(b)(17)	Liability insurance (264.147)	Attachments F.1 and F.2[a]	–	–
§270.14(b)(18)	Proof of financial coverage (264.149-150)	Attachments F.1 and F.2[a]	–	–
§270.14(b)(19)	Topographic map requirements	Attachment A[a,c]	–	–
§270.14(b)(19)(i)	Map scale and date	Attachment A[a,c]	–	–
§270.14(b)(19)(ii)	100-year floodplain	Attachment A[a]	–	–
§270.14(b)(19)(iii)	Surface waters	Attachment A	–	–
§270.14(b)(19)(iv)	Land use	Attachment A	–	–
§270.14(b)(19)(v)	Wind rose	Attachment A	–	–
§270.14(b)(19)(vi)	Map orientation	Attachment A[a,c]	–	–
§270.14(b)(19)(vii)	Legal boundaries	Attachment A[c]	–	–
§270.14(b)(19)(viii)	Access controls	Attachment A	–	–
§270.14(b)(19)(ix)	Wells	Attachment A	–	–
§270.14(b)(19)(x)	Buildings	Attachment A	–	–
	Treatment, storage, and disposal operations	Attachment A	–	–
	Run-on/run-off control systems	2.0 (2.1.12 and 2.2.7), Attachments A (A.4), G (G.2.4.2), and H (H.2.7.6)	–	–
	Storm sewer systems	Attachment A[a]	–	–
	Sanitary sewer systems	Attachment A[a]	–	–

Table 1-1
(Continued)
Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Document	Location in SMC	Location in NOD Response
	Process sewer systems	Attachment A[a]	–	–
	Loading/unloading areas	Attachment A	–	–
	Fire control facilities	Attachment A[a]	–	–
§270.14(b)(19)(xi)	Drainage barriers	2.0 (2.1.12 and 2.2.7), Attachment A (A.4)	–	–
§270.14(b)(19)(xii)	Location of operational units	2.0 (2.1.1 and 2.2.1), Attachment A (A.1)	–	–
§270.14(b)(20)	Other federal laws	3.0[a]	–	–
§270.3(a)	Wild and Scenic Rivers Act	3.0[a]	–	–
§270.3(b)	National Historic Preservation Act	3.0[a]	–	–
§270.3(c)	Endangered Species Act	3.0[a]	–	–
§270.3(d)	Costal Zone Management	3.0[a]	–	–
§270.3(e)	Fish and Wildlife Coordination Act	3.0[a]	–	–
§270.3(f)	Executive Orders	3.0[a]	–	–
§270.14(b)(21)	Notice of extension approval for land disposal facilities	NA	–	–
§270.14(c)	Groundwater monitoring requirements	Attachment A[a]	–	No. 5
§270.14(c)(1)	Groundwater monitoring under 265.90 through 265.94	NA	–	–
§270.14(c)(2)	Identification of uppermost aquifer, groundwater flow rate and direction	NA	–	–
§270.14(c)(3)	A topographic map required under 270.14(b)(19) that identifies proposed point of compliance	NA	–	–
	Proposed location of groundwater monitoring wells under 264.97	NA	–	–

Table 1-1
(Continued)
Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Document	Location in SMC	Location in NOD Response
§270.14(c)(4)	Description of plume of contamination that has entered groundwater	NA	–	–
§270.14(c)(4)(i)	Extent of plume indicated on topographic map	NA	–	–
§270.14(c)(4)(ii)	Identification of constituents and concentration for Appendix IX of 264	NA	–	–
§270.14(c)(5)	Detailed plan and an engineering report describing proposed groundwater monitoring program under 264.97	NA	–	–
§270.14(c)(6)	No releases detected in groundwater (264.98)	NA	–	–
§270.14(c)(6)(i)	List of proposed indicator parameters	NA	–	–
§270.14(c)(6)(ii)	Proposed groundwater monitoring system	NA	–	–
§270.14(c)(6)(iii)	Background values for each proposed monitoring parameter	NA	–	–
§270.14(c)(6)(iv)	Description of proposed sampling, analyses and statistical comparisons to be used	NA	–	–
§270.14(c)(7)	Release detected at point of compliance requires corrective action under 264.100	NA	–	–
§270.14(d)	Information requirements for solid waste management units (SWMU)	4.0	–	–
§270.14(d)(1)(i)	Location of SWMUs on topographic map	4.0	–	–
§270.14(d)(1)(ii)	Types of SWMUs	4.0	–	–
§270.14(d)(1)(iii)	Dimensions and descriptions of SWMUs	4.0	–	–
§270.14(d)(1)(iv)	Dates of operation	4.0	–	–
§270.14(d)(1)(v)	Waste types managed at SWMU	4.0	–	–
§270.14(d)(2)	Information on releases from SWMUs	4.0	–	–

Table 1-1
(Continued)
Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Document	Location in SMC	Location in NOD Response
§270.15	Containers	2.0 (2.1), Attachment G	–	–
§270.16	Tank systems	NA	–	–
§270.16(a)	Written assessment and certification	NA	–	–
§270.16(b)	Capacity/dimensions	NA	–	–
§270.16(c)	Systems and controls	NA	–	–
§270.16(d)	Piping and process flow	NA	–	–
§270.16(e)	External corrosion protection	NA	–	–
§270.16(f)	Installation	NA	–	–
§270.16(g)	Secondary containment system	NA	–	–
§270.16(h)	Request for variance from secondary containment	NA	–	–
§270.16(i)	Spill prevention	NA	–	–
§270.16(j)	Ignitable, reactive, or incompatible wastes	NA	–	–

[a] Requirement or information is also addressed in the "Los Alamos National Laboratory General Part B Permit Application," Revision 1.0 (LANL, 1998a), as appropriate.
[b] NA = not applicable.
[c] Some of the topographic map requirements are addressed in the "Los Alamos National Laboratory General Part A Permit Application," Revision 0.0 (LANL, 1998b).

Table H-1

Miscellaneous Unit Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Permit Renewal Document	Location in SMC	Location in NOD Response
§264.601(a)	Prevention of release of contaminants to groundwater	Sections 2.2.3 and 2.2.7, Attachment H (Sections H.1, H.2.7.6, and H.3.1))	Environmental Data – Surface and Groundwater Quality	No. 5
§264.601(a)(1)	Volume and characteristics of waste considering potential for migration through containing structures	2.0 (Sections 2.2.1, 2.2.3, 2.2.7), Attachment H (Sections H.1.1, H.1.2, H.1.3)	–	Nos. 1, 6
§264.601(a)(2)	Hydrologic/geologic characteristics	Attachment H (Section H.3.1), Supplement H-1 (Site Conditions)	Attachment A (Section H.3.1)	No. 5
§264.601(a)(3)	Quality of groundwater including other sources of contamination and their cumulative impact on groundwater	Attachment H, Supplement H-1	Attachment A (Section H.3.1)	No. 5
§264.601(a)(4)	Quantity and direction of groundwater flow	Attachment H	Attachment A (Section H.3.1)	–
§264.601(a)(5)	Proximity to and withdrawal rates of potential groundwater users	Attachment H	Attachment A (Section H.3.1)	–
§264.601(a)(6)	Regional patterns of land use	Attachment A (Section A.4)	–	–
§264.601(a)(7)	Potential for deposition and migration of waste constituents	Attachment H, Supplement H-1 (Groundwater Transport)	Attachment A (Section H.3.1)	No. 5

Table H-1 (Continued)

Miscellaneous Unit Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Permit Renewal Document	Location in SMC	Location in NOD Response
§264.601(a)(8)	Potential for health risks caused by human exposure to waste constituents	Attachment H	Attachment F	No. 6
§264.601(a)(9)	Potential for damage to domestic animals, wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents	Attachment H	Attachment F	No. 6
§264.601(b)	Prevention of release of contaminants to surface water	Attachment H (Sections H.1, H.2.7.6, and H.3.2)	Environmental Data – Surface and Groundwater Quality	–
§264.601(b)(1)	Volume and characteristics of the waste	2.0 (Sections 2.2.1, 2.2.3, 2.2.7), Attachment H (Sections H.1.1, H.1.2, H.1.3)	–	Nos. 1, 6
§264.601(b)(2)	Effectiveness and reliability of containment, confinement, and collection systems and structures	2.0 (Section 2.2.3), Attachment H (Sections H.1.1, H.1.2, H.1.3)	Process Operations – Ash Management, Miscellaneous – Waste Staging	No. 6
§264.601(b)(3)	Hydrologic characteristics of the unit and local area	Attachment H (Sections H.3.1 and H.3.2), Supplement H-1 (Site Conditions)	Attachment A (Section H.3.1)	No. 5

Table H-1 (Continued)

Miscellaneous Unit Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Permit Renewal Document	Location in SMC	Location in NOD Response
§264.601(b)(4)	Regional precipitation patterns	Attachment H (Section H.3.2), Supplement H-1 (Background, Meteorology)	Attachment A (Sections H.3.2 and H.3.3)	–
§264.601(b)(5)	Quantity, quality, and direction of groundwater flow	Attachment H	Attachment A (Section H.3.1.4)	No. 5
§264.601(b)(6)	Proximity of the unit to surface water	Attachment A (Section A.4), Attachment H (Section H.3.2)	Attachment A (Sections H.3.1 and H.3.3)	–
§264.601(b)(7)	Current and potential uses of nearby surface waters and water quality standards for those waters	Attachment H	Attachment A (Section H.3.1)	–
§264.601(b)(8)	Quality of surface waters and soils including other sources of contamination and their cumulative impact on surface waters and soils	Attachment H (Section H.3.2), Supplement H-1 (Meteorology)	Attachment A (Section H.3.3)	–
§264.601(b)(9)	Regional patterns of land use	Attachment A (Section A.4)	–	–
§264.601(b)(10)	Potential for health risks caused by human exposure to waste constituents	Attachment H	Attachment F	No. 6
§264.601(b)(11)	Potential for damage to domestic animals, wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents	Attachment H	Attachment F	No. 6

Table H-1 (Continued)

Miscellaneous Unit Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Permit Renewal Document	Location in SMC	Location in NOD Response
§264.601(c)	Prevention of release of contaminants to air	Section 2.2.3, Attachment H (Sections H.2 and H.3.3)	Process Operations – Ash Management, Environmental Data – Air Quality, Attachment F	Nos. 1, 6
§264.601(c)(1)	Volume and characteristics of waste including its potential for emission	2.0 (Sections 2.2.1, 2.2.3, 2.2.7), Attachment H (Section H.2)	Attachment F	Nos. 1, 6
§264.601(c)(2)	Effectiveness and reliability of systems/structures to reduce/prevent emissions of hazardous constituents to the air	2.0 (Sections 2.2.1, 2.2.3, 2.2.7), Attachment H (Section H.2)	Process Operations – Ash Management, Environmental Data – Air Quality, Attachment F	–
§264.601(c)(3)	Operating characteristics of the unit	2.0 (Section 2.2), Attachment H (Section H.2)	Process Operations	–
§264.601(c)(4)	Characteristics of the unit and the surrounding area	2.0, Attachment A (topographic map), Attachment H (Section H.3.3), Attachment H-1 (Meteorology)	Attachment F	–

Table H-1 (Continued)

Miscellaneous Unit Regulatory References and Corresponding Permit Renewal or Other Document Location

Regulatory Citation(s)	Description of Requirement	Location in this Permit Renewal Document	Location in SMC	Location in NOD Response
§264.601(c)(5)	Existing quality of the air including other sources of contaminants and their cumulative impact on the air	Attachment H (Section H.3.3)	Environmental Data – Air Quality, Attachment A (Section H.3.4)	Nos. 1, 6
§264.601(c)(6)	Potential health risks caused by human exposure to waste constituents	Attachment H	Attachment F	Nos. 1, 6
§264.601(c)(7)	Potential for damage to domestic animals, wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents	Attachment H	Attachment F	Nos. 1, 6
§264.602	Monitoring, analysis, inspection, response, reporting, and corrective action	2.0 (Section 2.3), 4.0 (Section 4.3), Attachment C[a], Attachment H	Process Operations – Ash Management, Environmental Data, Attachments A and E	No. 4
§264.603	Post-closure care	Attachment F.2[a]	Miscellaneous - Closure Plan	No. 11
§264.15	General inspection requirements	Attachment C[a]	–	No. 6
§264.33	Testing and Maintenance of Equipment	Attachment H (Section H.2.7.2)	Attachment A (Section H.2.7.2)	–
§264.75	Biennial report	2.0 (Section 2.3.1)	–	–
§264.76	Unmanifested waste report	2.0 (Section 2.3.2)	–	–
§264.77	Additional reports	2.0 (Section 2.3.3)	–	–
§264.101	Corrective action for solid waste management units	4.0	–	–

[a] Requirement or information is also addressed in the "Los Alamos National Laboratory General Part B Permit Application," Revision 1.0 (LANL, 1998a), as appropriate.

APPENDIX J

REVISED TABLE E.2-2 (from the draft "Los Alamos National Laboratory Hazardous Waste Facility Permit, Chapter 5, Technical Area 16 Conditions) IN REDLINE/STRIKEOUT FORMAT

Table E.2-2

Analytical Parameters and Test Methods[a]

Parameter	Test Method	Reference[b]
Ignitability	Pensky-Martens closed-cup method Setaflash closed-cup method Ignitability of solids	(L, S) SW1010, SW1020 (S) SW1030 (L, S) ASTM D93-80
~~Reactivity~~	~~Test method to determine hydrogen cyanide released from waste~~ ~~Test method to determine hydrogen sulfide released from waste~~	~~(L, S) SW, Section 7.3~~
Corrosivity	Electrometric (pH of aqueous solution)	(L) SW9040B
Toxicity characteristic (TC)	Toxicity characteristic leaching procedure (TCLP) extraction	(S) SW1311
TC Metals:	Graphite furnace atomic absorption (AA) spectroscopy, gaseous hydride AA, or direct aspiration AA, manual cold-vapor technique	
Mercury	Manual cold-vapor technique	(L) SW7470A, (S) SW7471A[c]
Barium		(L, S) SW7080A[d], SW7081[e]
Cadmium		(L, S) SW7130[d], SW7131A[e]
Chromium		(L, S) SW7190[d], SW7191[e]
Lead		(L, S) SW7420[d], SW7421[e]
Silver		(L, S) SW7760A[d], SW7761[e]
TC Other:	Gas chromatography (GC)/mass spectrometry (MS)	(L, S) SW8270C
Benzene	GC/MS capillary column technique	(S) SW8275A
Chloroform		
1,2-Dichloroethane		
2,4-Dinitrotoluene		
Methyl ethyl ketone		
Nitrobenzene		
Pyridine		
Volatile organics	GC/MS GC/MS capillary column technique	(L, S) SW8260B

Refer to footnotes at end of table.

Table E.2-2 (continued)

Analytical Parameters and Test Methods[a]

Parameter	Test Method	Reference[b]
Semivolatile organics	GC/MS	(L, S) SW8270C
	GC/MS capillary column technique	(S) SW8275A
Total RCRA metals[f]	Acid digestion	(L) SW3010A, (S) SW3050B
	Inductively coupled plasma atomic emission spectroscopy	(L, S) SW6010B
Barium		(L, S) SW6010B
Cadmium		(L, S) SW6010B
Chromium		(L, S) SW6010B
Lead		(L, S) SW6010B
Silver		(L, S) SW6010B
Mercury	Manual cold-vapor technique	(L) SW7470A, (S) SW7471A
Explosives Compounds	**High-Performance Liquid Chromatography**	**(L,S) SW8330**
	Thin-Layer Chromatography	**(L,S) SW8332**
	GC/Flame Ionization Detector	**(L,S) SW8015b**
	Solvent Extraction/GC	**(L,S) SW7580**
	GC/MS	
Perchlorates	**Ion Chromatography**	**(L) EPA Method 314.0**

[a] At Los Alamos National Laboratory, current analytical capabilities include limited analyses of mixed waste samples. These analyses include gross alpha, beta, and gamma screening. **For the Technical Area 16 Burn Ground, analyses will be conducted if the constituents were in the wastes treated at the open burning sites.**

[b] "SW" refers to U.S. Environmental Protection Agency, 1986 and all approved updates, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," *SW-846*.
(L) refers to liquid waste.
(S) refers to solid waste.

[c] Method being revised per the January 1998 *SW-846* Draft Update IVA.

[d] Method being integrated into Method 7010, per the January 1998 *SW-846* Draft Update IVA.

[e] Method being integrated into Method 7000B, per the January 1998 *SW-846* Draft Update IVA.

[f] See also atomic absorption methods. Total metals may be substituted for TCLP metals, if appropriate. RCRA = Resource Conservation and Recovery Act.

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.

2-25-02

James L. Holt
Associate Director, Operations
Los Alamos National Laboratory
Operator

Date Signed

2/25/02

Joseph C. Vozella
Associate Director for Facility Operations
U.S. Department of Energy
National Nuclear Security Administration
Office of Los Alamos Site Operations
Owner/Operator

Date Signed