TA16

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November 18, 2002

Mr. Carl Will
State of New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East
Building One
Santa Fe, New Mexico 87505-6303

Reference: Work Assignment No. *Y513, 06110.040;* State of New Mexico Environment Department, Santa Fe, New Mexico; Research and Permitting Support for Los Alamos National Laboratory (LANL); Discussion and Review of Risk-Based Analyses Performed in Support of Permitting the TA-16 Burning Ground; Task 07.

Dear Mr. Will:

This letter summarizes the screening level risk analyses performed by TechLaw, Inc. (TechLaw) in support of the permitting of the open burning operations at the Technical Area 16 (TA-16) Burning Ground of the Department of Energy's Los Alamos National Laboratory, Los Alamos, New Mexico (LANL). As described below, the analyses have been revised to address many of the issues raised in our letter dated September 27, 2002:

- LANL's air modeling results were reexamined and a value based on the overall maximum unitized annual average air concentration was used in both analyses.

- LANL released an updated version of their Ecorisk DataBase (Release 1.5). Ecological screening levels (ESLs) from the updated database were used in the screening analysis of soil deposition.

- LANL furnished additional information on the waste streams treated by open burning at TA-16 in 2000. This information was used to refine the estimates of emitted quantities for barium and other constituents. The information was also used to identify additional emission factors in the EPA's *Emission Factors for the*

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Disposal of Energetic Materials by Open Burning and Open Detonation (OB/OD), EPA/600/R-98/103 (Validated OB/OD Data Base), that appear to be sufficient as surrogates for some of the high explosives burned at TA-16 during 2000.

- TechLaw estimated potential impacts from cadmium emissions to the atmosphere from open burning operations at TA-16. The estimates were based on the assumption that the cadmium was present as a coating on the metal items flashed at TA-16.

Two types of risk-based calculations were performed:

- TechLaw repeated the screening analysis of on-site dry deposition that was performed and submitted by LANL as part of the first facility response to New Mexico Environmental Department (NMED) comments (*Response to Notice of Deficiency; TA-16 Part B Application Revision 3.0, January 31, 2000*). One-year deposition and ten-year deposition soil concentrations were calculated for comparison to both the NMED human health soil screening levels (SSLs) and the ESLs; and

- TechLaw calculated potential carcinogenic and noncarcinogenic risks via the inhalation pathway for a hypothetical adult resident assumed to reside on the LANL boundary (just over a mile south of the TA-16 Burning Ground).

A summary of each analysis performed by TechLaw appears below.

Estimate of On-site Soil Concentrations and Comparisons to NMED-approved Screening Levels

In reviewing LANL's responses to the first NMED NOD, TechLaw noted that LANL configured the CALPUFF model to estimate dry deposition from the open burn operation as a point source (i.e., as a stack). LANL was asked to justify this approach by showing that it adequately and conservatively represented the actual open burning process at TA-16 compared to the use of the area source algorithm in CALPUFF or other air dispersion models suitable for modeling open burning operations.[1] In the second facility response to NMED comments, LANL did not furnish such a demonstration but provided some information on why the point source algorithm was used. Because questions remained about the technical basis of the air modeling methodology, TechLaw repeated the deposition analysis using the overall maximum annual average air concentration generated by LANL's CALPUFF modeling as the basis for estimating dry deposition flux

[1] It is TechLaw's opinion that LANL should have used the area source algorithm available in CALPUFF to more accurately model the source characteristics of the open burning operation at TA-16. Several inquiries have been sent to Earth Tech, the developers of CALPUFF, to determine if the area source algorithm should be used when modeling open burn operations. A response has not yet been received from Earth Tech although receipt of the initial request was acknowledged.

and, thus, soil concentrations. Other assumptions were made that were more conservative in nature than those employed in LANL's analysis. TechLaw's analysis showed that the soil concentration for none of the constituents included in the analysis exceeded its NMED soil screening level or ESL. A summary of the conservative assumptions used in TechLaw's analysis is presented below.

- The overall maximum, unitized, annual average air concentration from LANL's CALPUFF modeling was used as the basis for estimating dry deposition and, ultimately, soil concentration. While confidence in the accuracy of LANL's air modeling results was low, use of the maximum annual average air concentration ensured that the analysis was based on the maximum value predicted by the CALPUFF model. The value of 4.63×10^{-8} g/m^3 per g/sec was converted to a deposition flux by multiplying by a generic deposition velocity of 0.3 meters per second. This approach was implemented to overestimate the deposition flux, as deposition fluxes calculated directly by the air dispersion model are usually used. Ultimately, a value of 6.25×10^{-8} mg/kg per gram emitted (in a year) was calculated (using the same methodology employed in LANL's analysis) for use in estimating soil concentrations.

- TechLaw used the same approach as LANL in calculating constituent-specific soil concentrations. As LANL had done, TechLaw multiplied the annual constituent-specific soil concentrations by ten to estimate soil concentrations at the end of the ten-year life of the permit.

- Because questions remained about LANL's choice of emission factors for D003-contaminated materials, TechLaw addressed two separate sets of emission factors for this waste stream. First, the emission factors used by LANL were considered. Then, a second set of emission factors for the burning of dunnage with diesel fuel was extracted from EPA's Validated OB/OD Emission Factor Data Base and the analysis was repeated.

- Based on additional information supplied by LANL, TechLaw expanded the analysis of impacts from the treatment of high explosives to include emission factors for the open burning of PBX type propellants and propellants that were based on HMX. These two sets of emission factors were included in addition to the set of emission factors for M31A1E1 triple-based propellant addressed in LANL's analysis. The two additional sets of emission factors were taken from EPA's Validated OB/OD Emission Factor Data Base.

- To introduce an additional level of conservatism, TechLaw used the NMED residential soil screening levels, rather than the industrial levels employed in LANL's analysis, for comparison to the estimated constituent-specific soil concentrations. As LANL had done, TechLaw also compared the predicted soil concentrations to NMED-approved/LANL-derived ESLs. The ESLs were taken from Release 1.5 of the Ecorisk Database (September 2002) prepared by the LANL Environmental Restoration Project.

As stated above, all comparisons performed by TechLaw showed that no constituent-specific soil concentrations exceeded their corresponding NMED soil screening level or ESL. In agreement with LANL's reported results, TechLaw's soil concentrations were orders of magnitude lower that the soil screening levels and ESLs for the vast majority of constituents.

It must be noted that soil screening levels and ESLs were not available for all constituents for which a soil concentration was estimated.

Estimate of Risk and Hazard to an Off-site Adult Resident via the Inhalation Pathway

To estimate carcinogenic risks and hazard quotients for emitted constituents via the inhalation pathway, TechLaw used the equations and parameter values presented in Tables C-2-1 and C-2-2 of EPA's *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities*, EPA530-D-98-001B. As in the analysis of soil deposition effects, the maximum, unitized, annual average air concentration obtained from LANL's CALPUFF modeling was used as the basis for estimating risks and hazards via the inhalation pathway. The maximum modeled value of 4.63×10^{-8} g/m^3 per g/second was converted to units of μg/m^3 per gram emitted (in a year) resulting in a value of 2×10^{-9} μg/m^3 per gram for use as the annual average air concentration in the analysis. A summary of the conservative assumptions used in TechLaw's analysis is presented below.

- The maximum modeled unitized annual average air concentration generated in LANL's CALPUFF air modeling analysis was chosen to represent the unitized annual average air concentration at the LANL facility boundary in the analysis. Because confidence in the accuracy of LANL's air modeling results was low, the analysis was based on the overall maximum air concentration predicted by CALPUFF. A value modeled at the actually boundary would normally be used.

- As in the deposition analysis described above, TechLaw addressed two separate sets of emission factors for the open burning of D003-contaminated material. First, the emission factors used by LANL were considered. Then, a second set of emission factors for the burning of dunnage with diesel fuel was extracted from EPA's Validated OB/OD Emission Factor Data Base and the inhalation pathway analysis was repeated.

- Because LANL supplied new and additional data on annual treatment quantities, TechLaw expanded the analysis of impacts from the treatment of high explosives to include emission factors for the open burning of PBX type propellants (PBXN-110) and propellants that were based on HMX (M43). These two sets of emission factors were included in addition to the set of emission factors for M31A1E1 triple-based propellant addressed in LANL's analysis. The two additional sets of

emission factors were taken from EPA's Validated OB/OD Emission Factor Data Base.

Barium in Ash from the Treatment of High Explosives

LANL noted that barium was detected in the ash left from the burning of baratol. Using treatment quantities from 2000 supplied by LANL, barium was considered in both the soil deposition screening analysis and the analysis of risk and hazard via inhalation. The emission factor proposed by LANL in the second NOD response (the emission factor for lead emitted from the open burning of double-based propellant from EPA's Validated OB/OD Emission Factor Data Base) was used as the basis for the emission calculation. The value of 5.6×10^{-3} lb emitted per lb of NEW treated was extracted from Appendix D of the EPA document.

The estimated soil concentration for barium was well below the NMED soil screening level and the ESL. The analysis of the inhalation pathway showed that the risk and hazard presented by barium were both well below the respective target levels.

Cadmium in Ash from the Treatment of High Explosives

LANL did not include cadmium in the analysis of soil deposition. While LANL showed that cadmium was present in ash at levels above accepted background, they did not identify its source and, thus, could not estimate the amount of cadmium potentially emitted during a year. A subsequent inquiry to LANL on the possible source of the cadmium and some additional research conducted by TechLaw indicated that the most likely source for the cadmium was cadmium coatings on flashed metal. TechLaw developed a rough estimate of the amount of cadmium that may have been emitted due to metal flashing operations at LANL in 2000. The estimate was based on a typical coating thickness, the amount of metal flashed in 2000, and the emission factor of 1 lb of cadmium emitted for every 1 lb of cadmium treated proposed in Table 4 of Appendix B of LANL's response to the first NOD.

The analysis was repeated using the maximum emission factor reported for cadmium in emission tests of the open burning of rocket motors at the Nevada Test Site [4.33×10^{-5} lb emitted per lb of NEW (net explosive weight) treated]. As at LANL, no cadmium was reported as present in the rocket motors, however, cadmium was detected in the emissions (note that cadmium was not detected in any of the open burns considered in EPA's Validated OB/OD Emission Factor Data Base). The calculation is furnished for informational purposes only as the emission factor originally proposed by LANL (1 lb per lb) constitutes a more conservative basis for the analysis. Also, the emission factors cited in the Nevada Test Site report have not been reviewed and validated like the factors contained in EPA's Validated OB/OD Emission Factor Data Base.

The estimated soil concentrations for cadmium were well below the NMED soil screening level and the ESL. The analysis of the inhalation pathway showed that the risk and hazard presented by cadmium were both well below the respective target levels.

Uncertainties in the Analyses

In general, the analyses performed by LANL and TechLaw show that open burning at TA-16 poses no threat to humans or the environment because of the relatively low quantities of hazardous constituents emitted to the atmosphere. However, the analyses (soil deposition screening and the estimate of inhalation risks and hazards) are subject to uncertainties that should be considered when interpreting the results.

Questions remain about the air modeling approach used by LANL. It is not known whether the results of LANL's CALPUFF modeling lead to an underestimate or overestimate of air concentrations and deposition fluxes. LANL provided no information showing that the total plume rise and energy available for dispersion predicted by CALPUFF was a conservative representation of the actual process at TA-16.

There is also considerable uncertainty in the identification of emitted constituents and the estimated amounts of emissions. The emission factors used in the analyses are also subject to uncertainty as the waste streams that generated the emissions data are surrogates for the actual waste streams treated at TA-16.

These analyses are based on the quantities of wastes treated at TA-16 during 2000. As shown in Table 1 of Appendix B of LANL's response to the first NOD, the treatment quantities for all types of wastes for 2000 represent minimums over the period 1996 through 2000.

Deposition is a cumulative process and basing the screening analysis on the ten-year period may not be a conservative approach. Determining the deposition over the entire active life of the open burning operations at TA-16 may be more appropriate.

Many of the constituents addressed in the analyses do not have NMED soil screening levels, ESLs, toxicity criteria, or suitable surrogates so their impact on health and/or the environment could not be quantified.

Due to these uncertainties, TechLaw supports the use of the results of LANL's and TechLaw's analyses in conjunction with other information (e.g., soil sampling data, operation descriptions, predicted treatment quantities, knowledge of waste stream constituents) in making permitting decisions. The results should not be used as the sole support for such decisions.

If you have any questions, please feel free to contact Ms. Paige Walton at (801) 451-2978 or Mr. Michael S. Smith at (770) 752-7585, extension 103.

Sincerely,

June K. Dreith (p. Walton)

June K. Dreith
Project Manager

Enclosure
cc: Ms. Lee Winn, NMED
Ms. Paige Walton, TechLaw
Mr. Michael S. Smith, TechLaw
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BURNING OF HE-CONTAMINATED SOLVENT

Air Modeling Results Based on Unit Emissions

Max Modeled Deposition 6.25E-08 mg-yr/(kg-g)
Max Modeled Air Conc 2.00E-09 ug-yr/(m3-g)

Emissions and Analysis for Solvent Burns

Constituent	Emissions (lb/yr)	Emissions g/yr	Deposition Conc/yr mg/kg	Deposition 10-yr Permit mg/kg	NMED SSL* mg/kg	ESL mg/kg	Air Conc ug/m3	Unit Risk Factor m3/ug	Cancer Risk	RfC mg/m3	HAZARD QUOTIENT
acetone	1	453.59	2.83E-05	2.83E-04		3.8	9.07E-07			3.50E-01	1.88E-09
acetonitrile	1	453.59	2.83E-05	2.83E-04			9.07E-07			5.90E-02	1.11E-08
ammonium hydroxide	1	453.59	2.83E-05	2.83E-04			9.07E-07				
BDNPF ether	0.6	272.154	1.70E-05	1.70E-04			5.44E-07				
butyl acetate	0.2	90.718	5.67E-06	5.67E-05			1.81E-07				
butyl nitrite	1.00E-03	0.45359	2.83E-08	2.83E-07			9.07E-10				
chloroform	1.60E-01	72.5744	4.54E-06	4.54E-05	0.38	2.80E+01	1.45E-07	2.30E-05	1.04E-12	3.00E-04	3.51E-07
chromium**	2.00E-04	0.090718	5.67E-09	5.67E-08	2.30E+02	2.00E-01	1.81E-10	8.29E-02	4.67E-12	1.00E-04	1.32E-09
DMSO	5.00E-02	22.6795	1.42E-06	1.42E-05			4.54E-08				
1,2-dichloroethane	1.80E+00	816.462	5.10E-05	5.10E-04	3.3	2.3	1.63E-06	2.60E-05	1.32E-11	4.90E-03	2.42E-07
ethyl acetate	2.00E+00	907.18	5.67E-05	5.67E-04			1.81E-06			3.15	4.18E-10
ethanol	2.00E+00	907.18	5.67E-05	5.67E-04			1.81E-06				
2,4-dinitrotoluene	3.00E-01	136.077	8.50E-06	8.50E-05	1.20E+02	1	2.72E-07			7.00E-03	2.82E-08
HCl	1.00E+00	453.59	2.83E-05	2.83E-04			9.07E-07			2.00E-02	3.30E-08
isopropyl alcohol	5.00E-01	226.795	1.42E-05	1.42E-04			4.54E-07				
mercury***	2.00E-02	9.0718	5.67E-07	5.67E-06	6.1	3.50E-04	1.81E-08			3.00E-04	4.38E-08
methanol	9.00E+00	4082.31	2.55E-04	2.55E-03			8.16E-06			1.8	3.29E-09
methylene chloride	3.00E-01	136.077	8.50E-06	8.50E-05		7.1	2.72E-07	4.70E-07	3.97E-14	3	6.58E-11
MEK	4.00E-02	18.1436	1.13E-06	1.13E-05			3.63E-08			1	2.63E-11
nitric acid	1.00E+00	453.59	2.83E-05	2.83E-04			9.07E-07				
potassium hydroxide	1.00E+00	453.59	2.83E-05	2.83E-04			9.07E-07				
pump oil	2.00E-01	90.718	5.67E-06	5.67E-05			1.81E-07				
sodium hydroxide	4.00E+00	1814.36	1.13E-04	1.13E-03			3.63E-06				
sulfuric acid	5.00E+00	2267.95	1.42E-04	1.42E-03			4.54E-06				
tetrahydrafuran	3.00E-01	136.077	8.50E-06	8.50E-05			2.72E-07	1.94E-06	1.64E-13	0.301	6.55E-10
toluene	1.00E+00	453.59	2.83E-05	2.83E-04	1.80E+02	7.00E+01	9.07E-07			4.00E-01	1.64E-09
trichloroethylene	5.00E-01	226.795	1.42E-05	1.42E-04		1.9	4.54E-07	1.70E-06	2.40E-13	2.10E-02	1.57E-08
TOTALS									**1.93E-11**		**7.33E-07**

*Where multiple SSLs were available, the most conservative (lowest) value was used.
**Chromium ESL for earthworms, Cr+6
***Mercury ESL for Birds, methyl mercury

BURNING OF HE-CONTAMINATED TRASH

Air Modeling Results Based on Unit Emissions

Max Modeled Dep Factor 6.25E-08 mg-yr/(kg-g)
Max Modeled Air Conc 2.00E-09 ug-yr/(m3-g)

Emissions and Analysis for HE Contaminated Trash from AP-42

Constituent	Emission Factor (lb/ton)	Emissions lb/yr	Emissions g/yr	Deposition Conc/yr mg/kg	Deposition 10-yr Permit mg/kg	NMED SSL mg/kg	ESL mg/kg	Air Conc ug/m3	Unit Risk Factor m3/ug	Cancer Risk	RfC mg/m3	HAZARD QUOTIENT
PM	16	14.4	6531.696	4.08E-04	4.08E-03			1.31E-05				
NOx	6	5.4	2449.386	1.53E-04	1.53E-03			4.90E-06				
SOx	1	0.9	408.231	2.55E-05	2.55E-04			8.16E-07				
CO	85	76.5	34699.635	2.17E-03	2.17E-02			6.94E-05				
CH4	13	11.7	5307.003	3.32E-04	3.32E-03			1.06E-05				
Non-Methane HCs	30	27	12246.93	7.65E-04	7.65E-03			2.45E-05				
Anthracene	8.00E-07	7.20E-07	3.27E-04	2.04E-11	2.04E-10	1.60E+04	2.20E+02	6.53E-13			1.1	4.30E-16
Benzo(b)fluoranthene	2.00E-06	1.80E-06	8.16E-04	5.10E-11	5.10E-10	6.2	1.80E+01	1.63E-12	8.90E-05	4.52E-17		
Benzo(a)anthracene	2.00E-06	1.80E-06	8.16E-04	5.10E-11	5.10E-10	6.2	3	1.63E-12	8.90E-05	4.52E-17		
Chrysene	2.00E-06	1.80E-06	8.16E-04	5.10E-11	5.10E-10	6.10E+02	2.40E+00	1.63E-12	8.90E-07	4.52E-19		
Fluoranthene	8.00E-05	7.20E-05	3.27E-02	2.04E-09	2.04E-08	2.30E+03	2.60E+01	6.53E-11			1.40E-01	3.38E-13
Phenanthrene	2.00E-05	1.80E-05	8.16E-03	5.10E-10	5.10E-09	1.80E+03	1.10E+01	1.63E-11				
Pyrene	1.00E-05	9.00E-06	4.08E-03	2.55E-10	2.55E-09	1.80E+03	1.50E+01	8.16E-12			1.10E-01	5.38E-14
Retene	6.00E-06	5.40E-06	2.45E-03	1.53E-10	1.53E-09			4.90E-12				
benzene	5.00E-05	4.50E-05	2.04E-02	1.28E-09	1.28E-08	6.4	5.50E+01	4.08E-11	7.72E-06	9.79E-17	5.95E-03	4.97E-12
toluene	2.00E-05	1.80E-05	8.16E-03	5.10E-10	5.10E-09	1.80E+02	7.00E+01	1.63E-11			4.00E-01	2.96E-14
ethyl benzene	1.00E-05	9.00E-06	4.08E-03	2.55E-10	2.55E-09	68		8.16E-12			1	5.92E-15
1-hexene	4.00E-05	3.60E-05	1.63E-02	1.02E-09	1.02E-08			3.27E-11				
TOTAL 1										**1.89E-16**		**5.40E-12**

Emission Factors and Analysis for Dunnage and Diesel from EPA's OB/OD Data Base

	Emission Factor lb/lb	Emissions lb/ton	Emissions lb/yr	Emissions g/yr	Deposition Conc/yr mg/kg	Deposition 10-yr Permit mg/kg	NMED SSL mg/kg	ESL mg/kg	Air Conc ug/m3	Unit Risk Factor m3/ug	Cancer Risk	RfC mg/m3	HAZARD QUOTIENT
benzene	7.80E-05	1.56E-01	1.40E-01	6.37E+01	3.98E-06	3.98E-05	6.4	5.50E+01	1.27E-07	7.72E-06	3.05E-13	5.95E-03	1.55E-08
cyclohexane	2.70E-05	5.40E-02	4.86E-02	2.20E+01	1.38E-06	1.38E-05			4.41E-08			19.95	1.60E-12
cyclopentane	1.50E-06	3.00E-03	2.70E-03	1.22E+00	7.65E-08	7.65E-07			2.45E-09				
CO	6.00E-03	1.20E+01	1.08E+01	4.90E+03	3.06E-04	3.06E-03			9.80E-06				
CO2	1.50E+00	3.00E+03	2.70E+03	1.22E+06	7.65E-02	7.65E-01			2.45E-03				
ethane	9.30E-06	1.86E-02	1.67E-02	7.59E+00	4.75E-07	4.75E-06			1.52E-08				
ethylbenzene	5.50E-05	1.10E-01	9.90E-02	4.49E+01	2.81E-06	2.81E-05	68		8.98E-08			1	6.51E-11
ethylene	7.40E-05	1.48E-01	1.33E-01	6.04E+01	3.78E-06	3.78E-05			1.21E-07				
metholcyclohexane	1.60E-04	3.20E-01	2.88E-01	1.31E+02	8.16E-06	8.16E-05			2.61E-07			3.01	6.29E-11
methylcyclopentane	9.90E-06	1.98E-02	1.78E-02	8.08E+00	5.05E-07	5.05E-06			1.62E-08				
NO	8.00E-04	1.60E+00	1.44E+00	6.53E+02	4.08E-05	4.08E-04			1.31E-06				
NO2	4.20E-05	8.40E-02	7.56E-02	3.43E+01	2.14E-06	2.14E-05			6.86E-08				
OCDD***	1.00E-11	2.00E-08	1.80E-08	8.16E-06	5.10E-13	5.10E-12		5.20E-07	1.63E-14	0.0429	2.18E-16		
Propane	2.20E-06	4.40E-03	3.96E-03	1.80E+00	1.12E-07	1.12E-06			3.59E-09				
Propene	1.30E-05	2.60E-02	2.34E-02	1.06E+01	6.63E-07	6.63E-06			2.12E-08				
PM10	5.40E-03	1.08E+01	9.72E+00	4.41E+03	2.76E-04	2.76E-03			8.82E-06				
SO2	1.90E-04	3.80E-01	3.42E-01	1.55E+02	9.70E-06	9.70E-05			3.10E-07				
Toluene	1.20E-04	2.40E-01	2.16E-01	9.80E+01	6.12E-06	6.12E-05	1.80E+02	7.00E+01	1.96E-07			4.00E-01	3.55E-10
1-hexene	2.20E-06	4.40E-03	3.96E-03	1.80E+00	1.12E-07	1.12E-06			3.59E-09				
Zinc	6.30E-05	1.26E-01	1.13E-01	5.14E+01	3.21E-06	3.21E-05	2.30E+04	1.90E-01	1.03E-07				
TOTAL 2											**3.06E-13**		**1.60E-08**

***OCDD ESL based on 2,3,7,8-TCDD ESL for mammals and URF is based upon 2,3,7,8 TCDD SFi and a TEF of 0.001.

BURNING BULK HE AT TA-16

Air Modeling Results Based on Unit Emissions

Max Modeled Dep Factor	6.25E-08	mg-yr/(kg-g)
Max Modeled Air Conc	2.00E-09	ug-yr/(m3-g)

Emission Factors and Analysis for M31A1E1 for all bulk HE treated during 2000

Constituent	Emissions (lb/yr)	Emissions g/yr	Deposition Conc/yr mg/kg	Deposition 10-yr Permit mg/kg	NMED SSL mg/kg	ESL mg/kg	Air Conc ug/m3	Unit Risk m3/ug	Cancer Risk	RfC mg/m3	HAZARD QUOTIENT
CO	1.1	4.99E+02	3.12E-05	3.12E-04			9.98E-07		0.00E+00		
CO2	4935	2.24E+06	1.40E-01	1.40E+00			4.48E-03				
NO	10	4.54E+03	2.83E-04	2.83E-03			9.07E-06				
NO2	1	4.54E+02	2.83E-05	2.83E-04			9.07E-07				
PM10	7611	3.45E+06	2.16E-01	2.16E+00			6.90E-03				
SO2	10	4.54E+03	2.83E-04	2.83E-03			9.07E-06				
Total Aromatics*	0.42	1.91E+02	1.19E-05	1.19E-04	6.4	5.50E+01	3.81E-07	7.72E-06	9.14E-13	5.95E-03	4.64E-08
Non-methane HCs	0.84	3.81E+02	2.38E-05	2.38E-04			7.62E-07				
Total UnID'd HCs	0.17	7.71E+01	4.82E-06	4.82E-05			1.54E-07				
HCl	25	1.13E+04	7.09E-04	7.09E-03			2.27E-05			2.00E-02	8.24E-07
HF	42	1.91E+04	1.19E-03	1.19E-02			3.81E-05				
Total									**9.14E-13**		**8.71E-07**

*Conservatively assumed to be benzene

Emission Factors and Analysis for Metals in Ash

	Emission Factor (lb/lb)	Emissions (lb/yr)	Emissions g/yr	Deposition Conc/yr mg/kg	Deposition 10-yr Permit mg/kg	NMED SSL mg/kg	ESL mg/kg	Air Conc ug/m3	Unit Risk m3/ug	Cancer Risk	RfC mg/m3	HAZARD QUOTIENT
Barium	5.60E-03	1.36E+00	6.15E+02	3.84E-05	3.84E-04	5.20E+03	2.50E+00	1.23E-06			5.00E-04	1.78E-06
Cadmium	1	1.09E+01	4.94E+03	3.09E-04	3.09E-03		7.50E-03	9.88E-06	1.40E-03	4.30E-09	3.50E-03	2.05E-06
Cadmium	4.33E-05	4.71E-04	2.14E-01	1.34E-08	1.34E-07		7.50E-03	4.28E-10	1.40E-03	1.86E-13	3.50E-03	8.86E-11
Total										**4.30E-09**		**3.83E-06**

Emission Factors and Analysis for PBXN-110 for PBX based on HMX, HMX, EXON 461

	Emission Factor (lb/lb)	Emissions (lb/yr)	Emissions g/yr	Deposition Conc/yr mg/kg	Deposition 10-yr Permit mg/kg	NMED SSL mg/kg	ESL mg/kg	Air Conc ug/m3	Unit Risk m3/ug	Cancer Risk	RfC mg/m3	HAZARD QUOTIENT
i-butene	1.30E-06	8.30E-03	3.76E+00	2.35E-07	2.35E-06			7.53E-09				
m-ethyltoluene	2.00E-07	1.28E-03	5.79E-01	3.62E-08	3.62E-07			1.16E-09				
n-butane	1.00E-07	6.38E-04	2.89E-01	1.81E-08	1.81E-07			5.79E-10				
n-decane	1.30E-06	8.30E-03	3.76E+00	2.35E-07	2.35E-06			7.53E-09				
n-nonane	1.20E-06	7.66E-03	3.47E+00	2.17E-07	2.17E-06			6.95E-09				
p-ethyltoluene	4.30E-07	2.74E-03	1.24E+00	7.78E-08	7.78E-07			2.49E-09				
trans-2-butene	4.00E-07	2.55E-03	1.16E+00	7.24E-08	7.24E-07			2.32E-09				
acetylene	3.10E-06	1.98E-02	8.97E+00	5.61E-07	5.61E-06			1.79E-08				
benzene	4.90E-06	3.13E-02	1.42E+01	8.86E-07	8.86E-06		55	2.84E-08	7.72E-06	6.80E-14	5.95E-03	3.46E-09
ethane	1.00E-06	6.38E-03	2.89E+00	1.81E-07	1.81E-06			5.79E-09				
ethylbenzene	8.00E-07	5.10E-03	2.32E+00	1.45E-07	1.45E-06	68		4.63E-09			1	3.36E-12
ethylene	6.70E-06	4.28E-02	1.94E+01	1.21E-06	1.21E-05			3.88E-08				
HCl	1.80E-04	1.15E+00	5.21E+02	3.26E-05	3.26E-04			1.04E-06			2.00E-02	3.79E-08
methyl chloride	1.80E-07	1.15E-03	5.21E-01	3.26E-08	3.26E-07			1.04E-09			9.00E-02	8.39E-12
propane	3.00E-07	1.91E-03	8.68E-01	5.43E-08	5.43E-07			1.74E-09				
propene	3.00E-06	1.91E-02	8.68E+00	5.43E-07	5.43E-06			1.74E-08				
PM10	4.90E-01	3.13E+03	1.42E+06	8.86E-02	8.86E-01			2.84E-03				
total alkenes	1.60E-05	1.02E-01	4.63E+01	2.89E-06	2.89E-05			9.26E-08				
total aromatics	7.10E-06	4.53E-02	2.05E+01	1.28E-06	1.28E-05			4.11E-08				
non-meth. Hc's	5.10E-05	3.25E-01	1.48E+02	9.23E-06	9.23E-05			2.95E-07				
vinyl chloride	2.20E-07	1.40E-03	6.37E-01	3.98E-08	3.98E-07	0.21		1.27E-09	4.40E-06	1.74E-15	1.00E-01	9.23E-12
1-butene	6.00E-07	3.83E-03	1.74E+00	1.09E-07	1.09E-06			3.47E-09				
1-pentene	1.00E-07	6.38E-04	2.89E-01	1.81E-08	1.81E-07			5.79E-10				
1,3-butadiene	5.00E-07	3.19E-03	1.45E+00	9.04E-08	9.04E-07			2.89E-09				
Total										**6.98E-14**		**4.13E-08**

Emission Factor and Analysis for M43 for PBX based on RDX, RDX, BDNPA/F

	Emission Factor (lb/lb)	Emissions (lb/yr)	Emissions g/yr	Deposition Conc/yr mg/kg	Deposition 10-yr Permit mg/kg	NMED SSL mg/kg	ESL mg/kg	Air Conc ug/m3	Unit Risk m3/ug	Cancer Risk	RfC mg/m3	HAZARD QUOTIENT
i-butene	5.40E-07	3.75E-04	1.70E-01	1.06E-08	1.06E-07			3.40E-10				
i-pentene	9.10E-08	6.32E-05	2.86E-02	1.79E-09	1.79E-08			5.73E-11				
n-butane	9.10E-08	6.32E-05	2.86E-02	1.79E-09	1.79E-08			5.73E-11				
n-decane	8.20E-07	5.69E-04	2.58E-01	1.61E-08	1.61E-07			5.16E-10				
n-hexane	9.10E-08	6.32E-05	2.86E-02	1.79E-09	1.79E-08			5.73E-11				
n-octane	9.10E-08	6.32E-05	2.86E-02	1.79E-09	1.79E-08			5.73E-11				
p-ethyltoluene	1.80E-07	1.25E-04	5.67E-02	3.54E-09	3.54E-08			1.13E-10				
trans-2-butene	1.80E-07	1.25E-04	5.67E-02	3.54E-09	3.54E-08			1.13E-10				
acetylene	5.90E-06	4.09E-03	1.86E+00	1.16E-07	1.16E-06			3.71E-09				
benzene	1.70E-06	1.18E-03	5.35E-01	3.34E-08	3.34E-07		55	1.07E-09	7.72E-06	2.57E-15	5.95E-03	1.30E-10
cyclohexane	9.10E-08	6.32E-05	2.86E-02	1.79E-09	1.79E-08			5.73E-11				
cyclopentene	9.10E-08	6.32E-05	2.86E-02	1.79E-09	1.79E-08			5.73E-11				
ethane	1.80E-07	1.25E-04	5.67E-02	3.54E-09	3.54E-08			1.13E-10				
ethylbenzene	4.80E-06	3.33E-03	1.51E+00	9.44E-08	9.44E-07	68		3.02E-09			1	2.19E-12
HCl	1.00E-03	6.94E-01	3.15E+02	1.97E-05	1.97E-04			6.30E-07			2.00E-02	2.29E-08
propene	1.10E-06	7.63E-04	3.46E-01	2.16E-08	2.16E-07			6.93E-10				
PM10	1.20E-03	8.33E-01	3.78E+02	2.36E-05	2.36E-04			7.55E-07				
toluene	5.40E-07	3.75E-04	1.70E-01	1.06E-08	1.06E-07		70	3.40E-10			4.00E-01	6.16E-13
1-pentene	9.10E-08	6.32E-05	2.86E-02	1.79E-09	1.79E-08			5.73E-11				
1,3-butadiene	9.10E-08	6.32E-05	2.86E-02	1.79E-09	1.79E-08			5.73E-11				
Total										**2.57E-15**		**2.30E-08**