

**FINAL REPORT**

**BURRO CANYON OPEN BURN/OPEN  
DETONATION HEALTH RISK  
ASSESSMENT FOR  
NAVAL AIR WEAPONS STATION  
CHINA LAKE**

*Prepared for*

Naval Facilities Engineering Command Southwest  
San Diego, California

and

Naval Air Weapons Station  
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## LIST OF ACRONYMS

AB	Assembly Bill
AEI	average exposed individual
AP	ammonium perchlorate
APCD	Air Pollution Control District
ATCM	Airborne Toxic Control Measure
BCTF	Burro Canyon Treatment Facility
CAA	Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CalEPA	California Environmental Protection Agency
CARB	California Air Resources Board
CAS	Chemical Abstracts Service
CFR	Code of Federal Regulations
China Lake	Naval Air Weapons Station China Lake
COC	chemical of concern
DPM	diesel particulate matter
DTSC	Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
g/s	gram per second
GBUAPCD	Great Basin Unified Air Pollution Control District
GLC	ground-level concentration
HAP	hazardous air pollutant
HHRAP	Human Health Risk Assessment Protocol
HI	Hazard Index
HQ	hazard quotient
HRA	Health Risk Assessment
HRS	health risk screening
ISC	Industrial Source Complex
ISCST3	Industrial Source Complex Short-term Model
km	kilometers
lb	pound
lb/hr	pounds per hour
lb/lb	pound per pound
lb/yr	pounds per year
LMS	linearized multi-stage
m	meter
MEI	maximally exposed individual
$\mu\text{g}/\text{m}^3$	micrograms per cubic meter
$\mu\text{g}/\text{dl}$	micrograms per deciliter
mg/kg	milligrams per kilogram
mg/kg-d	milligrams per kilogram per day
NAWCWD	Naval Air Warfare Center Weapons Division
NAWS	Naval Air Weapons Station
NCEP	National Centers for Environmental Prediction
NC	nitrocellulose
NCI	National Cancer Institute
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NG	nitroglycerin

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**LIST OF ACRONYMS (CONTINUED)**

NIOSH	National Institute of Occupational Safety and Health
NQ	nitroguanidine
OB/OD	Open Burn/Open Detonation
OBODM	Open Burn and Open Detonation Model
OEHHA	Office of Environmental Health Hazard Assessment
OSHA	Occupational Safety and Health Administration
PM	particulate matter
PM <sub>10</sub>	particulate matter less than 10 microns in diameter
PRG	Preliminary Remediation Goal
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RDT&E	Research, Development, Test, & Evaluation
REEDM	Rocket Exhaust Effluent Dispersion Model
REL	reference exposure level
RfC	Reference Concentration
RfD	Reference Dose
RME	reasonable maximum exposure
RTVSM	Real-Time Volume Source Dispersion Model
SF	Slope Factor
TAC	toxic air contaminant
TEQ	Toxic Equivalent
TNT	trinitrotoluene
URF	unit risk factor
URS	URS Group, Inc.
ZOI	zone of impact

## EXECUTIVE SUMMARY

URS Group, Inc. (URS) prepared this updated Health Risk Assessment (HRA) in support of the Resource Conservation and Recovery Act (RCRA) Part B permit application for the Burro Canyon Treatment Facility (BCTF) located at Naval Air Weapons Station China Lake (China Lake). China Lake treats numerous types of energetic wastes, including propellants, explosives, and pyrotechnics, by Open Burn/Open Detonation (OB/OD) in the two units (i.e., OB and OD) at the BCTF. The OB/OD activities generate emissions regulated by the state of California. The purpose of the updated HRA is to evaluate the potential health risk impacts associated with the emissions into the surrounding environment from the OB and OD units, the two units subject to permit modification, using updated emissions data. This document presents the results of the updated HRA.

### Description of China Lake and Burro Canyon OB/OD Activities

China Lake is the Navy's largest Research, Development, Test, & Evaluation facility for weapons development and testing. It consists of 1.1 million acres of land surrounded by 12.5 million acres of airspace in California's remote and sparsely populated Mojave Desert. Much of the surrounding land is either owned or controlled by the United States Government.

China Lake operates one site in Burro Canyon, the BCTF, to conduct OB/OD events. The BCTF is seven miles from the nearest Base boundary to the east. The nearest Base boundary in the dominant wind direction is 17 miles to the northeast, while the nearest town (i.e., Trona) is located 9 miles to the southeast. The BCTF is located in a natural amphitheater surrounded by mountainous terrain.

The HRA evaluated direct and indirect sources of emissions during an OB/OD operation. The direct emissions result from the actual treatment through an OB or OD operation. The indirect emissions result from activities that support the treatment activities such as ash handling, grading, and windblown dust from disturbed ground.

### HRA Procedures

The HRA was prepared in accordance with a draft HRA protocol (URS, March 2005) that was submitted to and discussed with the Department of Toxic Substances Control (DTSC) and the most recent risk assessment guidelines published by the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA) (*Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*, dated October 2003). In addition, the HRA incorporated chemicals of potential concern, emission factors, and toxicological values that were approved by the DTSC for use in this HRA. Use of the OEHHA guidelines results in a worst-case analysis of risk. For example, the theoretical incremental cancer risk estimated in this HRA is based on an individual being continuously exposed to emissions from routine OB/OD operations for 24 hours per day, 365 days per year, for 70 years at the same location. This approach is generally more conservative than the traditional reasonable maximum exposure approach based on a 30-year residential exposure recommended by the

U.S. Environmental Protection Agency. Actual risks are likely to be substantially lower than those estimated using the OEHHA guidelines and could approach zero.

### **Summary of HRA Results**

To facilitate characterization of emissions, the various types of wastes treated are grouped into several emission categories, including families of energetics, an energetic-contaminated waste family, a munition components family, diesel and wood used during OB, and grading associated with OD. This HRA was conducted to calculate the maximum predicted cancer and noncancer risks when each emission category is treated to its permitted treatment limit individually by either OB or OD. The treatment limits are established in the RCRA Part B permit and are based on one or more of the following:

- 1) Cancer and noncancer health risk thresholds for toxic air contaminants;
- 2) Ambient air quality standards for criteria pollutants;
- 3) Logistical factors; and
- 4) Safety considerations.

The permitted treatment quantities for each individual emission category are presented in Table ES-1.

A summary of the permitted treatment limits and associated cancer, chronic noncancer, and acute noncancer risks from direct emission sources (i.e., treatment by OB or OD and the crater formed in an OD event) and indirect emission sources (i.e., windblown dust, grading after an OD event, and ash handling after an OB event) are presented in Tables ES-2, ES-3, and ES-4, respectively. The estimated risks are all at or below the applicable risk thresholds if the emission category is the only category considered. The tables do not include a cumulative total of the potential health risks for all emission categories combined. If the maximum permitted quantities of all waste categories are treated, the acceptable level of risk would be exceeded. Since the BCTF can treat a variety of waste types, an equivalency and tracking system based on the incremental risks associated with each treatment event is used to provide operating flexibility. The equivalency and tracking system is discussed in Section 4.0 and will be used to manage the quantities of each emission category treated such that the combination of all waste types treated in any one event and annually will not exceed acceptable risk levels.

The locations of the maximally exposed individuals (MEIs) on an hourly and annual basis are shown on Figure ES-1.

Figure ES-1. Location of MEIs

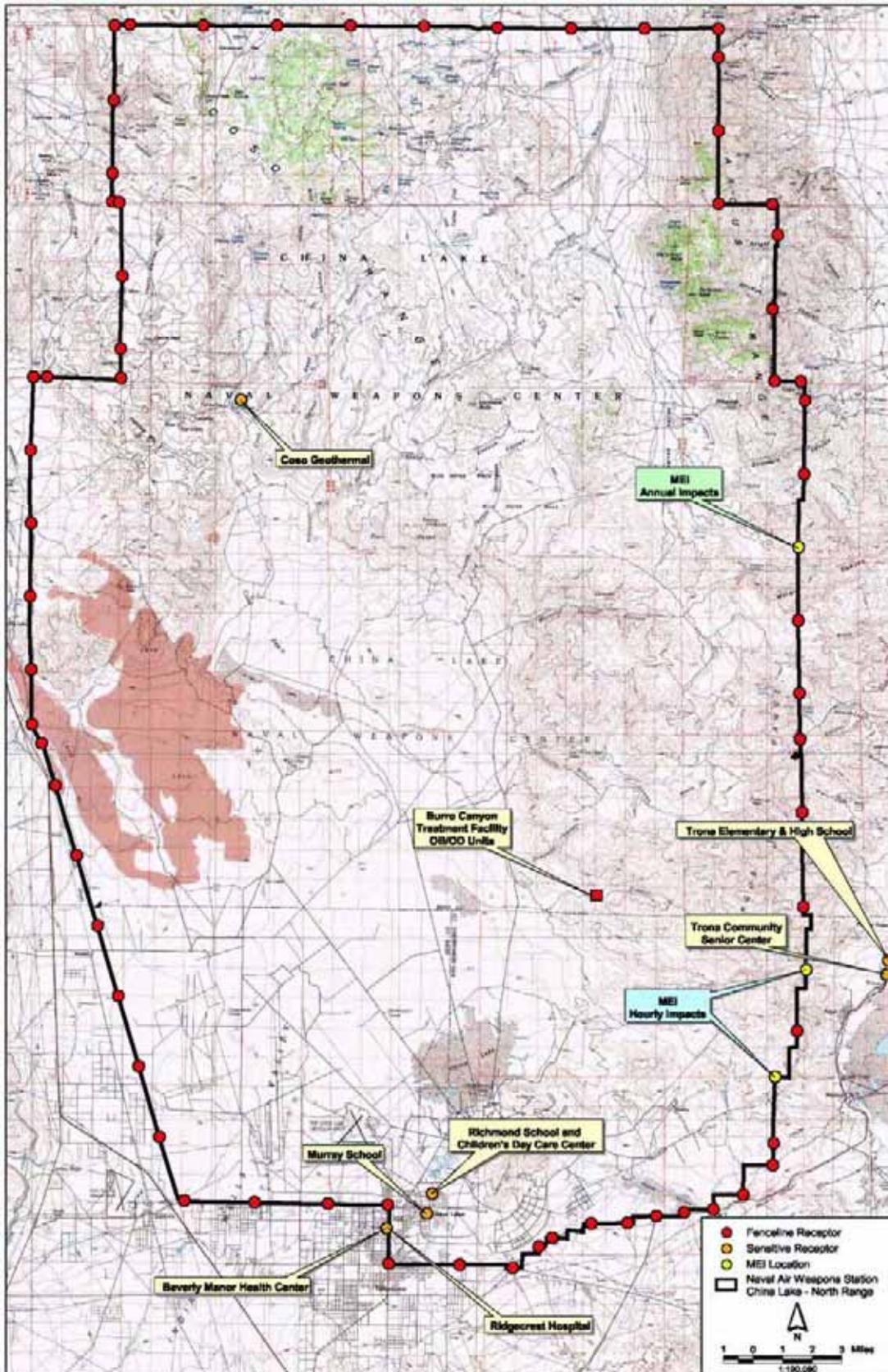


Table ES-1. Permitted Treatment Quantities for Each Emission Category

Emission Category <sup>1</sup>	Family	Sub Family	Permitted Hourly Treatment Quantity (lb/hr)	Limiting Factor	Permitted Annual Treatment Quantity (lb/yr)	Limiting Factor
<b>Open Burn</b>						
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
IIA - Double base with Lead	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
IIB - Double base without Lead	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	1,000	Logistical Limit	365,000	Logistical Limit
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	1,000	Logistical Limit	365,000	Logistical Limit
B1 - Nitramine / Binder	Explosive	Plastic Bonded	1,000	Logistical Limit	365,000	Logistical Limit
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	1,000	Logistical Limit	365,000	Logistical Limit
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	1,000	Logistical Limit	365,000	Logistical Limit
C1 - e.g., PbN3, ammonium picrate	Explosive	Other	1,000	Logistical Limit	365,000	Logistical Limit
Diesel	-	-	1,000	Logistical Limit	365,000	Logistical Limit
Wood	-	-	1,000	Logistical Limit	365,000	Logistical Limit
<b>Open Detonation</b>						
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
IIA - Double base with Lead	Propellant	Rocket/Missile	16,200	Criteria Pollutant Standard Threshold	1,495,000	Cancer Risk Threshold
IIB - Double base without Lead	Propellant	Rocket/Missile	30,000	Logistical Limit	1,500,000	Cancer Risk Threshold
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	30,000	Logistical Limit	1,500,000	Cancer Risk Threshold
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	30,000	Logistical Limit	1,500,000	Cancer Risk Threshold
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	30,000	Logistical Limit	1,500,000	Cancer Risk Threshold
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	30,000	Logistical Limit	5,475,000	Logistical Limit
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	30,000	Logistical Limit	5,475,000	Logistical Limit
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	30,000	Logistical Limit	5,475,000	Logistical Limit

Table ES-1. Permitted Treatment Quantities for Each Emission Category (Continued)

Emission Category <sup>1</sup>	Family	Sub Family	Permitted Hourly Quantity (lb/hr)	Limiting Factor	Permitted Annual Quantity (lb/yr)	Limiting Factor
B1 - Nitramine / Binder	Explosive	Plastic Bonded	30,000	Logistical Limit	5,475,000	Logistical Limit
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	30,000	Logistical Limit	5,475,000	Logistical Limit
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	30,000	Logistical Limit	5,475,000	Logistical Limit
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	16,200	Criteria Pollutant Standard Threshold	5,475,000	Logistical Limit
P - Pyrotechnics	Pyrotechnic	-	30,000	Logistical Limit	580,000	Cancer Risk Threshold
W - Energetic-contaminated wastes	ECW	-	30,000	Logistical Limit	5,475,000	Logistical Limit
M - Munition Components	Munition Components	-	30,000	Logistical Limit	5,475,000	Logistical Limit
<b>Other</b>						
OD Grading	-	-	1 <sup>2</sup>	Logistical Limit	365 <sup>3</sup>	Logistical Limit

<sup>1</sup> Ash handling is not included as a category here since it occurs with every OB event. Ash handling is assumed for 100 lbs. of ash per event and 36,500 lbs per year.

<sup>2</sup> Number of grading events per hour

<sup>3</sup> Number of grading events per year

Table ES-2. Summary of Maximum Cancer Risks for Each Emission Category

Emission Category	Family	Sub Family	Permitted Annual Treatment Quantity <sup>1</sup> (lb/yr)	MEI Cancer Risk (Threshold = 1.E-06)				
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	Total
<b>Open Burn</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	365,000	2.E-09	1.E-13	2.E-18	-	2.E-09
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	365,000	2.E-09	1.E-13	2.E-18	-	2.E-09
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	365,000	1.E-09	1.E-13	2.E-18	-	1.E-09
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	365,000	2.E-09	1.E-13	2.E-18	-	2.E-09
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	365,000	2.E-09	1.E-13	2.E-18	-	2.E-09
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	365,000	1.E-09	1.E-13	2.E-18	-	1.E-09
IIA - Double base with Lead	Propellant	Rocket/Missile	365,000	3.E-09	1.E-13	2.E-18	-	3.E-09
IIB - Double base without Lead	Propellant	Rocket/Missile	365,000	9.E-10	1.E-13	2.E-18	-	9.E-10
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	365,000	1.E-10	1.E-13	2.E-18	-	1.E-10
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	365,000	1.E-10	1.E-13	2.E-18	-	1.E-10
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	365,000	3.E-12	1.E-13	2.E-18	-	3.E-12
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	365,000	2.E-08	1.E-13	2.E-18	-	2.E-08
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	365,000	2.E-10	1.E-13	2.E-18	-	2.E-10
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	365,000	2.E-11	1.E-13	2.E-18	-	2.E-11
B1 - Nitramine / Binder	Explosive	Plastic Bonded	365,000	2.E-08	1.E-13	2.E-18	-	2.E-08
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	365,000	2.E-08	1.E-13	2.E-18	-	2.E-08
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	365,000	2.E-08	1.E-13	2.E-18	-	2.E-08
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	365,000	2.E-08	1.E-13	2.E-18	-	2.E-08
Diesel	-	-	365,000	2.E-07	1.E-13	2.E-18	-	2.E-07
Wood	-	-	365,000	1.E-08	1.E-13	2.E-18	-	1.E-08
<b>Open Detonation</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
IIA - Double base with Lead	Propellant	Rocket/Missile	1,495,000	1.E-06	1.E-13	-	3.E-08	1.E-06
IIB - Double base without Lead	Propellant	Rocket/Missile	1,500,000	1.E-06	1.E-13	-	3.E-08	1.E-06
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	1,500,000	1.E-06	1.E-13	-	3.E-08	1.E-06
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	1,500,000	1.E-06	1.E-13	-	3.E-08	1.E-06
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	1,500,000	1.E-06	1.E-13	-	3.E-08	1.E-06
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	5,475,000	3.E-07	1.E-13	-	1.E-07	4.E-07
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	5,475,000	1.E-07	1.E-13	-	1.E-07	2.E-07
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	5,475,000	1.E-07	1.E-13	-	1.E-07	2.E-07
B1 - Nitramine / Binder	Explosive	Plastic Bonded	5,475,000	8.E-07	1.E-13	-	1.E-07	9.E-07
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	5,475,000	4.E-07	1.E-13	-	1.E-07	5.E-07

Table ES-2. Summary of Maximum Cancer Risks for Each Emission Category (Continued)

Emission Category	Family	Sub Family	Permitted Annual Treatment Quantity <sup>1</sup> (lb/yr)	Maximum Cancer Risk				
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	Total
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	5,475,000	9.E-07	1.E-13	-	1.E-07	1.E-06
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	5,475,000	2.E-07	1.E-13	-	1.E-07	3.E-07
P - Pyrotechnics	Pyrotechnic	-	580,000	1.E-06	1.E-13	-	1.E-08	1.E-06
W - Energetic-contaminated wastes	ECW	-	5,475,000	4.E-07	1.E-13	-	1.E-07	5.E-07
M - Munition Components	Munition Components	-	5,475,000	4.E-07	1.E-13	-	1.E-07	5.E-07
<b>Other</b>								
OD Grading	-	-	365 <sup>5</sup>	1.E-11	1.E-13	-	-	1.E-11

<sup>1</sup> Treatment limit specified in RCRA permit.

<sup>2</sup> Risks associated with windblown dust apply to treatment by both OD and OB since emissions occur throughout the year.

<sup>3</sup> Risks associated with emissions from ash handling only apply to treatment by OB.

<sup>4</sup> Risks associated with emissions from the crater only apply to treatment by OD.

<sup>5</sup> Number of grading events per year

Table ES-3. Summary of Maximum Chronic Noncancer Risks for Each Emission Category

Emission Category	Family	Sub Family	Permitted Annual Treatment Quantity <sup>1</sup> (lb/yr)	MEI Chronic HI (Threshold = 1.0)				
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	Total
<b>Open Burn</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	365,000	2.4E-07	3.2E-09	4.1E-14	-	2.5E-07
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	365,000	4.9E-07	3.2E-09	4.1E-14	-	4.9E-07
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	365,000	3.1E-07	3.2E-09	4.1E-14	-	3.2E-07
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	365,000	2.4E-07	3.2E-09	4.1E-14	-	2.5E-07
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	365,000	4.9E-07	3.2E-09	4.1E-14	-	4.9E-07
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	365,000	3.1E-07	3.2E-09	4.1E-14	-	3.2E-07
IIA - Double base with Lead	Propellant	Rocket/Missile	365,000	4.3E-06	3.2E-09	4.1E-14	-	4.3E-06
IIB - Double base without Lead	Propellant	Rocket/Missile	365,000	2.3E-07	3.2E-09	4.1E-14	-	2.4E-07
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	365,000	1.9E-03	3.2E-09	4.1E-14	-	1.9E-03
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	365,000	1.9E-03	3.2E-09	4.1E-14	-	1.9E-03
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	365,000	2.8E-03	3.2E-09	4.1E-14	-	2.8E-03
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	365,000	1.2E-03	3.2E-09	4.1E-14	-	1.2E-03
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	365,000	1.1E-05	3.2E-09	4.1E-14	-	1.1E-05
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	365,000	1.3E-04	3.2E-09	4.1E-14	-	1.3E-04
B1 - Nitramine / Binder	Explosive	Plastic Bonded	365,000	5.1E-04	3.2E-09	4.1E-14	-	5.1E-04
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	365,000	7.3E-04	3.2E-09	4.1E-14	-	7.3E-04
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	365,000	1.2E-03	3.2E-09	4.1E-14	-	1.2E-03
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	365,000	1.6E-03	3.2E-09	4.1E-14	-	1.6E-03
Diesel	-	-	365,000	1.1E-04	3.2E-09	4.1E-14	-	1.1E-04
Wood	-	-	365,000	1.6E-05	3.2E-09	4.1E-14	-	1.6E-05
<b>Open Detonation</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
IIA - Double base with Lead	Propellant	Rocket/Missile	1,495,000	6.2E-03	3.2E-09	-	3.2E-03	9.4E-03
IIB - Double base without Lead	Propellant	Rocket/Missile	1,500,000	6.2E-03	3.2E-09	-	3.2E-03	9.4E-03
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	1,500,000	1.1E-02	3.2E-09	-	3.2E-03	1.4E-02
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	1,500,000	1.1E-02	3.2E-09	-	3.2E-03	1.4E-02
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	1,500,000	1.4E-02	3.2E-09	-	3.2E-03	1.7E-02
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	5,475,000	1.5E-02	3.2E-09	-	3.2E-03	1.8E-02
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	5,475,000	6.9E-04	3.2E-09	-	3.2E-03	3.9E-03
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	5,475,000	2.2E-03	3.2E-09	-	3.2E-03	5.4E-03
B1 - Nitramine / Binder	Explosive	Plastic Bonded	5,475,000	6.8E-03	3.2E-09	-	3.2E-03	1.0E-02
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	5,475,000	9.6E-03	3.2E-09	-	3.2E-03	1.3E-02

Table ES-3. Summary of Maximum Chronic Noncancer Risks for Each Emission Category (Continued)

Emission Category	Family	Sub Family	Permitted Annual Treatment Quantity <sup>1</sup> (lb/yr)	MEI Chronic HI				
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	Total
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	5,475,000	1.7E-02	3.2E-09	-	3.2E-03	2.1E-02
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	5,475,000	2.1E-02	3.2E-09	-	3.2E-03	2.4E-02
P - Pyrotechnics	Pyrotechnic	-	580,000	4.9E-03	3.2E-09	-	3.2E-03	8.2E-03
W - Energetic-contaminated wastes	ECW	-	5,475,000	2.0E-02	3.2E-09	-	3.2E-03	2.4E-02
M - Munition Components	Munition Components	-	5,475,000	2.0E-02	3.2E-09	-	3.2E-03	2.4E-02
<b>Other</b>								
OD Grading	-	-	365 <sup>5</sup>	3.4E-07	3.2E-09	-	-	3.4E-07

<sup>1</sup>Treatment limit specified in RCRA permit.

<sup>2</sup>Risks associated with windblown dust apply to treatment by both OD and OB since emissions occur throughout the year.

<sup>3</sup>Risks associated with emissions from ash handling only apply to treatment by OB.

<sup>4</sup>Risks associated with emissions from the crater only apply to treatment by OD.

<sup>5</sup>Number of grading events per year.

Table ES-4. Summary of Maximum Acute Noncancer Risks for Each Emission Category

Emission Category	Family	Sub Family	Permitted Hourly Treatment Quantity <sup>1</sup> (lb/hr)	MEI Acute HI (Threshold = 1.0)				
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	Total
<b>Open Burn</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	1000	3.2E-05	4.2E-07	6.7E-12	-	3.3E-05
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	1000	9.5E-05	4.2E-07	6.7E-12	-	9.5E-05
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	1000	1.1E-04	4.2E-07	6.7E-12	-	1.1E-04
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	1000	3.2E-05	4.2E-07	6.7E-12	-	3.3E-05
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	1000	9.5E-05	4.2E-07	6.7E-12	-	9.5E-05
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	1000	1.1E-04	4.2E-07	6.7E-12	-	1.1E-04
IIA - Double base with Lead	Propellant	Rocket/Missile	1000	1.5E-04	4.2E-07	6.7E-12	-	1.5E-04
IIB - Double base without Lead	Propellant	Rocket/Missile	1000	3.0E-05	4.2E-07	6.7E-12	-	3.0E-05
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	1000	3.1E-03	4.2E-07	6.7E-12	-	3.1E-03
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	1000	3.1E-03	4.2E-07	6.7E-12	-	3.1E-03
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	1000	3.8E-03	4.2E-07	6.7E-12	-	3.8E-03
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	1000	9.9E-04	4.2E-07	6.7E-12	-	9.9E-04
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	1000	2.0E-04	4.2E-07	6.7E-12	-	2.0E-04
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	1000	4.9E-05	4.2E-07	6.7E-12	-	5.0E-05
B1 - Nitramine / Binder	Explosive	Plastic Bonded	1000	1.6E-03	4.2E-07	6.7E-12	-	1.6E-03
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	1000	1.6E-03	4.2E-07	6.7E-12	-	1.6E-03
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	1000	9.9E-04	4.2E-07	6.7E-12	-	9.9E-04
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	1000	3.8E-04	4.2E-07	6.7E-12	-	3.8E-04
Diesel	-	-	1,000	6.4E-03	4.2E-07	6.7E-12	-	6.4E-03
Wood	-	-	1,000	3.9E-04	4.2E-07	6.7E-12	-	3.9E-04
<b>Open Detonation</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
IIA - Double base with Lead	Propellant	Rocket/Missile	16200	2.3E-03	4.2E-07	-	8.7E-04	3.2E-03
IIB - Double base without Lead	Propellant	Rocket/Missile	30000	8.4E-04	4.2E-07	-	8.7E-04	1.7E-03
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	30000	8.7E-02	4.2E-07	-	8.7E-04	8.8E-02
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	30000	8.7E-02	4.2E-07	-	8.7E-04	8.8E-02
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	30000	1.1E-01	4.2E-07	-	8.7E-04	1.1E-01
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	30000	2.8E-02	4.2E-07	-	8.7E-04	2.9E-02
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	30000	5.6E-03	4.2E-07	-	8.7E-04	6.5E-03
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	30000	1.4E-03	4.2E-07	-	8.7E-04	2.3E-03
B1 - Nitramine / Binder	Explosive	Plastic Bonded	30000	4.6E-02	4.2E-07	-	8.7E-04	4.7E-02
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	30000	4.6E-02	4.2E-07	-	8.7E-04	4.6E-02
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	30000	2.9E-02	4.2E-07	-	8.7E-04	3.0E-02
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	16200	5.8E-03	4.2E-07	-	8.7E-04	6.7E-03

Table ES-4. Summary of Maximum Acute Noncancer Risks for Each Emission Category (Continued)

Emission Category	Family	Sub Family	Permitted Hourly Treatment Quantity <sup>1</sup> (lb/hr)	MEI Acute HI				
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	Total
P - Pyrotechnics	Pyrotechnic	-	30000	1.4E-02	4.2E-07	-	8.7E-04	1.5E-02
W - Energetic-contaminated wastes	ECW	-	30000	4.8E-02	4.2E-07	-	8.7E-04	4.8E-02
M - Munition Components	Munition Components	-	30000	4.7E-02	4.2E-07	-	8.7E-04	4.8E-02
<b>Other</b>								
OD Grading	-	-	1 <sup>5</sup>	9.1E-06	4.2E-07	-	-	9.5E-06

<sup>1</sup>Treatment limit specified in RCRA permit.

<sup>2</sup>Risks associated with windblown dust apply to treatment by both OD and OB since emissions occur throughout the year.

<sup>3</sup>Risks associated with emissions from ash handling only apply to treatment by OB.

<sup>4</sup>Risks associated with emissions from the crater only apply to treatment by OD.

<sup>5</sup>Number of grading events per hour.

## 1.0 INTRODUCTION

This section discusses the purpose of this Health Risk Assessment (HRA) and provides an overview of this document.

### 1.1 PURPOSE OF ASSESSMENT

URS Group, Inc. (URS) prepared this updated HRA in support of the Resource Conservation and Recovery Act (RCRA) Part B permit application for the Burro Canyon Treatment Facility (BCTF) located at Naval Air Weapons Station China Lake (China Lake). China Lake treats numerous types of energetic wastes, including propellants, explosives, and pyrotechnics, by Open Burn/Open Detonation (OB/OD) in the two units (i.e., OB and OD) at the BCTF. The OB/OD activities generate emissions regulated by the state of California. The purpose of the updated HRA is to evaluate the potential health risk impacts associated with these emissions on the surrounding environment from the OB and OD units using updated data. This document presents the results of the updated HRA.

### 1.2 OVERVIEW OF DOCUMENT

The BCTF consists of two units, the OB unit and the OD unit. Both units are subject to permit modification. Both OB and OD operations generate emissions regulated by the state of California. The HRA evaluates potential health risk impacts associated with toxic air contaminant (TAC) emissions based on annual and event treatment limits as allowed by the permit and compares the results to a carcinogenic risk threshold of one in one million ( $1 \times 10^{-6}$ ) and a noncarcinogenic chronic and acute hazard index (HI) of 1.0.

The HRA was prepared in accordance with a draft HRA protocol (URS, 2005) submitted to and discussed with the Department of Toxic Substances Control (DTSC) and the most recent risk assessment guidelines published by the California Environmental Protection Agency (CalEPA), Office of Environmental Health Hazard Assessment (OEHHA) (OEHHA, 2003). In addition, the HRA incorporated updated emissions data and toxicological values that were approved by the DTSC. Use of the OEHHA guidelines results in a worst-case analysis of risk. For example, the theoretical incremental cancer risk estimated in this HRA is based on a maximally exposed individual (MEI) being continuously exposed to emissions from routine OB/OD operations for 24 hours per day, 365 days per year, for 70 years at the same location. This approach is more conservative than other approaches recommended by the U.S. Environmental Protection Agency (EPA), such as the reasonable maximum exposure (RME) approach based on a 30-year residential exposure or the average exposed individual (AEI) approach based on a 9-year exposure. Actual risks are likely to be substantially lower than those estimated using the OEHHA guidelines and could approach zero.

A typical HRA, such as this, consists of four basic steps to assess potential public health risk from a particular activity:

1. Emission data from the project or from comparable activities is collected, analyzed, and chemicals of concern (COCs) are selected;

2. Emissions of COCs from the unit are quantified and segregated according to category type. Ground-level impacts resulting from the transport and dilution of these emissions through the atmosphere are assessed by air dispersion modeling. Potential public exposures to these emissions resulting from this atmospheric transport are calculated.
3. Toxicity factors for the COCs and the sources for the toxicity factors are provided.
4. Potential cancer and noncancer health risks resulting from the calculated exposures are estimated using dose-response relationships developed from toxicological data.

In general, there are uncertainties at every step of the process, but the cumulative assumptions of HRAs that follow standard regulatory practices, as this one does, are more likely to cause an overprediction of health risks rather than an underestimation, probably by a substantial margin. The following factors may contribute to an overprediction of health risks:

1. A regulatory air dispersion model that tends to overpredict ground-level chemical concentrations;
2. State-approved toxicity factors developed from human and animal data thought to represent an upper bound of potential cancer potency factors and the most sensitive responses to noncarcinogens; and
3. An assumption of continuous 70-year exposure at a single off-site residential location.

Consistent with the OEHHA guidelines, this document is organized as follows:

- ◆ Section 2.0 reviews background site information and the regulatory setting for COCs locally and in California;
- ◆ Section 3.0 describes the hazard associated with emissions from the OB/OD operations;
- ◆ Section 4.0 presents the methodologies used for quantifying emissions, assessing ground-level concentrations (GLCs) from the OB/OD operations through air dispersion modeling and the calculation of environmental exposures as a result of the dispersion of COCs;
- ◆ Section 5.0 provides the toxicity factors used to assess potential cancer and noncancer health risks from the calculated exposures;
- ◆ Section 6.0 discusses the results of this HRA;
- ◆ Section 7.0 evaluates the uncertainties associated with the overall HRA process;
- ◆ Section 8.0 lists pertinent references used in the development of this document; and
- ◆ The appendices provide technical support information.

## 2.0 BACKGROUND

This section discusses the environmental and regulatory setting for this HRA. In addition, potential health effects are presented at the end of the section.

### 2.1 ENVIRONMENTAL SETTING

#### 2.1.1 Site Location and Ambient Conditions

China Lake is the Navy's largest Research, Development, Test, & Evaluation (RDT&E) facility for weapons development and testing. It consists of 1.1 million acres of land surrounded by 12.5 million acres of airspace in California's remote and sparsely populated Mojave Desert. Much of the surrounding land is either owned or controlled by the United States Government. China Lake provides a notable economic, employment, and cultural benefit to its surrounding community. The general location of China Lake is presented on Figure 2-1.

A diverse energetic waste stream is generated from activities associated with China Lake's RDT&E mission. An energetic contains a substance (or a mixture of substances) capable, by chemical reaction, of producing gas at high temperature and pressure as to cause damage to the surroundings. The term energetic includes all solid and liquid materials variously known as high and low explosives, propellants, together with igniter, primer, initiators, and pyrotechnics (e.g., illuminant, smoke, delay, decoy, flare, and incendiary compositions). Department of Transportation, Department of Defense, and Navy regulations prohibit the transport of most of this RDT&E energetic waste stream on public roadways, either because the wastes are research and development materials that have not been fully characterized with respect to explosive safety, or because the wastes have been altered or damaged. Therefore, most of this RDT&E energetic waste stream must be treated at China Lake.

For simplicity, the waste streams can be divided into two waste streams: (1) a munitions waste stream that consists of both standard munitions including rocket motors, bombs, projectiles, etc. (those that are either excessed or expired) and nonstandard munitions (standard munitions altered from some RDT&E process [e.g., heating, dropping]); and (2) a laboratory waste stream that consists of leftovers from mixes and castings of experimental explosives and propellants, energetic-contaminated "trash" (e.g., rags, gloves), samples from the mixes, and energetic-contaminated solvents.

China Lake operates one site to conduct OB/OD events. The BCTF is approximately seven miles from the nearest Base boundary to the east. The nearest Base boundary in the dominant wind direction is approximately 17 miles to the northeast, while the nearest town (i.e., Trona) is located approximately 9 miles to the southeast. The BCTF is located in a natural amphitheater surrounded by mountainous terrain, as shown on Figure 2-2. The land surrounding China Lake is primarily desert terrain and open space with some residential and commercial land uses southwest in the town of Ridgecrest and east in the town of Trona.

Figure 2-1. General Location of China Lake

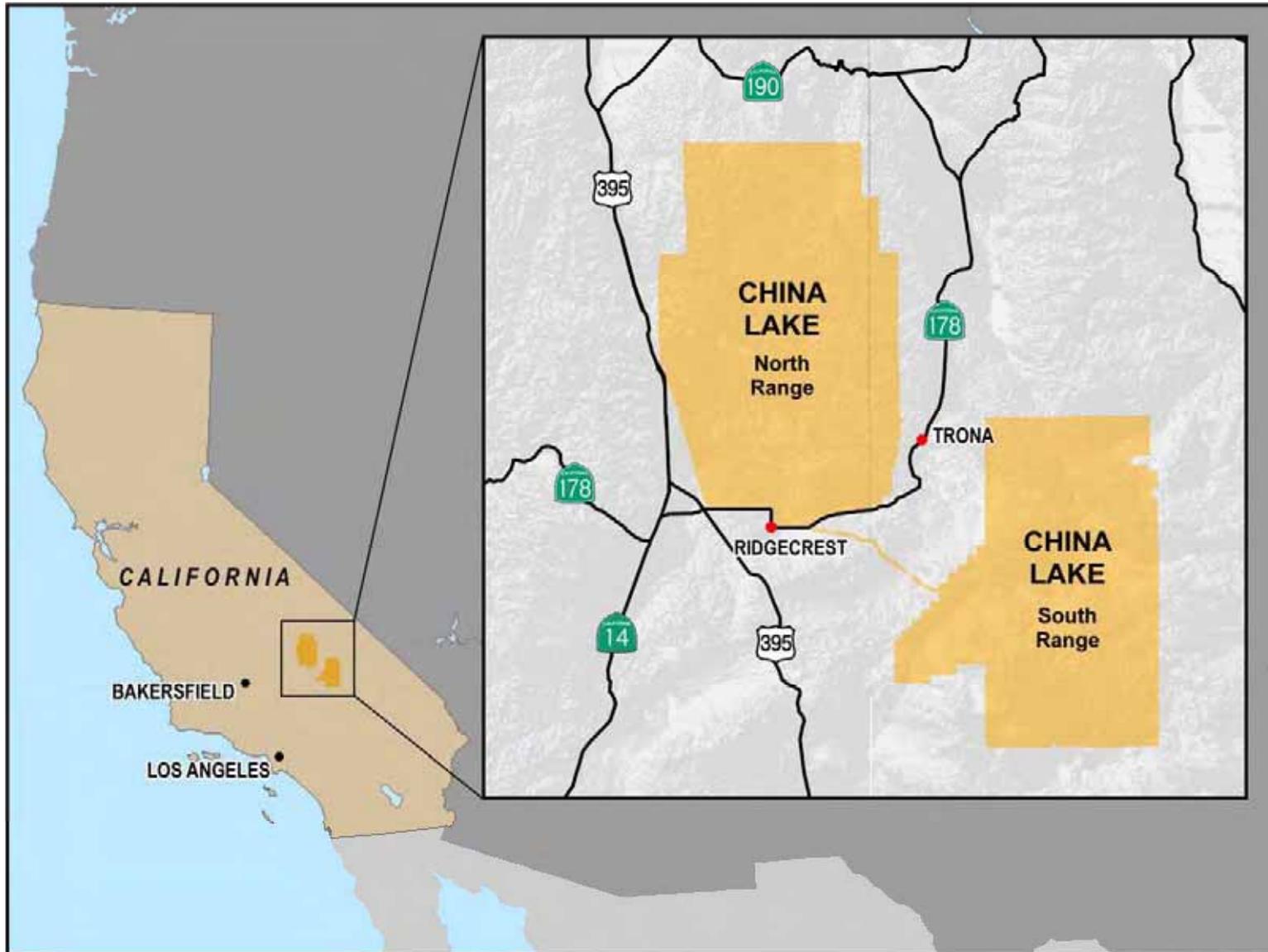
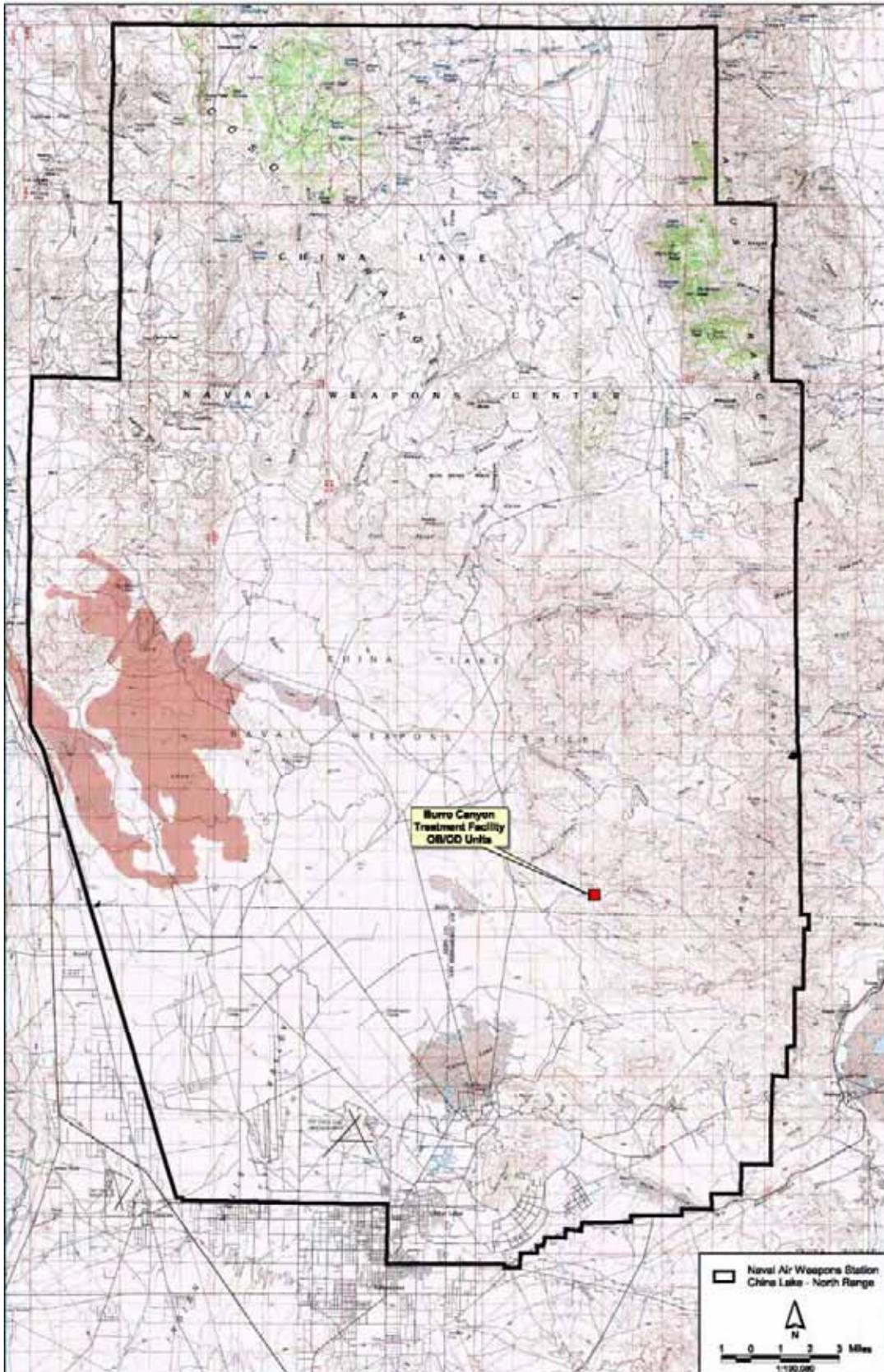


Figure 2-2. Location of the OB/OD Units at Burro Canyon



Currently, OD is the primary and preferred method of treating energetic hazardous wastes at China Lake. Rather than burying the waste items in preparation for treatment, the items are placed directly on the ground at the OD unit. This practice allows for maximum air entrainment, which in turn optimizes the important afterburning phase of the OD reaction to produce stable nontoxic chemicals. The use of donor explosives ensures that all waste items are completely reacted to nontoxic products. The energetic wastes, detonators, and fuses are packed carefully on the canyon floor using specific methods to ensure safety and thorough destruction. All detonations are observed from a steel bunker located on a hill approximately one mile to the south. After several detonation events, metal debris is removed and the area is graded level.

OB can also be conducted in an elevated burn pan, but is rarely used (last OB was in August 1998). Diesel and wood are typically used to sustain OB events. Per Great Basin Unified Air Pollution Control District (GBUAPCD) rules, only commercially available firewood may be used in OB events. When the event is complete, ash is removed from the burn pan, properly containerized, and transferred to the China Lake permitted hazardous waste storage unit.

China Lake experiences a desert climate with hot, dry summers and cold winters. During the summer months, average maximum temperatures are in the upper-90s to low-100s, with a normal high of about 102°F in July. Average maximum winter temperatures are in the low to mid-60s. Average minimum temperatures are in the high-60s in the summer and the low 30s in the winter, with a normal low of 30°F in January. Regional winds in China Lake predominantly blow from the southwest with annual average wind speed of approximately 7 miles per hour.

### 2.1.2 Existing Toxic Air Contaminant Levels

Monitoring stations for TACs are located throughout California. These stations, maintained either by the California Air Resources Board (CARB) or the local Air Pollution Control District (APCD), monitor and record existing levels of various organic gases and metals in air. The closest TAC air monitoring station to China Lake is located in the City of Bakersfield, in Kern County, which is located in the San Joaquin Valley APCD. The information presented below is provided for comparison with the results of this HRA. Based on the data collected, CARB has provided annual average concentrations of the top 10 TACs and estimated 70-year cancer health risks for this monitoring station. The data are provided in *The California Almanac of Emissions and Air Quality – 2005 Edition*, produced by CARB (CARB, 2005). The annual average TAC concentrations and associated estimated health risks in Bakersfield and in the San Joaquin Valley Air Basin are presented in Table 2-1 for selected years. In the case of diesel particulate matter (DPM), CARB states that because a routine method for monitoring ambient concentrations was not available, preliminary estimates of background DPM levels were made based on the particulate matter less than 10 microns in diameter (PM<sub>10</sub>) emissions database, PM<sub>10</sub> ambient monitoring data, several studies with chemical speciation of ambient PM<sub>10</sub>, and receptor modeling techniques. As such, since 1990, annual average concentrations of TACs in Kern County have declined due to the implementation of air toxics control programs. Excluding DPM, the estimated Bakersfield TAC background cancer risk was 460 in one million in 1990 and 181 in one million in 2000. In comparison, the corresponding background cancer risk within the San Joaquin Valley Air Basin was 450 in one million (1230 in one million with DPM) in 1990 and 196 in one million (586 in one million) in 2000. Estimated cancer risks are reported to have further declined in 2003.

**Table 2-1. Background Concentrations and Estimated Cancer Risks Associated With Selected TAC Emissions in Kern County**

Station	TAC	Annual Average Concentration <sup>a</sup>			Cancer Risk <sup>b</sup>		
		1990	2000	2003	1990	2000	2003
<b>Bakersfield</b>	Acetaldehyde	1.87	1.19	1.51	9	6	7
	Benzene	2.68	0.58	0.41	248	54	37
	1,3-Butadiene	0.39	0.13	0.06	146	47	24
	Carbon Tetrachloride	0.13	0.09	0.10	33	25	25
	Chromium (Hexavalent)	-- <sup>d</sup>	0.10	0.05	--	16	8
	para-Dichlorobenzene	-- <sup>d</sup>	0.11	0.15	--	7	10
	Formaldehyde	2.44	2.79	3.43	18	21	25
	Methylene Chloride	0.92	0.58	0.11	3	2	0
	Perchloroethylene	0.09	0.07	0.04	3	3	1
	DPM <sup>c</sup>	-- <sup>d</sup>	-- <sup>d</sup>	--	--	--	--
<b>Total Health Risk</b>				<b>460</b>	<b>181</b>	<b>137</b>	
<b>San Joaquin Valley Air Basin</b>	Acetaldehyde	1.94	1.09	1.34	9	5	7
	Benzene	2.45	0.63	0.46	227	58	43
	1,3-Butadiene	0.41	0.16	0.10	154	59	36
	Carbon Tetrachloride	0.13	0.10	0.10	34	25	26
	Chromium (Hexavalent)	-- <sup>d</sup>	0.12	0.08		18	12
	para-Dichlorobenzene	-- <sup>d</sup>	0.11	0.15		7	10
	Formaldehyde	2.45	2.61	3.02	18	19	22
	Methylene Chloride	0.76	0.53	0.14	3	2	1
	Perchloroethylene	0.13	0.08	0.03	5	3	1
	DPM	2.6	1.3	-- <sup>d</sup>	780	390	
<b>Total Health Risk</b>				<b>450</b> (1230 <sup>e</sup> )	<b>196</b> (586 <sup>e</sup> )	<b>158</b>	

<sup>a</sup>Concentrations for Chromium (Hexavalent) are in nanograms per cubic meter and concentrations for DPM are in micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ). All other concentrations are in parts per billion.

<sup>b</sup>Cancer risk represents the number of excess cancer cases per million people based on a lifetime (70-year) exposure to the annual average concentrations.

<sup>c</sup>DPM concentrations are estimates based on receptor modeling. Estimates are available only for selected years.

<sup>d</sup>No monitoring data available.

<sup>e</sup>Estimated cancer risk including DPM.

Source: *The California Almanac of Emissions and Air Quality – 2005 Edition*, CARB 2005. Bakersfield values are for the 5558 California Avenue site.

The calculated average cancer risk values from monitored TACs can be compared against the lifetime probability of being diagnosed with cancer in the United States from all causes, which is about 40%, or 400,000 in a million (National Cancer Institute [NCI], 2000). Medical advances have improved cancer cure rates such that the lifetime probability of dying from cancer in the United States today is about 22% or 220,000 in a million (NCI, 2000), or about 55% of the lifetime probability of a cancer diagnosis. Not only have cancer treatment advances improved long-term survivability, techniques and procedures developed for earlier diagnosis have improved. It is generally believed that a large portion of these cancer cases come from smoking habits, genetic susceptibilities, diet, natural radiation including radon, and other lifestyle factors.

## **2.2 REGULATORY SETTING**

The COCs evaluated in this study are TACs, substances for which specific air quality standards have not been established with a few exceptions, but which are capable of causing short-term (acute) and/or long-term (chronic noncarcinogenic, or carcinogenic) adverse human health effects. These TACs, however, are subject to a wide variety of federal, state, and local regulations.

### **2.2.1 Federal**

TACs have been regulated at the federal level since the Clean Air Act (CAA) of 1977. Following the passage of this law, regulations for seven hazardous air pollutants (HAPs) were promulgated as National Emission Standards for Hazardous Air Pollutants (NESHAPs) over a 13-year period. The federal Clean Air Act Amendments of 1990 (CAAA) revamped the NESHAPs program to offer a technology-based approach for reducing the emissions of a greater number of toxic chemicals. Under the CAAA, 189 substances were identified as HAPs and slated for regulation through the Federal Operating Permit Program.

### **2.2.2 State**

California's air toxics control program began in 1983 with the passage of the Toxic Air Contaminant Identification and Control Act, better known as Assembly Bill (AB) 1807 or the Tanner Bill. The Tanner Bill established a regulatory process for the scientific and public review of individual toxic chemicals. When a chemical is listed as a TAC under the Tanner process, CARB normally establishes minimum statewide emission control measures to be adopted by local APCDs or Air Quality Management Districts. The TAC list includes all HAP chemicals, as well as many others.

The second major component of California's air toxics program, supplementing the Tanner process, was provided by the passage of AB 2588, the Air Toxics "Hot Spots" Information and Assessment Act of 1987. AB 2588 currently regulates over 600 chemicals, including all of the Tanner-designated TACs. Under AB 2588, specified facilities must quantify emissions of regulated TACs and report them to the local APCD. If the APCD determines that a potentially significant public health risk is posed by a given facility, the facility is required to perform an HRA and notify the public in the affected area if the calculated risks exceed specified criteria.

In addition to the above, Proposition 65 was passed by California voters in 1986. Proposition 65 requires that a list of carcinogenic and reproductive toxicants found in the environment be compiled; the discharge of these toxicants into drinking water be prohibited; and warnings of public exposure by air, land, or water be posted if a potential public health risk is posed. The handling, production, or emission of any of these substances by a facility would require a public warning unless health risks could be demonstrated to be insignificant. For carcinogens, Proposition 65 defines the “no significant risk level” as the level of exposure that would result in an increased cancer risk of greater than 10 in one million over a 70-year lifetime. This program is currently administered by OEHHA.

CARB formally identified particulate matter (PM) emitted by diesel-fueled engines as a TAC in 1998. This action was taken at the end of a lengthy process that considered dozens of health studies, extensive analysis of health effects and exposure data, and public input collected over many years. This action will lead to additional control of diesel engine emissions over the next few years by CARB. The EPA has also evaluated both the cancer and noncancer health effects of diesel exhaust and issued its final health assessment for diesel engine exhaust (EPA, 2002a).

In September 2000, the CARB approved the *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (Diesel Risk Reduction Plan) (CARB, 2000). The Diesel Risk Reduction Plan outlines a comprehensive and ambitious program that includes the development of numerous new control measures over the next several years aimed at substantially reducing emissions from new and existing on-road vehicles (e.g., heavy-duty trucks and buses), off-road equipment (e.g., graders, tractors, forklifts, sweepers, and boats), portable equipment (e.g., pumps), and stationary engines (e.g., standby power generators). Therefore, a number of Airborne Toxic Control Measures (ATCMs) have been developed and others are in the process of being developed.

### 2.2.3 Local

In compliance with federal law, the GBUAPCD implements federal TAC regulatory requirements through the Federal Operating Permit Program.

In compliance with state law, the GBUAPCD also administers the AB 2588 Air Toxics “Hot Spots” Program. Facilities must periodically report their TAC emissions and, if the GBUAPCD determines that the facility poses a potential public health risk, the facility must perform an HRA. If the estimated health risks exceed threshold levels, the public in the affected area must be notified. The notification threshold is a cancer risk of 10 in one million and a chronic and acute noncancer HI of 1.0. In cases where risks exceed specified action levels, steps must be taken to reduce emissions, including the preparation of a Risk Reduction Plan.

OB/OD operations are also subject to GBUAPCD Rule 432. This rule requires that a Burn Plan documents the criteria pollutant and TAC impacts of emissions and stipulates conditions under which such an operation may be conducted. The Burn Plan must be renewed every year.

## 2.3 POTENTIAL HEALTH EFFECTS

### 2.3.1 Cancer Risk

Cancer risk is defined as the lifetime probability (chance) of developing cancer from exposure to a carcinogen, typically expressed as the increased chances in a million. The cancer risk for an inhaled COC is calculated from the exposure concentration (in micrograms per cubic meter [ $\mu\text{g}/\text{m}^3$ ]), its cancer toxicity factors and specified exposure assumptions. Cancer toxicity factors are the cancer potency (or slope) factor and the unit risk factor (URF). The cancer potency factor represents the potential risk of contracting cancer per ingested dose of the carcinogen. The URF is derived from the cancer potency factor with exposure assumptions for inhalation.

For particulate-bound COCs, exposure could come from indirect environmental pathways, such as deposition on the soil, followed by exposure through soil ingestion or absorption of the COC from soil adhered to the skin. Other potential ingestion pathways, such as ingestion of crops grown in soil potentially affected by deposited COCs, may be included, if applicable. Cancer risk from these pathways is calculated from cancer potency factors and exposure assumptions, as described further in Sections 5.0 and 6.0.

Cancer risks are calculated for all carcinogenic COCs and the results summed to calculate an overall cancer risk for all COCs combined. The calculation procedure assumes that cancer risk is proportional to concentration at any level of exposure; that is, there is no dose that would result in a zero probability of contracting cancer. This is generally considered to be a conservative assumption at low doses, as some theories on carcinogenesis assume that certain chemicals may require a threshold level or interaction with other agents, while others say that cancer can be caused at any exposure level. The zero-threshold approach is consistent with the current OEHHA regulatory guidance.

### 2.3.2 Noncancer Health Risk

The indicators of the potential for noncancer health impacts are expressed as a hazard quotient (HQ) for individual COCs and as an HI for the accumulated value for multiple COCs. The HQ is the ratio of the reported or calculated exposure concentration for the inhalation pathway (or exposure dose for the non-inhalation pathway) to a corresponding reference toxicity concentration identified by the OEHHA. The reference toxicity concentration for inhalation is either a Reference Concentration (RfC, based on EPA data) or a Reference Exposure Level (REL, based on OEHHA data) and the reference toxicity concentration for non-inhalation pathways is a Reference Dose (RfD, based on either EPA or OEHHA data). An HI is the sum of the HQs for all COCs that affect the same target organ system. For chronic exposure, HIs are calculated by summing the HQs for COCs that impact the same target organ system from both inhalation and non-inhalation exposure pathways and are based on chronic reference toxicity concentrations. For acute exposure, HIs are calculated by summing the HQs for COCs that impact the same target organ system for only the inhalation pathway. This approach is consistent with the current OEHHA regulatory guidance. Noncancer toxicity factors are discussed in Section 5.0.

### 3.0 HAZARD IDENTIFICATION

Hazard identification is the step that identifies the emissions from the activity, the sources of TAC emissions, and the selection of COCs.

#### 3.1 DATA COLLECTION AND ANALYSIS

OB and OD events emit hundreds of chemicals through complex and extremely violent reactions. Some of these chemicals pose known health concerns, while some are inert or do not pose any known health concerns. In an effort to simplify the analysis and focus on those chemicals that pose known health concerns, China Lake identified COCs (i.e., those chemicals with known health concerns and subject to regulatory scrutiny) through a rigorous evaluation process. China Lake started by creating a database of over 1000 chemicals developed from chemical lists in 1) California Air Toxics “Hot Spots” Program (AB 2588), 2) EPA Region 9 Preliminary Remediation Goals (PRGs), and 3) a chemical inventory prepared in 1996 from emission test data. After a detailed examination of the list, over half of the chemicals were removed based on several criteria, including duplicate chemicals and chemicals neither present nor produced in OB/OD activities, such as pesticides and pharmaceuticals. With approximately 500 chemicals remaining on the list, China Lake further refined the list by assigning each chemical to one of the four following quadrants:

- 1) Quadrant 1 – Chemicals with Known Health Concern and Available Emission Factor Data;
- 2) Quadrant 2 – Chemicals with Known Health Concern and No Available Emission Factor Data;
- 3) Quadrant 3 – Chemicals with No Known Health Concern and Available Emission Factor Data; and
- 4) Quadrant 4 – Chemicals with No Known Health Concern and No Available Emission Factor Data.

This approach and analysis are discussed in *Emissions from the Energetic Component of Energetic Wastes During Treatment by Open Detonation*, Naval Air Warfare Center Weapons Division (NAWCWD), China Lake, June 2005 (Energetic Emissions Report), (NAWCWD, 2005), a report prepared jointly by the China Lake Research and Environmental Planning and Management Departments.

#### 3.2 SELECTION OF CHEMICALS OF CONCERN

The chemicals contained in Quadrants 1 and 2 were evaluated in the HRA. The chemicals contained in Quadrants 3 and 4 were not evaluated in the HRA because they do not present a known health concern. The Quadrant 1 chemicals were easily evaluated in the HRA because emission factor data are readily available. The Quadrant 2 chemicals were the most problematic because they pose a potential health concern, but no emission factor data are available. China Lake prioritized the Quadrant 2 chemicals based on a health risk screening (HRS) approach. The HRS approach identified the chemicals most likely to result from the OB/OD activities and pose a potentially greater health risk. China Lake assigned surrogate emission factors to the chemicals accounting for over 90% of the Quadrant 2-related risk using the HRS approach. Selection of the surrogates and documentation of the energetic emission factors used in this HRA are discussed in the Energetic Emissions Report. Lists of COCs considered in this HRA are contained in Section 4.0.

## 4.0 EXPOSURE ASSESSMENT

The exposure assessment process begins with emissions estimates derived in the initial steps of the HRA and predicts the potential dose of each chemical to individuals in the surrounding population through air dispersion modeling. The air dispersion modeling results are shown in Appendix D - Modeled Downwind Concentrations. Exposure assessment spreadsheets containing the necessary exposure algorithms were used to estimate health effects in this HRA (Appendix H – Concentration and Exposure Calculations).

The HRA addresses inhalation exposure for all chemicals included in this study. Non-inhalation exposure pathways are addressed for those substances identified in the OEHHA guidance documents as requiring multipathway analysis or for which non-inhalation toxicity factors are identified.

### 4.1 EMISSIONS QUANTIFICATION

The analysis evaluated TAC emissions from the OB/OD activities at the BCTF. The emissions associated with the OB/OD activities are generated from direct and indirect sources of emissions during an OB/OD event. The direct emissions result from the actual treatment of appropriate wastes through an OB or OD event. The indirect emissions result from activities that support the waste treatment activities such as OB ash handling, OD grading, and windblown dust from disturbed ground. The HRA quantified the following direct and indirect emission sources:

- ◆ Treatment through OB including energetic, diesel, and wood combustion (direct);
- ◆ Treatment through OD including energetic, non-energetic, metal from casings, paints and coatings, and crater emissions (direct);
- ◆ OB ash handling (indirect);
- ◆ OD grading (indirect); and
- ◆ Windblown dust (indirect).

In order to facilitate the characterization of OB/OD emissions for this HRA, China Lake grouped energetic wastes into the following 19 families based on similar characteristics:

#### ***Propellant Families***

##### ***Gun Propellant***

1. IA<sub>w</sub> - Single Base (nitrocellulose [NC]) (with links and tracer)
2. IB<sub>w</sub> - Double Base (NC / nitroglycerin [NG]) (with links and tracer)
3. IC<sub>w</sub> - Triple Base (NC / NG / nitroguanidine [NQ]) (with links and tracer)
4. IA<sub>wo</sub> - Single Base (NC) (without links and tracer)
5. IB<sub>wo</sub> - Double Base (NC / NG) (without links and tracer)
6. IC<sub>wo</sub> - Triple Base (NC / NG / NQ) (without links and tracer)

**Rocket/Missile Propellant**

7. IIA - Double base with Lead
8. IIB - Double base without Lead
9. IIC - Ammonium Perchlorate (AP) / Binder / Aluminum
10. IID - AP / Binder / Aluminum / Nitramines (>50% AP)
11. IIE - AP / Binder Reduced Smoke
12. IIF - Nitramine / Energetic Binder / Aluminum / <20% AP

**Explosive Families****Melt Cast Explosives**

13. A1 - Trinitrotoluene (TNT) Based (Comp-B, Cyclotol, Octol)
14. A2 - TNT / Aluminum (H-6)

**Plastic Bonded Explosives (PBXs)**

15. B1 - Nitramine / Binder
16. B2 - Nitramine / Binder / Aluminum
17. B3 - Nitramine / Binder / Aluminum / AP

**Other Explosives**

18. C1 - e.g., PbN<sub>3</sub>, ammonium picrate

**Pyrotechnic Family**

19. P - Pyrotechnics

In addition, two families were created to address energetic-contaminated wastes (i.e., laboratory wastes such as paper, fabric, wood, glass, and plastic contaminated with energetic) and munition components (i.e., parts of large munition items, such as circuit boards, containing plastic and small amounts of metal that are not removed before treatment):

**Energetic-contaminated Waste Family**

20. W - Energetic-contaminated wastes

**Munition Components Family**

21. M - Munition Components

Energetics are primarily composed of carbon, hydrogen, nitrogen, and oxygen, with other trace elements, such as sulfur. Propellants are materials that burn very rapidly but controllably to create gas used to propel a projectile or rocket. Gun propellants are designed to reduce flame temperature in order to minimize corrosion of the gun barrels; therefore, metals are generally not used in gun propellants. Rocket propellants are designed to maximize the volume of propelling gases. Rocket propellants may include metal powders such as aluminum, barium, or lead to increase performance or moderate the burn rate. Explosives are materials that undergo more rapid chemical change or decomposition. Metal added to explosives produces a hotter reaction environment. Plastic explosives contain nitramine and a binder, which may range from waxes to polymers. Pyrotechnics include any number of formulations containing additives designed to emit smoke or sparks. Energetic-contaminated waste and munition components

include a variety of non-energetic waste streams that may include chlorinated compounds leading to production of dioxins. Each of the 21 families listed above was assigned appropriate emission factors based on the best available emissions test data obtained from enclosed chamber (Bangbox) and/or open air testing (Energetic Emissions Report). The emission factors for each energetic family (except for the energetic-contaminated waste and munition components families) are expressed as mass of chemical emitted per mass of energetic treated. The energetic-contaminated waste and munition components families have emission factors expressed as mass of chemical emitted per total mass of material [energetic weight plus waste (rags, etc.)] treated. Some families include casings, whereas others do not. Families treated by OB do not have metal emissions from casings. All families treated by OD include metal emission factors from casings, paints, and coatings, except for the C1, P, W, and M families. Projectiles for guns may be treated individually (“wo” designation above) or be belt linked and/or have the tracer pellets included (“w” designation above). Gun cartridge belts and tracer pellets contain different metals than typical casings. Metal emissions and the metal emission factors used in this HRA are discussed in *Metal Emissions From the Open Detonation Treatment of Energetic Wastes, Naval Air Warfare Center Weapons Division (NAWCWD), China Lake, CA, October 2004* (Metal Emissions Report), (NAWCWD, 2004), a report prepared jointly by the China Lake Research, Weapons/Targets, Ordnance Systems, and Environmental Planning and Management Departments, and Sverdrup, Inc.

In addition to emissions from the energetics, energetic-contaminated waste and munition components, emissions will also result from other emission categories. These other emission categories include wood and diesel used to initiate OB events and grading of the OD treatment area. Ash handling following OB events is not defined as a unique category. Health risks from ash handling are associated with each OB event. The health risks resulting from ash handling are added to each of the energetic families when treated by OB. Similarly, the crater associated with OD events is not defined as a unique category. Health risks from crater emissions, calculated using concentrations of COCs previously in the soil as determined from measured soil data, are associated with every OD event. The health risks resulting from crater emissions are added to those for each of the above energetic families when treated by OD. Finally, windblown dust is not related to a particular event. The health risks resulting from windblown dust are added to each of the energetic families when treated by either OB or OD. This is illustrated in Tables ES-2, ES-3, and ES-4. The emission estimation procedures are further described in Sections 4.2 and 4.3.

To provide OB/OD operating flexibility, an equivalency system is used to track types and quantities of wastes treated. This system allows China Lake to treat different types and quantities of wastes without exceeding a cancer risk threshold of one in one million ( $1 \times 10^{-6}$ ) or a noncancer chronic and acute HI of 1.0, while adhering to limits specified in the permit. During the year, China Lake will track the quantity of each emission category treated by OB/OD, including the volume of diesel and weight of wood used in OB events, and the number of grading events following OD events. China Lake can treat 100% of the permitted limit for a single emission category, or a lesser percentage of the permitted quantity for each of several different emission categories. The sum of all percentages (i.e., actual quantity vs. the maximum permitted quantity) must not exceed 100 percent.

Tables 4-1 and 4-2 demonstrate annual tracking and event tracking examples of the equivalency system. The examples are greatly simplified. In fact, the actual tracking will quickly become complicated because single items may include several emission categories, multiple waste streams may be treated in the same event, and indirect sources must also be included. The example in Table 4-1 demonstrates the equivalency system applied to annual tracking. Table 4-1 shows the following:

- ◆ Hypothetical permitted annual amounts along with associated cancer risk and chronic HI for four emission categories;
- ◆ The amount of each type of emission category treated in six hypothetical events;
- ◆ The percent of the permitted annual limit for each emission category for each event;
- ◆ The cancer risk associated with each event by emission category and the cumulative total cancer risk; and
- ◆ The chronic HI associated with each event by emission category as well as a cumulative HI.

In the first event, 200 pounds (lbs) of A, 100 lbs of B, and 100 lbs of C are treated. This event represents 18% of the combined annual limit, a cancer risk of  $1.8 \times 10^{-7}$ , and a cumulative chronic HI of 0.1. In the second event, 100 lbs each of A and B and 200 lbs of D are treated. The second event treats the same total amount, yet this event includes categories with higher allowable limits (less risk associated per lb), resulting in a lower contribution to the annual health risk. The cumulative percentage of permitted treatment capacity is 29.7%, showing that this second event contributed 11.7% (i.e., 6.3% less than the first event). The cumulative risk and chronic HI are  $2.63 \times 10^{-7}$  and 0.21, respectively, after two events. After six events, 89.3% of the annual limit has been consumed and the cumulative annual cancer risk and chronic HI are  $8.07 \times 10^{-7}$  and 0.59, respectively.

The example in Table 4-2 demonstrates the equivalency system applied to six individual events. Table 4-2 shows the following:

- ◆ Hypothetical permitted event amounts along with associated acute HI for four emission categories;
- ◆ The amount of each type of emission category treated in six hypothetical events; and
- ◆ The HI for each emission category per event and the total HI for each event.

The first event includes 200 lbs of A and 100 lbs each of B and C. The treatment limits for these categories are 2000 lbs, 500 lbs, and 200 lbs, respectively. Category D, which may also be treated, has a limit of 1200 lbs per event. The HI for this first event is 0.76. The second event includes 100 lbs each of A and B and 200 lbs of D. Although the second event treats the same total quantity, this event includes categories with higher allowable limits, resulting in a lower HI of 0.40 for the event. This methodology is followed for each treatment event. The acute HIs are calculated and reported by event and not cumulatively, since acute impacts are not cumulative.

Therefore, as shown in Tables 4-1 and 4-2, the equivalency system is used to assure that the total risks remain below applicable thresholds. Compliance is demonstrated by comparing quantities treated against permit limits, and not by tracking risks.

Table 4-1. Equivalency System Example – Annual Limits

Emission Category	Permitted Annual Limit (lbs)	Maximum Estimated Cancer risk	Maximum Estimated Chronic HI
A	5000	1.00E-06	1
B	2500	1.00E-06	0.6
C	1000	1.00E-06	0.4
D	3500	4.00E-07	1

Emission Category	Amount Treated per Event (lbs)						Sum	% of Annual Limit
	1	2	3	4	5	6		
A	200	100	100	200	0	200	800	16.0
B	100	100	0	200	200	0	600	24.0
C	100	0	100	0	100	50	350	35.0
D	0	200	0	200	100	0	500	14.3
								89.3

Emission Category	Percent of Permitted Annual Limit Treated per Event (%)						Sum
	1	2	3	4	5	6	
A	4.0	2.0	2.0	4.0	0.0	4.0	16.0
B	4.0	4.0	0.0	8.0	8.0	0.0	24.0
C	10.0	0.0	10.0	0.0	10.0	5.0	35.0
D	0.0	5.7	0.0	5.7	2.9	0.0	14.3
Cumulative Sum	18.0	29.7	41.7	59.4	80.3	89.3	89.3

Emission Category	Cancer Risk by Emission Category per Event						Sum
	1	2	3	4	5	6	
A	4.00E-08	2.00E-08	2.00E-08	4.00E-08	0.00E+00	4.00E-08	1.60E-07
B	4.00E-08	4.00E-08	0.00E+00	8.00E-08	8.00E-08	0.00E+00	2.40E-07
C	1.00E-07	0.00E+00	1.00E-07	0.00E+00	1.00E-07	5.00E-08	3.50E-07
D	0.00E+00	2.29E-08	0.00E+00	2.29E-08	1.14E-08	0.00E+00	5.71E-08
Cumulative Sum	1.80E-07	2.63E-07	3.83E-07	5.26E-07	7.17E-07	8.07E-07	8.07E-07

Emission Category	Chronic HI by Emission Category per Event						Sum
	1	2	3	4	5	6	
A	0.04	0.02	0.02	0.04	0.00	0.04	0.16
B	0.02	0.02	0.00	0.05	0.05	0.00	0.14
C	0.04	0.00	0.04	0.00	0.04	0.02	0.14
D	0.00	0.06	0.00	0.06	0.03	0.00	0.14
Cumulative Sum	0.10	0.21	0.27	0.41	0.53	0.59	0.59

Table 4-2. Equivalency System Example – Event Limits

Emission Category	Permitted Maximum Event Quantity (lbs)	Maximum Estimated Acute HI
A	2000	0.6
B	500	1.0
C	200	1.0
D	1200	1.0

Emission Category	Amount Treated per Event (lbs)					
	1	2	3	4	5	6
A	200	100	500	200	0	200
B	100	100	0	200	200	0
C	100	0	100	0	100	50
D	0	200	0	200	100	0

Emission Category	Acute HI by Emission Category per Event						Maximum
	1	2	3	4	5	6	
A	0.06	0.03	0.15	0.06	0.00	0.06	
B	0.20	0.20	0.00	0.40	0.40	0.00	
C	0.50	0.00	0.50	0.00	0.50	0.25	
D	0.00	0.17	0.00	0.17	0.08	0.00	
HI	<b>0.76</b>	<b>0.40</b>	<b>0.65</b>	<b>0.63</b>	<b>0.98</b>	<b>0.31</b>	<b>0.98</b>

## 4.2 DIRECT EMISSIONS

### 4.2.1 Open Burning

The HRA quantified the carcinogenic risk and chronic and acute noncancer HIs for each OB emission category based on permitted treatment quantities derived from logistical limitations, safety considerations, or the applicable regulatory thresholds (i.e., cancer risk of  $1 \times 10^{-6}$ , acute and chronic noncancer HIs of 1.0, or criteria pollutant standards). The total annual and event emissions from the 18 energetic families treated by OB are based on the permitted treatment limits and emission factors from test results listed in Table 4-3. The maximum hourly emissions were based on one OB event being completed in one hour. Pyrotechnics, energetic-contaminated waste, and munitions components are not treated by OB. As cased munitions are not treated by OB, metal emissions from casing, paints, and coatings are not included in the emission factors for the OB families. Note that metals may be present as an ingredient in energetics. These metals are included in the emission factors for both OB and OD treatment. The total annual and event emissions from diesel and wood are based on permitted treatment limits and published emission factors.

The long- and short-term emissions from diesel combustion were calculated based on two different approaches in accordance with Appendix D of the OEHHA guidelines, using 1) estimates of DPM for long-term potential health effects (i.e., cancer and chronic noncancer) and 2) estimates of individual COCs for potential short-term health effects (i.e., acute noncancer). The DPM emissions were estimated using emission factors developed from OB source testing (URS, January 2000) and the individual COCs were estimated using emission factors from the Ventura County APCD (Ventura County APCD, 2001). The diesel emission factors are presented in Table 4-4.

The emissions from wood combustion were calculated based on emission factors for residential fireplaces from the EPA's AP-42 Section 1.9 (EPA, 1996). The wood emission factors are also presented in Table 4-4. The detailed OB emissions estimates are contained in Appendix B - Chemicals of Concern, Emission Factors and Emission Rates.

Although emission factors for dioxins and furans are shown for both individual species and Toxic Equivalent (TEQ), calculations of health risk emissions are counted as TEQ rather than individual species. Emission factors for lead are shown, although lead is not included in the health risk calculation. Instead, blood lead levels are assessed using an uptake/biokinetic model.

### 4.2.2 Open Detonation

The HRA quantified the carcinogenic risk and chronic and acute noncancer HIs for each OD emission category (including metals and crater emissions) based on permitted treatment quantities derived from logistical limitations, safety considerations, or the applicable regulatory thresholds. The total annual and event emissions from the 19 energetic, W, and M families, are based on the permitted treatment limits and emission factors from test results listed in Table 4-3. The maximum hourly emissions are based on two complete OD events occurring within one hour. The OD metal emissions account for casing metals and metals in paints and coatings. Emissions from these metals are included in the emission factors for each OD family.

Crater emissions were added to each OD family, including the W and M families. Crater emissions were estimated based on historical PM<sub>10</sub> emissions reported to GBUAPCD from these activities. The PM<sub>10</sub> was speciated based on China Lake soil data (China Lake, 2003). The China Lake soil data used in the crater emissions estimates are presented in Table 4-5. The detailed OD emissions estimates are contained in Appendix B - Chemicals of Concern, Emission Factors and Emission Rates.

### 4.3 INDIRECT EMISSIONS

#### 4.3.1 Open Burn Ash Handling

The HRA quantified the carcinogenic risk and chronic and acute noncancer HIs for ash handling based on the number of events per hour and per year. The OB ash handling annual and hourly emissions were based on the very conservative assumption that the maximum amount of ash from the OB treatment of 1000 lbs would be 100 lbs per event and 365 events per year, analytical results from ash samples (China Lake Environmental Project Office, 1992; Lusk, 1995), and PM emission factors for the mechanical handling of ash from the EPA's AP-42 Section 13.2.4 (EPA, 1995a). The maximum hourly emissions were based on one complete ash handling event occurring within one hour. Ash handling emissions were added to each OB family. The analytical results from ash samples used in the ash handling emissions estimates are presented in Table 4-6. The detailed OB ash handling emissions estimates are contained in Appendix B - Chemicals of Concern, Emission Factors and Emission Rates.

#### 4.3.2 Grading Following Open Detonation Events

The HRA quantified the carcinogenic risk and chronic and acute noncancer HIs for grading following OD events based on the number of events per hour and per year. The annual average grading emissions were based on the number of annual grading events, erodible area, China Lake soil data (China Lake, 2003), and emission factors and methodology from EPA's AP-42, Section 11.9 (EPA, 1998), for heavy construction operations. The China Lake soil data are presented in Table 4-5. The area graded (or erodible area) is approximately 22,300 square meters. The maximum hourly emissions were based on one complete grading event occurring within one hour. The detailed grading emissions estimates are contained in Appendix B – Chemicals of Concern, Emission Factors and Emission Rates.

#### 4.3.3 Windblown Dust

The windblown dust annual average and maximum hourly emissions were estimated based on the entire surface area for the OB/OD unit, China Lake soil data (China Lake, October 2003) presented in Table 4-5, and the methodology described in *Windblown Dust from Unpaved Roads (Section 7.13 - Updated August 1997)*, *Almanac Emission Projection Data by EIC* (CARB, 2005). The surface area used for the OB/OD unit was 160,000 square meters (approximately 39 acres). This area includes the sides of the canyon (vegetated area) as well as the disturbed area (unvegetated area). The detailed windblown dust emissions estimates are contained in Appendix B - Chemicals of Concern, Emission Factors and Emission Rates.

Table 4-3. Emission Factors for OB and OD Energetic, Energetic-contaminated Waste and Munition Component Emission Categories

Chemical of Concern	Family:	IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA <sup>1</sup>	IIB <sup>1</sup>	IIC <sup>1</sup>	IID <sup>1</sup>	IIE <sup>1</sup>	IIF <sup>1</sup>	A1 <sup>1</sup>	A2 <sup>1</sup>	B1 <sup>1</sup>	B2 <sup>1</sup>	B3 <sup>1</sup>	C1	P <sup>2</sup>	W <sup>2</sup>	M <sup>2</sup>	
	CAS Number	(g/g EW) <sup>3</sup>	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW+W) <sup>4</sup>	(g/g EW+W)						
Acenaphthene	83329	5.00E-07		5.00E-07	5.00E-07		5.00E-07		5.00E-07	5.00E-07	5.00E-07	5.00E-07											
Acenaphthylene	208968	5.00E-07		5.00E-07	5.00E-07		5.00E-07		5.00E-07	5.00E-07	5.00E-07	5.00E-07											
Acetaldehyde	75070															1.34E-06	1.34E-06						
Acetone	67641												1.40E-05			3.71E-06	3.71E-06	1.40E-05				8.68E-03	8.68E-03
Acetonitrile	75058																						
Acetophenone	98862																					1.80E-06	1.80E-06
Acetylaminofluorene, 2-	53963																						
Acrolein	107028												2.10E-06			5.51E-06	5.51E-06	2.10E-06				7.15E-06	7.15E-06
Acrylonitrile	107131															9.06E-06	9.06E-06						
Allyl chloride	107051																			1.80E-05			
Aluminum	7429905									1.10E-02	1.10E-02		2.70E-02		1.70E-02		2.70E-02	2.70E-02	1.90E-01	1.90E-02	1.90E-01	1.90E-01	1.90E-01
Aminobiphenyl, 4-	92671																						
Ammonia	7664417	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04	6.87E-04			
Aniline	62533																						
Anthracene	120127																						
Antimony and Chemicals	7440360																						
Arsenic	7440382																						
Azobenzene	103333																						
Barium	7440393							5.50E-05												2.40E-04	2.40E-04		
Benzaldehyde	100527												6.00E-05					6.00E-05	1.10E-04				
Benzene	71432	1.00E-05	6.70E-05		1.00E-05	6.70E-05		1.20E-04	3.20E-06	5.70E-05	5.70E-05		1.40E-05	9.70E-05	7.20E-06	8.10E-04	8.10E-04	1.40E-05	1.10E-04	4.50E-05	1.17E-05	1.17E-05	
Benidine	92875	3.00E-08			3.00E-08			3.10E-07	3.00E-08														
Benzo(A)Anthracene	56553							1.40E-07	1.40E-07														
Benzo(A)pyrene	50328							8.10E-08															
Benzo(b)fluoranthene	205992																						
Benzo(k)fluoranthene	207089																						
Benzo[g,h,i]perylene	191242																						
Benzoofuran, 2,3-	271896																			1.10E-07			
Benzoic acid	65850																			1.10E-04			
Benzyl alcohol	100516												9.30E-06					9.30E-06	1.10E-04				
Benzyl chloride	100447																						
Beryllium	7440417																			1.10E-04			
Biphenyl, 1,1-	92524																					3.10E-06	
Bis(2-chloroethyl)ether	111444																					3.10E-06	
Bis(2-chloroisopropyl)ether	39638329																					4.00E-04	
Bis(2-ethylhexyl)phthalate (DEHP)	117817		3.00E-04			3.00E-04																	
Bromodichloromethane	75274									7.10E-07	7.10E-07		6.80E-06					6.80E-06					
Bromoform (tribromomethane)	75252									4.20E-07	4.20E-07		6.80E-06					6.80E-06					
Bromomethane	74839									7.10E-07	7.10E-07											1.70E-06	
Butadiene-1,3	106990		6.70E-06			6.70E-06		5.10E-06					2.80E-06	1.70E-06	1.50E-06	2.10E-05	2.10E-05	2.80E-06	1.10E-04	1.20E-05			
Butanol, 1-	71363																			7.70E-03			
Butyl benzyl phthalate	85687		3.00E-04			3.00E-04																4.00E-04	
Butylacrylate	141322																						
Butylbenzene, n-	104518	2.60E-07	1.90E-06		2.60E-07	1.90E-06		4.60E-06						2.00E-06	2.30E-06				1.10E-04	2.40E-06			
Butylbenzene, T-	98066	2.60E-07	1.90E-06		2.60E-07	1.90E-06		4.60E-06						2.00E-06	2.30E-06				1.10E-04	2.40E-06			
Cadmium	7440439																					1.10E-03	
Carbazole	86748	3.00E-08			3.00E-08			3.10E-07	3.00E-08														
Carbon Monoxide	630080	1.40E-02	1.40E-02	1.30E-04	1.40E-02	1.40E-02	1.30E-04	1.10E-01	2.70E-03	4.20E-03	4.20E-03	1.40E-04	7.10E-03	5.50E-02	5.20E-03	3.10E-02	3.10E-02	7.10E-03	5.30E-02	2.20E-02			
Carbon tetrachloride	56235									1.10E-06	1.10E-06												
Chlorine	7782505									4.60E-03	4.60E-03	9.20E-03	4.60E-03					4.60E-03		1.59E-04	1.59E-04	1.59E-04	1.59E-04
Chloroacetophenone, 2-	532274																						
Chloroaniline, 4-	106478																						

Table 4-3. Emission Factors for OB and OD Energetic, Energetic-contaminated Waste and Munition Component Emission Categories (Continued)

Chemical of Concern	Family:	IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA <sup>1</sup>	IIB <sup>1</sup>	IIC <sup>1</sup>	IID <sup>1</sup>	IIE <sup>1</sup>	IIF <sup>1</sup>	A1 <sup>1</sup>	A2 <sup>1</sup>	B1 <sup>1</sup>	B2 <sup>1</sup>	B3 <sup>1</sup>	C1	P <sup>2</sup>	W <sup>2</sup>	M <sup>2</sup>	
	CAS Number	(g/g EW) <sup>3</sup>	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW+W) <sup>4</sup>	(g/g EW+W)						
Chlorobenzene	108907																						
Chloroethane (Ethyl chloride)	75003																				3.10E-06		
Chloroform	67663									4.20E-07	4.20E-07		6.80E-06					6.80E-06					
Chloromethane (Methyl chloride)	74873									7.10E-07	7.10E-07										1.70E-06		
Chloronaphthalene	91587																						
Chlorophenol, 2-	95578																						
Chlorotoluene, o-	95498																						
Chromium (hex.)	18540299																				2.67E-05		
Chromium III	16065831																				1.33E-04		
Chrysene	218019																						
Cobalt	7440484																						
Copper	7440508									5.50E-05	5.50E-05		5.40E-07										
Cumene (Isopropylbenzene)	98828		5.20E-07			5.20E-07									7.30E-07	3.00E-07	3.00E-07		5.40E-07	9.48E-04	1.20E-03	9.48E-04	9.48E-04
Cyclohexane	110827							6.90E-07						1.60E-06		7.50E-06	7.50E-06			1.10E-04	5.60E-07		
Dibenz[a,h]anthracene	53703							1.40E-07	1.40E-07														
Dibenzofuran	132649							1.20E-07						1.90E-07		2.00E-06	2.00E-06			1.10E-07			
Dibromochloromethane	124481									4.20E-07	4.20E-07		6.20E-03										
Dichlorobenzene, 1,2-	95501																						
Dichlorobenzene, 1,3-	541731																						
Dichlorobenzene, 1,4-	106467																						
Dichlorobenzidine, 3,3'-	91941																						
Dichlorodifluoromethane	75718									1.10E-06	1.10E-06		6.20E-03					6.20E-03					
Dichloroethane, 1,1-	75343																						
Dichloroethane, 1,2-	107062																						
Dichloroethylene (cis), 1,2-	156592																						
Dichloroethylene (trans), 1,2-	156605																						
Dichloroethylene, 1,1- (Dichloroethene, 1,1-)	75354																						
Dichlorophenol, 2,4-	120832																						
Dichloropropane, 1,2-	78875																						
Dichloropropene, 1,3-	542756																						
Diethyl ether (Ethyl ether)	60297																			1.10E-07			
Diethyl phthalate	84662		3.00E-04			3.00E-04										1.50E-03	1.50E-03				4.00E-04		
Dimethyl Phthalate	131113																						
Dimethylbenz(a)anthracene, 7,12-	57976							1.40E-07	1.40E-07														
Dimethylbenzidine, 3,3'-	119937	3.00E-08			3.00E-08			3.10E-07	3.00E-08												1.10E-04		
Dimethylphenol, 2,4-	105679																				1.10E-04		
Dinitrobenzene, 1,3-	99650																						
Dinitrophenol, 2,4-	51285																						
Dinitropyrene, 1,6-	42397648																						
Dinitrotoluene, 2,4-	121142	3.00E-08			3.00E-08			1.60E-07						4.50E-07		2.10E-07	2.10E-07			5.90E-07			
Dinitrotoluene, 2,6-	606202	3.00E-08			3.00E-08			1.40E-07						2.40E-08		4.10E-08	4.10E-08			8.00E-08			
Di-n-octyl phthalate	117840		3.00E-04			3.00E-04																4.00E-04	
Dioxane, 1,4-	123911																				1.10E-07		
Diphenylamine	122394	3.00E-08			3.00E-08			3.10E-07	3.00E-08														
Ethylbenzene	100414	2.60E-07	1.90E-06		2.60E-07	1.90E-06		4.60E-06						2.00E-06	2.30E-06	3.80E-05	3.80E-05			1.10E-04	2.40E-06	2.05E-05	2.05E-05
Ethylene	74851	7.80E-06	3.30E-04		7.80E-06	3.30E-04		2.90E-04	6.50E-06				4.80E-05	3.10E-05	3.20E-05	3.90E-04	3.90E-04	4.80E-05	7.70E-03	2.70E-04			
Fluoranthene	206440																						
Fluorene	86737																						
Fluorotrichloromethane (Trichlorofluoromethane)	75694									1.10E-06	1.10E-06												
Formaldehyde	50000																						
Furan (Epoxy-1,3-butadiene, 4-)	110009																			1.10E-07			
Heptachlorodibenzofuran, 1,2,3,4,6,7,8-	67562394															4.10E-12	4.10E-12					5.63E-11	5.63E-11
Heptachlorodibenzofuran, 1,2,3,4,7,8,9-	55673897																					2.31E-11	2.31E-11
Heptachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8-	35822469															2.34E-12	2.34E-12					9.62E-12	9.62E-12

Table 4-3. Emission Factors for OB and OD Energetic, Energetic-contaminated Waste and Munition Component Emission Categories (Continued)

Chemical of Concern	Family:	IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA <sup>1</sup>	IIB <sup>1</sup>	IIC <sup>1</sup>	IID <sup>1</sup>	IIE <sup>1</sup>	IIF <sup>1</sup>	A1 <sup>1</sup>	A2 <sup>1</sup>	B1 <sup>1</sup>	B2 <sup>1</sup>	B3 <sup>1</sup>	C1	P <sup>2</sup>	W <sup>2</sup>	M <sup>2</sup>	
	CAS Number	(g/g EW) <sup>3</sup>	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW+W) <sup>4</sup>	(g/g EW+W)						
Hexachlorobenzene	118741																						
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	87683																						
Hexachlorodibenzofuran, 1,2,3,4,7,8-	70648269															1.09E-12	1.09E-12				2.98E-11	2.98E-11	
Hexachlorodibenzofuran, 1,2,3,6,7,8-	57117449																				2.43E-11	2.43E-11	
Hexachlorodibenzofuran, 1,2,3,7,8,9-	72918219																				1.30E-11	1.30E-11	
Hexachlorodibenzofuran, 2,3,4,6,7,8-	60851345															9.26E-13	9.26E-13				3.62E-11	3.62E-11	
Hexachlorodibenzo-p-Dioxin, 1,2,3,4,7,8-	39227286																				1.89E-12	1.89E-12	
Hexachlorodibenzo-p-Dioxin, 1,2,3,6,7,8-	57653857																				3.13E-12	3.13E-12	
Hexachlorodibenzo-p-Dioxin, 1,2,3,7,8,9-	19408743																				2.43E-12	2.43E-12	
Hexachloroethane	67721																			2.40E-06			
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	8.40E-04	8.40E-04	8.40E-04	8.40E-04	8.40E-04	8.40E-04	1.20E-05	3.00E-08	3.00E-08	3.00E-08	3.00E-08	7.40E-03	9.60E-06	5.00E-08	7.40E-03	7.40E-03	7.40E-03		1.90E-04	7.40E-03	7.40E-03	
Hexane, n-	110543	1.90E-05	1.50E-06		1.90E-05	1.50E-06		3.50E-06						9.30E-07	5.50E-07	1.90E-05	1.90E-05		7.70E-03	1.70E-06			
Hydrogen chloride	7647010									2.10E-01	2.10E-01	2.20E-01	3.80E-03						3.80E-03	1.70E-06	1.44E-04	1.44E-04	
Hydrogen Cyanide	74908											6.86E-04	6.86E-04	6.86E-04	6.86E-04	6.86E-04	6.86E-04	6.86E-04	6.86E-04		4.91E-04	4.91E-04	
Indeno[1,2,3-cd]pyrene	193395																						
Iron	7439896																		9.48E-04		9.48E-04	9.48E-04	
Isophorone	78591		5.20E-07			5.20E-07		2.80E-06						5.10E-06	1.00E-05				1.10E-04	4.10E-07			
Isoprene	9003310		6.70E-06			6.70E-06		5.10E-06					2.80E-06	1.70E-06	1.50E-06			2.80E-06	7.70E-03	1.20E-05			
Lead	7439921							1.30E-02											1.30E-02	1.30E-03			
Methylcholanthrene, 3-	56495																						
Methylcyclohexane	108872		5.20E-07			5.20E-07		2.80E-06						5.10E-06	1.00E-05	5.30E-06	5.30E-06		7.70E-03	4.10E-07			
Methylene chloride	75092									6.00E-07	6.00E-07		6.20E-03					6.20E-03		4.10E-04			
Methylethyl ketone	78933																		7.70E-03				
Methylnaphthalene, 2-	91576	5.00E-07		5.00E-07	5.00E-07		5.00E-07		5.00E-07	5.00E-07	5.00E-07	5.00E-07	1.70E-05					1.70E-05					
Methylphenol, 2-	95487																			1.10E-04			
Methylphenol, 3-	108394																			1.10E-04			
Methylphenol, 4-	106445																			1.10E-04			
Methyltertbutyl ether (MTBE)	1634044																			1.10E-07			
Molybdenum	7439987																						
Naphthalene	91203	5.00E-07		5.00E-07	5.00E-07		5.00E-07	5.40E-07	5.00E-07	5.00E-07	5.00E-07	5.00E-07	6.30E-05	1.80E-06		1.40E-06	1.40E-06	6.30E-05	6.30E-07				
Nickel and chemicals	7440020																						
Nitric Oxide	10102439	2.40E-03	1.50E-02	5.20E-03	2.40E-03	1.50E-02	5.20E-03	2.40E-02	6.30E-03	2.10E-03	2.10E-03	4.00E-03	4.00E-03	1.80E-02	9.90E-03	1.20E-02	1.20E-02	4.00E-03	9.00E-04	1.30E-02	7.41E-03	7.41E-03	
Nitroacenaphthene, 5-	602879																						
Nitroaniline, 2-	88744												6.30E-06					6.30E-06					
Nitrobenzene	98953																						
Nitrochrysene, 6-	7496028																						
Nitrogen Dioxide	10102440	5.20E-04	1.70E-03	2.10E-03	5.20E-04	1.70E-03	2.10E-03	2.80E-03	4.70E-04	1.00E-03	1.00E-03	2.40E-03	2.40E-03	2.50E-03	4.50E-05	1.70E-02	1.70E-02	2.40E-03	1.10E-03	2.80E-03	8.81E-03	8.81E-03	
Nitroglycerin	55630	3.00E-08	5.00E-08	3.00E-08	3.00E-08	5.00E-08	3.00E-08	5.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	5.00E-08	5.00E-08	3.00E-08	3.00E-08	5.00E-08	3.00E-08	3.00E-08	
Nitroguanidine	556887	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	3.00E-08	
Nitrophenol, 4-	100027																						
Nitropropane, 2-	79469												1.10E-05					1.10E-05					
Nitropyrene, 1-	5522430																						
Nitrosodiethylamine, N-	55185																						
Nitrosodimethylamine, N-	62759																						
Nitrosodi-n-butylamine, N-	924163																						
Nitrosodi-n-propylamine, N-	621647																						
Nitrosodiphenylamine, N-	86306																						
Nitroso-N-methylethylamine, N-	10595956																						
Nitrosopiperidine, N-	100754																						
Nitrosopyrrolidine, N-	930552																						
Nitrotoluene, o-	88722																						
Nitrotoluene, p-	99990																						
Octachlorodibenzofuran, 1,2,3,4,6,7,8,9-	3901020															3.23E-12	3.23E-12				4.85E-11	4.85E-11	

Table 4-3. Emission Factors for OB and OD Energetic, Energetic-contaminated Waste and Munition Component Emission Categories (Continued)

Chemical of Concern	Family:	IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA <sup>1</sup>	IIB <sup>1</sup>	IIC <sup>1</sup>	IID <sup>1</sup>	IIE <sup>1</sup>	IIF <sup>1</sup>	A1 <sup>1</sup>	A2 <sup>1</sup>	B1 <sup>1</sup>	B2 <sup>1</sup>	B3 <sup>1</sup>	C1	P <sup>2</sup>	W <sup>2</sup>	M <sup>2</sup>	
	CAS Number	(g/g EW) <sup>3</sup>	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW+W) <sup>4</sup>	(g/g EW+W)						
Octachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8,9-	3268879															6.64E-12	6.64E-12			1.80E-09	1.17E-11	1.17E-11	
Pentachlorobenzene	608935																						
Pentachlorodibenzofuran, 1,2,3,7,8-	57117416																					1.95E-11	1.95E-11
Pentachlorodibenzofuran, 2,3,4,7,8-	57117314																					4.94E-11	4.94E-11
Pentachlorodibenzo-p-Dioxin, 1,2,3,7,8-	40321764																					2.59E-12	2.59E-12
Pentachloronitrobenzene	82688																						
Pentachlorophenol	87865																						
Phenanthrene	85018																						
Phenol	108952																						
Propanol, 2-	67630																			7.70E-03			
Propylbenzene, n-	103651	2.60E-07	1.90E-06		2.60E-07	1.90E-06		4.60E-06						2.00E-06	2.30E-06					1.10E-04	2.40E-06		
Propylene (Propene)	115071	2.00E-06	6.00E-05		2.00E-06	6.00E-05		5.10E-05	1.10E-06	1.70E-06	1.70E-06		1.60E-05	7.20E-06	9.40E-06	7.30E-05	7.30E-05	1.60E-05	7.70E-03	5.60E-05			
Pyrene	129000																				7.70E-03		
Pyridine	110861																				1.10E-04		
Styrene	100425		9.40E-06			9.40E-06		3.60E-06					1.80E-06	1.50E-06		1.70E-03	1.70E-03	1.80E-06	1.10E-04	7.10E-06			
Sulfur Dioxide	7446095													2.60E-04						2.60E-04	1.00E-03	1.00E-03	1.00E-03
Tetrachlorobenzene, 1,2,4,5-	95943																						
Tetrachlorodibenzofuran, 2,3,7,8-	51207319																					1.34E-11	1.34E-11
Tetrachlorodibenzo-p-Dioxin, 2,3,7,8-	1746016																					9.40E-13	9.40E-13
Tetrachloroethane, 1,1,2,2-	79345																				2.40E-06		
Tetrachloroethylene (PCE)	127184																				2.40E-06		
Tetrachlorophenol, 2,3,4,6-	58902																				2.40E-06		
Tetranitro-N-methylaniline, N,2,4,6- (Tetryl, Trinitrophenylmethyl nitramine)	479458															5.00E-08	5.00E-08						
Thallium and chemicals	7446186																						
Toluene	108883	1.80E-06	1.70E-05		1.80E-06	1.70E-05		3.00E-05	3.40E-06					6.70E-06	3.30E-06	2.50E-04	2.50E-04			1.10E-04	3.00E-05	1.39E-05	1.39E-05
Toluidine, o- (Methylaniline, 2-)	95534	1.80E-06	1.70E-05		1.80E-06	1.70E-05		3.00E-05	3.40E-06														
Total HpCDD	35822469															5.34E-12	5.34E-12					1.86E-11	1.86E-11
Total HpCDF	67562394															6.13E-12	6.13E-12					1.32E-10	1.32E-10
Total HxCDD	19408743																					4.22E-11	4.22E-11
Total HxCDF	57117449															5.08E-12	5.08E-12					2.94E-10	2.94E-10
Total PeCDD	40321764																					5.37E-11	5.37E-11
Total PeCDF	57117314															2.98E-12	2.98E-12					4.63E-10	4.63E-10
Total TCDD	1746016																					5.52E-11	5.52E-11
Total TCDF	51207319															3.52E-12	3.52E-12					6.08E-10	6.08E-10
Trichlorobenzene, 1,2,4-	120821																						
Trichloroethane, 1,1,1- (Methyl chloroform)	71556												1.70E-05						1.70E-05			2.56E-05	2.56E-05
Trichloroethane, 1,1,2-	79005												1.70E-05						1.70E-05				
Trichloroethylene (TCE)	79016																						
Trichlorophenol, 2,4,5-	95954																						
Trichlorophenol, 2,4,6-	88062																						
Trimethylbenzene, 1,2,4-	95636																				1.10E-04		
Trimethylbenzene, 1,3,5-	108678																				1.10E-04		
Trimethylpentane, 2,2,4-	540841		7.70E-07			7.70E-07		9.50E-06						2.90E-06	7.30E-07						7.70E-03	1.20E-06	
Trinitrobenzene, 1,3,5-	99354	3.00E-08			3.00E-08									5.90E-08		4.40E-08	4.40E-08				1.80E-08		
Trinitrotoluene, 2,4,6- (TNT)	118967	3.00E-08			3.00E-08									2.50E-07	5.00E-08								
Vanadium & Chemicals	7440622																					8.07E-09	8.07E-09
Vinyl acetate	108054																			7.70E-03			
Vinyl Chloride	75014									1.50E-06	1.50E-06										2.30E-06		
Xylene, m-	108383																				1.10E-04		
Xylene, o-	95476																				1.10E-04		
Xylene, p-	106423																				1.10E-04		
Xylenes	1330207															8.37E-07	8.37E-07				1.10E-04	2.00E-05	2.00E-05
Zinc	7440666																				5.04E-04	7.50E-05	5.04E-04

Table 4-3. Emission Factors for OB and OD Energetic, Energetic-contaminated Waste and Munition Component Emission Categories (Continued)

Chemical of Concern	Family:	IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA <sup>1</sup>	IIB <sup>1</sup>	IIC <sup>1</sup>	IID <sup>1</sup>	IIE <sup>1</sup>	IIF <sup>1</sup>	A1 <sup>1</sup>	A2 <sup>1</sup>	B1 <sup>1</sup>	B2 <sup>1</sup>	B3 <sup>1</sup>	C1	P <sup>2</sup>	W <sup>2</sup>	M <sup>2</sup>
	CAS Number	(g/g EW) <sup>3</sup>	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW)	(g/g EW+W) <sup>4</sup>	(g/g EW+W)					
<b>Surrogates with EFs</b>																						
Aminopyridine, 4-	504245																					
Bis(2-chloro-1-methylethyl)ether	108601																			3.10E-06		
Bis(chloromethyl)ether	542881																					
Chloronitrobenzene, o-	88733																					
Chloropicrin (trichloronitromethane)	76062												1.10E-05					1.10E-05				
Diaminotoluene, 2,4-	95807																					
Diazomethane	334883																					
Dibutyl phthalate	84742		3.00E-04			3.00E-04																
Dimethylamine	124403	3.00E-08			3.00E-08			3.10E-07	3.00E-08					1.10E-05				1.10E-05	1.10E-05			
Dimethylcarbamoyl chloride	79447																			1.80E-05		
Dimethylhydrazine, 1,2-	540738																					
Dinitrobenzene, 1,2-	528290																					
Dinitrobenzene, 1,4-	100254																					
Dinitro-o-cresol, 4,6-	534521																					
Ethoxyethanol, 2-	110805																					
Ethyleneimine (Aziridine)	151564																9.06E-06	9.06E-06				
Glutaraldehyde	111308																1.34E-06	1.34E-06				
Malononitrile	109773																					
Manganese	7439965																		9.48E-04		9.48E-04	9.48E-04
Methacrylonitrile	126987																9.06E-06	9.06E-06				
Methanol	67561																					
Perchlorate	7601903									7.10E-07	7.10E-07									1.70E-06		
Phosgene	75445									7.10E-07	7.10E-07											
Phosphorus (white)	7723140																					
Selenium	7782492																					
Silica, Crystalline	1175																				9.48E-04	9.48E-04
Sulfuric acid	7664939													2.60E-04								
Urethane (Ethyl carbamate)	51796												5.40E-05					5.40E-05	5.40E-05			
<b>Metals in Casings</b>																						
Aluminum	7429905	5.24E-03	5.24E-03	5.24E-03	5.24E-03	5.24E-03	5.24E-03															
Antimony and Chemicals	7440360	3.68E-05	3.68E-05	3.68E-05	3.68E-05	3.68E-05	3.68E-05															
Barium	7440393	6.86E-07	6.86E-07	6.86E-07	6.86E-07	6.86E-07	6.86E-07															
Cadmium	7440439							5.38E-04	5.38E-04	5.38E-04	5.38E-04	5.38E-04		1.65E-05	1.65E-05	7.79E-05	1.65E-05	7.79E-05				
Chromium III	16065831							1.81E-05	1.81E-05	1.81E-05	1.81E-05	1.81E-05		1.77E-07	1.77E-07	3.48E-06	1.77E-07	5.13E-06				
Chromium VI	18540299							3.01E-06	3.01E-06	3.01E-06	3.01E-06	3.01E-06		2.95E-08	2.95E-08	5.81E-07	2.95E-08	8.55E-07				
Copper	7440508	8.01E-02	8.01E-02	8.01E-02	8.01E-02	8.01E-02	8.01E-02															
Iron	7439896	2.32E-04	2.32E-04	2.32E-04	1.47E-04	1.47E-04	1.47E-04	2.63E-05	2.63E-05	2.63E-05	2.63E-05	2.63E-05		9.96E-05	9.96E-05	5.27E-05	9.96E-05	2.57E-04				
Lead	7439921	5.98E-05	5.98E-05	5.98E-05	5.98E-05	5.98E-05	5.98E-05															
Manganese	7439965	2.61E-04	2.61E-04	2.61E-04	1.48E-06	1.48E-06	1.48E-06	1.61E-07	1.61E-07	1.61E-07	1.61E-07	1.61E-07		9.05E-07	9.05E-07	4.40E-07	9.05E-07	2.14E-06				
Molybdenum	7439987							6.70E-08	6.70E-08	6.70E-08	6.70E-08	6.70E-08						1.65E-07			8.04E-07	
Nickel	7440020																					5.36E-06
Strontium	7440246	3.28E-05	3.28E-05	3.28E-05				2.38E-05	2.38E-05	2.38E-05	2.38E-05	2.38E-05						3.57E-06				3.57E-06
Zinc	7440666	3.43E-02	3.43E-02	3.43E-02	3.43E-02	3.43E-02	3.43E-02							7.56E-04	7.56E-04		7.56E-04					

Notes:  
<sup>1</sup>The emission factors for Metals in Casings are for OD only.  
<sup>2</sup>All emission factors for the P, W, and M categories are for OD only.  
<sup>3</sup>Gram of chemical per gram of energetic.  
<sup>4</sup>Gram of chemical per gram of energetic plus weight of material.

CAS – Chemical Abstracts Service

Sources: NAWCWD, China Lake, Emissions from the Energetic Component of Energetic Wastes During Treatment by Open Detonation, NAWCWD TP 8603, June 2005.  
 NAWCWD, China Lake, Metals Emissions From the Open Detonation Treatment of Energetic Wastes, NAWCWD TP 8528, October 2004.  
 URS, China Lake Open Detonation Simulation Tests for Explosive-contaminated Waste, November 2003.

Table 4-4. Emission Factors for Diesel and Wood Combustion

Chemical of Concern	CAS Number	Diesel Emission Factor <sup>1</sup> (lb/1000gal)	Wood <sup>3</sup> Emission Factor (lb/ton)
DPM <sup>2</sup>	9901	96.5	
Acetaldehyde	75070	0.3506	
Acrolein	107028	0.3506	
Arsenic	7440382	0.0016	
Benzene	71432	0.0044	
Benzo(A)pyrene	50328	0.0445	0.016
Butadiene-1,3	106990	0.0148	
Cadmium	7440439	0.0015	
Carbon monoxide	630080	-	252.6
Chlorobenzene	108907	0.0002	
Chromium (hex.)	18540299	0.0001	
Chromium III	16065831	0.0005	
Copper	7440508	0.0041	
Ethylbenzene	100414	0.0002	
Formaldehyde	50000	0.3506	2.4
Hexane, n-	110543	0.0035	
Hydrogen chloride	7647010	0.1863	
Lead	7439921	0.0083	
Manganese	7439965	0.0031	
Mercury	7439976	0.002	
Naphthalene	91203	0.0053	
Nickel and chemicals	7440020	0.0039	
Nitrogen dioxide	10102440	-	2.6
Propylene (Propene)	115071	0.01	
Selenium	7782492	0.0022	
Sulfur dioxide	7446095	-	0.4
Toluene	108883	0.0044	
Xylenes	1330207	0.0016	
Zinc	7440666	0.0224	

<sup>1</sup> Ventura County, May 2001 (all diesel emission factors except DPM)

<sup>2</sup> DPM: Source Test Report for Open Burn Simulator, URS, January 2000 (JP-5 PM emission factor used to represent DPM emission factor)

<sup>3</sup> EPA AP-42, Section 1.9, Wood Burning in Residential Fireplaces (Wood burning emissions factors)

Table 4-5. Analytical Results for Chemicals in the Soil<sup>1</sup>

Chemical of Concern	CAS Number	Average Concentration in the Soil <sup>1,2</sup> (mg/kg)	Average Concentration in the Soil <sup>1,2</sup> (lb/lb)
Aluminum	7429905	5416	5.42E-03
Antimony	7440360	1.4	1.40E-06
Arsenic	7440382	2.3	2.26E-06
Barium	7440393	87.8	8.78E-05
Beryllium	7440417	0.20	2.03E-07
Cadmium	7440439	1.15	1.15E-06
Chromium III	16065831	11.9	1.19E-05
Chromium (hex.)	18540299	0.08	8.00E-08
Cobalt	7440484	4.47	4.47E-06
Copper	7440508	72.1	7.21E-05
Lead	7439921	31.0	3.10E-05
Mercury	7439976	0.02	2.00E-08
Molybdenum	7439987	1.15	1.15E-06
Nickel and chemicals	7440020	8.72	8.72E-06
Selenium	7782492	1.65	1.65E-06
Thallium and chemicals	7446186	11.0	1.10E-05
Vanadium and chemicals	7440622	29.7	2.97E-05
Zinc	7440666	40.0	4.00E-05
<b>Inorganics</b>			
Perchlorate	7601903	45.5	4.55E-05
<b>Dioxins/Furans</b>			
Tetrachlorodibenzo-p-Dioxin, 2,3,7,8-	1746016	0.00E+00	0.00E+00
Pentachlorodibenzo-p-Dioxin, 1,2,3,7,8-	40321764	0.00E+00	0.00E+00
Hexachlorodibenzo-p-Dioxin, 1,2,3,4,7,8-	39227286	0.00E+00	0.00E+00
Hexachlorodibenzo-p-Dioxin, 1,2,3,6,7,8-	57653857	0.00E+00	0.00E+00
Hexachlorodibenzo-p-Dioxin, 1,2,3,7,8,9-	19408743	0.00E+00	0.00E+00
Heptachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8-	35822469	3.93E-06	3.93E-12
Octachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8,9-	3268879	3.44E-05	3.44E-11
Tetrachlorodibenzofuran, 2,3,7,8-	51207319	0.00E+00	0.00E+00
Pentachlorodibenzofuran, 1,2,3,7,8-	57117416	0.00E+00	0.00E+00
Pentachlorodibenzofuran, 2,3,4,7,8-	57117314	0.00E+00	0.00E+00
Hexachlorodibenzofuran, 1,2,3,4,7,8-	70648269	1.01E-06	1.01E-12
Hexachlorodibenzofuran, 1,2,3,6,7,8-	57117449	0.00E+00	0.00E+00
Hexachlorodibenzofuran, 1,2,3,7,8,9-	72918219	0.00E+00	0.00E+00
Hexachlorodibenzofuran, 2,3,4,6,7,8-	60851345	0.00E+00	0.00E+00
Heptachlorodibenzofuran, 1,2,3,4,6,7,8-	67562394	3.06E-06	3.06E-12
Heptachlorodibenzofuran, 1,2,3,4,7,8,9-	55673897	0.00E+00	0.00E+00
Octachlorodibenzofuran, 1,2,3,4,6,7,8,9-	39001020	4.62E-06	4.62E-12
Total TCDD	1746016	0.00E+00	0.00E+00

Table 4-5. Analytical Results for Chemicals in the Soil<sup>1</sup> (Continued)

Chemical of Concern	CAS Number	Average Concentration in the Soil <sup>1,2</sup> (mg/kg)	Average Concentration in the Soil <sup>1,2</sup> (lb/lb)
Total PeCDD	40321764	0.00E+00	0.00E+00
Total HxCDD	19408743	0.00E+00	0.00E+00
Total HpCDD	35822469	5.43E-06	5.43E-12
Total TCDF	51207319	1.66E-06	1.66E-12
Total PeCDF	57117314	0.00E+00	0.00E+00
Total HxCDF	57117449	1.14E-06	1.14E-12
Total HpCDF	67562394	3.04E-06	3.04E-12
<b>Explosives</b>			
Cyclotetramethylene Tetranitramine (HMX)	2691410	0.79	7.90E-07
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	2.15	2.15E-06
Trinitrobenzene, 1,3,5-	99354	0.25	2.50E-07
Dinitrobenzene, 1,3-	99650	0.03	3.00E-08
Tetranitro-N-methylaniline, N,2,4,6-	479458	0.12	1.20E-07
Nitrobenzene	98953	0.04	4.00E-08
4-Amino-2,6-dinitrotoluene <sup>3</sup>	19406510	0.07	7.00E-08
2-Amino-4,6-dinitrotoluene <sup>3</sup>	35572782	0.13	1.30E-07
Trinitrotoluene, 2,4,6- (TNT)	118967	0.67	6.70E-07
Dinitrotoluene, 2,6-	606202	0.06	6.00E-08
Dinitrotoluene, 2,4-	121142	0.04	4.00E-08
Nitrotoluene, o-	88722	0.06	6.00E-08
Nitrotoluene, p-	99990	0.08	8.00E-08
Nitrotoluene, m-	99081	0.08	8.00E-08

<sup>1</sup> Soil concentration data used for crater, grading, and wind erosion emission calculations. Emission rates are then derived using the PM<sub>10</sub> emission factor appropriate to the emission category.

<sup>2</sup> The data represent the average concentration in samples in which the COC was detected. The analytes represent those requested by DTSC. Strontium was not on the list of requested COCs and was, therefore, not measured.

<sup>3</sup> These compounds do not have published toxicity factors, and were not included in the calculation of health risk.

mg/kg – milligrams per kilogram

lb/lb – pound per pound

Source: China Lake, “Soil Investigation Report for the Sixth Site Investigation (Soil Only) at the Burro Canyon OB/OD Facility,” October 2003.

Table 4-6. Analytical Results for Chemicals in Ash Samples

Chemical of Concern	CAS Number	Average Concentration in the Ash <sup>1</sup> (mg/kg)	Average Concentration in the Ash <sup>1</sup> (lb/lb)
Antimony	7440360	19.4	1.94E-05
Barium	7440393	59.4	5.94E-05
Chromium III	16065831	21.7	2.17E-05
Cobalt	7440484	3.0	3.00E-06
Copper	7440508	27.1	2.71E-05
Lead	7439921	180.4	1.80E-04
Nickel	7440020	3.1	3.10E-06
Vanadium	7440622	20.0	2.00E-05
Zinc	7440666	102.3	1.02E-04
Chloromethane	74873	0.01	1.00E-08
Chloroethane	75003	0.025	2.50E-08
Trichlorofluoromethane	75694	0.07	7.00E-08
Acetone	67641	0.503	5.03E-07
Carbon Disulfide	75150	0.006	6.00E-09
Methylene Chloride	75092	0.057	5.70E-08
2-Butanone (MEK)	78933	0.664	6.64E-07
Chloroform	67663	0.02	2.00E-08
1,1,1-Trichloroethane	71556	0.075	7.50E-08
Benzene	71432	0.018	1.80E-08
2-Hexanone <sup>2</sup>	591786	0.024	2.40E-08
Toluene	108883	0.079	7.90E-08
Ethybenzene	100414	0.005	5.00E-09
Meta+Para-Xylene	1330207	0.019	1.90E-08
Ortho-Xylene	1330207	0.005	5.00E-09
HMX	2691410	2.87	2.87E-06
RDX	121824	6.15	6.15E-06
1,3-DNB	99650	2.17	2.17E-06
2,4,6-TNT	118967	5.08	5.08E-06
4-Am-2,6-DNT <sup>2</sup>	19406510	0.77	7.70E-07
2,6/2,4-DNT	121142	23.4	2.34E-05

<sup>1</sup> Ash concentration data used for ash handling emission calculations. Emission rates are then derived using the PM<sub>10</sub> emission factor for ash handling.

<sup>2</sup> These compounds do not have published toxicity factors, and were not included in the calculation of health risk.

Sources:

China Lake, Laboratory Report, Diversified Analytical Services, November 1992.  
China Lake, Laboratory Metals Analysis, EPA Method 3055, November 1995.

## 4.4 AIR DISPERSION MODELING

Immediately after an OB/OD treatment event, the emissions are transported downwind depending on meteorological conditions at the time of the event and the height of the resulting plume. The downwind GLC of emissions resulting from OB/OD treatment activities is necessary to estimate the associated potential health impacts in an HRA. Air dispersion modeling is a standard procedure used to estimate downwind concentrations. Selection of the appropriate dispersion model is based on the OB/OD plume characteristics.

### 4.4.1 Model Selection

The GLCs resulting from OB/OD activities were determined from air dispersion modeling that followed the guidelines specified in the OEHHA guidelines, were consistent with the *Guideline on Air Quality Modeling* (EPA, 2005a) (Title 40 Code of Federal Regulations [40 CFR] 51 Appendix W), and incorporated portions of the *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities*, or HHRAP (EPA, 2005b).

Dispersion modeling for discrete OB/OD events and the subsequent calculation of associated risk includes:

- ◆ Selection of the appropriate model to simulate the activity being characterized;
- ◆ Determination of appropriate source characteristics to reflect the activity modeled;
- ◆ Determination of appropriate emission rates for the chemicals emitted as a result of the treatment process; and
- ◆ Calculation of ambient concentrations and deposition values at appropriate receptor locations and averaging periods.

The 2005 EPA HHRAP guidance requires an understanding of the likely impact to the surrounding environment through multiple pathways, including the prediction of GLCs, and both dry and wet deposition values. The HHRAP guidance was written explicitly for hazardous waste combustors, which typically operate as a point source with relatively steady hourly emissions and was based upon use of the EPA-approved Industrial Source Complex (ISC) model.

The OB/OD operations at China Lake are not a steady state operation, but occur at discrete periods for very short durations. (OD is nearly instantaneous and OB is typically less than 30 minutes in length.) OD and OB treatments are not standard release scenarios as envisioned by traditional HRA modeling guidance.

The EPA has recognized the unique nature of OB/OD treatment activities and has approved a model explicitly developed to simulate these activities, the Open Burn and Open Detonation Model (OBODM) (EPA, 2003). As currently configured, the OBODM (version 1.3.0020) evaluates potential air quality impacts associated with OB/OD activities using empirical emission factors obtained from measurements (e.g., Bang Box test results) or predicted byproducts of combustion models (e.g., POLU13).

The emission factors in OBODM are based on specific treatable items (e.g., TNT or 2,4,6-Trinitrotoluene) and are defined by the quantities of pollutants released per unit mass of energetic burned or detonated. For example, there are 49 pollutants associated with the treatment of TNT as determined by Bang Box or POLU13 results. Each of the 49 pollutants has a specific emission factor presented in mass of pollutant per mass of energetic. Along with the caloric heat content of the energetic treated, OBODM also provides the molecular weight, density, the pollutant half-life, and the emission factor for each pollutant in each of the “fuels” contained in the OBODM library. There are currently 40 “fuel/explosive” items in the OBODM library.

Even though the OBODM library contains 40 items and pollutant-specific emission factors for those items, the inherent OBODM library of emission factors was not used to calculate risks from China Lake OB/OD operations. Rather, the emission factors documented by China Lake in the *Energetic Emissions Report, Metal Emissions Report, and China Lake Open Detonation Simulation Tests for Explosive-contaminated Waste* (URS, 2004), and approved by DTSC (as presented in Sections 4.2 and 4.3) were used to determine the GLCs and subsequent risk associated with China Lake OB/OD activities. The emission factors were developed from measurements of emissions from more recent tests and are considered more representative of OB/OD activities at China Lake. Default OBODM inputs for burn rate and heat content were adjusted so that the input parameters chosen resulted in plume heights from treatment events that were consistent with the plume heights in the 450 to 700 meter (m) range that were typically observed during prior OB/OD activities at China Lake.

The OBODM calculates the downwind transport and dispersion of the pollutants using cloud rise and dispersion model algorithms from existing dispersion models, including the Rocket Exhaust Effluent Dispersion Model (REEDM) (Bjorklund et al., 1990a), Dugway Proving Ground’s Real-Time Volume Source Dispersion Model (RTVSM) (Bjorklund, 1990b), and the EPA’s Industrial Source Complex Short-term Model (ISCST3) (Bowers et al., 1979).

Features of OBODM include:

- ◆ Simulates transport and dispersion of the cloud generated by the OD activity. (Note: The OBODM model is not coded to simulate the low-level dust cloud generated by the initial shock wave that disturbs the surface and entrains dust at low levels immediately after the detonation. The impacts from the low-level dust cloud were addressed with another model as described later.)
- ◆ Estimates pollutant concentrations over a user-specified averaging period.
- ◆ Tracks and estimates plume expansion during the initial rise and downwind transport. These estimates are based on the plumes’ thermal expansion capabilities (heat release rate), wind speed, atmospheric stability class, and the rate of entrainment of outside air into the plume (entrainment coefficient).
- ◆ Capable of modeling actual hourly meteorological data for up to five years.
- ◆ Multiple points of pollutant release can be modeled simultaneously.
- ◆ Deposition values can be determined for particulates in simple terrain.
- ◆ Gas-phase concentrations can be calculated for simple, intermediate and complex terrain.
- ◆ Instantaneous and quasi-instantaneous releases from point/volume and/or line sources can be modeled.

OBODM was specifically developed to simulate the type of activity occurring at the BCTF. It also addresses the needs of HRA guidance. Therefore, OBODM was selected as the most appropriate model to calculate ambient concentrations for this HRA from the actual energetics treated in the OB/OD events. Specifically, OBODM was used to model the transport and dispersion of emissions from the following activities:

- ◆ Treatment of energetics, diesel, and wood through OB; and
- ◆ Treatment of energetics, energetic-contaminated waste, and munitions components through OD.

Emissions from all other activities were modeled using the latest version of ISCST3 (i.e., version 02035). Specifically, ISCST3 was used in this HRA to model the transport and dispersion of emissions from the following activities:

- ◆ Crater emissions resulting from OD;
- ◆ OB ash handling;
- ◆ OD grading; and
- ◆ Windblown dust from disturbed areas.

#### 4.4.2 Modeling Methodology

Each model (i.e., OBODM and ISCST3) was used iteratively to determine maximum ambient impacts from a number of likely OB/OD scenarios at China Lake to ensure a conservative assessment of risk, while ensuring operational flexibility. To maintain its commitment to minimizing risks to the surrounding area, China Lake determined from a mix of possible treatment scenarios and modeling evaluations, hourly and annual waste treatment limits that will result in meeting the specified risk and hazard criteria.

The modeling methodology:

1. Used OBODM to simulate treatment of the energetic families at China Lake. The OBODM input parameters were refined by varying the emission strength, fuel heat content, and burn rate or time in increments until the resulting plume heights were representative of those witnessed in the field.
2. Used ISCST3 to simulate the crater dust cloud, OB ash handling, windblown dust, and grading operations at China Lake. The ISCST3 input parameters were based on site information and assumptions about typical operations.
3. From the OBODM and ISCST3 simulations, calculated the GLC for a unit amount (1 gram per second [g/s]) of a surrogate chemical (i.e., aluminum for particulates and styrene for gases) at discrete receptors for each acute and chronic risk exposure scenario. This concentration is in terms of  $\mu\text{g}/\text{m}^3/\text{g}/\text{s}$  and is known as X/Q.
4. Identified the receptor locations of the maximum X/Q based on the unit amount of the surrogate chemicals for each acute and chronic risk exposure scenario. These locations are the annual and hourly MEIs. The air dispersion model results are contained in Appendix D - Modeled Downwind Concentrations.
5. Used the maximum X/Q to calculate the chemical-specific concentrations for the MEIs for each acute and chronic risk exposure scenario based on the impact from a unit amount of the surrogate chemical

multiplied by the emission rates for each emission category. The chemical-specific concentrations for the MEIs are contained in Appendix H - Concentration and Exposure Calculations.

### 4.4.3 Model Input

#### 4.4.3.1 Meteorological Data

The air dispersion models allow meteorological input for either a single hour or sequential hourly meteorological data. Hourly surface meteorological data were available from the Greenpoint Monitoring Station at China Lake. This station is located one mile south of the OB/OD units and at an elevation about 700 feet higher than that of the OB/OD units. Four complete years of Greenpoint surface sequential hourly meteorological data (i.e., 1999-2002) were available. OBODM and ISCST3 do not require that specific time periods of meteorological data be identified and so these four full years of data were used in these models in this HRA.

China Lake conducts quality assurance/quality control (QA/QC) procedures through quarterly site performance audits for the Greenpoint surface data. The audits are conducted in accordance with 1) *Quality Assurance Handbook for Air Pollution Measurement Systems* (EPA, 1995b), 2) *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA, 2000), and 3) *Ambient Monitoring Guidelines for Prevention of Significant Deterioration* (EPA, 1987).

In addition to surface data, atmospheric mixing heights obtained from upper air data are necessary for the dispersion models to determine the transport characteristics of the plume. Typically, a representative upper air data set requires two measurements per day throughout the course of the year. China Lake records upper air data. However, upon review of the data, it was revealed that there was a substantial amount of missing data because the data were collected on an as-needed basis instead of the routine data collection many other upper air stations perform around the country. A review of upper air stations in the region revealed that Oakland (CA), Vandenberg (CA), San Diego (CA), and Desert Rock (near Las Vegas, NV) routinely collect data that could be obtained relatively easily. It was determined that Desert Rock data would be most representative of upper air data near China Lake because of its inland desert climate. Thus, the meteorological data for the HRA used upper air data from Desert Rock for years 1999-2002 to correspond with the same period of Greenpoint surface data to determine mixing heights.

The National Centers for Environmental Prediction (NCEP) conducts the QA/QC procedures for upper air data. For checking data quality, NCEP utilizes computerized comparisons of the actual upper-air data received from an upper-air station with that generated from a 6-hour numerical weather prediction model. These automated data quality control programs are then combined with knowledge of how the real atmosphere operates. NCEP meteorologists examine the validity of the upper-air data and check the continuity of model comparisons from cycle to cycle. This provides the human element necessary to balance the computer's prognosis. If the temperature, geopotential height, and/or wind data compare poorly, the upper-air data are either deleted or corrected. Typically, most data deletions are for temperature and height data above 10 kilometers (km). Often NCEP meteorologists find bad data not flagged by the computer or determine that data flagged as bad by the computer are actually good and should be kept. It should be noted that, at the present time, relative humidity data are not as closely

checked for accuracy as are the other radiosonde data because data analysis tools have yet to be developed.

The surface and upper air data were preprocessed using standard EPA procedures for use with the OBODM and ISCST3 models.

#### **4.4.3.2 Model Options and Source Parameters**

There is considerable variability in source characteristics based on the nature of the source (i.e., OB, OD, crater, grading, wood burning, diesel, windblown dust, and ash handling) and amount of each emission category treated. The source characteristics for each model (i.e., OBODM and ISCST3) were developed based on the range of waste types (i.e., emission categories) and amounts that are typical and maximum.

The OBODM plume height and dispersion calculation requires the following inputs:

- ◆ Amount of waste to be treated;
- ◆ Heat content of the waste;
- ◆ Burn duration or burn rate; and
- ◆ Location and physical dimensions of the emission source.

For an OD event, the burn rate is nearly instantaneous, so the higher the heat content of the energetic waste and the more of it, the larger the cloud and the higher the plume height. For an OB event, the burn rate is typically longer and, therefore, the final plume height is usually not as high as that associated with an OD event. Characteristics evaluated to determine final (conservative) parameters included variation in emission strength, fuel heat content, and burn rate or time, so that simulated plume heights were similar to those witnessed. The release parameters for diesel and wood were assumed to be subsumed into the OB operation and, therefore, are the same in OBODM. The final OBODM source parameters used in the HRA are presented in Table 4-7.

**Table 4-7. OBODM Source Release Parameters for OD and OB Events**

Parameter	OD	OB
Release Height – meter (m)	24.2	1.0
Emission Strength (lb)	15000	1000
Initial Dimensions – Side (m)	--	2.0
Initial Dimensions – Vertical (m)	--	1.0
Initial Diameter (m)	48.33	--
Fuel Heat Content (calories per gram)	925	500
Fuel Burn Rate (g/s)	2721555	283.7
Fuel Burn Time (seconds)	2.5	1600
Surrogate Pollutant/Species Name	Aluminum	Styrene
Surrogate Pollutant/Species Type	Particulate	Gaseous
Molecular Weight (grams per gram mole)	27	104.2
Ratio of mass of pollutant/species per mass of fuel or explosive (grams per gram)	0.0013	0.0023

A volume source in ISCST3 was used to simulate the crater dust cloud from an OD event, ash handling from an OB event, grading, and windblown dust. For the OD crater the volume source dimensions are based on the initial cloud resulting from the disturbance. Acute hazard was calculated based on maximum events and subsequent downwind transport and impact, whereas chronic risk and hazard associated with these types of activities were based on average parameters. The ISCST3 source parameters used in the HRA are presented in Table 4-8.

**Table 4-8. ISCST3 Source Release Parameters for OD and Fugitive Source Events**

Emission Category	Modeled Emission Rate (g/s)	Release Height <sup>1</sup> (m)	Lateral Dimension (m)	Vertical Dimension <sup>2</sup> (m)	Simulation Notes
OD Crater	1226	12.1	46.5	11.26	Emission rate file based on daily activity at 1300 local
OB Ash Handling	1.0	1.0	2.0	1.5	Hour of day factor based on daily activity from 1100-1600 local
Grading	138.6	2.0	35	2.0	Emission rate file with 3-hour activity period per day and once per week
Windblown Dust	0-1990.5	2.0	100	2.0	Emission rate file based on AP-42 windblown dust equation and hourly meteorological data

<sup>1</sup>The release height is defined for these (volume) sources as the vertical height from ground level of the center point of the volume of release.

<sup>2</sup>The vertical dimension is defined for these (volume) sources as a statistical representation of the plume based on the expected or observed initial vertical dispersion of the plume.

The emission rates shown in Table 4-8 were modeled in accordance with the activity level as shown in the last column in Table 4-8. For example, the OD activity modeling used a 1226 g/s emission rate for the hour at 1300 local time to correspond with an OD event during that hour. The remaining hours in the day

had a zero g/s emission rate. Ash handling was simulated as if occurring daily during the hours of 1100-1600 local time with an emission rate of 1 g/s. Grading was simulated as if occurring over a 3-hour period (varying between 1000 and 1600) once per week. Finally, windblown dust was simulated using the EPA AP-42 Chapter 13 equations and calculating an emission rate for each hour of meteorological data where wind speeds exceeded threshold values based on surface roughness. Therefore, when the wind speeds are less than the threshold velocity, there are no emissions and when wind speeds exceed the threshold velocity, the emissions vary by the hourly wind speed with g/s emission rates up to about 1990 g/s.

#### **4.4.3.3 Modeling Grid**

The air dispersion modeling determined GLCs at different locations as if they were downwind of the OB/OD units. Receptors were placed along the China Lake boundary. Specific off-site residential receptors are not included in the sensitive receptor evaluation, since no residences are closer than the boundary and it is assumed that the impact decreases with distance. In addition, the nearest off- and on-site occupational receptors and sensitive receptors (i.e., schools, nursing homes, day care, and hospitals) to the OB/OD unit were included in the analysis. The nearest Base housing is adjacent to Richmond School listed below and the values found at the Richmond receptor are assumed to represent the Base housing exposure. The following sensitive receptors were included in the HRA:

#### **On China Lake property:**

- ◆ NAWS Child Development Center  
Lauritzen and Nimitz  
China Lake, CA 93555
- ◆ Richmond School  
1206 Kearsarge  
Ridgecrest, CA 93555
- ◆ Murray School  
921 E. Inyokern Rd.  
Ridgecrest, CA 93555

#### **Off China Lake property:**

- ◆ Ridgecrest Hospital  
1081 N. China Lake Blvd.  
Ridgecrest, CA 93555
- ◆ Beverly Manor Health Center  
1131 N. China Lake Blvd.  
Ridgecrest, CA 93555
- ◆ Trona Elementary and High School  
83600 Trona Road  
Trona, CA 93562
- ◆ Trona Community Senior Center  
13187 Market St.  
Trona, CA 93562

Coso Geothermal is the nearest occupational receptor representing non-China Lake employees. The receptor locations used in the HRA are presented in Table 4-9 and on Figure 4-1.

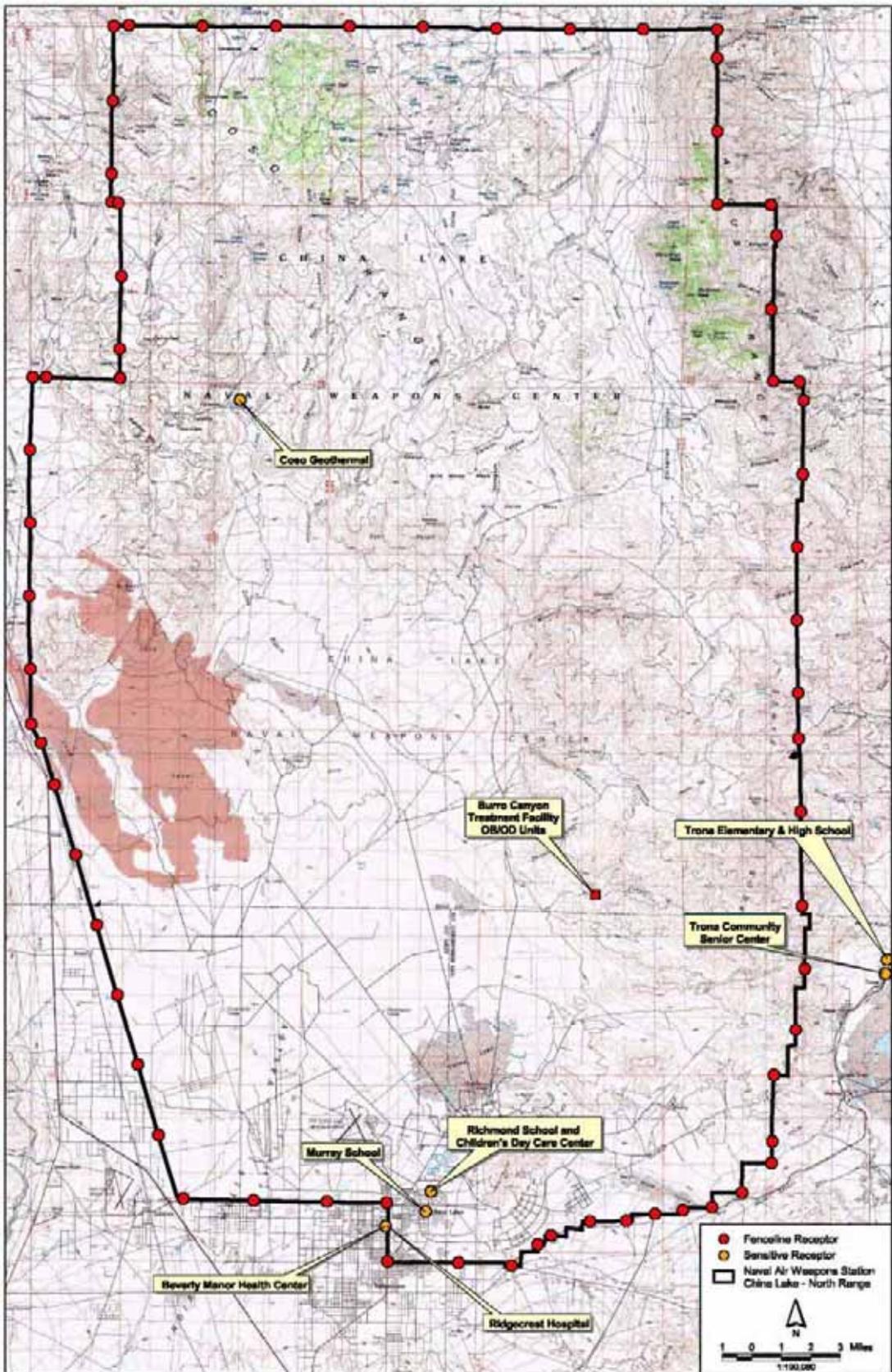
Table 4-9. Receptor Locations for OBODM and ISCST3 Modeling

Receptor Type	UTM X (m)	UTM Y (m)	Elevation (m)	Distance from Burro Canyon (km)
Fenceline Receptors	419751	3990755	1171	42.1
	419803	3986755	1059	39.4
	419855	3982755	1042	37.0
	419907	3978756	1090	34.9
	419959	3974756	1131	33.2
	419997	3971792	932	32.1
	420654	3970807	893	31.2
	420759	3990738	1206	41.3
	421228	3968427	809	30.1
	422377	3964595	755	28.4
	423525	3960763	733	27.2
	424184	4000277	1686	46.4
	424197	4001881	1699	47.7
	424231	4005881	1844	51.0
	424266	4009881	2043	54.5
	424673	3956932	695	26.5
	424676	4000277	1688	46.1
	424710	3996277	1578	42.8
	424744	3992277	1631	39.7
	424758	3990673	1359	38.5
	425265	4009876	2246	54.0
	425821	3953100	689	26.5
	426969	3949268	709	27.0
	428042	3945689	734	28.0
	429265	4009856	2319	52.2
	432042	3945659	722	24.9
	433265	4009836	2049	50.7
	436041	3945630	697	22.1
	437265	4009816	1949	49.4
	439206	3942323	693	23.0
	439288	3945606	680	20.1
	441265	4009797	1720	48.5
	443205	3942275	686	21.3
	445265	4009777	1483	47.9
	446101	3942241	749	20.5
	447168	3943226	749	19.3
	448235	3943883	701	18.5
	449265	4009757	1308	47.6
	450370	3944539	649	17.7
	452340	3944704	619	17.6
453265	4009737	1516	47.6	
453899	3944786	612	17.7	
455295	3945114	596	17.7	
457019	3945196	600	18.2	
457019	4000195	2379	38.5	
457122	4004193	1831	42.5	
457225	4008192	1831	46.4	
457265	4009717	1754	47.9	
458907	3945771	602	18.4	

Table 4-9. Receptor Locations for OBODM and ISCST3 Modeling (Continued)

Receptor Type	UTM X (m)	UTM Y (m)	Elevation (m)	Distance From Burro Canyon (km)
Fenceline Receptors (Continued)	460138	3990508	1917	29.8
	460172	3994508	1441	33.7
	460206	3998508	1660	37.5
	460220	3946263	610	18.6
	460220	3952502	858	13.6
	460220	4000113	1472	39.1
	460302	3948890	581	16.5
	460713	3954964	922	12.4
	461287	3958330	926	11.3
	461780	3973434	1356	15.8
	461780	3977434	1642	18.8
	461780	3981434	1520	22.2
	461780	3985434	1536	25.7
	461780	3989434	1464	29.4
	461780	3990591	1586	30.5
	461811	3970949	1200	14.2
	461862	3961778	1154	11.2
461862	3965778	1338	11.8	
461862	3966949	1360	12.2	
Sensitive Receptors	437728	3945278	689	21.3
	438795	3944457	692	21.4
	441832	3946509	674	18.0
	466458	3958001	504	16.4
	466705	3958904	498	16.4
	432228	3988702	1109	32.3

Figure 4-1. Receptor Location Map for OBODM and ISCST3 Modeling



#### 4.4.4 Deposition

The OEHHA guidance risk formulas used in the calculation of risk for this analysis exclusively use concentration values as the modeled input and do not require explicit calculation of deposition values. Default deposition parameters were applied when needed. Therefore, while OBODM is coded to explicitly model dry deposition due to gravitational settling and ISCST3 is coded to model deposition parameters too, only GLCs calculated in OBODM and ISCST3 were used to determine risk.

#### 4.4.5 Aerodynamic Wake Effects

There are no buildings or structures located near the OB/OD unit. Therefore, it was not necessary to evaluate aerodynamic wake effects or building downwash in the HRA.

### 4.5 MULTIPATHWAY ANALYSIS

In identifying pathways that could potentially lead to exposure, the type of chemicals emitted, land use in the area, and lifestyle (i.e., urban versus rural or agricultural) must be considered. Consistent with the OEHHA guidelines, the following pathways have been identified as potential exposure routes for the OB/OD emissions:

- ◆ Inhalation;
- ◆ Soil ingestion;
- ◆ Dermal exposure; and
- ◆ Mother's milk ingestion.

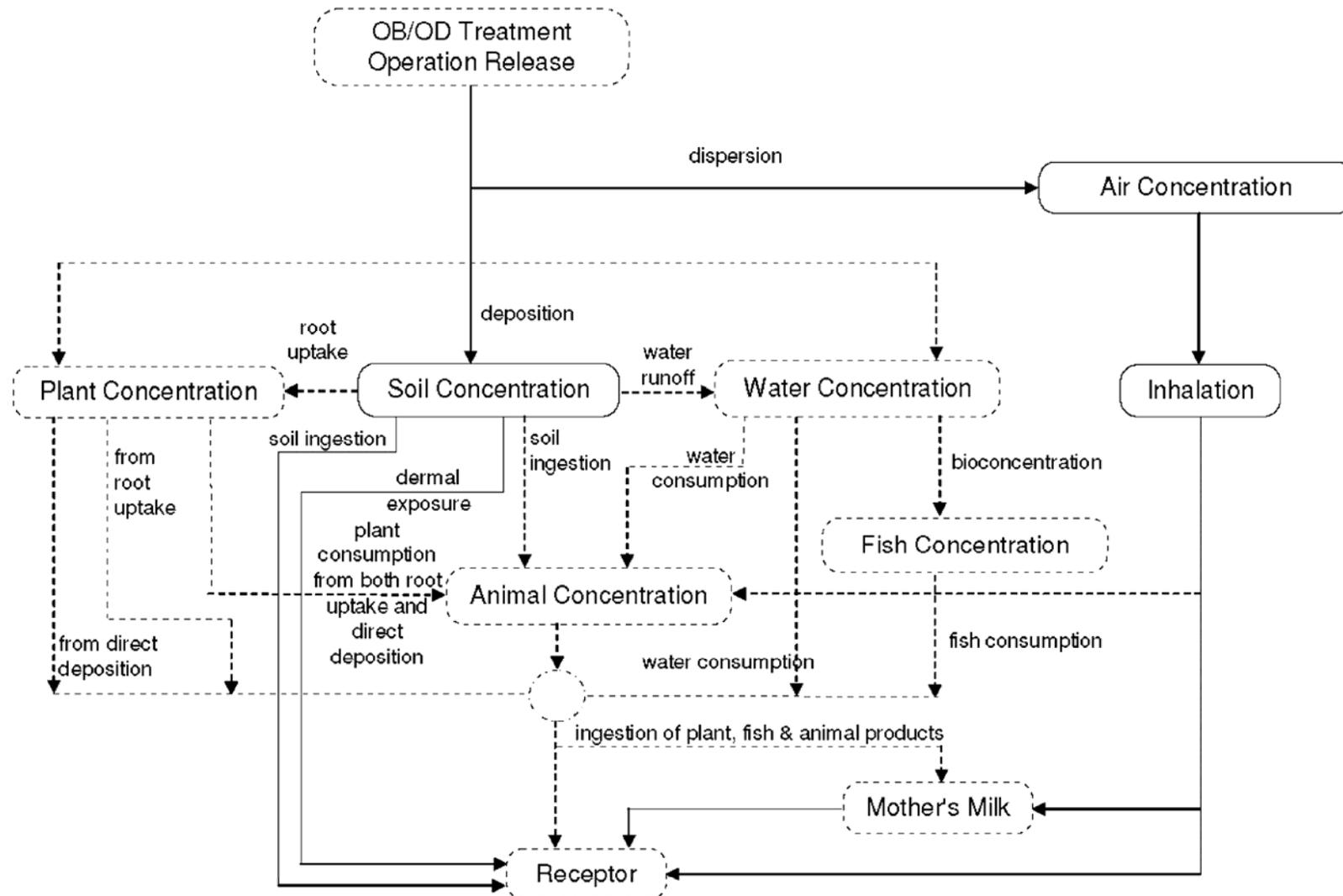
Other pathways listed in the OEHHA guidelines for consideration, such as water ingestion, dairy and beef, and poultry and eggs were not viable exposure routes for China Lake OB/OD activities because the zone of impact (ZOI) did not extend beyond the China Lake boundary and the BCTF is not near the boundary. A conceptual model applicable to this assessment is illustrated on Figure 4-2. Table 4-10 shows the exposure pathways applicable to each chemical evaluated in this HRA.

The calculation approach for each exposure pathway is described briefly below. The detailed description of each pathway and how it is addressed is presented in the OEHHA guidelines.

#### 4.5.1 Inhalation Exposure

Exposure to substances in ambient air occurs through inhalation of both gases and PM. For the purpose of this HRA, particulate emissions are considered to be entirely absorbed in the lungs, yielding a conservative estimate of exposure. In reality, only a fraction of the inhaled particulates would deposit in the lungs and be absorbed. Inhalation exposure for the average adult is determined by multiplying the estimated concentration in air by an average daily breathing rate specified by the OEHHA guidelines.

Figure 4-2. Conceptual Model for Assessment of OB/OD Operations at China Lake



Note: The solid lines represent applicable pathways. The dashed lines represent inactive pathways that are not applicable and are not considered as a part of this report.

Table 4-10. Applicable Exposure Pathways

Chemical of Concern	CAS Number	Inhalation Pathway	Dermal Absorption Pathway	Soil Ingestion Pathway	Mother's Milk Ingestion Pathway
Acenaphthene	83329	✓	✓	✓	
Acenaphthylene	208968	✓	✓	✓	
Acetaldehyde	75070	✓			
Acetone	67641	✓	✓	✓	
Acetonitrile	75058	✓	✓	✓	
Acetophenone	98862	✓	✓	✓	
Acetylaminofluorene, 2-	53963	✓	✓	✓	
Acrolein	107028	✓	✓	✓	
Acrylonitrile	107131	✓	✓	✓	
Allyl chloride	107051	✓	✓	✓	
Aluminum	7429905	✓	✓	✓	
Aminobiphenyl, 4-	92671	✓	✓	✓	
Aminopyridine, 4-	504245	✓	✓	✓	
Ammonia	7664417	✓			
Aniline	62533	✓	✓	✓	
Anthracene	120127	✓	✓	✓	
Antimony and chemicals	7440360	✓	✓	✓	
Arsenic	7440382	✓	✓	✓	
Azobenzene	103333	✓	✓	✓	
Barium	7440393	✓	✓	✓	
Benzaldehyde	100527	✓	✓	✓	
Benzene	71432	✓	✓	✓	
Benzidine	92875	✓	✓	✓	
Benzo(A)Anthracene	56553	✓	✓	✓	
Benzo(A)pyrene	50328	✓	✓	✓	
Benzo(b)fluoranthene	205992	✓	✓	✓	
Benzo(k)fluoranthene	207089	✓	✓	✓	
Benzo[g,h,i]perylene	191242	✓	✓	✓	
Benzofuran, 2,3-	271896	✓	✓	✓	
Benzoic acid	65850	✓	✓	✓	
Benzyl alcohol	100516	✓	✓	✓	
Benzyl chloride	100447	✓	✓	✓	
Beryllium	7440417	✓	✓	✓	
Biphenyl, 1,1-	92524	✓	✓	✓	
Bis(2-chloro-1-methylethyl)ether	108601	✓	✓	✓	
Bis(2-chloroethyl)ether	111444	✓	✓	✓	
Bis(2-chloroisopropyl)ether	39638329	✓	✓	✓	
Bis(2-ethylhexyl)phthalate (DEHP)	117817	✓	✓	✓	
Bis(chloromethyl)ether	542881	✓	✓	✓	
Bromodichloromethane	75274	✓	✓	✓	
Bromoform (tribromomethane)	75252	✓	✓	✓	
Bromomethane	74839	✓	✓	✓	
Butadiene-1,3	106990	✓	✓	✓	

Table 4-10. Applicable Exposure Pathways (Continued)

Chemical of Concern	CAS Number	Inhalation Pathway	Dermal Absorption Pathway	Soil Ingestion Pathway	Mother's Milk Ingestion Pathway
Butanol, 1-	71363	✓	✓	✓	
Butyl benzyl phthalate	85687	✓	✓	✓	
Butylacrylate	141322	✓	✓	✓	
Butylbenzene, n-	104518	✓	✓	✓	
Butylbenzene, T-	98066	✓	✓	✓	
Cadmium	7440439	✓	✓	✓	
Carbazole	86748	✓	✓	✓	
Carbon Monoxide	630080	✓			
Carbon tetrachloride	56235	✓	✓	✓	
Chlorine	7782505	✓	✓	✓	
Chloroacetophenone, 2-	532274	✓	✓	✓	
Chloroaniline, 4-	106478	✓	✓	✓	
Chlorobenzene	108907	✓	✓	✓	
Chloroethane (Ethyl chloride)	75003	✓	✓	✓	
Chloroform	67663	✓	✓	✓	
Chloromethane (Methyl chloride)	74873	✓	✓	✓	
Chloronaphthalene	91587	✓	✓	✓	
Chloronitrobenzene, o-	88733	✓	✓	✓	
Chlorophenol, 2-	95578	✓	✓	✓	
Chloropicrin (trichloronitromethane)	76062	✓			
Chlorotoluene, o-	95498	✓	✓	✓	
Chromium (hex.)	18540299	✓	✓	✓	
Chromium III	16065831	✓	✓	✓	
Chrysene	218019	✓	✓	✓	
Cobalt	7440484	✓	✓	✓	
Copper	7440508	✓	✓	✓	
Cumene (Isopropylbenzene)	98828	✓	✓	✓	
Cyclohexane	110827	✓	✓	✓	
Cyclotetramethylene Tetranitamine (HMX)	2691410	✓	✓	✓	
Diaminotoluene, 2,4-	95807	✓	✓	✓	
Diazomethane	334883	✓	✓	✓	
Dibenz[a,h]anthracene	53703	✓	✓	✓	
Dibenzofuran	132649	✓	✓	✓	
Dibromochloromethane	124481	✓	✓	✓	
Dibutyl phthalate	84742	✓	✓	✓	
Dichlorobenzene, 1,2-	95501	✓	✓	✓	
Dichlorobenzene, 1,3-	541731	✓	✓	✓	
Dichlorobenzene, 1,4-	106467	✓	✓	✓	
Dichlorobenzidine, 3,3-	91941	✓	✓	✓	
Dichlorodifluoromethane	75718	✓	✓	✓	
Dichloroethane, 1,1-	75343	✓	✓	✓	
Dichloroethane, 1,2-	107062	✓	✓	✓	
Dichloroethylene (cis), 1,2-	156592	✓	✓	✓	

Table 4-10. Applicable Exposure Pathways (Continued)

Chemical of Concern	CAS Number	Inhalation Pathway	Dermal Absorption Pathway	Soil Ingestion Pathway	Mother's Milk Ingestion Pathway
Dichloroethylene (trans), 1,2-	156605	✓	✓	✓	
Dichloroethylene, 1,1- (Dichloroethene, 1,1-)	75354	✓	✓	✓	
Dichlorophenol, 2,4-	120832	✓	✓	✓	
Dichloropropane, 1,2-	78875	✓	✓	✓	
Dichloropropene, 1,3-	542756	✓	✓	✓	
Diesel PM	9901	✓	✓	✓	
Diethyl ether (Ethyl ether)	60297	✓	✓	✓	
Diethyl phthalate	84662	✓	✓	✓	
Dimethyl Phthalate	131113	✓	✓	✓	
Dimethylamine	124403	✓	✓	✓	
Dimethylbenz(a)anthracene, 7,12-	57976	✓	✓	✓	
Dimethylbenzidine, 3,3'-	119937	✓	✓	✓	
Dimethylcarbamoyl chloride	79447	✓	✓	✓	
Dimethylhydrazine, 1,2-	540738	✓	✓	✓	
Dimethylphenol, 2,4-	105679	✓	✓	✓	
Dinitrobenzene, 1,2-	528290	✓	✓	✓	
Dinitrobenzene, 1,3-	99650	✓	✓	✓	
Dinitrobenzene, 1,4-	100254	✓	✓	✓	
Dinitro-o-cresol, 4,6-	534521	✓	✓	✓	
Dinitrophenol, 2,4-	51285	✓	✓	✓	
Dinitropyrene, 1,6-	42397648	✓	✓	✓	
Dinitrotoluene, 2,4-	121142	✓	✓	✓	
Dinitrotoluene, 2,6-	606202	✓	✓	✓	
Dinitrotoluene, 4-Amino-2,6-	19406510	✓	✓	✓	
Dinitrotoluene, 2-Amino-4,6-	35572782	✓	✓	✓	
Di-n-octyl phthalate	117840	✓	✓	✓	
Dioxane, 1,4-	123911	✓	✓	✓	
Diphenylamine	122394	✓	✓	✓	
Ethoxyethanol, 2-	110805	✓	✓	✓	
Ethylbenzene	100414	✓	✓	✓	
Ethylene	74851	✓			
Ethyleneimine (Aziridine)	151564	✓	✓	✓	
Fluoranthene	206440	✓	✓	✓	
Fluorene	86737	✓	✓	✓	
Fluorotrichloromethane (Trichlorofluoromethane)	75694	✓	✓	✓	
Formaldehyde	50000	✓	✓	✓	
Furan (Epoxy-1,3-butadiene, 4-)	110009	✓	✓	✓	
Glutaraldehyde	111308	✓			
Heptachlorodibenzofuran, 1,2,3,4,6,7,8-	67562394	✓	✓	✓	✓
Heptachlorodibenzofuran, 1,2,3,4,7,8,9-	55673897	✓	✓	✓	✓
Heptachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8-	35822469	✓	✓	✓	✓
Hexachlorobenzene	118741	✓	✓	✓	
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	87683	✓	✓	✓	

Table 4-10. Applicable Exposure Pathways (Continued)

Chemical of Concern	CAS Number	Inhalation Pathway	Dermal Absorption Pathway	Soil Ingestion Pathway	Mother's Milk Ingestion Pathway
Hexachlorodibenzofuran, 1,2,3,4,7,8-	70648269	✓	✓	✓	✓
Hexachlorodibenzofuran, 1,2,3,6,7,8-	57117449	✓	✓	✓	✓
Hexachlorodibenzofuran, 1,2,3,7,8,9-	72918219	✓	✓	✓	✓
Hexachlorodibenzofuran, 2,3,4,6,7,8-	60851345	✓	✓	✓	✓
Hexachlorodibenzo-p-Dioxin, 1,2,3,4,7,8-	39227286	✓	✓	✓	✓
Hexachlorodibenzo-p-Dioxin, 1,2,3,6,7,8-	57653857	✓	✓	✓	✓
Hexachlorodibenzo-p-Dioxin, 1,2,3,7,8,9-	19408743	✓	✓	✓	✓
Hexachloroethane	67721	✓	✓	✓	
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	✓	✓	✓	
Hexane, n-	110543	✓	✓	✓	
Hexanone, 2-	591786	✓	✓	✓	
Hydrogen chloride	7647010	✓			
Hydrogen Cyanide	74908	✓	✓	✓	
Indeno[1,2,3-cd]pyrene	193395	✓	✓	✓	
Iron	7439896	✓			
Isophorone	78591	✓	✓	✓	
Isoprene	9003310	✓			
Lead	7439921	✓	✓	✓	
Malononitrile	109773	✓	✓	✓	
Manganese	7439965	✓	✓	✓	
Mercury	7439976	✓	✓	✓	
Methacrylonitrile	126987	✓	✓	✓	
Methanol	67561	✓	✓	✓	
Methylcholanthrene, 3-	56495	✓	✓	✓	
Methylcyclohexane	108872	✓	✓	✓	
Methylene chloride	75092	✓	✓	✓	
Methylethyl ketone	78933	✓	✓	✓	
Methylnaphthalene, 2-	91576	✓	✓	✓	
Methylphenol, 2-	95487	✓	✓	✓	
Methylphenol, 3-	108394	✓	✓	✓	
Methylphenol, 4-	106445	✓	✓	✓	
Methyltertbutyl ether (MTBE)	1634044	✓	✓	✓	
Molybdenum	7439987	✓			
Naphthalene	91203	✓	✓	✓	
Nickel and chemicals	7440020	✓	✓	✓	
Nitric Oxide	10102439	✓	✓	✓	
Nitroacenaphthene, 5-	602879	✓	✓	✓	
Nitroaniline, 2-	88744	✓	✓	✓	
Nitrobenzene	98953	✓	✓	✓	
Nitrochrysene, 6-	7496028	✓	✓	✓	
Nitrogen Dioxide	10102440	✓	✓	✓	
Nitroglycerin	55630	✓	✓	✓	
Nitroguanidine	556887	✓	✓	✓	

Table 4-10. Applicable Exposure Pathways (Continued)

Chemical of Concern	CAS Number	Inhalation Pathway	Dermal Absorption Pathway	Soil Ingestion Pathway	Mother's Milk Ingestion Pathway
Nitrophenol, 4-	100027	✓	✓	✓	
Nitropropane, 2-	79469	✓	✓	✓	
Nitropyrene, 1-	5522430	✓	✓	✓	
Nitrosodiethylamine, N-	55185	✓	✓	✓	
Nitrosodimethylamine, N-	62759	✓	✓	✓	
Nitrosodi-n-butylamine, N-	924163	✓	✓	✓	
Nitrosodi-n-propylamine, N-	621647	✓	✓	✓	
Nitrosodiphenylamine, N-	86306	✓	✓	✓	
Nitroso-N-methylethylamine, N- (Nitrosomethylethylamine, N-)	10595956	✓	✓	✓	
Nitrosopiperidine, N-	100754	✓	✓	✓	
Nitrosopyrrolidine, N-	930552	✓	✓	✓	
Nitrotoluene, m-	99081	✓	✓	✓	
Nitrotoluene, o-	88722	✓	✓	✓	
Nitrotoluene, p-	99990	✓	✓	✓	
Octachlorodibenzofuran, 1,2,3,4,6,7,8,9-	39001020	✓	✓	✓	✓
Octachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8,9-	3268879	✓	✓	✓	✓
Pentachlorobenzene	608935	✓	✓	✓	
Pentachlorodibenzofuran, 1,2,3,7,8-	57117416	✓	✓	✓	✓
Pentachlorodibenzofuran, 2,3,4,7,8-	57117314	✓	✓	✓	✓
Pentachlorodibenzo-p-Dioxin, 1,2,3,7,8-	40321764	✓	✓	✓	✓
Pentachloronitrobenzene	82688	✓	✓	✓	
Pentachlorophenol	87865	✓	✓	✓	
Perchlorate	7601903	✓	✓	✓	
Phenanthrene	85018	✓	✓	✓	
Phenol	108952	✓	✓	✓	
Phosgene	75445	✓			
Phosphorus (white)	7723140	✓	✓	✓	
Propanol, 2-	67630	✓			
Propylbenzene, n-	103651	✓	✓	✓	
Propylene (Propene)	115071	✓			
Pyrene	129000	✓	✓	✓	
Pyridine	110861	✓	✓	✓	
Selenium	7782492	✓	✓	✓	
Silica, Crystalline	1175	✓			
Strontium	7440246	✓	✓	✓	
Styrene	100425	✓	✓	✓	
Sulfur Dioxide	7446095	✓			
Sulfuric acid	7664939	✓			
Tetrachlorobenzene, 1,2,4,5-	95943	✓	✓	✓	
Tetrachlorodibenzofuran, 2,3,7,8-	51207319	✓	✓	✓	✓
Tetrachlorodibenzo-p-Dioxin, 2,3,7,8-	1746016	✓	✓	✓	✓
Tetrachloroethane, 1,1,2,2-	79345	✓	✓	✓	

Table 4-10. Applicable Exposure Pathways (Continued)

Chemical Name	CAS Number	Inhalation Pathway	Dermal Absorption Pathway	Soil Ingestion Pathway	Mother's Milk Ingestion Pathway
Tetrachloroethylene (PCE)	127184	✓	✓	✓	
Tetrachlorophenol, 2,3,4,6-	58902	✓	✓	✓	
Tetranitro-N-methylaniline, N,2,4,6- (Tetryl, Trinitrophenylmethylnitramine)	479458	✓	✓	✓	
Thallium and chemicals	7446186	✓	✓	✓	
Toluene	108883	✓	✓	✓	
Toluidine, o- (Methylaniline, 2-)	95534	✓	✓	✓	
Total HpCDD	35822469	✓	✓	✓	✓
Total HpCDF	67562394	✓	✓	✓	✓
Total HxCDD	19408743	✓	✓	✓	✓
Total HxCDF	57117449	✓	✓	✓	✓
Total PeCDD	40321764	✓	✓	✓	✓
Total PeCDF	57117314	✓	✓	✓	✓
Total TCDD	1746016	✓	✓	✓	✓
Total TCDF	51207319	✓	✓	✓	✓
Trichlorobenzene, 1,2,4-	120821	✓	✓	✓	
Trichloroethane, 1,1,1- (Methyl chloroform)	71556	✓	✓	✓	
Trichloroethane, 1,1,2-	79005	✓	✓	✓	
Trichloroethylene (TCE)	79016	✓	✓	✓	
Trichlorophenol, 2,4,5-	95954	✓	✓	✓	
Trichlorophenol,2,4,6-	88062	✓	✓	✓	
Trimethylbenzene, 1,2,4-	95636	✓	✓	✓	
Trimethylbenzene, 1,3,5-	108678	✓	✓	✓	
Trimethylpentane, 2,2,4-	540841	✓	✓	✓	
Trinitrobenzene, 1,3,5-	99354	✓	✓	✓	
Trinitrotoluene, 2,4,6- (TNT)	118967	✓	✓	✓	
Urethane (Ethyl carbamate)	51796	✓	✓	✓	
Vanadium and chemicals	7440622	✓	✓	✓	
Vinyl acetate	108054	✓	✓	✓	
Vinyl Chloride	75014	✓	✓	✓	
Xylenes	1330207	✓	✓	✓	
Zinc	7440666	✓	✓	✓	

#### 4.5.2 Soil Ingestion

Chemicals emitted in the particulate phase are subject to deposition onto ground surfaces and mixing in the uppermost layer of soil. These particulates include metals and semivolatile organics. Soil concentration calculations assume a constant deposition rate onto soil and an even mixing of emissions into the top one centimeter of soil. Loss mechanisms, primarily degradation over time, are considered in estimating the soil concentration of certain organic emissions over the period of interest.

Exposure from incidental ingestion of soil is estimated by multiplying the soil concentration estimate of each substance by a soil ingestion rate specified by the OEHHA guidelines and dividing by the body weight. The soil ingestion rate is an age-weighted value that reflects higher consumption rates for a child and significantly less consumption for an adult.

#### 4.5.3 Dermal Exposure

Dermal exposure results when soil containing deposited particulate-borne chemicals contacts the skin and these chemicals are absorbed into the body. The daily exposure rate was calculated by multiplying the soil concentration of each chemical by an estimate of the exposed skin surface area, amount of soil on the skin, and a chemical-specific absorption rate. The OEHHA guidelines provide default estimates of skin area, soil contact rate, and absorption rate.

#### 4.5.4 Mother's Milk Ingestion

Certain semivolatile organic substances emitted from OB/OD activities have the tendency to accumulate in fatty tissue, including the fat in breast milk. Exposure to nursing infants may occur through breast feeding. An infant's intake through breast milk ingestion depends on the consumption rate of breast milk and the duration of breast feeding. Concentrations of chemicals in breast milk are a function of the total maternal exposure and the elimination rate of chemicals from the body. Steady-state chemical levels in the mother's body (body burden) were estimated by summing the maternal exposure from all applicable exposure routes and applying a first-order elimination rate cited in the OEHHA guidelines (OEHHA, 2003). The infant is conservatively assumed to continue breast feeding until the age of one.

#### 4.5.5 Total Exposure

The total daily exposure rate for each emitted chemical is calculated by summing the individual exposure for each pathway. In Section 5.0, these total daily exposure rates are used to assess the potential health risk.

### 4.6 OFF- AND ON-SITE EXPOSURE

The OEHHA guidelines require the evaluation of potential health impacts from a facility at off-site residences and workplaces. Since China Lake has schools, on-Base housing, and a child development center, on-site receptors to address these specific exposed populations were included in the HRA. The off-site exposure was calculated similar to OEHHA's exposure and risk calculations for a hypothetical residential MEI at the China Lake fence line. The off-site MEI is assumed to live at the point of highest

toxicity-weighted concentration of facility emissions, in a residentially zoned area, for 24 hours per day, 365 days per year, for 70 continuous years. The MEI concept ensures that exposure will not be underestimated because time spent at work, on vacation, commuting locally, or moving from one residence to another would otherwise reduce the actual exposure to emissions from the OB/OD activities. The on-site exposure was calculated in the same manner as the off-site exposure, except for appropriate adjustments to the exposure parameters.

An off-site occupational MEI was not determined since the result is likely to be lower than the residential MEI because exposures occur over a shorter duration and exposure concentrations are lower. An on-site occupational MEI was not determined since facility worker exposure determination is not required under the OEHHA guidelines and facility worker health and safety are regulated separately. The RME and AEI also were not calculated because they would yield less conservative results than the MEI.

#### **4.7 ZONE OF IMPACT**

Under OEHHA guidelines, the ZOI for the carcinogenic HRA encompasses the area subject to an added lifetime cancer risk of greater than one in one million. In addition, the ZOI for the noncarcinogenic HRA encompasses the area subject to a HI greater than 1.0. In this HRA, the maximum cancer risks are less than or equal to one in one million. In addition, the maximum HIs are less than or equal to 1.0. Thus, there are no carcinogenic or noncarcinogenic ZOIs.

#### **4.8 SENSITIVE RECEPTORS**

Sensitive receptors are locations where exposed individuals may be more sensitive to health effects than the general population. OEHHA guidelines define sensitive receptors as hospitals, primary and secondary schools, day care centers, and nursing homes. In this HRA, sensitive receptors are identified in Section 4.4.3.3.

## 5.0 DOSE-RESPONSE ASSESSMENT

This is the step that identifies whether a substance is a potential human carcinogen or is capable of causing adverse noncancer health effects. Dose-response assessment has been defined as “an attempt to describe the expected human response to any given level of an exposure” (Hart and Turturro, 1986). Multiple governmental agencies and scientific organizations, such as the EPA, the National Academy of Sciences, the World Health Organization, and OEHHA, have developed dose-response relationships for numerous chemicals. Dose-response assessment can produce three toxicity factors useful in evaluating potential adverse health effects: Cancer potency factors and URFs for carcinogens, chronic noncancer RELs (chronic RELs) for substances producing noncarcinogenic toxic effects over a long-term exposure period, and acute noncancer RELs (acute RELs) for acutely toxic chemicals. This HRA used current toxicity factors approved by the DTSC and published by the listed agencies in order of priority:

1. Air Toxics Hot Spots Program Risk Assessment Guidelines, Appendix L - Table 1, OEHHA/CARB Approved Health Values for Use in Hot Spot Facility Risk Assessments, August 2003 (OEHHA, 2003);
2. Oak Ridge National Laboratory Risk Assessment Information System (RAIS)/Integrated Risk Information System (IRIS), September 2003 (RAIS, 2003);
3. EPA Region 6, Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Table A-4, July 1998 (EPA, 1998);
4. Risk Assessment Guidance for Superfund (RAGS), Interim Guidance, November 1995 (EPA, 1995c);
5. EPA Region 9, PRGs, October 2002 and October 2004 (EPA, 2004); and
6. National Institute for Occupational Safety and Health (NIOSH) Publication No. 2005-151, September 2005 (NIOSH, 2005).

### 5.1 HEALTH EFFECTS

The chemicals contained in Quadrants 1 and 2 evaluated in the HRA and their potential health effects are presented in Table 5-1.

### 5.2 CANCER TOXICITY FACTORS

Cancer potency (or slope) factors represent the potential risk of contracting cancer per dose of carcinogen where dose is in units of milligrams of carcinogen per kilogram of body weight per day. URFs define the theoretical risk of developing cancer as a result of continuous exposure to an airborne concentration of 1  $\mu\text{g}/\text{m}^3$  of a carcinogen. URFs are derived from cancer potency factors based on inhalation rate, body weight, and exposure time assumptions. The cancer risk resulting from low levels of exposure to a carcinogen cannot be measured directly by either animal or human epidemiology studies. Therefore, mathematical models are used to extrapolate health effects observed in high dose animal studies or relatively high dose human epidemiology studies, to the low doses encountered in the environment. Generally, cancer potency factors determined from extrapolating from high to low doses represent upper-bound or worst-case estimates and are often calculated from factors estimated at 95% upper confidence

limits. The inherent assumption is that there is no threshold concentration below which exposure does not cause a potential cancer outcome.

The linearized multi-stage (LMS), low-dose extrapolation model is commonly used by the EPA's Carcinogen Assessment Group and OEHHA to extrapolate data from animal studies to environmental exposure conditions in humans (EPA, 1986; California Department of Health Services, 1985). The LMS model estimates an upperbound estimate of risk that is consistent with health-conservative theories for mechanisms of carcinogenesis (EPA, 1986). When epidemiology data are used as the basis for estimating a cancer potency factor, a variety of models are used. In all cases, the cancer potency factors are based on the assumption that any exposure to a carcinogen contributes to an individual's chance of developing cancer within a lifetime. The cancer toxicity factors used in this HRA are presented in Table 5-2.

### **5.3 CHRONIC NONCANCER REFERENCE EXPOSURE LEVELS**

Chronic noncancer RELs define a dose or exposure concentration at which adverse noncancer health effects would be likely if an individual were exposed continuously to that dose over a long-term exposure period. Similar to carcinogens, chronic noncancer RELs are derived from animal studies or human epidemiological data and focus on the most sensitive animal or human data set and target organ or system (i.e., liver, kidney, central nervous system, etc.). Different laboratory animals may be used to test the toxicity of a particular substance. Several different target organs are typically examined. The study yielding the lowest effect level would be used as the basis for developing the chronic REL from animal data. Unlike cancer toxicity factors, noncancer RELs assume that there is a dose below which no adverse effects are expected. Chronic RELs are used to evaluate exposures to noncarcinogens as well as noncarcinogenic effects from carcinogens and are developed for both inhalation and non-inhalation exposure routes. The chronic RELs used in this HRA are presented in Table 5-2. The applicable target organs for each COC are presented in Table 5-3. Compounds having toxicity factors but no specific target organ endpoints were assigned a target organ endpoint or assigned to "other" at the direction of DTSC. All compounds having published toxicity factors were carried throughout the risk assessment.

### **5.4 ACUTE NONCANCER REFERENCE EXPOSURE LEVELS**

Acute health effects may result from short-term exposures that typically occur on an infrequent basis. Unlike chronic exposures, criteria for measuring acute health effects have not been standardized. Rather, several approaches may be used to establish allowable one-hour concentrations based on short-term toxicity studies in the literature. The acute RELs used in this HRA are presented in Table 5-2. The applicable target organs for each COC are presented in Table 5-4. Compounds having toxicity factors but no specific target organ endpoints were assigned a target organ endpoint or assigned to "other" at the direction of DTSC. All compounds having published toxicity factors were carried throughout the risk assessment.

### **5.5 LEAD DOSE-RESPONSE ASSESSMENT**

For lead, the chronic noncancer health effects are related to blood levels as opposed to concentrations in the ambient air. DTSC prefers that lead be assessed as a developmental toxicant and assessed using an

uptake/biokinetic model. As recommended by OEHHA (OEHHA, 2001), the current version of the Lead Health Risk Assessment Spreadsheet Model (LeadSpread Version 7) was used to derive estimated blood lead levels relative to a blood lead level of concern of 10 micrograms per deciliter ( $\mu\text{g}/\text{dl}$ ). Blood lead concentrations above the threshold are considered a potential risk for adverse developmental outcomes.

Table 5-1. Health Effects Categories for Chemicals Evaluated in the HRA

Chemical of Concern	CAS Number	Cancer	Chronic Noncancer	Acute Noncancer
Acenaphthene	83329		✓	
Acenaphthylene	208968	✓	✓	✓
Acetaldehyde	75070	✓	✓	
Acetone	67641		✓	
Acetonitrile	75058		✓	
Acetophenone	98862		✓	✓
Acetylaminofluorene, 2-	53963	✓		
Acrolein	107028		✓	✓
Acrylonitrile	107131	✓	✓	✓
Allyl chloride	107051	✓	✓	
Aluminum	7429905		✓	
Aminobiphenyl, 4-	92671	✓		
Aminopyridine, 4-	504245		✓	
Ammonia	7664417		✓	✓
Aniline	62533	✓	✓	✓
Anthracene	120127		✓	
Antimony	7440360		✓	✓
Arsenic	7440382	✓	✓	✓
Azobenzene	103333	✓		
Barium	7440393		✓	✓
Benzaldehyde	100527		✓	
Benzene	71432	✓	✓	✓
Benzidine	92875	✓	✓	
Benzo(A)Anthracene	56553	✓		
Benzo(A)pyrene	50328	✓		✓
Benzo(b)fluoranthene	205992	✓		
Benzo(k)fluoranthene	207089	✓		
Benzo[g,h,i]perylene	191242	✓		✓
Benzofuran, 2,3-	271896		✓	
Benzoic acid	65850		✓	
Benzyl alcohol	100516		✓	
Benzyl chloride	100447	✓	✓	✓
Beryllium	7440417	✓	✓	✓
Biphenyl, 1,1-	92524		✓	
Bis(2-chloro-1-methylethyl)ether	108601	✓	✓	
Bis(2-chloroethyl)ether	111444	✓		✓
Bis(2-chloroisopropyl)ether	39638329	✓	✓	
Bis(2-ethylhexyl)phthalate (DEHP)	117817	✓	✓	
Bis(chloromethyl)ether	542881	✓		
Bromodichloromethane	75274	✓	✓	
Bromoform (tribromomethane)	75252	✓	✓	✓
Bromomethane	74839		✓	✓
Butadiene-1,3	106990	✓	✓	
Butanol, 1-	71363		✓	

**Table 5-1. Health Effects Categories for Chemicals Evaluated in the HRA  
(Continued)**

Chemical of Concern	CAS Number	Cancer	Chronic Noncancer	Acute Noncancer
Butyl benzyl phthalate	85687		✓	
Butylacrylate	141322	✓	✓	
Butylbenzene, n-	104518		✓	
Butylbenzene, T-	98066		✓	
Cadmium	7440439	✓	✓	✓
Carbazole	86748	✓		
Carbon monoxide	630080			✓
Carbon tetrachloride	56235	✓	✓	✓
Chlorine	7782505		✓	✓
Chloroacetophenone, 2-	532274		✓	
Chloroaniline, 4-	106478		✓	✓
Chlorobenzene	108907		✓	✓
Chloroethane (Ethyl chloride)	75003	✓	✓	
Chloroform	67663	✓	✓	✓
Chloromethane (Methyl chloride)	74873	✓	✓	✓
Chloronaphthalene	91587		✓	✓
Chloronitrobenzene, o-	88733	✓	✓	
Chlorophenol, 2-	95578		✓	✓
Chloropicrin (trichloronitromethane)	76062		✓	✓
Chlorotoluene, o-	95498		✓	
Chromium (hex.)	18540299	✓	✓	✓
Chromium III	16065831			✓
Chrysene	218019	✓		✓
Cobalt	7440484	✓	✓	
Copper	7440508		✓	✓
Cumene (Isopropylbenzene)	98828		✓	
Cyclohexane	110827		✓	
Diaminotoluene, 2,4-	95807	✓		
Diazomethane	334883		✓	✓
Dibenz[a,h]anthracene	53703	✓		✓
Dibenzofuran	132649		✓	
Dibromochloromethane	124481	✓	✓	
Dibutyl phthalate	84742		✓	✓
Dichlorobenzene, 1,2-	95501		✓	✓
Dichlorobenzene, 1,3-	541731		✓	
Dichlorobenzene, 1,4-	106467	✓	✓	✓
Dichlorobenzidine, 3,3-	91941	✓		✓
Dichlorodifluoromethane	75718		✓	✓
Dichloroethane, 1,1-	75343	✓	✓	✓
Dichloroethane, 1,2-	107062	✓	✓	✓
Dichloroethylene (cis), 1,2-	156592		✓	
Dichloroethylene (trans), 1,2-	156605		✓	
Dichloroethylene, 1,1- (Dichloroethene, 1,1-)	75354	✓	✓	✓
Dichlorophenol, 2,4-	120832		✓	✓

**Table 5-1. Health Effects Categories for Chemicals Evaluated in the HRA  
(Continued)**

Chemical of Concern	CAS Number	Cancer	Chronic Noncancer	Acute Noncancer
Dichloropropane, 1,2-	78875	✓	✓	✓
Dichloropropene, 1,3-	542756	✓	✓	✓
Diesel PM	9901	✓		✓
Diethyl ether (Ethyl ether)	60297		✓	
Diethyl phthalate	84662		✓	✓
Dimethyl Phthalate	131113		✓	
Dimethylamine	124403		✓	
Dimethylbenz(a)anthracene, 7,12-	57976	✓		
Dimethylbenzidine, 3,3'-	119937	✓		
Dimethylcarbamoyl chloride	79447	✓		
Dimethylhydrazine, 1,2-	540738	✓		
Dimethylphenol, 2,4-	105679		✓	
Dinitrobenzene, 1,2-	528290		✓	
Dinitrobenzene, 1,3-	99650		✓	
Dinitrobenzene, 1,4-	100254		✓	
Dinitro-o-cresol, 4,6-	534521		✓	✓
Dinitrophenol, 2,4-	51285		✓	✓
Dinitropyrene, 1,6-	42397648	✓		
Dinitrotoluene, 2,4-	121142	✓	✓	✓
Dinitrotoluene, 2,6-	606202		✓	✓
Di-n-octyl phthalate	117840		✓	
Dioxane, 1,4-	123911	✓	✓	✓
Diphenylamine	122394		✓	
Ethoxyethanol, 2-	110805		✓	✓
Ethylbenzene	100414	✓	✓	✓
Ethylene	74851		✓	
Ethyleneimine (Aziridine)	151564	✓		
Fluoranthene	206440		✓	
Fluorene	86737		✓	
Fluorotrichloromethane (Trichlorofluoromethane)	75694		✓	✓
Formaldehyde	50000	✓	✓	✓
Furan (Epoxy-1,3-butadiene, 4-)	110009		✓	
Glutaraldehyde	111308		✓	
Heptachlorodibenzofuran, 1,2,3,4,6,7,8-	67562394	✓	✓	
Heptachlorodibenzofuran, 1,2,3,4,7,8,9-	55673897	✓	✓	
Heptachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8-	35822469	✓	✓	
Hexachlorobenzene	118741	✓	✓	✓
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	87683	✓	✓	✓
Hexachlorodibenzofuran, 1,2,3,4,7,8-	70648269	✓	✓	
Hexachlorodibenzofuran, 1,2,3,6,7,8-	57117449	✓	✓	
Hexachlorodibenzofuran, 1,2,3,7,8,9-	72918219	✓	✓	
Hexachlorodibenzofuran, 2,3,4,6,7,8-	60851345	✓	✓	
Hexachlorodibenzo-p-Dioxin, 1,2,3,4,7,8-	39227286	✓	✓	

**Table 5-1. Health Effects Categories for Chemicals Evaluated in the HRA  
(Continued)**

<b>Chemical of Concern</b>	<b>CAS Number</b>	<b>Cancer</b>	<b>Chronic Noncancer</b>	<b>Acute Noncancer</b>
Hexachlorodibenzo-p-Dioxin, 1,2,3,6,7,8-	57653857	✓	✓	
Hexachlorodibenzo-p-Dioxin, 1,2,3,7,8,9-	19408743	✓	✓	
Hexachloroethane	67721	✓	✓	✓
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	✓	✓	
Hexane, n-	110543		✓	
Hydrogen chloride	7647010		✓	✓
Hydrogen Cyanide	74908		✓	✓
Indeno[1,2,3-cd]pyrene	193395	✓		
Iron	7439896		✓	✓
Isophorone	78591	✓	✓	
Isoprene	9003310		✓	
Lead <sup>1</sup>	7439921			
Malononitrile	109773		✓	
Manganese	7439965		✓	
Mercury	7439976		✓	✓
Methacrylonitrile	126987		✓	
Methanol	67561		✓	✓
Methylcholanthrene, 3-	56495	✓		
Methylcyclohexane	108872		✓	
Methylene chloride	75092	✓	✓	✓
Methylethyl ketone	78933		✓	✓
Methylnaphthalene, 2-	91576	✓	✓	✓
Methylphenol, 2-	95487		✓	✓
Methylphenol, 3-	108394		✓	✓
Methylphenol, 4-	106445		✓	✓
Methyltertbutyl ether (MTBE)	1634044	✓	✓	
Molybdenum	7439987		✓	✓
Naphthalene	91203	✓	✓	✓
Nickel and chemicals	7440020	✓	✓	✓
Nitric Oxide	10102439		✓	
Nitroacenaphthene, 5-	602879	✓		
Nitroaniline, 2-	88744		✓	
Nitrobenzene	98953		✓	✓
Nitrochrysene, 6-	7496028	✓		
Nitrogen Dioxide	10102440		✓	✓
Nitroglycerin	55630	✓		
Nitroguanidine	556887		✓	
Nitrophenol, 4-	100027		✓	✓
Nitropropane, 2-	79469	✓	✓	
Nitropyrene, 1-	5522430	✓		
Nitrosodiethylamine, N-	55185	✓		
Nitrosodimethylamine, N-	62759	✓		
Nitrosodi-n-butylamine, N-	924163	✓		
Nitrosodi-n-propylamine, N-	621647	✓		

**Table 5-1. Health Effects Categories for Chemicals Evaluated in the HRA  
(Continued)**

Chemical of Concern	CAS Number	Cancer	Chronic Noncancer	Acute Noncancer
Nitrosodiphenylamine, N-	86306	✓		
Nitroso-N-methylethylamine, N- (Nitrosomethylethylamine, N-)	10595956	✓		
Nitrosopiperidine, N-	100754	✓		
Nitrosopyrrolidine, N-	930552	✓		
Nitrotoluene, o-	88722		✓	
Nitrotoluene, p-	99990		✓	
Octachlorodibenzofuran, 1,2,3,4,6,7,8,9-	39001020	✓	✓	
Octachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8,9-	3268879	✓	✓	
Pentachlorobenzene	608935		✓	✓
Pentachlorodibenzofuran, 1,2,3,7,8-	57117416	✓	✓	
Pentachlorodibenzofuran, 2,3,4,7,8-	57117314	✓	✓	
Pentachlorodibenzo-p-Dioxin, 1,2,3,7,8-	40321764	✓	✓	
Pentachloronitrobenzene	82688	✓	✓	✓
Pentachlorophenol	87865	✓	✓	✓
Perchlorate	7601903		✓	
Phenanthrene	85018		✓	
Phenol	108952		✓	✓
Phosgene	75445			✓
Phosphorus (white)	7723140		✓	
Propanol, 2-	67630		✓	✓
Propylbenzene, n-	103651		✓	
Propylene (Propene)	115071		✓	
Pyrene	129000		✓	
Pyridine	110861		✓	✓
Selenium	7782492		✓	✓
Silica, Crystalline	1175		✓	
Strontium	7440246			✓
Styrene	100425		✓	✓
Sulfur Dioxide	7446095		✓	✓
Sulfuric acid	7664939		✓	✓
Tetrachlorobenzene, 1,2,4,5-	95943		✓	✓
Tetrachlorodibenzofuran, 2,3,7,8-	51207319	✓	✓	
Tetrachlorodibenzo-p-Dioxin, 2,3,7,8-	1746016	✓	✓	
Tetrachloroethane, 1,1,2,2-	79345	✓	✓	✓
Tetrachloroethylene (PCE)	127184	✓	✓	✓
Tetrachlorophenol, 2,3,4,6-	58902		✓	
Tetranitro-N-methylaniline, N,2,4,6- (Tetryl, Trinitrophenylmethylnitramine)	479458		✓	
Thallium and chemicals	7446186			✓
Toluene	108883		✓	✓
Toluidine, o- (Methylaniline, 2-)	95534	✓		✓
Total HpCDD	35822469	✓	✓	
Total HpCDF	67562394	✓	✓	
Total HxCDD	19408743	✓	✓	

**Table 5-1. Health Effects Categories for Chemicals Evaluated in the HRA  
(Continued)**

<b>Chemical of Concern</b>	<b>CAS Number</b>	<b>Cancer</b>	<b>Chronic Noncancer</b>	<b>Acute Noncancer</b>
Total HxCDF	57117449	✓	✓	
Total PeCDD	40321764	✓	✓	
Total PeCDF	57117314	✓	✓	
Total TCDD	1746016	✓	✓	
Total TCDF	51207319	✓	✓	
Trichlorobenzene, 1,2,4-	120821		✓	✓
Trichloroethane, 1,1,1- (Methyl chloroform)	71556		✓	✓
Trichloroethane, 1,1,2-	79005	✓	✓	✓
Trichloroethylene (TCE)	79016	✓	✓	✓
Trichlorophenol, 2,4,5-	95954		✓	✓
Trichlorophenol,2,4,6-	88062	✓	✓	
Trimethylbenzene, 1,2,4-	95636		✓	
Trimethylbenzene, 1,3,5-	108678		✓	
Trimethylpentane, 2,2,4-	540841		✓	
Trinitrobenzene, 1,3,5-	99354		✓	✓
Trinitrotoluene, 2,4,6- (TNT)	118967	✓	✓	
Urethane (Ethyl carbamate)	51796	✓		
Vanadium and chemicals	7440622			✓
Vinyl acetate	108054		✓	✓
Vinyl Chloride	75014	✓	✓	✓
Xylenes	1330207		✓	✓
Zinc	7440666		✓	

<sup>1</sup> Lead is evaluated as a developmental toxicant.

Table 5-2. Cancer Toxicity Factors and Chronic and Acute Noncancer RELs

Chemical of Concern	CAS Number	Quadrant	Surrogate	Cancer URF (Inhalation)		Cancer Potency Factor (Inhalation)		Cancer Oral Slope Factor		Chronic REL (Inhalation)		Chronic REL (Oral)		Acute REL	
				( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ ) <sup>-1</sup>	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ ) <sup>-1</sup>	Reference	$\mu\text{g}/\text{m}^3$	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ )	Reference	$\mu\text{g}/\text{m}^3$	Reference
Acenaphthene	83329	1		-	-	-	-	-	-	2.10E+02	EPA 9 PRGs	6.00E-02a	IRIS	-	-
Acenaphthylene	208968	1	Naphthalene	3.40E-05	OEHHA	1.20E-01	OEHHA	-	-	9.00E+00	OEHHA	2.00E-02a	IRIS	7.86E+04	HHRAP
Acetaldehyde	75070	1		2.70E-06	OEHHA	1.00E-02	OEHHA	-	-	9.00E+00	OEHHA	-	-	-	-
Acetone	67641	1		-	-	-	-	-	-	3.30E+03	EPA 9 PRGs	9.00E-01a	IRIS	-	-
Acetonitrile	75058	1		-	-	-	-	-	-	6.00E+01a	IRIS	6.00E-03w	PRTV	-	-
Acetophenone	98862	1		-	-	-	-	-	-	2.00E-02w	PRTV	1.00E-01a	IRIS	3.01E+04	HHRAP
Acetylaminofluorene, 2-	53963	1	2-Nitrofluorene	1.10E-05	OEHHA	3.90E-02	OEHHA	1.20E-01	OEHHA	-	-	-	-	-	-
Acrolein	107028	1		-	-	-	-	-	-	6.00E-02	OEHHA	5.00E-04a	IRIS	1.90E-01	OEHHA
Acrylonitrile	107131	1		2.90E-04	OEHHA	1.00E+00	OEHHA	1.00E+00	OEHHA	5.00E+00	OEHHA	1.00E-03b	HEAST	21700x	HHRAP
Allyl chloride	107051	1		6.00E-06	OEHHA	2.10E-02	OEHHA	2.10E-02	OEHHA	1.00E+00	IRIS	5.00E-02w	PRTV	-	-
Aluminum	7429905	1		-	-	-	-	-	-	5.00E+00	PRTV	1.00E+00	PRTV	-	-
Aminobiphenyl, 4-	92671	1		6.00E-03	OEHHA	2.10E+01	OEHHA	2.10E+01	OEHHA	-	-	-	-	-	-
Aminopyridine, 4-	504245	2		-	-	-	-	-	-	7.00E-02	EPA 9 PRGs	2.00E-05b	HEAST	-	-
Ammonia	7664417	1		-	-	-	-	-	-	2.00E+02	OEHHA	-	-	3.20E+03	OEHHA
Aniline	62533	1		1.60E-06	OEHHA	5.70E-03	OEHHA	5.70E-03a	OEHHA	1.00E+00	OEHHA	7.00E-03	IRIS	3.05E+04	HHRAP
Anthracene	120127	1		-	-	-	-	-	-	1.05E+03	EPA 9 PRGs	3.00E-01a	IRIS	-	-
Antimony and chemicals	7440360	1		-	-	-	-	-	-	2.00E-01	OEHHA	4.00E-04a	IRIS	1.49E+03	HHRAP
Arsenic	7440382	1		3.30E-03	OEHHA	1.20E+01	OEHHA	9.45E+00	OEHHA	3.00E-02	OEHHA	3.00E-04	OEHHA	1.90E-01	OEHHA
Azobenzene	103333	1		3.10E-05a	OEHHA	1.10E-01	OEHHA	1.10E-01	OEHHA	-	-	-	-	-	-
Barium	7440393	1		-	-	-	-	-	-	5.00E-01b,c	HEAST	7.00E-02a	IRIS	1.52E+03	HHRAP
Benzaldehyde	100527	1		-	-	-	-	-	-	3.50E+02	EPA 9 PRGs	1.00E-01a	IRIS	-	-
Benzene	71432	1		2.90E-05	OEHHA	1.00E-01	OEHHA	1.00E-01	OEHHA	6.00E+01	OEHHA	4.00E-03a	IRIS	1.30E+03	OEHHA
Benidine	92875	1		1.40E-01	OEHHA	5.00E+02	OEHHA	5.00E+02	OEHHA	1.00E+01	OEHHA	3.00E-03a	IRIS	-	-
Benzo(A)Anthracene	56553	1		1.10E-04	OEHHA	3.90E-01	OEHHA	1.20E+00	OEHHA	-	-	-	-	-	-
Benzo(A)pyrene	50328	1		1.10E-03	OEHHA	3.90E+00	OEHHA	1.20E+01	OEHHA	-	-	-	-	1.00E+03	HHRAP
Benzo(b)fluoranthene	205992	1		1.10E-04	OEHHA	3.90E-01	OEHHA	1.20E+00	OEHHA	-	-	-	-	-	-
Benzo(k)fluoranthene	207089	1		1.10E-04	OEHHA	3.90E-01	OEHHA	1.20E+00	OEHHA	-	-	-	-	-	-
Benzo[g,h,i]perylene	191242	1	Chrysene	1.10E-05	OEHHA	3.90E-02	OEHHA	1.20E-01	OEHHA	-	-	-	-	2.99E+02	HHRAP
Benzofuran, 2,3-	271896	1	Dibenzofuran	-	-	-	-	-	-	1.40E+01	EPA 9 PRGs	4.00E-03v	PRTV	-	-
Benzoic acid	65850	1		-	-	-	-	-	-	1.40E+04	EPA 9 PRGs	4.00E+00a	IRIS	-	-
Benzyl alcohol	100516	1		-	-	-	-	-	-	1.05E+03	EPA 9 PRGs	3.00E-01b	HEAST	-	-
Benzyl chloride	100447	1		4.90E-05	OEHHA	1.70E-01	OEHHA	1.70E-01a	OEHHA	1.20E+01	OEHHA	2.90E-03	EPA 9 PRGs	2.40E+02	OEHHA
Beryllium	7440417	1		2.40E-03	OEHHA	8.40E+00	OEHHA	4.30E+00w	IRIS	7.00E-03	OEHHA	2.00E-03	OEHHA	9.95E+00	HHRAP
Biphenyl, 1,1-	92524	1		-	-	-	-	-	-	1.75E+02	EPA 9 PRGs	5.00E-02a	IRIS	-	-
Bis(2-chloro-1-methylethyl)ether	108601	2		1.00E-05b	HEAST	3.50E-02	HEAST	7.00E-02b	HEAST	1.30E-01	EPA 9 PRGs	4.00E-02	EPA 9 PRGs	-	-
Bis(2-chloroethyl)ether	111444	1		7.10E-04	OEHHA	2.50E+00	OEHHA	2.50E+00	OEHHA	-	-	-	-	5.85E+04	HHRAP
Bis(2-chloroisopropyl)ether	39638329	1		1.00E-05	EPA 9 PRGs	3.50E-02	EPA 9 PRGs	7.00E-02	EPA 9 PRGs	1.90E-01	EPA 9 PRGs	4.00E-02	IRIS	-	-
Bis(2-ethylhexyl)phthalate (DEHP)	117817	1		2.40E-06	OEHHA	8.40E-03	OEHHA	8.40E-03	OEHHA	7.00E+01	OEHHA	2.00E-02a	IRIS	-	-
Bis(chloromethyl)ether	542881	2		1.30E-02	OEHHA	4.60E+01	OEHHA	4.60E+01	OEHHA	-	-	-	-	-	-
Bromodichloromethane	75274	1		3.70E-05	OEHHA	1.30E-01	OEHHA	1.30E-01	OEHHA	1.10E-01	EPA 9 PRGs	2.00E-02a	IRIS	-	-
Bromoform (tribromomethane)	75252	1		1.10E-06a	IRIS	3.85E-03	IRIS	7.90E-03a	IRIS	1.10E-01	EPA 9 PRGs	2.00E-02a	IRIS	1.55E+04	HHRAP
Bromomethane	74839	1		-	-	-	-	-	-	5.00E+00	OEHHA	1.40E-03a	IRIS	3.90E+03	OEHHA
Butadiene-1,3	106990	1		1.70E-04	OEHHA	6.00E-01	OEHHA	3.40E+00	OEHHA	2.00E+01	OEHHA	5.7E-03	EPA 9 PRGs	-	-

Table 5-2. Cancer Toxicity Factors and Chronic and Acute Noncancer RELs (Continued)

Chemical of Concern	CAS Number	Quadrant	Surrogate	Cancer URF (Inhalation)		Cancer Potency Factor (Inhalation)		Cancer Oral Slope Factor		Chronic REL (Inhalation)		Chronic REL (Oral)		Acute REL	
				( $\mu\text{g}/\text{m}^3$ ) <sup>1</sup>	Reference	( $\text{mg}/\text{kg}\text{-d}$ ) <sup>1</sup>	Reference	( $\text{mg}/\text{kg}\text{-d}$ ) <sup>1</sup>	Reference	$\mu\text{g}/\text{m}^3$	Reference	( $\text{mg}/\text{kg}\text{-d}$ )	Reference	$\mu\text{g}/\text{m}^3$	Reference
Butanol, 1-	71363	1		-	-	-	-	-	-	9.10E+00	EPA 9 PRGs	1.00E-01a	IRIS	-	-
Butyl benzyl phthalate	85687	1		-	-	-	-	-	-	7.00E+02	EPA 9 PRGs	2.00E-01a	IRIS	-	-
Butylacrylate	141322	1	Ethylacrylate	1.37E-05	EPA 9 PRGs	4.80E-02	EPA 9 PRGs	4.80E-02b	HEAST	4.80E+01	OEHHA	-	-	-	-
Butylbenzene, n-	104518	1		-	-	-	-	-	-	1.40E+02	EPA 9 PRGs	4.00E-02	EPA 9 PRGs	-	-
Butylbenzene, T-	98066	1		-	-	-	-	-	-	1.40E+02	EPA 9 PRGs	4.00E-02	EPA 9 PRGs	-	-
Cadmium	7440439	1		4.20E-03	OEHHA	1.50E+01	OEHHA	3.80E-01	OEHHA	2.00E-02	OEHHA	5.00E-04	OEHHA	2.99E+01	HHRAP
Carbazole	86748	1		5.71E-06	EPA 9 PRGs	2.00E-02	EPA 9 PRGs	2.00E-02b	HEAST	-	-	-	-	-	-
Carbon Monoxide	630080	1		-	-	-	-	-	-	-	-	-	-	2.30E+04	OEHHA
Carbon tetrachloride	56235	1		4.20E-05	OEHHA	1.50E-01	OEHHA	1.50E-01	OEHHA	4.00E+01	OEHHA	7.00E-04a	IRIS	1.90E+03	OEHHA
Chlorine	7782505	1		-	-	-	-	-	-	2.00E-01	OEHHA	1.00E-01a	IRIS	2.10E+02	OEHHA
Chloroacetophenone, 2-	532274	1		-	-	-	-	-	-	3.00E-02	OEHHA	8.60E-06	EPA 9 PRGs	-	-
Chloroaniline, 4-	106478	1		-	-	-	-	-	-	1.40E+01	EPA 9 PRGs	4.00E-03a	IRIS	3.00E+04	HHRAP
Chlorobenzene	108907	1		-	-	-	-	-	-	1.00E+03	OEHHA	2.00E-02a	IRIS	3.45E+05	HHRAP
Chloroethane (Ethyl chloride)	75003	1		8.29E-07	EPA 9 PRGs	2.90E-03	EPA 9 PRGs	2.90E-03	EPA 9 PRGs	3.00E+04	OEHHA	4.00E-01	EPA 9 PRGs	-	-
Chloroform	67663	1		5.30E-06	OEHHA	1.90E-02	OEHHA	3.10E-02	OEHHA	3.00E+02	OEHHA	1.00E-02a	IRIS	1.50E+02	OEHHA
Chloromethane (Methyl chloride)	74873	1		1.80E-06b	HEAST	6.30E-03	HEAST	1.30E-02b	HEAST	9.00E+01a	IRIS	2.6E-02	EPA 9 PRGs	2.07E+05	HHRAP
Chloronaphthalene	91587	1		-	-	-	-	-	-	2.80E+02	EPA 9 PRGs	8.00E-02a	IRIS	5.99E+02	HHRAP
Chloronitrobenzene, o-	88733	2		2.77E-06	EPA 9 PRGs	9.70E-03	EPA 9 PRGs	9.70E-03	HEAST	7.00E-02	PRTV	1.00E-03	PRTV	-	-
Chlorophenol, 2-	95578	1		-	-	-	-	-	-	1.80E+01	EPA 9 PRGs	5.00E-03a	IRIS	6.31E+03	HHRAP
Chloropicrin (trichloronitromethane)	76062	2		-	-	-	-	-	-	4.00E-01	OEHHA	-	-	2.90E+01	OEHHA
Chlorotoluene, o-	95498	1		-	-	-	-	-	-	7.00E+01	EPA 9 PRGs	2.00E-02a	IRIS	-	-
Chromium (hex.)	18540299	1		1.50E-01	OEHHA	5.10E+02	OEHHA	-	-	2.00E-01	OEHHA	2.00E-02	OEHHA	1.50E+02	HHRAP
Chromium III	16065831	1		-	-	-	-	-	-	-	-	1.50E+00a	IRIS	1.49E+03	HHRAP
Chrysene	218019	1		1.10E-05	OEHHA	3.90E-02	OEHHA	1.20E-01	OEHHA	-	-	-	-	2.99E+02	HHRAP
Cobalt	7440484	1		2.80E-03	PRTV	9.80E+00	PRTV	-	-	2.00E-02	PRTV	2.00E-02	PRTV	-	-
Copper	7440508	1		-	-	-	-	-	-	2.40E+00	OEHHA	4.00E-02b,f	HEAST	1.00E+02	OEHHA
Cumene (Isopropylbenzene)	98828	1		-	-	-	-	-	-	4.00E+02a	IRIS	1.00E-01a	IRIS	-	-
Cyclohexane	110827	1		-	-	-	-	-	-	6.00E+03a	IRIS	1.70E+00	EPA 9 PRGs	-	-
Diaminotoluene, 2,4-	95807	2		1.10E-03	OEHHA	4.00E+00	OEHHA	3.80E+00	OEHHA	-	-	-	-	-	-
Diazomethane	334883	2	Bromomethane	-	-	-	-	-	-	5.00E+00	OEHHA	1.40E-03a	IRIS	3.90E+03	OEHHA
Dibenz[a,h]anthracene	53703	1		1.20E-03	OEHHA	4.10E+00	OEHHA	4.10E+00	OEHHA	-	-	-	-	3.01E+04	HHRAP
Dibenzofuran	132649	1		-	-	-	-	-	-	7.3E+00	EPA 9 PRGs	4.00E-03v	PRTV	-	-
Dibromochloromethane	124481	1		2.70E-05	OEHHA	9.40E-02	OEHHA	9.40E-02	OEHHA	7.00E+01	EPA 9 PRGs	2.00E-02a	IRIS	-	-
Dibutyl phthalate	84742	2		-	-	-	-	-	-	3.50E+02	EPA 9 PRGs	1.00E-01a	IRIS	1.50E+04	HHRAP
Dichlorobenzene, 1,2-	95501	1		-	-	-	-	-	-	2.00E+02b,c	HEAST	9.00E-02a	IRIS	3.01E+05	HHRAP
Dichlorobenzene, 1,3-	541731	1		-	-	-	-	-	-	1.1E+02	EPA 9 PRGs	3.0E-02	EPA 9 PRGs	-	-
Dichlorobenzene, 1,4-	106467	1		1.10E-05	OEHHA	4.00E-02	OEHHA	5.40E-03	OEHHA	8.00E+02	OEHHA	3.00E-02	EPA 9 PRGs	6.61E+05	HHRAP
Dichlorobenzidine, 3,3-	91941	1		3.40E-04	OEHHA	1.20E+00	OEHHA	1.20E+00	OEHHA	-	-	-	-	6.21E+03	HHRAP
Dichlorodifluoromethane	75718	1		-	-	-	-	-	-	2.00E+02b,c	HEAST	2.00E-01b	HEAST	1.48E+07	HHRAP
Dichloroethane, 1,1-	75343	1		1.60E-06	OEHHA	5.70E-03	OEHHA	5.70E-03	OEHHA	5.00E+02b,c	HEAST	1.00E-01b	HEAST	1.21E+06	HHRAP
Dichloroethane, 1,2-	107062	1		2.20E-05	OEHHA	7.20E-02	OEHHA	4.70E-02	OEHHA	4.00E+02	OEHHA	3.00E-02	EPA 9 PRGs	8.09E+03	HHRAP
Dichloroethylene (cis), 1,2-	156592	1		-	-	-	-	-	-	3.50E+01	EPA 9 PRGs	1.00E-02	PRTV	-	-
Dichloroethylene (trans), 1,2-	156605	1		-	-	-	-	-	-	7.00E+01	EPA 9 PRGs	2.00E-02a	IRIS	-	-

Table 5-2. Cancer Toxicity Factors and Chronic and Acute Noncancer RELs (Continued)

Chemical of Concern	CAS Number	Quadrant	Surrogate	Cancer URF (Inhalation)		Cancer Potency Factor (Inhalation)		Cancer Oral Slope Factor		Chronic REL (Inhalation)		Chronic REL (Oral)		Acute REL	
				( $\mu\text{g}/\text{m}^3$ ) <sup>1</sup>	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ ) <sup>1</sup>	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ ) <sup>1</sup>	Reference	$\mu\text{g}/\text{m}^3$	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ )	Reference	$\mu\text{g}/\text{m}^3$	Reference
Dichloroethylene, 1,1- (Dichloroethene, 1,1-)	75354	1		5.00E-05	PRTV	1.75E-01	PRTV	6.00E-01w	PRTV	7.00E+01	OEHHA	5.00E-02a	IRIS	7.93E+04	HHRAP
Dichlorophenol, 2,4-	120832	1		-	-	-	-	-	-	1.05E+01	EPA 9 PRGs	3.00E-03a	IRIS	3.00E+04	HHRAP
Dichloropropane, 1,2-	78875	1		1.00E-05	OEHHA	3.60E-02	OEHHA	3.60E-02	OEHHA	4.00E+00a	IRIS	1.10E-03	EPA 9 PRGs	5.08E+05	HHRAP
Dichloropropene, 1,3-	542756	1		1.60E-05	OEHHA	5.50E-02	OEHHA	9.10E-02	OEHHA	2.00E+01a	IRIS	3.00E-02a	IRIS	1.36E+04	HHRAP
Diesel PM	9901	N/A		3.00E-04	OEHHA	1.10E+00	OEHHA	-	-	5.00E+00	OEHHA	-	-	-	-
Diethyl ether (Ethyl ether)	60297	1		-	-	-	-	-	-	7.00E+02	EPA 9 PRGs	2.00E-01a	IRIS	-	-
Diethyl phthalate	84662	1		-	-	-	-	-	-	2.80E+03	EPA 9 PRGs	8.00E-01a	IRIS	1.50E+04	HHRAP
Dimethyl Phthalate	131113	1		-	-	-	-	-	-	3.50E+04	EPA 9 PRGs	1.00E+01w	PRTV	-	-
Dimethylamine	124403	2		-	-	-	-	-	-	2.10E-02	OEHHA	5.70E-06	EPA 9 PRGs	-	-
Dimethylbenz(a)anthracene, 7,12-	57976	1		7.10E-02	OEHHA	2.50E+02	OEHHA	2.50E+02	OEHHA	-	-	-	-	-	-
Dimethylbenzidine, 3,3'-	119937	1		2.63E-03	EPA 9 PRGs	2.3E+00	EPA 9 PRGs	2.30E+00	HEAST	-	-	-	-	-	-
Dimethylcarbamoyl chloride	79447	2		3.70E-03	OEHHA	1.30E+01	OEHHA	1.30E+01	OEHHA	-	-	-	-	-	-
Dimethylhydrazine, 1,2-	540738	2		1.60E-01	OEHHA	5.50E+02	OEHHA	5.50E+02	OEHHA	-	-	-	-	-	-
Dimethylphenol, 2,4-	105679	1		-	-	-	-	-	-	7.00E+01	EPA 9 PRGs	2.00E-02a	IRIS	-	-
Dinitrobenzene, 1,2-	528290	2		-	-	-	-	-	-	3.50E-01	EPA 9 PRGs	1.00E-04	HEAST	-	-
Dinitrobenzene, 1,3-	99650	1		-	-	-	-	-	-	3.50E-01	EPA 9 PRGs	1.00E-04a	IRIS	-	-
Dinitrobenzene, 1,4-	100254	2		-	-	-	-	-	-	3.50E-01	EPA 9 PRGs	1.00E-04	HEAST	-	-
Dinitro-o-cresol, 4,6-	534521	2	2,4-Dinitrophenol	-	-	-	-	-	-	7.00E+00	EPA 9 PRGs	1.00E-04	PRTV	9.79E+02	HHRAP
Dinitrophenol, 2,4-	51285	1		-	-	-	-	-	-	7.00E+00	EPA 9 PRGs	2.00E-03a	IRIS	9.79E+02	HHRAP
Dinitropyrene, 1,6-	42397648	1		1.10E-02	OEHHA	3.90E+01	OEHHA	1.20E+02	OEHHA	-	-	-	-	-	-
Dinitrotoluene, 2,4-	121142	1		8.90E-05	OEHHA	3.10E-01	OEHHA	3.10E-01	OEHHA	7.00E+00	EPA 9 PRGs	2.00E-03a	IRIS	4.47E+02	HHRAP
Dinitrotoluene, 2,6-	606202	1		-	-	-	-	6.80E-01a,g	IRIS	3.50E+00	EPA 9 PRGs	1.00E-03b	HEAST	4.47E+02	HHRAP
Di-n-octyl phthalate	117840	1		-	-	-	-	-	-	1.40E+02	EPA 9 PRGs	4.00E-02	PRTV	-	-
Dioxane, 1,4-	123911	1		7.70E-06	OEHHA	2.70E-02	OEHHA	2.70E-02	OEHHA	3.00E+03	OEHHA	-	-	3.00E+03	OEHHA
Diphenylamine	122394	1		-	-	-	-	-	-	8.75E+01	EPA 9 PRGs	2.50E-02a	IRIS	-	-
Ethoxyethanol, 2-	110805	2		-	-	-	-	-	-	7.00E+01	OEHHA	4.00E-01b	HEAST	3.70E+02	OEHHA
Ethylbenzene	100414	1		1.10E-06	PRTV	3.85E-03	PRTV	-	-	2.00E+03	OEHHA	1.00E-01a,v,w	IRIS	5.43E+05	HHRAP
Ethylene	74851	1	Propylene	-	-	-	-	-	-	3.00E+03	OEHHA	-	-	-	-
Ethyleneimine (Aziridine)	151564	2		1.90E-02	OEHHA	6.50E+01	OEHHA	6.50E+01	OEHHA	-	-	-	-	-	-
Fluoranthene	206440	1		-	-	-	-	-	-	1.40E+02	EPA 9 PRGs	4.00E-02a	IRIS	-	-
Fluorene	86737	1		-	-	-	-	-	-	1.40E+02	EPA 9 PRGs	4.00E-02a	IRIS	-	-
Fluorotrichloromethane (Trichlorofluoromethane)	75694	1		-	-	-	-	-	-	7.00E+02	OEHHA	3.00E-01a	IRIS	2.81E+06	HHRAP
Formaldehyde	50000	1		6.00E-06	OEHHA	2.10E-02	OEHHA	-	-	3.00E+00	OEHHA	2.00E-01a	IRIS	9.40E+01	OEHHA
Furan (Epoxy-1,3-butadiene, 4-)	110009	1		-	-	-	-	-	-	3.50E+00	EPA 9 PRGs	1.00E-03a	IRIS	-	-
Glutaraldehyde	111308	2		-	-	-	-	-	-	8.00E-02	OEHHA	-	-	-	-
Heptachlorodibenzofuran, 1,2,3,4,6,7,8-	67562394	1		3.80E-01	OEHHA	1.30E+03	OEHHA	1.30E+01	OEHHA	4.00E-03	OEHHA	1.00E-06	OEHHA	-	-
Heptachlorodibenzofuran, 1,2,3,4,7,8,9-	55673897	1		3.80E-01	OEHHA	1.30E+03	OEHHA	1.30E+01	OEHHA	4.00E-03	OEHHA	1.00E-06	OEHHA	-	-
Heptachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8-	35822469	1		3.80E-01	OEHHA	1.30E+03	OEHHA	1.30E+01	OEHHA	4.00E-03	OEHHA	1.00E-06	OEHHA	-	-
Hexachlorobenzene	118741	1		5.10E-04	OEHHA	1.80E+00	OEHHA	1.80E+00	OEHHA	2.80E+00	OEHHA	8.00E-04	IRIS	7.45E+01	HHRAP

Table 5-2. Cancer Toxicity Factors and Chronic and Acute Noncancer RELs (Continued)

Chemical of Concern	CAS Number	Quadrant	Surrogate	Cancer URF (Inhalation)		Cancer Potency Factor (Inhalation)		Cancer Oral Slope Factor		Chronic REL (Inhalation)		Chronic REL (Oral)		Acute REL	
				( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference	( $\text{mg}/\text{kg}\text{-d}$ ) <sup>-1</sup>	Reference	( $\text{mg}/\text{kg}\text{-d}$ ) <sup>-1</sup>	Reference	$\mu\text{g}/\text{m}^3$	Reference	( $\text{mg}/\text{kg}\text{-d}$ )	Reference	$\mu\text{g}/\text{m}^3$	Reference
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	87683	1		2.20E-05a	IRIS	7.70E-02	IRIS	7.80E-02a	IRIS	8.60E-02	EPA 9 PRGs	2.00E-04b	HEAST	32000x	HHRAP
Hexachlorodibenzofuran, 1,2,3,4,7,8-	70648269	1		3.80E+00	OEHHA	1.30E+04	OEHHA	1.30E+01	OEHHA	4.00E-04	OEHHA	1.00E-07	OEHHA	-	-
Hexachlorodibenzofuran, 1,2,3,6,7,8-	57117449	1		3.80E+00	OEHHA	1.30E+04	OEHHA	1.30E+04	OEHHA	4.00E-04	OEHHA	1.00E-07	OEHHA	-	-
Hexachlorodibenzofuran, 1,2,3,7,8,9-	72918219	1		3.80E+00	OEHHA	1.30E+04	OEHHA	1.30E+01	OEHHA	4.00E-04	OEHHA	1.00E-07	OEHHA	-	-
Hexachlorodibenzofuran, 2,3,4,6,7,8-	60851345	1		3.80E+00	OEHHA	1.30E+04	OEHHA	1.30E+04	OEHHA	4.00E-04	OEHHA	1.00E-07	OEHHA	-	-
Hexachlorodibenzo-p-Dioxin, 1,2,3,4,7,8-	39227286	1		3.80E+00	OEHHA	1.30E+04	OEHHA	1.30E+01	OEHHA	4.00E-04	OEHHA	1.00E-07	OEHHA	-	-
Hexachlorodibenzo-p-Dioxin, 1,2,3,6,7,8-	57653857	1		3.80E+00	OEHHA	1.30E+04	OEHHA	1.30E+01	OEHHA	4.00E-04	OEHHA	1.00E-07	OEHHA	-	-
Hexachlorodibenzo-p-Dioxin, 1,2,3,7,8,9-	19408743	1		3.80E+00	OEHHA	1.30E+04	OEHHA	1.30E+04	OEHHA	4.00E-04	OEHHA	1.00E-07	OEHHA	-	-
Hexachloroethane	67721	1		1.10E-05	OEHHA	3.90E-02	OEHHA	3.90E-02	OEHHA	3.50E+00	EPA 9 PRGs	1.00E-03a	IRIS	2.90E+04	HHRAP
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	1		3.14E-05	EPA 9 PRGs	1.10E-01	EPA 9 PRGs	1.10E-01a	IRIS	1.05E+01	EPA 9 PRGs	3.00E-03a	IRIS	-	-
Hexane, n-	110543	1		-	-	-	-	-	-	7.00E+03	OEHHA	6.00E-02b	HEAST	-	-
Hydrogen chloride	7647010	1		-	-	-	-	-	-	9.00E+00	OEHHA	-	-	2.10E+03	OEHHA
Hydrogen Cyanide	74908	1		-	-	-	-	-	-	9.00E+00	OEHHA	2.00E-02a	IRIS	3.40E+02	OEHHA
Indeno[1,2,3-cd]pyrene	193395	1		1.10E-04	OEHHA	3.90E-01	OEHHA	1.20E+00	OEHHA	-	-	-	-	-	-
Iron	7439896	1		-	-	-	-	-	-	5.00E+03	NIOSH	-	-	2.50E+06	NIOSH
Isophorone	78591	1		2.71E-07	EPA 9 PRGs	9.50E-04	EPA 9 PRGs	9.50E-04a	IRIS	2.00E+03	OEHHA	2.00E-01a	IRIS	-	-
Isoprene	9003310	1	Propylene	-	-	-	-	-	-	3.00E+03	OEHHA	-	-	-	-
Lead*	7439921	1		1.20E-05	OEHHA	4.20E-02	OEHHA	8.50E-03	OEHHA	-	-	-	-	3.81E+01	HHRAP
Malononitrile	109773	2		-	-	-	-	-	-	7.00E-02	EPA 9 PRGs	1.00E-04	PRTV	-	-
Manganese	7439965	2		-	-	-	-	-	-	2.00E-01	OEHHA	1.40E-01a,m	IRIS	-	-
Mercury	7439976	2		-	-	-	-	-	-	9.00E-02	OEHHA	3.00E-04	OEHHA	1.80E+00	OEHHA
Methacrylonitrile	126987	2		-	-	-	-	-	-	7.00E-04b,c	HEAST	1.00E-04a	IRIS	-	-
Methanol	67561	2		-	-	-	-	-	-	4.00E+03	OEHHA	5.00E-01a	IRIS	2.80E+04	OEHHA
Methylcholanthrene, 3-	56495	1		6.30E-03	OEHHA	2.20E+01	OEHHA	2.20E+01	OEHHA	-	-	-	-	-	-
Methylcyclohexane	108872	1		-	-	-	-	-	-	3.00E+03b	HEAST	8.60E-01	EPA 9 PRGs	-	-
Methylene chloride	75092	1		1.00E-06	OEHHA	3.50E-03	OEHHA	1.40E-02	OEHHA	4.00E+02	OEHHA	6.00E-02a	IRIS	1.40E+04	OEHHA
Methylethyl ketone	78933	1		-	-	-	-	-	-	1.00E+03	OEHHA	6.00E-01a	IRIS	1.30E+04	OEHHA
Methylnaphthalene, 2-	91576	1	Naphthalene	3.40E-05	OEHHA	1.20E-01	OEHHA	-	-	9.00E+00	OEHHA	2.00E-02a	IRIS	7.86E+04	HHRAP
Methylphenol, 2-	95487	1		-	-	-	-	-	-	6.00E+02	OEHHA	5.00E-02a	IRIS	66300y	HHRAP
Methylphenol, 3-	108394	1		-	-	-	-	-	-	6.00E+02	OEHHA	5.00E-02a	IRIS	66300y	HHRAP
Methylphenol, 4-	106445	1		-	-	-	-	-	-	6.00E+02	OEHHA	5.00E-03b	HEAST	66300y	HHRAP
Methyltertbutyl ether (MTBE)	1634044	1		2.60E-07	OEHHA	9.10E-04	OEHHA	1.80E-03	OEHHA	8.00E+03	OEHHA	8.57E-01	EPA 9 PRGs	-	-
Molybdenum	7439987	1		-	-	-	-	-	-	1.50E+04	OSHA	-	-	5.00E+06	NIOSH
Naphthalene	91203	1		3.40E-05	OEHHA	1.20E-01	OEHHA	-	-	9.00E+00	OEHHA	2.00E-02a	IRIS	7.86E+04	HHRAP
Nickel and chemicals	7440020	1		2.60E-04	OEHHA	9.10E-01	OEHHA	-	-	5.00E-02	OEHHA	5.00E-02	OEHHA	6.00E+00	OEHHA
Nitric Oxide	10102439	1		-	-	-	-	-	-	-	-	1.00E-01w	IRIS	-	-
Nitroacenaphthene, 5-	602879	1		3.70E-05	OEHHA	1.30E-01	OEHHA	1.30E-01	OEHHA	-	-	-	-	-	-
Nitroaniline, 2-	88744	1		-	-	-	-	-	-	1.00E-01	PRTV	3.00E-03	PRTV	-	-

Table 5-2. Cancer Toxicity Factors and Chronic and Acute Noncancer RELs (Continued)

Chemical of Concern	CAS Number	Quadrant	Surrogate	Cancer URF (Inhalation)		Cancer Potency Factor (Inhalation)		Cancer Oral Slope Factor		Chronic REL (Inhalation)		Chronic REL (Oral)		Acute REL	
				( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ ) <sup>-1</sup>	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ ) <sup>-1</sup>	Reference	$\mu\text{g}/\text{m}^3$	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ )	Reference	$\mu\text{g}/\text{m}^3$	Reference
Nitrobenzene	98953	1		-	-	-	-	-	-	1.70E+00	OEHHA	5.00E-04a	IRIS	1.51E+04	HHRAP
Nitrochrysene, 6-	7496028	1		1.10E-02	OEHHA	3.90E+01	OEHHA	1.20E+02	OEHHA	-	-	-	-	-	-
Nitrogen Dioxide	10102440	1		-	-	-	-	-	-	4.70E+02	OEHHA	1.00E+00w	IRIS	4.70E+02	OEHHA
Nitroglycerin	55630	1		4.00E-06	EPA 9 PRGs	1.40E-02	EPA 9 PRGs	1.40E-02	EPA 9 PRGs	-	-	-	-	-	-
Nitroguanidine	556887	1		-	-	-	-	-	-	3.50E+02	EPA 9 PRGs	1.00E-01a	IRIS	-	-
Nitrophenol, 4-	100027	1	2,4-Dinitrophenol	-	-	-	-	-	-	7.00E+00	EPA 9 PRGs	2.00E-03a	IRIS	9.79E+02	HHRAP
Nitropropane, 2-	79469	1		2.70E-03b	HEAST	9.45E+00	HEAST	9.50E+00w	PRTV	2.00E+01	OEHHA	5.71E-03	EPA 9 PRGs	-	-
Nitropyrene, 1-	5522430	1		1.10E-04	OEHHA	3.90E-01	OEHHA	1.20E+00	OEHHA	-	-	-	-	-	-
Nitrosodiethylamine, N-	55185	1		1.00E-02	OEHHA	3.60E+01	OEHHA	3.60E+01	OEHHA	-	-	-	-	-	-
Nitrosodimethylamine, N-	62759	1		4.60E-03	OEHHA	1.60E+01	OEHHA	1.60E+01	OEHHA	1.4E-04	EPA 9 PRGs	8.00E-06	PRTV	-	-
Nitrosodi-n-butylamine, N-	924163	1		3.10E-03	OEHHA	1.10E+01	OEHHA	1.10E+01	OEHHA	-	-	-	-	-	-
Nitrosodi-n-propylamine, N-	621647	1		2.00E-03	OEHHA	7.00E+00	OEHHA	7.00E+00a	OEHHA	-	-	-	-	-	-
Nitrosodiphenylamine, N-	86306	1		2.60E-06	OEHHA	9.00E-03	OEHHA	9.00E-03	OEHHA	1.4E+00	-	2.00E-02	PRTV	-	-
Nitroso-N-methylethylamine, N- (Nitrosomethylethylamine, N-)	10595956	1		6.30E-03	OEHHA	2.20E+01	OEHHA	2.20E+01a	OEHHA	-	-	-	-	-	-
Nitrosopiperidine, N-	100754	1		2.70E-03	OEHHA	9.40E+00	OEHHA	9.40E+00	OEHHA	-	-	-	-	-	-
Nitrosopyrrolidine, N-	930552	1		6.00E-04	OEHHA	2.10E+00	OEHHA	2.10E+00a	OEHHA	-	-	-	-	-	-
Nitrotoluene, o-	88722	1	p-nitrotoluene	-	-	2.3E-01	EPA 9 PRGs	2.30E-01	EPA 9 PRGs	2.9E-02	EPA 9 PRGs	1.00E-02b	HEAST	-	-
Nitrotoluene, p-	99990	1		-	-	1.7E-02	EPA 9 PRGs	1.70E-02	EPA 9 PRGs	4.0E-01	EPA 9 PRGs	1.00E-02	RAIS	-	-
Octachlorodibenzofuran, 1,2,3,4,6,7,8,9-	39001020	1		3.80E-03	OEHHA	1.30E+01	OEHHA	1.30E+01	OEHHA	4.00E-02	OEHHA	1.00E-05	OEHHA	-	-
Octachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8,9-	3268879	1		3.80E-03	OEHHA	1.30E+01	OEHHA	1.30E+01	OEHHA	4.00E-02	OEHHA	1.00E-05	OEHHA	-	-
Pentachlorobenzene	608935	1		-	-	-	-	-	-	2.80E+00	EPA 9 PRGs	8.00E-04a	IRIS	1.00E+03	HHRAP
Pentachlorodibenzofuran, 1,2,3,7,8-	57117416	1		1.90E+00	OEHHA	6.50E+03	OEHHA	6.50E+02	OEHHA	8.00E-04	OEHHA	2.00E-07	OEHHA	-	-
Pentachlorodibenzofuran, 2,3,4,7,8-	57117314	1		1.90E+01	OEHHA	6.50E+04	OEHHA	6.50E+04	OEHHA	8.00E-05	OEHHA	2.00E-08	OEHHA	-	-
Pentachlorodibenzo-p-Dioxin, 1,2,3,7,8-	40321764	1		3.80E+01	OEHHA	1.30E+05	OEHHA	1.30E+05	OEHHA	8.00E-05	OEHHA	2.00E-08	OEHHA	-	-
Pentachloronitrobenzene	82688	1		7.43E-05	EPA 9 PRGs	2.60E-01	EPA 9 PRGs	2.60E-01b	HEAST	1.05E+01	EPA 9 PRGs	3.00E-03a	IRIS	1.45E+03	HHRAP
Pentachlorophenol	87865	1		4.60E-06	OEHHA	1.80E-02	OEHHA	8.10E-02	OEHHA	2.00E-01	OEHHA	3.00E-02a	IRIS	1.53E+03	HHRAP
Perchlorate	7601903	2		-	-	-	-	-	-	-	-	1.00E-04	EPA 9 PRGs	-	-
Phenanthrene	85018	1	Anthracene	-	-	-	-	-	-	1.05E+03	EPA 9 PRGs	3.00E-01a	IRIS	-	-
Phenol	108952	1		-	-	-	-	-	-	2.00E+02	OEHHA	3.00E-01a	IRIS	5.80E+03	OEHHA
Phosgene	75445	2		-	-	-	-	-	-	-	-	-	-	4.00E+00	OEHHA
Phosphorus (white)	7723140	2		-	-	-	-	-	-	7.00E-02	OEHHA	2.00E-05a	IRIS	-	-
Propanol, 2-	67630	1		-	-	-	-	-	-	7.00E+03	OEHHA	-	-	3.20E+03	OEHHA
Propylbenzene, n-	103651	1		-	-	-	-	-	-	1.40E+02	EPA 9 PRGs	4.00E-02	EPA 9 PRGs	-	-
Propylene (Propene)	115071	1		-	-	-	-	-	-	3.00E+03	OEHHA	-	-	-	-
Pyrene	129000	1		-	-	-	-	-	-	1.05E+02	EPA 9 PRGs	3.00E-02a	IRIS	-	-
Pyridine	110861	1		-	-	-	-	-	-	3.50E+00	EPA 9 PRGs	1.00E-03a	IRIS	4.85E+04	HHRAP
Selenium	7782492	2		-	-	-	-	-	-	2.00E+01	OEHHA	5.00E-03a	IRIS	2.94E+00	HHRAP
Silica, Crystalline	1175	2		-	-	-	-	-	-	3.00E+00	OEHHA	-	-	-	-
Strontium	7440246	2		-	-	-	-	-	-	-	-	6.00E-01	IRIS	-	-
Styrene	100425	1		-	-	-	-	-	-	9.00E+02	OEHHA	2.00E-01a	IRIS	2.10E+04	OEHHA
Sulfur Dioxide	7446095	1		-	-	-	-	-	-	6.60E+02	OEHHA	-	-	6.60E+02	OEHHA

Table 5-2. Cancer Toxicity Factors and Chronic and Acute Noncancer RELs (Continued)

Chemical of Concern	CAS Number	Quadrant	Surrogate	Cancer URF (Inhalation)		Cancer Potency Factor (Inhalation)		Cancer Oral Slope Factor		Chronic REL (Inhalation)		Chronic REL (Oral)		Acute REL	
				( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ ) <sup>-1</sup>	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ ) <sup>-1</sup>	Reference	$\mu\text{g}/\text{m}^3$	Reference	( $\text{mg}/\text{kg}\cdot\text{d}$ )	Reference	$\mu\text{g}/\text{m}^3$	Reference
Sulfuric acid	7664939	2		-	-	-	-	-	-	1.00E+00	OEHHA	-	-	1.20E+02	OEHHA
Tetrachlorobenzene, 1,2,4,5-	95943	1		-	-	-	-	-	-	1.05E+00	EPA 9 PRGs	3.00E-04a	IRIS	3.00E+04	HHRAP
Tetrachlorodibenzofuran, 2,3,7,8- Tetrachlorodibenzo-p-Dioxin, 2,3,7,8-	51207319	1		3.80E+00	OEHHA	1.30E+04	OEHHA	1.30E+04	OEHHA	4.00E-04	OEHHA	1.00E-07	OEHHA	-	-
Tetrachloroethane, 1,1,2,2-	79345	1		3.80E+01	OEHHA	1.30E+05	OEHHA	1.30E+05	OEHHA	4.00E-05	OEHHA	1.00E-08	OEHHA	-	-
Tetrachloroethylene (PCE)	127184	1		5.80E-05	OEHHA	2.00E-01	OEHHA	2.70E-01	OEHHA	2.10E+02	EPA 9 PRGs	6.00E-02	PRTV	2.06E+04	HHRAP
Tetrachlorophenol, 2,3,4,6-	58902	1		5.90E-06	OEHHA	2.10E-02	OEHHA	5.40E-01	OEHHA	3.50E+01	OEHHA	1.00E-02a	IRIS	2.00E+04	OEHHA
Tetrachlorophenol, 2,3,4,6-	58902	1		-	-	-	-	-	-	8.80E+01	OEHHA	3.00E-02a	IRIS	-	-
Tetranitro-N-methylaniline, N,2,4,6- (Tetryl, Trinitrophenylmethylnitramine)	479458	1		-	-	-	-	-	-	3.50E+01	EPA 9 PRGs	1.00E-02b	HEAST	-	-
Thallium and chemicals	7446186	1		-	-	-	-	-	-	-	-	8.00E-05a	IRIS	1.34E+02	HHRAP
Toluene	108883	1		-	-	-	-	-	-	3.00E+02	OEHHA	2.00E-01a	IRIS	3.70E+04	OEHHA
Toluidine, o- (Methylaniline, 2-)	95534	1		6.86E-05	EPA 9 PRGs	2.40E-01	EPA 9 PRGs	2.40E-01b	HEAST	-	-	-	-	2.63E+04	HHRAP
Total HpCDD	35822469	1		3.80E-01	OEHHA	1.30E+03	OEHHA	1.30E+04	OEHHA	4.00E-03	OEHHA	1.00E-06	OEHHA	-	-
Total HpCDF	67562394	1		3.80E-01	OEHHA	1.30E+03	OEHHA	1.30E+03	OEHHA	4.00E-03	OEHHA	1.00E-06	OEHHA	-	-
Total HxCDD	19408743	1		3.80E+00	OEHHA	1.30E+04	OEHHA	1.30E+04	OEHHA	4.00E-04	OEHHA	1.00E-07	OEHHA	-	-
Total HxCDF	57117449	1		3.80E+00	OEHHA	1.30E+04	OEHHA	1.30E+04	OEHHA	4.00E-04	OEHHA	1.00E-07	OEHHA	-	-
Total PeCDD	40321764	1		1.90E+01	OEHHA	1.30E+05	OEHHA	6.50E+04	OEHHA	8.00E-05	OEHHA	2.00E-08	OEHHA	-	-
Total PeCDF	57117314	1		1.90E+01	OEHHA	6.50E+04	OEHHA	6.50E+04	OEHHA	8.00E-05	OEHHA	2.00E-08	OEHHA	-	-
Total TCDD	1746016	1		3.80E+01	OEHHA	1.30E+05	OEHHA	1.30E+05	OEHHA	4.00E-05	OEHHA	1.00E-08	OEHHA	-	-
Total TCDF	51207319	1		3.80E+00	OEHHA	1.30E+04	OEHHA	1.30E+04	OEHHA	4.00E-04	OEHHA	1.00E-07	OEHHA	-	-
Trichlorobenzene, 1,2,4-	120821	1		-	-	-	-	3.60E-03	OEHHA	4.00E+00	IRIS	1.00E-02a	IRIS	2.23E+04	HHRAP
Trichloroethane, 1,1,1- (Methyl chloroform)	71556	1		-	-	-	-	-	-	1.00E+03	OEHHA	2.00E-01v	PRTV	6.80E+04	OEHHA
Trichloroethane, 1,1,2-	79005	1		1.60E-05	OEHHA	5.70E-02	OEHHA	7.20E-02	OEHHA	1.40E+01	EPA 9 PRGs	4.00E-03a	IRIS	1.64E+05	HHRAP
Trichloroethylene (TCE)	79016	1		2.00E-06	OEHHA	7.00E-03	OEHHA	1.30E-02	OEHHA	6.00E+02	OEHHA	3.00E-04ah	IRIS	537000x	HHRAP
Trichlorophenol, 2,4,5-	95954	1		-	-	-	-	-	-	3.50E+02	EPA 9 PRGs	1.00E-01a	IRIS	2.99E+04	HHRAP
Trichlorophenol, 2,4,6-	88062	1		2.00E-05	OEHHA	7.00E-02	OEHHA	7.00E-02	OEHHA	3.50E-01	EPA 9 PRGs	1.00E-04	EPA 9 PRGs	-	-
Trimethylbenzene, 1,2,4-	95636	1		-	-	-	-	-	-	6.00E+00v	PRTV	5.00E-02v	PRTV	-	-
Trimethylbenzene, 1,3,5-	108678	1		-	-	-	-	-	-	6.00E+00	PRTV	5.00E-02	PRTV	-	-
Trimethylpentane, 2,2,4-	540841	1	Methylcyclo-hexane	-	-	-	-	-	-	3.00E+03b	HEAST	8.60E-01	EPA 9 PRGs	-	-
Trinitrobenzene, 1,3,5-	99354	1		-	-	-	-	-	-	1.05E+02	EPA 9 PRGs	3.00E-02a	IRIS	3.00E+04	HHRAP
Trinitrotoluene, 2,4,6- (TNT)	118967	1		8.57E-06	EPA 9 PRGs	3.00E-02	EPA 9 PRGs	3.00E-02a	IRIS	2.20E-01	EPA 9 PRGs	5.00E-04a	IRIS	-	-
Urethane (Ethyl carbamate)	51796	2		2.90E-04	OEHHA	1.00E+00	OEHHA	1.00E+00	OEHHA	-	-	-	-	-	-
Vanadium and chemicals	7440622	1		-	-	-	-	-	-	-	-	7.00E-03b	HEAST	3.00E+01	OEHHA
Vinyl acetate	108054	1		-	-	-	-	-	-	2.00E+02	OEHHA	1.00E+00b	HEAST	17600x	HHRAP
Vinyl Chloride	75014	1		7.80E-05	OEHHA	2.70E-01	OEHHA	2.70E-01	OEHHA	2.60E+01	OEHHA	3.00E-03a	IRIS	1.80E+05	OEHHA
Xylenes	1330207	1		-	-	-	-	-	-	7.00E+02	OEHHA	2.00E+00b	HEAST	2.20E+04	OEHHA
Zinc	7440666	1		-	-	-	-	-	-	3.50E+01	OEHHA	3.00E-01a	IRIS	-	-

## References (in order of priority):

- 1) OEHHA - Air Toxics Hot Spots Program Risk Assessment Guidelines, Appendix L - Table 1, OEHHA/ARB Approved Health Values for Use in Hot Spot Facility Risk Assessments, August 2003
- 2) IRIS/PRTV/HEAST (RAIS) - Oak Ridge National Laboratory Risk Assessment Information System (RAIS), September 2003 with order: Tier 1 (IRIS), Tier 2 (PRTV), and Tier 3 (HEAST, and other sources).
- 3) HHRAP - US EPA Region 6, Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Table A-4, July 1998.
- 4) RAGS - Risk Assessment Guidance for Superfund (RAGS) (Interim Guidance) (November 1995).
- 5) EPA 9 PRGs - EPA Region 9, PRGs, October 2002 and October 2004.
- 6) NIOSH - NIOSH Publication No. 2005-151 (September 2005).

## Footnotes:

- a. According to RAIS, this value is from the Integrated Risk Information System (IRIS).
- b. According to RAIS, this value is from the Health Effects and Environmental Affects Summary Table (HEAST).
- c. According to RAIS, this value is from the Peer Reviewed Toxicity Values (PRTV).
- f. HEAST concluded that toxicity data were inadequate for calculation of oral RfDs for copper and substituted the current drinking water standard (MCLG) of 1.3 mg/L. The RAIS converts this MCLG to an RfD for chronic and subchronic oral exposure.
- g. Listed as "Dinitrotoluene mixture, 2,4-/2,6-" in IRIS. The value is based on a study using technical grade DNT.
- m. IRIS no longer separates manganese values for chronic oral RfDs into water and diet RfDs. The chronic oral RfD for the total oral intake of manganese is 1.40E-01. However, when assessing exposure to manganese from drinking water or soil, IRIS recommends a modifying factor of 3, thereby lowering the RfD to 4.67E-02, which has been rounded to 4.6e-02. Rounding to 4.7E-02 is more accurate, but makes the value less conservative. HEAST values remain separated into water and diet subchronic RfDs.
- n. The cancer potency of PCB mixtures is determined using a three tiered approach that depends on the information available. Criteria for use of the Risk and Persistence Tier include: food chain exposure; sediment or soil ingestion; dust or aerosol inhalation.
- r. Region 4 has adopted a Toxicity Equivalency Factor (TEF) methodology for carcinogenic polycyclic aromatic hydrocarbons (PAHs) and dioxins and furans on the Target Chemical List as described in Supplemental Guidance from RAGS: Region 4 Bulletins, Human Health Risk Assessment (Interim Guidance) (November 1995). These TEFs are based on potency of each chemicals relative to that of benzo(a)pyrene (BaP) and 2,3,7,8-TCDD. The following TEFs were used to convert each PAH concentration to an equivalent concentration of BaP: 1)benzo(a)pyrene, TEF=1.0; 2) benz(a)anthracene, TEF=0.1; (3)benzo(b)fluoranthene, TEF=0.1; (4)benzo(k)fluoranthene, TEF=0.01; (5) chrysene, TEF=0.001; (6) dibenz(a,h)anthracene, TEF=1.0; (7) indeno(1,2,3-cd)pyrene, TEF=0.1. The following TEFs were used to convert each dioxin and furan concentration to an equivalent concentration of TCDD: (1) 2,3,7,8-TCDD, TEF=1.0; (2) 2,3,7,8-PeCDD, TEF=0.5; (3) 2,3,7,8-HxCDD, TEF=0.1; (4)2,3,7,8-HpCDD, TEF=0.01; (5) OCDD, TEF=0.001; (6) 2,3,7,8 - TCDF, TEF=0.1; (7) 1,2,3,7,8-PeCDF, TEF=0.5; (8)2,3,4,7,8-PeCDF, TEF=0.05; (9) 2,3,7,8-HxCDF, TEF=0.1; (10)2,3,7,8-HpCDF, TEF=0.01; and (11)OCDF, TEF=0.001.
- u. The inhalation Slope Factor was calculated from inhalation unit risk as described in Supplemental Guidance from RAGS: Region 4 Bulletins, Human Health Risk Assessment (Interim Guidance) (November 1995).
- w. This value was withdrawn by NCEA. "The cancer slope factor was withdrawn because of the re-evaluation of the rodent data which does not support genotoxic mode of action based on our proposed cancer guidelines. This chemical is now being reassessed for IRIS which automatically flags further use of any provisional cancer or noncancer assessments." If this chemical is identified as a risk driver, the risk assessor should consult the EPA Superfund Technical Support Center. All withdrawn values should be clearly documented when used in any risk assessment activity.
- ad. The inhalation Unit Risk was calculated from inhalation slope factor as described in Supplemental Guidance from RAGS: Region 4 Bulletins, Human Health Risk Assessment (Interim Guidance) (November 1995).
- ah. These toxicity values present EPA's most current evaluation of the potential health risks from exposure to trichloroethylene (TCE). The citation presented is as follows: 20001. Trichloroethylene Health Risks Assessment: Synthesis and Characterization (External Review Draft). USEPA EPA/600/P-01/002A. 01 August 2001. U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DD,. This NCEA report can be viewed at <http://oaspub.epa.gov/eims/eimsapi.dispdetail?deid=23249>. EPA Region IX and Region III have adopted these toxicity values as well.
- x. According to HHRAP, the TEEL-1 value is based on ERPG-1 value.
- y. According to HHRAP, this value equals TEEL-1 value from sum of all three cresol isomers.
- \*. Lead was only evaluated as a developmental toxicant using Lead Spread Version 7

Table 5-3. Target Organ Systems for Chronic Noncancer Health Effects

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Acenaphthene	83329	3	0	0	0	0	0	0	0	0	0	0	0	3	
Acenaphthylene	208968	0	0	0	0	0	0	0	0	0	0	0	0	3	
Acetaldehyde	75070	0	0	0	0	0	0	0	0	0	0	1	0	0	
Acetone	67641	0	0	0	0	0	3	0	0	0	3	0	3	0	
Acetonitrile	75058	3	0	0	0	0	0	0	0	3	3	0	0	0	
Acetophenone	98862	0	0	0	0	0	0	0	0	0	0	0	0	3	
Acetylaminofluorene, 2-	53963	0	0	0	0	0	0	0	0	0	0	0	0	0	
Acrolein	107028	0	0	0	0	0	1	0	0	0	0	0	1	0	
Acrylonitrile	107131	0	0	0	0	0	0	0	0	0	0	0	1	0	
Allyl chloride	107051	3	0	0	0	0	0	0	0	3	0	0	3	0	
Aluminum	7429905	0	0	0	0	0	3	0	0	0	0	0	3	0	
Aminobiphenyl, 4-	92671	0	0	0	0	0	0	0	0	0	0	0	0	0	
Aminopyridine, 4-	504245	0	0	0	0	0	0	0	0	0	0	0	3	0	
Ammonia	7664417	0	0	0	0	0	0	0	0	0	0	1	0	0	
Aniline	62533	3	0	3	0	0	3	3	0	3	0	0	3	0	
Anthracene	120127	0	0	0	0	0	0	0	0	0	0	0	0	3	
Antimony	7440360	0	0	3	0	0	3	0	0	0	0	0	3	0	
Arsenic	7440382	0	0	3	1	0	0	0	0	0	1	0	0	0	
Azobenzene	103333	0	0	0	0	0	0	0	0	0	0	0	0	0	
Barium	7440393	0	0	0	0	0	0	0	0	3	0	0	0	3	
Benzaldehyde	100527	3	0	0	0	0	0	0	0	3	0	0	0	0	
Benzene	71432	0	0	0	1	0	0	1	0	0	1	0	0	0	
Benidine	92875	3	0	0	0	0	0	3	0	3	0	0	0	0	
Benzo(A)Anthracene	56553	0	0	0	0	0	0	0	0	0	0	0	0	3	
Benzo(A)pyrene	50328	0	0	0	0	0	0	0	0	0	0	0	0	3	
Benzo(b)fluoranthene	205992	0	0	0	0	0	0	0	0	0	0	0	0	3	
Benzo(k)fluoranthene	207089	0	0	0	0	0	0	0	0	0	0	0	0	3	
Benzo[g,h,i]perylene	191242	0	0	0	0	0	0	0	0	0	0	0	0	3	
Benzo[2,3-f]pyrene	271896	0	0	0	0	0	0	0	0	0	0	0	0	3	
Benzoic acid	65850	0	0	0	0	0	0	0	0	0	0	0	0	3	
Benzyl alcohol	100516	0	0	0	0	0	0	0	0	0	0	0	0	3	
Benzyl chloride	100447	0	0	0	0	0	3	0	0	0	3	0	3	0	
Beryllium	7440417	2	0	0	0	0	0	0	1	0	0	0	1	0	
Biphenyl, 1,1'-	92524	3	0	0	0	0	3	0	0	3	3	0	3	0	
Bis(2-chloro-1-methylethyl)ether	108601	0	0	0	0	0	0	0	0	3	0	0	0	3	
Bis(2-chloroethyl)ether	111444	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bis(2-chloroisopropyl)ether	39638329	0	0	0	0	0	0	3	0	0	0	0	0	3	
Bis(2-ethylhexyl)phthalate (DEHP)	117817	3	0	0	0	0	3	0	0	0	3	3	3	0	
Bis(chloromethyl)ether	542881	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bromodichloromethane	75274	0	0	0	0	0	0	0	0	3	0	0	0	3	
Bromoform (tribromomethane)	75252	3	0	0	0	0	3	0	0	3	3	0	3	0	
Bromomethane	74839	0	0	0	1	0	0	0	0	0	1	0	1	0	
Butadiene-1,3	106990	0	0	0	0	0	0	0	0	0	0	1	0	0	
Butanol, 1-	71363	0	0	0	0	0	3	0	0	0	3	0	3	0	
Butyl benzyl phthalate	85687	3	0	0	0	0	0	0	0	0	0	0	0	0	
Butylacrylate	141322	0	0	0	0	0	1	0	0	0	0	0	1	0	

Table 5-3. Target Organ Systems for Chronic Noncancer Health Effects (Continued)

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Butylbenzene, n-	104518	0	0	0	0	0	0	0	0	0	0	0	0	3	
Butylbenzene, T-	98066	0	0	0	0	0	0	0	0	0	0	0	0	3	
Cadmium	7440439	0	0	0	0	0	0	0	0	3	0	0	1	0	
Carbazole	86748	0	0	0	0	0	0	0	0	0	0	0	0	0	
Carbon Monoxide	630080	0	0	0	0	0	0	0	0	0	0	0	0	0	
Carbon tetrachloride	56235	1	0	0	1	0	0	0	0	0	1	0	0	0	
Chlorine	7782505	0	0	0	0	0	0	0	0	0	0	0	1	0	
Chloroacetophenone, 2-	532274	0	0	0	0	0	3	0	0	0	0	0	3	3	
Chloroaniline, 4-	106478	0	0	0	0	0	0	0	3	0	0	0	0	3	
Chlorobenzene	108907	1	0	0	0	0	0	0	0	1	0	1	0	0	
Chloroethane (Ethyl chloride)	75003	1	0	0	1	0	0	0	0	0	0	0	0	0	
Chloroform	67663	1	0	0	1	0	0	0	0	1	0	0	0	0	
Chloromethane (Methyl chloride)	74873	3	0	0	0	0	0	0	0	3	3	3	0	0	
Chloronaphthalene	91587	3	0	0	0	0	0	0	0	0	0	0	0	3	
Chloronitrobenzene, o-	88733	0	0	0	0	0	0	0	0	0	0	0	0	3	
Chlorophenol, 2-	95578	0	0	0	0	0	0	0	0	0	0	3	0	0	
Chloropicrin (trichloronitromethane)	76062	0	0	0	0	0	0	0	0	0	0	0	1	0	
Chlorotoluene, o-	95498	3	0	0	0	0	3	0	0	3	3	0	3	3	
Chromium (hex.)	18540299	0	0	0	0	0	0	2	0	0	0	0	1	0	
Chromium III	16065831	0	0	0	0	0	0	0	0	0	0	0	0	2	
Chrysene	218019	0	0	0	0	0	0	0	0	0	0	0	0	3	
Cobalt	7440484	0	0	0	0	0	0	0	0	0	0	0	3	3	
Copper	7440508	3	0	0	0	0	3	0	0	3	0	0	3	3	
Cumene (Isopropylbenzene)	98828	0	0	0	3	0	3	0	0	3	3	0	3	3	
Cyclohexane	110827	0	0	0	0	0	3	0	0	0	3	0	3	3	
Cyclotetramethylene Tetranitramine (HMX)	2691410	3	0	0	0	0	0	0	0	0	0	0	0	3	
Diaminotoluene, 2,4-	95807	0	0	0	0	0	0	0	0	0	0	0	0	0	
Diazomethane	334883	0	0	0	0	0	3	0	0	0	0	0	3	0	
Dibenz[a,h]anthracene	53703	0	0	0	0	0	0	0	0	0	0	0	0	3	
Dibenzofuran	132649	0	0	0	0	0	0	0	0	0	0	3	0	0	
Dibromochloromethane	124481	3	0	0	0	0	0	0	0	0	0	0	0	3	
Dibutyl phthalate	84742	3	0	0	0	0	3	0	0	0	0	0	3	0	
Dichlorobenzene, 1,2-	95501	3	0	0	0	0	3	0	0	3	0	0	3	3	
Dichlorobenzene, 1,3-	541731	0	0	0	0	0	0	0	0	0	0	0	3	0	
Dichlorobenzene, 1,4-	106467	1	0	0	0	0	0	0	0	1	1	0	1	0	
Dichlorobenzidine, 3,3-	91941	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dichlorodifluoromethane	75718	0	0	3	0	0	0	0	0	0	3	0	0	0	
Dichloroethane, 1,1-	75343	3	0	0	0	0	0	0	0	3	3	0	3	3	
Dichloroethane, 1,2-	107062	1	0	0	0	0	0	0	0	0	0	0	0	0	
Dichloroethylene (cis), 1,2-	156592	0	0	0	0	0	0	0	0	0	0	0	0	3	
Dichloroethylene (trans), 1,2-	156605	0	0	0	0	0	0	0	3	0	0	0	0	3	
Dichloroethylene, 1,1- (Dichloroethene, 1,1-)	75354	1	0	0	0	0	0	0	0	0	0	0	0	0	
Dichlorophenol, 2,4-	120832	0	0	0	0	0	0	0	0	0	3	0	0	3	
Dichloropropane, 1,2-	78875	3	0	0	0	0	3	0	0	3	3	0	3	3	
Dichloropropene, 1,3-	542756	3	0	0	0	0	3	0	0	3	3	0	3	3	
Diesel PM	9901	0	0	0	0	0	0	0	0	0	0	0	1	0	
Diethyl ether (Ethyl ether)	60297	0	0	0	0	0	3	0	0	0	3	0	3	3	
Diethyl phthalate	84662	0	0	0	0	0	3	0	0	0	3	3	3	3	

Table 5-3. Target Organ Systems for Chronic Noncancer Health Effects (Continued)

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Dimethyl Phthalate	131113	3	0	0	0	0	3	0	0	0	0	0	3	0	0
Dimethylamine	124403	0	0	0	0	0	3	0	0	0	0	0	3	3	0
Dimethylbenz(a)anthracene, 7,12-	57976	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Dimethylbenzidine, 3,3'-	119937	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dimethylcarbamoyl chloride	79447	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dimethylhydrazine, 1,2-	540738	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dimethylphenol, 2,4-	105679	0	0	0	0	0	0	3	0	0	0	0	0	0	3
Dinitrobenzene, 1,2-	528290	3	0	3	0	0	3	3	0	0	3	0	0	3	0
Dinitrobenzene, 1,3-	99650	3	0	3	0	0	3	3	0	0	3	0	0	3	0
Dinitrobenzene, 1,4-	100254	3	0	3	0	0	3	3	0	0	3	0	0	3	0
Dinitro-o-cresol, 4,6-	534521	0	0	3	0	3	0	0	0	0	0	0	0	0	0
Dinitrophenol, 2,4-	51285	0	0	0	0	0	3	0	0	0	0	0	0	0	3
Dinitropyrene, 1,6-	42397648	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dinitrotoluene, 2,4-	121142	3	0	0	0	0	0	3	0	0	3	0	0	0	0
Dinitrotoluene, 2,6-	606202	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Dinitrotoluene, 4-Amino-2,6-	19406510	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Dinitrotoluene, 4-Amino-4,6-	35572782	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Di-n-octyl phthalate	117840	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Dioxane, 1,4-	123911	1	0	1	0	0	0	0	0	1	0	0	0	0	0
Diphenylamine	122394	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethoxyethanol, 2-	110805	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Ethylbenzene	100414	1	0	0	1	1	0	0	0	1	0	0	0	0	0
Ethylene	74851	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethyleneimine (Aziridine)	151564	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluoranthene	206440	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluorene	86737	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluorotrichloromethane (Trichlorofluoromethane)	75694	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Formaldehyde	50000	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Furan (Epoxy-1,3-butadiene, 4-)	110009	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glutaraldehyde	111308	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Heptachlorodibenzofuran, 1,2,3,4,6,7,8-	67562394	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Heptachlorodibenzofuran, 1,2,3,4,7,8,9-	55673897	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Heptachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8-	35822469	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Hexachlorobenzene	118741	3	0	0	0	0	0	0	0	0	0	0	0	0	3
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	87683	0	0	0	0	0	3	0	0	3	0	0	3	3	0
Hexachlorodibenzofuran, 1,2,3,4,7,8-	70648269	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Hexachlorodibenzofuran, 1,2,3,6,7,8-	57117449	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Hexachlorodibenzofuran, 1,2,3,7,8,9-	72918219	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Hexachlorodibenzofuran, 2,3,4,6,7,8-	60851345	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Hexachlorodibenzo-p-Dioxin, 1,2,3,4,7,8-	39227286	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Hexachlorodibenzo-p-Dioxin, 1,2,3,6,7,8-	57653857	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Hexachlorodibenzo-p-Dioxin, 1,2,3,7,8,9-	19408743	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Hexachloroethane	67721	0	0	0	0	0	3	0	0	3	0	0	3	3	0
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hexane, n-	110543	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Hexanone, 2-	591786	0	0	0	0	0	1	0	0	0	1	0	1	1	0
Hydrogen chloride	7647010	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hydrogen Cyanide	74908	0	0	1	0	1	0	0	0	0	1	0	0	0	0

Table 5-3. Target Organ Systems for Chronic Noncancer Health Effects (Continued)

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Indeno[1,2,3-cd]pyrene	193395	0	0	0	0	0	0	0	0	0	0	0	0	0	
Iron	7439896	0	0	0	0	0	0	0	0	0	0	0	0	3	
Isophorone	78591	0	0	0	1	0	0	0	0	0	0	0	0	0	
Isoprene	9003310	0	0	0	0	0	0	0	0	0	0	0	0	1	
Lead	7439921	0	0	0	0	0	0	0	0	0	0	0	0	0	
Malononitrile	109773	0	0	0	0	0	0	0	0	0	0	0	0	3	
Manganese	7439965	0	0	0	0	0	0	0	0	0	1	0	0	0	
Mercury	7439976	0	0	0	0	0	0	0	2	2	1	0	0	0	
Methacrylonitrile	126987	0	0	0	0	0	3	0	0	0	3	0	0	3	
Methanol	67561	0	0	0	1	0	0	0	0	0	0	0	0	0	
Methylcholanthrene, 3-	56495	0	0	0	0	0	0	0	0	0	0	0	0	3	
Methylcyclohexane	108872	0	0	0	0	0	3	0	0	0	3	0	3	0	
Methylene chloride	75092	0	0	1	0	0	0	0	0	0	1	0	0	0	
Methylethyl ketone	78933	0	0	0	0	0	3	0	0	0	3	0	3	0	
Methylnaphthalene, 2-	91576	0	0	3	0	3	0	0	0	0	0	0	0	3	
Methylphenol, 2-	95487	3	0	3	0	0	3	0	0	3	3	0	3	0	
Methylphenol, 3-	108394	3	0	3	0	0	3	0	0	3	3	0	3	0	
Methylphenol, 4-	106445	3	0	3	0	0	3	0	0	3	3	0	3	0	
Methyltertbutyl ether (MTBE)	1634044	1	0	0	0	0	1	0	0	1	0	0	0	0	
Molybdenum	7439987	3	0	0	0	0	3	0	0	3	0	0	3	0	
Naphthalene	91203	0	0	0	0	0	0	0	0	0	0	0	1	0	
Nickel and chemicals	7440020	2	0	0	0	0	0	1	0	0	0	0	1	0	
Nitric Oxide	10102439	0	0	0	0	0	2	2	0	0	2	0	2	0	
Nitroacenaphthene, 5-	602879	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitroaniline, 2-	88744	0	0	0	0	0	0	0	0	0	0	0	0	3	
Nitrobenzene	98953	3	0	3	0	0	3	3	0	3	0	3	0	0	
Nitrochrysene, 6-	7496028	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitrogen Dioxide	10102440	0	0	3	0	0	3	0	0	0	0	0	3	0	
Nitroglycerin	55630	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitroguanidine	556887	0	0	0	3	0	0	0	0	0	0	3	0	3	
Nitrophenol, 4-	100027	0	0	0	0	0	0	0	0	0	0	0	0	3	
Nitropropane, 2-	79469	3	0	0	0	0	3	0	0	3	3	0	3	0	
Nitropyrene, 1-	5522430	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitrosodiethylamine, N-	55185	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitrosodimethylamine, N-	62759	2	0	0	0	0	0	0	0	2	0	0	2	0	
Nitrosodi-n-butylamine, N-	924163	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitrosodi-n-propylamine, N-	621647	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitrosodiphenylamine, N-	86306	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitroso-N-methylethylamine, N- (Nitrosomethylethylamine, N-)	10595956	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitrosopiperidine, N-	100754	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitrosopyrrolidine, N-	930552	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nitrotoluene, m-	99081	3	0	3	0	0	0	3	0	0	3	0	0	3	
Nitrotoluene, o-	88722	3	0	3	0	0	0	3	0	0	3	0	0	3	
Nitrotoluene, p-	99990	3	0	3	0	0	0	3	0	0	3	0	0	3	
Octachlorodibenzofuran, 1,2,3,4,6,7,8,9-	39001020	0	0	0	0	0	0	0	0	0	0	0	0	3	
Octachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8,9-	3268879	0	0	0	0	0	0	0	0	0	0	0	0	3	
Pentachlorobenzene	608935	3	0	0	0	0	0	0	0	3	0	0	0	3	
Pentachlorodibenzofuran, 1,2,3,7,8-	57117416	0	0	0	0	0	0	0	0	0	0	0	0	3	

Table 5-3. Target Organ Systems for Chronic Noncancer Health Effects (Continued)

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Pentachlorodibenzofuran, 2,3,4,7,8-	57117314	0	0	0	0	0	0	0	0	0	0	0	0	3	
Pentachlorodibenzo-p-Dioxin, 1,2,3,7,8-	40321764	0	0	0	0	0	0	0	0	0	0	0	0	3	
Pentachloronitrobenzene	82688	3	0	0	0	0	0	0	0	0	0	0	0	3	
Pentachlorophenol	87865	3	0	3	0	0	3	0	0	3	3	0	3	0	
Perchlorate	7601903	0	0	0	0	2	0	0	0	0	0	0	0	0	
Phenanthrene	85018	0	0	0	0	0	0	0	0	0	0	0	0	3	
Phenol	108952	1	0	1	0	0	0	0	0	1	1	0	0	0	
Phosgene	75445	0	0	0	0	0	0	0	0	0	0	0	0	0	
Phosphorus (white)	7723140	3	0	0	0	0	3	0	0	0	0	0	3	0	
Propanol, 2-	67630	0	0	0	1	0	0	0	0	1	0	0	0	0	
Propylbenzene, n-	103651	0	0	0	0	0	0	0	0	0	0	0	0	3	
Propylene (Propene)	115071	0	0	0	0	0	0	0	0	0	0	1	0	0	
Pyrene	129000	0	0	0	0	0	0	0	0	3	0	0	0	3	
Pyridine	110861	3	0	0	0	3	0	0	0	3	3	0	3	0	
Selenium	7782492	1	0	1	0	0	0	0	0	0	1	0	0	0	
Silica, Crystalline	1175	0	0	0	0	0	0	0	0	0	0	0	0	1	
Strontium	7440246	0	2	0	0	0	0	0	0	0	0	0	0	2	
Styrene	100425	0	0	0	0	0	0	0	0	0	1	0	0	0	
Sulfur Dioxide	7446095	0	0	0	0	0	1	0	0	0	0	1	1	0	
Sulfuric acid	7664939	0	0	0	0	0	0	0	0	0	0	1	0	0	
Tetrachlorobenzene, 1,2,4,5-	95943	0	0	0	0	0	0	0	0	3	0	0	0	3	
Tetrachlorodibenzofuran, 2,3,7,8-	51207319	3	0	0	3	3	0	3	0	0	0	3	3	0	
Tetrachlorodibenzo-p-Dioxin, 2,3,7,8-	1746016	3	0	0	3	3	0	3	0	0	3	3	0	0	
Tetrachloroethane, 1,1,2,2-	79345	3	0	0	0	0	0	0	0	3	3	0	3	0	
Tetrachloroethylene (PCE)	127184	1	0	0	0	0	0	0	0	1	0	0	0	0	
Tetrachlorophenol, 2,3,4,6-	58902	3	0	0	0	0	0	0	0	0	0	0	0	3	
Tetranitro-N-methylaniline, N,2,4,6- (Tetryl, Trinitrophenylmethylnitramine)	479458	3	0	0	0	0	3	0	0	3	3	0	3	0	
Thallium and chemicals	7446186	0	0	0	0	0	0	0	0	0	0	0	0	2	
Toluene	108883	0	0	0	1	0	0	0	0	0	1	0	1	0	
Toluidine, o- (Methylaniline, 2-)	95534	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total HpCDD	35822469	0	0	0	0	0	0	0	0	0	0	0	0	3	
Total HpCDF	67562394	0	0	0	0	0	0	0	0	0	0	0	0	3	
Total HxCDD	19408743	0	0	0	0	0	0	0	0	0	0	0	0	3	
Total HxCDF	57117449	0	0	0	0	0	0	0	0	0	0	0	0	3	
Total PeCDD	40321764	0	0	0	0	0	0	0	0	0	0	0	0	3	
Total PeCDF	57117314	0	0	0	0	0	0	0	0	0	0	0	0	3	
Total TCDD	1746016	3	0	0	3	3	0	3	0	0	0	3	3	0	
Total TCDF	51207319	3	0	0	3	3	0	3	0	0	0	3	3	0	
Trichlorobenzene, 1,2,4-	120821	3	0	0	0	0	3	0	0	0	0	3	3	0	
Trichloroethane, 1,1,1- (Methyl chloroform)	71556	0	0	0	0	0	0	0	0	0	1	0	0	0	
Trichloroethane, 1,1,2-	79005	3	0	0	0	0	3	0	0	3	3	0	3	0	
Trichloroethylene (TCE)	79016	0	0	0	0	0	1	0	0	0	1	0	0	0	
Trichlorophenol, 2,4,5-	95954	3	0	0	0	0	0	0	0	3	0	0	0	0	
Trichlorophenol, 2,4,6-	88062	0	0	0	0	0	0	0	0	0	0	0	0	3	
Trimethylbenzene, 1,2,4-	95636	0	0	0	0	0	3	3	0	0	3	0	3	0	
Trimethylbenzene, 1,3,5-	108678	0	0	0	0	0	3	3	0	0	3	0	3	0	
Trimethylpentane, 2,2,4-	540841	0	0	0	0	0	0	0	0	0	0	0	0	3	

Table 5-3. Target Organ Systems for Chronic Noncancer Health Effects (Continued)

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Trinitrobenzene, 1,3,5-	99354	0	0	0	0	0	0	3	0	0	0	0	0	0	3
Trinitrotoluene, 2,4,6- (TNT)	118967	3	0	3	0	0	3	3	0	3	3	0	3	3	0
Urethane (Ethyl carbamate)	51796	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium and chemicals	7440622	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Vinyl acetate	108054	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Vinyl Chloride	75014	3	0	0	0	0	0	3	3	0	3	0	3	0	0
Xylenes	1330207	0	0	0	0	0	0	0	0	0	1	0	1	0	0
Zinc	7440666	0	0	0	3	0	0	0	0	0	0	0	0	0	3

Notes:

- 1 = Inhalation only
- 2 = Oral only
- 3 = Inhalation and Oral
- 0 = No health effect for specific target organ system

<sup>1</sup> Where the OEHHA source does not identify a target organ for the COC, a target organ is assigned according to DTSC direction.

Sources:

OEHHA Risk Assessment Guidelines (August 2003), Table 3, Appendix L, [http://www.oehha.ca.gov/air/chronic\\_rels/AllChrels.html](http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html) (OEHHA, 2003)  
 Oak Ridge National Laboratory Risk Assessment Information System (RAIS), September 2003 (RAIS, 2003)  
 NIOSH Pocket Guide to Chemical Hazards, September 2005 (NIOSH, 2005)

Table 5-4. Target Organ Systems for Acute Noncancer Health Effects

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Acenaphthene	83329	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Acenaphthylene	208968	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Acetaldehyde	75070	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Acetone	67641	0	3	0	0	0	3	0	3	3	0	0	3	0	0
Acetonitrile	75058	0	0	0	0	3	3	0	0	0	0	0	0	0	0
Acetophenone	98862	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Acetylaminofluorene, 2-	53963	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acrolein	107028	0	1	0	0	0	0	0	1	0	0	0	1	0	0
Acrylonitrile	107131	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Allyl chloride	107051	0	0	0	0	3	0	0	3	0	0	0	0	0	0
Aluminum	7429905	0	3	0	0	0	0	0	3	3	0	0	3	0	0
Aminobiphenyl, 4-	92671	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aminopyridine, 4-	504245	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Ammonia	7664417	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Aniline	62533	0	3	3	0	3	0	0	3	0	0	0	3	3	0
Anthracene	120127	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Antimony	7440360	0	3	0	0	0	0	0	3	3	0	0	3	0	0
Arsenic	7440382	0	0	0	0	0	1	0	0	2	0	0	0	0	0
Azobenzene	103333	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barium	7440393	0	0	0	0	3	0	0	0	0	3	0	0	0	0
Benzaldehyde	100527	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Benzene	71432	0	0	1	0	0	1	0	0	0	0	0	0	1	0
Benzydine	92875	0	0	3	0	3	0	0	0	3	0	0	0	3	0
Benzo(A)Anthracene	56553	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Benzo(A)pyrene	50328	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Benzo(b)fluoranthene	205992	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Benzo(k)fluoranthene	207089	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Benzo[g,h,i]perylene	191242	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Benzo(furan, 2,3-	271896	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Benzoic acid	65850	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Benzyl alcohol	100516	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Benzyl chloride	100447	0	3	0	0	0	3	0	3	3	0	0	3	0	0
Beryllium	7440417	0	0	0	1	0	0	0	1	0	0	0	0	0	1
Biphenyl, 1,1-	92524	0	3	0	0	3	3	0	3	0	0	0	3	0	0
Bis(2-chloro-1-methylethyl)ether	108601	0	0	0	0	3	0	0	0	0	3	0	0	0	0
Bis(2-chloroethyl)ether	111444	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bis(2-chloroisopropyl)ether	39638329	0	0	3	0	0	0	0	0	0	3	0	0	3	0
Bis(2-ethylhexyl)phthalate (DEHP)	117817	0	3	0	0	0	3	3	3	0	0	0	3	0	0
Bis(chloromethyl)ether	542881	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromodichloromethane	75274	0	0	0	0	3	0	0	0	0	3	0	0	0	0
Bromoform (tribromomethane)	75252	0	3	0	0	3	3	0	3	3	0	0	3	0	0
Bromomethane	74839	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Butadiene-1,3	106990	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Butanol, 1-	71363	0	3	0	0	0	3	0	3	3	0	0	3	0	0
Butyl benzyl phthalate	85687	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Butylacrylate	141322	0	1	0	0	0	0	0	1	1	0	0	1	0	0

Table 5-4. Target Organ Systems for Acute Noncancer Health Effects (Continued)

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Butylbenzene, n-	104518	0	0	0	0	0	0	0	0	0	3	0	0	0	
Butylbenzene, T-	98066	0	0	0	0	0	0	0	0	0	3	0	0	0	
Cadmium	7440439	0	0	0	0	3	0	0	1	0	0	0	0	0	
Carbazole	86748	0	0	0	0	0	0	0	0	0	0	0	0	0	
Carbon Monoxide	630080	0	0	0	0	0	0	0	0	0	0	0	0	0	
Carbon tetrachloride	56235	0	0	0	0	0	1	0	0	0	0	0	0	0	
Chlorine	7782505	0	0	0	0	0	0	0	1	0	0	0	0	0	
Chloroacetophenone, 2-	532274	0	3	0	0	0	0	0	3	3	0	0	3	0	
Chloroaniline, 4-	106478	0	0	0	3	0	0	0	0	0	3	0	0	3	
Chlorobenzene	108907	0	0	0	0	1	0	1	0	0	0	0	0	0	
Chloroethane (Ethyl chloride)	75003	0	0	0	0	0	0	0	0	0	0	0	0	0	
Chloroform	67663	0	0	0	0	1	0	0	0	0	0	0	0	0	
Chloromethane (Methyl chloride)	74873	0	0	0	0	3	3	3	0	0	0	0	0	0	
Chloronaphthalene	91587	0	0	0	0	0	0	0	0	0	3	0	0	0	
Chloronitrobenzene, o-	88733	0	0	0	0	0	0	0	0	0	3	0	0	0	
Chlorophenol, 2-	95578	0	0	0	0	0	0	3	0	0	0	0	0	0	
Chloropicrin (trichloronitromethane)	76062	0	0	0	0	0	0	0	1	0	0	0	0	0	
Chlorotoluene, o-	95498	0	3	0	0	3	3	0	3	3	0	0	3	0	
Chromium (hex.)	18540299	0	0	2	0	0	0	0	1	0	0	0	0	2	
Chromium III	16065831	0	0	0	0	0	0	0	0	0	2	0	0	0	
Chrysene	218019	0	0	0	0	0	0	0	0	0	3	0	0	0	
Cobalt	7440484	0	0	0	0	0	0	0	3	3	0	0	0	0	
Copper	7440508	0	3	0	0	3	0	0	3	3	0	0	3	0	
Cumene (Isopropylbenzene)	98828	0	3	0	0	3	3	0	3	3	0	0	3	0	
Cyclohexane	110827	0	3	0	0	0	3	0	3	3	0	0	3	0	
Cyclotetramethylene Tetranitramine (HMX)	2691410	0	0	0	0	0	0	0	0	0	3	0	0	0	
Diaminotoluene, 2,4-	95807	0	0	0	0	0	0	0	0	0	0	0	0	0	
Diazomethane	334883	0	3	0	0	0	0	0	3	0	0	0	3	0	
Dibenz[a,h]anthracene	53703	0	0	0	0	0	0	0	0	0	3	0	0	0	
Dibenzofuran	132649	0	0	0	0	0	0	3	0	0	0	0	0	0	
Dibromochloromethane	124481	0	0	0	0	0	0	0	0	0	3	0	0	0	
Dibutyl phthalate	84742	0	3	0	0	0	0	0	3	0	0	0	3	0	
Dichlorobenzene, 1,2-	95501	0	3	0	0	3	0	0	3	3	0	0	3	0	
Dichlorobenzene, 1,3-	541731	0	0	0	0	0	0	0	3	0	0	0	0	0	
Dichlorobenzene, 1,4-	106467	0	0	0	0	1	1	0	1	0	0	0	0	0	
Dichlorobenzidine, 3,3-	91941	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dichlorodifluoromethane	75718	0	0	0	0	0	3	0	0	0	0	0	0	0	
Dichloroethane, 1,1-	75343	0	0	0	0	3	3	0	3	3	0	0	0	0	
Dichloroethane, 1,2-	107062	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dichloroethylene (cis), 1,2-	156592	0	0	0	0	0	0	0	0	0	3	0	0	0	
Dichloroethylene (trans), 1,2-	156605	0	0	0	3	0	0	0	0	0	3	0	0	3	
Dichloroethylene, 1,1- (Dichloroethene, 1,1-)	75354	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dichlorophenol, 2,4-	120832	0	0	0	0	0	3	0	0	0	3	0	0	0	
Dichloropropane, 1,2-	78875	0	3	0	0	3	3	0	3	3	0	0	3	0	
Dichloropropene, 1,3-	542756	0	3	0	0	3	3	0	3	3	0	0	3	0	
Diesel PM	9901	0	0	0	0	0	0	0	1	0	0	0	0	0	
Diethyl ether (Ethyl ether)	60297	0	3	0	0	0	3	0	3	3	0	0	3	0	

Table 5-4. Target Organ Systems for Acute Noncancer Health Effects (Continued)

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Diethyl phthalate	84662	0	3	0	0	0	3	3	3	3	0	0	3	0	0
Dimethyl Phthalate	131113	0	3	0	0	0	0	0	3	0	0	0	3	0	0
Dimethylamine	124403	0	3	0	0	0	0	0	3	3	0	0	3	0	0
Dimethylbenz(a)anthracene, 7,12-	57976	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Dimethylbenzidine, 3,3'-	119937	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dimethylcarbamoyl chloride	79447	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dimethylhydrazine, 1,2-	540738	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dimethylphenol, 2,4-	105679	0	0	3	0	0	0	0	0	0	3	0	0	3	0
Dinitrobenzene, 1,2-	528290	0	3	3	0	0	3	0	0	3	0	0	3	3	0
Dinitrobenzene, 1,3-	99650	0	3	3	0	0	3	0	0	3	0	0	3	3	0
Dinitrobenzene, 1,4-	100254	0	3	3	0	0	3	0	0	3	0	0	3	3	0
Dinitro-o-cresol, 4,6-	534521	3	0	0	0	0	0	0	0	0	0	3	0	0	0
Dinitrophenol, 2,4-	51285	0	3	0	0	0	0	0	0	0	3	0	3	0	0
Dinitropyrene, 1,6-	42397648	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dinitrotoluene, 2,4-	121142	0	0	3	0	0	3	0	0	0	0	0	0	3	0
Dinitrotoluene, 2,6-	606202	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Dinitrotoluene, 4-Amino-2,6-	19406510	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Dinitrotoluene, 4-Amino-4,6-	35572782	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Di-n-octyl phthalate	117840	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Dioxane, 1,4-	123911	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Diphenylamine	122394	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethoxyethanol, 2-	110805	0	0	1	0	0	0	1	0	0	0	0	0	1	0
Ethylbenzene	100414	1	0	0	0	1	0	0	0	0	0	1	0	0	0
Ethylene	74851	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethyleneimine (Aziridine)	151564	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluoranthene	206440	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluorene	86737	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluorotrichloromethane (Trichlorofluoromethane)	75694	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Formaldehyde	50000	0	1	0	0	0	0	0	1	0	0	0	1	0	0
Furan (Epoxy-1,3-butadiene, 4-)	110009	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glutaraldehyde	111308	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Heptachlorodibenzofuran, 1,2,3,4,6,7,8-	67562394	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Heptachlorodibenzofuran, 1,2,3,4,7,8,9-	55673897	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Heptachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8-	35822469	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Hexachlorobenzene	118741	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	87683	0	3	0	0	3	0	0	3	3	0	0	3	0	0
Hexachlorodibenzofuran, 1,2,3,4,7,8-	70648269	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Hexachlorodibenzofuran, 1,2,3,6,7,8-	57117449	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Hexachlorodibenzofuran, 1,2,3,7,8,9-	72918219	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Hexachlorodibenzofuran, 2,3,4,6,7,8-	60851345	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Hexachlorodibenzo-p-Dioxin, 1,2,3,4,7,8-	39227286	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Hexachlorodibenzo-p-Dioxin, 1,2,3,6,7,8-	57653857	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Hexachlorodibenzo-p-Dioxin, 1,2,3,7,8,9-	19408743	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Hexachloroethane	67721	0	3	0	0	3	0	0	3	3	0	0	3	0	0
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hexane, n-	110543	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Hexanone, 2-	591786	0	1	0	0	0	1	0	1	1	0	0	1	0	0

Table 5-4. Target Organ Systems for Acute Noncancer Health Effects (Continued)

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Hydrogen chloride	7647010	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Hydrogen Cyanide	74908	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Indeno[1,2,3-cd]pyrene	193395	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron	7439896	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Isophorone	78591	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isoprene	9003310	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Lead	7439921	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malononitrile	109773	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Manganese	7439965	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Mercury	7439976	0	0	0	2	2	1	0	0	0	0	0	0	0	2
Methacrylonitrile	126987	0	3	0	0	0	3	0	0	3	0	0	3	0	0
Methanol	67561	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methylcholanthrene, 3-	56495	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Methylcyclohexane	108872	0	3	0	0	0	3	0	3	3	0	0	3	0	0
Methylene chloride	75092	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Methylethyl ketone	78933	0	3	0	0	0	3	0	3	3	0	0	3	0	0
Methylnaphthalene, 2-	91576	3	0	0	0	0	0	0	0	0	3	3	0	0	0
Methylphenol, 2-	95487	0	3	0	0	3	3	0	3	3	0	0	3	0	0
Methylphenol, 3-	108394	0	3	0	0	3	3	0	3	3	0	0	3	0	0
Methylphenol, 4-	106445	0	3	0	0	3	3	0	3	3	0	0	3	0	0
Methyltertbutyl ether (MTBE)	1634044	0	1	0	0	1	0	0	0	0	0	0	1	0	0
Molybdenum	7439987	0	3	0	0	3	0	0	3	0	0	0	3	0	0
Naphthalene	91203	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Nickel and chemicals	7440020	0	0	1	0	0	0	0	1	0	0	0	0	1	0
Nitric Oxide	10102439	0	2	2	0	0	2	0	2	2	0	0	2	2	0
Nitroacenaphthene, 5-	602879	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitroaniline, 2-	88744	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Nitrobenzene	98953	0	3	3	0	3	0	3	0	3	0	0	3	3	0
Nitrochrysene, 6-	7496028	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrogen Dioxide	10102440	0	3	0	0	0	0	0	3	0	0	0	3	0	0
Nitroglycerin	55630	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitroguanidine	556887	0	0	0	0	0	0	3	0	0	3	0	0	0	0
Nitrophenol, 4-	100027	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Nitropropane, 2-	79469	0	3	0	0	3	3	0	3	3	0	0	3	0	0
Nitropyrene, 1-	5522430	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrosodiethylamine, N-	55185	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrosodimethylamine, N-	62759	0	0	0	0	2	0	0	2	0	0	0	0	0	0
Nitrosodi-n-butylamine, N-	924163	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrosodi-n-propylamine, N-	621647	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrosodiphenylamine, N-	86306	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitroso-N-methylethylamine, N- (Nitrosomethylethylamine, N-)	10595956	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrosopiperidine, N-	100754	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrosopyrrolidine, N-	930552	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrotoluene, m-	99081	0	0	3	0	0	3	0	0	3	0	0	0	3	0
Nitrotoluene, o-	88722	0	0	3	0	0	3	0	0	3	0	0	0	3	0
Nitrotoluene, p-	99990	0	0	3	0	0	3	0	0	3	0	0	0	3	0
Octachlorodibenzofuran, 1,2,3,4,6,7,8,9-	39001020	0	0	0	0	0	0	0	0	0	3	0	0	0	0

Table 5-4. Target Organ Systems for Acute Noncancer Health Effects (Continued)

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Octachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8,9-	3268879	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Pentachlorobenzene	608935	0	0	0	0	3	0	0	0	0	3	0	0	0	0
Pentachlorodibenzofuran, 1,2,3,7,8-	57117416	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Pentachlorodibenzofuran, 2,3,4,7,8-	57117314	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Pentachlorodibenzo-p-Dioxin, 1,2,3,7,8-	40321764	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Pentachloronitrobenzene	82688	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Pentachlorophenol	87865	0	3	0	0	3	3	0	3	3	0	0	3	0	0
Perchlorate	7601903	2	0	0	0	0	0	0	0	0	0	2	0	0	0
Phenanthrene	85018	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Phenol	108952	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Phosgene	75445	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphorus (white)	7723140	0	3	0	0	0	0	0	0	3	0	0	3	0	0
Propanol, 2-	67630	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Propylbenzene, n-	103651	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Propylene (Propene)	115071	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Pyrene	129000	0	0	0	0	3	0	0	0	0	3	0	0	0	0
Pyridine	110861	3	0	0	0	3	3	0	0	3	0	3	0	0	0
Selenium	7782492	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Silica, Crystalline	1175	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Strontium	7440246	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Styrene	100425	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Sulfur Dioxide	7446095	0	1	0	0	0	0	0	1	1	0	0	1	0	0
Sulfuric acid	7664939	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Tetrachlorobenzene, 1,2,4,5-	95943	0	0	0	0	3	0	0	0	0	3	0	0	0	0
Tetrachlorodibenzofuran, 2,3,7,8-	51207319	3	0	3	0	0	0	3	3	0	0	3	0	3	0
Tetrachlorodibenzo-p-Dioxin, 2,3,7,8-	1746016	3	0	3	0	0	0	3	3	0	0	3	0	3	0
Tetrachloroethane, 1,1,2,2-	79345	0	0	0	0	3	3	0	0	3	0	0	0	0	0
Tetrachloroethylene (PCE)	127184	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Tetrachlorophenol, 2,3,4,6-	58902	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Tetranitro-N-methylaniline, N,2,4,6- (Tetryl, Trinitrophenylmethylnitramine)	479458	0	3	0	0	3	3	0	3	3	0	0	3	0	0
Thallium and chemicals	7446186	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Toluene	108883	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Toluidine, o- (Methylaniline, 2-)	95534	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total HpCDD	35822469	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Total HpCDF	67562394	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Total HxCDD	19408743	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Total HxCDF	57117449	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Total PeCDD	40321764	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Total PeCDF	57117314	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Total TCDD	1746016	3	0	3	0	0	0	3	3	0	0	3	0	3	0
Total TCDF	51207319	3	0	3	0	0	0	3	3	0	0	3	0	3	0
Trichlorobenzene, 1,2,4-	120821	0	3	0	0	0	0	3	3	3	0	0	3	0	0
Trichloroethane, 1,1,1- (Methyl chloroform)	71556	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Trichloroethane, 1,1,2-	79005	0	3	0	0	3	3	0	3	0	0	0	3	0	0
Trichloroethylene (TCE)	79016	0	1	0	0	0	1	0	0	0	0	0	1	0	0
Trichlorophenol, 2,4,5-	95954	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Trichlorophenol,2,4,6-	88062	0	0	0	0	0	0	0	0	0	3	0	0	0	0

Table 5-4. Target Organ Systems for Acute Noncancer Health Effects (Continued)

Chemical of Concern	CAS Number	Target Organ System <sup>1</sup>													
		Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other
Trimethylbenzene, 1,2,4-	95636	0	3	3	0	0	3	0	3	3	0	0	3	3	0
Trimethylbenzene, 1,3,5-	108678	0	3	3	0	0	3	0	3	3	0	0	3	3	0
Trimethylpentane, 2,2,4-	540841	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Trinitrobenzene, 1,3,5-	99354	0	0	3	0	0	0	0	0	0	3	0	0	3	0
Trinitrotoluene, 2,4,6- (TNT)	118967	0	3	3	0	3	3	0	3	3	0	0	3	3	0
Urethane (Ethyl carbamate)	51796	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vanadium and chemicals	7440622	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Vinyl acetate	108054	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Vinyl Chloride	75014	0	0	3	3	0	3	0	3	0	0	0	0	3	3
Xylenes	1330207	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Zinc	7440666	0	0	0	0	0	0	0	0	0	3	0	0	0	0

Notes:

- 1 = Inhalation only
- 2 = Oral only
- 3 = Inhalation and Oral
- 0 = No health effect for specific target organ system

<sup>1</sup> Where the OEHHA source does not identify a target organ for the COC, a target organ is assigned according to DTSC direction.

Sources:

- OEHHA Risk Assessment Guidelines (August 2003), Table 2, Appendix L, [http://www.oehha.ca.gov/air/acute\\_rels/allAcRELS.html](http://www.oehha.ca.gov/air/acute_rels/allAcRELS.html) (OEHHA, 2003)
- Risk Assessment Information System (RAIS), Oak Ridge National Laboratory, September 2003 (RAIS, 2003)
- NIOSH Pocket Guide to Chemical Hazards, September 2005 (NIOSH, 2005)

## 6.0 RISK CHARACTERIZATION

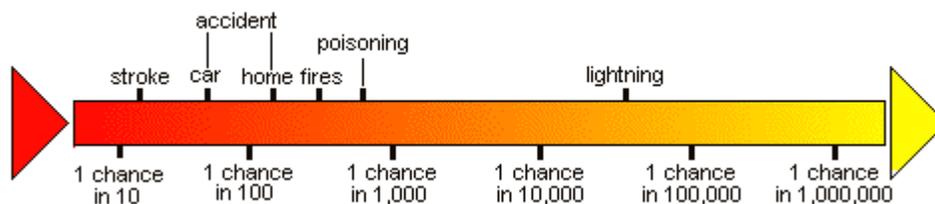
Risk characterization is the final step in the risk assessment process where the results of the exposure and dose-response assessments are combined to estimate the potential for adverse health effects. Risk analysts describe risks numerically in scientific notation. For example,  $1 \times 10^{-5}$  means one chance in 100,000 or 10 chances in one million of an event occurring. In many cases, a 10 in a million cancer risk or an HI of 1.0 is the significance criteria for public notification for various regulatory programs such as AB 2588 and Proposition 65. Cancer risk is defined as the upperbound incremental probability of an individual developing cancer over a lifetime as a result of an exposure to potential carcinogens. The cancer risk level is intended to ensure a sufficient safety margin to prevent a single project or activity from causing a substantial contribution to the overall number of cancer cases in an area. It is not intended or designed to serve as a means to evaluate cumulative risk associated with multiple activities not associated with the project in question or to assess risk posed by ambient background conditions.

The conclusions of an HRA must be considered in context. As a general matter, the background probability of an individual contracting cancer in his or her lifetime is about 40% or 400,000 in one million (i.e., 4 in 10 people are expected to contract cancer in their lifetimes). This overall probability of contracting cancer can be influenced by diet, smoking, heredity, chemicals in the environment and the workplace, and other factors.

It should be recognized that when small populations are exposed, population risk estimates may be very small. For example, if 100 people are exposed to an individual lifetime cancer risk of  $1 \times 10^{-5}$ , the expected number of cases is 0.001 (EPA, 1995c). For HRA purposes, a lifetime of exposure is considered to be 70 years, 365 days a year, 24 hours per day. It should be further recognized that an HRA does not calculate the exact risk for all individuals, but a hypothetical risk assuming that a series of “worst-case scenario” exposure assumptions apply. The chance that an individual would be exposed to any of these exposure assumptions is small, and for all assumptions even smaller (e.g., 70 years of continuously breathing air at the location of maximum impact). Thus, an individual’s actual risk is likely to be significantly overestimated by the methodology of an HRA.

It is also important to place health risk and the assessment of probability in the context of daily activity. To provide an idea of the size of risks from environmental hazards, the continuum below provides risk statistics for some familiar events:

### Putting Risks in Perspective



Source: "Air Pollution and Health Risk", EPA Publication 450/3-90-022 (1991)

Health effect categories evaluated in this HRA include the following:

- ◆ Lifetime risk of developing cancer;
- ◆ Potential for chronic or long-term noncancer effects; and
- ◆ Potential for acute or short-term noncancer effects.

This section provides a summary of the results for each of the health effects of interest. The HRA quantified the following direct and indirect emission sources:

- ◆ Treatment through OB including diesel and wood combustion (direct);
- ◆ Treatment through OD including metal and crater emissions (direct);
- ◆ OB ash handling (indirect);
- ◆ OD grading (indirect); and
- ◆ Windblown dust (indirect).

The risk calculations were performed using a set of linked spreadsheets. Separate spreadsheets were developed for the following categories of information:

- ◆ Emission rates by COC, by emission category (Appendix B - Chemicals of Concern, Emission Factors and Emission Rates);
- ◆ Meteorological data (Appendix C - Dispersion Modeling Inputs);
- ◆ Air dispersion model results (X/Q) (Appendix D - Modeled Downwind Concentrations);
- ◆ Exposure and dose parameters (Appendix E - Constants, Substance-specific Parameters and Exposure Pathways);
- ◆ Toxicity factors by COC, by health effect (Appendix F - Toxicity Factors);
- ◆ Target organs by COC, by health effect (Appendix G - Target Organ Systems);
- ◆ Exposure by media and dose by media, by COC (Appendix H - Concentration and Exposure Calculations); and
- ◆ Risk by pathway, by COC, by health effect (Appendix I - Risk Characterization Calculations).

## 6.1 ANNUAL AND EVENT TREATMENT LIMITS

The HRA quantifies the cancer risk and chronic and acute noncancer HIs associated with the treatment of each emission category at the permitted annual and event treatment limits. The permit health risk limits are a carcinogenic risk threshold of one in one million ( $1 \times 10^{-6}$ ) and a non-carcinogenic chronic and acute HI of 1.0 at the MEI. An equivalency system will be used to track the emission categories treated to ensure that treatment quantities specified in the permit are not exceeded. A summary of the permitted treatment limits and limiting factors for each emission category is presented in Table 6-1.

The MEI locations and a windrose of the years 1999 through the end of 2002 are presented on Figure 6-1. Hourly impacts are based on a single hourly dispersion condition (plume height, wind speed, wind direction, atmospheric stability) and calculated at each downwind receptor location for each hour of meteorological data. The hourly MEI is then the location with the maximum hourly impact. An annual impact is based on the combination of all the hourly impacts considered at each location. The annual MEI is then the location with the maximum annual impact. The annual and hourly MEIs are likely to be at different locations because the worst-case hourly meteorological conditions are likely to be very different than the average annual condition due to diurnal and seasonal differences in meteorology.

## 6.2 CANCER HEALTH EFFECTS

The maximum cancer risk at the MEI based on the permitted treatment limits is one in one million ( $1 \times 10^{-6}$ ) or less for each emission category as shown in Table 6-2. Given that a combination of wastes will be treated in any particular year, the quantity of each emission category will be tracked and accumulated annually to ensure the combined amounts treated do not exceed the equivalent permitted treatment limits (and, therefore, the total cancer risk does not exceed  $1 \times 10^{-6}$ ) over the course of the year.

The cancer risk results were analyzed by exposure pathway and chemical contributions. The contributions by exposure pathway (i.e., inhalation, soil, dermal, and mother's milk) for each emission category are presented in Table 6-3. For OB, the primary pathway contributing to the cancer risk is the inhalation pathway, yet for OD, while the primary pathway contributing to cancer risk is still inhalation, dermal and soil ingestion contribute a larger percentage of the risk compared to OB. For chemical contribution, tables were created to display the contributions by chemical (in percentages) for the energetic, energetic-contaminated waste, and munition component families. For each family treated by OB the contribution by chemical is presented in Table 6-4. For each family treated by OD the contribution by chemical is presented in Table 6-5. For OD emission categories where risk from crater dust was added to the risk from the energetic, arsenic in soil accounted for approximately 90% of the cancer risk. Arsenic in the soil at Burro Canyon is naturally occurring with observed concentrations in the soil the same as the natural background. Therefore, for those emission categories where ambient soil concentrations are the only source of arsenic, the arsenic was removed from the health risk total. For OB activities, the primary chemicals contributing to the cancer risk are RDX, benzene, benzidine, 3,3'-dimethylbenzidine, 1,3-butadiene, ethyleneimine, 7, 12-dimethylbenz(a)anthracene, dibromochloromethane, naphthalene, 2-methylnaphthalene, and acenaphthylene, depending on the family. For OD activities, the primary chemicals contributing to the cancer risk are cadmium, RDX, 3,3'-dimethylbenzidine, total

pentachlorodibenzofurans, dibromochloromethane, and benzidine, depending on the family. The contributions by chemical for other emission categories are presented in Appendix I – Risk Characterization Calculations.

### 6.3 CHRONIC NONCANCER HEALTH EFFECTS

The maximum chronic noncancer HI at the MEI was  $2.4 \times 10^{-2}$  or less for each emission category as shown in Table 6-6. Given that a combination of wastes will be treated in any particular year, the quantity of each emission category will be tracked and accumulated annually to ensure that the combined amounts treated do not exceed the equivalent permitted annual treatment limits (and, therefore, the total chronic noncancer HI does not exceed 1.0) over the course of the year.

The chronic noncancer HI results were analyzed by target organ and chemical contributions. The maximum chronic noncancer HIs by target organ for each emission category are presented in Table 6-7. For both OB and OD activities the primary target organs resulting in the maximum chronic noncancer HIs are the respiratory, skin and eye systems depending on the emission category. OB activities yielded a larger noncancer chronic HI overall. The contributions by chemical (in percentages) for each energetic family for OB and OD activities are presented in Tables 6-8 and 6-9, respectively, including the “W” and “M” families for OD. For OB activities, the primary chemicals contributing to the chronic noncancer HI are chlorine, ammonia, aluminum, nitrogen dioxide, methylacrylonitrile, hydrogen chloride, barium, sulfuric acid, dimethylamine, and DEHP, depending on the family. For OD activities, the primary chemicals contributing to the chronic noncancer HI are copper, aluminum, cadmium, chlorine, methacrylonitrile, and hydrogen chloride, depending on the family. The contributions by chemical for the other emission categories are presented in Appendix I - Risk Characterization Calculations.

### 6.4 ACUTE NONCANCER HEALTH EFFECTS

The maximum acute noncancer HI at the MEI was  $5.6 \times 10^{-1}$  or less for each emission category as shown in Table 6-10. Given that a combination of wastes will be treated in any particular event, the quantity of each emission category will be tracked and accumulated for each event to ensure the combined amounts treated do not exceed the equivalent permitted hourly treatment limits (and, therefore, the maximum acute noncancer HI does not exceed 1.0) for each event.

The acute noncancer HI results were analyzed by target organ and chemical contributions. The maximum acute noncancer HIs by target organ for each emission category are presented in Table 6-11. For both OB and OD activities, the primary target organs resulting in the maximum acute noncancer HIs are the alimentary tract, eye, kidney, skin and respiratory systems depending on the emission category. OB activities yielded a larger acute noncancer HI overall. The contributions by chemical (in percentages) for each energetic family for OB and OD activities are presented in Tables 6-12 and 6-13, respectively, including the “W” and “M” families for OD. For those emission categories where ambient soil concentrations are the only source of arsenic, the arsenic was removed from the health risk total. For OB activities, the primary chemicals contributing to the acute noncancer HI are nitrogen dioxide, hydrogen chloride, chlorine, acrolein, hydrogen cyanide, ammonia, copper, sulfuric acid, and 2-propanol,

depending on the family. For OD activities, the primary chemicals contributing to the acute noncancer HI are copper, nitrogen dioxide, acrolein, hydrogen chloride, chlorine, hydrogen cyanide, ammonia, sulfuric acid, and 2-propanol, depending on the family. The contributions by chemical for the other emission categories are presented in Appendix I - Risk Characterization Calculations.

## **6.5 HEALTH EFFECTS ASSOCIATED WITH LEAD EMISSIONS**

Maximum estimates of lead concentrations in the blood according to a percentile approach were derived from LeadSpread as discussed in Section 5.5. The maximum estimated blood lead level (C1, OD treatment) for PICA child exposure was 8.0 µg/dl for the 99<sup>th</sup> percentile, below the threshold level of concern of 10 µg/dl. Further, the adult exposure for the 99<sup>th</sup> percentile showed a maximum lead blood level of 3.8 µg/dl. For the child exposure, the 99<sup>th</sup> percentile maximum lead blood level was 6.7 µg/dl. Please refer to Table 6-14 for a summary of the estimated maximum exposures by percentile. The individual tables are in Appendix I.

## **6.6 PERMITTED QUANTITIES COMPARED TO RISK THRESHOLDS**

A secondary analysis was also conducted to determine the maximum quantity of each energetic family that could be treated without exceeding the cancer and noncancer risk thresholds (i.e., one in one million for cancer risk and 1.0 for chronic and acute noncancer hazard index [HI]). The results of this secondary analysis are presented in Table 6-15. These results show that, for many of the emission categories, much larger quantities of wastes could be treated than are specified in the permit without exceeding the risk thresholds. However, the permitted treatment limits, which are much lower than these maximum quantities, will be the applicable limits. The limiting factor for treatment quantities are safety and logistics, rather than health risk or criteria pollutant standards.

Figure 6-1. Prevailing Wind Direction and Location of MEIs

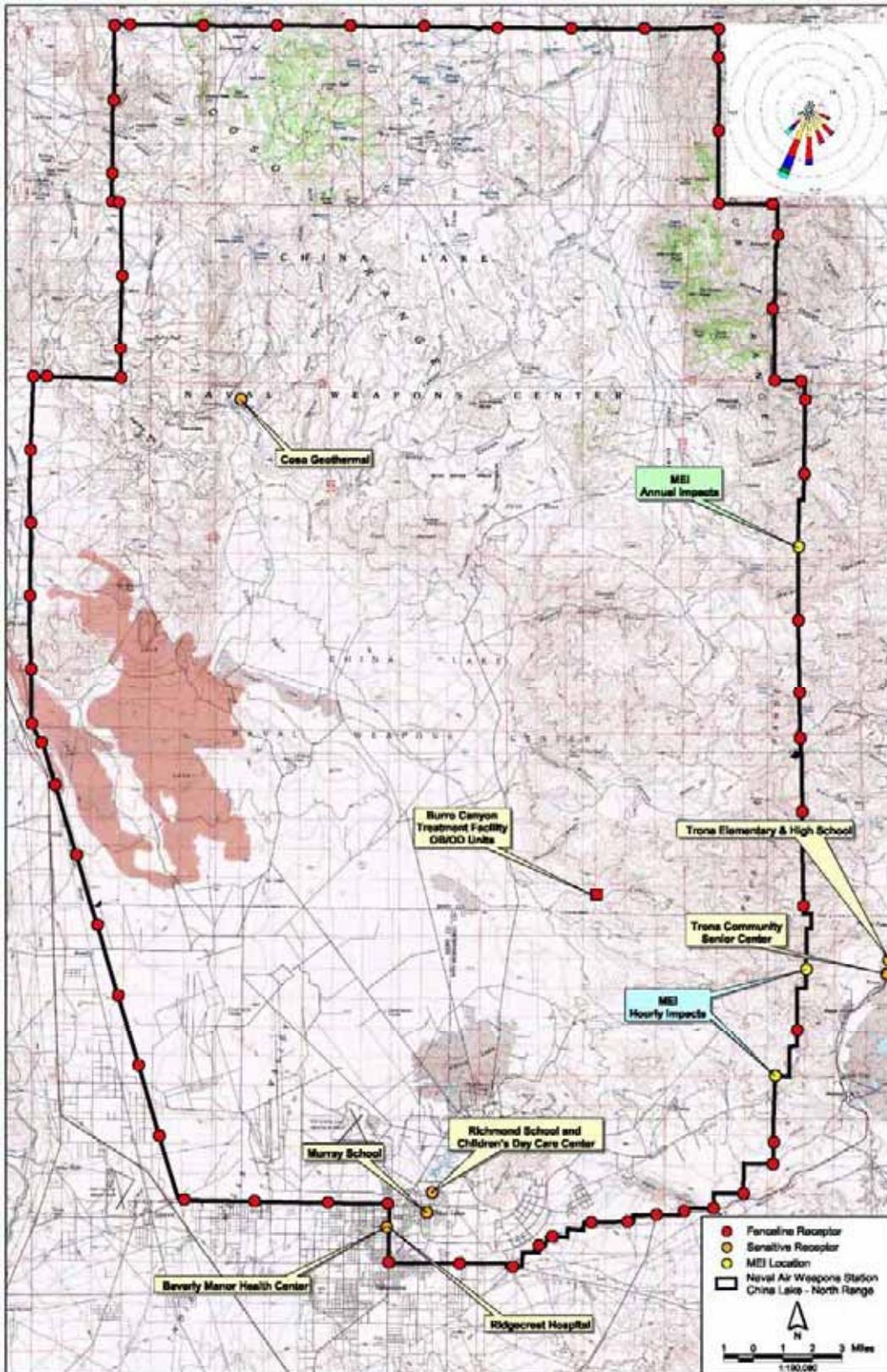


Table 6-1. Permitted Treatment Quantities for Each Emission Category

Emission Category <sup>1</sup>	Family	Sub Family	Permitted Hourly Treatment Quantity (lb/hr)	Limiting Factor	Permitted Annual Treatment Quantity (lb/yr)	Limiting Factor
<b>Open Burn</b>						
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	1,000	Logistical Limit	365,000	Logistical Limit
IIA - Double base with Lead	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
IIB - Double base without Lead	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	1,000	Logistical Limit	365,000	Logistical Limit
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	1,000	Logistical Limit	365,000	Logistical Limit
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	1,000	Logistical Limit	365,000	Logistical Limit
B1 - Nitramine / Binder	Explosive	Plastic Bonded	1,000	Logistical Limit	365,000	Logistical Limit
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	1,000	Logistical Limit	365,000	Logistical Limit
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	1,000	Logistical Limit	365,000	Logistical Limit
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	1,000	Logistical Limit	365,000	Logistical Limit
Diesel	-	-	1,000	Logistical Limit	365,000	Logistical Limit
Wood	-	-	1,000	Logistical Limit	365,000	Logistical Limit
<b>Open Detonation</b>						
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	30,000	Logistical Limit	5,475,000	Logistical Limit
IIA - Double base with Lead	Propellant	Rocket/Missile	16,200	Criteria Pollutant Standard	1,495,000	Cancer Risk Threshold
IIB - Double base without Lead	Propellant	Rocket/Missile	30,000	Logistical Limit	1,500,000	Cancer Risk Threshold
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	30,000	Logistical Limit	1,500,000	Cancer Risk Threshold
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	30,000	Logistical Limit	1,500,000	Cancer Risk Threshold
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	30,000	Logistical Limit	1,500,000	Cancer Risk Threshold
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	30,000	Logistical Limit	5,475,000	Logistical Limit
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	30,000	Logistical Limit	5,475,000	Logistical Limit
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	30,000	Logistical Limit	5,475,000	Logistical Limit

Table 6-1. Permitted Treatment Quantities for Each Emission Category (Continued)

Emission Category <sup>1</sup>	Family	Sub Family	Permitted Hourly Quantity (lb/hr)	Limiting Factor	Permitted Annual Quantity (lb/yr)	Limiting Factor
B1 - Nitramine / Binder	Explosive	Plastic Bonded	30,000	Logistical Limit	5,475,000	Logistical Limit
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	30,000	Logistical Limit	5,475,000	Logistical Limit
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	30,000	Logistical Limit	5,475,000	Logistical Limit
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	16,200	Criteria Pollutant Standard	5,475,000	Logistical Limit
P - Pyrotechnics	Pyrotechnic	-	30,000	Logistical Limit	580,000	Cancer Risk Threshold
W - Energetic-contaminated wastes	ECW	-	30,000	Logistical Limit	5,475,000	Logistical Limit
M - Munition Components	Munition Components	-	30,000	Logistical Limit	5,475,000	Logistical Limit
<b>Other</b>						
OD Grading	-	-	1 <sup>3</sup>	Logistical Limit	365 <sup>4</sup>	Logistical Limit

<sup>1</sup> Ash handling is not included as a category here since it occurs with every OB event. Ash handling is assumed for 100 lbs. of ash per event and 36,500 lbs per year.

<sup>2</sup> Number of grading events per hour

<sup>3</sup> Number of grading events per year

Table 6-2. Summary of Maximum Cancer Risks for Each Emission Category

Emission Category	Family	Sub Family	Permitted Annual Treatment Quantity <sup>1</sup> (lb/yr)	Maximum Cancer Risk				
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	Total
<b>Open Burn</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	365,000	2.E-09	1.E-13	2.E-18	-	2.E-09
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	365,000	2.E-09	1.E-13	2.E-18	-	2.E-09
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	365,000	1.E-09	1.E-13	2.E-18	-	1.E-09
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	365,000	2.E-09	1.E-13	2.E-18	-	2.E-09
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	365,000	2.E-09	1.E-13	2.E-18	-	2.E-09
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	365,000	1.E-09	1.E-13	2.E-18	-	1.E-09
IIA - Double base with Lead	Propellant	Rocket/Missile	365,000	3.E-09	1.E-13	2.E-18	-	3.E-09
IIB - Double base without Lead	Propellant	Rocket/Missile	365,000	9.E-10	1.E-13	2.E-18	-	9.E-10
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	365,000	1.E-10	1.E-13	2.E-18	-	1.E-10
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	365,000	1.E-10	1.E-13	2.E-18	-	1.E-10
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	365,000	3.E-12	1.E-13	2.E-18	-	3.E-12
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	365,000	2.E-08	1.E-13	2.E-18	-	2.E-08
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	365,000	2.E-10	1.E-13	2.E-18	-	2.E-10
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	365,000	2.E-11	1.E-13	2.E-18	-	2.E-11
B1 - Nitramine / Binder	Explosive	Plastic Bonded	365,000	2.E-08	1.E-13	2.E-18	-	2.E-08
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	365,000	2.E-08	1.E-13	2.E-18	-	2.E-08
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	365,000	2.E-08	1.E-13	2.E-18	-	2.E-08
C1 - e.g. PbN <sub>3</sub> , ammonium picrate	Explosive	Other	365,000	2.E-08	1.E-13	2.E-18	-	2.E-08
Diesel	-	-	365,000	2.E-07	1.E-13	2.E-18	-	2.E-07
Wood	-	-	365,000	1.E-08	1.E-13	2.E-18	-	1.E-08
<b>Open Detonation</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	5,475,000	2.E-08	1.E-13	-	1.E-07	1.E-07
IIA - Double base with Lead	Propellant	Rocket/Missile	1,495,000	1.E-06	1.E-13	-	3.E-08	1.E-06
IIB - Double base without Lead	Propellant	Rocket/Missile	1,500,000	1.E-06	1.E-13	-	3.E-08	1.E-06
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	1,500,000	1.E-06	1.E-13	-	3.E-08	1.E-06
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	1,500,000	1.E-06	1.E-13	-	3.E-08	1.E-06
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	1,500,000	1.E-06	1.E-13	-	3.E-08	1.E-06
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	5,475,000	3.E-07	1.E-13	-	1.E-07	4.E-07
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	5,475,000	1.E-07	1.E-13	-	1.E-07	2.E-07
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	5,475,000	1.E-07	1.E-13	-	1.E-07	2.E-07
B1 - Nitramine / Binder	Explosive	Plastic Bonded	5,475,000	8.E-07	1.E-13	-	1.E-07	9.E-07
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	5,475,000	4.E-07	1.E-13	-	1.E-07	5.E-07
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	5,475,000	9.E-07	1.E-13	-	1.E-07	1.E-06
C1 - e.g. PbN <sub>3</sub> , ammonium picrate	Explosive	Other	5,475,000	2.E-07	1.E-13	-	1.E-07	3.E-07
P - Pyrotechnics	Pyrotechnic	-	580,000	1.E-06	1.E-13	-	1.E-08	1.E-06

Table 6-2. Summary of Maximum Cancer Risks for Each Emission Category (Continued)

Emission Category	Family	Sub Family	Permitted Annual Treatment Quantity <sup>1</sup> (lb/yr)	Maximum Cancer Risk				
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	Total
W - Energetic-contaminated wastes	ECW	-	5,475,000	4.E-07	1.E-13	-	1.E-07	5.E-07
M - Munition Components	Munition Components	-	5,475,000	4.E-07	1.E-13	-	1.E-07	5.E-07
<b>Other</b>								
OD Grading	-	-	365 <sup>5</sup>	1.E-11	1.E-13	-	-	1.E-11

<sup>1</sup> Treatment limit specified in RCRA permit.

<sup>2</sup> Risks associated with windblown dust apply to treatment by both OD and OB since emissions occur throughout the year.

<sup>3</sup> Risks associated with emissions from ash handling only apply during treatment by OB.

<sup>4</sup> Risks associated with emissions from the crater only apply during treatment by OD.

<sup>5</sup> Number of grading events per year

Table 6-3. Cancer Risk by Exposure Pathway for Each Emission Category

Emission Category	Family	Sub Family	Annual Quantity (lb/yr)	Inhalation Risk	Dermal Risk	Soil Ingestion Risk	Mother's Milk Ingestion Risk	Total Cancer Risk
<b>Open Burn<sup>1</sup></b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	365,000	2.E-09	6.E-15	2.E-14	3.E-18	2.E-09
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	365,000	2.E-09	6.E-15	2.E-14	3.E-18	2.E-09
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	365,000	1.E-09	6.E-15	2.E-14	3.E-18	1.E-09
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	365,000	2.E-09	6.E-15	2.E-14	3.E-18	2.E-09
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	365,000	2.E-09	6.E-15	2.E-14	3.E-18	2.E-09
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	365,000	1.E-09	6.E-15	2.E-14	3.E-18	1.E-09
IIA - Double base with Lead	Propellant	Rocket/Missile	365,000	3.E-09	2.E-10	3.E-11	3.E-18	3.E-09
IIB - Double base without Lead	Propellant	Rocket/Missile	365,000	8.E-10	8.E-11	1.E-11	3.E-18	9.E-10
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	365,000	1.E-10	6.E-15	2.E-14	3.E-18	1.E-10
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	365,000	1.E-10	6.E-15	2.E-14	3.E-18	1.E-10
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	365,000	3.E-12	6.E-15	2.E-14	3.E-18	3.E-12
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	365,000	2.E-08	6.E-15	2.E-14	3.E-18	2.E-08
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	365,000	2.E-10	6.E-15	2.E-14	3.E-18	2.E-10
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	365,000	2.E-11	6.E-15	2.E-14	3.E-18	2.E-11
B1 - Nitramine / Binder	Explosive	Plastic Bonded	365,000	2.E-08	3.E-11	1.E-11	3.E-11	2.E-08
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	365,000	2.E-08	3.E-11	1.E-11	3.E-11	2.E-08
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	365,000	2.E-08	6.E-15	2.E-14	3.E-18	2.E-08
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	365,000	2.E-08	6.E-15	2.E-14	3.E-18	2.E-08
Diesel	-	-	365,000	2.E-07	6.E-15	2.E-14	0.E+00	2.E-07
Wood	-	-	365,000	4.E-10	6.E-15	2.E-14	0.E+00	1.E-08
<b>Open Detonation<sup>2</sup></b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	5,475,000	1.E-07	6.E-09	2.E-08	3.E-12	1.E-07
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	5,475,000	1.E-07	6.E-09	2.E-08	3.E-12	1.E-07
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	5,475,000	1.E-07	6.E-09	2.E-08	3.E-12	1.E-07
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	5,475,000	1.E-07	6.E-09	2.E-08	3.E-12	1.E-07
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	5,475,000	1.E-07	6.E-09	2.E-08	3.E-12	1.E-07
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	5,475,000	1.E-07	6.E-09	2.E-08	3.E-12	1.E-07
IIA - Double base with Lead	Propellant	Rocket/Missile	1,495,000	6.E-07	3.E-08	4.E-07	3.E-12	1.E-06
IIB - Double base without Lead	Propellant	Rocket/Missile	1,500,000	6.E-07	3.E-08	4.E-07	3.E-12	1.E-06
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	1,500,000	6.E-07	3.E-08	4.E-07	3.E-12	1.E-06
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	1,500,000	6.E-07	3.E-08	4.E-07	3.E-12	1.E-06
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	1,500,000	6.E-07	3.E-08	4.E-07	3.E-12	1.E-06
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	5,475,000	4.E-07	6.E-09	2.E-08	3.E-12	4.E-07
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	5,475,000	1.E-07	9.E-09	7.E-08	3.E-12	2.E-07
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	5,475,000	1.E-07	9.E-09	7.E-08	3.E-12	2.E-07
B1 - Nitramine / Binder	Explosive	Plastic Bonded	5,475,000	7.E-07	2.E-08	2.E-07	4.E-10	9.E-07
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	5,475,000	4.E-07	9.E-09	7.E-08	4.E-10	5.E-07
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	5,475,000	7.E-07	2.E-08	2.E-07	3.E-12	1.E-06

Table 6-3. Cancer Risk by Exposure Pathway for Each Emission Category (Continued)

Emission Category	Family	Sub Family	Annual Quantity (lb/yr)	Inhalation Risk	Dermal Risk	Soil Ingestion Risk	Mother's Milk Ingestion Risk	Total Cancer Risk
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	5,475,000	3.E-07	6.E-09	2.E-08	3.E-12	3.E-07
P - Pyrotechnics	Pyrotechnic	-	580,000	7.E-07	2.E-08	4.E-07	7.E-12	1.E-06
W - Energetic-contaminated wastes	ECW	-	5,475,000	3.E-07	9.E-08	5.E-08	8.E-08	5.E-07
M - Munition Components	Munition Components	-	5,475,000	3.E-07	9.E-08	5.E-08	8.E-08	5.E-07
<b>Other</b>								
OD Grading	-	-	365 <sup>3</sup>	9.E-12	7.E-13	2.E-12	0.E+00	1.E-11

Notes:

<sup>1</sup>The OB risks are inclusive of windblown dust and ash handling risks.

<sup>2</sup>The OD risks are inclusive of windblown dust and crater risks.

<sup>3</sup>Number of events.

Table 6-4. Contribution to Cancer Risk by Chemical for Each OB Energetic Emission Category

Chemical of Concern <sup>2</sup>	CAS #	Contribution to Cancer Risk <sup>1</sup>																	
		IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA	IIB	IIC	IID	IIE	IIF	A1	A2	B1	B2	B3	C1
Acenaphthylene	208968	0.05%		0.06%	0.05%		0.06%		0.10%	0.91%	0.91%	32.66%							
Acetaldehyde	75070															0.00%	0.00%		
Acrylonitrile	107131														0.60%	0.60%			
Benzene	71432	0.91%	6.11%		0.91%	6.11%		5.17%	0.55%	86.34%	86.34%		0.09%	79.83%	43.76%	5.36%	5.36%	0.09%	0.96%
Benzidine	92875	13.72%			13.72%			66.75%	25.61%										
Benzo(A)Anthracene	56553							0.64%	2.55%										
Benzo(A)pyrene	50328							3.72%											
Bis(2-ethylhexyl)phthalate (DEHP)	117817		2.30%			2.30%													
Bromodichloromethane	75274									1.40%	1.40%		0.06%					0.06%	
Bromoform (tribromomethane)	75252									0.02%	0.02%		0.00%					0.00%	
Butadiene-1,3	106990		3.66%			3.66%		1.32%					0.11%	8.39%	54.70%	0.83%	0.83%	0.11%	5.77%
Carbazole	86748	0.00%			0.00%			0.00%	0.00%										
Carbon tetrachloride	56235									2.50%	2.50%								
Chloroform	67663									0.12%	0.12%		0.01%					0.01%	
Chloromethane (Methyl chloride)	74873									0.07%	0.07%								
Dibenz[a,h]anthracene	53703							2.36%	9.37%										
Dibromochloromethane	124481									0.60%	0.60%		36.63%					36.63%	
Dimethylbenz(a)anthracene, 7,12-	57976							15.07%	59.75%										
Dimethylbenzidine, 3,3'-	119937	0.25%			0.25%			1.23%	0.47%										88.48%
Dinitrotoluene, 2,4-	121142	0.01%			0.01%			0.02%						1.15%		0.00%	0.00%		0.02%
Dioxane, 1,4-	123911																		0.00%
Ethylbenzene	100414	0.00%	0.01%		0.00%	0.01%		0.01%						0.06%	0.54%	0.01%	0.01%		0.04%
Heptachlorodibenzofuran, 1,2,3,4,6,7,8-	67562394															0.00%	0.00%		
Heptachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8-	35822469															0.00%	0.00%		
Hexachlorodibenzofuran, 1,2,3,4,7,8-	70648269															0.00%	0.00%		
Hexachlorodibenzofuran, 2,3,4,6,7,8-	60851345															0.01%	0.01%		
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	84.54%	84.21%	99.81%	84.54%	84.21%	99.81%	0.57%	0.01%	0.05%	0.05%	1.80%	51.16%	8.69%	0.33%	53.85%	53.85%	51.16%	
Isophorone	78591		0.00%			0.00%		0.00%						0.04%	0.58%				0.01%
Methylene chloride	75092									0.03%	0.03%		1.36%					1.36%	
Methylnaphthalene, 2-	91576	0.05%		0.06%	0.05%		0.06%		0.10%	0.91%	0.91%	32.66%	0.13%					0.13%	
Methyltertbutyl ether (MTBE)	1634044																		0.00%
Naphthalene	91203	0.05%		0.06%	0.05%		0.06%	0.03%	0.10%	0.91%	0.91%	32.66%	0.48%	1.78%		0.01%	0.01%	0.48%	0.01%
Nitroglycerin	55630	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.23%	0.00%			0.00%	0.00%	0.00%	
Nitropropane, 2-	79469												6.53%					6.53%	
Octachlorodibenzofuran, 1,2,3,4,6,7,8,9-	39001020															0.00%	0.00%		
Octachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8,9-	3268879															0.00%	0.00%		
Toluidine, o- (Methylaniline, 2-)	95534	0.40%	3.72%		0.40%	3.72%		3.10%	1.39%										
Total HpCDD	35822469															0.00%	0.00%		
Total HpCDF	67562394															0.00%	0.00%		
Total HxCDF	57117449															0.08%	0.08%		
Total PeCDF	57117314															0.23%	0.23%		
Total TCDF	51207319															0.05%	0.05%		
Trichloroethane, 1,1,2-	79005												0.06%					0.06%	
Trinitrotoluene, 2,4,6- (TNT)	118967	0.00%			0.00%									0.06%	0.09%				
Vinyl Chloride	75014									6.13%	6.13%								

Table 6-4. Contribution to Cancer Risk by Chemical for Each OB Energetic Emission Category (Continued)

Chemical of Concern <sup>2</sup>	CAS #	Contribution to Cancer Risk <sup>1</sup>																	
		IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA	IIB	IIC	IID	IIE	IIF	A1	A2	B1	B2	B3	C1
Ethyleneimine (Aziridine)	151564														38.96%	38.96%			
Urethane (Ethyl carbamate)	51796												3.39%				3.39%	4.72%	
<b>Total</b>		<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	
<b>Maximum Contribution from One Chemical of Concern</b>		<b>84.54%</b>	<b>84.21%</b>	<b>99.81%</b>	<b>84.54%</b>	<b>84.21%</b>	<b>99.81%</b>	<b>66.75%</b>	<b>59.75%</b>	<b>86.34%</b>	<b>86.34%</b>	<b>32.66%</b>	<b>51.16%</b>	<b>79.83%</b>	<b>54.70%</b>	<b>53.85%</b>	<b>53.85%</b>	<b>51.16%</b>	<b>88.48%</b>

<sup>1</sup> The contribution by chemical represents the percent contribution of each chemical relative to the total risk from all chemicals for each energetic family. The other emissions that also occur from other sources during OB or OD such as wind blown dust, crater, or ash handling are not factored in this table.

<sup>2</sup> All chemicals having non-zero contributions are listed. Values listed as 0.00% contribute less than 0.005%.

Table 6-5. Contribution to Cancer Risk by Chemical for Each OD Energetic Emission Category

Chemical of Concern <sup>2</sup>	CAS #	Contribution to Cancer Risk <sup>1</sup>																					
		IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA	IIB	IIC	IID	IIE	IIF	A1	A2	B1	B2	B3	C1	P	W	M	
Acenaphthylene	208968	0.05%		0.06%	0.05%		0.06%		0.00%	0.00%	0.00%	0.00%											
Acetaldehyde	75070															0.00%	0.00%						
Acrylonitrile	107131															0.22%	0.45%						
Allyl chloride	107051																				0.00%		
Benzene	71432	0.91%	6.11%		0.91%	6.11%		0.07%	0.00%	0.03%	0.03%		0.09%	1.83%	0.14%	1.93%	3.99%	0.03%	0.96%	0.01%	0.06%	0.06%	
Benzdine	92875	13.72%			13.72%			0.85%	0.08%														
Benzo(A)Anthracene	56553							0.01%	0.01%														
Benzo(A)pyrene	50328							0.05%															
Bis(2-chloroethyl)ether	111444																				0.02%		
Bis(2-chloroisopropyl)ether	39638329																				0.00%		
Bis(2-ethylhexyl)phthalate (DEHP)	117817		2.30%			2.30%															0.01%		
Bromodichloromethane	75274									0.00%	0.00%		0.06%								0.02%		
Bromoform (tribromomethane)	75252									0.00%	0.00%		0.00%								0.00%		
Butadiene-1,3	106990		3.66%			3.66%		0.02%					0.11%	0.19%	0.17%	0.30%	0.62%	0.04%	5.77%	0.02%			
Cadmium	7440439																				70.76%		
Carbazole	86748	0.00%			0.00%			0.00%	0.00%														
Carbon tetrachloride	56235									0.00%	0.00%												
Chloroethane (Ethyl chloride)	75003																				0.00%		
Chloroform	67663									0.00%	0.00%		0.01%								0.00%		
Chloromethane (Methyl chloride)	74873									0.00%	0.00%										0.00%		
Chromium (hex.)	18540299																				28.65%		
Dibenz[a,h]anthracene	53703							0.03%	0.03%														
Dibromochloromethane	124481									0.00%	0.00%		36.63%					13.21%					
Dimethylbenz(a)anthracene, 7,12-	57976							0.19%	0.19%														
Dimethylbenzidine, 3,3'-	119937	0.25%			0.25%			0.02%	0.00%											88.48%			
Dinitrotoluene, 2,4-	121142	0.01%			0.01%			0.00%						0.03%		0.00%	0.00%			0.02%			
Dioxane, 1,4-	123911																			0.00%			
Ethylbenzene	100414	0.00%	0.01%		0.00%	0.01%		0.00%						0.00%	0.00%	0.00%	0.01%		0.04%	0.00%	0.00%	0.00%	
Heptachlorodibenzofuran, 1,2,3,4,6,7,8-	67562394															0.00%	0.00%					0.00%	0.00%
Heptachlorodibenzofuran, 1,2,3,4,7,8,9-	55673897																					0.00%	0.00%
Heptachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8-	35822469															0.00%	0.00%					0.00%	0.00%
Hexachlorodibenzofuran, 1,2,3,4,7,8-	70648269															0.00%	0.00%					0.02%	0.02%
Hexachlorodibenzofuran, 1,2,3,6,7,8-	57117449																					0.30%	0.30%
Hexachlorodibenzofuran, 1,2,3,7,8,9-	72918219																					0.01%	0.01%
Hexachlorodibenzofuran, 2,3,4,6,7,8-	60851345															0.01%	0.01%					0.44%	0.44%
Hexachlorodibenzo-p-Dioxin, 1,2,3,4,7,8-	39227286																					0.00%	0.00%
Hexachlorodibenzo-p-Dioxin, 1,2,3,6,7,8-	57653857																					0.00%	0.00%
Hexachlorodibenzo-p-Dioxin, 1,2,3,7,8,9-	19408743																					0.03%	0.03%
Hexachloroethane	67721																					0.00%	
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121824	84.54%	84.21%	99.81%	84.54%	84.21%	99.81%	0.01%	0.00%	0.00%	0.00%	0.00%	51.16%	0.20%	0.00%	19.44%	40.09%	18.46%		0.04%	42.60%	42.60%	
Isophorone	78591		0.00%			0.00%		0.00%						0.00%	0.00%					0.01%	0.00%		
Methylene chloride	75092									0.00%	0.00%		1.36%								0.49%	0.00%	
Methylnaphthalene, 2-	91576	0.05%		0.06%	0.05%		0.06%		0.00%	0.00%	0.00%	0.00%	0.13%								0.05%		

Table 6-5. Contribution to Cancer Risk by Chemical for Each OD Energetic Emission Category (Continued)

Chemical of Concern <sup>2</sup>	CAS #	IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA	IIB	IIC	IID	IIE	IIF	A1	A2	B1	B2	B3	C1	P	W	M	
Methyltertbutyl ether (MTBE)	1634044																						
Naphthalene	91203	0.05%		0.06%	0.05%		0.06%	0.00%	0.00%	0.00%	0.00%	0.00%	0.48%	0.04%		0.00%	0.01%	0.17%	0.01%				
Nitroglycerin	55630	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%			0.00%	0.00%	0.00%		0.00%	0.00%	0.00%	
Nitropropane, 2-	79469												6.53%					2.36%					
Octachlorodibenzofuran, 1,2,3,4,6,7,8,9-	39001020															0.00%	0.00%				0.00%	0.00%	
Octachlorodibenzo-p-Dioxin, 1,2,3,4,6,7,8,9-	3268879															0.00%	0.00%			0.00%	0.00%	0.00%	
Pentachlorodibenzofuran, 1,2,3,7,8-	57117416																				0.02%	0.02%	
Pentachlorodibenzofuran, 2,3,4,7,8-	57117314																				3.01%	3.01%	
Pentachlorodibenzo-p-Dioxin, 1,2,3,7,8-	40321764																				0.32%	0.32%	
Tetrachlorodibenzofuran, 2,3,7,8-	51207319																				0.16%	0.16%	
Tetrachlorodibenzo-p-Dioxin, 2,3,7,8-	1746016																				0.11%	0.11%	
Tetrachloroethane, 1,1,2,2-	79345																			0.00%			
Tetrachloroethylene (PCE)	127184																			0.00%			
Toluidine, o- (Methylaniline, 2-)	95534	0.40%	3.72%		0.40%	3.72%		0.04%	0.00%														
Total HpCDD	35822469															0.00%	0.00%				0.00%	0.00%	
Total HpCDF	67562394															0.00%	0.00%				0.01%	0.01%	
Total HxCDD	19408743																				0.51%	0.51%	
Total HxCDF	57117449															0.03%	0.06%				3.58%	3.58%	
Total PeCDD	40321764																				6.53%	6.53%	
Total PeCDF	57117314															0.08%	0.17%				28.17%	28.17%	
Total TCDD	1746016																				6.72%	6.72%	
Total TCDF	51207319															0.02%	0.04%				7.40%	7.40%	
Trichloroethane, 1,1,2-	79005												0.06%					0.02%					
Trinitrotoluene, 2,4,6- (TNT)	118967	0.00%			0.00%									0.00%	0.00%								
Vinyl Chloride	75014									0.00%	0.00%										0.00%		
Bis(2-chloro-1-methylethyl)ether	108601																				0.00%		
Dimethylcarbamoyl chloride	79447																				0.49%		
Ethyleneimine (Aziridine)	151564															14.06%	29.00%						
Urethane (Ethyl carbamate)	51796												3.39%					1.22%	4.72%				
Cadmium	7440439							90.29%	91.16%	91.42%	91.42%	91.45%		94.88%	96.79%	56.80%	24.81%	53.93%					
Chromium VI	18540299							8.44%	8.52%	8.54%	8.54%	8.55%		2.83%	2.89%	7.08%	0.74%	9.89%					
Nickel	7440020															0.02%		0.11%					
<b>Total</b>		<b>100%</b>	<b>100%</b>																				
<b>Maximum Contribution from One Chemical of Concern</b>		<b>84.54%</b>	<b>84.21%</b>	<b>99.81%</b>	<b>84.54%</b>	<b>84.21%</b>	<b>99.81%</b>	<b>90.29%</b>	<b>91.16%</b>	<b>91.42%</b>	<b>91.42%</b>	<b>91.45%</b>	<b>51.16%</b>	<b>94.88%</b>	<b>96.79%</b>	<b>56.80%</b>	<b>40.09%</b>	<b>53.93%</b>	<b>88.48%</b>	<b>70.76%</b>	<b>42.60%</b>	<b>42.60%</b>	

<sup>1</sup> The contribution by chemical represents the percent contribution of each chemical relative to the total risk from all chemicals for each energetic family. The other emissions that also occur from other sources during OB or OD such as wind blown dust, crater, or ash handling are not factored in this table.

<sup>2</sup> All chemicals having non-zero contributions are listed. Values listed as 0.00% contribute less than 0.005%.

Table 6-6. Summary of Maximum Chronic Noncancer Risks for Each Emission Category

Emission Category	Family	Sub Family	Permitted Annual Treatment Quantity <sup>1</sup> (lb/yr)	MEI Chronic HI				
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	Total
<b>Open Burn</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	365,000	2.4E-07	3.2E-09	4.1E-14	-	2.5E-07
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	365,000	4.9E-07	3.2E-09	4.1E-14	-	4.9E-07
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	365,000	3.1E-07	3.2E-09	4.1E-14	-	3.2E-07
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	365,000	2.4E-07	3.2E-09	4.1E-14	-	2.5E-07
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	365,000	4.9E-07	3.2E-09	4.1E-14	-	4.9E-07
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	365,000	3.1E-07	3.2E-09	4.1E-14	-	3.2E-07
IIA - Double base with Lead	Propellant	Rocket/Missile	365,000	4.3E-06	3.2E-09	4.1E-14	-	4.3E-06
IIB - Double base without Lead	Propellant	Rocket/Missile	365,000	2.3E-07	3.2E-09	4.1E-14	-	2.4E-07
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	365,000	1.9E-03	3.2E-09	4.1E-14	-	1.9E-03
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	365,000	1.9E-03	3.2E-09	4.1E-14	-	1.9E-03
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	365,000	2.8E-03	3.2E-09	4.1E-14	-	2.8E-03
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	365,000	1.2E-03	3.2E-09	4.1E-14	-	1.2E-03
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	365,000	1.1E-05	3.2E-09	4.1E-14	-	1.1E-05
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	365,000	1.3E-04	3.2E-09	4.1E-14	-	1.3E-04
B1 - Nitramine / Binder	Explosive	Plastic Bonded	365,000	5.1E-04	3.2E-09	4.1E-14	-	5.1E-04
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	365,000	7.3E-04	3.2E-09	4.1E-14	-	7.3E-04
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	365,000	1.2E-03	3.2E-09	4.1E-14	-	1.2E-03
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	365,000	1.6E-03	3.2E-09	4.1E-14	-	1.6E-03
Diesel	-	-	365,000	1.1E-04	3.2E-09	4.1E-14	-	1.1E-04
Wood	-	-	365,000	1.6E-05	3.2E-09	4.1E-14	-	1.6E-05
<b>Open Detonation</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	5,475,000	1.8E-02	3.2E-09	-	3.2E-03	2.1E-02
IIA - Double base with Lead	Propellant	Rocket/Missile	1,495,000	6.2E-03	3.2E-09	-	3.2E-03	9.4E-03
IIB - Double base without Lead	Propellant	Rocket/Missile	1,500,000	6.2E-03	3.2E-09	-	3.2E-03	9.4E-03
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	1,500,000	1.1E-02	3.2E-09	-	3.2E-03	1.4E-02
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	1,500,000	1.1E-02	3.2E-09	-	3.2E-03	1.4E-02
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	1,500,000	1.4E-02	3.2E-09	-	3.2E-03	1.7E-02
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	5,475,000	1.5E-02	3.2E-09	-	3.2E-03	1.8E-02
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	5,475,000	6.9E-04	3.2E-09	-	3.2E-03	3.9E-03
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	5,475,000	2.2E-03	3.2E-09	-	3.2E-03	5.4E-03
B1 - Nitramine / Binder	Explosive	Plastic Bonded	5,475,000	6.8E-03	3.2E-09	-	3.2E-03	1.0E-02
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	5,475,000	9.6E-03	3.2E-09	-	3.2E-03	1.3E-02
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	5,475,000	1.7E-02	3.2E-09	-	3.2E-03	2.1E-02
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	5,475,000	2.1E-02	3.2E-09	-	3.2E-03	2.4E-02

Table 6-6. Summary of Maximum Chronic Noncancer Risks for Each Emission Category (Continued)

Emission Category	Family	Sub Family	Permitted Annual Treatment Quantity <sup>1</sup> (lb/yr)	MEI Chronic HI				
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	Total
P - Pyrotechnics	Pyrotechnic	-	580,000	4.9E-03	3.2E-09	-	3.2E-03	8.2E-03
W - Energetic-contaminated wastes	ECW	-	5,475,000	2.0E-02	3.2E-09	-	3.2E-03	2.4E-02
M - Munition Components	Munition Components	-	5,475,000	2.0E-02	3.2E-09	-	3.2E-03	2.4E-02
<b>Other</b>								
OD Grading	-	-	365 <sup>5</sup>	3.4E-07	3.2E-09	-	-	3.4E-07

<sup>1</sup> Treatment limit specified in RCRA permit.

<sup>2</sup> Risks associated with windblown dust apply to treatment by both OD and OB since emissions occur throughout the year.

<sup>3</sup> Risks associated with emissions from ash handling only apply during treatment by OB.

<sup>4</sup> Risks associated with emissions from the crater only apply during treatment by OD.

<sup>5</sup> Number of grading events per year.

Table 6-7. Chronic Noncancer HIs by Target Organ for Each Emission Category

EmissionCategory	Family	Sub Family	Permitted Annual Treatment Quantity <sup>1</sup> (lb/yr)	Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other	Maximum
<b>Open Burn</b>																		
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	365,000	5.8E-09	0.0E+00	5.1E-08	6.8E-09	2.2E-09	1.1E-07	1.3E-08	5.7E-11	6.0E-09	1.2E-08	3.4E-12	2.5E-07	6.4E-08	5.4E-09	2.5E-07
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	365,000	2.2E-07	0.0E+00	1.4E-07	4.6E-08	3.7E-11	3.5E-07	4.4E-08	5.7E-11	6.1E-10	2.2E-07	1.9E-07	4.9E-07	6.9E-09	2.1E-09	4.9E-07
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	365,000	1.6E-10	0.0E+00	1.8E-07	5.6E-12	2.2E-09	1.8E-07	3.5E-10	5.7E-11	5.2E-10	6.8E-12	3.4E-12	3.2E-07	2.7E-09	4.8E-09	3.2E-07
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	365,000	5.8E-09	0.0E+00	5.1E-08	6.8E-09	2.2E-09	1.1E-07	1.3E-08	5.7E-11	6.0E-09	1.2E-08	3.4E-12	2.5E-07	6.4E-08	5.4E-09	2.5E-07
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	365,000	2.2E-07	0.0E+00	1.4E-07	4.6E-08	3.7E-11	3.5E-07	4.4E-08	5.7E-11	6.1E-10	2.2E-07	1.9E-07	4.9E-07	6.9E-09	2.1E-09	4.9E-07
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	365,000	1.6E-10	0.0E+00	1.8E-07	5.6E-12	2.2E-09	1.8E-07	3.5E-10	5.7E-11	5.2E-10	6.8E-12	3.4E-12	3.2E-07	2.7E-09	4.8E-09	3.2E-07
IIA - Double base with Lead	Propellant	Rocket/Missile	365,000	2.3E-09	0.0E+00	2.3E-07	8.3E-08	9.0E-11	8.2E-07	8.1E-08	5.7E-11	4.3E-06	8.4E-08	1.0E-08	9.6E-07	5.8E-07	4.3E-06	4.3E-06
IIB - Double base without Lead	Propellant	Rocket/Missile	365,000	2.8E-10	0.0E+00	4.2E-08	2.5E-09	2.2E-09	9.8E-08	2.6E-09	5.7E-11	6.4E-10	2.5E-09	3.4E-12	2.4E-07	5.9E-08	4.8E-09	2.4E-07
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	365,000	1.1E-06	0.0E+00	8.6E-08	7.5E-08	2.2E-09	8.8E-05	4.0E-08	2.3E-09	1.3E-06	2.0E-07	3.1E-10	1.9E-03	8.8E-05	2.9E-07	1.9E-03
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	365,000	1.1E-06	0.0E+00	8.6E-08	7.5E-08	2.2E-09	8.8E-05	4.0E-08	2.3E-09	1.3E-06	2.0E-07	3.1E-10	1.9E-03	8.8E-05	2.9E-07	1.9E-03
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	365,000	1.6E-10	0.0E+00	3.2E-06	5.6E-12	3.0E-06	2.0E-07	3.5E-10	5.7E-11	5.2E-10	3.0E-06	3.4E-12	2.8E-03	2.7E-09	4.8E-09	2.8E-03
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	365,000	6.0E-06	0.0E+00	5.1E-06	1.0E-08	3.1E-06	2.4E-04	9.5E-09	5.7E-11	4.9E-06	7.3E-06	5.5E-09	1.2E-03	2.4E-04	0.0E+00	1.2E-03
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	365,000	1.8E-07	1.4E-07	3.4E-06	2.0E-07	3.1E-06	4.1E-07	2.5E-07	1.4E-07	1.8E-07	3.2E-06	1.4E-07	1.1E-05	6.3E-08	2.4E-09	1.1E-05
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	365,000	9.0E-09	0.0E+00	3.0E-06	5.5E-09	3.0E-06	1.3E-04	1.4E-08	5.7E-11	9.6E-09	3.0E-06	3.0E-09	1.3E-04	1.3E-04	2.3E-09	1.3E-04
B1 - Nitramine / Binder	Explosive	Plastic Bonded	365,000	1.1E-08	0.0E+00	4.4E-06	5.7E-07	3.0E-06	5.1E-04	5.4E-07	5.7E-11	1.4E-09	5.1E-04	7.7E-08	6.0E-06	5.1E-04	6.3E-08	5.1E-04
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	365,000	1.1E-08	0.0E+00	4.4E-06	5.7E-07	3.0E-06	7.3E-04	5.4E-07	5.7E-11	1.4E-09	5.1E-04	7.7E-08	2.2E-04	7.2E-04	6.3E-08	7.3E-04
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	365,000	6.0E-06	0.0E+00	5.1E-06	1.0E-08	3.1E-06	2.4E-04	9.5E-09	5.7E-11	4.9E-06	7.3E-06	5.5E-09	1.2E-03	2.4E-04	8.5E-06	1.2E-03
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	365,000	1.7E-05	0.0E+00	3.1E-06	7.1E-07	4.2E-06	1.6E-03	1.6E-06	5.7E-11	3.9E-05	2.3E-04	2.2E-07	1.6E-03	1.6E-03	2.3E-05	1.6E-03
Diesel	-	-	7,300 <sup>2</sup>	6.6E-11	0.0E+00	2.0E-11	2.3E-12	3.0E-22	2.2E-09	3.5E-10	5.7E-11	5.2E-10	6.8E-12	4.6E-14	1.1E-04	2.7E-09	3.5E-10	1.1E-04
Wood	-	-	18,250	6.6E-11	0.0E+00	2.0E-11	0.0E+00	3.0E-22	1.6E-05	3.5E-10	5.7E-11	5.2E-10	6.8E-12	4.6E-14	1.6E-05	2.7E-09	3.5E-10	1.6E-05
<b>Open Detonation</b>																		
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	5,475,000	1.7E-02	0.0E+00	1.2E-04	5.1E-04	2.9E-08	2.0E-02	3.6E-04	5.8E-05	1.8E-02	6.8E-04	4.7E-08	2.1E-02	2.1E-02	8.6E-04	2.1E-02
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	5,475,000	1.7E-02	0.0E+00	1.2E-04	5.1E-04	4.9E-10	2.0E-02	3.6E-04	5.8E-05	1.8E-02	6.9E-04	2.5E-06	2.1E-02	2.1E-02	8.6E-04	2.1E-02
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	5,475,000	1.7E-02	0.0E+00	1.2E-04	5.1E-04	2.9E-08	2.0E-02	3.6E-04	5.8E-05	1.8E-02	6.8E-04	4.7E-08	2.1E-02	2.1E-02	8.6E-04	2.1E-02
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	5,475,000	1.7E-02	0.0E+00	1.2E-04	5.1E-04	2.9E-08	2.0E-02	3.6E-04	5.8E-05	1.8E-02	1.1E-05	4.7E-08	2.1E-02	2.1E-02	8.6E-04	2.1E-02
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	5,475,000	1.7E-02	0.0E+00	1.2E-04	5.1E-04	4.9E-10	2.0E-02	3.6E-04	5.8E-05	1.8E-02	1.4E-05	2.5E-06	2.1E-02	2.1E-02	8.6E-04	2.1E-02
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	5,475,000	1.7E-02	0.0E+00	1.2E-04	5.1E-04	2.9E-08	2.0E-02	3.6E-04	5.8E-05	1.8E-02	1.1E-05	4.7E-08	2.1E-02	2.1E-02	8.6E-04	2.1E-02

Table 6-7. Chronic Noncancer HIs by Target Organ for Each Emission Category (Continued)

Emission Category	Family	Sub Family	Annual Quantity (lb/yr)	Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other	Maximum
IIA - Double base with Lead	Propellant	Rocket/Missile	1,495,000	6.7E-05	0.0E+00	2.1E-05	2.6E-06	3.3E-10	2.3E-03	3.6E-04	5.8E-05	6.7E-03	7.3E-06	8.4E-08	7.0E-03	2.7E-03	3.7E-04	7.0E-03
IIB - Double base without Lead	Propellant	Rocket/Missile	1,500,000	6.7E-05	0.0E+00	2.1E-05	2.3E-06	7.9E-09	2.2E-03	3.6E-04	5.8E-05	6.7E-03	7.0E-06	4.7E-08	7.0E-03	2.7E-03	3.5E-04	7.0E-03
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	1,500,000	7.0E-05	0.0E+00	2.1E-05	2.6E-06	7.9E-09	2.6E-03	3.6E-04	5.8E-05	6.7E-03	7.7E-06	4.8E-08	1.4E-02	3.0E-03	3.5E-04	1.4E-02
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	1,500,000	7.0E-05	0.0E+00	2.1E-05	2.6E-06	7.9E-09	2.6E-03	3.6E-04	5.8E-05	6.7E-03	7.7E-06	4.8E-08	1.4E-02	3.0E-03	3.5E-04	1.4E-02
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	1,500,000	6.7E-05	0.0E+00	3.2E-05	2.3E-06	1.1E-05	2.2E-03	3.6E-04	5.8E-05	6.7E-03	1.8E-05	4.7E-08	1.7E-02	2.7E-03	3.5E-04	1.7E-02
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	5,475,000	1.5E-04	0.0E+00	8.8E-05	2.4E-06	4.0E-05	5.4E-03	3.6E-04	5.8E-05	6.0E-04	1.0E-04	1.2E-07	1.8E-02	5.8E-03	0.0E+00	1.8E-02
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	5,475,000	6.7E-05	0.0E+00	6.3E-05	1.4E-05	3.9E-05	2.3E-03	3.6E-04	5.8E-05	1.2E-03	5.0E-05	9.8E-08	3.8E-03	2.7E-03	3.6E-04	3.8E-03
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	5,475,000	6.7E-05	0.0E+00	6.0E-05	1.4E-05	3.9E-05	4.0E-03	3.6E-04	5.8E-05	1.2E-03	4.9E-05	8.6E-08	5.4E-03	4.5E-03	3.6E-04	5.4E-03
B1 - Nitramine / Binder	Explosive	Plastic Bonded	5,475,000	6.7E-05	0.0E+00	7.9E-05	9.8E-06	4.0E-05	9.0E-03	3.7E-04	5.8E-05	3.8E-03	6.8E-03	1.1E-06	5.3E-03	9.4E-03	3.5E-04	9.4E-03
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	5,475,000	6.7E-05	0.0E+00	7.9E-05	2.1E-05	4.0E-05	1.2E-02	3.6E-04	5.8E-05	1.2E-03	6.8E-03	1.1E-06	6.5E-03	1.2E-02	3.7E-04	1.2E-02
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	5,475,000	1.5E-04	0.0E+00	8.8E-05	2.4E-06	4.0E-05	5.4E-03	4.1E-04	5.8E-05	3.9E-03	1.1E-04	1.2E-07	2.1E-02	5.8E-03	4.7E-04	2.1E-02
P - Pyrotechnics	Pyrotechnic	-	5,475,000	2.9E-04	0.0E+00	6.1E-05	1.2E-05	5.6E-05	2.3E-02	3.8E-04	5.8E-05	1.0E-03	3.0E-03	2.9E-06	2.4E-02	2.3E-02	6.5E-04	2.4E-02
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	580,000	9.5E-05	0.0E+00	2.1E-05	2.5E-06	6.6E-11	2.5E-03	3.6E-04	5.8E-05	5.5E-03	7.4E-06	4.0E-07	6.5E-03	2.9E-03	3.8E-04	6.5E-03
W - Energetic-contaminated wastes	ECW	-	5,475,000	2.7E-04	0.0E+00	5.8E-05	1.1E-05	3.0E-05	2.2E-02	3.6E-04	5.8E-05	7.4E-04	2.5E-03	1.6E-06	2.4E-02	2.3E-02	5.8E-04	2.4E-02
M - Munition Components	Munition Components	-	5,475,000	3.1E-04	0.0E+00	5.8E-05	5.0E-05	6.9E-05	2.2E-02	4.0E-04	5.8E-05	7.4E-04	2.5E-03	4.1E-05	2.4E-02	2.3E-02	6.9E-04	2.4E-02
<b>Other</b>																		
OD Grading	-	-	365 <sup>4</sup>	7.0E-09	0.0E+00	2.2E-09	2.4E-10	0.0E+00	2.4E-07	3.8E-08	6.1E-09	5.6E-08	7.3E-10	5.0E-12	3.4E-07	2.9E-07	3.7E-08	3.4E-07

<sup>1</sup> Treatment limit specified in RCRA permit.

<sup>2</sup> The OB risks are inclusive of windblown dust and ash handling risks.

<sup>3</sup> The OD risks are inclusive of windblown dust and crater risks.

<sup>4</sup> Number of events.

Table 6-8. Contribution to Chronic Noncancer HIs by Chemical for Each OB Energetic Emission Category

Chemical of Concern <sup>2</sup>	CAS #	Contribution to Chronic Noncancer HI <sup>1</sup>																	
		IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA	IIB	IIC	IID	IIE	IIF	A1	A2	B1	B2	B3	C1
Acetone	67641											0.00%			0.00%	0.00%	0.00%		
Acrolein	107028											0.12%			0.70%	0.50%	0.12%		
Aluminum	7429905									4.53%	4.53%		18.31%	99.89%		29.23%	18.31%	95.33%	
Ammonia	7664417	55.69%	27.75%	43.16%	55.69%	27.75%	43.16%		57.92%	0.01%	0.01%	0.00%	0.01%	1.27%	0.10%		0.01%	0.01%	
Barium	7440393							99.87%											
Biphenyl, 1,1-	92524																	0.00%	
Bis(2-ethylhexyl)phthalate (DEHP)	117817		34.62%				34.62%												
Bromoform (tribromomethane)	75252									0.01%	0.01%		0.21%				0.21%		
Bromomethane	74839									0.00%	0.00%								
Butanol, 1-	71363																	2.12%	
Butylbenzene, n-	104518							0.03%											
Butylbenzene, T-	98066							0.03%											
Chlorine	7782505									47.36%	47.36%	65.29%	78.00%				78.00%		
Copper	7440508									0.05%	0.05%		0.00%				0.00%	0.99%	
Cumene (Isopropylbenzene)	98828		0.01%			0.01%								0.00%	0.00%	0.00%	0.00%	0.00%	
Cyclohexane	110827												0.00%		0.00%	0.00%		0.00%	
Diethyl ether (Ethyl ether)	60297																	0.00%	
Diethyl phthalate	84662		0.87%			0.87%									0.00%	0.00%			
Dinitrotoluene, 2,6-	606202							0.04%											
Hydrogen chloride	7647010									48.04%	48.04%	34.70%	1.43%				1.43%		
Isoprene	9003310							0.00%											
Methylcyclohexane	108872		0.00%			0.00%							0.00%	0.00%	0.00%	0.00%		0.01%	
Methylethyl ketone	78933																	0.02%	
Methylphenol, 2-	95487																	0.00%	
Methylphenol, 3-	108394																	0.00%	
Methylphenol, 4-	106445																	0.00%	
Naphthalene	91203	0.90%		0.70%	0.90%		0.70%		0.94%	0.00%	0.00%	0.00%	0.02%	0.07%			0.02%	0.00%	
Nitrogen Dioxide	10102440	17.94%	29.22%	56.14%	17.94%	29.22%	56.14%		16.86%	0.00%	0.00%	0.01%	0.02%	1.97%	0.00%	0.28%	0.20%	0.02%	0.01%
Nitroguanidine	556887							0.00%											
Nitropropane, 2-	79469												0.00%					0.00%	
Propylbenzene, n-	103651							0.03%											
Propylene (Propene)	115071	0.01%	0.16%		0.01%	0.16%			0.01%	0.00%	0.00%		0.00%	0.00%			0.00%	0.01%	
Sulfur Dioxide	7446095													0.15%				0.00%	
Tetranitro-N-methylaniline, N,2,4,6- (Tetryl, Trinitrophenylmethylnitramine)	479458														0.00%	0.00%			
Toluene	108883	0.10%	0.46%		0.10%	0.46%			0.19%					0.01%	0.00%			0.00%	
Trichloroethane, 1,1,2-	79005												0.00%					0.00%	
Trimethylbenzene, 1,2,4-	95636																	0.05%	
Trimethylbenzene, 1,3,5-	108678																	0.05%	
Trimethylpentane, 2,2,4-	540841							0.00%											
Trinitrotoluene, 2,4,6- (TNT)	118967	2.21%			2.21%									0.42%	0.01%				
Vinyl acetate	108054																	0.10%	
Vinyl Chloride	75014									0.00%	0.00%								
Xylenes	1330207																	0.00%	
Chloropicrin (trichloronitromethane)	76062												0.09%					0.09%	
Dibutyl phthalate	84742		6.92%			6.92%													

Table 6-8. Contribution to Chronic Noncancer HIs by Chemical for Each OB Energetic Emission Category (Continued)

Contribution to Chronic Noncancer HI <sup>1</sup>																			
Chemical of Concern <sup>2</sup>	CAS #	IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA	IIB	IIC	IID	IIE	IIF	A1	A2	B1	B2	B3	C1
Dimethylamine	124403	23.16%			23.16%				24.09%				1.78%					1.78%	1.31%
Methacrylonitrile	126987															99.02%	70.07%		
Sulfuric Acid	7664939													96.11%					
<b>Total</b>		<b>100%</b>																	
<b>Maximum Contribution from One Chemical of Concern</b>		<b>55.69%</b>	<b>34.62%</b>	<b>56.14%</b>	<b>55.69%</b>	<b>34.62%</b>	<b>56.14%</b>	<b>99.87%</b>	<b>57.92%</b>	<b>48.04%</b>	<b>48.04%</b>	<b>65.29%</b>	<b>78.00%</b>	<b>96.11%</b>	<b>99.89%</b>	<b>99.02%</b>	<b>70.07%</b>	<b>78.00%</b>	<b>95.33%</b>

<sup>1</sup> The contribution by chemical represents the percent contribution of each chemical relative to the total risk from all chemicals for each energetic family. The other emissions that also occur from other sources during OB or OD such as wind blown dust, crater, or ash handling are not factored in this table.

<sup>2</sup> All chemicals having non-zero contributions are listed. Values listed as 0.00% contribute less than 0.005%.

Table 6-9. Contribution to Chronic Noncancer HIs by COC for Each OD Energetic Emission Category

Chemical of Concern <sup>2</sup>	CAS #	Contribution to Chronic Noncancer HI <sup>1</sup>																					
		IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA	IIB	IIC	IID	IIE	IIF	A1	A2	B1	B2	B3	C1	P	W	M	
Acetone	67641												0.00%			0.00%	0.00%	0.00%				0.06%	0.06%
Acrolein	107028												0.12%			0.70%	0.50%	0.10%				0.30%	0.30%
Allyl chloride	107051																			0.02%			
Aluminum	7429905										2.91%	2.91%		18.31%		80.40%		29.23%	16.12%	95.33%		96.51%	96.33%
Ammonia	7664417	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%			0.00%	0.00%	0.00%	0.01%		0.08%			0.01%	0.01%				
Barium	7440393								0.25%												0.53%		
Benzidine	92875								0.00%	0.00%													
Biphenyl, 1,1-	92524																			0.00%			
Bis(2-ethylhexyl)phthalate (DEHP)	117817		0.01%				0.01%																
Bromoform (tribromomethane)	75252											0.01%	0.01%					0.18%					
Bromomethane	74839											0.00%	0.00%										
Butanol, 1-	71363																			2.12%			
Cadmium	7440439																				98.86%		
Chlorine	7782505										30.47%	30.47%	47.24%	78.00%					68.67%			2.02%	2.02%
Chloromethane (Methyl chloride)	74873																				0.00%		
Copper	7440508										0.03%	0.03%		0.00%				0.00%	0.99%	0.56%	1.00%	1.00%	
Cumene (Isopropylbenzene)	98828		0.00%				0.00%									0.00%	0.00%	0.00%		0.00%	0.00%		
Cyclohexane	110827																			0.00%			
Diethyl ether (Ethyl ether)	60297																			0.00%			
Diethyl phthalate	84662		0.00%				0.00%										0.00%	0.00%					
Ethylbenzene	100414								0.00%						0.00%						0.00%		
Hexachloroethane	67721																				0.00%		
Hydrogen chloride	7647010										30.91%	30.91%	25.11%	1.43%					1.26%			0.04%	0.04%
Methylcyclohexane	108872		0.00%				0.00%									0.00%	0.00%	0.00%		0.01%			
Methylethyl ketone	78933																			0.02%			
Methylphenol, 2-	95487																			0.00%			
Methylphenol, 3-	108394																			0.00%			
Methylphenol, 4-	106445																			0.00%			
Naphthalene	91203	0.00%		0.00%	0.00%		0.00%			0.00%	0.00%	0.00%	0.02%					0.02%	0.00%				
Nitrogen Dioxide	10102440	0.00%	0.01%	0.01%	0.00%	0.01%	0.01%			0.00%	0.00%	0.01%	0.02%		0.00%	0.28%	0.20%	0.02%	0.01%			0.05%	0.05%
Nitropropane, 2-	79469																		0.00%				
Propylene (Propene)	115071	0.00%	0.00%		0.00%	0.00%				0.00%	0.00%		0.00%		0.00%			0.00%	0.01%				
Sulfur Dioxide	7446095																			0.00%		0.00%	0.00%
Tetrachlorodibenzofuran, 2,3,7,8-	51207319																					0.00%	0.00%
Tetrachlorodibenzo-p-Dioxin, 2,3,7,8-	1746016																					0.00%	0.00%
Tetrachloroethane, 1,1,2,2-	79345																				0.00%		
Tetrachloroethylene (PCE)	127184																				0.00%		
Tetranitro-N-methylaniline, N,2,4,6- (Tetryl, Trinitrophenylmethylnitramine)	479458																0.00%	0.00%					
Toluene	108883	0.00%	0.00%		0.00%	0.00%										0.00%				0.00%		0.00%	0.00%
Total TCDD	1746016																					0.00%	0.09%
Total TCDF	51207319																					0.00%	0.10%
Trichloroethane, 1,1,2-	79005													0.00%					0.00%				
Trimethylbenzene, 1,2,4-	95636																						

Table 6-9. Contribution to Chronic Noncancer HIs by COC for Each OD Energetic Emission Category (Continued)

Chemical of Concern <sup>2</sup>	CAS #	Contribution to Chronic Noncancer HI <sup>1</sup>																				
		IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA	IIB	IIC	IID	IIE	IIF	A1	A2	B1	B2	B3	C1	P	W	M
Trimethylbenzene, 1,3,5-	108678																		0.05%			
Trinitrotoluene, 2,4,6- (TNT)	118967	0.00%			0.00%									0.09%	0.01%							
Vinyl acetate	108054																		0.10%			
Vinyl Chloride	75014									0.00%	0.00%											
Xylenes	1330207																		0.00%		0.00%	0.00%
Bis(2-chloro-1-methylethyl)ether	108601																			0.03%		
Chloropicrin (trichloronitromethane)	76062													0.09%				0.08%				
Dibutyl phthalate	84742		0.00%			0.00%																
Dimethylamine	124403	0.00%			0.00%									1.78%				1.56%	1.31%			
Methacrylonitrile	126987															99.02%	70.07%					
Aluminum	7429905	3.03%	3.03%	3.03%	3.03%	3.03%	3.03%															
Antimony	7440360	0.53%	0.53%	0.53%	0.53%	0.53%	0.53%															
Cadmium	7440439							99.75%	100.00%	35.64%	35.64%	27.63%		99.91%	19.51%			11.63%				
Chromium VI	18540299									0.02%	0.02%	0.02%			0.00%			0.01%				
Copper	7440508	96.42%	96.41%	96.42%	96.42%	96.41%	96.42%															
Molybdenum	7439987							0.00%	0.00%	0.00%	0.00%	0.00%				0.00%		0.00%				
Nickel	7440020																	0.32%				
<b>Total</b>		<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>
<b>Maximum Contribution from One Chemical of Concern</b>		<b>96.42%</b>	<b>96.41%</b>	<b>96.42%</b>	<b>96.42%</b>	<b>96.41%</b>	<b>96.42%</b>	<b>99.75%</b>	<b>100.00%</b>	<b>35.64%</b>	<b>35.64%</b>	<b>47.24%</b>	<b>78.00%</b>	<b>99.91%</b>	<b>80.40%</b>	<b>99.02%</b>	<b>70.07%</b>	<b>68.67%</b>	<b>95.33%</b>	<b>98.86%</b>	<b>96.51%</b>	<b>96.33%</b>

<sup>1</sup> The contribution by chemical represents the percent contribution of each chemical relative to the total risk from all chemicals for each energetic family. The other emissions that also occur from other sources during OB or OD such as wind blown dust, crater, or ash handling are not factored in this table.

<sup>2</sup> All chemicals having non-zero contributions are listed. Values listed as 0.00% contribute less than 0.005%.

Table 6-10. Summary of Maximum Acute Noncancer Risks for Each Emission Category

Emission Category	Family	Sub Family	Permitted Hourly Treatment Quantity <sup>1</sup> (lb/hr)	MEI Acute HI				Total
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	
<b>Open Burn</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	1000	3.2E-05	4.2E-07	6.7E-12	-	3.3E-05
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	1000	9.5E-05	4.2E-07	6.7E-12	-	9.5E-05
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	1000	1.1E-04	4.2E-07	6.7E-12	-	1.1E-04
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	1000	3.2E-05	4.2E-07	6.7E-12	-	3.3E-05
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	1000	9.5E-05	4.2E-07	6.7E-12	-	9.5E-05
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	1000	1.1E-04	4.2E-07	6.7E-12	-	1.1E-04
IIA - Double base with Lead	Propellant	Rocket/Missile	1000	1.5E-04	4.2E-07	6.7E-12	-	1.5E-04
IIB - Double base without Lead	Propellant	Rocket/Missile	1000	3.0E-05	4.2E-07	6.7E-12	-	3.0E-05
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	1000	3.1E-03	4.2E-07	6.7E-12	-	3.1E-03
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	1000	3.1E-03	4.2E-07	6.7E-12	-	3.1E-03
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	1000	3.8E-03	4.2E-07	6.7E-12	-	3.8E-03
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	1000	9.9E-04	4.2E-07	6.7E-12	-	9.9E-04
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	1000	2.0E-04	4.2E-07	6.7E-12	-	2.0E-04
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	1000	4.9E-05	4.2E-07	6.7E-12	-	5.0E-05
B1 - Nitramine / Binder	Explosive	Plastic Bonded	1000	1.6E-03	4.2E-07	6.7E-12	-	1.6E-03
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	1000	1.6E-03	4.2E-07	6.7E-12	-	1.6E-03
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	1000	9.9E-04	4.2E-07	6.7E-12	-	9.9E-04
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	1000	3.8E-04	4.2E-07	6.7E-12	-	3.8E-04
Diesel	-	-	1,000	6.4E-03	4.2E-07	6.7E-12	-	6.4E-03
Wood	-	-	1,000	3.9E-04	4.2E-07	6.7E-12	-	3.9E-04
<b>Open Detonation</b>								
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	30000	5.6E-01	4.2E-07	-	8.7E-04	5.6E-01
IIA - Double base with Lead	Propellant	Rocket/Missile	16200	2.3E-03	4.2E-07	-	8.7E-04	3.2E-03
IIB - Double base without Lead	Propellant	Rocket/Missile	30000	8.4E-04	4.2E-07	-	8.7E-04	1.7E-03
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	30000	8.7E-02	4.2E-07	-	8.7E-04	8.8E-02
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	30000	8.7E-02	4.2E-07	-	8.7E-04	8.8E-02
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	30000	1.1E-01	4.2E-07	-	8.7E-04	1.1E-01
IIF - Nitramine / Energetic Binder / AI / <20% AP	Propellant	Rocket/Missile	30000	2.8E-02	4.2E-07	-	8.7E-04	2.9E-02
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	30000	5.6E-03	4.2E-07	-	8.7E-04	6.5E-03
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	30000	1.4E-03	4.2E-07	-	8.7E-04	2.3E-03
B1 - Nitramine / Binder	Explosive	Plastic Bonded	30000	4.6E-02	4.2E-07	-	8.7E-04	4.7E-02
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	30000	4.6E-02	4.2E-07	-	8.7E-04	4.6E-02
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	30000	2.9E-02	4.2E-07	-	8.7E-04	3.0E-02

Table 6-10. Summary of Maximum Acute Noncancer Risks for Each Emission Category (Continued)

Emission Category	Family	Sub Family	Permitted Hourly Treatment Quantity <sup>1</sup> (lb/hr)	MEI Acute HI				
				Emission Category	Windblown Dust <sup>2</sup>	Ash Handling <sup>3</sup>	Crater <sup>4</sup>	Total
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	16200	5.8E-03	4.2E-07	-	8.7E-04	6.7E-03
P - Pyrotechnics	Pyrotechnic	-	30000	1.4E-02	4.2E-07	-	8.7E-04	1.5E-02
W - Energetic-contaminated wastes	ECW	-	30000	4.8E-02	4.2E-07	-	8.7E-04	4.8E-02
M - Munition Components	Munition Components	-	30000	4.7E-02	4.2E-07	-	8.7E-04	4.8E-02
<b>Other</b>								
OD Grading	-	-	1 <sup>5</sup>	9.1E-06	4.2E-07	-	-	9.5E-06

<sup>1</sup> Treatment limit specified in RCRA permit.

<sup>2</sup> Risks associated with windblown dust apply to treatment by both OD and OB since emissions occur throughout the year.

<sup>3</sup> Risks associated with emissions from ash handling only apply during treatment by OB.

<sup>4</sup> Risks associated with emissions from the crater only apply during treatment by OD.

<sup>5</sup> Number of grading events per hour.

Table 6-11. Acute Noncancer HIs by Target Organ for Each Emission Category

Emission Category	Family	Sub Family	Permitted Hourly Treatment Quantity <sup>1</sup> (lb/hr)	Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other	Maximum
<b>Open Burn</b>																		
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	1,000	1.4E-07	0.0E+00	1.5E-05	1.9E-07	0.0E+00	5.4E-06	1.9E-07	4.7E-07	1.4E-07	2.8E-09	1.9E-07	3.3E-05	1.4E-07	2.2E-07	3.3E-05
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	1,000	6.4E-07	0.0E+00	1.5E-05	1.3E-06	0.0E+00	6.4E-06	1.3E-06	1.5E-06	1.5E-07	5.0E-07	1.8E-06	9.5E-05	6.4E-07	2.2E-07	9.5E-05
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	1,000	1.4E-07	0.0E+00	1.4E-07	2.1E-09	0.0E+00	5.4E-06	1.8E-11	2.8E-07	1.4E-07	1.7E-11	2.1E-09	1.1E-04	1.4E-07	2.2E-07	1.1E-04
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	1,000	1.4E-07	0.0E+00	1.5E-05	1.9E-07	0.0E+00	5.4E-06	1.9E-07	4.7E-07	1.4E-07	2.8E-09	1.9E-07	3.3E-05	1.4E-07	2.2E-07	3.3E-05
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	1,000	6.4E-07	0.0E+00	1.5E-05	1.3E-06	0.0E+00	6.4E-06	1.3E-06	1.5E-06	1.5E-07	5.0E-07	1.8E-06	9.5E-05	6.4E-07	2.2E-07	9.5E-05
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	1,000	1.4E-07	0.0E+00	1.4E-07	2.1E-09	0.0E+00	5.4E-06	1.8E-11	2.8E-07	1.4E-07	1.7E-11	2.1E-09	1.1E-04	1.4E-07	2.2E-07	1.1E-04
IIA - Double base with Lead	Propellant	Rocket/Missile	1,000	1.7E-07	0.0E+00	1.2E-04	2.3E-06	0.0E+00	5.4E-06	2.3E-06	2.5E-06	1.7E-07	2.9E-08	2.3E-06	1.5E-04	1.7E-07	1.1E-06	1.5E-04
IIB - Double base without Lead	Propellant	Rocket/Missile	1,000	1.4E-07	0.0E+00	2.9E-06	6.5E-08	0.0E+00	5.4E-06	6.3E-08	3.4E-07	1.4E-07	2.3E-09	6.5E-08	3.0E-05	1.4E-07	2.2E-07	3.0E-05
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	1,000	1.4E-05	0.0E+00	4.5E-06	1.2E-06	0.0E+00	3.0E-03	1.1E-06	1.3E-06	1.4E-05	8.8E-08	1.2E-06	3.1E-03	1.4E-05	2.2E-07	3.1E-03
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	1,000	1.4E-05	0.0E+00	4.5E-06	1.2E-06	0.0E+00	3.0E-03	1.1E-06	1.3E-06	1.4E-05	8.8E-08	1.2E-06	3.1E-03	1.4E-05	2.2E-07	3.1E-03
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	1,000	1.4E-07	0.0E+00	1.5E-07	2.1E-09	0.0E+00	3.6E-03	1.8E-11	2.8E-07	1.4E-07	4.9E-05	2.1E-09	3.8E-03	1.4E-07	2.2E-07	3.8E-03
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	1,000	2.8E-07	0.0E+00	7.6E-06	1.4E-06	0.0E+00	8.6E-04	2.6E-07	5.4E-07	2.8E-07	5.0E-05	1.4E-06	9.9E-04	2.8E-07	2.2E-07	9.9E-04
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	1,000	1.6E-07	0.0E+00	5.8E-05	1.8E-06	0.0E+00	1.5E-05	1.8E-06	2.1E-06	1.4E-07	4.9E-05	1.8E-06	2.0E-04	9.8E-06	2.2E-07	2.0E-04
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	1,000	1.4E-07	0.0E+00	5.5E-06	1.4E-07	0.0E+00	5.4E-06	1.4E-07	4.1E-07	1.4E-07	4.9E-05	1.4E-07	8.0E-06	1.4E-07	2.2E-07	4.9E-05
B1 - Nitramine / Binder	Explosive	Plastic Bonded	1,000	1.5E-07	0.0E+00	3.3E-05	1.5E-05	0.0E+00	7.2E-04	1.5E-05	1.6E-05	1.4E-07	5.2E-05	1.8E-05	1.6E-03	2.6E-06	2.2E-07	1.6E-03
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	1,000	1.5E-07	0.0E+00	3.3E-05	1.5E-05	0.0E+00	7.2E-04	1.5E-05	1.6E-05	1.4E-07	5.2E-05	1.8E-05	1.6E-03	2.6E-06	2.2E-07	1.6E-03
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	1,000	2.8E-07	0.0E+00	7.6E-06	1.4E-06	0.0E+00	8.6E-04	2.6E-07	5.4E-07	2.8E-07	5.0E-05	1.4E-06	9.9E-04	2.8E-07	2.2E-07	9.9E-04
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	1,000	2.3E-04	0.0E+00	5.6E-05	2.1E-06	0.0E+00	3.2E-04	2.1E-06	2.3E-06	2.3E-04	6.4E-05	2.1E-06	3.8E-04	2.6E-04	4.1E-06	3.8E-04
Diesel	-	-	1,000	2.8E-07	0.0E+00	1.8E-10	3.3E-05	0.0E+00	6.4E-03	1.2E-08	1.5E-05	1.4E-07	4.3E-10	3.3E-05	6.4E-03	2.8E-07	3.7E-07	6.4E-03
Wood	-	-	1,000	1.4E-07	0.0E+00	1.8E-10	2.1E-09	0.0E+00	3.1E-04	1.8E-11	3.1E-04	1.4E-07	1.8E-11	2.1E-09	3.1E-04	1.4E-07	2.2E-07	3.1E-04
<b>Open Detonation</b>																		
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	30,000	5.6E-01	0.0E+00	4.4E-04	9.9E-06	0.0E+00	5.6E-01	5.5E-06	5.9E-04	5.6E-01	1.2E-07	9.9E-06	5.6E-01	5.6E-01	4.6E-04	5.6E-01
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	30,000	5.6E-01	0.0E+00	4.4E-04	4.1E-05	0.0E+00	5.6E-01	3.6E-05	6.2E-04	5.6E-01	1.4E-05	5.5E-05	5.6E-01	5.6E-01	4.6E-04	5.6E-01
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	30,000	5.6E-01	0.0E+00	2.2E-05	4.5E-06	0.0E+00	5.6E-01	3.7E-08	5.8E-04	5.6E-01	3.6E-08	4.5E-06	5.6E-01	5.6E-01	4.6E-04	5.6E-01
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	30,000	5.6E-01	0.0E+00	4.4E-04	9.9E-06	0.0E+00	5.6E-01	5.5E-06	5.9E-04	5.6E-01	1.2E-07	9.9E-06	5.6E-01	5.6E-01	4.6E-04	5.6E-01
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	30,000	5.6E-01	0.0E+00	4.4E-04	4.1E-05	0.0E+00	5.6E-01	3.6E-05	6.2E-04	5.6E-01	1.4E-05	5.5E-05	5.6E-01	5.6E-01	4.6E-04	5.6E-01
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	30,000	5.6E-01	0.0E+00	2.2E-05	4.5E-06	0.0E+00	5.6E-01	3.7E-08	5.8E-04	5.6E-01	3.6E-08	4.5E-06	5.6E-01	5.6E-01	4.6E-04	5.6E-01
IIA - Double base with Lead	Propellant	Rocket/Missile	16,200	2.9E-04	0.0E+00	1.8E-03	3.9E-05	0.0E+00	3.7E-04	3.5E-05	6.2E-04	2.9E-04	4.7E-07	3.9E-05	3.2E-03	2.9E-04	4.8E-04	3.2E-03
IIB - Double base without Lead	Propellant	Rocket/Missile	30,000	2.9E-04	0.0E+00	8.2E-05	6.2E-06	0.0E+00	4.4E-04	1.8E-06	5.9E-04	2.9E-04	1.0E-07	6.2E-06	1.7E-03	2.9E-04	4.7E-04	1.7E-03
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	30,000	6.7E-04	0.0E+00	1.3E-04	3.7E-05	0.0E+00	8.6E-02	3.1E-05	6.1E-04	6.7E-04	2.5E-06	3.7E-05	8.8E-02	6.7E-04	4.7E-04	8.8E-02
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	30,000	6.7E-04	0.0E+00	1.3E-04	3.7E-05	0.0E+00	8.6E-02	3.1E-05	6.1E-04	6.7E-04	2.5E-06	3.7E-05	8.8E-02	6.7E-04	4.7E-04	8.8E-02
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	30,000	2.9E-04	0.0E+00	4.6E-06	4.5E-06	0.0E+00	1.0E-01	3.7E-08	5.8E-04	2.9E-04	1.4E-03	4.5E-06	1.1E-01	2.9E-04	4.7E-04	1.1E-01
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	30,000	2.9E-04	0.0E+00	2.2E-04	4.3E-05	0.0E+00	2.5E-02	7.5E-06	5.9E-04	2.9E-04	1.4E-03	4.3E-05	2.9E-02	2.9E-04	0.0E+00	2.9E-02
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	30,000	2.9E-04	0.0E+00	1.7E-03	5.6E-05	0.0E+00	7.1E-04	5.3E-05	6.4E-04	2.9E-04	1.4E-03	5.6E-05	6.5E-03	5.6E-04	4.6E-04	6.5E-03
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	30,000	2.9E-04	0.0E+00	1.6E-04	8.4E-06	0.0E+00	4.4E-04	3.9E-06	5.9E-04	2.9E-04	1.4E-03	8.4E-06	1.1E-03	2.9E-04	4.6E-04	1.4E-03
B1 - Nitramine / Binder	Explosive	Plastic Bonded	30,000	2.9E-04	0.0E+00	9.4E-04	4.4E-04	0.0E+00	2.1E-02	4.3E-04	1.1E-03	2.9E-04	1.5E-03	5.1E-04	4.7E-02	3.6E-04	4.6E-04	4.7E-02
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	30,000	2.9E-04	0.0E+00	9.4E-04	4.4E-04	0.0E+00	2.1E-02	4.3E-04	1.0E-03	2.9E-04	1.5E-03	5.1E-04	4.6E-02	3.6E-04	4.6E-04	4.6E-02
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	30,000	2.9E-04	0.0E+00	2.2E-04	4.3E-05	0.0E+00	2.5E-02	7.5E-06	1.2E-03	2.9E-04	1.4E-03	4.3E-05	3.0E-02	2.9E-04	4.6E-04	3.0E-02
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	16,200	3.9E-03	0.0E+00	8.7E-04	3.7E-05	0.0E+00	5.2E-03	3.2E-05	6.2E-04	3.9E-03	9.8E-04	3.7E-05	6.7E-03	4.2E-03	5.2E-04	6.7E-03

Table 6-11. Acute Noncancer HIs by Target Organ for Each Emission Category (Continued)

Emission Category	Family	Sub Family	Permitted Hourly Treatment Quantity <sup>1</sup> (lb/hr)	Alimentary Tract	Bone	Cardiovascular	Developmental	Endocrine	Eye	Hematologic	Immune	Kidney	Nervous	Reproductive	Respiratory	Skin	Other	Maximum
P – Pyrotechnics	Pyrotechnic	-	30,000	8.6E-03	0.0E+00	6.7E-04	2.9E-05	0.0E+00	1.0E-02	2.4E-05	6.1E-04	8.6E-03	2.0E-05	4.8E-05	1.5E-02	9.7E-03	6.3E-04	1.5E-02
W - Energetic-contaminated wastes	ECW	-	30,000	6.9E-03	0.0E+00	3.8E-07	1.1E-05	0.0E+00	3.5E-02	6.3E-06	5.9E-04	6.9E-03	1.0E-03	1.1E-05	4.8E-02	8.0E-03	4.6E-04	4.8E-02
M - Munition Components	Munition Components	-	30,000	6.9E-03	0.0E+00	3.8E-07	1.1E-05	0.0E+00	3.5E-02	6.3E-06	5.9E-04	6.9E-03	1.0E-03	1.1E-05	4.8E-02	7.9E-03	4.6E-04	4.8E-02
<b>Other</b>																		
OD Grading	-	-	1 <sup>3</sup>	3.0E-06	0.0E+00	0.0E+00	4.7E-08	0.0E+00	3.0E-06	3.9E-10	6.1E-06	0.0E+00	3.8E-10	4.7E-08	9.1E-06	3.0E-06	4.8E-06	9.1E-06

<sup>1</sup>Treatment limit specified in RCRA permit.

<sup>1</sup>The OB risks are inclusive of windblown dust and ash handling risks.

<sup>2</sup>The OD risks are inclusive of windblown dust and crater risks.

<sup>3</sup>Number of events.

Table 6-12. Contribution to Acute Noncancer HIs by Chemical for Each OB Energetic Emission Category

Chemical of Concern <sup>2</sup>	CAS #	Contribution to Acute Noncancer HI <sup>1</sup>																	
		IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA	IIB	IIC	IID	IIE	IIF	A1	A2	B1	B2	B3	C1
Acrolein	107028												27.31%			44.23%	44.23%	27.31%	
Ammonia	7664417	16.25%	5.54%	4.58%	16.25%	5.54%	4.58%	3.48%	17.67%	0.17%	0.17%	0.14%	0.53%	2.65%		0.33%	0.33%	0.53%	1.39%
Bromoform (tribromomethane)	75252									0.00%	0.00%		0.00%					0.00%	
Bromomethane	74839									0.00%	0.00%								
Chlorine	7782505									17.53%	17.53%	28.47%	54.12%					54.12%	
Copper	7440508									0.44%	0.44%		0.01%					0.01%	61.38%
Diethyl phthalate	84662		0.52%			0.52%										0.15%	0.15%		
Dioxane, 1,4-	123911																		0.00%
Fluorotrichloromethane (Trichlorofluoromethane)	75694									0.00%	0.00%								
Hydrogen chloride	7647010									80.02%	80.02%	68.07%	4.47%					4.47%	
Hydrogen Cyanide	74908													100.00%					
Methylethyl ketone	78933																		3.83%
Methylphenol, 2-	95487																		0.01%
Methylphenol, 3-	108394																		0.01%
Methylphenol, 4-	106445																		0.01%
Nitrogen Dioxide	10102440	83.75%	93.40%	95.42%	83.75%	93.40%	95.42%	96.51%	82.32%	1.70%	1.70%	3.32%	12.62%	65.71%		55.16%	55.16%	12.62%	15.15%
Propanol, 2-	67630																		15.58%
Styrene	100425		0.01%			0.01%		0.00%					0.00%	0.00%		0.12%	0.12%	0.00%	0.03%
Sulfur Dioxide	7446095													4.87%					2.55%
Toluene	108883	0.00%	0.01%		0.00%	0.01%		0.01%	0.01%					0.00%	0.00%	0.01%	0.01%		0.02%
Trichloroethane, 1,1,2-	79005												0.00%					0.00%	
Vinyl Chloride	75014									0.00%	0.00%								
Xylenes	1330207															0.00%	0.00%		0.03%
Chloropicrin (trichloronitromethane)	76062												0.94%					0.94%	
Dibutyl phthalate	84742		0.52%			0.52%													
Phosgene	75445									0.14%	0.14%								
Sulfuric Acid	7664939													26.77%					
<b>Total</b>		<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>
<b>Maximum Contribution from One Chemical of Concern</b>		<b>83.75%</b>	<b>93.40%</b>	<b>95.42%</b>	<b>83.75%</b>	<b>93.40%</b>	<b>95.42%</b>	<b>96.51%</b>	<b>82.32%</b>	<b>80.02%</b>	<b>80.02%</b>	<b>68.07%</b>	<b>54.12%</b>	<b>65.71%</b>	<b>100.00%</b>	<b>55.16%</b>	<b>55.16%</b>	<b>54.12%</b>	<b>61.38%</b>

<sup>1</sup> The contribution by chemical represents the percent contribution of each chemical relative to the total risk from all chemicals for each energetic family. The other emissions that also occur from other sources during OB or OD such as wind blown dust, crater, or ash handling are not factored in this table.

<sup>2</sup> All chemicals having non-zero contributions are listed. Values listed as 0.00% contribute less than 0.005%.

Table 6-13. Contribution of Acute Noncancer HIs by Chemical for Each OD Energetic Emission Category

Chemical of Concern <sup>2</sup>	CAS #	Contribution to Acute Noncancer HI <sup>1</sup>																					
		IAw	IBw	ICw	IAwo	IBwo	ICwo	IIA	IIB	IIC	IID	IIE	IIF	A1	A2	B1	B2	B3	C1	P	W	M	
Acrolein	107028												27.31%			44.10%	44.23%	26.72%			55.18%	55.18%	
Ammonia	7664417	0.03%	0.03%	0.03%	0.03%	0.03%	0.03%	3.48%	17.67%	0.17%	0.17%	0.14%	0.53%	2.65%		0.33%	0.33%	0.52%	1.39%	1.05%			
Bis(2-chloroethyl)ether	111444																			0.00%			
Bromoform (tribromomethane)	75252																	0.00%					
Bromomethane	74839																			0.00%			
Chlorine	7782505												17.53%	17.53%	28.47%	54.12%			52.95%	3.70%	1.11%	1.11%	
Copper	7440508												0.44%	0.44%		0.01%			0.01%	61.38%	58.61%	13.90%	13.90%
Diethyl phthalate	84662		0.00%				0.00%									0.15%	0.15%			0.13%			
Dioxane, 1,4-	123911																		0.00%				
Fluorotrichloromethane (Trichlorofluoromethane)	75694											0.00%	0.00%										
Hexachloroethane	67721																			0.00%			
Hydrogen chloride	7647010											80.02%	80.02%	68.07%	4.47%			4.37%		0.00%	0.10%	0.10%	
Hydrogen Cyanide	74908															100.00%							
Methylethyl ketone	78933																		3.83%				
Methylphenol, 2-	95487																		0.01%				
Methylphenol, 3-	108394																		0.01%				
Methylphenol, 4-	106445																		0.01%				
Nitrogen Dioxide	10102440	0.14%	0.45%	0.55%	0.14%	0.45%	0.55%	96.51%	82.32%	1.70%	1.70%	3.32%	12.62%	65.71%		55.01%	55.16%	12.34%	15.15%	29.10%	27.49%	27.49%	
Propanol, 2-	67630																		15.58%				
Styrene	100425		0.00%				0.00%	0.00%					0.00%	0.00%		0.12%	0.12%	0.00%	0.03%	0.00%			
Sulfur Dioxide	7446095													4.87%					2.55%	7.40%	2.22%	2.22%	
Tetrachloroethylene (PCE)	127184																		0.00%				
Toluene	108883	0.00%	0.00%		0.00%	0.00%		0.01%	0.01%					0.00%	0.00%	0.01%	0.01%		0.02%	0.00%	0.00%	0.00%	
Trichloroethane, 1,1,2-	79005													0.00%				0.00%					
Vinyl Chloride	75014										0.00%	0.00%							0.00%				
Xylenes	1330207															0.00%	0.00%		0.03%		0.00%	0.00%	
Chloropicrin (trichloronitromethane)	76062													0.94%				0.92%					
Dibutyl phthalate	84742		0.00%				0.00%																
Phosgene	75445										0.14%	0.14%											
Sulfuric Acid	7664939													26.77%									
Antimony	7440360	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%																
Copper	7440508	99.83%	99.52%	99.42%	99.83%	99.52%	99.42%																
Molybdenum	7439987							0.00%	0.00%	0.00%	0.00%	0.00%				0.00%		0.00%					
Nickel	7440020															0.28%		2.16%					
<b>Total</b>		<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	
<b>Maximum Contribution from One Chemical of Concern</b>		<b>99.83%</b>	<b>99.52%</b>	<b>99.42%</b>	<b>99.83%</b>	<b>99.52%</b>	<b>99.42%</b>	<b>96.51%</b>	<b>82.32%</b>	<b>80.02%</b>	<b>80.02%</b>	<b>68.07%</b>	<b>54.12%</b>	<b>65.71%</b>	<b>100.00%</b>	<b>55.01%</b>	<b>55.16%</b>	<b>52.95%</b>	<b>61.38%</b>	<b>58.61%</b>	<b>55.18%</b>	<b>55.18%</b>	

<sup>1</sup> The contribution by chemical represents the percent contribution of each chemical relative to the total risk from all chemicals for each energetic family. The other emissions that also occur from other sources during OB or OD such as wind blown dust, crater, or ash handling are not factored in this table.

<sup>2</sup> All chemicals having non-zero contributions are listed. Values listed as 0.00% contribute less than 0.005%.

Table 6-14. Maximum Estimate of Lead Concentrations

Receptor	Percentile Estimate of Lead Level in Blood (µg/dl)				
	50th	90th	95th	98th	99th
BLOOD Pb, ADULT	1.3	2.3	2.7	3.3	3.8
BLOOD Pb, CHILD	2.2	4.1	4.8	5.9	6.7
BLOOD Pb, PICA CHILD	2.7	4.9	5.8	7.0	8.0
BLOOD Pb, OCCUPATIONAL	1.1	2.0	2.4	2.9	3.3

Note:

The values displayed above are for the maximum results from OD of the C1 family energetic category. Other families are less than the estimates for OD of C1.

Table 6-15. Maximum Treatment Capacity at Applicable Risk Thresholds for Each Emission Category

Emission Category	Family	Sub Family	Maximum Possible Hourly Quantity (lb/hr)	Maximum Possible Annual Quantity (lb/yr)	Cancer Risk	Chronic Noncancer HI	Acute Noncancer HI
<b>Open Burn</b>							
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	30,572,468	225,337,951	1.E-06	7.6E-02	1.0E+00
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	10,517,685	224,458,479	1.E-06	7.6E-02	1.0E+00
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	8,704,627	266,030,275	1.E-06	9.0E-02	1.0E+00
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	30,572,468	225,337,951	1.E-06	7.6E-02	1.0E+00
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	10,517,685	224,458,479	1.E-06	7.6E-02	1.0E+00
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	8,704,627	266,030,275	1.E-06	9.0E-02	1.0E+00
IIA - Double base with Lead	Propellant	Rocket/Missile	15,048	106,073,747	1.E-06	3.7E-02	2.3E-03
IIB - Double base without Lead	Propellant	Rocket/Missile	33,211,778	420,411,754	1.E-06	1.4E-01	1.0E+00
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	327,300	3,726,974,328	1.E-06	2.1E+01	1.0E+00
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	327,300	3,726,974,328	1.E-06	2.1E+01	1.0E+00
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	265,804	129,008,596,188	1.E-06	1.0E+03	1.0E+00
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	1,010,361	15,480,108	1.E-06	5.4E-02	1.0E+00
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	5,043,311	2,025,792,896	1.E-06	7.5E-01	1.0E+00
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	20,105,644	14,904,811,239	1.E-06	1.1E+01	1.0E+00
B1 - Nitramine / Binder	Explosive	Plastic Bonded	623,724	16,293,827	1.E-06	2.8E-02	1.0E+00
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	623,724	16,293,827	1.E-06	3.8E-02	1.0E+00
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	1,010,361	15,480,108	1.E-06	5.4E-02	1.0E+00
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	15,160	21,534,517	1.E-06	1.0E-01	5.7E-03
Diesel	-	-	155,747	1,634,089	1.E-06	4.8E-04	1.0E+00
Wood	-	-	2,583,516	28,030,293	1.E-06	1.2E-03	1.0E+00
<b>Open Detonation</b>							
IAw - Single Base (NC) (with links and tracer)	Propellant	Gun	53,675	42,222,952	1.E-06	1.6E-01	1.0E+00
IBw - Double Base (NC / NG) (with links and tracer)	Propellant	Gun	53,418	42,195,736	1.E-06	1.6E-01	1.0E+00
ICw - Triple Base (NC / NG / NQ) (with links and tracer)	Propellant	Gun	53,364	43,313,547	1.E-06	1.7E-01	1.0E+00
IAwo - Single Base (NC) (without links and tracer)	Propellant	Gun	53,675	42,222,952	1.E-06	1.6E-01	1.0E+00
IBwo - Double Base (NC / NG) (without links and tracer)	Propellant	Gun	53,418	42,195,736	1.E-06	1.6E-01	1.0E+00
ICwo - Triple Base (NC / NG / NQ) (without links and tracer)	Propellant	Gun	53,364	43,313,547	1.E-06	1.7E-01	1.0E+00
IIA - Double base with Lead	Propellant	Rocket/Missile	16,200	1,495,000	1.E-06	9.4E-03	3.2E-03
IIB - Double base without Lead	Propellant	Rocket/Missile	17,445,924	1,500,000	1.E-06	9.4E-03	1.0E+00
IIC - AP / Binder / Aluminum	Propellant	Rocket/Missile	341,697	1,500,000	1.E-06	1.4E-02	1.0E+00
IID - AP / Binder / Aluminum / Nitramines (>50% AP)	Propellant	Rocket/Missile	341,697	1,500,000	1.E-06	1.4E-02	1.0E+00
IIE - AP / Binder Reduced Smoke	Propellant	Rocket/Missile	278,009	1,500,000	1.E-06	1.7E-02	1.0E+00
IIF - Nitramine / Energetic Binder / Al / <20% AP	Propellant	Rocket/Missile	1,033,602	13,065,790	1.E-06	4.4E-02	1.0E+00
A1 - TNT Based (Comp-B, Cyclotol, Octol)	Explosive	Melt Cast	4,612,037	25,823,933	1.E-06	1.8E-02	1.0E+00
A2 - TNT / Aluminum (H-6)	Explosive	Melt Cast	13,169,031	26,076,265	1.E-06	2.6E-02	1.0E+00
B1 - Nitramine / Binder	Explosive	Plastic Bonded	643,648	5,912,337	1.E-06	1.1E-02	1.0E+00

Table 6-15. Maximum Treatment Capacity at Applicable Risk Thresholds for Each Emission Category (Continued)

Emission Category	Family	Sub Family	Maximum Possible Hourly Quantity (lb/hr)	Maximum Possible Annual Quantity (lb/yr)	MEI Cancer Risk	Chronic Noncancer HI	Acute Noncancer HI
B2 - Nitramine / Binder / Aluminum	Explosive	Plastic Bonded	645,414	10,845,220	1.E-06	2.5E-02	1.0E+00
B3 - Nitramine / Binder / Aluminum / AP	Explosive	Plastic Bonded	1,011,940	5,646,709	1.E-06	2.1E-02	1.0E+00
C1 - e.g. PbN3, ammonium picrate	Explosive	Other	16,200	16,506,995	1.E-06	7.2E-02	6.7E-03
P - Pyrotechnics	Pyrotechnic	-	161,386	580,000	1.E-06	8.2E-03	8.1E-02
W - Energetic-contaminated wastes	ECW	-	620,022	11,371,162	1.E-06	4.9E-02	1.0E+00
M - Munition Components	Munition Components	-	621,014	11,371,162	1.E-06	4.9E-02	1.0E+00
<b>Other</b>							
OD Grading	-	-	1,255,783	31,549,047	1.E-06	3.0E-02	1.0E+00

## 7.0 UNCERTAINTIES

Although OEHHA has striven to use the best science available in developing the HRA guidelines followed here, a great deal of uncertainty associated with the process of assessing health risk remains. The uncertainty arises from lack of data in many areas necessitating the use of assumptions. The assumptions used in the OEHHA guidelines and in this HRA are designed to err on the side of health protection in order to avoid underestimation of risk to the public.

Uncertainty is associated with all steps of the HRA process. Uncertainty in the selection of COCs is associated with the current status of the predictive data bases and the procedures used to include or exclude constituents as COCs. Uncertainty exists with regard to emission estimates. Dispersion modeling uncertainties may be associated with the selection of the model itself and appropriate meteorologic inputs. Uncertainty associated with the exposure assessment includes the values used as input variables for a given intake route, the methods used and the assumptions made to determine exposure point concentrations, and the predictions regarding future land use and population characteristics. Uncertainty in the toxicity assessment includes the quality of the existing data to support dose-response relationships, extrapolation of toxicity data in animals to humans, and the weight-of-evidence used for determining the carcinogenicity of COCs. Uncertainty in risk characterization derives from the exposure to multiple chemicals and whether their health effects are cumulative.

While there are various sources of uncertainty, as described above, the direction of uncertainty can be influenced by the assumptions made throughout the HRA, including selection of COCs, quantification of emissions, model inputs, and selection of values for dose response relationships. Throughout the HRA, assumptions were made so that the final risks are likely overestimated because of the safety factors built into the assumptions. Thus, the resultant uncertainty in the numerical HRA is probably in how much lower the actual risks are.

Generally, HRAs carry two types of uncertainty – measurement and informational uncertainty. Measurement uncertainty refers to the usual variance that accompanies scientific measurements. The HRA reflects the accumulated variances of the individual values used. Informational uncertainty stems from inadequate availability of information needed to complete the toxicity and exposure assessments. Often, this gap is significant, such as the absence of information on the effects of human exposure to low doses of a chemical, on the biological mechanism of action of a chemical, or the behavior of a chemical in soil.

Once the HRA is complete, the results must be reviewed and evaluated to identify the type and magnitude of uncertainty involved. Reliance on results from an HRA without consideration of uncertainties, limitations, and assumptions inherent in the process is misleading. For example, to account for uncertainties in the development of exposure assumptions, conservative estimates must be made to ensure that the particular assumptions made are protective of sensitive subpopulations of the MEIs. If a number of conservative assumptions are combined in an exposure model, the resulting calculations can propagate the uncertainties associated with those assumptions, thereby producing a much larger uncertainty for the final results. This uncertainty is biased toward overpredicting both carcinogenic and noncarcinogenic risks. Thus, both the results of the HRA and the uncertainties associated with those results must be

considered when making risk management decisions such as permit limitations on the amount of waste that may be treated at the BCTF.

The interpretation is especially relevant when the risks exceed the point-of-departure for defining “acceptable” risk. For example, when risks calculated using a high degree of conservatism are below an “acceptable” risk level (i.e.,  $10^{-6}$ ), the interpretation of no significant risk is straightforward. However, when risks calculated using a high degree of conservatism are above the “acceptable” risk level, a conclusion can be difficult unless certainty is considered, and even then it can be controversial.

## 7.1 SELECTION OF COCs

An uncertainty is associated with the final risk values with regard to the selection of COCs to be used in the quantitative HRA. All chemicals identified as product or casing constituents, byproducts of combustion, detected in emission source tests, and having a toxicity factor published by a governmental agency or scientific organization were retained as COCs.

The systematic approach designed for Quadrant 1 and 2 compounds (as discussed in Section 3) began with an elimination of chemicals containing elements not found in the parent materials. There is the potential to underestimate the health risk if unidentified alternative sources of these elements are present.

Under the quadrant approach, species that are not listed in a regulatory document are not considered in the HRA. All chemical species are toxic to some extent, even water. Use of this quadrant approach has the potential to underestimate the overall health risk because measured species that have not been identified in the regulatory documents (Quadrant 3) were not accounted for in the HRA. Toxicological data for the vast majority of these species are not readily available, making accounting for them difficult at best.

This quadrant approach also has forced the consideration of species that have not been measured, but are listed in regulatory documents (Quadrant 2). The health risk screening process depends on subjective estimates of the likelihood and amount of emissions of chemicals that were not detected. The reliance on species that are listed in regulatory documents in the assessment of health risk is a conservative approach and accepted practice in the environmental industry.

There are chemicals that could theoretically be emitted from the OB/OD operations that were not included because they were not detected in any test. Many additional constituents might be expected from families containing sources of ammonium perchlorate and nitrogen. Chemical equilibrium modeling also identifies additional chemicals that may be formed. Certain chemicals may actually be different since the emission factors are derived from source tests in a controlled environment with walls that may interfere with some recombination reactions that would otherwise occur without walls.

Finally, some chemicals were not analyzed for or reported in the test results. For example, rare earths such as strontium may be present in the soil, however, data is not available because these metals were not included in the soil site investigation. Dioxins/furans may be present in ash, however, the samples were not analyzed for these compounds.

The overall effect on the estimated risk as a result of the absence of some constituents and the addition of surrogate chemicals from the health risk screening is uncertain since the combination of constituents could be either more or less toxic. Below are the principal areas where potential uncertainty exists with regard to COCs and a description of the anticipated direction of uncertainty in the final estimate of risk. Overprediction means that the assumptions/information used are likely to result in higher estimated risks than would actually exist. Neutral means that the assumptions/information used are not likely to significantly affect the final calculated risk or that the information was accurately known. Underprediction would mean that the assumptions/information used are likely to result in lower estimated risks than would actually exist.

- |  |         |
|--|---------|
| • Identification of waste constituents             | Neutral |
| • Identification of chemicals of potential concern | Neutral |

## 7.2 EMISSION ESTIMATES

There is uncertainty in the development of the energetic emission factor database. Emissions from OB/OD treatment consist of emissions of unreacted waste constituents, products of combustion, and products of incomplete combustion. Treatment emissions data were used to calculate the GLCs using air dispersion models, and in turn, human health risk estimates. Therefore uncertainty in treatment emissions data results in a corresponding level of uncertainty in the calculated risk.

Emission factors for energetics, energetic-contaminated wastes and munition components evaluated in this analysis were measured from actual tests. In populating the emission factor database, blanks were left for most species that were not reported in the test results, while surrogates were chosen for the highest risk pollutants that were not reported in the test results. There is a possibility that this action could result in an underestimate of the health risk. However, in most cases the species would have been reported if it were present in detectable quantities. If chemicals that may be present in the emissions were not sampled for, depending on their toxicities and emission factors, the health risks may also be underestimated. An alternative approach would be to identify surrogate emission factors for each of these species. Because of the large number of chemicals in this category, this alternative approach would have overestimated the emissions, and hence the risk, by a significant quantity. Assigning surrogate emission factors for those compounds representing over 90% of the risk using the health risk screening approach, as described in Section 3.1, is more likely to accurately represent the health risk of the process.

The database was also populated with zeros when the investigators specifically looked for a chemical but were not able to detect it and their detection method should have found insignificant concentrations. Under these conditions there is no valid reason to believe that these species are produced by the detonation reactions. There is a slight chance that the use of zero emission factors will result in an underestimate of the health risk. An alternative approach would be to use an emission factor of half of the detection limit. This conservative alternative would result in an overestimate of the risk. Use of the former approach is more likely to accurately represent the health risk of the process.

Families of energetics simplify the tracking of waste items treated. Emission factor data in the database were from testing individual ordnance items and assigning them to families depending on the characteristics of the energetic. These are the best OB and OD data currently available. OD treatment events at China Lake usually involve mixtures of families rather than individual families. Reaction of products from one emission category with products from another emission category is possible and may produce species that are not found when treating either family individually. Using emissions data from individual families could underestimate the emission products when reactants from multiple emission categories are present.

In selection of an emission factor to use in a HRA from a series of experimental emission factors, the scientifically valid approach would be to use either the mean or the median emission factor from the data set. The approach in this document is to use the highest emission factor within the data set. This approach is likely to overestimate the health risk to the extent that the highest value exceeds the mean, but remains within the variance in the experimental data.

Standard EPA methods were used to generate most of the results in the database. These methods would likely have resulted in reporting emissions of these species if they had been present. Quadrant 1 chemicals that do not have data within a family are assigned surrogate emission factors. The use of surrogates for all of these unreported species will likely result in an overestimate of their contribution to the HRA.

The health risk screening approach used for Quadrant 2 chemicals involves a mathematical combination of estimated species concentration and toxicity, through selection of a surrogate. Errors in assignment of either value will affect which species are identified among the high-risk chemicals. Concentration estimates cover a range of 3 orders of magnitude. Surrogate toxicities cover ranges of 6 to 9 orders of magnitude. Errors in the assignment of the surrogate are more likely to influence ranking than will concentration estimates.

Below is the principal area where potential uncertainty exists with regard to emissions data and the anticipated direction of uncertainty in the final estimate of risk.

- Quantification of emissions of chemicals of potential concern                      Neutral

### 7.3 AIR DISPERSION MODELING

Air dispersion modeling was conducted to determine air dispersion factors ( $X/Q$ ) which, in combination with contaminant-specific emission rates, were used to calculate GLCs. Based on the information available, modeling assumptions and the technical capabilities of the dispersion models, there is uncertainty in the estimation of the air dispersion factors. Site-specific data were used where available.

Areas of uncertainty exist in air dispersion modeling such as plume rise, large buoyant plume interaction with the top of the boundary layer, entrainment, effects of topography, and the representativeness of the meteorological data used to run the dispersion models (Hall, et al., 1999). Plume rise is affected by numerous variables represented by parameters of turbulence resulting from factors such as downwash and meteorological variables. The ISCST3 model uses dispersion coefficients that approximate these

turbulence parameters for different stability classes according to the meteorological input file. While this method of estimating a stability class is appropriate, the effect of other variables that affect turbulence in the area of evaluation may be neglected. The use of site-specific meteorological data such as turbulence parameters at the surface up to the boundary layer can improve concentration estimates (Isakov, et al., 2003).

The modeling protocol used in the HRA air pathway assessment assumed that the receptors are each downwind from the release point and the OB/OD plumes always travel in a straight line in a given hour. This method of using an invariant wind assumption is used to conservatively calculate the maximum air dispersion factor possible by maintaining the target receptor along the plume centerline for the averaging period. This assumption is conservative because it in effect transports the plume from the source to the receptor in the shortest time and distance. This results in the least amount of dispersion and the calculation of a worst-case (highest value) dispersion factor possible. A problem in modeling long-range transport of air pollutants is determining the correct trajectory of the plume, since an incorrect trajectory may carry pollutants tens or hundreds of kilometers from the actual point of impact. This HRA likely stays in the range of up to a few kilometers' difference. The trajectory errors that result in the calculation of the air dispersion factor are systematic, depending on the type and thermal conductance of the surface. The magnitude of the problem can introduce a wind direction error of up to 40 degrees and wind speed changes by a factor of two (Pack, et al., 1978).

The assumption that the emission plumes travel in a straight line is a valid assumption for receptors that have relatively short distances (i.e., less than 25 km). At greater distances from the source, it is very possible that the plume will come under the influence of different atmospheric conditions or the effects of diverse terrain, such as in the case of complex topography like that at China Lake. For receptors located in complex terrain or at large distances from the source, it is unlikely that the plume will maintain a persistent, straight line to the receptor. As a result of these influencing factors, the plume will potentially undergo directional meandering and additional dispersion to dilute pollutant concentrations before the plume reaches the receptor. Therefore, the invariant wind direction procedure is expected to result in the overprediction of air dispersion factors and resulting GLCs.

The models used for predicting downwind concentrations from emissions assume that dispersion follows a uniform Gaussian distribution within the plume. In reality, the physical process of atmospheric dispersion is far more complex and dependent on source and terrain features than the model is capable of considering. However, in areas of flat terrain with normal meteorological conditions, the models provide a reasonable estimate of emittant concentrations. The EPA believes that, under such conditions, the models are accurate to within a factor of two (EPA, 2005a). With insignificant terrain influences and normal weather conditions during an event, the uncertainty in the estimate of ambient concentration of emittants is small. Nevertheless, models are generally considered reasonably reliable in estimating the magnitude of highest concentrations resulting from a release, although they may not necessarily be time- and space-specific (40 CFR 51, Appendix W). When applied properly, air dispersion models are typically accurate to  $\pm 10$  to 40% and can be used to yield a "best estimate" of air concentrations (40 CFR 51, Appendix W).

The plume rise algorithms inherent in OBODM were developed specifically for the type of activity simulated by the model. However, the calculated plume rise, which affects atmospheric loading rates, is dependent on the input values chosen. As with any release simulation, the choice of input parameters can result in very different impacts, especially for non-standard source types such as OB/OD. China Lake has chosen conservative values where applicable so as to return a conservative assessment of risk. Because of the selection of these values, China Lake has tried to limit the uncertainty in the modeled impacts.

As noted in prior sections, only GLCs calculated in both models (OBODM and ISCST3) were used to determine risk. A number of factors may influence the final GLC such as the action of deposition and subsequent downwind plume depletion as plume material is deposited along its transit path before reaching a ground level receptor.

Both the action of deposition and depletion of the plume may be considered and those options are available to certain extents in each of the models used. For example, while OBODM is coded to explicitly model dry deposition, OBODM does so only for the gravitational settling portion, ignoring the additional, but typically much smaller deposition due to surface flux of smaller aerosols and gases, which can be calculated and accounted for outside of the model. On the other hand, the ISCST3 model has separate options to calculate deposition parameters to include gravitational settling and plume depletion. These options in ISCST3 were not used so as to conserve plume mass in the GLC calculations.

To ensure a conservative assessment of GLCs and hence, risk based on those GLCs China Lake did not invoke all the available deposition or plume depletion options in either OBODM or ISCST3 in support of the modeling analyses.

The simulation of the discrete events associated with OB/OD at China Lake was done by selecting an appropriate hour during the day during which an event would occur. As with the other input parameters selected, there is some uncertainty as to the resulting impact. However, the selection was based on China Lake operations and a likely time period for the activity to occur. Therefore, while uncertainty remains, it should be limited as likely event time periods were chosen.

Below are the principal areas where potential uncertainty exists with regard to air dispersion modeling and the anticipated direction of uncertainty in the final estimate of risk.

- |  |                |
|--|----------------|
| • Assumption of invariant wind direction | Overprediction |
| • Selection of model input parameters    | Overprediction |
| • Accounting for plume depletion         | Overprediction |

## 7.4 EXPOSURE ASSESSMENT

Uncertainty in the exposure assessment arises from the methods used to calculate exposure point concentrations, determination of land use conditions, the selection of receptors, and the selection of exposure parameters.

### 7.4.1 Land Use and Exposure Routes

Both current and future land use assumptions incorporated into this HRA can be uncertain. For the current land use conditions, certain assumptions are made regarding the growth and consumption of fruits, vegetables, and beef from local sources. No local fruits, vegetables, or animals are assumed to come from the local area for the local population. However, consumption of a very small quantity of local edibles by the local population is possible.

Future land use conditions assume that homes could be built at the points of maximum predicted air concentrations. Such growth is not expected to occur in the isolated areas surrounding the facility and the local communities.

### 7.4.2 Exposure Point Concentrations

In all cases, predicted concentrations of chemicals were used as exposure point concentrations. These predictions were made using models to represent the natural systems that exist at the China Lake facility. The air dispersion models used were conservative.

The models do not account for degradation of chemicals while being transported downwind or exposed to sunlight. For example, benzo(a)pyrene is a very unstable chemical in the atmosphere. Therefore, the concentration may be overestimated but the products of reaction or degradation in the atmosphere could have a lower or higher toxicity, underestimating or overestimating the risk accordingly.

Models were also used to calculate chemical concentrations in the soil from predicted air concentrations. Factors generally represent the maximum amount of contaminant transfer that may occur. In reality, the contaminant transfer is dependent on the form and makeup of the chemical and the physical site conditions. Actual transfer factors for this site are not known. The selected methodologies are intended to be conservative and more likely overestimate rather than underestimate chemical concentrations.

Empirically estimated or literature values of the organic carbon partition coefficient, octanol water partition coefficient, and soil degradation rates were used in the estimation of contaminant concentrations in soil. In several cases, information on a chemical is limited and required the use of very conservative default values.

The average concentration of a chemical in the soil depends on several competing processes. These processes include degradation, volatilization, leaching, resuspension, and soil runoff. The removal processes, in most instances, will operate simultaneously with deposition to produce a steady-state soil concentration. The effect of these competing processes on the concentrations of chemicals in the soil over time is, therefore, subject to uncertainty.

The quantification of dioxins from atmospheric deposition as studied here, becomes uncertain when trying to ascertain whether old dioxin and related chemicals that persist and recycle in the environment are more significant or not.

Another aspect that may serve to overestimate risks is associated with the estimation of soil concentrations from air concentrations, particularly the time of exposure/deposition. For the sake of

simplicity, all soil concentrations were estimated using an exposure time of 25,550 days (70 years) which results in the highest soil concentrations (as compared to using an exposure time of 2,190 days/6 years for a child or 9,125 days/25 years for an employee). This assumption was made to simplify the number of calculations made for this HRA. In reality, the time of exposure has little effect on the final soil concentration of most chemicals; therefore, this assumption will result in an overestimation of risk.

### 7.4.3 Receptor Identification

The property boundary receptors considered assume that hypothetical residents are exposed to the predicted air concentrations at these locations. These receptors are subject to a high degree of uncertainty, as no persons currently reside in these areas and the arid, mountainous conditions are not highly conducive to development, nor are they able to be developed in a significant amount of the area because the Bureau of Land Management owns this land. It is highly unlikely that a residential receptor would ever exist at the remote off-site areas considered as the points of maximum air concentrations.

### 7.4.4 Exposure Parameters

Assumptions used in the regulatory guidelines followed for this HRA also lead to uncertainty. For example, OEHHA guidelines present specific values for quantifying exposure due to the amount of soil that people incidentally ingest. The suggested values accurately represent the exposure for only a limited number of people. Ingestion rates for soil, human milk, and the rate of soil contact with the skin used for the MEI represent a 95<sup>th</sup> percentile point estimate. These estimates are, by definition, much higher than typical ingestion rates. For the average person, a different set of data that predicts a lower exposure may be more appropriate.

Generally, the uncertainty can be assessed quantitatively for a number of assumptions made in determining factors for calculating exposures and intakes. Many of these parameters were determined from statistical analyses on human population characteristics. Often the database used to summarize a particular exposure parameter (i.e., inhalation rate) is quite large. Consequently, the values chosen for such variables have low uncertainty. For many parameters for which limited information exists (i.e., dermal absorption of organic chemicals in the soil), the uncertainty is greater. However, sufficient data often exists to estimate these parameters with less certainty.

Many of the quantities used to calculate exposures and risks in this report were selected from a distribution of possible values. For the MEI scenario, the value representing the 95<sup>th</sup> percentile is generally selected for each parameter to ensure that the assessment bounds the actual risks from a postulated exposure. This risk number is used in risk management decisions, but does not indicate what a more average or typical exposure might be, or what risk range might be expected for individuals in the exposed population. To address these issues, the CalEPA has suggested the use of an AEI receptor, whose intake variables are set at approximately the 50<sup>th</sup> percentile of the distribution. The risks for this receptor seek to incorporate the range of uncertainty associated with various intake assumptions. However, for this HRA only the upper end of possible exposure values was evaluated using the MEI scenario. This receptor has all intake variables set at the most conservative values possible, and represents an exposure that is likely to be much higher than reality.

The definitions of the exposed population and the exposure characteristic are also subject to uncertainty. The choice of a 70-year exposure period for the MEI scenario for lifetime risk estimates is very conservative in the sense that no person will actually spend 24 hours a day, 365 days a year over a 70-year period at exactly the point of highest toxicity-weighted annual average air concentrations. The average period of U.S. residency at any one location is about 9 years, and the 90<sup>th</sup> percentile of residency (typically used by the EPA in RME estimates) is about 30 years.

In addition to using 70 years as a basis for estimating exposure under the MEI scenario, the risk calculations also assume that OB/OD operations occur, as described, for a 70-year period. Continuous 70-year operation of the OB/OD is not likely. A decrease in operating time would result in a linear decrease in estimated risk.

Below are the principal areas where potential uncertainty exists with regard to the exposure assessment and the anticipated direction of uncertainty in the final estimate of risk.

- |  |                |
|--|----------------|
| • Assumption of land use/exposure routes         | Overprediction |
| • Calculation of exposure point concentrations   | Overprediction |
| • Selection of hypothetical vs. actual receptors | Overprediction |
| • Selection of exposure parameters               | Overprediction |

## 7.5 DOSE RESPONSE ASSESSMENT

Uncertainty associated with the dose response assessment is associated with the COCs and their health hazards. Specifically, uncertainty is introduced in the nature and strength of the evidence of the causation or the likelihood that a chemical that induces adverse effects in animals will also induce adverse effects in humans. Hazard assessment of carcinogenicity is evaluated as a weight-of-evidence determination, using either the International Agency for Research on Cancer or EPA methods. Positive animal cancer test data suggest that humans contain tissue(s) that may also manifest a carcinogenic response; however, the animal data cannot necessarily be used to predict the target tissue in humans. In the hazard assessment of noncancer effects, however, positive animal data suggest the nature of the effects (i.e., the target tissues and types of effects) anticipated in humans.

Uncertainty in the hazard assessment arises from the nature and quality of the animal and human data. Uncertainty is reduced when similar effects are observed across species, strain, sex, and exposure route; when the magnitude of the response is clearly dose-related; when pharmacokinetic data indicate a similar fate in humans and animal; when postulated mechanisms of toxicity are similar for humans and animals; and when the COC is structurally similar to other chemicals for which the toxicity is more completely characterized.

Uncertainty in the dose-response evaluation includes the determination of a cancer potency factor for the carcinogenic assessment and derivation of a REL (either RfD for non-inhalation or RfC for inhalation) for the noncarcinogenic assessment. Uncertainty is introduced from interspecies (animal to human)

extrapolation which, in the absence of quantitative pharmacokinetic or mechanistic data, is usually based on consideration of interspecies differences in basal metabolic rate. Uncertainty also results from intraspecies variation. Most toxicity experiments are performed with animals that are very similar in age and genotype, so that intragroup biological variation is minimal, but the human population of concern may reflect a great deal of heterogeneity including unusual sensitivity or tolerance to the COC. Even toxicity data from human occupational exposure reflect a bias because only those individuals sufficiently healthy to attend work regularly (the “healthy worker effect”) and those not unusually sensitive to the chemical are likely to be occupationally exposed. Finally, uncertainty arises from the quality of the key study from which the quantitative estimate is derived and the database. For cancer effects, the uncertainty in carcinogenic assessment is the method by which data from high doses in animal studies are extrapolated to the dose range expected for environmentally exposed humans. The linear multistage model, which is used in nearly all quantitative estimations of human risk from animal data, is based on a nonthreshold assumption of carcinogenesis. There is evidence to suggest, however, that epigenetic carcinogens, as well as many genotoxic carcinogens, have a threshold below which they are noncarcinogens; therefore, the use of the linear multistage model is conservative for chemicals that exhibit a threshold for carcinogenicity.

To convert the animal data to cancer potency factors for use in the low-dose human HRAs, mathematical models are used. These models analyze the high-dose animal data and attempt to predict what the human response would be at doses that are a thousand or a million or more times lower, assuming that there is no threshold of carcinogenic effect. The output of the potency models used by OEHHA and EPA provide a maximum likelihood estimate of risk and a 95% upper confidence limit. Agencies typically rely on the 95% upper confidence limit of potency for calculating cancer risk.

Generally speaking, although it is not possible to predict with certainty which substances will cause cancer in humans based on animal studies alone, virtually all known human carcinogens that have been adequately tested produce cancer in laboratory animals. Probable human carcinogens have limited or no human evidence of carcinogenicity, but “sufficient” animal data to state that it is carcinogenic from lifetime rodent bioassays. Possible carcinogens have limited animal data to classify the chemical as such, in that the cancer rate was positive only in one species and strain, at one site, at one dose, for only one type of exposure. In this categorization of carcinogens, uncertainty exists, but the direction is vague, since overestimation can occur with the inclusion of probable and possible known carcinogens, but underestimation can occur with uncertainty in potency factors and exclusion of non-classifiable chemicals.

Another source of uncertainty in the HRA is the lack of cancer potency factors for chemicals identified by the EPA as possible human carcinogens. These chemicals could increase the overall cancer risks experienced by receptors.

For noncancer effects, additional uncertainty factors may be applied in the derivation of the RfD or RfC to mitigate poor quality of the key study or gaps in the database. Additional uncertainty for noncancer effects arises from the use of an effect level in the estimation of an RfD or RfC, because this estimation is predicted on the assumption of a threshold below which adverse effects are not expected. Therefore, an uncertainty factor is usually applied to estimate a no-effect level. Additional uncertainty arises in

estimation of an RfD or RfC for chronic exposure from less-than-chronic data. Unless empirical data indicate that effects do not worsen with increasing duration of exposure, an additional uncertainty factor is applied to the no-effect level on the less-than-chronic study. Uncertainty in the derivation of RELs is mitigated by the use of uncertainty and modifying factors that normally range between 3 and 10. The resulting combination of uncertainty and modifying factors may reach 1,000 or more.

Uncertainty arises from extrapolation of dose-response parameters to other exposure routes, for example, the extrapolation of RfCs to RfDs without the use of an inhalation absorption factor. Typically, RCRA and Comprehensive Environmental Response, Compensation, and Liability Act-type HRAs require the conversion of an air concentration to an internal dose. So while this conversion is not thought to add significantly to the uncertainty in an HRA, it is not recommended unless the primary literature is consulted first. Uncertainty also arises from the application of oral dose-response parameters to inhalation exposures. By not adjusting for absorption that occurs during ingestion versus that which occurs upon inhalation, risks may be either over or underestimated. Particulates and gases/vapors behave differently in the lungs, and the heterogeneity of lung tissue cells may greatly affect the retention/exhalation of various contaminants. In addition, the derivation of dermal RfDs and cancer potency factors from oral values may cause uncertainty. This is particularly the case when no gastrointestinal absorption rates are available in the literature or when only qualitative statements regarding absorption are available.

One of the primary sources of uncertainty in the HRA arises from the toxicity (dose-response) parameters selected for use in quantitatively estimating risk. There are some significant differences between the values considered by the EPA and CalEPA. For example, the inhalation cancer potency factor for hexavalent chromium from the EPA is 41 milligrams per kilogram per day  $(\text{mg}/\text{kg}\cdot\text{d})^{-1}$ ; however, the CalEPA uses a value of 510  $(\text{mg}/\text{kg}\cdot\text{d})^{-1}$ . This adds a significant amount of uncertainty in the HRA for the inhalation pathway. Large differences are also noted for other COCs such as benzene, where the CalEPA value is  $1.0\text{E-}1$   $(\text{mg}/\text{kg}\cdot\text{d})^{-1}$  and the EPA value is  $2.9\text{E-}2$   $(\text{mg}/\text{kg}\cdot\text{d})^{-1}$ .

Several organic constituents present in the energetic materials do not have regulatory accepted toxicity data upon which to assess potential health effects. In the absence of toxicity data, cancer potency factors and RELs for surrogates were recommended by DTSC. In some instances, threshold limit values associated with occupational exposure were used where acute RELs were not defined. The surrogates or alternative health criteria selected may be conservative (overestimate risk) in some cases and not in others.

Below are the principal areas where potential uncertainty exists with regard to the dose-response assessment and the anticipated direction of uncertainty in the final estimate of risk.

- |   |                |
|---|----------------|
| • Characterization of chemical toxicity | Overprediction |
| • Selection of toxicity factors         | Neutral        |

## 7.6 RISK CHARACTERIZATION

Uncertainty in risk characterization results primarily from assumptions made regarding additivity of effects from exposure to multiple chemicals from various exposure routes. Cancer risks from all emitted

carcinogens are added, and HQs for substances impacting the same target organ/system are added to determine the HI. High uncertainty exists when summing cancer risks for several substances across different exposure pathways. This assumes that each substance has a similar effect and/or mode of action. Chemicals often affect different target organs, have different mechanisms of action, and differ in their fate in the body, so additivity may not be an appropriate assumption. However, the assumption of additivity is made to provide a conservative estimate of risk.

In addition, the risk characterization does not consider antagonistic or synergistic effects. Many examples of additivity and synergism (interactive effects greater than additive) are known, however, little or no information is available to determine the potential for antagonism or synergism for the COCs. Therefore, this uncertainty cannot be discussed for its impact on the HRA, since it may either underestimate or overestimate potential human risk.

The uncertainty and bias present in the risk characterization process incorporates each of the biases and uncertainties introduced by the preceding HRA steps in this section. In addition, a further degree of uncertainty, and potential bias, is introduced when combining the risks for multiple pathways for an MEI. For many individuals, it may not be appropriate to apply the MEI ingestion and exposure parameters for all pathways. For example, it may not be reasonable to sum risks from soil ingestion, dermal ingestion, and breast feeding, particularly if worst case values are used for all of these pathways. It may be more appropriate to sum only certain pathway risks for displaying total risk results, and showing the risks for other pathways independently.

Below are the principal areas where potential uncertainty exists with regard to risk characterization and the anticipated direction of uncertainty in the final estimate of risk.

- |   |                |
|---|----------------|
| • Assumption of additivity                | Overprediction |
| • Accounting for antagonism and synergism | Neutral        |
| • Summation of multiple pathways          | Overprediction |

Risk estimates developed as a result of an HRA are not interpreted as an expected rate of health effects to exposed individuals, but estimates of potential risk based on current knowledge and assumptions guided by the OEHHA guidelines methods of conservatism. The uncertainties are weighted heavily on the side of protection of health so as not to underestimate risk. The HRA process was created primarily as a comparison tool to prioritize concerns in the legislative and rulemaking process where binding decisions affect life and property.

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