APPENDIX B-2

EMISSIONS AND MODEL INPUT DOCUMENTATION FOR EDS

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PREFACE

Appendix B-2 presents emission rates for the U.S. Army's Explosive Destruction System (EDS) when processing various munition types one batch at a time; the methodology used to develop the emission rates; a sample calculation demonstrating the emission rate methodology; and the calculation methodology used to develop short-term and long-term average emission rates for use in the Multiple Pathway Health Risk Assessment (MPHRA). The information presented in this Appendix, through Attachment 3, was developed by Leidos and provided to Battelle for use in this MPHRA report on April 27, 2015. Minor edits were incorporated into the Leidos material when it was attached to this report. The material presented in Attachment 4 to this Appendix was developed by ERM. Tables identified with an "Attachment 1 -", "Attachment 2 -", "Attachment 3 -", and "Attachment 4 -" followed by a Table number can be found in Attachment 1, Attachment 2, Attachment 3, and Attachment 4 of this appendix, respectively. All other tables (those without "Attachment") are in the Appendix B-2 front matter.

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Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
AFS	Air Filtration System
Ag	silver
As	arsenic
cfm	cubic feet per minute
ºC	degree Centigrade
Cd	cadmium
CO	carbon monoxide
Cu	copper
DOT	Department of Transportation
dscm	dry standard cubic meter
EDS	Explosive Destruction System
ft	feet
ft^3	cubic feet
g	gram
g-mol	gram moles
g/s	gram per second
HD	distilled mustard
HT	mixture of approximately 60 percent HD and 40 percent Agent T
hr	hour
in	inch
K	(degree) Kelvin
kg	kilogram
L	liter
lb	pound
MEK	methyl ethyl ketone, also known as 2-butanone
MPHRA	Multiple Pathway Health Risk Assessment
mg/L	milligram per liter
mg/m^3	milligram per cubic meter
mm	millimeter
MW	molecular weight
NEW	net explosive weight
NO_x	nitrogen oxides
Pb	lead
PCAPP	Pueblo Chemical Agent-destruction Pilot Plant
PCD	Pueblo Chemical Depot
PM	particulate matter
ppmv	parts per million by volume
psia	pounds per square inch absolute
psig	pounds per square inch gauge
RCRA	Resource Conservation and Recovery Act
scf	standard cubic foot
SO_2	sulfur dioxide
TNT	trinitrotoluene
VP	vapor pressure
WTS	Waste Transfer System
yr	year

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EDS EMISSIONS FOR MPHRA--PCAPP WITH EDS

1 BACKGROUND

Emissions calculations were performed for Explosive Destruction System (EDS) operations being used to support the Pueblo Chemical Agent-Destruction Pilot Plant (PCAPP) at the US Army's Pueblo Chemical Depot (PCD) near Pueblo, Colorado. The EDS will be used to destroy mustard (HD/HT) filled munitions and Department of Transportation (DOT) containers as well as downloaded bursters, i.e., bursters that have been removed from the munition. Table B-1 lists items to be destroyed by campaign along with the estimated time needed to treat/destroy the various items. Attachment 1 contains an extensive list of assumptions, operating conditions, and other inputs used in the calculations. The following bullet lists summarize the major assumptions used:

1) General assumptions:
   - Two EDS units on site
   - Each EDS is in its own environmental enclosure
   - Each enclosure has its own air filtration system (AFS) (9,200 cubic feet per minute [cfm])
   - AFS will capture agent resulting from releases during handling of munitions within the enclosure; these emissions are anticipated to be minor and infrequent.
   - Only one EDS will process agent on any given day (therefore all calculations are based on a single operating EDS)
   - EDS will operate 6 days per week
   - EDS operation will occur between 8 am and 8 pm (daytime hours) only
   - One maintenance day per week (Sunday).

2) Munition/container assumptions:
   - DOT containers are processed individually
   - Munitions are processed in batches of six (6-packs)
   - Each batch/shot takes 1 day to process.

3) Burster assumptions:
   - Downloaded bursters are not contaminated with chemical agent; therefore no reagent treatment is required
   - EDS will be rinsed with water and purged with inert gas after bursters are detonated
   - Ten bursters will be processed per shot
   - Burster calculations are based on the largest size burster at PCD (0.41 pounds (lb) net explosive weight (NEW) per burster with 0.8 lb NEW of donor charge)
   - Each burster batch/shot takes 2 hours (hr) (six shots per day).

4) Campaign assumptions:
   - Munitions and downloaded bursters will be processed in campaigns (see Table B-1)
   - Leaker campaign consists of DOT containers and leaking munitions of all three sizes
   - No two munition campaigns (leakers, 155mm, 105mm. and 4.2-inch mortar) will be performed in the same year period (or 12 month period)
   - The burster campaign will be performed at the end of the 4.2-inch mortar campaign
   - The total operation will take place over 5 years (yr) (60 months).

Table B-1. PCD EDS Treatment Campaign Data

Campaign	Items per Batch	Batches	Mustard Fill per Batch (lb)	Duration (weeks)	Total fill treated (lb)
Leaker	Varies	116	32[a]	24	3,712
155mm	6	51	70.2	11	3,580
105mm	6	64	19.0	13	1,216
4.2-inch mortar	6	11	36.0	3	396
Burster	10	8	none	2 (days)	0

Notes:

a. The leaker campaign consists of various size items that will be combined into various size batches. Fill amount per batch ranges from 27.5 lb to 46.8 lb with an average of 32 lb.

2 EMISSION CALCULATIONS

Emission calculations were performed using two methods--an empirical method and a modeling method.

The empirical method used data obtained from an emission monitoring test at Aberdeen Proving Ground (TRC, 2011; TRC, 2012). Emissions measured during that test were converted to emission factors which were then employed to calculate potential EDS emissions at PCD. Attachment 2 provides an example calculation. Samples for that emission test were collected at the exhaust stack and therefore represent controlled emissions, i.e., emissions after they have passed through the Air Filtration System AFS (post-filter emissions).

The modeling method used templates developed for Resource Conservation and Recovery Act (RCRA) permit applications at Dugway Proving Ground and Deseret Chemical Depot and the Clean Air Act Notice of Intent for Deseret Chemical Depot. Attachment 3 to this appendix provides additional background and supplemental information about the EDS and the calculation methods. Attachment 4 provides an example calculation using methyl ethyl ketone (MEK), also referred to as 2-butanone in the main body of this report. The modeling calculations are set up to provide uncontrolled emissions, i.e., emissions before they pass through the AFS (pre-filter emissions).

Potential emissions from the EDS are generated when detonating donor charges used to access the agent, when destroying downloaded bursters or those contained in the items being treated, and when treating mustard agent with reagent. Emissions potentially occur whenever material is drained from the EDS via the Waste Transfer System (WTS). During each EDS shot, neutralent and rinsate wastes are drained from the EDS vessel into the WTS. As the liquid drains into the WTS, vapors in the WTS are forced out to the AFS by displacement. The final step before opening the EDS vessel door is to purge the EDS vessel and WTS transfer lines with inert gas to remove any traces of hazardous vapors. These events (draining the neutralent, draining the rinsate, and inert gas purge) are the EDS process steps that result in emissions. These emission events each take approximately 10 minutes; therefore the combined duration of events is less than 1 hour. In order to develop a maximum hourly emission rate, all EDS emissions were assumed to occur within the same 60-minute period.

Table B-2 summarizes the results of emissions calculations using the empirical data. Only chemicals with positive detections are included. The data in Table B-2 represent controlled (post-filter) emissions because those were the only data collected during the emission test. In order to estimate uncontrolled (pre-filter) emissions, filter efficiencies were applied to estimate the amount of chemical that would have had to enter the filter system to produce the measured amount in the post-filter emissions.

Table B-3 summarizes results of emissions calculations obtained from the modeling method. These data are uncontrolled (pre-filter) data. In order to estimate controlled emissions the filter efficiency values were applied to calculate the amount of chemical that would be present in the controlled (post-filter) emissions.

Table B-2. Emissions Estimates (Post-filter) Based on Empirical Data[a]

Chemical	Campaign				
	Leaker (g/batch)	105mm (g/batch)	155mm (g/batch)	4.2-in mortar (g/batch)	Burster (g/batch)
Gases					
ammonia	7.21E+00	7.10E+00	3.99E+00	7.59E+00	4.80E+00
carbon monoxide (CO)	0	0	0	0	3.00E+03
hydrogen cyanide	1.16E+00	1.08E+00	8.77E-01	0.00E+00	2.26E+00
sulfur dioxide (SO_2)	5.36E+00	3.19E+00	1.18E+01	6.03E+00	0
VOCs					
methane	9.09E+01	8.57E+01	1.89E+02	8.04E+01	1.59E+02
ethanol	2.07E-01	1.23E-01	4.54E-01	2.33E-01	0
toluene	5.24E-02	3.11E-02	1.15E-01	5.89E-02	0
acetone	1.32E-01	7.87E-02	2.91E-01	1.49E-01	0
carbon disulfide	6.37E-02	3.79E-02	1.40E-01	7.17E-02	0
vinyl chloride	1.04E-02	6.20E-03	2.29E-02	1.17E-02	0
SVOCs					
none	0	0	0	0	0
Metals					
aluminum (Al)	5.00E-01	5.44E-01	1.01E+00	3.91E-01	1.24E+00
arsenic (As)	1.20E-02	1.09E-02	2.51E-02	1.09E-02	1.87E-02
cadmium (Cd)	6.54E-03	3.89E-03	1.44E-02	7.36E-03	0
copper (Cu)	1.20E-01	1.35E-01	2.42E-01	9.11E-02	3.18E-01
lead (Pb)	4.41E-02	4.78E-02	8.92E-02	3.46E-02	1.08E-01
silver (Ag)	2.97E-04	1.77E-04	6.51E-04	3.34E-04	0

Notes:

a. These values are **post-filter** values. In order to estimate a **pre-filter** value the filter efficiency factor must be applied.

0 = Estimated emission is zero.

Table B-3. Emission Estimates (Pre-filter) Based on Modeling Method[a]

Constituent[b]	Campaign				
	Leaker Campaign Uncontrolled (g/batch)	105mm Campaign Uncontrolled (g/batch)	155mm Campaign Uncontrolled (g/batch)	4.2-in Campaign Uncontrolled (g/batch)	Burster Campaign Uncontrolled (g/batch)
dichlorodifluoromethane	1.20E-03	1.13E-03	1.49E-03	1.20E-03	0
trans-1,2-dichloroethene	8.81E-05	8.29E-05	1.09E-04	8.84E-05	0
cis-1,2-dichloroethene	2.06E-04	1.94E-04	2.55E-04	2.06E-04	0
1,3-dichlorobenzene	5.58E-07	5.25E-07	6.93E-07	5.60E-07	0
1,2-dichlorobenzene	6.25E-07	5.88E-07	7.77E-07	6.27E-07	0
bis(2-chloroisopropyl)ether	2.27E-07	2.13E-07	2.82E-07	2.28E-07	0
2,4-dichlorophenol	3.93E-08	3.69E-08	4.88E-08	3.94E-08	0
1,2,4-trichlorobenzene	1.10E-07	1.04E-07	1.37E-07	1.11E-07	0
2-methylnaphthalene	6.84E-07	6.81E-07	6.97E-07	6.84E-07	0
acenaphthylene	1.75E-07	1.65E-07	2.13E-07	1.75E-07	0
phenanthrene	6.33E-08	6.30E-08	6.45E-08	6.33E-08	0
ethyl benzene	1.34E-05	1.27E-05	1.59E-05	1.34E-05	0
o-xylene	3.09E-05	2.94E-05	3.70E-05	3.10E-05	0
styrene	9.74E-05	9.17E-05	1.20E-04	9.77E-05	0
MEK (2-butanone)	4.18E-04	3.96E-04	5.08E-04	4.20E-04	0
naphthalene	2.22E-05	2.20E-05	2.30E-05	2.22E-05	0
phenol	6.34E-06	6.32E-06	6.43E-06	6.34E-06	0
2-methylphenol	3.05E-06	3.05E-06	3.08E-06	3.05E-06	0
3&4-methylphenol	9.33E-07	9.30E-07	9.45E-07	9.33E-07	0
nitrobenzene	1.22E-07	1.14E-07	1.51E-07	1.22E-07	0
1,1-dichloroethene	6.36E-05	5.98E-05	7.89E-05	6.38E-05	0
1,2-dichloroethane	9.43E-05	8.88E-05	1.17E-04	9.47E-05	0
1,4-dichlorobenzene	6.22E-07	5.85E-07	7.73E-07	6.24E-07	0
benzene	8.14E-03	7.72E-03	9.89E-03	8.17E-03	0
chlorobenzene	1.03E-05	9.73E-06	1.28E-05	1.04E-05	0
chloroform	7.20E-04	6.77E-04	8.93E-04	7.22E-04	0
tetrachloroethene	2.64E-03	2.49E-03	3.29E-03	2.65E-03	0
trichloroethene	3.24E-04	3.05E-04	4.02E-04	3.25E-04	0
methylene chloride	1.06E-06	1.06E-06	1.06E-06	1.06E-06	0
1,4-dithiane	1.00E-03	9.44E-04	1.25E-03	1.01E-03	0
1,4-thioxane	1.04E-02	9.75E-03	1.29E-02	1.04E-02	0
mustard (HD)	1.28E-05	1.20E-05	1.59E-05	1.28E-05	0
monoethanolamine	1.52E+01	1.47E+01	1.86E+01	1.51E+01	0
nitrogen oxides (NO_x) as NO_2	2.17E-02	2.03E-02	1.64E-02	1.91E-02	4.23E-02
ammonia	7.21E+00	7.10E+00	3.99E+00	7.59E+00	4.80E+00
hydrogen cyanide	1.16E+00	1.08E+00	8.77E-01	0.00E+00	2.26E+00
acetylene	4.85E+00	4.54E+00	3.67E+00	0.00E+00	9.45E+00
ethane	5.37E-02	5.03E-02	4.07E-02	0.00E+00	1.05E-01

Notes:

a. The values in this table are **pre-filter** values; to obtain **post-filter** values a filter efficiency factor must be applied.
b. Only chemicals with an emission rate equal to or greater than $1x10^{-10}$ lb/hr (i.e., $4.54x10^{-8}$ g/batch) are listed in this table. This cutoff was used because constituents with emission values less than $1x10^{-10}$ lb/hr are so low as to be undetectable by air monitoring methods.

0 = estimated emission is zero.

2.1 Empirical Method

The constituents in Table B-2 are the only chemicals with positive detections during emission testing and are the only emissions estimated using empirical data. The emission test occurred in two parts; one part was bare explosives and the other was HD-filled containers. Data from the bare explosives test were used to estimate emissions from the downloaded bursters. Data from the HD-filled containers were used to estimate emissions from munitions. Test data from the HD emission test were used to develop emission factors in the form of lb of constituent per lb of mustard treated. Emissions for the PCD EDS campaigns were obtained by multiplying the emission factors by the pounds of mustard treated. Therefore, if the emission factor is 1 gram (g) of chemical per lb of mustard, the amount of that chemical emitted when treating a batch of 4.2-inch mortars, which contains 36 lb of mustard, would be 36 g per batch.

2.2 Modeling Method

The EDS process generates two types of liquid waste, the neutralent and the rinsate. These wastes are collected in separate waste drums, and RCRA characterization analyses were performed on each waste stream. The modeling method was based on the following assumptions:

- Vapors from the treatment of HD in the EDS result from volatilization of the various constituents from the neutralent and rinsate wastes.
- Vapor emissions from the WTS are produced by displacement of gases in the WTS when neutralent or rinsate or purge gas is fed into the system (there is no powered exhaust from the WTS).
- For calculating vapor emission from neutralent and rinsate Raoult's law applies, meaning that the chemical species in the vapor emissions are the same as those in the neutralent and rinsate and that the vapor concentrations are proportional to the concentration in the liquid wastes.
- Gaseous emissions from detonation of donor charges and bursters pass through the WTS prior to entering the AFS unit.
- Standard emission factors for explosives detonations can be used to estimate gases produced by detonation of donor charge and bursters.

In the modeling method, air emissions consist of chemicals evaporating from the liquid wastes. Historical values from the RCRA waste characterization analyses of neutralent and rinsate wastes were used to determine the types and quantities of gases and vapors expelled from the WTS during EDS operations.

Gases expelled from the WTS occur when liquid is added to the system and when the inert gas purge of the EDS vessel is performed. Because no powered air flow occurs through the WTS, the emission duration is very short. Emission durations are approximately 10 minutes each for neutralent drain, first rinse drain, and second rinse drain. Gases expelled from the WTS exit through duct work that connects the EDS WTS to the AFS that services the environmental enclosure surrounding the EDS workspace.

APPENDIX B-2

ATTACHMENT 1

BACKGROUND AND SUPPLEMENTAL DATA

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APPENDIX B-2
ATTACHMENT 1
BACKGROUND AND SUPPLEMENTAL DATA

Att 1-1 TYPICAL EDS SETUP ASSUMPTIONS

- Two identical EDSs, each EDS in its own enclosure.
- The enclosure is for worker safety: protection from rain, snow, etc.
- Enclosure dimensions: 40 feet (ft) wide, 60 ft long, and 15 ft high at the peak; (volume is 32,100 cubic feet [ft^3] per manufacturers specification).
- Each enclosure has two AFS units each operating at approximately 4,600 cfm for a total exhaust rate of 9,200 cfm.
- Each AFS unit includes: pre-filter, high efficiency particulate air (HEPA) filter, two activated carbon beds, and final HEPA filter.
- Enclosure provides containment if an agent vapor leaks from a munition into the work area before the EDS vessel can be sealed.

Att 1-2 EDS ASSUMPTIONS

- Each EDS has a WTS that receives liquid and gaseous wastes from the EDS.
- Emissions from the WTS waste drums are ducted to the AFS where it mixes with enclosure air before passing through the AFS.
- Chemical agent is processed 6 days per week with only 1 EDS operating on any given day.
- Chemical agent is processed during daylight hours only.
- There is 1 day per week (Sunday) for maintenance when no chemical agent will be on site and nothing will be processed through either EDS.

Att 1-3 HD TREATMENT ASSUMPTIONS:

- HD treatment is a 1-day process.
- Gaseous EDS emissions include vapors expelled from the WTS when liquids drain from the EDS vessel or gases enter the waste drums. These include:
  - The neutralent drain lasts 10 minutes
  - Gas expansion from detonation encompasses a nominal 8.25 minutes, time adjusted to produce an equivalent molar-equivalent gas flow rate to the inert gas purge
  - The first rinse drain lasts 10 minutes
  - The second rinse drain lasts 10 minutes
  - The inert gas purge lasts 15 minutes.
- Six shots (batches) of munitions will be processed per week.
- All munitions are treated in batches of six munitions per shot.
- DOT containers are processed one per batch.
- There will only be 1 munition campaign per year.
- Annual emissions are based on grams of emission per batch multiplied by the number of batches in a campaign.

Att 1-4 DOWNLOADED BUSTER DESTRUCTION ASSUMPTIONS:

- Bursters are destroyed in batches of 10 containing up to 4.1 lb trinitrotoluene (TNT)-equivalent NEW. An additional 0.8 lb NEW of donor charge is added to initiate the bursters.
- Burster destruction takes approximately 2 hr so there will be six batches of bursters destroyed per day.
- Burster destruction does not entail neutralization, rinsing, or inert gas purge, therefore emissions are due to gas expansion upon detonation of the charges.
- Rate (lb/hr) and concentration (milligrams per cubic meter [mg/m^3]) calculations were based on the maximum (not average) values obtained for various processes.
- The burster campaign will take place immediately after the 4.2-inch mortar campaign; therefore, it will occur in the same year as the 4.2-inch mortar campaign.

Att 1-5 EMISSION CALCULATION METHOD:

Att 1-5.1 Empirical Method

- Emissions are based on emission factors derived from emission testing.
- Emissions measured during emission tests were converted to factors by calculating emissions per lb of mustard agent treated (for mustard-filled items) or emissions per lb NEW of burster charge (for items containing bursters).
- The emission factors were then multiplied by the lb of HD or the lb NEW of burster to calculate PCD EDS emissions.
- When treated items contain both a burster and mustard agent, both factors were applied and the results of the two calculations added to derive PCD EDS emissions.

Att 1-5.2 Modeling Method

- Emissions were calculated based on the gases/vapors expected to exit the WTS during the various stages in the EDS process.
- Potential pollutants were identified in RCRA characterization analyses of neutralent and rinsate wastes during past EDS operations involving sulfur mustard agents. Initial concentrations for neutralent and rinsate wastes were set at historical average concentrations. Attachment 1 Table B-1 lists components of neutralent and rinsate liquids along with historical concentrations. These liquid concentrations were used to calculate vapor emissions as described in the example calculation presented in Attachment 2 to this appendix.
- In addition to vapors produced from treatment of HD, gases are generated from detonation of the donor charges and bursters contained within the munitions being treated. Attachment 1 – Table B-2 and Attachment 1 – Table B-3 list the gaseous chemical concentrations used to calculate emissions as described in the example calculation presented in Attachment 2 to this appendix for various munitions and donor charges.
- Emissions generated when treating downloaded bursters are due to detonation of the bursters plus the donor charges.
- Vapor pressures for the various constituents were used in conjunction with initial liquid concentrations, quantities of reagent and rinse water, system volumes, expected temperatures and pressures, and process durations to calculate expected vaporous emissions from the EDS.

- The main calculation yielded g of constituent per batch which were used to calculate hourly and annual mass emission rates.
- Calculations assumed constant conditions throughout the entire year.

Att 1-6 EMERGENCY OPERATIONS ASSUMPTIONS:

- Emergency operations are implemented when an unexpected release of chemical agent occurs within the environmental enclosure. Such a release may be either agent vapors or liquid agent.
- The most likely location for an unplanned release to occur is at the work table where munitions are prepared for placement into the EDS vessel.
- A near real-time agent monitor located at the work table will alarm if agent vapors are detected above the alarm level of 0.7 times the vapor screening level (0.7 x 0.003 mg/m^3 = 0.00021 mg/m^3).
- Local ventilation at the work table captures vapors and directs them to the AFS.
- Upon activation of an agent alarm, workers respond according to a Standing Operating Procedure and Emergency Response Plan to identify the source of the release, contain the release, and cleanup of residual contamination.
- Normal operations continue as directed by the Supervisor and Safety Officer after the release is contained and cleaned up.
- The activated carbon filters in the AFS have sufficient excess capacity to control vapors generated without breaking through the first carbon filter bed in the event that the entire contents of the largest item in the environmental enclosure were to be released.

Attachment 1 - Table B-1. Neutralent and Rinsate Concentrations used in Modeling Method Calculations

Constituent	Dilute Neutralent Concentration [a] (mg/L)	Dilute Rinsate Concentration [b] (mg/L)
As	6.88E-01	5.21E-01
barium (Ba)	4.80E+00	6.40E-01
Cd	1.44E+00	2.52E-01
chromium (Cr)	7.52E-01	7.23E-02
Pb	1.19E+00	1.65E-01
selenium (Se)	3.41E-01	1.71E-02
Ag	1.17E-01	1.32E-02
mercury (Hg)	4.25E-03	5.52E-04
zinc (Zn)	1.59E+01	4.01E-01
Cu	8.19E+01	2.17E+01
nickel (Ni)	9.28E-01	2.98E-02
antimony (Sb)	3.50E-01	1.03E-01
strontium (Sr)	1.49E-01	1.50E-01
dichlorodifluoromethane	1.76E-02	1.10E-03
trans-1,2-dichloroethene	1.42E-02	1.10E-03
cis-1,2-dichloroethene	4.88E-02	1.10E-03
1,3-dichlorobenzene	7.08E-03	0
1,2-dichlorobenzene	1.13E-02	0
bis(2-chloroisopropyl)ether	6.37E-03	0
2,4-dichlorophenol	5.66E-03	0
1,2,4-trichlorobenzene	7.08E-03	0
4-chloroaniline	4.25E-03	0
2-methylnaphthalene	1.63E-02	7.94E-03
2-chloronaphthalene	7.08E-03	0
acenaphthylene	1.27E-01	4.08E-02
acenaphthylene	1.34E-02	1.00E-02
fluorene	3.11E-02	1.31E-02
N-nitrosodiphenylamine	4.95E-03	4.58E-03
phenanthrene	7.22E-02	2.33E-02
anthracene	2.12E-02	8.38E-03
di-n-butylphthalate	5.59E-02	4.32E-02
fluoranthene	3.54E-02	1.18E-02
pyrene	5.73E-02	1.14E-02
3,3'-dichlorobenzidine	5.73E-02	0
acetone	4.60E-01	5.90E-02
ethyl benzene	3.68E-02	1.00E-03
o-xylene	1.12E-01	2.76E-03
styrene	4.87E-01	1.10E-03
MEK (2-butanone)	1.74E-01	1.63E-01
naphthalene	3.13E-01	1.01E-01
toluene	5.35E-01	7.00E-03
phenol	1.49E-02	1.43E-02
2-methylphenol	6.37E-03	9.32E-03
3&4-methylphenol	4.25E-03	4.91E-03
nitrobenzene	9.91E-03	0
1,1-dichloroethene	6.37E-03	5.52E-04
1,2-dichloroethane	4.88E-02	2.21E-03
1,4-dichlorobenzene	8.49E-03	0
benzene	3.37E+00	6.23E-02
chlorobenzene	7.29E-02	1.10E-03

Attachment 1 - Table B-1. Neutralent and Rinsate Concentrations used in Modeling Method Calculations (continued)

Constituent	Dilute Neutralent Concentration [a] (mg/L)	Dilute Rinsate Concentration [b] (mg/L)
chloroform	1.75E-01	5.52E-03
tetrachloroethene	7.84E+00	8.83E-03
trichloroethene	3.18E-01	2.21E-03
vinyl chloride	1.27E+01	1.28E+00
methylene chloride	0	1.10E-03
1,4-dithiane	7.31E+01	3.25E+00
1,4-thioxane	5.74E+01	1.65E+00
mustard (HD)	1.93E+00	0

Notes:

a. Neutralent concentrations represent neutralent concentration after applying the dilution factor (0.71) due to steam condensation.
b. Rinsate concentrations represent rinsate concentrations after applying the dilution factor (0.55) due to steam condensation.

mg/L = milligram per liter

Attachment 1 - Table B-2. Explosives Emission Components Mole Fractions for 4.2-inch Mortars

Explosive Type	TNT-equivalent	Actual Explosive (lb/batch)	Emissions from Explosives (lb/batch)												
			N_2	H_2O	CO	C (PM)	NO_x	CH_4	NH_3	HCN	C_2H_2	C_2H_6	Total	Total Gas	Total Dry Gas
tetryl [1]	1.21	0.69	0.514	0.330	0.51	0.044	0.00007	0.0	0.0	0.0	0.0	0.0	0.694	0.651	0.58
donor charge [2]	1.2	1.36	0.514	0.330	0.51	0.0	0.0	0.0	0.030	0.0	0.0	0.0	1.388	1.388	1.058
	Total	2.21	0.683	0.439	0.886	0.044	0.0001	0.0	0.030	0.0	0.0	0.0	2.083	2.039	1.600
	Total NEW	2.470													
atmospheric pressure (psia)		12.31													
gas temperature (°C)		60													
gas density (lb/ft^3) at STP			0.076	0.047	0.076	Solid	0.076	0.043	0.045	0.074	0.073	0.076	0.043	0.042	0.051
volume (ft^3) at ATP			12.9	13.4	0.2	0	0.001	0.0	1.0	0.0	0.0	0.0	27.5	27.5	14.1
dry gas volume mole fraction			0.36	0	0.005	0	4.00E-05	0.0	0.027	0.0	0.0	0.0	NA	NA	0.396

Notes:

N_2 = nitrogen; H_2O = water; C = carbon; PM = particulate matter; NO_x = nitrogen oxides; CH_4 = methane; NH_3 = ammonia; HCN = hydrogen cyanide; C_2H_2 = acetylene; and C_2H_6 = ethane

STP = standard temperature and pressure; ATP = actual temperature and pressure.

References:

1. Cheetah Thermochemical Code (version 6).
2. EPA, AP-42, Fifth Edition, Volume 1, Section 13.3, Explosive Detonation, Table 13.3-1, January 1995.

Attachment 1 - Table B-3. Emission Component Mole Fractions by Campaign

Campaign	Dry Gas Volume Fraction (mole fraction)									Total Dry Gas
	N_2	CO	C (PM)	NO_x	CH_4	NH_3	HCN	C_2H_2	C_2H_6	
Leaker	0.34	0.006	0	0.00004	0.0022	0.025	0.0025	0.011	0.00010	0.386
155mm	0.44	0.008	0	0.00007	0.0035	0.029	0.0040	0.018	0.00017	0.499
105mm	0.40	0.007	0	0.00005	0.0024	0.029	0.028	0.012	0.00012	0.449
4.2-inch mortar	0.36	0.2	0	0.00004	0	0.027	0	0	0	0.396
Burster	0.45	0.010	0	0.00011	0.0056	0.022	0.0065	0.028	0.00027	0.517

Notes: N_2 = nitrogen; H_2O = water; C = carbon; PM = particulate matter; NO_x = nitrogen oxides; CH_4 = methane; NH_3 = ammonia; HCN = hydrogen cyanide; C_2H_2 = acetylene; and C_2H_6 = ethane

APPENDIX B-2
ATTACHMENT 2
DESCRIPTION OF CALCULATIONS USED IN THE EMPIRICAL METHOD

The empirical method estimated PCD EDS emissions by applying emission factors derived from actual emission data to the various PCD EDS campaigns. The following example illustrates how the emission factors were developed and applied to 4.2-inch mortar campaign. The same calculations were performed for each of the PCD EDS campaigns.

The emission test was performed in two parts. One part was emission monitoring for explosives only, and the other part was emission monitoring for treatment of HD-filled containers. The emission factors were calculated in the same manner for both test scenarios.

Att 2-1 Calculate Emission Factor

The emission factor was calculated by the following equation.

Emission factor = measured emission rate / lb of explosive (or agent) used in the test

For gases, the emission factor was calculated by converting the emission rate from parts per million by volume (ppmv) to grams (g) by multiplying ppmv by 12.187 (gas constant) x the molecular weight (MW) of the gas and dividing by the temperature in Kelvin (K). That value was then multiplied by the dry standard cubic meters (dscm) of exhaust gas divided by 1,000 giving the answer in grams. That value was then converted to an emission factor by dividing the mass of agent by the pounds of explosive (or mustard agent) used in the test.

Using CO as an example,

Where:

CO emission = 222.8 ppmv
CO g-mol. wt. = 28
Temperature = 298.15 K
Volume of emission = 10,783 dscm

Mass of CO = ((222.8 ppmv of CO x 12.187 x 28 g-mol. wt. of CO)/298.15°K) x 10,783 dscm / 1000

= 2,749.6 g

CO Emission factor = mass of CO / lb of explosive used in emission test

= 2,749.6 g CO / 3.76 lb NEW
= 731.3 g CO/lb NEW

For constituents where the emission value is given in grams per second (g/s) the calculation was performed by multiplying the emission rate (g/s) times the sampling duration (3,600 seconds) and dividing by the mass of explosive (or mustard agent) used in the test. Using arsenic (As), which had an emission rate of 4.76E-06 g/s during the bare explosive emission test as an example:

As emission factor = 4.76E-06 g/sec x 3,600 sec / 3.76 lb NEW

= 4.56E-03 g As/lb NEW

Attachment 2 – Table B-1 lists emission factors for the chemicals detected during emission testing.

Attachment 2 - Table B-1. Emission Factors from Empirical Data

Emission Component	Bursters			Mustard+Donor Charge		
	Emission Rate	Units	Emission Factor (g/lb NEW)	Emission Rate	Units	Emission Factor g/lb HD)
CO	222.8	ppmv	731.3	0	ppmv	0
SO_2	0	ppmv	0	0.76	ppmv	1.68E-01
methane	0.0404	g/s	38.7	2.74E-02	g/s	1.33E+00
ethanol	0	g/s	0	1.71E-04	g/s	6.47E-03
toluene	0	g/s	0	3.95E-05	g/s	1.64E-03
acetone	0	g/s	0	8.52E-05	g/s	4.14E-03
carbon disulfide	0	g/s	0	4.10E-05	g/s	1.99E-03
vinyl chloride	0	g/s	0	7.87E-06	g/s	3.26E-04
Al	3.16E-04	g/s	0	9.18E-05	g/s	3.80E-03
As	4.76E-06	g/s	4.56E-03	4.77E-06	g/s	1.98E-04
Cd	0	g/s	0	4.21E-06	g/s	2.04E-04
Cu	8.11E-05	g/s	7.8E-02	1.90E-05	g/s	7.19E-04
Pb	2.76E-05	g/s	2.6E-02	8.32E-06	g/s	3.45E-04
Ag	0	g/s	0	2.24E-07	g/s	9.28E-06

Notes:
ppmv = part per million by volume
g/s = gram per second
g/lb NEW = gram of constituent per pound of net explosive weight
g/lb HD = gram of constituent per pound of mustard agent

These emission factors were then applied to the PCD EDS campaigns to estimate PCD EDS emissions.

Emissions from mustard agent and donor charges were calculated using the Mustard+Donor charge (M+D) emission factor, and emissions from the bursters contained in the munitions were calculated using the Bursters (B) emission factor. Using As and the 4.2-in mortar campaign as an example, the As emissions calculation is shown below.

As emission = (M+D factor) x lb of HD/batch + (B factor) x lb NEW of burster/batch
= 1.98E-04 g As/lb HD x 36 lb HD + 4.56E-03 g As/lb NEW x 0.84 lb NEW/batch
= 7.11E-03 g/batch + 3.83E-03 b/batch
= 1.09E-02 g/batch

Attachment 2 – Table B-2 provides the emission estimate for the 4.2-in mortar campaign.

Attachment 2 - Table B-2. Emission Estimate for 4.2-in Mortar Campaign

Emission Component	Agent + Donor Charge		Burster		Total
	Emission Factor (g/lb agent)	Emission per Batch (g/batch)	Emission Factor (g/lb NEW)	Emission per Batch (g/batch)	Emission per Batch (g/batch)
CO	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SO_2	1.68E-01	6.03E+00	0.00E+00	0.00E+00	6.03E+00
methane	1.33E+00	4.79E+01	3.87E+01	3.25E+01	8.04E+01
ethanol	6.47E-03	2.33E-01	0.00E+00	0.00E+00	2.33E-01
toluene	1.64E-03	5.89E-02	0.00E+00	0.00E+00	5.89E-02
acetone	4.14E-03	1.49E-01	0.00E+00	0.00E+00	1.49E-01
carbon disulfide	1.99E-03	7.17E-02	0.00E+00	0.00E+00	7.17E-02
vinyl chloride	3.26E-04	1.17E-02	0.00E+00	0.00E+00	1.17E-02
Al	3.80E-03	1.37E-01	3.03E-01	2.54E-01	3.91E-01
As	1.98E-04	7.11E-03	4.56E-03	3.83E-03	1.09E-02
Cd	2.04E-04	7.36E-03	0.00E+00	0.00E+00	7.36E-03
Cu	7.19E-04	2.59E-02	7.76E-02	6.52E-02	9.11E-02
Pb	3.45E-04	1.24E-02	2.64E-02	2.22E-02	3.46E-02
Ag	9.28E-06	3.34E-04	0.00E+00	0.00E+00	3.34E-04

Notes:

g/lb agent = gram of constituent per pound of agent
g/batch = gram of constituent per batch
g/lb NEW = gram of constituent per pound net explosive weight

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APPENDIX B-2
ATTACHMENT 3
DESCRIPTION OF CALCULATIONS USED IN THE MODEL METHOD

This attachment describes calculations performed to estimate vaporous emissions based on analysis of liquid neutralent and rinsate samples plus assumed or modeled emissions from detonation of explosives.

The EDS will treat items in the following campaigns:

- 4.2-inch HD-filled mortars
- 105-mm HD-filled projectiles
- 155-mm HD-filled projectiles
- Leaking munitions and DOT containers containing HD drained from leaking munitions
- Downloaded uncontaminated 155-mm projectile bursters

This attachment uses inputs for the 4.2-inch mortar campaign to demonstrate the calculation methodology.

The EDS detonation capacity is 9.0 lb of TNT-equivalent NEW. The mustard agent treatment capacity is 72 lb of mustard agent. For the 4.2-inch mortar example, the amount of mustard agent being treated is 36 lb/batch. Attachment 3 – Table B-1 lists the various EDS capacities used in the calculation.

Attachment 3 - Table B-1. EDS Capacities

System Component	Volume (L)
P2 EDS vessel	606
Neutralent waste container	1,249
Rinsate waste container	473
Waste transfer plumbing	23
Effective volume of neutralent WTS	1,272
Effective volume of rinsate WTS	496
Total effective volume of P2 system with rinsate WTS	1,101
Total volume of P2 EDS system	2,350
Total system volume with both WTS and P2 EDS	2,373
Volume of plumbing lines	23

Attachment 3 - Table B-2 lists inputs used in the example calculations for the amount of agent treated along with the amounts of reagent, rinsewater, and inert gas used during the batch process.

Attachment 3 - Table B-2. Agent, Neutralent, Rinsate, and Inert Gas Inputs

Input	Value	Units
Munition Fill		
Mass of mustard agent	36	lb
	16,344	g
Density of agent	1.27	g/mL
Volume of agent = mass/density	12.87	L
Neutralent		
Reagent: 90% monoethanolamine	156	L
Mass of reagent = volume x density	159	kg
Mass of monoethanolamine = 159 x 90%	142.9	kg
Mass of water = 159 x 10%	15.9	kg
Density of water	1.00	kg/L
Density of monoethanolamine	1.02	kg/L
Volume of water in reagent = mass/density	15.9	L
Volume of monoethanolamine in reagent = mass/density	140.14	L
Additional water (condensed steam)	46.4	L
Additional water (cooling water)	23	L
Total volume of neutralent	238	L
Neutralent dilution factor by condensed steam and cooling water = (total volume –additional water) / total volume	0.71	
Rinsate		
Volume of water added in 1st rinse	20.0	L
Volume of water from steam condensate	126.8	L
Volume of water added in 2nd rinse	136.0	L
Total Volume of rinsate	282.8	L
Rinsate dilution factor due to steam condensate = (total volume – additional water) / total volume	0.55	
Inert Gas Purge		
Inert gas used for purging	82.5	scf

Att 3-1 LIQUID WASTE EVAPORATION CALCULATION METHOD OVERVIEW

The process used to calculate emissions is outlined in the following steps:

1. Calculate volumes and capacities (see Attachment 3 - Table B-1).

    a. Obtain volumes and capacities for system components.
    b. Calculate quantity of liquid neutralent waste, rinsate waste, and amount of Inert gas purge.
    c. Calculate system volume.
    d. Calculate quantity of vapor vented from WTS when liquid is added to waste drum, when gas expansion takes place from EDS compressed gases, and during Inert gas purge.

2. Calculate mass and volume of reagent, rinse water, steam, and inert gas used (see Attachment 3 – Table B-2).

    a. Calculate volume of reagent and mass of monoethanolamine, water, and steam condensate.
    b. Calculate volume of rinsate and mass of monoethanolamine, water, and steam condensate.

3. Calculate vapor composition (see Section Att 3-3.2).

    a. Calculate total mass of components in liquid neutralent waste.
    b. Calculate gram moles (g-moles) of components in liquid neutralent waste.
    c. Calculate mole fractions of components in liquid neutralent waste.
    d. Calculate component partial pressures using Raoult's law.
    e. Calculate EDS gases (inert gas and explosive burning gases) partial pressures.
    f. Calculate mole fractions of components in vapor (in equilibrium with liquid).
    g. Calculate lb-moles of components in vapor per batch.
    h. Calculate lb of components in vapor per batch.
    i. Calculate component emission rate (lb-moles/hr and lb/hr).

4. Calculate vapor emissions from WTS after drum filter.

    a. Calculate g/batch in expelled air.
    b. Calculate lb/hr emission rate.

5. Repeat above calculations for rinsate.

6. Repeat above calculations for EDS gas expansion.

7. Repeat above calculations for Inert gas purge.

8. Calculate emissions (in terms of g/batch and lb/hr) from the WTS by adding all the emissions from neutralent drain, rinsate drain, EDS gas expansion, and Inert gas purge operations.

9. Calculate controlled emissions from enclosure AFS.

    a. Calculate batch controlled emission rate (g/batch).
    b. Calculate hourly controlled emission rate (lb/hr).
    c. Calculate annual controlled emission rate (ton/yr).

Att 3-2 CALCULATION BASES AND ASSUMPTIONS

Neutralent and rinsate waste concentrations used in these calculations are average concentrations of historical analytical results from 16 neutralent samples and 17 rinsate samples from the treatment of munitions at DPG that were the same age and same source of mustard agent as the munitions stored at PCD. Only chemicals with at least one positive detection were included in the model. If not all samples had positive detections, a value of half the reporting limit was used for non-detects in order to arrive at the average value. For example, if 4 out of 16 samples were non-detect at 0.1 milligram/liter (mg/L) and the remaining 12 samples had a reported concentration of 0.2 mg/L, the average value would be (4 x 0.1 mg/L/2 + 12 x 0.2 mg/L)/16 = 0.16 mg/L.

Input values for gases derived from detonation of explosives (contained in the donor charge and munition burster) were based on U.S. Environmental Protection Agency, AP-42, Table 13.3-1, Emission Factors for Detonation of Explosives, 1995 and from stoichiometric calculations. Emission factors for tetryl are not included in AP-42. Therefore, they were modeled with the Cheetah computer code (version 6), using the Becker-Kistiakowsky-Wilson-Sandia (BKWS) product library and the Becker Kistiakowsky-Wilson (BKW) equation-of-state. Cheetah was

developed by Lawrence Livermore National Laboratory for use in predicting the detonation performance of energetic materials. The products are based on the thermodynamics of the system and model a complete detonation or combustion.

Att 3-2.1 Other Assumptions

1. When a volume of liquid is drained from the EDS, an equal volume of vapor is expelled from the WTS.

2. Temperature of neutralent waste at time of transfer is 60°C.

3. Temperature of the rinsate at time of transfer is 90°C. No credit taken for the fact that only the 1st rinse is at 90°C, the 2nd rinse is at ambient temperature.

4. Temperatures of liquid and vapor in the neutralent waste drum and rinsate waste drum are equal to the neutralent/rinsate waste at the time it is drained. No credit is taken for cooling in the waste drum, and no credit is taken for the second rinse being at ambient temperature.

5. Vapor is in equilibrium with liquid, and Raoult's law applies. No credit taken for the time it takes to reach equilibrium.

6. Time to drain neutralent or rinsate wastes from the EDS is 10 minutes.

7. Vapors expelled from the waste treatment system are expelled at a constant rate over the duration of the 10 minutes. Duration for the inert gas purge is 15 minutes. Duration for gas expansion is selected such that it provides the same molar gas flow rate as the Inert gas purge.

8. Gas expansion and inert gas purge gases pass through the neutralent waste drum before entering the AFS.

9. Ambient pressure is 12.31 lb per square inch absolute (psia).

10. The pressure in the WTS is 12.31 psia.

11. Gas flow is assumed to be plug flow during displacement of gases by liquid drain, gas expansion, and Inert gas purge.

Att 3-3 NEUTRALENT WASTE CALCULATIONS

Att 3-3.1 Calculate Volumes and Capacities of System Components

When neutralent is being drained into the WTS, only the neutralent waste drum is open to the system. When rinsate is being drained from the EDS vessel, only the rinsate waste drum is open to the system. Therefore, emissions will evolve from only one of the two drums at a time

Att 3-3.2 Calculate Vapor Composition in Neutralent Waste Drum

The remainder of this example shows calculations using physical and chemical properties of MEK. The properties of MEK along with the concentration of MEK in the neutralent and rinsate are listed in Attachment 3 – Table B-3.

Attachment 3 - Table B-3. Concentrations and Properties of MEK

Component	Conc. in Neutralent (mg/L)	Conc. in Rinsate (mg/L)	Molecular Weight	VP at 60°C (psia)	VP at 90°C (psia)
MEK	0.17	0.16	72.1	7.41E+00	2.33E+01

Note: VP = vapor pressure

a. Component mass in liquid neutralent waste
= (component concentration) (volume of neutralent waste)

MEK mass in liquid
= (0.17 mg/L) (238 L)
= 4.15E+01 mg

b. Component g-moles in liquid neutralent waste
= (component mass) / (component MW)

MEK g-moles
= (4.15E+01 mg) (0.001 g/mg) / (72.1 g/g-mole)
= 5.75E-04 g-moles

Note: Using this same calculation for each component in the neutralent waste and summing the results yielded a sum of g-moles of all components in the neutralent waste liquid as 4.72E+03 g-moles.

c. Component mole fraction in liquid neutralent waste
= (moles of component) / (sum of moles of all components)

MEK mole fraction
= (5.75E-04 g-moles) / (4.72E+03 g-moles)
= 8.15E-08

d. Component partial pressure (using Raoult's Law)
= (component mole fraction) (component vapor pressure)

MEK partial pressure at 60°C
= (8.15E-08) (7.41E+00 psia)
= 6.04E-07 psia

e. Component mole fraction in vapor
= (component partial pressure) / (system pressure)

MEK mole fraction in vapor
= (6.04E-07 psia) / (12.31 psia)
= 4.90E-08

f. Component lb-moles in vapor
= (component mole fraction) (total lb-moles of vapor)

MEK lb-moles in vapor
= (4.90E-08) (1.6E-02 lb-moles)
= 7.87E-10 lb-moles/batch

g. Component mass in vapor
= (component lb-moles) (component MW)

MEK mass
= (7.87E-10 lb-moles) (72.1 lb/lb-mole)
= 5.67E-08 lb
= 5.67E-08 lb × 454 g/lb
= 2.58E-05 g/batch

Att 3-4 RINSATE EMISSIONS

Calculation of rinsate emissions was performed in an identical manner to the neutralent emissions though rinsate starting values were used rather than neutralent starting values. The starting concentrations for rinsate emissions were the component rinsate concentrations rather than the neutralent concentrations (see Attachment 1 – Table B-1 for the MEK concentration). Component concentration enters the calculation at step a in paragraph Att 3-3.2.

The volume of rinsate is 238 L per batch. The concentration of MEK in the rinsate is 0.16 mg/L. This yields a mass of MEK in the rinsate emission of 4.83E-05 g/batch.

Att 3-5 EDS GAS EXPANSION EMISSION

The same equations (starting in paragraph Att 3-3.2) used to calculate MEK emissions from draining the neutralent were used to calculate MEK emissions due to gas expansion. However, in order to estimate emissions due to gas expansion, the calculations were performed twice. The first calculation estimated emissions due to gases already in the system that were displaced by gas expansion. These emissions were based on neutralent vapor concentrations (because expansion gases exit through the neutralent waste drum) and did not include gases generated by detonation of the explosives. The second calculation estimated emissions due to expansion of the detonation gases and included neutralent waste vapors as well as gases generated by detonation of the explosives.

Att 3-5.1 Calculation of Gas Expansion Volumes

The first calculation calculated the volume of gases already in the system displaced by detonation gases. That volume is equal to the volume of dry gas generated by the detonation (14.05 ft^3).

The second volume calculation was based on the volume of gas in the WTS (volume of WTS minus volume occupied by liquid neutralent) the volume of dry gas generated by the detonation.

a. Second volume of displaced gas
= (volume of WTS) – (volume of neutralent) – (gas displaced by explosives gas expansion)
= (44.92 ft^3) – (8.39 ft^3) – (14.05ft^3)]
= 22.48 ft^3

The composition of the first volume of gas was assumed to be neutralent component vapors, while the composition of the second volume of gas included neutralent component vapors plus gases generated by detonation of the explosives. For ease of calculation the molar flow rate for the gas expansion calculation was set equal to the molar flow rate of the Inert gas purge.

Att 3-5.2 First Volume of Gas Expansion

The following values were obtained for the gas expansion emissions calculations in the MEK example:

a. Component mole fraction in vapor
= (component partial pressure) / (system pressure)

MEK mole fraction in vapor
= (6.04E-07 psia) / (12.31 psia)
= 4.90E-08

b. Component lb-moles in vapor
= (component mole fraction) (total lb-moles of vapor)

Note: Refer to step f paragraph Att 3-3.2 for methodology for calculating total lb-moles of vapor. For calculation of the first volume of gas expansion, the total lb-moles of vapor was 2.13E-02 lb-moles.

MEK lb-moles in vapor
= (4.90E-08) (2.69E-02 lb-moles)
= 1.32E-09 lb-moles/batch

c. Component mass in vapor
= (component lb-moles) (component MW)

MEK mass in vapor
= (1.32E-09 lb-moles MEK) (72.1 lb MEK/lb-mole)
= 9.50E-08 lb/batch
= 9.50E-08 lb/batch × 454 g/lb
= 4.31E-05 g/batch

Att 3-5.3 Second Volume of Gas Expansion

a. Component mole fraction in vapor
= (component partial pressure) / (system pressure)

MEK mole fraction in vapor
= (6.04E-07 psia) / (12.3 psia)
= 4.90E-08

b. Component lb-moles in vapor
= (component MEK mole fraction) (total lb-moles of vapor)

Note: Total lb-moles of vapor in the second volume of gas is the sum of the lb-moles of each component (4.30E-02 lb-moles)

MEK lb-moles in vapor
= (4.90E-08) (4.30E-02 lb-moles)
= 2.11E-09 lb-moles/batch

c. Component mass in vapor = (component lb-moles) (component MW)
MEK mass
= (2.11E-09 lb-moles/batch) (72.1 lb MEK/lb-mole)
= 1.52E-07 lb/batch
= 1.52E-07 lb/batch × 454 g/lb = 6.90E-05 g/batch

Att 3-5.4 Total Gas Expansion Volumes Results

The total gas expansion volume calculations yielded results needed for subsequent calculations. The mass values for the first and second gas volume calculations were summed to produce the total g/batch produced by gas expansion.

Total gas expansion emission
= g/batch first volume + g/batch second volume

Total gas expansion emission entering WTS filter
= 4.31E-05 g/batch + 6.90E-05 g/batch
= 1.12E-04 g/batch

Att 3-6 INERT GAS PURGE EMISSIONS

Inert gas purge calculation followed the same example as the gas expansion calculation. The calculation was performed in two parts. The first part accounted for the gases in the WTS at the time the inert gas purge begins, and the second part accounted for gases leaving the WTS due to the inert gas purge. Looked at another way, the first part of the calculation accounted for WTS gases left over from the rinsate drain, while the second part of the calculation accounted for vapors sparged from the neutralent as the inert gas passes through.

The same equations used to calculate emissions from draining the neutralent were used to calculate emissions in the two parts of the inert gas purge calculation. However, in order to estimate inert gas purge emissions, the total moles of gas in the system had to be adjusted to account for the inert gas added via the purge.

Att 3-6.1 Calculation of Inert Gas Purge Volume

The inert gas purge calculation used the amount of inert gas (nitrogen) equal to a 500 pound per square inch gauge (psig) drop in pressure in the inert gas supply tank. Therefore, using the ideal gas law relationship of final volume equals initial volume times final pressure divided by initial pressure ($V_2 = V_1 \times P_2/P_1$) and assuming the tank was full at the beginning of the purge, a 200 standard cubic foot (scf) tank at 1200 psig, and an ambient air pressure of 12.3 psia, the volume of nitrogen remaining in the tank after the purge would be 117.5 scf therefore, 82.5 scf (200 scf - 117.5 scf = 82.5 scf which equates to 111.5 acf) of nitrogen used for the purge. This is equivalent to 0.21 lb-moles of nitrogen.

The first gas volume was equal to the EDS vessel volume plus the gas volume in the WTS at the start of the purge:

a. First volume of displaced gas
   = (volume of WTS) – (volume of neutralent) – (gas displaced by gas expansion)
   = (44.92 ft^3) – (8.39 ft^3) – (14.05ft^3)]
   = 22.48 ft^3

The second gas volume was equal to the volume of inert gas used in the purge minus the first gas volume:

b. Second gas volume
   = (volume of inert gas) - (first gas volume) – (EDS gas expelled by inert purge)

   Second gas volume
   = (111.5 ft^3) – 22.48 ft^3) – 35.44 ft^3)
   = 53.6 ft^3

Att 3-6.2 First Part of Inert Gas Purge Calculation

The following values were obtained for the Inert gas purge emissions calculations:

a. Component mole fraction in vapor
= (component partial pressure) / (system pressure)

MEK mole fraction in vapor
= (6.04E-07 psia) / (12.3 psia)
= 4.90E-08

b. Component lb-moles in vapor
= (component mole fraction) (total lb-moles of vapor)

Note: Refer to step f in paragraph Att 3-3.2 for methodology used to calculate total lb-moles of vapor.

MEK lb-moles in vapor
= (4.90E-08) (4.30E-02 lb-moles)
= 2.11E-09 lb-moles/batch

c. Component mass in vapor
= (component lb-moles) (component MW)

MEK mass
= (2.11E-09 lb-moles) (72.1 lb MEK/lb-mole)
= 1.52E-07 lb/batch
= 1.52E-07 lb/batch × 454 g/lb
= 6.90E-05 g/batch

Att 3-6.3 Second Part of Inert gas purge Calculation

a. Component mole fraction in vapor
= (component partial pressure) / (system pressure)

MEK mole fraction in vapor
= (6.04E-07 psia) / (12.3 psia)
= 4.90E-08

b. Component lb-moles in vapor
= (component mole fraction) (total lb-moles of vapor)

MEK lb-moles in vapor
= (4.90E-08) (1.02E-01 lb-moles)
= 5.02E-09 lb-moles/batch

c. Component mass in vapor
= (component lb-moles) (component MW)

MEK mass
= (5.02E-09 lb-moles/batch) (72.1 lb MEK/lb-mole)
= 3.62E-07 lb/batch
= 3.62E-07 lb/batch × 454 g/lb
= 1.64E-04 g/batch

Att 3-6.4 Inert Gas Purge Results (Combining First and Second Parts of the Calculation)

As with the gas expansion calculations, the results of the two parts of the inert gas purge calculation provided the values used in later calculations. The g/batch of emissions during the two parts of the inert gas purge were summed to give the g/batch of the entire inert gas purge, while the larger of the two hourly emission rates was used as the hourly emission rate for the entire inert gas purge.

MEK mass of MEK in inert gas purge
= (emission mass from the first volume calculation)
+ (emission mass from the second volume calculation)

MEK mass of MEK in inert gas purge entering WTS filter
= (6.90E-05 g/batch) + (1.64E-04 g/batch)
= 2.33E-04 g/batch

Att 3-7 CALCULATE ENCLOSURE AFS EMISSIONS

Gases exiting the WTS are directed via ductwork to the enclosure AFS. Therefore, the mass of components entering the enclosure AFS is the same as the mass exiting the WTS.

Component mass entering enclosure AFS
= (component mass exiting WTS)

MEK mass entering AFS
= 2.58E-05 g/batch from neutralent drain
= 4.83E-05 g/batch from rinsate drain
= 1.12E-04 g/batch from gas expansion
= 2.33E-04 g/batch from Inert gas purge

Att 3-7.1 Maximum Hourly Emission Rate from the Enclosure AFS

The duration of each emission is approximately 10 minutes; therefore the total duration of emissions is less than 1 hour. To be conservative it was assumed that all emissions occur during a single 60-minute period; therefore, the maximum hourly emission rate was the sum of the four emission events.

Max MEK emission = neutralent drain + rinsate drain + gas expansion + inert gas purge
= 2.58E-05 g/batch + 4.83E-05 g/batch + 1.12E-04 g/batch + 2.33E-04 g/batch
= 4.20E-04 g/batch

Att 3-7.2 PCD EDS Annual Emissions

Treatment of items in the PCD EDS is on a campaign basis starting with the leaker campaign which will be completed before the PCAPP begins operations. Subsequent PCD EDS campaigns will be coordinated with PCAPP operations once the plant is operational. Therefore, no two EDS campaigns are expected to occur in the same consecutive 12 month period (or in the same calendar year) except for the 4.2-inch mortar campaign and the burster campaign which are the last two EDS campaigns. The burster campaign will occur immediately after the 4.2-inch mortar campaign.

Att 3-8 REFERENCES

TRC, 2011. Bare Shot Emissions Test Report, Sampling of the Explosive Destruction System at Aberdeen Proving Ground - Edgewood South, Edgewood, Maryland, Prepared for SAIC, December 2011.

TRC, 2012. HD Treatment Emissions Test Report, Emissions Testing of the Explosive Destruction System During HD Treatment at Aberdeen Proving Ground - Edgewood South, Edgewood, Maryland, Prepared for SAIC, August 2012.

U.S. Environmental Protection Agency, 1995. *AP-42 Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point Sources,* Fifth Edition, Office of Air Quality, Planning and Standards, Research Triangle Park, NC.

APPENDIX B-2
ATTACHMENT 4
EDS CALCULATED EMISSION RATES FOR MPHRA MODEL

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Attachment 4 - Table B-1. EDS Emission Rate and Campaign Data From Leidos

Emission rates were provided by Leidos on a per batch basis (g/batch) for type of munition campaign. These emission rates also represent the maximum hourly emission rate. Most emission rates were provided before controls (i.e., based on modeled data); however, some emission rates were provided after controls (i.e., based on test data). The green shading in the table below indicates which value was provided by Leidos. When uncontrolled values were provided, controlled emission rates were estimated using the control efficiency based on the carbon absorption factor. When controlled values were provided, uncontrolled emission rates were back-calculated using the control efficiency based on the carbon absorption factor.

Compound	Maximum Short-term Emission Rate (g/batch, i.e., g/hr)											
	Uncontrolled					Carbon Factor	Control Efficiency	Controlled				
	Leaker Campaign	105mm Campaign	155mm Campaign	4.2-in Campaign	Burster Campaign			Leaker Campaign	105mm Campaign	155mm Campaign	4.2-in Campaign	Burster Campaign
1,1-dichloroethene	6.36E-05	5.98E-05	7.89E-05	6.38E-05	0	3	0	6.36E-05	5.98E-05	7.89E-05	6.38E-05	0.00E+00
1,2,4-trichlorobenzene	1.10E-07	1.04E-07	1.37E-07	1.11E-07	0	3	0	1.10E-07	1.04E-07	1.37E-07	1.11E-07	0.00E+00
1,2-dichlorobenzene	6.25E-07	5.88E-07	7.77E-07	6.27E-07	0	5	66%	2.13E-07	2.00E-07	2.64E-07	2.13E-07	0.00E+00
1,2-dichloroethane	9.43E-05	8.88E-05	1.17E-04	9.47E-05	0	3	0	9.43E-05	8.88E-05	1.17E-04	9.47E-05	0.00E+00
1,3-dichlorobenzene	5.58E-07	5.25E-07	6.93E-07	5.60E-07	0	5	66%	1.90E-07	1.79E-07	2.36E-07	1.90E-07	0.00E+00
1,4-dichlorobenzene	6.22E-07	5.85E-07	7.73E-07	6.24E-07	0	5	66%	2.11E-07	1.99E-07	2.63E-07	2.12E-07	0.00E+00
1,4-dithiane	1.00E-03	9.44E-04	1.25E-03	1.01E-03	0	2	0	1.00E-03	9.44E-04	1.25E-03	1.01E-03	0.00E+00
1,4-oxathiane	1.04E-02	9.75E-03	1.29E-02	1.04E-02	0	3	0	1.04E-02	9.75E-03	1.29E-02	1.04E-02	0.00E+00
2,4-dichlorophenol	3.93E-08	3.69E-08	4.88E-08	3.94E-08	0		0	3.93E-08	3.69E-08	4.88E-08	3.94E-08	0.00E+00
2-butanone	4.18E-04	3.96E-04	5.08E-04	4.20E-04	0	3	0	4.18E-04	3.96E-04	5.08E-04	4.20E-04	0.00E+00
2-methylnaphthalene	6.84E-07	6.81E-07	6.97E-07	6.84E-07	0		0	6.84E-07	6.81E-07	6.97E-07	6.84E-07	0.00E+00
2-methyl phenol	3.05E-06	3.05E-06	3.08E-06	3.05E-06	0	5	66%	1.04E-06	1.04E-06	1.05E-06	1.04E-06	0.00E+00
3-methyl phenol	4.67E-07	4.65E-07	4.73E-07	4.67E-07	0	5	66%	1.59E-07	1.58E-07	1.61E-07	1.59E-07	0.00E+00
4-methyl phenol	4.67E-07	4.65E-07	4.73E-07	4.67E-07	0	5	66%	1.59E-07	1.58E-07	1.61E-07	1.59E-07	0.00E+00
acenaphthylene	1.75E-07	1.65E-07	2.13E-07	1.75E-07	0		0	1.75E-07	1.65E-07	2.13E-07	1.75E-07	0.00E+00
acetone	1.32E-01	7.87E-02	2.91E-01	1.49E-01	0	3	0	1.32E-01	7.87E-02	2.91E-01	1.49E-01	0.00E+00
acetylene	4.85E+00	4.54E+00	3.67E+00	0.00E+00	9.45E+00	0	0	4.85E+00	4.54E+00	3.67E+00	0.00E+00	9.45E+00
benzene	8.14E-03	7.72E-03	9.89E-03	8.17E-03	0	5	66%	2.77E-03	2.62E-03	3.36E-03	2.78E-03	0.00E+00
bis(2-chloroisopropyl) ether	2.27E-07	2.13E-07	2.82E-07	2.28E-07	0		0	2.27E-07	2.13E-07	2.82E-07	2.28E-07	0.00E+00
carbon disulfide	6.37E-02	3.79E-02	1.40E-01	7.17E-02	0	2	0	6.37E-02	3.79E-02	1.40E-01	7.17E-02	0.00E+00
chlorobenzene	1.03E-05	9.73E-06	1.28E-05	1.04E-05	0	5	66%	3.50E-06	3.31E-06	4.35E-06	3.54E-06	0.00E+00
chloroform	7.20E-04	6.77E-04	8.93E-04	7.22E-04	0	4	33%	4.82E-04	4.54E-04	5.98E-04	4.84E-04	0.00E+00
cis-1,2-dichloroethene	2.06E-04	1.94E-04	2.55E-04	2.06E-04	0	3	0	2.06E-04	1.94E-04	2.55E-04	2.06E-04	0.00E+00
dichlorodifluoromethane	1.20E-03	1.13E-03	1.49E-03	1.20E-03	0	3	0	1.20E-03	1.13E-03	1.49E-03	1.20E-03	0.00E+00
ethane	5.37E-02	5.03E-02	4.07E-02	0.00E+00	1.05E-01	0	0	5.37E-02	5.03E-02	4.07E-02	0.00E+00	1.05E-01
ethanol	2.07E-01	1.23E-01	4.54E-01	2.33E-01	0	3	0	2.07E-01	1.23E-01	4.54E-01	2.33E-01	0.00E+00
ethylbenzene	1.34E-05	1.27E-05	1.59E-05	1.34E-05	0	5	66%	4.56E-06	4.32E-06	5.41E-06	4.56E-06	0.00E+00
HD	1.28E-05	1.20E-05	1.59E-05	1.28E-05	0	5	66%	4.35E-06	4.08E-06	5.41E-06	4.35E-06	0.00E+00
methane	9.09E+01	8.57E+01	1.89E+02	8.04E+01	1.59E+02	0	0	9.09E+01	8.57E+01	1.89E+02	8.04E+01	1.59E+02
methylene chloride	1.06E-06	1.06E-06	1.06E-06	1.06E-06	0	3	0	1.06E-06	1.06E-06	1.06E-06	1.06E-06	0.00E+00
monoethanolamine	1.52E+01	1.47E+01	1.86E+01	1.51E+01	0		0	1.52E+01	1.47E+01	1.86E+01	1.51E+01	0.00E+00
naphthalene	2.22E-05	2.20E-05	2.30E-05	2.22E-05	0	5	66%	7.55E-06	7.48E-06	7.82E-06	7.55E-06	0.00E+00
nitrobenzene	1.22E-07	1.14E-07	1.51E-07	1.22E-07	0	5	66%	4.15E-08	3.88E-08	5.13E-08	4.15E-08	0.00E+00
phenanthrene	6.33E-08	6.30E-08	6.45E-08	6.33E-08	0		0	6.33E-08	6.30E-08	6.45E-08	6.33E-08	0.00E+00
phenol	6.34E-06	6.32E-06	6.43E-06	6.34E-06	0	5	66%	2.16E-06	2.15E-06	2.19E-06	2.16E-06	0.00E+00
styrene	9.74E-05	9.17E-05	1.20E-04	9.77E-05	0	5	66%	3.31E-05	3.12E-05	4.08E-05	3.32E-05	0.00E+00
tetrachloroethene	2.64E-03	2.49E-03	3.29E-03	2.65E-03	0	5	66%	8.98E-04	8.47E-04	1.12E-03	9.01E-04	0.00E+00
toluene	1.54E-01	9.15E-02	3.38E-01	1.73E-01	0	5	66%	5.24E-02	3.11E-02	1.15E-01	5.89E-02	0.00E+00
trans-1,2-dichloroethene	8.81E-05	8.29E-05	1.09E-04	8.84E-05	0	3	0	8.81E-05	8.29E-05	1.09E-04	8.84E-05	0.00E+00
trichloroethene	3.24E-04	3.05E-04	4.02E-04	3.25E-04	0	4	33%	2.17E-04	2.04E-04	2.69E-04	2.18E-04	0.00E+00
vinyl chloride	1.04E-02	6.20E-03	2.29E-02	1.17E-02	0	1	0	1.04E-02	6.20E-03	2.29E-02	1.17E-02	0.00E+00
xylenes	3.09E-05	2.94E-05	3.70E-05	3.10E-05	0	5	66%	1.05E-05	1.00E-05	1.26E-05	1.05E-05	0.00E+00
aluminum	5.00E-01	5.44E-01	1.01E+00	3.91E-01	1.24E+00		0	5.00E-01	5.44E-01	1.01E+00	3.91E-01	1.24E+00
ammonia	7.21E+00	7.10E+00	3.99E+00	7.59E+00	4.80E+00		0	7.21E+00	7.10E+00	3.99E+00	7.59E+00	4.80E+00
arsenic	1.20E-02	1.09E-02	2.51E-02	1.09E-02	1.87E-02		0	1.20E-02	1.09E-02	2.51E-02	1.09E-02	1.87E-02
cadmium	6.54E-03	3.89E-03	1.44E-02	7.36E-03	0		0	6.54E-03	3.89E-03	1.44E-02	7.36E-03	0.00E+00
copper	1.20E-01	1.35E-01	2.42E-01	9.11E-02	3.18E-01		0	1.20E-01	1.35E-01	2.42E-01	9.11E-02	3.18E-01
hydrogen cyanide	1.16E+00	1.08E+00	8.77E-01	0.00E+00	2.26E+00		0	1.16E+00	1.08E+00	8.77E-01	0.00E+00	2.26E+00
lead	4.41E-02	4.78E-02	8.92E-02	3.46E-02	1.08E-01		0	4.41E-02	4.78E-02	8.92E-02	3.46E-02	1.08E-01
silver	2.97E-04	1.77E-04	6.51E-04	3.34E-04	0		0	2.97E-04	1.77E-04	6.51E-04	3.34E-04	0.00E+00

EDS Processing Schedule

Campaign	Items per Batch	Batches	HD Fill per Batch (lb)	Duration (weeks)	Total Fill Treated (lb)	
Leaker	Varies	116	32[a]	24	3,712	
155mm	6	51	70.2	11	3,580	
105mm	6	64	19	13	1,216	
4.2-inch	6	11	36	3	396	
Bursters	10	8	none	2 (days)	0	
4.2-inch	3	6	12	216		All pollutants
Bursters	0.3	6	12	21		All pollutants, except HD
				3,693		

Attachment 4 - Table B-2. EDS Controlled Short-term Emission Rate Calculations

a. Emission rates were by provided by Leidos on a per batch basis (g/batch) for each type of munition campaign. These emission rates are equal to the worst-case hourly emission rate. The maximum controlled emission rate for each pollutant was converted from g/hr to g/s by the following equation:

Emissions (g/s) = (Emissions, g/hr) x (1 hr/60 min) x (1 min/60 s)

b. Each EDS unit has its own environmental enclosure. Gases from the environmental enclosure and EDS waste transfer system are vented together through a pair of final air filtration systems and stacks.

Name	CAS	Maximum Short-term Emission Rate (g/hr)					Maximum Modeled Short-term EDS Controlled Emission Rates		
		Controlled							
		Leaker Campaign	105mm Campaign	155mm Campaign	4.2-in Campaign	Burster Campaign	g/hr	lb/hr	g/s
1,1-dichloroethene	75-35-4	6.36E-05	5.98E-05	7.89E-05	6.38E-05	0.00E+00	7.89E-05	1.74E-07	2.19E-08
1,2,4-trichlorobenzene	120-82-1	1.10E-07	1.04E-07	1.37E-07	1.11E-07	0.00E+00	1.37E-07	3.02E-10	3.81E-11
1,2-dichlorobenzene	95-50-1	2.13E-07	2.00E-07	2.64E-07	2.13E-07	0.00E+00	2.64E-07	5.82E-10	7.34E-11
1,2-dichloroethane	107-06-2	9.43E-05	8.88E-05	1.17E-04	9.47E-05	0.00E+00	1.17E-04	2.58E-07	3.25E-08
1,3-dichlorobenzene	541-73-1	1.90E-07	1.79E-07	2.36E-07	1.90E-07	0.00E+00	2.36E-07	5.19E-10	6.55E-11
1,4-dichlorobenzene	106-46-7	2.11E-07	1.99E-07	2.63E-07	2.12E-07	0.00E+00	2.63E-07	5.79E-10	7.30E-11
1,4-dithiane	505-29-3	1.00E-03	9.44E-04	1.25E-03	1.01E-03	0.00E+00	1.25E-03	2.75E-06	3.47E-07
1,4-oxathiane	15980-15-1	1.04E-02	9.75E-03	1.29E-02	1.04E-02	0.00E+00	1.29E-02	2.84E-05	3.58E-06
2,4-dichlorophenol	120-83-2	3.93E-08	3.69E-08	4.88E-08	3.94E-08	0.00E+00	4.88E-08	1.07E-10	1.36E-11
2-butanone	78-93-3	4.18E-04	3.96E-04	5.08E-04	4.20E-04	0.00E+00	5.08E-04	1.12E-06	1.41E-07
2-methyl phenol	95-48-7	1.04E-06	1.04E-06	1.05E-06	1.04E-06	0.00E+00	1.05E-06	2.31E-09	2.91E-10
2-methylnaphthalene	91-57-6	6.84E-07	6.81E-07	6.97E-07	6.84E-07	0.00E+00	6.97E-07	1.54E-09	1.94E-10
3-methyl phenol	108-39-4	1.59E-07	1.58E-07	1.61E-07	1.59E-07	0.00E+00	1.61E-07	3.54E-10	4.46E-11
4-methyl phenol	106-44-5	1.59E-07	1.58E-07	1.61E-07	1.59E-07	0.00E+00	1.61E-07	3.54E-10	4.46E-11
acenaphthylene	208-96-8	1.75E-07	1.65E-07	2.13E-07	1.75E-07	0.00E+00	2.13E-07	4.69E-10	5.92E-11
acetone	67-64-1	1.32E-01	7.87E-02	2.91E-01	1.49E-01	0.00E+00	2.91E-01	6.41E-04	8.08E-05
acetylene	74-86-2	4.85E+00	4.54E+00	3.67E+00	0.00E+00	9.45E+00	9.45E+00	2.08E-02	2.63E-03
benzene	71-43-2	2.77E-03	2.62E-03	3.36E-03	2.78E-03	0.00E+00	3.36E-03	7.41E-06	9.34E-07
bis(2-chloroisopropyl) ether	39638-32-9	2.27E-07	2.13E-07	2.82E-07	2.28E-07	0.00E+00	2.82E-07	6.21E-10	7.83E-11
carbon disulfide	75-15-0	6.37E-02	3.79E-02	1.40E-01	7.17E-02	0.00E+00	1.40E-01	3.08E-04	3.89E-05
chlorobenzene	108-90-7	3.50E-06	3.31E-06	4.35E-06	3.54E-06	0.00E+00	4.35E-06	9.59E-09	1.21E-09
chloroform	67-66-3	4.82E-04	4.54E-04	5.98E-04	4.84E-04	0.00E+00	5.98E-04	1.32E-06	1.66E-07
cis-1,2-dichloroethene	156-59-2	2.06E-04	1.94E-04	2.55E-04	2.06E-04	0.00E+00	2.55E-04	5.62E-07	7.08E-08
dichlorodifluoromethane	75-71-8	1.20E-03	1.13E-03	1.49E-03	1.20E-03	0.00E+00	1.49E-03	3.28E-06	4.14E-07
ethane	74-84-0	5.37E-02	5.03E-02	4.07E-02	0.00E+00	1.05E-01	1.05E-01	2.31E-04	2.92E-05
ethanol	64-17-5	2.07E-01	1.23E-01	4.54E-01	2.33E-01	0.00E+00	4.54E-01	1.00E-03	1.26E-04
ethylbenzene	100-41-4	4.56E-06	4.32E-06	5.41E-06	4.56E-06	0.00E+00	5.41E-06	1.19E-08	1.50E-09
HD	505-60-2	4.35E-06	4.08E-06	5.41E-06	4.35E-06	0.00E+00	2.01E-02	4.43E-05	5.58E-06
methane	74-82-8	9.09E+01	8.57E+01	1.89E+02	8.04E+01	1.59E+02	1.89E+02	4.16E-01	5.25E-02
methylene chloride	75-09-2	1.06E-06	1.06E-06	1.06E-06	1.06E-06	0.00E+00	1.06E-06	2.33E-09	2.94E-10
monoethanolamine	141-43-5	1.52E+01	1.47E+01	1.86E+01	1.51E+01	0.00E+00	1.86E+01	4.10E-02	5.17E-03
naphthalene	91-20-3	7.55E-06	7.48E-06	7.82E-06	7.55E-06	0.00E+00	7.82E-06	1.72E-08	2.17E-09
nitrobenzene	98-95-3	4.15E-08	3.88E-08	5.13E-08	4.15E-08	0.00E+00	5.13E-08	1.13E-10	1.43E-11
phenanthrene	85-01-8	6.33E-08	6.30E-08	6.45E-08	6.33E-08	0.00E+00	6.45E-08	1.42E-10	1.79E-11
phenol	108-95-2	2.16E-06	2.15E-06	2.19E-06	2.16E-06	0.00E+00	2.19E-06	4.82E-09	6.07E-10
styrene	100-42-5	3.31E-05	3.12E-05	4.08E-05	3.32E-05	0.00E+00	4.08E-05	8.99E-08	1.13E-08
tetrachloroethene	127-18-4	8.98E-04	8.47E-04	1.12E-03	9.01E-04	0.00E+00	1.12E-03	2.46E-06	3.11E-07
toluene	108-88-3	5.24E-02	3.11E-02	1.15E-01	5.89E-02	0.00E+00	1.15E-01	2.53E-04	3.19E-05
trans-1,2-dichloroethene	156-60-5	8.81E-05	8.29E-05	1.09E-04	8.84E-05	0.00E+00	1.09E-04	2.40E-07	3.03E-08
trichloroethene	79-01-6	2.17E-04	2.04E-04	2.69E-04	2.18E-04	0.00E+00	2.69E-04	5.93E-07	7.48E-08
vinyl chloride	75-01-4	1.04E-02	6.20E-03	2.29E-02	1.17E-02	0.00E+00	2.29E-02	5.04E-05	6.36E-06
xylenes	1330-20-7	1.05E-05	1.00E-05	1.26E-05	1.05E-05	0.00E+00	1.26E-05	2.77E-08	3.49E-09
aluminum	7429-90-5	5.00E-01	5.44E-01	1.01E+00	3.91E-01	1.24E+00	1.24E+00	2.73E-03	3.44E-04
ammonia	7664-41-7	7.21E+00	7.10E+00	3.99E+00	7.59E+00	4.80E+00	7.59E+00	1.67E-02	2.11E-03
arsenic	7440-38-2	1.20E-02	1.09E-02	2.51E-02	1.09E-02	1.87E-02	2.51E-02	5.53E-05	6.97E-06
cadmium	7440-43-9	6.54E-03	3.89E-03	1.44E-02	7.36E-03	0.00E+00	1.44E-02	3.17E-05	4.00E-06
copper	7440-50-8	1.20E-01	1.35E-01	2.42E-01	9.11E-02	3.18E-01	3.18E-01	7.00E-04	8.83E-05
hydrogen cyanide	74-90-8	1.16E+00	1.08E+00	8.77E-01	0.00E+00	2.26E+00	2.26E+00	4.98E-03	6.28E-04
lead	7439-92-1	4.41E-02	4.78E-02	8.92E-02	3.46E-02	1.08E-01	1.08E-01	2.38E-04	3.00E-05
silver	7440-22-4	2.97E-04	1.77E-04	6.51E-04	3.34E-04	0.00E+00	6.51E-04	1.43E-06	1.81E-07

Attachment 4 - Table B-3. EDS Uncontrolled Short-term Emission Rate Calculations

a. Emission rates were by provided by Leidos on a per batch basis (g/batch) for each type of munition campaign. These emission rates are equal to the worst-case hourly emission rate. The maximum uncontrolled emission rate for each pollutant was converted from g/hr to g/s by the following equation:

Emissions (g/s) = (Emissions, g/hr) x (1 hr/60 min) x (1 min/60 s)

b. Each EDS unit has its own environmental enclosure. Gases from the environmental enclosure and EDS waste transfer system are vented together through a pair of final air filtration systems and stacks.

Name	CAS	Maximum Short-term Emission Rate (g/hr)					Maximum Modeled Short-term EDS Uncontrolled Emission Rates		
		Uncontrolled							
		Leaker Campaign	105mm Campaign	155mm Campaign	4.2-in Campaign	Burster Campaign	g/hr	lb/hr	g/s
1,1-dichloroethene	75-35-4	6.36E-05	5.98E-05	7.89E-05	6.38E-05	0.00E+00	7.89E-05	1.74E-07	2.19E-08
1,2,4-trichlorobenzene	120-82-1	1.10E-07	1.04E-07	1.37E-07	1.11E-07	0.00E+00	1.37E-07	3.02E-10	3.81E-11
1,2-dichlorobenzene	95-50-1	6.25E-07	5.88E-07	7.77E-07	6.27E-07	0.00E+00	7.77E-07	1.71E-09	2.16E-10
1,2-dichloroethane	107-06-2	9.43E-05	8.88E-05	1.17E-04	9.47E-05	0.00E+00	1.17E-04	2.58E-07	3.25E-08
1,3-dichlorobenzene	541-73-1	5.58E-07	5.25E-07	6.93E-07	5.60E-07	0.00E+00	6.93E-07	1.53E-09	1.93E-10
1,4-dichlorobenzene	106-46-7	6.22E-07	5.85E-07	7.73E-07	6.24E-07	0.00E+00	7.73E-07	1.70E-09	2.15E-10
1,4-dithiane	505-29-3	1.00E-03	9.44E-04	1.25E-03	1.01E-03	0.00E+00	1.25E-03	2.75E-06	3.47E-07
1,4-oxathiane	15980-15-1	1.04E-02	9.75E-03	1.29E-02	1.04E-02	0.00E+00	1.29E-02	2.84E-05	3.58E-06
2,4-dichlorophenol	120-83-2	3.93E-08	3.69E-08	4.88E-08	3.94E-08	0.00E+00	4.88E-08	1.07E-10	1.36E-11
2-butanone	78-93-3	4.18E-04	3.96E-04	5.08E-04	4.20E-04	0.00E+00	5.08E-04	1.12E-06	1.41E-07
2-methyl phenol	95-48-7	3.05E-06	3.05E-06	3.08E-06	3.05E-06	0.00E+00	3.08E-06	6.78E-09	8.56E-10
2-methylnaphthalene	91-57-6	6.84E-07	6.81E-07	6.97E-07	6.84E-07	0.00E+00	6.97E-07	1.54E-09	1.94E-10
3-methyl phenol	108-39-4	4.67E-07	4.65E-07	4.73E-07	4.67E-07	0.00E+00	4.73E-07	1.04E-09	1.31E-10
4-methyl phenol	106-44-5	4.67E-07	4.65E-07	4.73E-07	4.67E-07	0.00E+00	4.73E-07	1.04E-09	1.31E-10
acenaphthylene	208-96-8	1.75E-07	1.65E-07	2.13E-07	1.75E-07	0.00E+00	2.13E-07	4.69E-10	5.92E-11
acetone	67-64-1	1.32E-01	7.87E-02	2.91E-01	1.49E-01	0.00E+00	2.91E-01	6.41E-04	8.08E-05
acetylene	74-86-2	4.85E+00	4.54E+00	3.67E+00	0.00E+00	9.45E+00	9.45E+00	2.08E-02	2.63E-03
benzene	71-43-2	8.14E-03	7.72E-03	9.89E-03	8.17E-03	0.00E+00	9.89E-03	2.18E-05	2.75E-06
bis(2-chloroisopropyl) ether	39638-32-9	2.27E-07	2.13E-07	2.82E-07	2.28E-07	0.00E+00	2.82E-07	6.21E-10	7.83E-11
carbon disulfide	75-15-0	6.37E-02	3.79E-02	1.40E-01	7.17E-02	0.00E+00	1.40E-01	3.08E-04	3.89E-05
chlorobenzene	108-90-7	1.03E-05	9.73E-06	1.28E-05	1.04E-05	0.00E+00	1.28E-05	2.82E-08	3.56E-09
chloroform	67-66-3	7.20E-04	6.77E-04	8.93E-04	7.22E-04	0.00E+00	8.93E-04	1.97E-06	2.48E-07
cis-1,2-dichloroethene	156-59-2	2.06E-04	1.94E-04	2.55E-04	2.06E-04	0.00E+00	2.55E-04	5.62E-07	7.08E-08
dichlorodifluoromethane	75-71-8	1.20E-03	1.13E-03	1.49E-03	1.20E-03	0.00E+00	1.49E-03	3.28E-06	4.14E-07
ethane	74-84-0	5.37E-02	5.03E-02	4.07E-02	0.00E+00	1.05E-01	1.05E-01	2.31E-04	2.92E-05
ethanol	64-17-5	2.07E-01	1.23E-01	4.54E-01	2.33E-01	0.00E+00	4.54E-01	1.00E-03	1.26E-04
ethylbenzene	100-41-4	1.34E-05	1.27E-05	1.59E-05	1.34E-05	0.00E+00	1.59E-05	3.50E-08	4.42E-09
HD	505-60-2	1.28E-05	1.20E-05	1.59E-05	1.28E-05	0.00E+00	2.01E-02	4.43E-05	5.58E-06
methane	74-82-8	9.09E+01	8.57E+01	1.89E+02	8.04E+01	1.59E+02	1.89E+02	4.16E-01	5.25E-02
methylene chloride	75-09-2	1.06E-06	1.06E-06	1.06E-06	1.06E-06	0.00E+00	1.06E-06	2.33E-09	2.94E-10
monoethanolamine	141-43-5	1.52E+01	1.47E+01	1.86E+01	1.51E+01	0.00E+00	1.86E+01	4.10E-02	5.17E-03
naphthalene	91-20-3	2.22E-05	2.20E-05	2.30E-05	2.22E-05	0.00E+00	2.30E-05	5.07E-08	6.39E-09
nitrobenzene	98-95-3	1.22E-07	1.14E-07	1.51E-07	1.22E-07	0.00E+00	1.51E-07	3.33E-10	4.19E-11
phenanthrene	85-01-8	6.33E-08	6.30E-08	6.45E-08	6.33E-08	0.00E+00	6.45E-08	1.42E-10	1.79E-11
phenol	108-95-2	6.34E-06	6.32E-06	6.43E-06	6.34E-06	0.00E+00	6.43E-06	1.42E-08	1.79E-09
styrene	100-42-5	9.74E-05	9.17E-05	1.20E-04	9.77E-05	0.00E+00	1.20E-04	2.64E-07	3.33E-08
tetrachloroethene	127-18-4	2.64E-03	2.49E-03	3.29E-03	2.65E-03	0.00E+00	3.29E-03	7.25E-06	9.14E-07
toluene	108-88-3	1.54E-01	9.15E-02	3.38E-01	1.73E-01	0.00E+00	3.38E-01	7.45E-04	9.40E-05
trans-1,2-dichloroethene	156-60-5	8.81E-05	8.29E-05	1.09E-04	8.84E-05	0.00E+00	1.09E-04	2.40E-07	3.03E-08
trichloroethene	79-01-6	3.24E-04	3.05E-04	4.02E-04	3.25E-04	0.00E+00	4.02E-04	8.85E-07	1.12E-07
vinyl chloride	75-01-4	1.04E-02	6.20E-03	2.29E-02	1.17E-02	0.00E+00	2.29E-02	5.04E-05	6.36E-06
xylenes	1330-20-7	3.09E-05	2.94E-05	3.70E-05	3.10E-05	0.00E+00	3.70E-05	8.15E-08	1.03E-08
aluminum	7429-90-5	5.00E-01	5.44E-01	1.01E+00	3.91E-01	1.24E+00	1.24E+00	2.73E-03	3.44E-04
ammonia	7664-41-7	7.21E+00	7.10E+00	3.99E+00	7.59E+00	4.80E+00	7.59E+00	1.67E-02	2.11E-03
arsenic	7440-38-2	1.20E-02	1.09E-02	2.51E-02	1.09E-02	1.87E-02	2.51E-02	5.53E-05	6.97E-06
cadmium	7440-43-9	6.54E-03	3.89E-03	1.44E-02	7.36E-03	0.00E+00	1.44E-02	3.17E-05	4.00E-06
copper	7440-50-8	1.20E-01	1.35E-01	2.42E-01	9.11E-02	3.18E-01	3.18E-01	7.00E-04	8.83E-05
hydrogen cyanide	74-90-8	1.16E+00	1.08E+00	8.77E-01	0.00E+00	2.26E+00	2.26E+00	4.98E-03	6.28E-04
lead	7439-92-1	4.41E-02	4.78E-02	8.92E-02	3.46E-02	1.08E-01	1.08E-01	2.38E-04	3.00E-05
silver	7440-22-4	2.97E-04	1.77E-04	6.51E-04	3.34E-04	0.00E+00	6.51E-04	1.43E-06	1.81E-07

Attachment 4 - Table B-4. EDS Controlled Long-term Emission Rate Calculations

Basis and Emission Calculations:

a. Emission rates were by provided by Leidos on a per batch basis (g/batch) for each type of munition campaign.
b. Total emissions from each campaign were calculated as follows.

Pollutant emissions per campaign (g/campaign) = (pollutant emission rate, g/batch) x (batches/campaign)

c. Total emissions for the entire 5-year project were calculated as follows:

Total EDS emissions per 5-yr project (g) = (emissions from leaker campaign, g) + (emissions from 105mm campaign) + (emissions from 155mm campaign, g) + (emissions from 4.2-in campaign) + (emissions from burster campaign)

d. Total average long-term emission rates were calculated based on a 5-year operating period, with a 12 hr/day average operation schedule over the 5-yr duration of the project.

Average Long-term Emissions (g/s) = (Total Emissions for the 5-yr project, g) / [(5 yr) x (52 weeks/yr) x (7 day/week) x (12 hr/day) x (60 min/hr) x (60 s/min)]

Average Long-term Emissions (lb/hr) = (Average long-term emission rate, g/s) / (454 g/lb) x (60 s/min) x (60 min/hr)

e. See the HD emission rate calculation sheet for HD-specific calculation methodology.

Emissions Summary:

Name	CAS	Leaker Campaign			105mm Campaign			155mm Campaign			4.2-in Campaign			Burster Campaign			Total 5-yr EDS Emissions		Operating Schedule				Duration of EDS Operations		Modeled (Average) Long-term Emission Rate	
		Maximum Controllled Emission Rate (g/batch)	Batches per campaign	Controlled Emissions (g/campaign)	Maximum Controllled Emission Rate (g/batch)	Batches per campaign	Controlled Emissions (g/campaign)	Maximum Controllled Emission Rate (g/batch)	Batches per campaign	Controlled Emissions (g/campaign)	Maximum Controllled Emission Rate (g/batch)	Batches per campaign	Controlled Emissions (g/campaign)	Maximum Controllled Emission Rate (g/batch)	Batches per campaign	Controlled Emissions (g/campaign)	g	lb	yr	week/yr	day/week	hr/day	hr	s	lb/hr	g/s
1,1-dichloroethene	75-35-4	6.36E-05	116	7.38E-03	5.98E-05	64	3.83E-03	7.89E-05	51	4.02E-03	6.38E-05	11	7.02E-04	0.00E+00	8	0.00E+00	1.59E-02	3.51E-05	5	52	7	12	21,840	7.9E+07	1.61E-09	2.03E-10
1,2,4-trichlorobenzene	120-82-1	1.10E-07	116	1.28E-05	1.04E-07	64	6.66E-06	1.37E-07	51	6.99E-06	1.11E-07	11	1.22E-06	0.00E+00	8	0.00E+00	2.76E-05	6.08E-08	5	52	7	12	21,840	7.9E+07	2.79E-12	3.51E-13
1,2-dichlorobenzene	95-50-1	2.13E-07	116	2.47E-05	2.00E-07	64	1.28E-05	2.64E-07	51	1.35E-05	2.13E-07	11	2.34E-06	0.00E+00	8	0.00E+00	5.33E-05	1.17E-07	5	52	7	12	21,840	7.9E+07	5.37E-12	6.77E-13
1,2-dichloroethane	107-06-2	9.43E-05	116	1.09E-02	8.88E-05	64	5.68E-03	1.17E-04	51	5.97E-03	9.47E-05	11	1.04E-03	0.00E+00	8	0.00E+00	2.36E-02	5.21E-05	5	52	7	12	21,840	7.9E+07	2.38E-09	3.01E-10
1,3-dichlorobenzene	541-73-1	1.90E-07	116	2.20E-05	1.79E-07	64	1.14E-05	2.36E-07	51	1.20E-05	1.90E-07	11	2.09E-06	0.00E+00	8	0.00E+00	4.75E-05	1.05E-07	5	52	7	12	21,840	7.9E+07	4.79E-12	6.05E-13
1,4-dichlorobenzene	106-46-7	2.11E-07	116	2.45E-05	1.99E-07	64	1.27E-05	2.63E-07	51	1.34E-05	2.12E-07	11	2.33E-06	0.00E+00	8	0.00E+00	5.30E-05	1.17E-07	5	52	7	12	21,840	7.9E+07	5.35E-12	6.74E-13
1,4-dithiane	505-29-3	1.00E-03	116	1.16E-01	9.44E-04	64	6.04E-02	1.25E-03	51	6.38E-02	1.01E-03	11	1.11E-02	0.00E+00	8	0.00E+00	2.51E-01	5.53E-04	5	52	7	12	21,840	7.9E+07	2.53E-08	3.20E-09
1,4-oxathiane	15980-15-1	1.04E-02	116	1.21E+00	9.75E-03	64	6.24E-01	1.29E-02	51	6.58E-01	1.04E-02	11	1.14E-01	0.00E+00	8	0.00E+00	2.60E+00	5.73E-03	5	52	7	12	21,840	7.9E+07	2.62E-07	3.31E-08
2,4-dichlorophenol	120-83-2	3.93E-08	116	4.56E-06	3.69E-08	64	2.36E-06	4.88E-08	51	2.49E-06	3.94E-08	11	4.33E-07	0.00E+00	8	0.00E+00	9.84E-06	2.17E-08	5	52	7	12	21,840	7.9E+07	9.93E-13	1.25E-13
2-butanone	78-93-3	4.18E-04	116	4.85E-02	3.96E-04	64	2.53E-02	5.08E-04	51	2.59E-02	4.20E-04	11	4.62E-03	0.00E+00	8	0.00E+00	1.04E-01	2.30E-04	5	52	7	12	21,840	7.9E+07	1.05E-08	1.33E-09
2-methyl phenol	95-48-7	1.04E-06	116	1.20E-04	1.04E-06	64	6.64E-05	1.05E-06	51	5.34E-05	1.04E-06	11	1.14E-05	0.00E+00	8	0.00E+00	2.51E-04	5.54E-07	5	52	7	12	21,840	7.9E+07	2.54E-11	3.20E-12
2-methylnaphthalene	91-57-6	6.84E-07	116	7.93E-05	6.81E-07	64	4.36E-05	6.97E-07	51	3.55E-05	6.84E-07	11	7.52E-06	0.00E+00	8	0.00E+00	1.66E-04	3.66E-07	5	52	7	12	21,840	7.9E+07	1.67E-11	2.11E-12
3-methyl phenol	108-39-4	1.59E-07	116	1.84E-05	1.58E-07	64	1.01E-05	1.61E-07	51	8.19E-06	1.59E-07	11	1.74E-06	0.00E+00	8	0.00E+00	3.85E-05	8.47E-08	5	52	7	12	21,840	7.9E+07	3.88E-12	4.89E-13
4-methyl phenol	106-44-5	1.59E-07	116	1.84E-05	1.58E-07	64	1.01E-05	1.61E-07	51	8.19E-06	1.59E-07	11	1.74E-06	0.00E+00	8	0.00E+00	3.85E-05	8.47E-08	5	52	7	12	21,840	7.9E+07	3.88E-12	4.89E-13
acenaphthylene	208-96-8	1.75E-07	116	2.03E-05	1.65E-07	64	1.06E-05	2.13E-07	51	1.09E-05	1.75E-07	11	1.93E-06	0.00E+00	8	0.00E+00	4.36E-05	9.61E-08	5	52	7	12	21,840	7.9E+07	4.40E-12	5.55E-13
acetone	67-64-1	1.32E-01	116	1.53E+01	7.87E-02	64	5.04E+00	2.91E-01	51	1.48E+01	1.49E-01	11	1.64E+00	0.00E+00	8	0.00E+00	3.68E+01	8.11E-02	5	52	7	12	21,840	7.9E+07	3.71E-06	4.68E-07
acetylene	74-86-2	4.85E+00	116	5.63E+02	4.54E+00	64	2.91E+02	3.67E+00	51	1.87E+02	0.00E+00	11	0.00E+00	9.45E+00	8	7.56E+01	1.12E+03	2.46E+00	5	52	7	12	21,840	7.9E+07	1.13E-04	1.42E-05
benzene	71-43-2	2.77E-03	116	3.21E-01	2.62E-03	64	1.68E-01	3.36E-03	51	1.71E-01	2.78E-03	11	3.06E-02	0.00E+00	8	0.00E+00	6.91E-01	1.52E-03	5	52	7	12	21,840	7.9E+07	6.97E-08	8.79E-09
bis(2-chloroisopropyl) ether	39638-32-9	2.27E-07	116	2.63E-05	2.13E-07	64	1.36E-05	2.82E-07	51	1.44E-05	2.28E-07	11	2.51E-06	0.00E+00	8	0.00E+00	5.69E-05	1.25E-07	5	52	7	12	21,840	7.9E+07	5.73E-12	7.23E-13
carbon disulfide	75-15-0	6.37E-02	116	7.39E+00	3.79E-02	64	2.43E+00	1.40E-01	51	7.14E+00	7.17E-02	11	7.89E-01	0.00E+00	8	0.00E+00	1.77E+01	3.91E-02	5	52	7	12	21,840	7.9E+07	1.79E-06	2.26E-07
chlorobenzene	108-90-7	3.50E-06	116	4.06E-04	3.31E-06	64	2.12E-04	4.35E-06	51	2.22E-04	3.54E-06	11	3.89E-05	0.00E+00	8	0.00E+00	8.79E-04	1.94E-06	5	52	7	12	21,840	7.9E+07	8.86E-11	1.12E-11
chloroform	67-66-3	4.82E-04	116	5.60E-02	4.54E-04	64	2.90E-02	5.98E-04	51	3.05E-02	4.84E-04	11	5.32E-03	0.00E+00	8	0.00E+00	1.21E-01	2.66E-04	5	52	7	12	21,840	7.9E+07	1.22E-08	1.54E-09
cis-1,2-dichloroethene	156-59-2	2.06E-04	116	2.39E-02	1.94E-04	64	1.24E-02	2.55E-04	51	1.30E-02	2.06E-04	11	2.27E-03	0.00E+00	8	0.00E+00	5.16E-02	1.14E-04	5	52	7	12	21,840	7.9E+07	5.20E-09	6.56E-10
dichlorodifluoromethane	75-71-8	1.20E-03	116	1.39E-01	1.13E-03	64	7.23E-02	1.49E-03	51	7.60E-02	1.20E-03	11	1.32E-02	0.00E+00	8	0.00E+00	3.01E-01	6.62E-04	5	52	7	12	21,840	7.9E+07	3.03E-08	3.82E-09
ethane	74-84-0	5.37E-02	116	6.23E+00	5.03E-02	64	3.22E+00	4.07E-02	51	2.08E+00	0.00E+00	11	0.00E+00	1.05E-01	8	8.40E-01	1.24E+01	2.72E-02	5	52	7	12	21,840	7.9E+07	1.25E-06	1.57E-07
ethanol	64-17-5	2.07E-01	116	2.40E+01	1.23E-01	64	7.87E+00	4.54E-01	51	2.32E+01	2.33E-01	11	2.56E+00	0.00E+00	8	0.00E+00	5.76E+01	1.27E-01	5	52	7	12	21,840	7.9E+07	5.81E-06	7.33E-07
ethylbenzene	100-41-4	4.56E-06	116	5.28E-04	4.32E-06	64	2.76E-04	5.41E-06	51	2.76E-04	4.56E-06	11	5.01E-05	0.00E+00	8	0.00E+00	1.13E-03	2.49E-06	5	52	7	12	21,840	7.9E+07	1.14E-10	1.44E-11
HD	505-60-2	4.35E-06	116	5.05E-04	4.08E-06	64	2.61E-04	5.41E-06	51	2.76E-04	4.35E-06	11	4.79E-05	0.00E+00	8	0.00E+00	1.09E-03	2.40E-06	5	52	7	12	21,840	7.9E+07	1.20E-05	1.52E-06
methane	74-82-8	9.09E+01	116	1.05E+04	8.57E+01	64	5.48E+03	1.89E+02	51	9.64E+03	8.04E+01	11	8.84E+02	1.59E+02	8	1.27E+03	2.78E+04	6.13E+01	5	52	7	12	21,840	7.9E+07	2.81E-03	3.54E-04
methylene chloride	75-09-2	1.06E-06	116	1.23E-04	1.06E-06	64	6.78E-05	1.06E-06	51	5.41E-05	1.06E-06	11	1.17E-05	0.00E+00	8	0.00E+00	2.57E-04	5.65E-07	5	52	7	12	21,840	7.9E+07	2.59E-11	3.26E-12
monoethanolamine	141-43-5	1.52E+01	116	1.76E+03	1.47E+01	64	9.41E+02	1.86E+01	51	9.49E+02	1.51E+01	11	1.66E+02	0.00E+00	8	0.00E+00	3.82E+03	8.41E+00	5	52	7	12	21,840	7.9E+07	3.85E-04	4.86E-05
naphthalene	91-20-3	7.55E-06	116	8.76E-04	7.48E-06	64	4.79E-04	7.82E-06	51	3.99E-04	7.55E-06	11	8.30E-05	0.00E+00	8	0.00E+00	1.84E-03	4.04E-06	5	52	7	12	21,840	7.9E+07	1.85E-10	2.34E-11
nitrobenzene	98-95-3	4.15E-08	116	4.81E-06	3.88E-08	64	2.48E-06	5.13E-08	51	2.62E-06	4.15E-08	11	4.56E-07	0.00E+00	8	0.00E+00	1.04E-05	2.28E-08	5	52	7	12	21,840	7.9E+07	1.05E-12	1.32E-13
phenanthrene	85-01-8	6.33E-08	116	7.34E-06	6.30E-08	64	4.03E-06	6.45E-08	51	3.29E-06	6.33E-08	11	6.96E-07	0.00E+00	8	0.00E+00	1.54E-05	3.38E-08	5	52	7	12	21,840	7.9E+07	1.55E-12	1.95E-13
phenol	108-95-2	2.16E-06	116	2.50E-04	2.15E-06	64	1.38E-04	2.19E-06	51	1.11E-04	2.16E-06	11	2.37E-05	0.00E+00	8	0.00E+00	5.23E-04	1.15E-06	5	52	7	12	21,840	7.9E+07	5.27E-11	6.65E-12
styrene	100-42-5	3.31E-05	116	3.84E-03	3.12E-05	64	2.00E-03	4.08E-05	51	2.08E-03	3.32E-05	11	3.65E-04	0.00E+00	8	0.00E+00	8.28E-03	1.82E-05	5	52	7	12	21,840	7.9E+07	8.35E-10	1.05E-10
tetrachloroethene	127-18-4	8.98E-04	116	1.04E-01	8.47E-04	64	5.42E-02	1.12E-03	51	5.70E-02	9.01E-04	11	9.91E-03	0.00E+00	8	0.00E+00	2.25E-01	4.96E-04	5	52	7	12	21,840	7.9E+07	2.27E-08	2.87E-09
toluene	108-88-3	5.24E-02	116	6.08E+00	3.11E-02	64	1.99E+00	1.15E-01	51	5.87E+00	5.89E-02	11	6.48E-01	0.00E+00	8	0.00E+00	1.46E+01	3.21E-02	5	52	7	12	21,840	7.9E+07	1.47E-06	1.85E-07
trans-1,2-dichloroethene	156-60-5	8.81E-05	116	1.02E-02	8.29E-05	64	5.31E-03	1.09E-04	51	5.56E-03	8.84E-05	11	9.72E-04	0.00E+00	8	0.00E+00	2.21E-02	4.86E-05	5	52	7	12	21,840	7.9E+07	2.22E-09	2.81E-10
trichloroethene	79-01-6	2.17E-04	116	2.52E-02	2.04E-04	64	1.31E-02	2.69E-04	51	1.37E-02	2.18E-04	11	2.40E-03	0.00E+00	8	0.00E+00	5.44E-02	1.20E-04	5	52	7	12	21,840	7.9E+07	5.49E-09	6.92E-10
vinyl chloride	75-01-4	1.04E-02	116	1.21E+00	6.20E-03	64	3.97E-01	2.29E-02	51	1.17E+00	1.17E-02	11	1.29E-01	0.00E+00	8	0.00E+00	2.90E+00	6.39E-03	5	52	7	12	21,840	7.9E+07	2.92E-07	3.69E-08
xylenes	1330-20-7	1.05E-05	116	1.22E-03	1.00E-05	64	6.40E-04	1.26E-05	51	6.42E-04	1.05E-05	11	1.16E-04	0.00E+00	8	0.00E+00	2.62E-03	5.76E-06	5	52	7	12	21,840	7.9E+07	2.64E-10	3.33E-11
aluminum	7429-90-5	5.00E-01	116	5.80E+01	5.44E-01	64	3.48E+01	1.01E+00	51	5.15E+01	3.91E-01	11	4.30E+00	1.24E+00	8	9.92E+00	1.59E+02	3.49E-01	5	52	7	12	21,840	7.9E+07	1.60E-05	2.02E-06
ammonia	7664-41-7	7.21E+00	116	8.36E+02	7.10E+00	64	4.54E+02	3.99E+00	51	2.03E+02	7.59E+00	11	8.35E+01	4.80E+00	8	3.84E+01	1.62E+03	3.56E+00	5	52	7	12	21,840	7.9E+07	1.63E-04	2.06E-05
arsenic	7440-38-2	1.20E-02	116	1.39E+00	1.09E-02	64	6.98E-01	2.51E-02	51	1.28E+00	1.09E-02	11	1.20E-01	1.87E-02	8	1.50E-01	3.64E+00	8.02E-03	5	52	7	12	21,840	7.9E+07	3.67E-07	4.63E-08
cadmium	7440-43-9	6.54E-03	116	7.59E-01	3.89E-03	64	2.49E-01	1.44E-02	51	7.34E-01	7.36E-03	11	8.10E-02	0.00E+00	8	0.00E+00	1.82E+00	4.02E-03	5	52	7	12	21,840	7.9E+07	1.84E-07	2.32E-08
copper	7440-50-8	1.20E-01	116	1.39E+01	1.35E-01	64	8.64E+00	2.42E-01	51	1.23E+01	9.11E-02	11	1.00E+00	3.18E-01	8	2.54E+00	3.84E+01	8.47E-02	5	52	7	12	21,840	7.9E+07	3.88E-06	4.89E-07
hydrogen cyanide	74-90-8	1.16E+00	116	1.35E+02	1.08E+00	64	6.91E+01	8.77E-01	51	4.47E+01	0.00E+00	11	0.00E+00	2.26E+00	8	1.81E+01	2.66E+02	5.87E-01	5	52	7	12	21,840	7.9E+07	2.69E-05	3.39E-06
lead	7439-92-1	4.41E-02	116	5.12E+00	4.78E-02	64	3.06E+00	8.92E-02	51	4.55E+00	3.46E-02	11	3.81E-01	1.08E-01	8	8.64E-01	1.40E+01	3.08E-02	5	52	7	12	21,840	7.9E+07	1.41E-06	1.78E-07
silver	7440-22-4	2.97E-04	116	3.45E-02	1.77E-04	64	1.13E-02	6.51E-04	51	3.32E-02	3.34E-04	11	3.67E-03	0.00E+00	8	0.00E+00	8.27E-02	1.82E-04	5	52	7	12	21,840	7.9E+07	8.34E-09	1.05E-09

Attachment 4 - Table B-5. EDS Uncontrolled Long-term Emission Rate Calculations

Basis and Emission Calculations:

a. Emission rates were by provided by Leidos on a per batch basis (g/batch) for each type of munition campaign.
b. Total emissions from each campaign were calculated as follows.

Pollutant emissions per campaign (g/campaign) = (pollutant emission rate, g/batch) x (batches/campaign)

c. Total emissions for the entire 5-year project were calculated as follows:

Total EDS emissions per 5-yr project (g) = (emissions from leaker campaign, g) + (emissions from 105mm campaign) + (emissions from 155mm campaign, g) + (emissions from 4.2-in campaign) + (emissions from burster campaign)

d. Total average long-term emission rates were calculated based on a 5-year operating period, with a 12 hr/day average operation schedule over the 5-yr duration of the project.

Average Long-term emissions (g/s) = (Total Emissions for the 5-yr project, g) / [(5 yr) x (52 weeks/yr) x (7 day/week) x (12 hr/day) x (60 min/hr) x (60 s/min)]

Average Long-term Emissions (lb/hr) = (Average long-term emission rate, g/s) / (454 g/lb) x (60 s/min) x (60 min/hr)

e. See the HD emission rate calculation sheet for HD-specific calculation methodology.

Emissions Summary:

Name	CAS	Leaker Campaign			105mm Campaign			155mm Campaign			4.2-in Campaign			Burster Campaign			Total 5-yr EDS Emissions		Operating Schedule				Duration of EDS Operations		Modeled (Average) Long-term Emission Rate	
		Maximum Uncontrollled Emission Rate (g/batch)	Batches per campaign	Uncontrolled Emissions (g/campaign)	Maximum Uncontrollled Emission Rate (g/batch)	Batches per campaign	Uncontrolled Emissions (g/campaign)	Maximum Uncontrollled Emission Rate (g/batch)	Batches per campaign	Uncontrolled Emissions (g/campaign)	Maximum Uncontrollled Emission Rate (g/batch)	Batches per campaign	Uncontrolled Emissions (g/campaign)	Maximum Uncontrollled Emission Rate (g/batch)	Batches per campaign	Uncontrolled Emissions (g/campaign)	g	lb	yr	week/yr	day/week	hr/day	hr	s	lb/hr	g/s
1,1-dichloroethene	75-35-4	6.36E-05	116	7.38E-03	5.98E-05	64	3.83E-03	7.89E-05	51	4.02E-03	6.38E-05	11	7.02E-04	0.00E+00	8	0.00E+00	1.59E-02	3.51E-05	5	52	7	12	21,840	7.9E+07	1.61E-09	2.03E-10
1,2,4-trichlorobenzene	120-82-1	1.10E-07	116	1.28E-05	1.04E-07	64	6.66E-06	1.37E-07	51	6.99E-06	1.11E-07	11	1.22E-06	0.00E+00	8	0.00E+00	2.76E-05	6.08E-08	5	52	7	12	21,840	7.9E+07	2.79E-12	3.51E-13
1,2-dichlorobenzene	95-50-1	6.25E-07	116	7.25E-05	5.88E-07	64	3.76E-05	7.77E-07	51	3.96E-05	6.27E-07	11	6.90E-06	0.00E+00	8	0.00E+00	1.57E-04	3.45E-07	5	52	7	12	21,840	7.9E+07	1.58E-11	1.99E-12
1,2-dichloroethane	107-06-2	9.43E-05	116	1.09E-02	8.88E-05	64	5.68E-03	1.17E-04	51	5.97E-03	9.47E-05	11	1.04E-03	0.00E+00	8	0.00E+00	2.36E-02	5.21E-05	5	52	7	12	21,840	7.9E+07	2.38E-09	3.01E-10
1,3-dichlorobenzene	541-73-1	5.58E-07	116	6.47E-05	5.25E-07	64	3.36E-05	6.93E-07	51	3.53E-05	5.60E-07	11	6.16E-06	0.00E+00	8	0.00E+00	1.40E-04	3.08E-07	5	52	7	12	21,840	7.9E+07	1.41E-11	1.78E-12
1,4-dichlorobenzene	106-46-7	6.22E-07	116	7.22E-05	5.85E-07	64	3.74E-05	7.73E-07	51	3.94E-05	6.24E-07	11	6.86E-06	0.00E+00	8	0.00E+00	1.56E-04	3.43E-07	5	52	7	12	21,840	7.9E+07	1.57E-11	1.98E-12
1,4-dithiane	505-29-3	1.00E-03	116	1.16E-01	9.44E-04	64	6.04E-02	1.25E-03	51	6.38E-02	1.01E-03	11	1.11E-02	0.00E+00	8	0.00E+00	2.51E-01	5.53E-04	5	52	7	12	21,840	7.9E+07	2.53E-08	3.20E-09
1,4-oxathiane	15980-15-1	1.04E-02	116	1.21E+00	9.75E-03	64	6.24E-01	1.29E-02	51	6.58E-01	1.04E-02	11	1.14E-01	0.00E+00	8	0.00E+00	2.60E+00	5.73E-03	5	52	7	12	21,840	7.9E+07	2.62E-07	3.31E-08
2,4-dichlorophenol	120-83-2	3.93E-08	116	4.56E-06	3.69E-08	64	2.36E-06	4.88E-08	51	2.49E-06	3.94E-08	11	4.33E-07	0.00E+00	8	0.00E+00	9.84E-06	2.17E-08	5	52	7	12	21,840	7.9E+07	9.93E-13	1.25E-13
2-butanone	78-93-3	4.18E-04	116	4.85E-02	3.96E-04	64	2.53E-02	5.08E-04	51	2.59E-02	4.20E-04	11	4.62E-03	0.00E+00	8	0.00E+00	1.04E-01	2.30E-04	5	52	7	12	21,840	7.9E+07	1.05E-08	1.33E-09
2-methyl phenol	95-48-7	3.05E-06	116	3.54E-04	3.05E-06	64	1.95E-04	3.08E-06	51	1.57E-04	3.05E-06	11	3.36E-05	0.00E+00	8	0.00E+00	7.40E-04	1.63E-06	5	52	7	12	21,840	7.9E+07	7.46E-11	9.41E-12
2-methylnaphthalene	91-57-6	6.84E-07	116	7.93E-05	6.81E-07	64	4.36E-05	6.97E-07	51	3.55E-05	6.84E-07	11	7.52E-06	0.00E+00	8	0.00E+00	1.66E-04	3.66E-07	5	52	7	12	21,840	7.9E+07	1.67E-11	2.11E-12
3-methyl phenol	108-39-4	4.67E-07	116	5.41E-05	4.65E-07	64	2.98E-05	4.73E-07	51	2.41E-05	4.67E-07	11	5.13E-06	0.00E+00	8	0.00E+00	1.13E-04	2.49E-07	5	52	7	12	21,840	7.9E+07	1.14E-11	1.44E-12
4-methyl phenol	106-44-5	4.67E-07	116	5.41E-05	4.65E-07	64	2.98E-05	4.73E-07	51	2.41E-05	4.67E-07	11	5.13E-06	0.00E+00	8	0.00E+00	1.13E-04	2.49E-07	5	52	7	12	21,840	7.9E+07	1.14E-11	1.44E-12
acenaphthylene	208-96-8	1.75E-07	116	2.03E-05	1.65E-07	64	1.06E-05	2.13E-07	51	1.09E-05	1.75E-07	11	1.93E-06	0.00E+00	8	0.00E+00	4.36E-05	9.61E-08	5	52	7	12	21,840	7.9E+07	4.40E-12	5.55E-13
acetone	67-64-1	1.32E-01	116	1.53E+01	7.87E-02	64	5.04E+00	2.91E-01	51	1.48E+01	1.49E-01	11	1.64E+00	0.00E+00	8	0.00E+00	3.68E+01	8.11E-02	5	52	7	12	21,840	7.9E+07	3.71E-06	4.68E-07
acetylene	74-86-2	4.85E+00	116	5.63E+02	4.54E+00	64	2.91E+02	3.67E+00	51	1.87E+02	0.00E+00	11	0.00E+00	9.45E+00	8	7.56E+01	1.12E+03	2.46E+00	5	52	7	12	21,840	7.9E+07	1.13E-04	1.42E-05
benzene	71-43-2	8.14E-03	116	9.44E-01	7.72E-03	64	4.94E-01	9.89E-03	51	5.04E-01	8.17E-03	11	8.99E-02	0.00E+00	8	0.00E+00	2.03E+00	4.48E-03	5	52	7	12	21,840	7.9E+07	2.05E-07	2.59E-08
bis(2-chloroisopropyl) ether	39638-32-9	2.27E-07	116	2.63E-05	2.13E-07	64	1.36E-05	2.82E-07	51	1.44E-05	2.28E-07	11	2.51E-06	0.00E+00	8	0.00E+00	5.69E-05	1.25E-07	5	52	7	12	21,840	7.9E+07	5.73E-12	7.23E-13
carbon disulfide	75-15-0	6.37E-02	116	7.39E+00	3.79E-02	64	2.43E+00	1.40E-01	51	7.14E+00	7.17E-02	11	7.89E-01	0.00E+00	8	0.00E+00	1.77E+01	3.91E-02	5	52	7	12	21,840	7.9E+07	1.79E-06	2.26E-07
chlorobenzene	108-90-7	1.03E-05	116	1.19E-03	9.73E-06	64	6.23E-04	1.28E-05	51	6.53E-04	1.04E-05	11	1.14E-04	0.00E+00	8	0.00E+00	2.58E-03	5.69E-06	5	52	7	12	21,840	7.9E+07	2.61E-10	3.29E-11
chloroform	67-66-3	7.20E-04	116	8.35E-02	6.77E-04	64	4.33E-02	8.93E-04	51	4.55E-02	7.22E-04	11	7.94E-03	0.00E+00	8	0.00E+00	1.80E-01	3.97E-04	5	52	7	12	21,840	7.9E+07	1.82E-08	2.29E-09
cis-1,2-dichloroethene	156-59-2	2.06E-04	116	2.39E-02	1.94E-04	64	1.24E-02	2.55E-04	51	1.30E-02	2.06E-04	11	2.27E-03	0.00E+00	8	0.00E+00	5.16E-02	1.14E-04	5	52	7	12	21,840	7.9E+07	5.20E-09	6.56E-10
dichlorodifluoromethane	75-71-8	1.20E-03	116	1.39E-01	1.13E-03	64	7.23E-02	1.49E-03	51	7.60E-02	1.20E-03	11	1.32E-02	0.00E+00	8	0.00E+00	3.01E-01	6.62E-04	5	52	7	12	21,840	7.9E+07	3.03E-08	3.82E-09
ethane	74-84-0	5.37E-02	116	6.23E+00	5.03E-02	64	3.22E+00	4.07E-02	51	2.08E+00	0.00E+00	11	0.00E+00	1.05E-01	8	8.40E-01	1.24E+01	2.72E-02	5	52	7	12	21,840	7.9E+07	1.25E-06	1.57E-07
ethanol	64-17-5	2.07E-01	116	2.40E+01	1.23E-01	64	7.87E+00	4.54E-01	51	2.32E+01	2.33E-01	11	2.56E+00	0.00E+00	8	0.00E+00	5.76E+01	1.27E-01	5	52	7	12	21,840	7.9E+07	5.81E-06	7.33E-07
ethylbenzene	100-41-4	1.34E-05	116	1.55E-03	1.27E-05	64	8.13E-04	1.59E-05	51	8.11E-04	1.34E-05	11	1.47E-04	0.00E+00	8	0.00E+00	3.33E-03	7.32E-06	5	52	7	12	21,840	7.9E+07	3.35E-10	4.23E-11
HD	505-60-2	1.28E-05	116	1.48E-03	1.20E-05	64	7.68E-04	1.59E-05	51	8.11E-04	1.28E-05	11	1.41E-04	0.00E+00	8	0.00E+00	3.20E-03	7.06E-06	5	52	7	12	21,840	7.9E+07	1.20E-05	1.52E-06
methane	74-82-8	9.09E+01	116	1.05E+04	8.57E+01	64	5.48E+03	1.89E+02	51	9.64E+03	8.04E+01	11	8.84E+02	1.59E+02	8	1.27E+03	2.78E+04	6.13E+01	5	52	7	12	21,840	7.9E+07	2.81E-03	3.54E-04
methylene chloride	75-09-2	1.06E-06	116	1.23E-04	1.06E-06	64	6.78E-05	1.06E-06	51	5.41E-05	1.06E-06	11	1.17E-05	0.00E+00	8	0.00E+00	2.57E-04	5.65E-07	5	52	7	12	21,840	7.9E+07	2.59E-11	3.26E-12
monoethanolamine	141-43-5	1.52E+01	116	1.76E+03	1.47E+01	64	9.41E+02	1.86E+01	51	9.49E+02	1.51E+01	11	1.66E+02	0.00E+00	8	0.00E+00	3.82E+03	8.41E+00	5	52	7	12	21,840	7.9E+07	3.85E-04	4.86E-05
naphthalene	91-20-3	2.22E-05	116	2.58E-03	2.20E-05	64	1.41E-03	2.30E-05	51	1.17E-03	2.22E-05	11	2.44E-04	0.00E+00	8	0.00E+00	5.40E-03	1.19E-05	5	52	7	12	21,840	7.9E+07	5.45E-10	6.87E-11
nitrobenzene	98-95-3	1.22E-07	116	1.42E-05	1.14E-07	64	7.30E-06	1.51E-07	51	7.70E-06	1.22E-07	11	1.34E-06	0.00E+00	8	0.00E+00	3.05E-05	6.72E-08	5	52	7	12	21,840	7.9E+07	3.08E-12	3.88E-13
phenanthrene	85-01-8	6.33E-08	116	7.34E-06	6.30E-08	64	4.03E-06	6.45E-08	51	3.29E-06	6.33E-08	11	6.96E-07	0.00E+00	8	0.00E+00	1.54E-05	3.38E-08	5	52	7	12	21,840	7.9E+07	1.55E-12	1.95E-13
phenol	108-95-2	6.34E-06	116	7.35E-04	6.32E-06	64	4.04E-04	6.43E-06	51	3.28E-04	6.34E-06	11	6.97E-05	0.00E+00	8	0.00E+00	1.54E-03	3.39E-06	5	52	7	12	21,840	7.9E+07	1.55E-10	1.96E-11
styrene	100-42-5	9.74E-05	116	1.13E-02	9.17E-05	64	5.87E-03	1.20E-04	51	6.12E-03	9.77E-05	11	1.07E-03	0.00E+00	8	0.00E+00	2.44E-02	5.37E-05	5	52	7	12	21,840	7.9E+07	2.46E-09	3.10E-10
tetrachloroethene	127-18-4	2.64E-03	116	3.06E-01	2.49E-03	64	1.59E-01	3.29E-03	51	1.68E-01	2.65E-03	11	2.92E-02	0.00E+00	8	0.00E+00	6.63E-01	1.46E-03	5	52	7	12	21,840	7.9E+07	6.68E-08	8.43E-09
toluene	108-88-3	1.54E-01	116	1.79E+01	9.15E-02	64	5.85E+00	3.38E-01	51	1.73E+01	1.73E-01	11	1.91E+00	0.00E+00	8	0.00E+00	4.29E+01	9.45E-02	5	52	7	12	21,840	7.9E+07	4.33E-06	5.45E-07
trans-1,2-dichloroethene	156-60-5	8.81E-05	116	1.02E-02	8.29E-05	64	5.31E-03	1.09E-04	51	5.56E-03	8.84E-05	11	9.72E-04	0.00E+00	8	0.00E+00	2.21E-02	4.86E-05	5	52	7	12	21,840	7.9E+07	2.22E-09	2.81E-10
trichloroethene	79-01-6	3.24E-04	116	3.76E-02	3.05E-04	64	1.95E-02	4.02E-04	51	2.05E-02	3.25E-04	11	3.58E-03	0.00E+00	8	0.00E+00	8.12E-02	1.79E-04	5	52	7	12	21,840	7.9E+07	8.19E-09	1.03E-09
vinyl chloride	75-01-4	1.04E-02	116	1.21E+00	6.20E-03	64	3.97E-01	2.29E-02	51	1.17E+00	1.17E-02	11	1.29E-01	0.00E+00	8	0.00E+00	2.90E+00	6.39E-03	5	52	7	12	21,840	7.9E+07	2.92E-07	3.69E-08
xylenes	1330-20-7	3.09E-05	116	3.58E-03	2.94E-05	64	1.88E-03	3.70E-05	51	1.89E-03	3.10E-05	11	3.41E-04	0.00E+00	8	0.00E+00	7.69E-03	1.69E-05	5	52	7	12	21,840	7.9E+07	7.76E-10	9.79E-11
aluminum	7429-90-5	5.00E-01	116	5.80E+01	5.44E-01	64	3.48E+01	1.01E+00	51	5.15E+01	3.91E-01	11	4.30E+00	1.24E+00	8	9.92E+00	1.59E+02	3.49E-01	5	52	7	12	21,840	7.9E+07	1.60E-05	2.02E-06
ammonia	7664-41-7	7.21E+00	116	8.36E+02	7.10E+00	64	4.54E+02	3.99E+00	51	2.03E+02	7.59E+00	11	8.35E+01	4.80E+00	8	3.84E+01	1.62E+03	3.56E+00	5	52	7	12	21,840	7.9E+07	1.63E-04	2.06E-05
arsenic	7440-38-2	1.20E-02	116	1.39E+00	1.09E-02	64	6.98E-01	2.51E-02	51	1.28E+00	1.09E-02	11	1.20E-01	1.87E-02	8	1.50E-01	3.64E+00	8.02E-03	5	52	7	12	21,840	7.9E+07	3.67E-07	4.63E-08
cadmium	7440-43-9	6.54E-03	116	7.59E-01	3.89E-03	64	2.49E-01	1.44E-02	51	7.34E-01	7.36E-03	11	8.10E-02	0.00E+00	8	0.00E+00	1.82E+00	4.02E-03	5	52	7	12	21,840	7.9E+07	1.84E-07	2.32E-08
copper	7440-50-8	1.20E-01	116	1.39E+01	1.35E-01	64	8.64E+00	2.42E-01	51	1.23E+01	9.11E-02	11	1.00E+00	3.18E-01	8	2.54E+00	3.84E+01	8.47E-02	5	52	7	12	21,840	7.9E+07	3.88E-06	4.89E-07
hydrogen cyanide	74-90-8	1.16E+00	116	1.35E+02	1.08E+00	64	6.91E+01	8.77E-01	51	4.47E+01	0.00E+00	11	0.00E+00	2.26E+00	8	1.81E+01	2.66E+02	5.87E-01	5	52	7	12	21,840	7.9E+07	2.69E-05	3.39E-06
lead	7439-92-1	4.41E-02	116	5.12E+00	4.78E-02	64	3.06E+00	8.92E-02	51	4.55E+00	3.46E-02	11	3.81E-01	1.08E-01	8	8.64E-01	1.40E+01	3.08E-02	5	52	7	12	21,840	7.9E+07	1.41E-06	1.78E-07
silver	7440-22-4	2.97E-04	116	3.45E-02	1.77E-04	64	1.13E-02	6.51E-04	51	3.32E-02	3.34E-04	11	3.67E-03	0.00E+00	8	0.00E+00	8.27E-02	1.82E-04	5	52	7	12	21,840	7.9E+07	8.34E-09	1.05E-09

Attachment 4 - Table B-6. HD Emission Rate Calculations

Basis:

a. The maximum potential emission rate of agent (HD) emitted from each EDS enclosure stack is 0.7 times the Vapor Screening Level (VSL) when the system is in operation. The actual emission rate will be less than 0.7 times the VSL.

VSL	0.003	mg/m^3
	3.0E-06	g/m^3
0.7 VSL	2.1E-06	g/m^3

b. Each EDS unit has its own environmental enclosure. Gases from the environmental enclosure and EDS waste transfer system are vented together through a pair of final air filtration systems and stacks.

c. Potential HD emissions are based on the short-term emission rates and the campaign schedule.

HD from Leaker campaign (lb) = (1.1E-5 g HD/s) x (3,600 s/hr) / (454 g/lb) x (12 hr/day) x (1 day/batch) x (116 batches)
= 1.2E-01

HD from 155mm campaign (lb) = (1.1E-5 g HD/s) x (3,600 s/hr) / (454 g/lb) x (12 hr/day) x (1 day/batch) x (51 batches)
= 5.4E-02

HD from 105mm campaign (lb) = (1.1E-5 g HD/s) x (3,600 s/hr) / (454 g/lb) x (12 hr/day) x (1 day/batch) x (64 batches)
= 6.7E-02

HD from 4.2-inch campaign (lb) = (1.1E-5 g HD/s) x (3,600 s/hr) / (454 g/lb) x (12 hr/day) x (1 day/batch) x (11 batches)
= 1.2E-02

HD from Bursters campaign (lb) = (1.1E-5 g HD/s) x (3,600 s/hr) / (454 g/lb) x (12 hr/day) x (1 day/batch) x (8 batches)
= 8.4E-03

Total Potential HD emissions per 5-yr project (lb) = 2.6E-01

d. The long-term average modeling period is as follows:

Modeling Period			
yr	**week/yr**	**day/week**	**hr/day**
5	52	7	12

Emission Calculations:

Short-term

Flow Rate (m^3/s) = (flow rate, ft^3/min) x (1 min/60 s) x (1 m^3/35.3145 ft^3)

Emission Rate (g/s) = (flow rate, m^3/s) x (0.7 x VSL, g/m^3)
= (flow rate, m^3/s) x (0.7 x 3.0 E-06 g/m^3)
= (flow rate, m^3/s) x (2.1 E-06 g/m^3)

Short-term Emissions Summary:

EDS	Flow Rate		Emission Rate	Total ST Emission Rate	
	ft^3/min	**m^3/s**	**g/s**	**g/s**	**lb/hr**
EDS-1A	5,631	2.66	5.6E-06	1.1E-05	8.7E-05
EDS-1B	5,501	2.60	5.5E-06		

Long-term

Average Long-term Emissions (lb/hr) = (Total HD emissions per 5-yr project, lb) / (EDS average long-term operating schedule, hr/5-yr project)
= (Total HD emissions per 5-yr project, lb) / (12 hr/day x 7 day/week x 52 week/yr x 5 yr)
= 1.20E-05

Average Long-term emissions (g/s) = (Average Long-term Emissions, lb/hr) / (3,600 s/hr) x (454 g/lb)
= 1.52E-06

Long-term Emissions Summary:

EDS	Total Average LT Emission Rate	
	g/s	**lb/hr**
EDS-1	1.5E-06	1.2E-05