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ADDENDUM
TO
MULTIPATHWAY HUMAN HEALTH
RISK ASSESSMENT REPORT
FOR
EXPLOSIVE DESTRUCTION TECHNOLOGY (EDT) ALTERNATIVES
AT
BLUE GRASS CHEMICAL AGENT-DESTRUCTION PILOT PLANT

[REVISED EDS MODELING]

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APPENDICES

Appendix 1 Risk Assessment Calculations – EDS Technology

DEFINITIONS

AERMAP – AERMOD's terrain preprocessor
AERMOD – American Meteorological Society/Environmental Protection Agency Regulatory Model
AMS – American Meteorological Society
BGAD – Blue Grass Army Depot
BGCAPP – Blue Grass Chemical Agent Destruction Pilot Plant
COPC – Constituent of Potential Concern
CSF – Cancer Slope Factor
DAVINCH – Detonation of Ammunition in a Vacuum Integrated Chamber
EA – Environmental Assessment
EDS – Explosive Destruction System
EDT – Explosive Destruction Technology
EPA – Environmental Protection Agency
Final HHRAP – 2005 Human Health Risk Assessment Protocol Guidance for Hazardous Waste Combustion Facilities
HI – Hazard Index
HIA – Acute Hazard Index
HQ – Hazard Quotient
HQA – Acute Hazard Quotient
IRIS – Integrated Risk Information System
ISCST3 – Industrial Source Complex Short Term, Ver. 3 Air Model
MPHHRA – Multi-Pathway Human Health Risk Assessment
NAD27 – North American Datum 1927
OEHHA – California EPA - Office of Environmental Health Hazard Assessment
OSWER – Office of Solid Waste and Emergency Response
RfC – Reference Concentration
RfD – Reference Dose toxicity value
RSL – USEPA Risk Screening Level
SDC – Static Detonation Chamber
SDC1 – SDC process stack source
SDC2 – SDC building vent source
SPB – Supercritical Water Oxidation Processing Building
TDC – Transportable Detonation Chamber
TEEL-1 – United States Department of Energy Temporary Emergency Exposure Limits.
UTM – Universal Transverse Mercator

1.0 INTRODUCTION AND EXECUTIVE SUMMARY

In January 2013, a screening-level Multi-Pathway Human Health Risk Assessment (MPHHRA) was performed to estimate the potential impacts of the limited duration operation of an Explosive Destruction Technology (EDT) facility designed to destroy chemical munitions stored at Blue Grass Army Depot (BGAD) Kentucky to human health. The MPHHRA generally followed the U.S. EPA guidance document, Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Final (September 2005) and EPA's Guideline on Air Quality Models (40 CFR, Part 51, Appendix W). Four alternatives were evaluated for destruction of a portion of the stockpile at the Blue Grass Chemical Agent Destruction Pilot Plant (BGCAPP). Each of the four different EDT options was considered independently in the MPHHRA.

The MPHHRA results were previously provided to document the comparison of threshold toxicological factors to estimated emissions for the four treatment technologies being evaluated. The results were included in an Environmental Assessment being developed by Oak Ridge National Laboratory (ORNL). This Addendum addresses one of the technologies, the Explosive Destruction System (EDS). Changes were made to the operating schedule, location, and number of units for this technology after the MPHHRA was published. This Addendum documents the nature of those changes and the overall impact of the changes on the risk assessment results. The results of the procedures and calculations presented in this Addendum will also become part of the EA.

No changes were made in this Addendum to any assumptions, calculations, or conclusions related to the other three EDT Technologies. The methodologies employed to perform risk and hazard calculations were identical to those discussed in the MPHHRA unless specifically called out in this Addendum.

- Emission rates of all compounds estimated to be emitted by the EDS were identical to those used in the MPHHRA,
- All compounds specified as potential emissions from the EDS in the MPHHRA were identical to those specified in this Addendum,
- Receptors placed on nearby water bodies were unchanged in this Addendum,

Changes made to the protocol for assessment of risk for the EDS technology include:

- The site evaluated for construction of the EDS facility is of the site specified by the other three technologies.

- Seven EDS units were utilized for the evaluation in this Addendum, rather than fourteen, as specified by the MPHHRA. However, the total hours of operation for the EDS facility as a whole are unchanged. The seven units are designated for 24 hours/7 day per week operation, as opposed to fourteen units operated at 12 hours/7 days per week.

The results of the evaluation performed as part of this Addendum are summarized in Table 1-1 and demonstrate that emissions from the EDS alternative meet acceptable risk and hazard thresholds. A summary of the EDS results, compared to the other technology alternatives in the MPHHRA as follows:

- A total of 77 COPCs (Constituents of Potential Concern) were identified by the four EDT vendors, published literature, or engineering calculations. Of the 77 COPCs, 26 have carcinogenic toxicity factors, 66 have chronic non-carcinogenic toxicity factors, and 71 have acute toxicity factors.
- The maximum lifetime cancer risk to any human receptor presented by the worst-case EDT option is 4.0 E-08, which is less than 1 % of the acceptable risk level of 1 in 100,000 (i.e., 1.0 E-05). When added to the risk calculated in 2010 for BGCAPP operations, the maximum lifetime cancer risk is only 2 % of the acceptable risk level. Emissions from the TDC alternative result in this lifetime cancer risk for the adult farmer.
- For non-carcinogenic effects, the maximum combined Hazard Index (HI) to any human receptor presented by the worst-case EDT option is 0.00l3, which is less than 1 % of the acceptable level of 0.25. When added to the HI calculated in 2010 for BGCAPP operations, the maximum lifetime HI is 0.0137, only 5 % of the acceptable risk level. This worst-case HI is based on the TDC alternative result for the farmer child exposure scenario.
- The total acute HI (i.e., the hazards associated with short-term emission release events for each COPC that has both a quantified short-term emission rate and an available acute toxicity value) presented by the worst-case EDT option is the TDC alternative, which is less than 1 % of the acceptable level of 0.25. When combined with the BGCAPP acute HI, the worst-case option is about 10 % of the acceptable level.

In summary, the revisions to the EDS alternative have not resulted in risk or hazard greater than acceptable limits. Additionally, the results presented in this addendum related to revised modeling for the EDS alternative do not represent the worst-case EDT option when compared to the previous results from the other three technology options.

Table 1-1
Summary Results of Multi-Pathway Human Health Risk Assessment Including Revised EDS Modeling

Hazard and Risk Characterization from EDT Facility Only									
Exposure Scenario	**Scenario Location**	**Total Cancer Risk (Benchmark = 1E-05)**				**Total Hazard Index (Benchmark = 0.25)**			
		Davinch	EDS	TDC	SDC	Davinch	EDS	TDC	SDC
Adult Resident	Rmax	2.01E-08	5.00E-10	2.42E-08	4.65E-10	0.000681	0.0000139	0.00120	0.000011
Child Resident	Rmax	4.16E-09	1.01E-10	4.89E-09	9.35E-11	0.000710	0.0000141	0.00121	0.000011
Fisher	Rmax	2.01E-08	5.01E-10	2.42E-08	4.65E-10	0.000681	0.0000139	0.00120	0.000011
Fisher Child	Rmax	4.16E-09	1.01E-10	4.89E-09	9.36E-11	0.000710	0.0000141	0.00121	0.000011
Farmer	Fmax	**3.26E-08**	**6.67E-10**	**4.03E-08**	**1.38E-09**	0.000868	0.0000139	0.00125	0.000016
Farmer Child	Fmax	5.43E-09	1.01E-10	6.60E-09	2.57E-10	**0.000985**	**0.0000141**	**0.00129**	**0.000018**
Acute Exposure	Amax	--	--	--	--	0.000246	0.0000124	**0.00083**	0.000395
Worst-Case Hazard and Risk Characterization from EDT Facility and BGCAPP Facility									
Farmer	Fmax	2.13E-07	1.80E-07	**2.20E-07**	1.81E-07				
Farmer Child	Fmax					0.013385	0.0124141	**0.01369**	0.012418
Acute Exposure	Amax	--	--	--	--	0.025846	0.0256124	**0.02643**	0.025995

Notes:

[a] US EPA Region 6 recommends that a hazard index benchmark of 0.25 be utilized to account for COPCs in areas with industrial activity. Although significant industrial activities do not exist near BGCAPP, this very conservative benchmark was used for comparison to emissions to ensure risks were not underestimated.

[b] The acute risk assessment scenario evaluates short-term 1-hour maximum air concentrations based on hourly emission rates. Inhalation is the route of exposure.

2.0 REVISED FACILITY DESCRIPTION

The Blue Grass Army Depot (BGAD) is described in the MPHHRA and that information is unchanged. No changes related to the overall site are presented in this addendum.

2.1 EDT Alternatives

Four EDTs are considered for this MPHHRA:

1. Dynasafe's Static Detonation Chamber (SDC),
2. CH2M Hill's Transportable Detonation Chamber (TDC),
3. Kobe Steel's Detonation of Ammunition in a Vacuum Integrated Chamber (DAVINCH), and
4. US Army's Explosive Destruction System (EDS).

Only changes to the location and configuration of the EDS alternative are described in this addendum. The EDS uses explosive charges to access chemical munitions, eliminating their explosive capacity before the chemical agent is neutralized. The system's main component, a sealed, stainless steel vessel, contains all the blast, vapor, and fragments from the process. Agent treatment is confirmed by sampling residual liquid and air from the vessel prior to reopening the EDS.

2.2 EDT OPERATIONS

2.2.1 Feed Material Assumptions

Table 2-1 presents the quantity of feed materials and anticipated processing schedule by the EDT alternatives.

2.2.2 Duration of EDS Operations

The EDS specification provides for operation 24 hours per day, 7 days per week during a period of operation. Based on this schedule, seven EDS units are required.

2.3 EDS Location

The revised EDS location is north of the SPB Tank Farm at the BGCAPP facility. The EDS site location within the BGAD facility is described more fully in Section 3.2 of this report.

Table 2-1
BGCAPP EDT Processing Rates

EDT Technology	Leakers				
	Demand Rate (munitions/hr)	Availability Factor	Effective Processing Rate		
			munitions/hr	munitions/day	munitions/week
SDC2000			0.29	7.0	49.1
TDC60			0.55	13.1	92.0
DV60			0.73	17.5	122.6
EDS			0.085	1.70	10.2

EDT Technology	Rejects				
	Demand Rate (munitions/hr)	Availability Factor	Effective Processing Rate		
			munitions/hr	munitions/day	munitions/week
SDC2000			3.80	91.1	637.7
TDC60			1.24	29.8	208.5
DV60			1.46	35.0	245.3
EDS			0.51	10.2	61.2

EDT Technology	Quantity of Leakers in the campaign	Quantity of Rejects in the campaign	Effective Weekly Processing Rate Per Unit		Weeks Required to Process with One Unit	Weeks Available	Number of Units Required	Weeks Required to Process with Multiple Units	Uncommitted Machine Weeks Available
			Leakers	Rejects					
SDC2000									
TDC60									
DV60									
EDS									

2.4 EDT Emission Sources

The four EDT Alternatives each result in emissions of different COPCs with different emission rates, which were identified and discussed in the MPHHRA. The characteristics of the emissions sources, including the revised values for the EDS alternative are summarized in Table 2-2.

A list of possible COPCs was developed by ERM Consulting & Engineering based on vendor information regarding potential EDT emissions and evaluation of munitions intended for destruction.

The COPCs were evaluated separately for each technology and are shown by technology in the MPHHRA. No changes to the values presented in the MPHHRA are needed based on the revisions to the plan for the EDS alternative.

2.5 Estimated Emission Rates

Estimated emission rates were also developed by ERM Consulting & Engineering based on vendor information regarding potential EDT emissions and evaluation of munitions intended for destruction of HAPs. No changes to the emission rates have been made related to the revised plan for the EDS alternative.

Table 2-2
Source Characteristics Required for Air Modeling

Source Characteristics		SDC 1 Process Stack	SDC 2 Enclosure Stack	TDC Stack 2 Units	DAVINCH Stack 2 Units	EDS Stack 7 Units
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Base Elevation	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Height	m	15.24	4.9	15.24	15.24	15.24
	ft	50	16	50	50	50
Diameter	m	0.3	0.91	0.85	0.76	1.62
	ft	1.0	3.0	2.8	2.5	5.30
Temperature+	K	324	amb*	amb.+5.5*	amb*	300
	°F	124	amb*	amb.+10*	amb*	81
Velocity+	m/s	5.08	11.5	18.2	32.8	9.7
	ft/s	16.7	37.7	59.7	108	31.7
Emission Rate	g/s	1	1	1	1	1
	lb/hr	7.92	7.92	7.92	7.92	7.92
Mean Particle Size+	Microns	0.3	0.3	0.3	0.3	0.3
Mass Fraction#	(dimensionless)	1	1	1	1	1
Particle Density	g/cm^3	1	1	1	1	1

+ Source characteristics provided by MPHRA Report from Pueblo Army Depot.
** AERMOD feature that allows seasonal variation in temperature utilized for modeling.*
 # Mass Fraction of particles in the fine mode = 100%.

3.0 AIR DISPERSION AND DEPOSITION MODELING

Methodologies and models utilized for this project are as described in detail in the MPHHRA and are in accordance with common practice and regulatory guidance. Although air dispersion modeling was performed to recharacterize risk and hazard estimates for the revised EDS, no changes were made to the methodologies used.

3.1 Model Description

The AMS/EPA Regulatory Model, AERMOD (version 12060), is used for this analysis since it is the preferred model listed in EPA's "Guideline on Air Quality Models". This air model replaced the previous US EPA preferred model, ISCST3.

3.2 Emission Source Characterization

The construction site for the proposed Blue Grass Chemical Agent-Destruction Pilot Plant (BGCAPP) is located within the Blue Grass Army Depot in Richmond, Kentucky and is shown on Figure 3-1. Figure 3-2 presents the general arrangement of the BGCAPP building and equipment in the vicinity of the proposed EDT site. Since the location of the EDS facility was revised, no buildings are located at a distance that impacts downwash from the stack.

3.2.1 Stack Coordinates and Base Elevation

Reference points for emission sources from the facility plot plan were determined using USGS 7.5 minute quadrant maps. The Kentucky State Plane – South Zone grid utilized for facility mapping was converted to Universal Transverse Mercator (UTM), North American Datum 1927 (NAD27) using the program Google Earth – Earth Point Program. Table 2-2 in the previous section presents the coordinates for all evaluated emission sources and other emissions source characteristics used as inputs to AERMOD.

3.2.2 Stack Height and Building Wake Effects

The EDS alternative technology emissions are modeled as if all flow is emitted from a single source.

The EDS stack has an assumed stack height of 50 ft, per Bechtel Parsons specifications and is unchanged from previous MPHHRA modeling. Since no buildings are located in the vicinity of the EDS stack, building wake effects are not anticipated to influence the dispersion of stack gas.

3.2.3 Stack Gas Temperature, Flowrate and Velocity

The stack gas temperature and velocities are design parameters obtained from the 2012 PCAPP MPHRA Report. Stack diameter for the EDS unit was calculated using the assumed stack height and vendor supplied stack velocity. Since the number of stacks was modified from 14 to 7, some stack characteristics for the single EDS stack changed accordingly and are shown in Table 2-2.

3.2.4 Modeled Emission Rate and Particle-Size Distribution

AERMOD air modeling was performed based on a unit emission rate of 1.0 g/s, instead of compound-specific emission rates in an identical manner to that which was reported for the MPHHRA. The particle density of 1 g/cm^3 that was assumed for the sources and recommended in HHRAP was also used in this addendum.

3.3 Urban/Rural

As in the MPHHRA report, dispersion coefficients are set to rural.

3.4 Deposition Parameters

Deposition parameters for this addendum are unchanged from the MPHHRA.

3.5 Meteorological Data

No changes related to meteorological data were made from the MPHHRA for this addendum.

3.6 Receptor Grid and Terrain

The receptor grid for this project was designed according to HHRAP guidance. The grid includes 100-meter spacing out to three kilometers from the facility centroid and 500-meter spacing out to 10 kilometers. Figure 3-4 indicates the entire grid developed, including the 100-meter dense receptor spacing and the 500-meter receptor spacing that extends to 10 kilometers from the centroid of the designated sources, excluding most on-site receptors. On-site receptors are shown at 100-meter spaces over the surface of Lake Vega, which was modeled for water-based exposure scenarios.

Terrain elevations were included in the modeling analysis for completeness. AERMAP (version 11103) is used to calculate the receptor elevations from 7.5-minute DEM data files. AERMAP also calculates the critical hill height for each receptor location.

3.7 Chemical-Specific Parameters

No changes related to chemical-specific parameters were made from the MPHHRA for this addendum.

3.8 Modeling Results

The unitized modeling results presented in this section include concentration, dry deposition, wet deposition and total deposition for short-term (1-hour) and long-term (annual) exposures. There are a total of 87 model runs. Most modeled maximums occurred north of the facility, except for the SDC2 stack, which had most modeled maximums occurring at the Lake Vega water receptors on-site. The modeling run types and counts are summarized in Table 3-1.

Results of dispersion modeling runs for particle and particle bound phase modeling are summarized in Table 3-2. Tables 3-6 through 3-9 provide summary results for modeling runs for vapor phase modeling. Results provided include concentration maxima, as well as total, dry and wet deposition maxima.

Table 3-1
Modeling Run Types and Counts

Source	Phase Type	Model Run Count
EDS	Vapor	10
	Particle/Particle-Bound	1

Table 3-2
Particle/Particle-Bound Phase Modeling Maxima Summary

	Units	EDS
Particle Phase Annual Concentration (Cyp)	μg-s/g-m^3	1.78E-01
Particle Phase Annual Total Deposition (Dytp)	s/m^2-yr	1.35E-03
Particle Phase Annual Dry Deposition (Dydp)	s/m^2-yr	1.34E-03
Particle Phase Annual Wet Deposition (Dywp)	s/m^2-yr	1.00E-05
Particle Phase Hourly Concentration (Chp)	μg-s/g-m^3	1.56E+02

Table 3-3
Vapor Phase Modeling Maxima Summary – Concentration

COPC	CAS	Chemical Grouping	AERMOD MODEL ID	Unitized Modeled Maximum Concentration ($\mu g/m^3/g/s$) EDS 1-hour	Unitized Modeled Maximum Concentration ($\mu g/m^3/g/s$) EDS Annual
acetone	67-64-1	Organic	ACETONE	158.76	0.18
bis(2-ethylhexyl)-phthalate	117-81-7	Organic	BIS2EPTH	153.84	0.18
carbon disulfide	75-15-0	Organic	CRBDSULF	157.24	0.18
ethanol	64-17-5	Organic	ETHANOL	157.35	0.18
H	505-60-2	Organic	H	158.61	0.18
methane	74-82-8	Organic	METHANE	158.95	0.18
methylene chloride	75-09-2	Organic	METHCHLO	159.02	0.18
toluene	108-88-3	Organic	TOLUENE	158.94	0.18
vinyl chloride	75-01-4	Organic	VINLCHLR	158.81	0.18
mercuric chloride	7487-94-7	Inorganic	MERCCHLR	153.28	0.17
elemental mercury	7439-97-6	Inorganic	MERCURY	159.04	0.18

Table 3-4
Vapor Phase Modeling Maxima Summary - Total Deposition

COPC	CAS	Chemical Grouping	AERMOD MODEL ID	Unitized Modeled Maximum Total Deposition (s/m^2-yr) EDS 1-hour	Unitized Modeled Maximum Total Deposition (s/m^2-yr) EDS Annual
acetone	67-64-1	Organic	ACETONE	1.00E-05	1.00E-04
bis(2-ethylhexyl)-phthalate	117-81-7	Organic	BIS2EPTH	2.00E-04	3.89E-03
carbon disulfide	75-15-0	Organic	CRBDSULF	4.00E-05	3.70E-04
ethanol	64-17-5	Organic	ETHANOL	4.00E-05	4.20E-04
H	505-60-2	Organic	H	1.00E-05	1.00E-04
methane	74-82-8	Organic	METHANE	0	2.00E-05
methylene chloride	75-09-2	Organic	METHCHLO	0	4.00E-05
toluene	108-88-3	Organic	TOLUENE	0	3.00E-05
vinyl chloride	75-01-4	Organic	VINLCHLR	0	5.00E-05
mercuric chloride	7487-94-7	Inorganic	MERCCHLR	5.00E-04	3.88E-02
elemental mercury	7439-97-6	Inorganic	MERCURY	0	1.00E-05

Table 3-5
Vapor Phase Modeling Maxima Summary - Dry Deposition

COPC	CAS	Chemical Grouping	AERMOD MODEL ID	Unitized Modeled Maximum Dry Deposition (s/m^2-yr) EDS 1-hour	Unitized Modeled Maximum Dry Deposition (s/m^2-yr) EDS Annual
acetone	67-64-1	Organic	ACETONE	1.00E-05	7.00E-05
bis(2-ethylhexyl)-phthalate	117-81-7	Organic	BIS2EPTH	2.00E-04	2.69E-03
carbon disulfide	75-15-0	Organic	CRBDSULF	4.00E-05	3.70E-04
ethanol	64-17-5	Organic	ETHANOL	4.00E-05	3.00E-04
H	505-60-2	Organic	H	1.00E-05	7.00E-05
methane	74-82-8	Organic	METHANE	0	2.00E-05
methylene chloride	75-09-2	Organic	METHCHLO	0	4.00E-05
toluene	108-88-3	Organic	TOLUENE	0	3.00E-05
vinyl chloride	75-01-4	Organic	VINLCHLR	0	5.00E-05
mercuric chloride	7487-94-7	Inorganic	MERCCHLR	5.00E-04	3.71E-02
elemental mercury	7439-97-6	Inorganic	MERCURY	0	1.00E-05

Table 3-6
Vapor Phase Modeling Maxima Summary - Wet Deposition

COPC	CAS	Chemical Grouping	AERMOD	Unitized Modeled Maximum Wet Deposition (s/m^2-yr)	
			MODEL ID	EDS	
				1-hour	Annual
acetone	67-64-1	Organic	ACETONE	1.00E-05	3.00E-05
bis(2-ethylhexyl)-phthalate	117-81-7	Organic	BIS2EPTH	1.40E-04	1.22E-03
carbon disulfide	75-15-0	Organic	CRBDSULF	0	0
ethanol	64-17-5	Organic	ETHANOL	4.00E-05	2.20E-04
H	505-60-2	Organic	H	1.00E-05	4.00E-05
methane	74-82-8	Organic	METHANE	0	0
methylene chloride	75-09-2	Organic	METHCHLO	0	0
toluene	108-88-3	Organic	TOLUENE	0	0
vinyl chloride	75-01-4	Organic	VINLCHLR	0	0
mercuric chloride	7487-94-7	Inorganic	MERCCHLR	1.70E-04	1.71E-03
elemental mercury	7439-97-6	Inorganic	MERCURY	0	0

4.0 EXPOSURE SCENARIO IDENTIFICATION

Individual human receptors evaluated in the risk assessment have different potential direct and indirect exposure to COPCs emitted from the EDT facility, depending on age, activities, and location. This section identifies these receptors and defines the pathways by which the receptors are exposed to the COPCs. The selected pathways and exposure scenarios described are the same as previously used for the MPHHRA.

4.1 Use of HHRAP Recommended Default Model Parameters

The risk modeling used for this addendum is identical to that used in the MPHHRA in the application of site specific data and HHRAP defaults. These parameters are not discussed in this addendum since they are characterized in the MPHHRA.

4.2 Special On-site and Off-site Water Body Considerations

Water bodies identified as relevant are identical that that used in the MPHHRA and include Lake Vega Reservoir and the [redacted]. The modeled pollutant concentration at the receptor grid point on the lower Kentucky River that was nearest to the source was utilized as the concentration for the entire water body. The location of this receptor grid point is slightly different in this addendum due to the changes to the receptor map used. Receptors were placed at 100 meter increments on the surface of Lake Vega and the results from air dispersion modeling for all receptors were averaged to yield the concentration utilized in the risk model for Lake Vega impacts. Although the locations of these receptor grid points were slightly changed due to the shift of the receptor map, the methodology is unchanged.

4.3 Exposure Period Considerations

Based on guidance recommendations, the assumed duration of exposure to the modeled concentrations of COPCs vary based on age and the exposure pathway. No changes were made in the addendum to exposure periods.

5.0 TOXICITY DATA

Chemical toxicity data utilized for this MPHHRA was largely based on information in the Battelle Memorial Institute's March 2012 MPHRA Report for Explosive Destruction Technology Alternatives at the Pueblo Chemical Depot. Additional toxicity data not included in the PCAPP MPHRA database were compiled based on EPA's preferred hierarchy for these types of applications. No changes were made to the toxicity data from that presented in the MPHHRA.

6.0 RISK RESULTS

The risk characterization for the EDS alternative was performed in accordance with USEPA risk assessment guidelines and in a manner identical to the MPHHRA. This section presents the results of the EDS alternative, based on the changes described in Section 1.0 of this addendum. Summary results of the EDT MPHHRA are presented in Section 6.4 below. Detailed EDS alternative model output also is provided in Appendix 1 – Addendum. Health effects results are presented in the following order: carcinogenic risk, non-carcinogenic hazard, and acute hazard. A summary of the top five COPCs contributing the majority of the risk and hazard follows these health effects results.

Quantitative estimates of carcinogenic risks and non-carcinogenic hazards were calculated for direct inhalation exposures and indirect exposures to EDS emissions. Estimated total carcinogenic risk was compared to an acceptable level of 1 case in one hundred thousand (1×10^{-5}).

The typical benchmark for evaluation of the estimated long-term, non-carcinogenic hazard from airborne unit emissions is 1.0. US EPA Region 6 recommended that a hazard index benchmark of 0.25 be utilized to take background concentrations of COPCs into consideration in areas where significant industrial activity takes place. Although the BGAD location does not represent an area of significant industrial activity, hazard indices based on emissions from the EDS facility were compared against this very conservative benchmark [i.e., total non-carcinogenic hazard was compared to an acceptable hazard index (HI) of 0.25 (or total cumulative dose is less than 25 percent of the RfD)]. In addition, an acute hazard analysis was performed and the results were compared to an acceptable HI of 1.0.

Cumulative BGCAPP impacts (i.e., risks of EDS and BGCAPP main plant operating simultaneously) were also addressed by adding the results of the EDS MPHHRA to the results of the previous SLHHRA results and compared to the stated acceptable levels. These cumulative results are tabulated and presented below in Section 6.6.

6.1 Characterization of Carcinogenic Health Effects

Carcinogenic risk is estimated as the probability of an individual developing cancer over a lifetime as a result of exposure to specified emissions. For this risk assessment, carcinogenic risk is estimated as an incremental probability of fatal cancer from exposure to emissions from the EDS alternative for specific potential carcinogens (i.e., excess individual lifetime cancer risk). Carcinogenic risk is estimated from both direct and indirect exposures as described in

Section 4.0 of this report. The toxicity factors used to develop the risk estimate and presented in Table 5-1 are identical to those used in the MPHHRA.

6.2 Characterization of Non-Carcinogenic Health Effects

For COPCs with non-carcinogenic effects, the potential for non-carcinogenic toxic effects in an individual is evaluated by comparing the estimated exposure level over a specified time period with the appropriate non-cancer reference dose, also presented in Table 5-1 as RfD and identical to those factors used in the MPHHRA. The non-carcinogenic hazard quotient (HQ) is a unitless value that considers a threshold exposure limit that below which health effects are not expected to occur. Sensitive populations are considered in this benchmark. HQs represent a non-carcinogenic hazard associated with an individual COPC and a specific exposure pathway.

Both direct and indirect exposures are considered in the estimation of non-cancer health effects. HQs for direct exposures to COPCs are calculated by dividing the inhalation intake of a COPC by the inhalation reference dose (RfD) for that COPC. HQs for indirect exposures to COPCs are calculated similarly, and incorporate the averaging time for non-carcinogenic health effects.

A Hazard Index (HI) is generated by summing HQ's for all selected COPCs for a given receptor.

6.3 Characterization of Acute Health Effects

Potential acute hazards associated with short-term emission release events were evaluated for each COPC in a manner identical to the MPHHRA. The acute HQ (HQA) represents the hazard associated with short-term direct exposure to each COPC in air during a short-term emission release event. HQAs for each COPC were summed to calculate the overall acute HI (HIA).

6.4 Results for EDS Technology

Overall risk and hazard results are provided with all pertinent assumptions, input constants, and conditions in Appendix 1 - Addendum. The tables included in the following sections provide summary information and clarification of results.

Table 6-1 presents the total carcinogenic and non-carcinogenic risks estimated for each human receptor by pathway, including acute exposure. Table 6-2 identifies the COPC responsible for the maximum impact for each pathway for each exposure scenario.

6.5 Summary and Cumulative EDS and BGCAPP Risk and Hazard Results

Table 6-3 provides a summary of the carcinogenic risks, non-carcinogenic hazards, and acute hazards, for all of the EDTs. This table includes the results of three rounds of risk and hazard modeling:

1. Baseline results previously obtained when conducting the BGCAPP SLHHRA
2. Results previously obtained when conducting the MPHHRA for the entire EDT facility, which included results from the SDC alternative, TDC alternative and DAVINCH alternative; and
3. Results derived during the development of this addendum that focuses on the EDS technology.

Table 6-3 compares the total impacts from all three phases of modeling to acceptable levels. None of the EDT technologies is expected to result in impacts, individually or in addition to 2010 estimated BGCAPP impacts that exceed acceptable limits. In fact, the results of cumulative risk from both sources are well below threshold values.

The results for both cumulative non-carcinogenic and cumulative carcinogenic risk calculations are approximately one-tenth or less of the established, generally accepted and recommended (i.e., for areas of industrial activity) bench marks. The air modeling and risk calculations clearly indicate that unacceptable non-carcinogenic or carcinogenic health effects are not expected. This conclusion (i.e., adverse health effects are not expected due to BGCAPP and EDT emissions) is further strengthened by the use of very conservative assumptions which over-estimated the chronic and acute health hazards while also overestimating the cancer risks posed by BGCAPP and EDT air emissions.

Table 6-1
Total Carcinogenic Risk and Non-carcinogenic Hazard – EDS Technology

Exposure Scenario	**Scenario Location**	**Cancer Risk (Benchmark = 1E-05)**			**Total Hazard Index (Benchmark = 0.25)**		
		Oral	Inhalation	Total	Oral	Inhalation	Total
Adult Resident	Rmax	3.19E-12	4.97E-10	5.00E-10	1.37E-07	1.38E-05	1.39E-05
Child Resident	Rmax	1.43E-12	9.95E-11	1.01E-10	3.07E-07	1.38E-05	1.41E-05
Fisher	Rmax	3.43E-12	4.97E-10	5.01E-10	1.48E-07	1.38E-05	1.39E-05
Fisher Child	Rmax	1.46E-12	9.95E-11	1.01E-10	3.14E-07	1.38E-05	1.41E-05
Farmer	Fmax	4.45E-12	6.63E-10	6.67E-10	1.44E-07	1.38E-05	1.39E-05
Farmer Child	Fmax	1.47E-12	9.95E-11	1.01E-10	3.16E-07	1.38E-05	1.41E-05
Acute Exposure	Amax	--	--	--	--	1.24E-05	--

Table 6-2
Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – EDS Technology

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	COPC	Max HQ	COPC
Adult Resident	inhalation	4.95E-10	H	1.38E-05	H
	oral	3.17E-12	H	1.37E-07	H
	soil	7.70E-19	H	3.33E-14	H
	produce	8.78E-16	H	3.80E-11	H
Child Resident	inhalation	9.90E-11	H	1.38E-05	H
	oral	1.42E-12	H	3.07E-07	H
	soil	1.44E-18	H	3.11E-13	H
	produce	4.28E-16	H	9.26E-11	H
Fisher	inhalation	4.95E-10	H	1.38E-05	H
	oral	3.41E-12	H	1.48E-07	H
	soil	7.70E-19	H	3.33E-14	H
	produce	8.78E-16	H	3.80E-11	H
	fish	2.42E-13	H	1.05E-08	H

Table 6-2
Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – EDS Technology (Continued)

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	COPC	Max HQ	COPC
Fisher Child	inhalation	9.90E-11	H	1.38E-05	H
	oral	1.45E-12	H	3.14E-07	H
	soil	1.44E-18	H	3.11E-13	H
	produce	4.28E-16	H	9.26E-11	H
	fish	3.41E-14	H	7.37E-09	H
Farmer	inhalation	6.60E-10	H	1.38E-05	H
	oral	4.43E-12	H	1.44E-07	H
	soil	1.93E-20	H	3.33E-14	H
	produce	3.30E-15	H	1.47E-10	H
	beef	4.30E-14	H	1.40E-09	H
	milk	1.54E-13	H	5.01E-09	H
	pork	1.63E-15	H	5.37E-11	H
	egg	7.54E-21	H	1.31E-14	H
	chicken	1.16E-20	H	2.01E-14	H

Table 6-2
Maximum Impact COPC Carcinogenic Risk and Non-carcinogenic Hazard – EDS Technology (Continued)

Exposure Scenario	Exposure Pathway	Carcinogenic Risk		Non Carcinogenic Hazard	
		Max Cancer Risk	COPC	Max HQ	COPC
Farmer Child	inhalation	9.90E-11	H	1.38E-05	H
	oral	1.46E-12	H	3.16E-07	H
	soil	1.44E-18	H	3.11E-13	H
	produce	1.64E-15	H	3.55E-10	H
	beef	3.98E-15	H	8.61E-10	H
	milk	3.84E-14	H	8.30E-09	H
	pork	1.89E-16	H	4.10E-11	H
	egg	4.34E-20	H	9.40E-15	H
	chicken	6.34E-20	H	1.37E-14	H
Acute Exposure	inh	NA	NA	7.22E-06	Methane

Table 6-3
Summary of Incremental EDT Impacts and Cumulative BGCAPP Impacts

Hazard and Risk Characterization from EDT Facility Only									
Exposure Scenario	**Scenario Location**	**Total Cancer Risk (Benchmark = 1E-05)**				**Total Hazard Index (Benchmark = 0.25)**			
		Davinch	EDS	TDC	SDC	Davinch	EDS	TDC	SDC
Adult Resident	Rmax	2.01E-08	5.00E-10	2.42E-08	4.65E-10	0.000681	0.0000139	0.00120	0.000011
Child Resident	Rmax	4.16E-09	1.01E-10	4.89E-09	9.35E-11	0.000710	0.0000141	0.00121	0.000011
Fisher	Rmax	2.01E-08	5.01E-10	2.42E-08	4.65E-10	0.000681	0.0000139	0.00120	0.000011
Fisher Child	Rmax	4.16E-09	1.01E-10	4.89E-09	9.36E-11	0.000710	0.0000141	0.00121	0.000011
Farmer	Fmax	**3.26E-08**	**6.67E-10**	**4.03E-08**	**1.38E-09**	0.000868	0.0000139	0.00125	0.000016
Farmer Child	Fmax	5.43E-09	1.01E-10	6.60E-09	2.57E-10	**0.000985**	**0.0000141**	**0.00129**	**0.000018**
Acute Exposure	Amax	--	--	--	--	0.000246	0.0000124	**0.00083**	0.000395
Worst-Case Hazard and Risk Characterization from EDT Facility and BGCAPP Facility									
Farmer	Fmax	2.13E-07	1.80E-07	**2.20E-07**	1.81E-07				
Farmer Child	Fmax					0.013385	0.0124141	**0.01369**	0.012418
Acute Exposure	Amax	--	--	--	--	0.025846	0.0256124	**0.02643**	0.025995

Notes:

[a] US EPA Region 6 recommends that a hazard index benchmark of 0.25 be utilized to account for COPCs (compounds of potential concern) in areas with industrial activity. Although significant industrial activities do not exist near BGCAPP, this very conservative benchmark was used for comparison to emissions to ensure risks were not underestimated.

[b] The acute risk assessment scenario evaluates short-term 1-hour maximum air concentrations based on hourly emission rates. Inhalation is the route of exposure.

7.0 UNCERTAINTY IN HUMAN HEALTH RISK ASSESSMENT

When evaluating the results of a risk assessment, it is necessary to discuss the inherent uncertainty associated with risk assessment activities. Since the potential for the introduction of uncertainty is evident at every step of the risk assessment process, conservatism is utilized for many point values and assumptions, to ensure that the overall risk and hazard estimation overestimates the potential for health effects. Uncertainty with respect to this facility was discussed in detail in the MPHHRA and is unchanged with respect to the performance of activities associated with risk/hazard characterization for the EDS. Therefore, no further discussion of uncertainty is provided in this addendum.

8.0 CONCLUSION/RECOMMENDATION

No further refinement of the risks/hazards of the proposed EDS facility (e.g., refinement of the air dispersion modeling parameters, nor additional risk evaluation) is needed due to the overall favorable results of this risk assessment. Calculations of risk/hazard developed using estimated facility emissions and the conservative assumptions made in this risk assessment also do not indicate that additional sampling to refine the concentration of pollutants in air emissions is necessary.