



OFFICE OF RIVER PROTECTION

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Richland, Washington 99352

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DEPARTMENT OF ECOLOGY
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14-ECD-0031

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Washington State
Department of Ecology
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Ms. Hedges:

U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION SUBMITS
REQUEST FOR REVIEW AND APPROVAL OF CRITERIA & TOXICS AIR EMISSIONS
NOTICE OF CONSTRUCTION FOR THE OPERATION OF THE CORE SAMPLING
SYSTEM IN HIGH PURGE GAS MODE AND SECOND TIER REVIEW PETITION FOR
THE OPERATION OF THE CORE SAMPLER IN HIGH PURGE GAS MODE

This Notice of Construction and Application for Second Tier Review are being submitted in compliance with WAC 173-400, "General Regulations for Air Pollution Sources." Documents are: "Criteria & Toxics Air Emissions Notice of Construction for the Operation of the Core Sampling System in High Purge Gas Mode," (Attachment 1); "Notice of Construction Application," (Attachment 2); "Second Tier Review Petition for the Operation of the Core Sampler in High Purge Gas Mode," (Attachment 3); and "Application for Second Tier Review or Third Tier Review," (Attachment 4).

If you have any questions, please contact Dennis W. Bowser, Environmental Compliance Division, (509) 373-2566.

A handwritten signature in black ink, appearing to read "Kevin W. Smith".

Kevin W. Smith
Manager

ECD:DWB

Attachments: (4)

cc: See page 2

Ms. Jane A. Hedges
14-ECD-0031

-2-

JUL 08 2014

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Attachment 1
14-ECD-0031
(63 Pages)

Criteria & Toxics Air Emissions Notice of Construction for the
Operation of the Core Sampling System in High Purge Gas Mode


Dennis W. Bowser

Criteria & Toxics Air Emissions Notice of Construction for the Operation of the Core Sampling System in High Purge Gas Mode

Prepared by:
Washington River Protection Solutions LLC

Date Published
June 2014

Prepared For:
United States Department of Energy
Office of River Protection
P.O. Box 550
Richland, Washington

EXECUTIVE SUMMARY

This document serves as a notice of construction (NOC) application pursuant to the requirements of *Washington Administrative Code* (WAC) 173-400, "General Regulations for Air Pollution Sources," and *Washington Administrative Code* (WAC) 173-460, "Controls for New Sources of Toxic Air Pollutants," for operation of up to two core sampling systems in high purge gas flow mode with a portable exhauster to provide sampling capability in support of tank waste characterization and future Tank Farm operational activities. Characterization of Hanford's waste tanks is necessary to support the Tri-Party Agreement (*Hanford Federal Facility Agreement and Consent Order* [Ecology et al. 1989]) M-045 Milestone series.

Hanford's Tank Farm Facility contains waste from nearly 50 years of production of defense related nuclear material and is comprised of radioactive fission products and chemical wastes generated during processing. To support the M-045 Milestone series, "Complete Closure of all Single-shell tanks (SSTs) Farms," SST and other miscellaneous tank waste will be transferred to Double-shell tanks (DSTs), which will support future waste feed delivery to Hanford's Waste Treatment and Immobilization Plant providing a long-term solution for treatment and safe waste storage. To reduce potential leaking from SSTs pump able liquids have been removed from the tanks, often leaving behind a stratified, solidified salt cake with interstitial liquids, and sludge. It is this material that may require sampling to determine how best to transfer the remaining tank waste. Other tanks may require sampling to test tank compatibility for waste transfers.

In the past, waste sampling and characterization in the Tank Farm Facility was performed using two permitted, truck-mounted core sampling systems that were capable of operating in both push and rotary mode. These permits have since been cancelled; however, the need to sample tank waste in this manner still exists.

The core sampling systems can operate in different modes depending upon the characteristics of the waste sampled. There are two primary bit types, a smooth bit that is normally used when the drill string is not rotated and the bit is pushed into the waste and a bit with teeth that is normally used when the drill string is rotated. A barrier fluid or air is used to prevent the release of tank gases. Water can be used as well as air at a low flow rate (less than 10 standard cubic feet per minute [scfm]) or at a high flow rate (greater than 10 scfm). This permit application is for when the core sampling system uses high purge gas flow rates and a portable exhauster to maintain negative pressure in the passively ventilated tank being sampled. To ensure that the tank remains under negative pressure during high purge gas air additions for bit cooling, an exhaust system will be used to abate emissions on those tanks that do not have an operating active ventilation system.

This NOC application is being submitted to obtain the State of Washington, Department of Ecology's (Ecology's) approval to operate up to two platform-mounted core sampling systems in high purge gas flow mode to obtain samples primarily from Hanford's SSTs, 100/200-series waste tanks, and miscellaneous catch tanks on the Hanford Site, if necessary. Samples taken in actively ventilated tanks will not utilize the portable exhauster and will be covered under the sampling provisions of the respective exhauster permits.

Estimated emissions from operating the core samplers in high purge gas flow mode for criteria pollutants were found to be below the exemption criteria in accordance with *Washington Administrative Code* (WAC) 173-400-100(5), "Source classifications." Emissions of toxic air pollutants from core sampling system operations were analyzed and 91 toxics were found to potentially be emitted. Of the 91 toxics identified, four were found to be above the WAC 173-460 de minimis screening levels. These included dimethyl mercury, ammonia, hexavalent chromium, and n-nitrosodimethylamine. Dimethyl mercury, hexavalent chromium and n-nitrosodimethylamine were found to exceed the small quantity emission rate. Dimethyl mercury also exceeded the acceptable source impact level. A Second Tier Health Impact Analysis will be submitted separately to analyze the impact of dimethyl mercury emissions on public health.

A best available control technology for toxics (tBACT) evaluation was performed for high purge gas flow mode operation and is included in Appendix B of this NOC application. The technologies considered for removal of those toxic air pollutants that exceeded de minimis levels were eliminated due to technical infeasibilities or because the costs exceeded the amount Ecology considers to be economically justifiable. The tBACT was determined to be a pre-filter and one nuclear grade high efficiency particulate air filter.

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LIST OF TERMS

AERMOD	American Meteorological Society/U.S. Environmental Protection Agency Regulatory Model
ANSI	American National Standards Institute
ASIL	acceptable source impact level
ASME	American Society of Mechanical Engineers
BACT	Best Available Control Technology
BARCT	best available radionuclide control technology
CAS	Chemical Abstracts Service
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DST	Double-shell tank
Ecology	State of Washington, Department of Ecology
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ETF	effluent treatment facility
HEPA	high-efficiency particulate air
HIA	Health Impact Analysis
IAC	impregnated activated carbon
LAER	lowest achievable emission rate
MTZ	mass transfer zone
NOC	notice of construction
NRC	National Research Council
ORP	U.S. Department of Energy, Office of River Protection
RACT	reasonably available control technology
RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
SQER	small quantity emission rate
SST	Single-shell tank
TAP	toxic air pollutant
tBACT	Best Available Control Technology for Toxics
TWINS	Tank Waste Information Network System
VOC	volatile organic compounds
WAC	Washington Administrative Code
WFD	waste feed delivery
WTP	Waste Treatment and Immobilization Plant

UNITS

\$/ton	dollars per ton
g/s	grams per second
gal	gallons
lb/yr	pound(s) per year
m	meter
scfm	standard cubic feet per minute
tons/year	tons per year
$\mu\text{g}/\text{m}^3$	microgram per cubic meter

METRIC CONVERSION CHART

Into metric units

Out of metric units

U.S. Customary Units	Multiply by	To get	U.S. Customary Units	Multiply by	To get
Length			Length		
Inches	25.40	Millimeters	millimeters	0.0393	inches
Inches	2.54	Centimeters	centimeters	0.393	inches
Feet	0.3048	Meters	meters	3.2808	feet
Yards	0.914	Meters	meters	1.09	yards
Miles	1.609	Kilometers	kilometers	0.62	miles
Area			Area		
square inches	6.4516	Square centimeters	square centimeters	0.155	square inches
square feet	0.093	square meters	square meters	10.7639	square feet
square yards	0.836	square meters	square meters	1.20	square yards
square miles	2.59	Square kilometers	square kilometers	0.39	square miles
Acres	0.404	Hectares	hectares	2.471	acres
Mass (weight)			Mass (weight)		
Ounces	28.35	Grams	grams	0.0352	ounces
Pounds	0.453	Kilograms	kilograms	2.2046	pounds
short ton	0.907	metric ton	metric ton	1.10	short ton
Volume			Volume		
fluid ounces	29.57	Milliliters	milliliters	0.03	fluid ounces
Quarts	0.95	Liters	liters	1.057	quarts
Gallons	3.79	Liters	liters	0.26	Gallons
cubic feet	0.03	cubic meters	cubic meters	35.3147	cubic feet
cubic yards	0.76456	cubic meters	cubic meters	1.308	cubic yards
Temperature			Temperature		
Fahrenheit	subtract 32 then multiply by 5/9ths	Celsius	Celsius	multiply by 9/5ths, then add 32	Fahrenheit
Energy			Energy		
kilowatt hour	3,413	British thermal unit	British thermal unit	0.000293	kilowatt hour
Kilowatt	0.948	British thermal unit per second	British thermal unit per second	1.055	kilowatt
Force/Pressure			Force/Pressure		
pounds per square inch	6.895	Kilopascals	kilopascals	0.14504	pounds per square inch

Source: *Engineering Unit Conversions*, M. R. Lindeburg, PE., Second Ed., 1990, Professional Publications, Inc., Belmont, California.

1.0 INTRODUCTION

This notice of construction (NOC) application is being submitted for approval in accordance with *Washington Administrative Code* (WAC) 173-400, "General Regulations for Air Pollution Sources," and *Washington Administrative Code* (WAC) 173-460, "Controls for New Sources of Toxic Air Pollutants." This NOC application describes the operation of the tank waste core sampling systems in high purge gas flow mode with a portable exhauster to obtain samples primarily from Hanford's passively ventilated Single-shell tanks (SSTs), 100/200-series waste tanks, and miscellaneous catch tanks on the Hanford Site, if necessary. This effort is essential to facilitate closure of the miscellaneous tanks and SSTs, to support waste feed delivery (WFD) to Hanford's Waste Treatment and Immobilization Plant (WTP), and to protect human health and the environment.

Emissions of all criteria air pollutants and toxic air pollutants (TAPs) for this activity were estimated based on tank concentration headspace data from the Tank Waste Information Network System (TWINS) database. Due to uncertainties in waste transfers between tanks over the life of these projects, a conservative approach was taken to estimate emissions. Emissions were estimated based upon the highest per-tank emission rate of each pollutant for all the tanks in both the 200 West and 200 East Areas. Each tank was assumed to have the highest per-tank emission rate for each pollutant; essentially each tank is considered to be a "worst case" tank.

The emissions for all criteria pollutants were estimated to be below the regulatory exemption levels. A total of 91 TAPs were identified in tank headspace samples with four, dimethyl mercury, ammonia, hexavalent chromium, and n-nitrosodimethylamine exceeding de minimis emission screening levels. Three TAPs, dimethyl mercury, hexavalent chromium, and n-nitrosodimethylamine were above the small quantity emission rate (SQER), and only dimethyl mercury exceeded the acceptable source impact level (ASIL). Because dimethyl mercury was found to exceed the ASIL, a Second Tier Health Impact Analysis (HIA), as required in *Washington Administrative Code* (WAC) 173-460-090, "Second tier review," is being submitted with this application.

Appendix B contains the evaluation of Best Available Control Technology for Toxics (tBACT). The technologies considered for abatement of the four TAPs exceeding de minimis levels were eliminated due to technical infeasibilities or because the costs exceeded the amounts the State of Washington, Department of Ecology (Ecology) considered to be economically justifiable. The tBACT was determined to be a nuclear grade high-efficiency particulate air (HEPA) filter.

2.0 FACILITY IDENTIFICATION AND LOCATION

The Tank Farms are located at:

U.S. Department of Energy, Office of River Protection
Hanford Site
200 East and West Area Tank Farms
Richland, Washington 99352

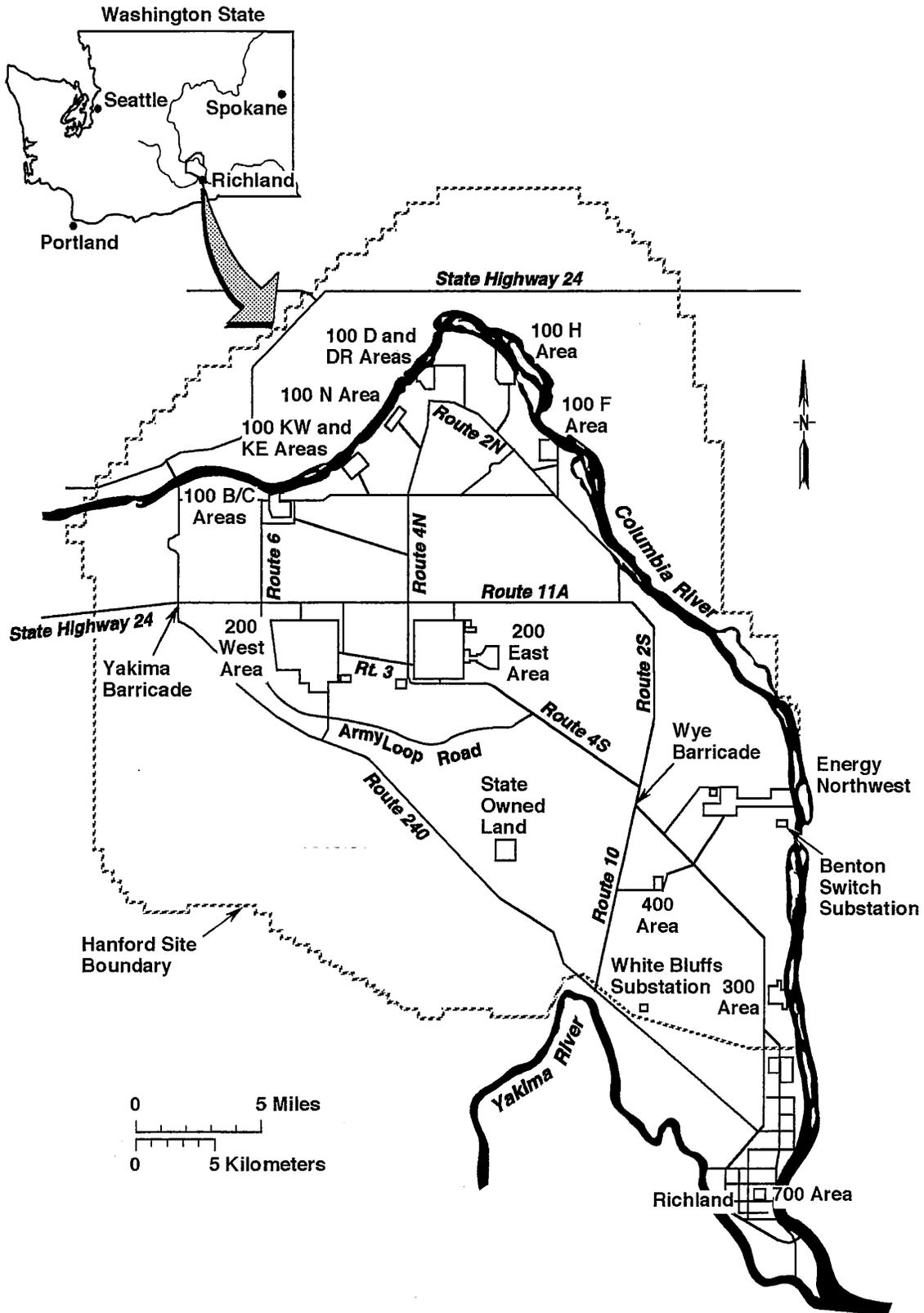
The Single and Double-shell tank Farms are located in the 200 East and West Areas of the Hanford Site (Figures 1 and 2).

3.0 RESPONSIBLE MANAGER

The current responsible facility manager is:

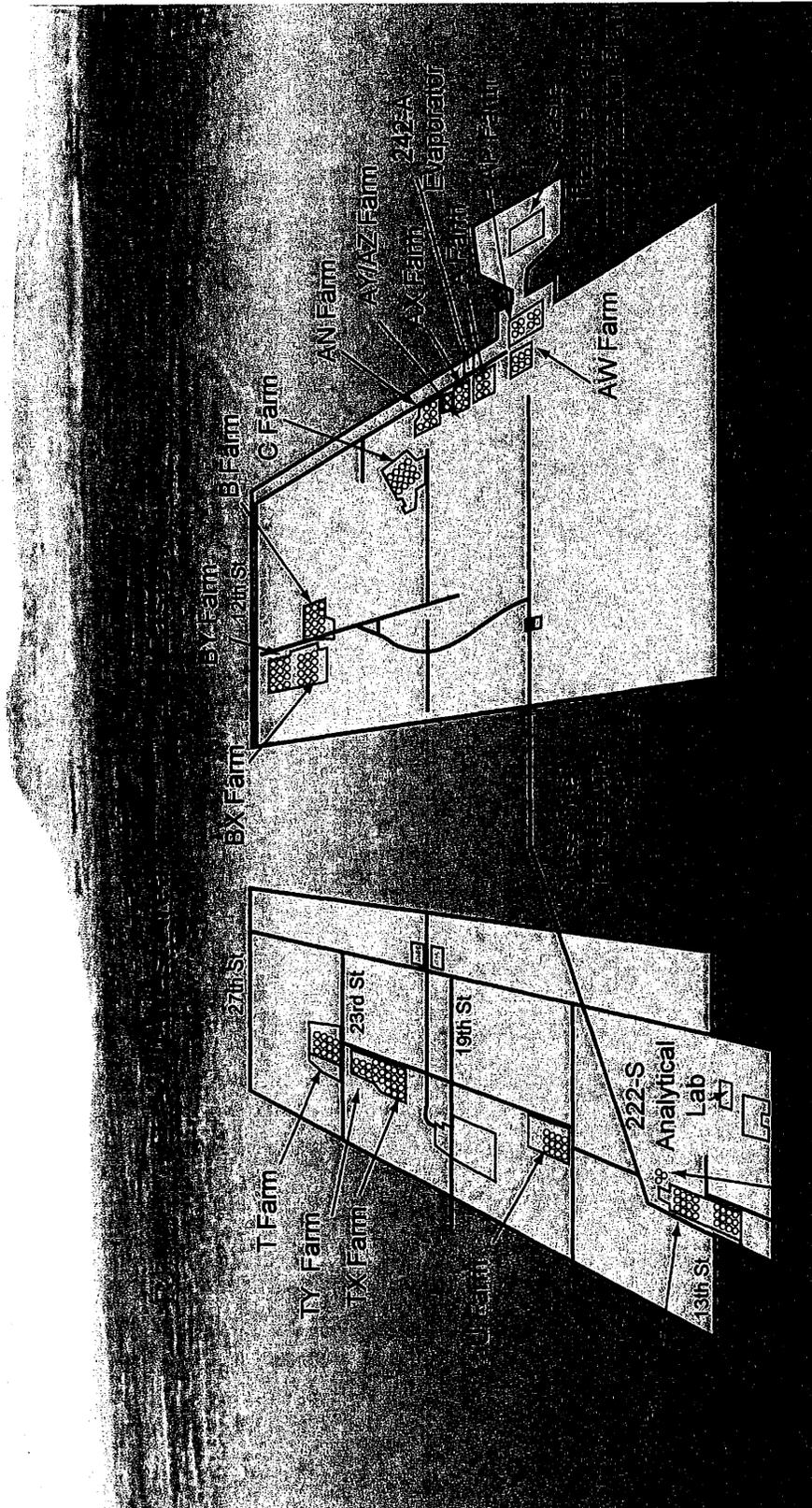
Kevin W. Smith, Manager
U.S. Department of Energy, Office of River Protection
P.O. Box 550
Richland, Washington 99352
(509) 372-2315

Figure 1. The Hanford Site.



H97020271.4R1

Figure 2. Location of all Single- and Double-Shell Tank Farms in 200 East and 200 West Areas of the Hanford Site.



4.0 PROPOSED ACTION

This NOC application is being submitted for approval to operate the core sampling systems in high purge gas flow mode with a portable exhauster within the Tank Farm Facility, with the primary purpose being tank waste sampling for characterization and analysis. The core sampling system is a platform-mounted unit able to be set on any tank including SSTs, Double-shell Tank (DSTs) or miscellaneous tanks using a crane. This system can be operated in low purge gas flow mode (< 10 standard cubic feet per minute [scfm]) without an exhauster or high purge gas flow (> 10 scfm) mode with a portable exhauster and is capable of penetrating hardened tank wastes.

To obtain a sample, the drill string containing the sampler will be drilled or pushed into the waste. The core sampler dimensions are approximately 2-inch diameter by 40-inches long and can obtain a 19-inch sample. A core sample is made up of 19-inch core segments (1-inch diameter) with an average of 5 segments per core. A piston inside the sampler creates a vacuum and draws the waste into the sampler. The sampler will close once the sample is obtained, trapping the sample and sealing the bottom of the core barrel. The barrier fluid and a seal on the bottom of the sampler are designed to prevent back flow of tank waste into the drill string. This protects the air pathway out of the tank.

When the system is in high purge gas flow mode, a purge gas with a flow rate up to a maximum of 120 (scfm) air will be injected to maintain pressure in the drill string for cooling and cleaning the drill bit and to prevent waste intrusion into the drill string while drilling (RPP-SPEC-42205, "Performance Specification for the Modified Core Sampling System").

An exhauster (with a nuclear grade HEPA filter) and accompanying stack will be necessary to actively ventilate SSTs or other tanks without active ventilation to control potentially unsafe pressurization and generation of radioactive aerosols. The purge air and the exhauster will only be operated for a short duration during the sampling of the tanks; total estimated operation is 300 hours per year for all systems. If necessary to operate the core sampler system in a DST or another actively ventilated tank, exhauster capabilities will not be required and the active ventilation system will be used.

The schedule for initial operation of the core sampling system is in 2014 and sampling will continue until the end of the tank cleanup work, currently projected to be 2052. The activities proposed within this NOC will negligibly increase criteria and toxic air pollutant emissions during tank waste sampling activities.

5.0 STATE ENVIRONMENTAL POLICY ACT

This project fulfills the requirements of *Washington Administrative Code* (WAC) 197-11 and RCW 43.21C.030(2)(C), "Guidelines for state agencies, local governments – Statements – Reports – Advice – Information," per RCW 43.21C.15, "RCW 43.21C.030(2)(c) inapplicable when statement previously prepared pursuant to national environmental policy act." which states, "*The requirements of RCW 43.21C.030(2)(c) pertaining to the preparation of a detailed statement by branches of government shall not apply when an adequate detailed statement has been previously prepared pursuant to the national environmental policy act of 1969, in which event said prepared statement may be utilized in lieu of a separately prepared statement under*

RCW 43.21C.030(2)(c).” The document that meets the agencies review needs for the current proposal is:

- DOE/EIS-0391, *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, Volume 2, Book 2, Appendix E.1.1.1.2., *Operations and Maintenance*.

The lead agency is the Office of River Protection, U.S. Department of Energy and the contact person is Mary Beth Burandt, Document Manager and her phone number is (509) 372-8828.

6.0 CHEMICAL AND PHYSICAL PROCESS

All waste in the tanks is constantly undergoing chemical and physical processes including volatilization, chemical reactions, and radionuclide decay even during quiescent conditions.

The SSTs currently contain approximately 10 million gallons of sludge, 20 million gallons of salt cake, and 100,000 gallons of drainable liquid. The SSTs are passively ventilated by way of HEPA breather filters. Waste disturbance in the SSTs occurs during sampling and retrieval operations. Hardened waste in the SSTs is being characterized for transfer to DSTs, which will support waste feed transfers to the WTP. The tanks will not be undergoing any waste disturbing activities during sampling.

7.0 EMISSION ESTIMATES

The source term used to develop criteria and toxic air pollutant emissions for operation of the core sampling exhaust system in high purge gas flow mode was derived from NOC application RPP-ENV-48229, “Criteria & Toxics Air Emissions Notice of Construction for the Operation of the 241-AP, 241-SY, and 241-AY/AZ Tank Farm Ventilation System Upgrades,” [Letter 11-NWP-121, “Re: Approval of Criteria and Toxic Air Emissions Notice of Construction (NOC) Application for the Operation of the 241-AP, 241-SY, and 241-AY/AZ Tank Farm Ventilation System Upgrades (Approval Order DE11NWP-001)”. The methodology used for this NOC application assumed the following:

1. When the maximum value in the TWINS database is the measurement detection limit, that value is assumed to be the reported value.
2. Measurements were made over a quiescent and passively ventilated tank for all SSTs and actively ventilated DSTs. A constant emission rate was assumed as long as the tank waste remained quiescent.
3. SSTs were passively ventilated during measurements and each DST ventilation system was assumed to have a flow rate for each tank of 1,000 standard cubic feet per minute (scfm) divided by the number of tanks in the tank farm.
4. The highest emission rate for each TAP, drawn from all tanks in the 200 Area East and West Tank Farm Facility, was used to establish a “worst case” tank.

The unabated emissions of criteria and toxic pollutants were estimated based upon measured headspace concentrations in the TWINS database. This database was searched for regulated criteria and toxic pollutants by the Chemical Abstracts Service (CAS) number for all tanks. Tank ventilation flow rates were derived from HNF-3588, *Organic Complexant Topical Report*, Rev. 1. For tanks not listed in HNF-3588, Rev. 1, or where the tanks listed in HNF-3588, Rev. 1 are known to have previously been actively ventilated, ventilation flow rates from a similar type SST were used. Flow rates were converted to per-tank fluxes.

7.1 ESTIMATED EMISSIONS OF CRITERIA POLLUTANTS

The estimated annual emissions of criteria pollutants from operation of the core samplers in high purge gas flow mode with portable exhauster are shown in Table A-1 in Appendix A. None of the criteria pollutants were estimated to exceed the *Washington Administrative Code* (WAC) 173-400-102, "Scope of registration and reporting requirements," thresholds.

7.2 ESTIMATED EMISSIONS OF TOXIC AIR POLLUTANTS

Estimated toxic air pollutant emissions are shown in Table A-2 in Appendix A. Ninety-one TAPs were collectively identified in the tank headspaces. Of these TAPs, estimated to be emitted from a single "worst case" tank, four exceeded the de minimis emission threshold in *Washington Administrative Code* (WAC) 173-460-150, "Table of ASIL, SQER and de minimis emission values," and include dimethyl mercury, ammonia, hexavalent chromium, and n-nitrosodimethylamine. Dimethyl mercury, ammonia, and n-nitrosodimethylamine exceeded the SQER emission thresholds and only dimethyl mercury was above the ASIL. A HIA per *Washington Administrative Code* (WAC) 173-460-090, "Second tier review," is being submitted separately for dimethyl mercury.

7.3 AIR DISPERSION MODELING

Ambient air concentrations during operation of the core sampler in rotary mode at the Hanford Site boundary were estimated using the U.S. Environmental Protection Agency (EPA) American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) dispersion model, Version 12060. EPA-454/B-03-001, *User's Guide for the AMS/EPA Regulatory Model – AERMOD*, was used as modeling guidance.

The model inputs included the physical parameters of the stack:

- Stack: height – 20 feet, diameter – 6-inches
- 120 cubic feet per minute flow rate
- Stack temperature of 293 degrees Kelvin.

The public access points to the site were used as the site boundaries. The surface meteorological inputs were from the Hanford Meteorological Station and the upper air data was obtained from the Spokane, Washington, National Weather Service for the years 2001 through 2005. Digital

elevation model data from the U.S. Geological Survey was used for model terrain input. The regulatory default mode was used. Receptor grid spacing was derived from Ecology's 08-02-025, *Guidance Document: First, Second and Third Tier Review of Toxic Pollution Sources* (Table 1).

Table 1. Ecology Recommended Receptor Grid Spacing.

Distance from Source (m)	Grid Spacing (m)
0 – 350	10
350 – 800	25
800 – 4,000	50
4,000 – 8,000	100
30,000 > 8,000	200

Emission points were chosen in four SST farms (A Farm, BX Farm, SX Farm, and T Farm) to represent emissions estimates from core sampling activities in the most northern and southern SST farms in the 200 East and 200 West Areas. Dispersion emissions were modeled separately for each of the four tank farms using an emission rate of 1 gram per second (g/s). Dispersion factors [(microgram per cubic meter [$\mu\text{g}/\text{m}^3$])/(g/s)] based on 1 hour, 24 hour, and annual averages were determined by selecting the offsite highest pollutant concentration ($\mu\text{g}/\text{m}^3$) from the four tank farms modeled using five years of meteorological data. As agreed to by Ecology, the AERMOD dispersion factor for annual emissions was adjusted to represent 300 hours of estimated operating time per year as opposed to 8,760 hours in a typical calendar year.

THIS WILL BE A PERMIT CONDITION. HOW DO WE ENFORCE THIS? REQUIRE AN HOUR METER AND IF SO, ON WHAT?

This method allowed for the actual exhaust rate for each TAP (g/s) to be multiplied by the dispersion factor [($\mu\text{g}/\text{m}^3$)/(g/s)] to achieve the maximum offsite concentration ($\mu\text{g}/\text{m}^3$). The resulting concentration could then be compared to the WAC 173-460-150 ASIL.

Table 2 shows the maximum dispersion factors obtained from emission points located in either A, BX, SX or T farms. The receptor with the highest concentration for each time period is along Highway 240 to the south and west of the 200 West Areas.

Table 2. Maximum Air Dispersion Factors and Location of Maximum Receptor from Emission Points Located in Either SX, BX, A or T Farms for Core Sampler Activities.

Averaging Period (Farm)	($\mu\text{g}/\text{m}^3$ per g/s)	Easting (m)	Northing (m)
1-hour (SX Farm)	7.88E+01	297,459	5,153,842
24-hour (SX Farm)	8.90E+00	297,652	5,153,793

Annual (SX Farm)	3.22E-01	297,264	5,153,890
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The air dispersion factors, based upon the specific TAP averaging period, were multiplied by the total emission rate in g/s for each TAP to calculate the ambient air concentrations shown in Table A-2.

7.4 ESTIMATED AMBIENT CONCENTRATIONS COMPARED TO WAC 173-460-150 THRESHOLDS

The results of the emissions and modeling are shown in Table A-2 in Appendix A. Four TAPs exceeded WAC 173-460-150 de minimis levels including dimethyl mercury, n-nitrosodimethylamine, ammonia, and hexavalent chromium. Hexavalent chromium (3.47E-03 pounds/year) exceeded the SQER limit of 1.28E-03 pounds/year, n-Nitrosodimethylamine (9.13E-02 pounds/year) exceeded the SQER limit of 4.16E-02, and dimethyl mercury emissions (3.79E-08 pounds/24-hr) exceeded the SQER limit of 1.00E-99 pounds/24-hr. The dispersed dimethyl mercury maximum offsite concentration was modeled to be 5.31E-09 µg/m³ relative to the WAC 173-460-150 ASIL of 1.00E-99 µg/m³. A HIA will be submitted separately describing the anticipated effect on human health from the dimethyl mercury emissions.

8.0 TANK VENTILATION PROCESS AND EMISSION CONTROL SYSTEMS

SSTs and other miscellaneous tanks are passively ventilated by way of radial HEPA breather filters. The tanks are interconnected through pipelines originating from valve pits or diversion boxes. The majority of the pipelines have a vapor seal, process blank or closed valve to regulate flow between the tanks, pits, and diversion boxes.

For lines that do not have a vapor seal, process blank or closed valve, alternate flow paths could result in diffuse or fugitive emissions from the valve pit, or diversion box. Covers have been installed over the pits to prevent water intrusion. These covers also provide a restriction to potential emissions from the pits and diversion boxes. The alternate flow paths are monitored as part of the Hanford Site-wide radioactive diffuse and fugitive emission unit.

Because air will be introduced into the tank during sampling to cool the drill string when operating in high purge gas flow mode, a portable exhaust system will be necessary to actively ventilate SSTs and other miscellaneous tanks to control potentially unsafe pressurization and generation of radioactive aerosols.

Sampling activities in actively ventilated tanks are covered under sampling provisions in their respective approval orders. When operating in high purge gas flow mode in a tank with active ventilation, the accompanying core sampling system exhauster will not be necessary. The ventilation systems remove particulates and moisture, collect condensate, and reduce relative humidity in the exhaust stream. Inlet air for the tanks is primarily provided through inlet air

filters, along with air infiltration through process pits and tank risers. Air flows from the tanks to a common header.

9.0 BEST AVAILABLE CONTROL TECHNOLOGY

Pursuant to *Washington Administrative Code* (WAC) 173-400-113(2), “New sources in attainment or unclassifiable areas – Review for compliance with regulations,” an analysis of Best Available Control Technology (BACT) for emissions of criteria pollutants was performed as well as a Best Available Control Technology for Toxins (tBACT) pursuant to *Washington Administrative Code* (WAC) 173-460-060(2), “Control technology requirements,” for toxics. Appendix B contains a tBACT. The tBACT analysis was performed using the “top-down” approach established for BACT. The approach consists of the following steps:

- 1) Identify all control technologies for an emissions source
- 2) Eliminate technically infeasible options
- 3) Rank remaining control technologies by control effectiveness
- 4) Evaluate most effective control(s) and document results
- 5) Select BACT for TAP(s).

Control technology was analyzed for the following four groups:

- 1) Ammonia
- 2) n-Nitrosodimethylamine
- 3) Dimethyl mercury
- 4) Hexavalent chromium.

A detailed evaluation of the emission control technologies was performed. After an effectiveness analysis, a cost per ton of pollutant removed was calculated. All of the costs per ton exceeded the cost ceiling estimates guidelines previously approved by Ecology and EPA as economically justifiable. Due to the low emission rates, the cost per ton to remove the pollutants becomes prohibitively expensive.

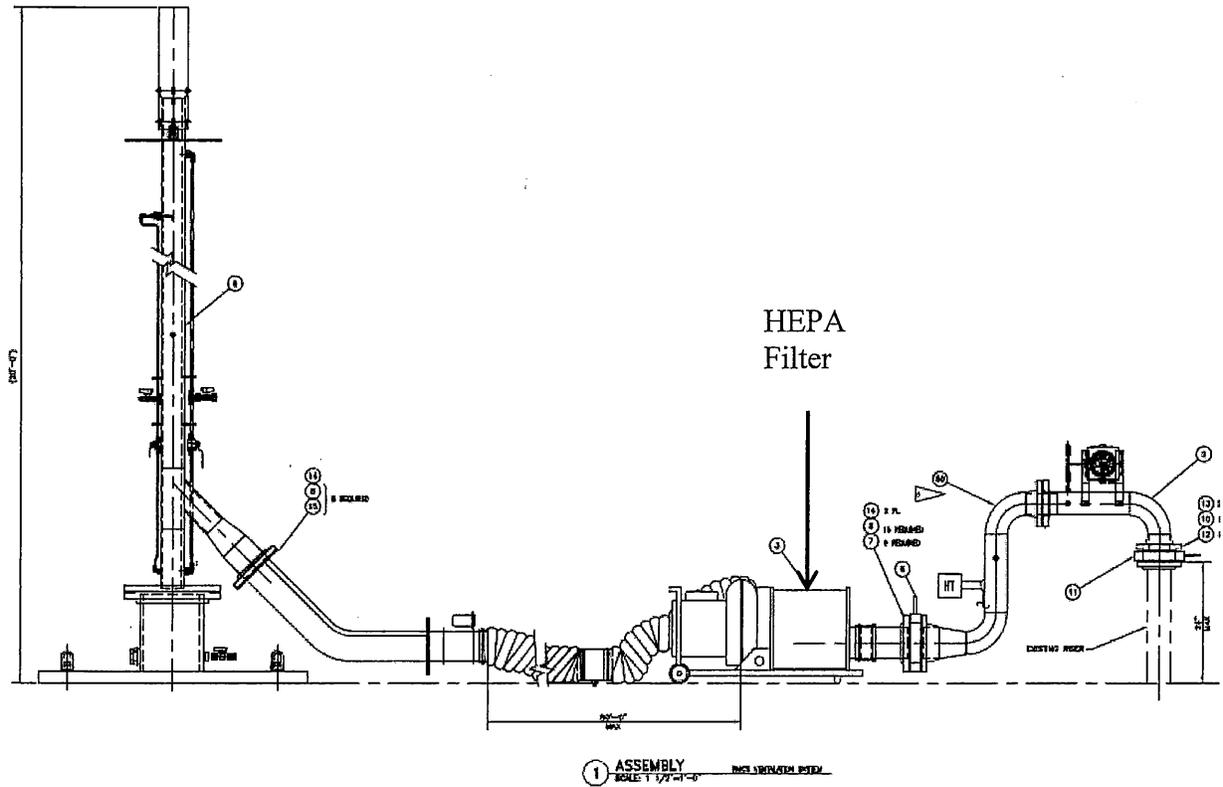
Based on the results of this tBACT, the proposed tBACT control technology for operation of the core sampling system in rotary mode consists of a pre-filter and one nuclear grade HEPA filter in the accompanying exhauster.

CONDENSER
AND
HEATER?

10.0 APPLICABLE CONTROL TECHNOLOGY DRAWINGS

Figure 3 depicts the exhauster design. The complete control technology design includes a tank riser inlet filter and an exhauster containing one nuclear grade HEPA filter followed by a 20-foot long, 6-inch inside diameter exhaust stack with a maximum of 120 scfm. The temperature of the stack gas will be approximately 20°C. The stack location will depend upon the farm; in general it will be away from other structures. The only fugitive emissions will occur when the system is connected and disconnected to a tank and will be minimal.

Figure 3. Abatement System for the Core Sampling System with Portable 20-Foot Stack.



11.0 MONITORING DURING OPERATIONS

To monitor for toxic air pollutants, sampling in tanks previously identified to contain dimethyl mercury will be performed during core sampling in high purge gas mode in non-actively ventilated tanks. Samples will be collected from a sample port and probe in the stack.

*only from known tanks?
samples will be compared to permitter values.*

12.0 REFERENCES

- 08-02-025, 2010, *Guidance Document: First, Second and Third Tier Review of Toxic Air Pollution Sources*, State of Washington Department of Ecology, Olympia, Washington.
- 11-NWP-121, 2011, “Re: Approval of Criteria and Toxic Air Emissions Notice of Construction (NOC) Application for the Operation of the 241-AP, 241-SY, and 241-AY/AZ Tank Farm Ventilation System Upgrades (Approval Order DE11NWP-001)” (internal letter from J. A. Hedges to S. L. Samuelson, Office of River Protection, U.S. Department of Energy, November 30), State of Washington Department of Ecology, Richland, Washington.
- DOE/EIS-0391, 2012, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, U.S. Department of Energy, Washington, D.C.
- Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order – Tri-Party Agreement*, 2 vols., as amended, State of Washington Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.
- EPA-454/B-03-001, 2004, *User’s Guide for the AMS/EPA Regulatory Model – AERMOD*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division, Research Triangle Park, North Carolina.
- National Environmental Policy Act of 1969*, 42 USC 4321, et seq.
- HNF-3588, 2002, *Organic Complexant Topical Report*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.
- RCW 43.21C, “State Environmental Policy Act,” *Revised Code of Washington*, as amended.
- RPP-ENV-48229, 2011, *Criteria & Toxics Air Emissions Notice of Construction for the Operation of the 241-AP, 241-SY, and 241-AY/AZ Tank Farm Ventilation System Upgrades*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington.
- RPP-SPEC-42205, 2013, *Performance Specification for the Modified Core Sampling System*, Rev. 2, Washington River Protection Solutions LLC, Richland, Washington.
- WAC 173-400, “General Regulations for Air Pollution Sources,” *Washington Administrative Code*, as amended.
- WAC 173-460, “Controls for New Sources of Toxic Air Pollutants,” *Washington Administrative Code*, as amended.
- WAC 197-11, “SEPA Rules,” *Washington Administration Code*, as amended.

APPENDIX A

Criteria and Toxic Air Pollutant Emission Rates

Table A-1. Criteria Pollutants Emission Rates and Comparison to De Minimis Levels.

Chemical	CAS #	Averaging Period	Emission Rate (g/s)	Emission Rate (lbs/yr)	De Minimis (lbs/yr)	Above De Minimis
Nitrogen oxides	10102-44-0	Year	1.59E-03	3.8	4,000	No
VOCs (volatile organic compounds)		Year	4.20E-03	10	4,000	No
SOx (Sulfur oxides)	7446-09-05	Year	3.52E-06	0.0084	4,000	No
Lead	7439-92-1	Year	9.50E-07	0.0023	10	No
Carbon monoxide	630-08-0	Year	5.40E-04	1.3	10,000	No

A	B	C	D	E	F	G	H	I	J	K	L	M
Chemical Name	CAS #	Avg. Period	Flux Per Tank (g/sec)	Dispersion Factor ($\mu\text{g}/\text{m}^3$)/(g/sec) c)	Maximum Offsite Concentration ($\mu\text{g}/\text{m}^3$)	Local Release (lb/averaging period)	WAC 173-460-150 ASIL ($\mu\text{g}/\text{m}^3$)	WAC 173-460-150 SQER (lb/averaging period)	WAC 173-460-150 De Minimis (lb/averaging period)	Exceeds ASIL	Exceeds SQER	Exceeds De Minimis
					F=D*E	G=D*(Seconds per Averaging period/453.6)				K=F>H	L=G>I	M=G>J
Ethylbenzene	100-41-4	Year	2.05E-05	3.22E-01	6.59E-06	4.87E-02	0.40	76.8	3.84	No	No	No
Styrene	100-42-5	24-hr	6.70E-06	8.90E+00	5.96E-05	4.26E-04	900	118	5.91	No	No	No
Benzyl Chloride	100-44-7	Year	1.94E-07	3.22E-01	6.25E-08	4.62E-04	0.0204	3.91	0.196	No	No	No
Nitrogen dioxide	10102-44-0	1-hr	7.99E-04	7.88E+01	6.30E-02	6.34E-03	470	1.03	0.457	No	No	No
n-Nitroso-n-methylethylamine	10595-95-6	Year	2.81E-08	3.22E-01	9.04E-09	6.69E-05	0.000159	0.0305	0.00153	No	No	No
p-Xylene	106-42-3	24-hr	2.36E-05	8.90E+00	2.10E-04	1.50E-03	221	29	1.45	No	No	No
1,4-Dichlorobenzene	106-46-7	Year	9.00E-07	3.22E-01	2.90E-07	2.14E-03	0.0909	17.4	0.872	No	No	No
1,2-Epoxybutane	106-88-7	24-hr	5.85E-07	8.90E+00	5.21E-06	3.72E-05	20	2.63	0.131	No	No	No
1,2-Dibromoethane	106-93-4	Year	1.15E-06	3.22E-01	3.72E-07	2.75E-03	0.0141	2.71	0.135	No	No	No
1,3-Butadiene	106-99-0	Year	2.89E-06	3.22E-01	9.30E-07	6.87E-03	0.00588	1.13	0.0564	No	No	No
Acrolein	107-02-8	24-hr	4.32E-08	8.90E+00	3.84E-07	2.74E-06	0.06	0.00789	0.000394	No	No	No
Allyl Chloride	107-05-1	Year	1.48E-07	3.22E-01	4.76E-08	3.52E-04	0.167	32	1.6	No	No	No
1,2-Dichloroethane	107-06-2	Year	2.36E-05	3.22E-01	7.60E-06	5.62E-02	0.0385	7.39	0.369	No	No	No
Acrylonitrile	107-13-1M	Year	1.78E-07	3.22E-01	5.75E-08	4.25E-04	0.00345	0.662	0.0331	No	No	No
Vinyl acetate	108-05-4	24-hr	6.49E-09	8.90E+00	5.78E-08	4.12E-07	200	26.3	1.31	No	No	No
Methyl Isobutyl Ketone	108-10-1	24-hr	4.01E-05	8.90E+00	3.57E-04	2.55E-03	3000	394	19.7	No	No	No
m-Xylene	108-38-3M	24-hr	1.37E-05	8.90E+00	1.22E-04	8.67E-04	221	29	1.45	No	No	No
3-Methylphenol	108-39-4	24-hr	6.87E-08	8.90E+00	6.11E-07	4.36E-06	600	78.9	3.94	No	No	No
Toluene	108-88-3	24-hr	5.92E-04	8.90E+00	5.27E-03	3.76E-02	5000	657	32.9	No	No	No
Chlorobenzene	108-90-7	24-hr	7.24E-06	8.90E+00	6.44E-05	4.59E-04	1000	131	6.57	No	No	No
Phenol	108-95-2	24-hr	1.18E-04	8.90E+00	1.05E-03	7.49E-03	200	26.3	1.31	No	No	No

A	B	C	D	E	F	G	H	I	J	K	L	M
Chemical Name	CAS #	Avg. Period	Flux Per Tank (g/sec)	Dispersion Factor ($\mu\text{g}/\text{m}^3$)/(g/sec)	Maximum Offsite Concentration ($\mu\text{g}/\text{m}^3$)	Local Release (lb/averaging period)	WAC 173-460-150 ASIL ($\mu\text{g}/\text{m}^3$)	WAC 173-460-150 SQER (lb/averaging period)	WAC 173-460-150 De Minimis (lb/averaging period)	Exceeds ASIL	Exceeds SQER	Exceeds De Minimis
					F=D*E	G=D*(Seconds per Averaging period/453.6)				K=F>H	L=G>I	M=G>J
n-Hexane	110-54-3	24-hr	7.48E-05	8.90E+00	6.66E-04	4.75E-03	700	92	4.6	No	No	No
Cyclohexane	110-82-7	24-hr	2.29E-05	8.90E+00	2.04E-04	1.46E-03	6000	789	39.4	No	No	No
Ethylene glycol monobutyl ether	111-76-2	24-hr	2.20E-06	8.90E+00	1.96E-05	1.40E-04	1.30E+04	1710	85.4	No	No	No
Propylene	115-07-1	24-hr	5.69E-05	8.90E+00	5.07E-04	3.61E-03	3000	394	19.7	No	No	No
Di(2-ethylhexyl)phthalate	117-81-7	Year	1.08E-08	3.22E-01	3.48E-09	2.57E-05	0.0417	8	0.4	No	No	No
1,4-Dioxane	123-91-1	Year	1.02E-05	3.22E-01	3.28E-06	2.42E-02	0.13	24.9	1.25	No	No	No
Perchloroethylene	127-18-4	Year	2.34E-05	3.22E-01	7.55E-06	5.58E-02	0.169	32.4	1.62	No	No	No
Vanadium Pentoxide	1314-62-1	1-hr	1.70E-06	7.88E+01	1.34E-04	1.35E-05	30	0.0657	0.00329	No	No	No
Polychlorinated Biphenyls (PCBs)	1336-36-3	Year	2.95E-07	3.22E-01	9.50E-08	7.02E-04	0.00175	0.336	0.0168	No	No	No
Trans-1,2-dichloroethene	156-60-5	24-hr	1.73E-09	8.90E+00	1.54E-08	1.10E-07	807	106	5.3	No	No	No
Butylated hydroxyanisole	25013-16-5	Year	2.06E-08	3.22E-01	6.64E-09	4.91E-05	17.5	3360	168	No	No	No
Formaldehyde	50-00-0	Year	3.41E-07	3.22E-01	1.10E-07	8.12E-04	0.167	32	1.6	No	No	No
n-Nitrosodiethylamine	55-18-5	Year	2.81E-08	3.22E-01	9.04E-09	6.69E-05	1.00E-04	0.0192	0.000959	No	No	No
Carbon Tetrachloride	56-23-5	Year	2.38E-05	3.22E-01	7.65E-06	5.66E-02	0.0238	4.57	0.228	No	No	No
1,1-Dimethylhydrazine	57-14-7	24-hr	2.52E-08	8.90E+00	2.25E-07	1.60E-06	0.5	0.0657	0.00329	No	No	No
Propylene Glycol	57-55-6	24-hr	3.26E-06	8.90E+00	2.90E-05	2.07E-04	28.5	3.75	0.187	No	No	No
n-Nitrosomorpholine	59-89-2	Year	1.30E-07	3.22E-01	4.18E-08	3.09E-04	0.000526	0.101	0.00505	No	No	No
Dimethyl Mercury	593-74-8	24-hr	5.97E-10	8.90E+00	5.31E-09	3.79E-08	1.00E-99	1.00E-99	1.00E-99	Yes	Yes	Yes

A	B	C	D	E	F	G	H	I	J	K	L	M
Chemical Name	CAS #	Avg. Period	Flux Per Tank (g/sec)	Dispersion Factor ($\mu\text{g}/\text{m}^3$)/(g/sec) ^c	Maximum Offsite Concentration ($\mu\text{g}/\text{m}^3$)	Local Release (lb/averaging period)	WAC 173-460-150 ASIL ($\mu\text{g}/\text{m}^3$)	WAC 173-460-150 SQER (lb/averaging period)	WAC 173-460-150 De Minimis (lb/averaging period)	Exceeds ASIL	Exceeds SQER	Exceeds De Minimis
					F=D*E	G=D*(Seconds per Averaging period/453.6)				K=F>H	L=G>I	M=G>J
Acetamide	60-35-5	Year	8.77E-08	3.22E-01	2.83E-08	2.09E-04	0.05	9.59	0.48	No	No	No
n-Nitrosodimethylamine	62-75-9	Year	3.83E-05	3.22E-01	1.23E-05	9.13E-02	0.000217	0.0416	0.00208	No	Yes	Yes
n-Nitrosodi-n-propylamine	621-64-7	Year	2.81E-08	3.22E-01	9.04E-09	6.69E-05	0.0005	0.0959	0.0048	No	No	No
Methyl Isocyanate	624-83-9	24-hr	2.56E-08	8.90E+00	2.28E-07	1.63E-06	1	0.131	0.00657	No	No	No
Carbon monoxide	630-08-0	1-hr	5.40E-04	7.88E+01	4.26E-02	4.29E-03	23000	50.4	1.14	No	No	No
Methyl Alcohol	67-56-1	24-hr	1.03E-03	8.90E+00	9.17E-03	6.54E-02	4000	526	26.3	No	No	No
Isopropyl Alcohol	67-63-0	1-hr	4.89E-05	7.88E+01	3.85E-03	3.88E-04	3200	7.01	0.35	No	No	No
Chloroform	67-66-3	Year	2.38E-05	3.22E-01	7.65E-06	5.66E-02	0.0435	8.35	0.417	No	No	No
Hexachloroethane	67-72-1	Year	2.44E-05	3.22E-01	7.85E-06	5.81E-02	0.0909	17.4	0.872	No	No	No
Benzene	71-43-2	Year	2.36E-05	3.22E-01	7.60E-06	5.62E-02	0.0345	6.62	0.331	No	No	No
1,1,1-Trichloroethane	71-55-6	24-hr	9.77E-07	8.90E+00	8.70E-06	6.20E-05	1000	131	6.57	No	No	No
Methyl Bromide	74-83-9	24-hr	9.30E-07	8.90E+00	8.28E-06	5.90E-05	5	0.657	0.0629	No	No	No
Methyl Chloride	74-87-3	24-hr	3.24E-06	8.90E+00	2.88E-05	2.06E-04	90	11.8	0.591	No	No	No
Hydrogen Cyanide	74-90-8	24-hr	8.25E-08	8.90E+00	7.34E-07	5.24E-06	9	1.18	0.0591	No	No	No
Lead and compounds (NOS)	7439-92-1	Year	9.50E-07	3.22E-01	3.06E-07	2.26E-03	0.0833	16	10	No	No	No
Manganese & Compounds	7439-96-5	24-hr	9.50E-07	8.90E+00	8.45E-06	6.03E-05	0.04	0.00526	0.000263	No	No	No
Mercury, Elemental	7439-97-6	24-hr	2.88E-07	8.90E+00	2.56E-06	1.83E-05	0.09	0.0118	0.000591	No	No	No
Arsenic & Inorganic Arsenic Compounds	7440-38-2	Year	9.50E-07	3.22E-01	3.06E-07	2.26E-03	0.000303	0.0581	0.00291	No	No	No
Beryllium & Compounds (NOS)	7440-41-7	Year	4.76E-08	3.22E-01	1.53E-08	1.13E-04	0.000417	0.08	0.004	No	No	No

A	B	C	D	E	F	G	H	I	J	K	L	M
Chemical Name	CAS #	Avg. Period	Flux Per Tank (g/sec)	Dispersion Factor ($\mu\text{g}/\text{m}^3$)/(g/sec)	Maximum Offsite Concentration ($\mu\text{g}/\text{m}^3$)	Local Release (lb/averaging period)	WAC 173-460-150 ASIL ($\mu\text{g}/\text{m}^3$)	WAC 173-460-150 SQER (lb/averaging period)	WAC 173-460-150 De Minimis (lb/averaging period)	Exceeds ASIL	Exceeds SQER	Exceeds De Minimis
					F=D*E	G=D*(Seconds per Averaging period/453.6)				K=F>H	L=G>I	M=G>J
Cadmium & Compounds	7440-43-9	Year	4.76E-07	3.22E-01	1.53E-07	1.13E-03	0.000238	0.0457	0.00228	No	No	No
Chromium Hexavalent: Soluble, except Chromic Trioxide	7440-47-3	Year	1.46E-06	3.22E-01	4.69E-07	3.47E-03	6.67E-06	0.00128	6.40E-05	No	Yes	Yes
Cobalt	7440-48-4	24-hr	9.50E-07	8.90E+00	8.45E-06	6.03E-05	0.1	0.013	0.000657	No	No	No
Copper & Compounds	7440-50-8	1-hr	4.76E-07	7.88E+01	3.75E-05	3.78E-06	100	0.219	0.011	No	No	No
Sulfur dioxide	7446-09-05	1-hr	3.52E-06	7.88E+01	2.77E-04	2.79E-05	660	1.45	0.457	No	No	No
Ethyl Chloride	75-00-3	24-hr	4.15E-06	8.90E+00	3.70E-05	2.64E-04	3.00E+04	3940	197	No	No	No
Vinyl Chloride	75-01-4	Year	2.38E-05	3.22E-01	7.65E-06	5.66E-02	0.0128	2.46	0.123	No	No	No
Acetonitrile	75-05-8	Year	5.55E-05	3.22E-01	1.79E-05	1.32E-01	60	11500	576	No	No	No
Acetaldehyde	75-07-0	Year	5.95E-05	3.22E-01	1.91E-05	1.42E-01	0.37	71	3.55	No	No	No
Dichloromethane	75-09-2	Year	1.61E-04	3.22E-01	5.19E-05	3.84E-01	1	192	9.59	No	No	No
Carbon disulfide	75-15-0	24-hr	5.80E-06	8.90E+00	5.17E-05	3.69E-04	800	105	5.26	No	No	No
Ethylene oxide	75-21-8	Year	1.12E-07	3.22E-01	3.61E-08	2.67E-04	0.0114	2.19	0.109	No	No	No
Bromoform	75-25-2	Year	1.27E-07	3.22E-01	4.09E-08	3.02E-04	0.909	174	8.72	No	No	No
1,1-Dichloroethane	75-34-3	Year	3.94E-07	3.22E-01	1.27E-07	9.39E-04	0.625	120	6	No	No	No
1,1-Dichloroethylene	75-35-4	24-hr	4.53E-05	8.90E+00	4.03E-04	2.88E-03	200	26.3	1.31	No	No	No
Chlorodifluoromethane	75-45-6	24-hr	1.45E-05	8.90E+00	1.29E-04	9.18E-04	5.00E+04	6570	328	No	No	No
1-Chloro-1,1-difluoroethane	75-68-3	24-hr	1.57E-05	8.90E+00	1.40E-04	9.96E-04	5.00E+04	6570	329	No	No	No
Ammonia	7664-41-7	24-hr	6.03E-02	8.90E+00	5.37E-01	3.83E+00	70.8	9.31	0.465	No	No	Yes

A	B	C	D	E	F	G	H	I	J	K	L	M
Chemical Name	CAS #	Avg. Period	Flux Per Tank (g/sec)	Dispersion Factor ($\mu\text{g}/\text{m}^3$)/(g/sec)	Maximum Offsite Concentration ($\mu\text{g}/\text{m}^3$)	Local Release (lb/averaging period)	WAC 173-460-150 ASIL ($\mu\text{g}/\text{m}^3$)	WAC 173-460-150 SQER (lb/averaging period)	WAC 173-460-150 De Minimis (lb/averaging period)	Exceeds ASIL	Exceeds SQER	Exceeds De Minimis
					F=D*E	G=D*(Seconds per Averaging period/453.6)				K=F>H	L=G>I	M=G>J
Selenium & Selenium Compounds (other than Hydrogen Selenide)	7782-49-2	24-hr	8.26E-08	8.90E+00	7.35E-07	5.24E-06	20	2.63	0.131	No	No	No
1,2-Dichloropropane	78-87-5	Year	6.93E-07	3.22E-01	2.23E-07	1.65E-03	0.1	19.2	0.959	No	No	No
Methyl Ethyl Ketone	78-93-3	24-hr	1.39E-04	8.90E+00	1.24E-03	8.82E-03	5000	657	32.9	No	No	No
1,1,2-Trichloroethane	79-00-5	Year	8.57E-06	3.22E-01	2.76E-06	2.04E-02	0.0625	12	0.6	No	No	No
Trichloroethylene	79-01-6	Year	2.36E-05	3.22E-01	7.60E-06	5.62E-02	0.5	95.9	4.8	No	No	No
Acrylic Acid	79-10-7	24-hr	9.44E-06	8.90E+00	8.40E-05	5.99E-04	1	0.131	0.00657	No	No	No
1,1,2,2-Tetrachloroethane	79-34-5	Year	1.08E-05	3.22E-01	3.47E-06	2.57E-02	0.0172	3.3	0.165	No	No	No
2-Nitropropane	79-46-9M	24-hr	2.77E-06	8.90E+00	2.47E-05	1.76E-04	20	2.63	0.131	No	No	No
Hexachlorobutadiene	87-68-3	Year	1.68E-05	3.22E-01	5.42E-06	4.01E-02	0.0455	8.73	0.437	No	No	No
Naphthalene	91-20-3M	Year	1.88E-07	3.22E-01	6.06E-08	4.48E-04	0.0294	5.64	0.282	No	No	No
n-Nitroso-di-n-butylamine	924-16-3	Year	2.81E-08	3.22E-01	9.04E-09	6.69E-05	0.000323	0.062	0.0031	No	No	No
n-Nitrosopyrrolidine	930-55-2	Year	2.81E-08	3.22E-01	9.04E-09	6.69E-05	0.00167	0.32	0.016	No	No	No
o-Xylene	95-47-6	24-hr	2.33E-05	8.90E+00	2.07E-04	1.48E-03	221	29	1.45	No	No	No
2-Methylphenol	95-48-7M	24-hr	4.12E-07	8.90E+00	3.67E-06	2.62E-05	600	78.9	3.94	No	No	No
Cumene	98-82-8	24-hr	1.02E-06	8.90E+00	9.07E-06	6.47E-05	400	52.6	2.63	No	No	No

APPENDIX B

Evaluation of Best Available Control Technology for Toxics (tBACT) for Core Sampling System Operation in Tank Farms

EXECUTIVE SUMMARY

This report is an evaluation of tBACT for operation of the Core Sampling System in high purge gas flow mode at the Hanford Site Tank Farm Facility. Operation of the core sampling system in high purge gas flow mode is expected to increase emissions of TAPs as defined in WAC 173-460, "Controls for New Sources of Toxic Air Pollutants." WAC 173-460 provides acceptable source impact levels, SQERs, and de minimis values for each toxic air pollutant. WAC 173-460-060, "Control technology requirements," subsection (2) requires that tBACT be employed for all TAPs for which the estimated increase in emissions exceeds the de minimis values.

The process used in this tBACT evaluation was based on methodology used, documented, and approved by the Ecology in Approval Order DE11NWP-001 (November 30, 2011) [Letter 11-NWP-121, "Re: Approval of Criteria and Toxic Air Emissions Notice of Construction (NOC) Application for the Operation of the 241-AP, 241-SY, and 241-AZ Tank Farm Ventilation System Upgrades (Approval Order DE11NWP-001)"] which followed guidance provided from Ecology and the U.S. Environmental Protection Agency to determine best available control technologies (BACT). This tBACT follows the five-step BACT process as follows:

- Step 1 - Identify all available control technologies for each pollutant subject to review
- Step 2 - Eliminate all technically infeasible control technologies
- Step 3 - Rank the remaining control technologies by control effectiveness
- Step 4 - Evaluate the feasible control technologies, beginning with the most efficient, with respect to economic, energy, and environmental impacts
- Step 5 - Select as tBACT the most effective control technology that is not rejected based on adverse economic, environmental, and/or energy impacts.

This tBACT evaluation addresses four TAPs that exceed the de minimis values:

- Dimethyl mercury (Mercury and Mercury-Related Compounds)
- Hexavalent chromium (Particulate Metal Compounds)
- n-Nitrosodimethylamine (Toxic Organic Compounds)
- Ammonia.

After a detailed evaluation of the four TAPs and the effectiveness of emission control technologies for each, an evaluation of the cost effectiveness of the treatment technologies was completed. The identified technology for dimethyl mercury was eliminated because, based on the cost ceiling guidelines previously approved by Ecology and EPA as economically unjustifiable and the extremely low dimethyl mercury emission rates. Although the evaluated technology would remove an estimated 98 to 99% of the pollutants, the cost of the abatement becomes prohibitive on a per ton basis due to the low emission rates (see Table BES-1). The Washington State Department of Health requires a high-efficiency particulate air (HEPA) filtration system that will remove the particulate radionuclides at an estimated 99.95% removal

efficiency. Particulate matter hexavalent chromium would be removed by the HEPA filtration system.

Based on the results of this tBACT evaluation, the proposed tBACT control technology for operation of the Rotary Mode Core Sampling (RMCS) System consists of an exhauster with one nuclear grade HEPA filter, a fan, and a 20-ft portable stack.

This tBACT evaluation meets one of the requirements of the NOC application for the Core Sampling System. This evaluation provides information on TAP emissions, proposed control technologies, and justification for implementation or rejection of those technologies.

Table BES-1. Total Annualized Costs of Abatement Technologies, Emissions per Year, and the Cost of Removal per Ton Compared to the Ceiling Cost Effectiveness Threshold.

	Total Annualized Costs (\$/year)	Emissions per Averaging Period (lbs)	Emissions per Year (tons)	Annual Cost of Removal (\$/ton)	Ceiling Cost of Effectiveness Threshold (\$/ton)
Ammonia (24-hour)					
Thermal Non-Catalytic Oxidizer	\$149,718	3.83	2.39E-02	\$12,000,000	\$52,500
Activated Carbon Adsorption	\$140,155	3.83	2.39E-02	\$9,700,000	\$52,500
Scrubber	\$118,056	3.83	2.39E-02	\$19,000,000	\$52,500
Toxic Organic Compounds (Year)					
Thermal Non-Catalytic Oxidizer	\$149,718	9.13E-02	4.57E-05	\$6,366,000,000	\$105,000
Activated Carbon Adsorption	\$140,155	9.13E-02	4.57E-05	\$3,200,000,000	\$105,000
Mercury and Mercury-Related Compounds (Year)					
Activated Treated Carbon Adsorption	\$113,620	3.79E-08	2.37E-10	\$500,000,000,000	\$105,000
Particulate Metal Compounds	Particulate metal compounds are removed by the required particulate filtration train for removal of radionuclides at 99.95% removal rate.				
<u>Assumption</u>					
Pounds of ammonia was multiplied by 12.5 - the number of 24 hour days in a 300 hour year.					

B1.0 INTRODUCTION

Implementation of the core sampling system operated in high purge gas flow mode will allow for more accurate sampling and characterization of tank waste. A New Source Review of the core sampling system indicated that a NOC permit application was required and is being submitted with this analysis. Increased pollutant emissions were compared to the de minimis values listed in *Washington Administrative Code* (WAC) 173-460-150, "Table of ASIL, SQER and de minimis emission values." Because four toxic air pollutants (TAPs) exceeded the de minimis emission values in WAC 173-460-150, it must be demonstrated that tBACT will be implemented during Core Sampler operation in high purge gas flow mode for each of these TAPs. One TAP (ammonia) exceeded the de minimis, two TAPs (n-nitrosodimethylamine and chromium hexavalent) exceed the SQER, and one pollutant (dimethyl mercury) exceeded the ASIL.

This tBACT evaluation meets one of the requirements of, and is an appendix in, the NOC application for operation of the Core Sampling System. It provides information on TAP emissions, proposed control technologies, and justification for implementation or rejection of those technologies for mitigation of toxic emissions during operation of the core sampling system in rotary mode.

B1.1 REGULATORY REQUIREMENTS AND METHODOLOGY

The definition of "Best available control technology (BACT)" is in *Washington Administrative Code* (WAC) 173-400-030, "Definitions," and tBACT is identical to the definition of BACT but applied to TAPs listed outlined in *Washington Administrative Code* (WAC) 173-460-020, "Applicability." A BACT or tBACT determination considers factors such as energy consumption, total source emissions and economic costs in determining what controls, if any, need to be on an emission source.

This tBACT demonstration is a modification of the U.S. Environmental Protection Agency's BACT analysis procedure delineated in the *New Source Review Workshop Manual, Prevention of Significant Deterioration and Nonattainment Area Permitting* (EPA, 1990), commonly referred to as the EPA Puzzle Book. There are five basic steps to EPA's "top-down" BACT process for evaluation of pollutant emission control technologies. These steps include the following:

- Step 1 - Identify all available control technologies for each pollutant subject to review
- Step 2 - Eliminate all technically infeasible control technologies
- Step 3 - Rank the remaining control technologies by control effectiveness
- Step 4 - Evaluate the feasible control technologies, beginning with the most efficient, with respect to economic, energy, and environmental impacts

- Step 5 - Select as BACT the most effective control technology that is not rejected based on adverse economic, environmental, and/or energy impacts.

Each step is expounded on below.

Step 1: Identifies all commercially available toxic air emission control options. This step involves a search for available technologies that can reduce the emission levels for the toxic contaminants of concern. Technologies required under previously completed lowest achievable emission rate (LAER) determinations are available for BACT purposes and are also included as control alternatives. They usually represent the “top” alternative (the highest emission reduction). The information sources used to identify control technologies include:

- Previous BACT and tBACT demonstrations
- EPA’s reasonably available control technology (RACT)/BACT/LAER Clearinghouses
- Regulatory authorities
- Federal, State and local new source review permits
- Control technology vendors
- Literature search
- Internet searches
- Similar commercial government applications.

Step 2: Eliminates all of the above-identified technically infeasible options and develops a short list of control technologies for further analysis. Screening criteria is applied to eliminate any control technology that is not available (cannot be obtained commercially) or not applicable (able to be reasonably installed and operated for control of tank farm process emissions). The determination of feasibility is based on evaluating vendor specifications and commercial or government application experience data for available control technologies previously identified. If a control technology has been installed and operated successfully on emissions with similar chemical and physical characteristics to those from processes that are being evaluated, it is demonstrated and is technically feasible.

The screening criteria developed for application to the suite of control technologies are as follows:

- The control technology has not been demonstrated at sufficient scale or removal efficiency for the application
- The control technology introduces additional hazards above and beyond the primary control hazard
- The control technology uses materials of construction that are unsuitable in a radiation field anticipated during operations or which impact the integrity of materials of construction (i.e., corrosion), and no suitable alternative materials can be substituted

- The control technology would be very difficult to modify for applicable field operations and maintenance activities anticipated during operations
- Control technology would generate secondary waste streams
- The control technology requires testability requirements where extraordinary measures would be required to ensure operational performance.

Step 3: Ranks the remaining control technologies in order of effectiveness for each unabated emission off-gas stream under evaluation. The most effective control technology is ranked at the top.

Step 4: Evaluates economic impacts for highly-ranked applicable technologies for each unabated emission off-gas stream analyzed. The purpose of the economic evaluations is to determine and compare “cost reasonableness” (\$/ton pollutant reduction) of the highly ranked technologies, in order, to determine whether impacts were acceptable. The economic analyses include factors for environmental impacts (e.g., secondary waste treatment, disposal costs) and energy impacts (e.g., utility costs). These economic impacts are based on average and incremental cost effectiveness or reasonableness of these analyses, expressed as cost per ton of pollutant removed. In addition, impacts on worker health and safety, such as labor for equipment maintenance, can be included.

Step 5: The control technology with the highest control efficiency is evaluated first for tBACT. If this technology is found to have acceptable energy, environmental, or economic impacts, then it is proposed as tBACT and no further analysis is necessary. If the top technology is shown to be inappropriate, based on energy, environmental, or economic impacts, the applicant must fully document the justification for this conclusion. Then the next most effective control technology on the list becomes the new candidate and is similarly evaluated. This process continues until the technology under consideration cannot be eliminated due to energy, environmental, or economic impacts, which would demonstrate the technology to be appropriate as tBACT.

A1.2 GENERAL APPROACH TO ECONOMIC IMPACT EVALUATION

An economic determination is made as to whether there is any unacceptable environmental, energy, or economic impacts for the highest ranked technology. If there are no unacceptable impacts, then the highest ranked technology is proposed as tBACT for each unabated off-gas stream. Economic evaluations are performed consistently across all technologies, and are rough order of magnitude cost estimates and employ the procedure found in EPA/452/B-02-001, *EPA Air Pollution Control Cost Manual*, Sixth Edition. The results of the economic analyses are included as cost tables.

The economic impacts of the control technology options are evaluated by calculating the cost effectiveness. This calculation is performed by estimating the total annualized cost of control (\$/yr) and dividing by the annual amount of emission reduction that would be achieved (tons/yr). The resulting cost effectiveness value (\$/ton) is compared to costs for similar applications and to guidance provided by regulatory agencies.

Typically, cost effectiveness evaluations are compared to survey values compiled by Federal and State regulatory agencies. In general, BACT cost effectiveness for pollutants are considered relative to “Plateau” and “Ceiling” values. “Plateau” level values are those below which a control technology is rarely thrown out as economically unjustifiable. The BACT cost “Ceiling” value is a value above which a control technology is rarely judged economically justifiable. No similar cost guidance has been developed for tBACT. However, previous tBACT evaluations submitted from Hanford and approved by the Ecology have used an additional cost factor (see Table 2-1) for determination of cost ceiling values. The most recently approved tBACT evaluation was Revision 1 of RPP-ENV-46679, *Evaluation of Best Available Control Technology for Toxics (tBACT) Double Shell Tank Farms Primary Ventilation Systems Supporting Waste Transfer Operations* (Appendix B in RPP-ENV-48229, *Criteria & Toxics Air Emissions Notice of Construction for the Operation of the 241-AP, 241-SY, and 241-AZ Tank Farm Ventilation System Upgrades*) [Letter 11-NWP-121, “Re: Approval of Criteria and Toxic Air Emissions Notice of Construction (NOC) Application for the Operation of the 241-AP, 241-SY, and 241-AZ Tank Farm Ventilation System Upgrades (Approval Order DE11NWP-001)]. Table B1 shows the cost factors also used for this analysis.

Table B1. Best Available Control Technology for Toxics Cost Factors

Method	Cost Factor	Cost Effectiveness Threshold (\$/ton)	
		Plateau	Ceiling
Toxic Air Pollutants (TAP) Classification			
Annual Averaging TAP	10	\$57,000	\$105,000
24-hour Averaging TAP	5	\$28,500	\$52,500

B2.0 WASTE TANK SAMPLING SYSTEM DESCRIPTION AND ASSOCIATED SOURCE TERM

B2.1 SYSTEM DESCRIPTION

The core sampling systems can operate in different modes depending upon the characteristics of the waste sampled. There are two bit types, a smooth bit that is normally used when the drill string is not rotated and the bit is pushed into the waste and a bit with teeth that is normally used when the drill string is rotated. A barrier fluid or air is used to prevent the release of tank gases. Water can be used as well as air at a low flow rate (less than 10 scfm) or at a high flow rate (>10 scfm and < 120 scfm). This permit application is for when the core sampling system is using high purge gas flow rates and a portable exhauster is used to maintain negative pressure in the tank being sampled. To ensure that the tank remains under negative pressure during high purge gas air additions for bit cooling, an exhaust system will be used to abate emissions on those tanks that do not have an operating active ventilation system.

The exhauster will only be implemented on SSTs or other miscellaneous tanks when operating the core sampler in rotary high purge gas flow mode. An exhauster is not required when sampling DSTs or another Tank Farm that already has an active ventilation system.

B2.2 SOURCE TERM

Ninety-one chemical compounds were identified as TAPs. Of the 91 identified TAPs, four were identified to be above the de minimis values in WAC 173-460-150. These four TAPs are listed in Table 3-1. Based on these four compounds, four tBACT analyses were required to assess emission control technologies for all TAPs above de minimis thresholds:

- Toxic organic compounds (Section B3.0)
- Ammonia (Section B4.0)
- Mercury compounds (Section 5.0)
- Particulate metal compounds (Section 6.0).

Table B2-1. Toxic Air Pollutants With Emissions above De Minimis Rates

Compound Name	Chemical Abstract Service #	Averaging Period	Release Rate (lb/avg. period)	De Minimis Release Rate (lb/avg. period)
Ammonia	7664-41-7	24-hr	3.83	0.465
Toxic Organic Compound				
n-Nitrosodimethylamine	62-75-9	Year	9.13E-02	0.00208
Mercury Compound				
Dimethyl Mercury	593-74-8	24-hr	3.79E-08	1.00E-99
Particulate Metals Compound				
Chromium Hexavalent: Soluble, except Chromic Trioxide	7440-47-3	Year	3.47E-03	6.40E-05

B3.0 IDENTIFICATION AND EVALUATION OF EMISSION CONTROL TECHNOLOGY OPTIONS FOR TOXIC ORGANIC COMPOUNDS

This section covers the detailed tBACT evaluation for emissions of toxic organic compounds (n-nitrosodimethylamine) during operation of the core sampling system in rotary mode. The total annual toxic organic compounds emitted from the operation of the Core Sampling System is estimated to be 4.57E-05 tons/year (derived from Table A3-1).

Step 1: Emission Control Technologies Identified for Toxic Organic Compounds

The following emission control technologies have been identified for the destruction and/or removal of toxic organic compound emissions:

- Activated carbon adsorption,
- Wet scrubber absorption,
- Thermal catalytic oxidation,
- Thermal non-catalytic oxidation.

Step 2: Elimination of Technically Infeasible Options/Development of Short List for Toxic Organic Compounds

Qualitative screening and elimination criteria were developed for the selective elimination of control technologies evaluated to be technically infeasible or not applicable for treatment of toxic organic compound emissions from Core Sampling System exhauster unit. The screening criteria were applied for the suite of control technologies for toxic organic compounds listed above and are shown in Table 4-1. The only identified emission control technology that was determined to be technically infeasible and eliminated for this application is thermal catalytic oxidation.

Table B3-1. Best Available Control Technology for Toxics Ranking by Effectiveness for Control of Toxic Organic Compounds

Control	Description	Screening Results
1	Activated Carbon Adsorption	Applicable
2	Wet Scrubber Absorption	Applicable
3	Thermal Catalytic Oxidizer	Eliminated
4	Thermal Non-Catalytic Oxidation	Applicable

Thermal Catalytic Oxidation: Thermal catalytic oxidation can be used to reduce volatile or toxic organic compound emissions from a variety of sources. Generally high flow, low concentration applications are best suited to produce high removal efficiencies for this technology. Particulates or halogenated volatile organic compounds and heavy metals can clog the packed bed or poison or deactivate the catalyst reducing the design life of the unit. Specific poisons include halogenated compounds, mercury, arsenic, sulfur, sodium, and calcium. Many of these compounds are found in the tank waste.

Step 3: Rank Remaining Control Technologies by Control Effectiveness

Effectiveness is defined by the ability of the control technology to reduce the post-treatment emission rate for a given TAP or group of TAPs. The short list of tBACT technologies for toxic organic compounds in order of removal efficiency is provided in Table B3-2. The technologies with a removal efficiency of 99% or greater were down-selected for further tBACT economic evaluation which include activated carbon adsorption and thermal non-catalytic oxidation.

Nevertheless, a general technology overview of wet scrubber absorption is described below for evaluation completeness.

**Table B3-2. Best Available Control Technology for Toxics
Ranking by Effectiveness for Control of Toxic Organic
Compounds**

Ranking/Technology	Removal Efficiency
1a. Activated Carbon Adsorption	99%
1b. Thermal Non-Catalytic Oxidation	99%
1c. Wet Scrubber Absorption	70-90%

Activated Carbon Adsorption: The principal use of activated carbon as a control technology is for the removal of volatile organic compounds such as hydrocarbons, solvents, toxic gases and organic-based odors. In addition, chemically-impregnated activated carbons can be used to control certain inorganic pollutants such as hydrogen sulfide, mercury, or radon. When properly applied, the adsorption process will remove pollutants for which it is designed, to non-detectable levels. Carbon adsorption is equally effective on single-component emissions as well as complex mixtures of pollutants.

Physical adsorption is dependent on the characteristics of the pollutant to be adsorbed, the temperature of the gas stream to be processed, and the concentration of the contaminant in the gas stream. The adsorption capacity for a particular pollutant represents the amount of the pollutant that can be adsorbed on a unit weight of activated carbon consumed at the conditions present in the application. Typical adsorption capacities for moderately adsorbed compounds range from 5 to 30% of the weight of the carbon.

Activated carbon adsorption is applicable to low boiling point, small toxic, and volatile organic molecules. Large toxic or organic molecules are very difficult to remove from an activated carbon bed either by steam or by hot inert gas stripping and frequently result in decomposition or permanent plugging of the carbon bed. When a small fraction of the toxic organic compounds "high boilers" (large molecular weight, high boiling point compounds) are present, a sacrificial guard bed is used to protect the main regenerable beds from poisoning. The guard bed is replaced when breakthrough occurs. Large toxic or organic molecule activated carbon adsorption is economical only when the recoverable toxic organic compound is the significant fraction of the total toxic organic compounds with a small percentage of high boilers.

For toxic or volatile organic compounds at low concentration (below 100 ppm), the typical control technology is fixed bed adsorption on activated carbon and disposal of carbon off site. In most cases, the adsorbent can be "reactivated" under conditions similar to the "activation process" (~1,000 °C steam/air environment) where the adsorbed compounds are destroyed and the carbon is returned to near its original capacity. In addition, fixed adsorption is analogous to

chromatography; the various organic compounds adsorbing have a significant impact on the adsorption capacity of other organic molecules, due to both displacement and near permanent deposition on the carbon bed. Thus, while the adsorbent may indicate a relatively high pure component adsorption capacity for a particular component, when the gas stream has a large variety of organic molecule sizes and boiling points, the equilibrium capacity indicated by adsorption isotherms for that component cannot be approached.

As an example, a pure component isothermal capacity of 10 weight% may be reduced to as low as 0.1 weight% in a multi-component system due to displacement by other components of the gas stream or by the “plugging” of otherwise available surface by high molecular weight compounds. The effect of “co-adsorbates” in the individual breakthrough adsorption time of the toxic organic compounds was estimated by the National Research Council (NRC) in relation to chemical agent incineration effluent control in a dynamic system (*The Disposal of Activated Carbon from Chemical Agent Disposal Facilities* [NRC 1999]) and is shown in Table 4-3.

Table B3-3. Estimated Carbon Filter Breakthrough Times for Substances of Potential Concern in Stack Gases from Chemical Agent Disposal Facility Liquid Incinerator^a

Volatile Organic Compound	Estimated Initial Concentration (ng/m ³) ^a	Estimated Breakthrough Time as Single Component ^b	Estimated Time for Multi-Component Pollution Abatement System Filtration Flue Gas ^c
Benzene	90,000	2.4 years	14.2 hours
Carbon tetrachloride	35,000	4.1 years	7.1 minutes
Chloroform	22,000	2.5 years	5.7 hours
Vinyl chloride	4,500	1.7 days	9.5 minutes

Notes:
^a Bed dimensions = 214 square feet, 1 foot deep, 3,030 kg of carbon.
^b Calculated based on D-R equation assuming complete saturation of filter at 135°F.
^c Based on multi-component computer model, 135°F, 67% relative humidity.
 Source: *The Disposal of Activated Carbon from Chemical Agent Disposal Facilities* (NRC 1999).

Also, many emission source terms are defined with many safety factors, typically increasing the assumed concentration of the toxic organic compounds in the inlet gas stream, often by as much as an order of magnitude. Adsorption capacity is concentration-dependent and an order of magnitude decrease in organic compound concentration typically results in halving the adsorption capacity. Therefore, using an inflated source term for toxic organic compound concentrations results in an oversized adsorption system.

Furthermore, due to mass transfer limitations, only very large adsorbent beds approach the equilibrium capacity under dynamic conditions. The length of the mass transfer zone (MTZ) is again highly dependent on the properties of both the adsorbent structure (macro- and micro-

porosity) and the properties of the organic compounds. This is further complicated in case of variable concentration of organic compounds entering the adsorbent bed because both adsorption and desorption mass transfer needs to be considered. In most cases, the desorption MTZ is significantly longer than the adsorption MTZ. These factors establish the minimum bed depth (in the flow direction) criterion for adsorbent bed design. Typically, the minimum bed depth for long term use applications should be several orders of magnitude longer than the MTZ. Therefore, adsorbent beds cannot be designed solely on the adsorbent mass basis; the geometry is also important. If the bed depth is shorter than one MTZ for a particular compound, then instantaneous breakthrough of the organic compound will occur (*Handbook of Separation Techniques for Chemical Engineers*, Section 3.1, "Gas Phase Adsorption" [Schweitzer 1988]).

In summary, activated carbon has been shown to be applicable for treatment of a wide variety of environmental pollutants: It is a proven technology that is simple to install and easy to operate and maintain. Capital costs are among the least expensive for most alternative treatment technologies. Operating costs are primarily related to the amount of activated carbon consumed in the adsorption process.

Thermal Non-Catalytic Oxidation: Thermal non-catalytic oxidation is the process of oxidizing combustible materials by raising the temperature of the material above its auto-ignition point in the presence of oxygen, and maintaining it at high temperature for sufficient time to complete combustion to carbon dioxide and water. Time, temperature, turbulence (for mixing), and the availability of oxygen all affect the rate and efficiency of the combustion process. These factors provide the basic design parameters for oxidation systems (ICAC 1999, *Institute of Clean Air Companies, Control Technology Information - Thermal Oxidation*).

Typical thermal oxidation design efficiencies range from 98 to 99.99% and above, depending on system requirements and characteristics of the pollutants (EPA 453/R-92-018, *Control Techniques for Volatile Organic Compound Emissions from Stationary Sources*; EPA 453/B-96-001, *OAQPS Control Cost Manual*). Thermal oxidation is often the best choice when high efficiencies are needed and the waste gas is above 20% of the Lower Explosive Limit. Oxidation units, in general, are not recommended for controlling gases containing halogen- or sulfur-containing compounds because of the formation of highly corrosive acid gases. It may be necessary to install a post-oxidation acid gas treatment system in such cases, depending on the outlet concentration to reduce increased corrosion rates (EPA 453/B-1996-001). Thermal incinerators are also not generally cost-effective for low-concentration, high-flow organic vapor streams (EPA-456/R-95-002, *Control and Pollution Prevention Options for Ammonia Emission*).

Wet Scrubber Absorption: Wet scrubber absorption is widely used as a raw material and/or product recovery technique in separation and purification of gaseous streams containing high concentrations of volatile and toxic organic compounds, especially water-soluble compounds such as methanol, ethanol, isopropanol, butanol, acetone, and formaldehyde (Croll Reynolds 1999, *Croll Reynolds Company, Inc., web site <http://www.croll.com>*). However, as an emission control technique, it is much more commonly employed for controlling inorganic gases than for volatile or toxic organic compounds. When using absorption as the primary control technique for organic vapors, the spent solvent must be easily regenerated or disposed of in an environmentally acceptable manner (EPA/625/6-91/014, *Control Technologies for Hazardous*

Air Pollutants). When used for particulate control, high concentrations can clog the bed, limiting these devices to controlling streams with relatively low dust loadings (EPA-452/R-97-001, *Stationary Source Control Techniques Document for Fine Particulate Matter*).

Physical absorption depends on properties of the gas stream and liquid solvent, such as density and viscosity, as well as specific characteristics of the pollutant(s) in the gas and the liquid stream (e.g., diffusivity, equilibrium solubility). These properties are temperature-dependent, and lower temperatures generally favor absorption of gases by the solvent. Absorption is also enhanced by greater contacting surface, higher liquid-gas ratios, and higher concentrations in the gas stream (EPA/625/6-91). Chemical absorption may be limited by the rate of reaction, although the rate-limiting step is typically the physical absorption rate, not the chemical reaction rate (EPA 453/B-96-001). In addition, spent scrubbing waste water will be generated during unit operations and usually is not returned to the original system for recycle.

Step 4: Evaluation of Most Effective Control Technologies

To generate the data for the evaluation of the most effective control technologies for toxic organic compounds, an economic evaluation of the two highest-ranked technologies with efficiencies of 99% or greater was performed. The economic evaluations, total capital and annual operating costs, for thermal non-catalytic oxidation and activated carbon adsorption are given in Tables A3-4 and A3-5, respectively.

The economic analyses included evaluation of direct and indirect capital costs (equipment and installation), as well as annual operating costs (utilities, labor, and maintenance costs). To estimate the technology equipment costs, the equipment was sized based on the flow of each unabated off-gas stream. The equipment cost estimates were based on EPA guidance documents and vendor information. Next, factors for fabrication from corrosion resistant materials were applied. The above costs do not include disposal of secondary waste or post-oxidation acid gas treatment.

The equipment costs used in this evaluation were obtained by NUCON International, Inc. by obtaining quotes from suppliers (Appendix 1) and using previous experience and expertise in ammonia tBACT evaluations (RPP-ENV-46679, *Evaluation of Best Available Control Technology for Toxics tBACT, Double Shell Tank Farms Primary Ventilation Systems Supporting Waste Transfer Operations*).

Step 5: Select tBACT

The cost(\$)/ton for removal of toxic organic compounds exceeds the cost effective threshold previously acceptable to Ecology. Therefore, no specific control technologies were selected for toxic organic compounds removal. The annualized costs are summarized in Section A7.0.

Table B3.4 Toxic Organic Compounds - Thermal Non-Catalytic Oxidation Capital and Annual Cost Summary		
Cost Item	Basis	Cost (\$)
Purchased Equipment Costs		
Equipment ¹		13,600
Required Ancillary Equipment (\$10/cfm)	120	1,200
Instrumentation and Control	15% of Equipment	2,040
Freight	5% of Equipment	680
Sub-total Purchased Equipment Costs (PEC)		17,520
Direct Installation Costs		
Handling & Erection	14% of Subtotal PEC	2,453
Electrical	4% of Subtotal PEC	701
Piping and Duct Work	4% of Subtotal PEC	701
Insulation for Piping and Equipment	4% of Subtotal PEC	701
Painting	2% of Subtotal PEC	350
Sub-total Direct Installation Costs (IC)		4,906
Site Preparation Cost		20,000
Total Site Preparation Cost		Equipment Specific 20,000
Building Costs (Equipment footprint - ft ²)	Not Addressed	N/A
Total Direct Costs = PEC + IC + Site Preparation		42,426
Indirect Capital Costs		
Engineering	10% of Subtotal PEC	1,752
Construction and Field Expenses	5% of Subtotal PEC	876
Start-up	10% of Subtotal PEC	1,752
Performance Tests	1% of Subtotal PEC	175
Contingencies	15% of Subtotal PEC	2,628
Total Indirect Capital Costs		7,183
Total Capital Costs (TCC) = Total Direct Costs + Total Indirect Capital Costs		49,609
Direct Annual Costs		
Utilities		
Electricity (\$/kwh)	0.06	15
Steam (\$/1000 lbs)	\$6.00	0
Water (\$/1000 gallons)	0	0
Natural Gas (\$/MCF)	\$7.51/MCF	35,525
Materials/Chemicals	Process Specific	0
Operating Expenses		
Operator (\$62.75/hr)	300 hours	18,825
Supervisor	15% of Operator	2,824
Secondary Waste	\$129.24/cf	0
Labor (set up, monitor, maintenance, take down) (\$62.75/Hr)	1440 hours	90,360
Materials		680
Indirect Annual Costs		
Overhead	Included in labor costs	0
Administrative	2% of TCC	992
Insurance	1% of TCC	496
Total Annual Costs (TAC) = Direct Annual Costs + Indirect Annual Costs		149,718
Rate of Return on Capital Investment	10%	
Service Life (years) [equipment corrosion]	10 years	
Capital Recovery Factor	2.84	
Annualized Capital Investment (ACI)		140,889
Grand Total Annualized Costs (ACI + TAC)		290,607
Tons of Toxic Organic Compounds/year		4.57E-05
Annualized Cost per Ton of Toxic Organic Compounds		\$6,370,000,000
See RPP-ENV-46679, Appendix I-B		
Assumptions		
¹ Equipment cost was determined by ratioing the estimated cost of the equipment for a 3000 cfm (\$340,000) unit to the 120 cfm RMCS System exhauster		
This unit would need to be on a skid to service tanks throughout the Tank Farm Facility		

Table B3.5. Toxic Organic Compounds - Activated Carbon Adsorption Capital and Annual Cost Summary		
Cost Item	Basis	Cost (\$)
Purchased Equipment Costs		
Equipment		14,920
Required Ancillary Equipment (\$10/cfm)	120	1,200
Instrumentation and Control	15% of Equipment	2,238
Freight	5% of Equipment	746
Sub-total Purchased Equipment Costs (PEC)		19,104
Direct Installation Costs		
Handling & Erection	14% of Subtotal PEC	2,675
Electrical	4% of Subtotal PEC	764
Piping and Duct Work	4% of Subtotal PEC	764
Insulation for Piping and Equipment	4% of Subtotal PEC	764
Painting	2% of Subtotal PEC	382
Sub-total Direct Installation Costs (IC)		5,349
Site Preparation Cost		20,000
Total Site Preparation Cost		Equipment Specific 20,000
Building Costs (Equipment footprint - ft ²)	Not Addressed	N/A
Total Direct Costs = PEC + IC + Site Preparation		44,453
Indirect Capital Costs (Installation)		
Engineering	10% of Subtotal PEC	1,910
Construction and Field Expenses	5% of Subtotal PEC	955
Start-up	10% of Subtotal PEC	1,910
Performance Tests	1% of Subtotal PEC	191
Contingencies	15% of Subtotal PEC	2,866
Total Indirect Capital Costs		7,833
Total Capital Costs (TCC) = Total Direct Costs + Total Indirect Capital Costs		52,286
Direct Annual Costs		
Utilities		
Electricity (\$/kwh)	0.06	0
Steam (\$/1000 lbs)	\$6.00	0
Water (\$/1000 gallons)	0	0
Natural Gas (\$/MCF)	\$7.51/MCF	0
Materials/Chemicals	Process Specific	0
Operating Expenses		
Operator (\$62.75/hr)	300 hours	18,825
Supervisor	15% of Operator	2,824
Secondary Waste	\$129.24/cf	16,801
Labor (set up, monitor, maintenance, take down) (\$62.75/Hr)	1440 hours	90,360
Materials		9,776
Indirect Annual Costs		
Overhead	Included in labor costs	0
Administrative	2% of TCC	1,046
Insurance	1% of TCC	523
Total Annual Costs (TAC) = Direct Annual Costs + Indirect Annual Costs		140,155
Rate of Return on Capital Investment	10%	
Service Life (years)	40	
Capital Recovery Factor	0.102	
Annualized Capital Investment (ACI)		5,333
Grand Total Annualized Costs (ACI + TAC)		145,488
Tons of TOXIC ORGANIC COMPOUNDS/year		4.57E-05
Annualized Cost per Ton of Toxic Organic Compounds		\$3,200,000,000
See RPP-ENV-46679, Appendix 1-C		
Assumptions		
Equipment cost was determined by ratioing the estimated cost of the equipment for a 3000 cfm (\$373,000) unit to the 120 cfm RMCS System exhauster.		
This unit would have to be on a skid, water and Electricity rates from City of Richland homepage		
Natural gas price of \$0.73392/therm estimates from Cascade Natural Gas in Kennewick, WA		
Natural gas price was derived using 1 therm = 100 ft ³		
Water is provided for process use free of charge by MSA		
Rounded \$0.73 for natural gas to \$1.00		
Labor costs assumes 6 samples @ 6 weeks per sample @ 40 hour work week		

B4.0 IDENTIFICATION AND EVALUATION OF EMISSION CONTROL TECHNOLOGY OPTIONS FOR AMMONIA

This section covers the detailed evaluation for ammonia emissions tBACT. Ammonia emissions from operation of the core sampler in rotary mode are estimated to be 3.83 lb/24 hr averaging period (or 2.39E-02 tons/year) derived from Table B2-1.

Step 1: Emission Control Technologies Identified

Documents from the EPA present add-on control technologies used for ammonia emissions control (EPA-456/R-95-002). The add-on control technologies identified are wet scrubbers and condensation. These technologies are thoroughly described in the EPA references EPA-456/R-95-002 and EPA/-452/B-02-001 and in RPP-20774 (Letter May, 2004-ED-057). Use of the EPA cost estimating program also suggests two other technologies that may be considered as control technologies, including activated carbon adsorption and thermal oxidation. The following emission control technologies have been identified for the destruction and/or removal of ammonia:

- Wet scrubber absorption
- Activated carbon adsorption with untreated adsorbent
- Activated carbon adsorption with treated adsorbent
- Thermal non-catalytic oxidation
- Thermal catalytic oxidation
- Biofiltration
- Condensation.

Step 2: Elimination of Technically Infeasible Options

Qualitative screening and elimination criteria were developed for the selective elimination of control technologies evaluated to be technically infeasible or not applicable for treatment of ammonia emissions from operation of the core sampling system in rotary mode. The screening criteria were applied for the suite of control technologies for ammonia removal and/or destruction listed above and is shown in Table B4-1. The identified emission control technologies that are technically infeasible and eliminated include:

- Activated carbon adsorption with untreated adsorbent
- Thermal catalytic oxidation
- Biofiltration
- Condensation.

Activated Carbon Adsorption with Untreated Adsorbent: Activated carbon adsorption with untreated adsorbent is not suitable for the RMCS System source term. This is due to low

adsorption capacity/efficiency of most commercially available adsorbents and associated with the low ammonia concentrations that occur during sampling. See Section B4.0, Activated Carbon Adsorption discussion, for additional details.

Table B4-1. Ammonia – Potential Best Available Control Technology for Toxics

Control	Technology	Screening Results
1	Wet Scrubber Absorption	Acceptable
2	Activated Carbon Adsorption with Untreated Adsorbent	Eliminated
3	Activated Carbon Adsorption with Chemically Treated Adsorbent	Acceptable
4	Thermal Non-Catalytic Oxidation	Acceptable
5	Thermal Catalytic Oxidation	Eliminated
6	Biofiltration	Eliminated
7	Condensation	Eliminated

Thermal Catalytic Oxidation: Thermal catalytic oxidation can be used to reduce volatile organic compounds and ammonia emissions from a variety of sources. Generally high flow, low concentration applications are best suited to control these process units. Particulates or halogenated volatile organic compounds and heavy metals can clog the packed bed or poison or deactivate the catalyst reducing the design life of the unit. Specific poisons include halogenated compounds, mercury, arsenic, sulfur, sodium, and calcium. See Section B4.0, Thermal Catalytic Oxidation discussion, for further details.

Biofiltration: A bio-filter consists of a bed packed with biological material, sometimes even two or three beds. The gas stream is fed through the filter bed where the contaminants are removed from the waste gas by adsorption to and absorption by the filtering material. The components are then decomposed by micro-organisms. The bed consists of a carrier containing biological material such as: compost, tree bark, coconut fibers or peat. To decrease the amount of acidification, calcium or dolomite is sometimes added to the packing material. At high concentrations, nitrogenous, sulfurous or halogenated compounds form nitric acid, sulfuric acid and hydrochloric acid, respectively, and may acidify the filtering material reducing the overall removal efficiency of the process, thus drastically increasing the replacement frequency of the filtering material.

Condensation: Condensation technology removes pollutants from a gas stream that is saturated with water or warm and damp, by condensing to far below the water's dew point. The condensate that forms on the heat exchanger serves as an absorption liquid for contaminants that are easily dissolvable in water. The relatively large contact surface that is required for the exchange of heat is also used as a contact surface for the exchange of dust. After passing through the condenser the gas stream is 100% saturated with water and the remaining condensate drips are collected with a demister; thus, the contaminants are captured and removed in the liquid phase.

Step 3: Rank Remaining Control Technologies by Control Effectiveness

The remaining applicable and available best control technologies for ammonia are shown in Table 5-2. All of these control technologies have a removal efficiency of 99% or greater and are ranked equally.

Table B4-2. Best Available Control Technology for Toxics Ranking by Effectiveness for Control of Ammonia

Ranking/Technology	Removal Efficiency
1a. Activated Carbon Adsorption with Chemically Treated Adsorbent	>99%
1b. Thermal Non-Catalytic Oxidation	>99%
1c. Wet Scrubber Absorption	99%

Activated Carbon Adsorption with Chemically Treated Adsorbent: For the removal of ammonia, the activated carbon needs to be chemically treated with phosphoric acid (between 15 and 30 weight %) to obtain removal efficiencies of greater than 99%. The activated carbon acts as a collection substrate while the ammonia removal takes place by a reaction between the ammonia and the phosphoric acid. The ammonia removal capacity under equilibrium conditions is near stoichiometric and is related to the phosphoric acid concentration. Adsorption efficiency is affected by other compounds that can be adsorbed on the activated carbon but will not be poisoned by them.

Removal efficiency is greater than 99% for fresh adsorbent and decreases near the stoichiometric loading of the adsorbent. Adsorption on chemically treated activated carbon is more suitable for low concentrations of ammonia, but it is capable of handling limited ammonia concentration spikes. Spent chemically treated adsorbent, which theoretically can be re-activated by thermal treatment, is typically disposed of in landfills. See Section B4.0, Activated Carbon Adsorption discussion, for further details.

Thermal Non-Catalytic Oxidation: Thermal non-catalytic oxidation is a high temperature air-ammonia process reaction without the use of a catalyst. The destruction efficiency depends on the temperature of the unit operations. Greater than 99% ammonia destruction can be achieved at low temperature.

This technology is also capable of handling various concentrations of ammonia in the inlet stream, and it is not sensitive to concentration spikes. In addition, thermal non-catalytic oxidation is not sensitive to halogenated or metallic compounds in the inlet stream (i.e., treats and destroys the majority of toxic or volatile organic compounds). However, acids and dioxins will be generated during the destruction of halogenated organic compounds, which will contribute an increased corrosion rate on materials of construction, thus shortening the design life of the process unit. Oxides of nitrogen are also generated by this process which, depending

on concentration, may require additional treatment. See Section A3.0, Thermal Non-Catalytic Oxidation discussion, for further details.

Wet Scrubber Absorption: Scrubber absorption is a common emission technology for ammonia reduction; however it is used at higher concentrations than present in SSTs. At defined source term concentrations, the scrubbing liquid has to be acidified to efficiently collect the ammonia. The scrubbing liquid is replenished based on the conversion rate to salt and needs to be treated as secondary waste.

The spent scrubbing secondary waste water cannot be returned to the DST system and will need to be sent to the effluent treatment facility (ETF). See Section B4.0, Wet Scrubber Absorption discussion, for further details.

Step 4: Evaluation of Most Effective Control Technologies

To generate the data for the evaluation of the most effective control technologies for ammonia, an economic evaluation of the above-identified technologies applied to each unabated off-gas stream was performed. The economic evaluations for ammonia control technologies are shown in the following tables:

- Table B4-3 – Thermal non-catalytic oxidation
- Table B4-4 – Activated carbon adsorbers with treated adsorbent
- Table B4-5 – Wet scrubber absorption.

The economic analyses included evaluation of direct and indirect capital costs (equipment, installation), as well as annual operating costs (utilities, labor, and maintenance costs). To estimate the technology equipment costs, the equipment was sized based on the flow of each unabated off-gas stream. The equipment cost estimates were based on EPA guidance documents and vendor information. Factors for fabrication from corrosion-resistant materials and adaptation to field operations and maintenance were applied. The above costs do not include disposal of secondary waste or post-oxidation acid gas treatment.

The equipment costs used in this evaluation were obtained by NUCON International, Inc. by supporting the design and fabrication of similar facilities; by obtaining quotes from suppliers (RPP-ENV.46679, Appendix 1) and using previous experience and expertise in ammonia tBACT evaluations; and by reviewing costs from RPP-20774 (Letter 04-ED-057) and 24590-WTP-RPT-ENV-01-005, *Best Available Control Technology Analysis for Toxic Air Pollutants for the WTP* (2002). Specific quote costs were given priority over the report estimated costs, which were 2002 and 2004 vintage, although in several cases where comparisons were made between estimates and quotes the differences in cost were minor. The total annualized costs were based on a 10% rate of return and a 40-year facility life for activated carbon adsorption with treated adsorbent and a 10-year facility life for thermal non-catalytic oxidation and wet scrubber absorption due to corrosion issues mainly from halogenated organic compounds and sulfuric acid scrubbing liquids, respectively.

Step 5: Select tBACT

The cost(\$)/ton for removal of ammonia exceeded the cost effective threshold previously acceptable to Ecology. Therefore, no specific control technologies were selected for ammonia removal. The annualized costs are summarized in Section B7.0.

Table B4-3. Ammonia - Thermal Non-Catalytic Oxidation Capital and Annual Cost Summary		
Cost Item	Basis	Cost (\$)
Purchased Equipment Costs		
Equipment		13,600
Required Ancillary Equipment (\$10/cfm)	120	1,200
Instrumentation and Control	15% of Equipment	2,040
Freight	5% of Equipment	680
Sub-total Purchased Equipment Costs (PEC)		17,520
Direct Installation Costs		
Handling & Erection	14% of Subtotal PEC	2,453
Electrical	4% of Subtotal PEC	701
Piping and Duct Work	4% of Subtotal PEC	701
Insulation for Piping and Equipment	4% of Subtotal PEC	701
Painting	2% of Subtotal PEC	350
Sub-total Direct Installation Costs (IC)		4,906
Site Preparation Cost		20,000
Total Site Preparation Cost	Equipment Specific	20,000
Building Costs (Equipment footprint - ft ²)	Not Addressed	N/A
Total Direct Costs = PEC + IC + Site Preparation		42,426
Indirect Capital Costs		
Engineering	10% of Subtotal PEC	1,752
Construction and Field Expenses	5% of Subtotal PEC	876
Start-up	10% of Subtotal PEC	1,752
Performance Tests	1% of Subtotal PEC	175
Contingencies	15% of Subtotal PEC	2,628
Total Indirect Capital Costs		7,183
Total Capital Costs (TCC) = Total Direct Costs + Total Indirect Capital Costs		49,609
Direct Annual Costs		
Utilities		
Electricity (\$/kwh)	0.06	15
Steam (\$/1000 lbs)	\$6.00	0
Water (\$/1000 gallons)	0	0
Natural Gas (\$/MCF)	\$7.51/MCF	35,525
Materials/Chemicals	Process Specific	0
Operating Expenses		
Operator (\$62.75/hr)	300 hours	18,825
Supervisor	15% of Operator	2,824
Secondary Waste	\$129.24/cf	0
Labor (set up, monitor, maintenance, take down) (\$62.75/Hr)	\$62.75 * 1440 hours	90,360
Materials		680
Indirect Annual Costs		
Overhead	Included in labor costs	0
Administrative	2% of TCC	992
Insurance	1% of TCC	496
Total Annual Costs (TAC) = Direct Annual Costs + Indirect Annual Costs		149,718
Rate of Return on Capital Investment	10%	
Service Life (years) [equipment corrosion]	10 years	
Capital Recovery Factor	2.84	
Annualized Capital Investment (ACI)		140,889
Grand Total Annualized Costs (ACI + TAC)		290,607
Tons of Toxic Organic Compounds/year		4.57E-05
Annualized Cost per Ton of Toxic Organic Compounds		\$6,400,000,000
See RPP-ENV-46679, Appendix 1-B		
Assumptions		
This unit would have to be on a skid, water is provided for process use free of charge by MSA		
Water and Electricity rates from City of Richland homepage		
Natural gas price of \$0.73392/therm (rounded to \$1.00) estimates from Cascade Natural Gas in Kennewick, WA.		
Annual cost for natural gas was derived by ratioing the annual cost of for a 3000 cfm exhauster (\$635,056) at 8760 hrs/yr operation to a 120 cfm exhauster operating 300 hours per year		
Natural gas price was derived using 1 therm = 100 ft ³		
Labor costs assumes 6 samples @ 6 weeks per sample @ 40 hour work week		

Table B4-4. Ammonia - Activated Carbon Adsorbers with Treated Adsorbent Capital and Annual Cost Summary		
Cost Item	Basis	Cost (\$)
Purchased Equipment Costs		
Equipment		\$16,120
Required Ancillary Equipment (\$10/cfm)	120	\$1,200
Instrumentation and Control	15% of Equipment	\$2,418
Freight	5% of Equipment	\$806
Sub-total Purchased Equipment Costs (PEC)		\$20,544
Direct Installation Costs		
Handling & Erection	14% of Subtotal PEC	\$2,876
Electrical	4% of Subtotal PEC	\$822
Piping and Duct Work	4% of Subtotal PEC	\$822
Insulation for Piping and Equipment	4% of Subtotal PEC	\$822
Painting	2% of Subtotal PEC	\$411
Sub-total Direct Installation Costs (IC)		\$5,752
Site Preparation Cost		\$20,000
Total Site Preparation Cost	Equipment Specific	\$20,000
Building Costs (Equipment footprint - ft ²)	Not Addressed	N/A
Total Direct Costs = PEC + IC + Site Preparation		\$46,296
Indirect Capital Costs		
Engineering	10% of Subtotal PEC	\$2,054
Construction and Field Expenses	5% of Subtotal PEC	\$1,027
Start-up	10% of Subtotal PEC	\$2,054
Performance Tests	1% of Subtotal PEC	\$205
Contingencies	15% of Subtotal PEC	\$3,082
Total Indirect Capital Costs		\$8,423
Total Capital Costs (TCC) = Total Direct Costs + Total Indirect Capital Costs		\$54,719
Direct Annual Costs		
Utilities		
Electricity (\$/kwh)	0.06	\$0
Steam (\$/1000 lbs)	\$6.00	\$0
Water (\$/1000 gallons)	0	\$0
Natural Gas (\$/MCF)	\$7.51/MCF	\$0
Materials/Chemicals	Process Specific	\$0
Operating Expenses		
Operator (\$62.75/hr)	300 hours	\$18,825
Supervisor	15% of Operator	\$2,824
Secondary Waste	\$129.24/cf	\$103,392
Labor (set up, monitor, maintenance, take down) (\$62.75/Hr)	1440 hours	\$90,360
Materials		\$9,520
Indirect Annual Costs		
Overhead	Included in labor costs	\$0
Administrative	2% of TCC	\$1,094
Insurance	1% of TCC	\$547
Total Annual Costs (TAC) = Direct Annual Costs + Indirect Annual Costs		\$226,562
Rate of Return on Capital Investment	10%	
Service Life (years)	40	
Capital Recovery Factor	0.102	
Annualized Capital Investment (ACI)		\$5,581
Grand Total Annualized Costs (ACI + TAC)		\$232,144
Tons of Ammonia/year		2.39E-02
Annualized Cost per Ton of Ammonia		\$9,700,000
See RPP-ENV-46679, Appendix 1-C		
Assumptions		
This unit would have to be on a skid , water is provided for process use free of charge by MSA		
Water and Electricity rates from City of Richland homepage		
Natural gas price of \$0.73392/therm (rounded to \$1.00) estimates from Cascade Natural Gas in Kennewick, WA		
Natural gas price was derived using 1 therm = 100 ft ³		
Labor costs assumes 6 samples @ 6 weeks per sample @ 40 hour work week		

Table B4-5. Ammonia - Wet Scrubber and Annual Cost Summary

Cost Item	Basis	Cost (\$)
Purchased Equipment Costs		
Equipment		48,960
Required Ancillary Equipment (\$10/cfm)	120	1,200
Instrumentation and Control	15% of Equipment	7,344
Freight	5% of Equipment	2,448
Sub-total Purchased Equipment Costs (PEC)		59,952
Direct Installation Costs		
Handling & Erection	14% of Subtotal PEC	8,393
Electrical	4% of Subtotal PEC	2,398
Piping and Duct Work	4% of Subtotal PEC	2,398
Insulation for Piping and Equipment	4% of Subtotal PEC	2,398
Painting	2% of Subtotal PEC	1,199
Sub-total Direct Installation Costs (IC)		16,787
Site Preparation Cost		20,000
Total Site Preparation Cost	Equipment Specific	20,000
Building Costs (Equipment footprint - ft ²)	Not Addressed	N/A
Total Direct Costs = PEC + IC + Site Preparation		96,739
Indirect Capital Costs		
Engineering	10% of Subtotal PEC	5,995
Construction and Field Expenses	5% of Subtotal PEC	2,998
Start-up	10% of Subtotal PEC	5,995
Performance Tests	1% of Subtotal PEC	600
Contingencies	15% of Subtotal PEC	8,993
Total Indirect Capital Costs		24,580
Total Capital Costs (TCC) = Total Direct Costs + Total Indirect Capital Costs		121,319
Direct Annual Costs		
Utilities		
Electricity (\$/kwh)	0.06	0
Steam (\$/1000 lbs)	\$6.00	0
Water (\$/1000 gallons)	\$0.25	400
Natural Gas (\$/MCF)	\$7.51/MCF	0
Materials/Chemicals	Process Specific	2,000
Operating Expenses		
Operator (\$62.75/hr)	300 hours	18,825
Supervisor	15% of Operator	2,824
Secondary Waste (cannot be directly calculate, but is high)	\$129.24/cf	0
Labor (set up, monitor, maintenance, take down) (\$62.75/Hr)	1440 hours	90,360
Materials		8
Indirect Annual Costs		
Overhead	Included in labor costs	0
Administrative	2% of TCC	2,426
Insurance	1% of TCC	1,213
Total Annual Costs (TAC) = Direct Annual Costs + Indirect Annual Costs		118,056
Rate of Return on Capital Investment	10%	
Service Life (years) [corrosion]	10 years	
Capital Recovery Factor	2.84	
Annualized Capital Investment (ACI)		344,546
Grand Total Annualized Costs (ACI + TAC)		462,602
Tons of Ammonia/year		2.39E-02
Annualized Cost per Ton of Ammonia		\$19,000,000
See RPP-ENV-46679, Appendix 1-D		
Assumptions		
This unit would have to be on a skid, water is provided for process use free of charge by MSA		
Water and Electricity rates from City of Richland homepage		
Natural gas price of \$0.73392/therm estimates from Cascade Natural Gas in Kennewick, WA		
Natural gas price was derived using 1 therm = 100 ft ³		
Rounded \$0.73 for natural gas to \$1.00		
Labor costs assumes 6 samples @ 6 weeks per sample @ 40 hour work week		
The cost of Materials/Chemicals under Utilities section was estimated by ratioing the estimate for a 3000 cfm exhauster (\$50,000) to a 100 cfm exhauster		

B5.0 IDENTIFICATION AND EVALUATION OF EMISSION CONTROL TECHNOLOGY OPTIONS FOR MERCURY COMPOUNDS

This section covers the detailed tBACT evaluation for mercury and related compounds including dimethyl mercury from operation of the RMCS system. Dimethyl mercury is the only compound identified exceeding its ASIL limit ($1.00\text{E-}99 \mu\text{g}/\text{m}^3$). The release rate is $1.90\text{E-}11$ tons/year (derived from Table B2-1).

Step 1: Emission Control Technologies Identified for Mercury Compounds

The following emission control technologies have been identified for mercury compounds including dimethyl mercury:

- Wet Scrubber Absorption
- Powdered Carbon Injection
- Powdered Carbon Injection with chemically treated carbon
- Fixed Carbon Beds
- Fixed Carbon Beds with chemically treated carbon
- Depleted Brine Scrubbing
- Selenium Filters
- Gold Amalgamation.

Step 2: Elimination of Technically Infeasible Options

Qualitative screening and elimination criteria were developed for the selective elimination of control technologies evaluated to be technically infeasible or not applicable for treatment of mercury compound, including dimethyl mercury, emissions from operating of the core sampling system in rotary mode. The screening criteria for applicability were applied to the control technologies listed above and are shown in Table B5-1. All identified control technologies except for one were eliminated for the removal of mercury compounds. The primary reason for elimination of these technologies is that they have not been proven on a sufficient scale and irresolvable technical difficulties exist. A brief description of each control technology is given below.

Wet Scrubber Absorption: Wet scrubbing requires highly reactive sulfur-containing additives in the scrubbing liquor and has a reasonable efficiency for water-soluble mercury compounds only. It has been applied on some coal-fired power plants where the primary purpose of the scrubbing is acid gas removal. There is no chemical reason or any experimental data indication to expect that organic mercury compounds can be removed. For example, dimethyl mercury, an organic mercury compound, is not water-soluble and is not applicable for wet scrubbing abatement technologies. Extensive waste liquid disposal or collection and treatment are required

to support this technology. See Section 5.0, Wet Scrubber Absorption discussion, for further details.

Table B5-1. Mercury Compounds – Potential Best Available Control Technology for Toxics

Control	Technical Description	Screening Results
1	Wet Scrubber Absorption	Eliminated
2	Powdered Carbon Injection	Eliminated
3	Powdered Carbon Injection with chemically treated carbon	Eliminated
4	Fixed Carbon Beds	Eliminated
5	Fixed Carbon Beds with chemically treated carbon	Applicable
6	Depleted Brine Scrubbing	Eliminated
7	Selenium Filters	Eliminated
8	Gold Amalgamation	Eliminated

Powdered Carbon Injection: Powdered carbon injection is an existing control technology for power plants where powdered carbon is injected into the flue gas and reacts with mercury both in the gas phase and upon deposition in the particulate collecting bag-house of the power plant. It can be considered only when bag-house collectors are installed downstream and the carbon is continually injected and removed in conjunction with the ash collected in the bag-house. Mercury removal efficiencies have been cited between 50 and 70% for elemental mercury.

Powdered Carbon Injection with Treated Carbon: Powdered Carbon Injection with chemically treated carbon is a variation of the above process and results in somewhat higher mercury removal efficiency at an increased carbon cost. Additionally, commensurate corrosion problems can occur from the typical additive bromine.

Fixed Carbon Beds with Untreated Carbon: Fixed carbon beds are used in several applications for mercury vapor control, but their use has been almost completely superseded by the use of chemically treated carbon in the fixed beds. The mercury is only physically adsorbed on untreated activated carbon and migrates through the adsorbent bed according to the mass transfer conditions in the fixed bed. Untreated carbon is more sensitive to the presence of toxic organic compounds and inorganic vapors than the treated carbons (EPA-452-R-R7-010, *Mercury Study Report to Congress, Volume VIII: An Evaluation of Mercury Control Technologies and Costs* and EG&G-2008-EERC-01-02, *EG&G Carbon Evaluation for Mercury Removal*).

Depleted Brine Scrubbing: Depleted brine scrubbing is applicable only to chlor-alkali plants where the brine is one of the flow streams. This technology is not applicable and is not used in the other applications.

Selenium Filters: Selenium on adsorbent-based filters was eliminated due to selenium being a toxic material. Sulfur on adsorbents is equally reactive without the additional toxic hazards and is lower in cost.

Gold Amalgamation: Gold amalgamation is not an industrial process and has only been applied in mercury concentration measuring instruments only. There is no commercial or industrial destruction or removal application for this process [“Development and Demonstration of Mercury Control by Adsorption Processes (MerCAP™)” (Sjostrom, et al. 2003)].

Step 3: Rank Remaining Control Technologies by Control Effectiveness

Effectiveness is defined by the ability of the control technology to reduce the post-treatment emission rate for dimethyl mercury. The only control technology found to be applicable for mercury (including dimethyl mercury) control is fixed carbon beds with chemically treated activated carbon.

Carbon that is chemically treated with sulfur or iodine can remove mercury compounds. The most common version of this in industrial applications is the sulfur impregnation of the carbon and is used in similar composition and size off-gas control in the U.S. (e.g., chemical weapons incineration off-gas mercury control, mixed waste incinerator off-gas control, nuclear waste melter off-gas control, petrochemical processing). In these applications, the impregnated activated carbon (IAC) is placed in a fixed bed, either vertically or horizontally, and used until the exhaustion of the IAC. The life of the IAC is dependent on total mercury inlet concentration.

Several laboratory, pilot and full-scale tests have been performed with varying degrees of inlet mercury concentrations in air, in natural gas, and with organic compounds present in the off-gases of melters, incinerators and other gaseous waste treatment facilities (INEEL/CON-97-01225, *Mercury Emissions Control Technologies for Mixed Waste Thermal Treatment*; INEEL/CON-00-01332, *Removal of Mercury from the Off-Gas from Thermal Treatment of Radioactive Liquid Wastes*). One of the common IACs is MERSORB^{®1}, for which additional test reports are also attached (Appendix 2).

Impregnated Activated Carbon mercury vapor abatement technologies are mature and have been successfully used for the control of effluents and emissions in both nuclear and military applications. The nuclear application typically treats radioactive waste melter effluents and incineration off-gases from processes such as the THOR[®] Process² (“Off-Gas Mercury Control using Sulfur Impregnated Activated Carbon – Test Results” [Soelberg et al. 2007]). The military applications consist primarily of the effluent control from chemical agent destruction, either by thermal or chemical processes.

Several of the tests reported in NUCON Bulletin 11B28, *MERSORB[®] Mercury Adsorbents* (see Appendix B) were performed using radioactive mercury (¹⁵⁹Hg). Comparing the total mercury

¹ MERSORB[®] is a registered trademark of NUCON International, Inc., 7000 Huntley Road, Columbus, Ohio.

² THOR[®] is a trademark of THOR Treatment Technologies, Richland, Washington.

decontamination results between the air gas carrier and natural gas carrier gas streams indicates that the total mercury removal was better from the natural gas stream, where organic mercury could form from the air stream. The manner in which the tests were run would have indicated different movement of mercury species by dual radioactivity peaks. No movement of mercury species were observed for long-term test data generated under chemical agent incineration condition air flows and operations.

There are also reports showing that dimethyl mercury in the presence of methanol decomposes to methane and elemental mercury (“Laboratory Study of Corrosion Effect of Dimethyl-Mercury on Natural Gas Processing Equipment” [Wongkasemjit and Wasantakorn 2000]). Considering that the methanol flux in the gas stream is about six orders of magnitude higher than the dimethyl mercury flux, it is expected that during adsorption treatment of both compounds through the IAC bed, it would give sufficient contact time to decouple the mercury from the methyl group.

In addition, Ecology evaluated mercury and dimethyl mercury releases from several landfills (Publication 05-07-039, *Determination of Total and Dimethyl Mercury in Raw Landfill Gas with Site Screening for Elemental Mercury at Eight Washington State Landfills for the Washington State Department of Ecology*). The sampling train, which used an untreated carbon substrate without impregnation, preferentially adsorbed dimethyl mercury to elemental mercury.

Under the current Ecology regulations, evaluation of dimethyl mercury abatement systems is triggered at levels over 1.00E-99.

The landfill study, cited above, used the best available detection method and resulted in a dimethyl mercury analysis above 20 ng/m³. This resulted in a reasonable relative standard deviation of ~10%. Below 2 ng/m³ the relative standard deviation increased to above 80%. Based on this report, in a similar gas stream matrix, the minimum reliable detection limit for dimethyl mercury is 10 ng/m³ or 110E-2 µg/m³.

Step 4: Evaluation of Most Effective Control Technologies

On the basis of the above, the only available, proven technology for total mercury control, even in the presence of dimethyl mercury, is treatment of the gas stream by IAC. The sizing, costing and operating costs are based on one of the IACs, MERSORB[®]. The economic evaluations, total capital and annual costs, are shown in Table B5-2.

The economic analyses included evaluation of direct and indirect capital costs (e.g., equipment, installation), as well as annual operating costs (e.g., utilities, labor, and maintenance costs). To estimate the technology equipment costs, the equipment was sized based on the flow of each unabated off-gas stream. The equipment cost estimates were based on EPA guidance documents and vendor information. Next, factors for fabrication from corrosion-resistant materials and adaptation to radioactive environment operations and maintenance were applied. The above costs do not include disposal of secondary waste or post-oxidation acid gas treatment.

The equipment costs used in this evaluation were obtained by NUCON International, Inc. who owns MERSORB[®] technology. The total annualized costs were based on a 10% rate of return and a 40-year facility life for mercury compounds including dimethyl mercury emissions control.

Step 5: Select tBACT

The cost (\$)/ton for removal of mercury and mercury related compounds exceeds the cost effective threshold previously acceptable to Ecology. Therefore, no specific control technologies were selected for mercury and mercury related compounds removal. The annualized costs are summarized in Section 8.

Table B5-2. Mercury - Fixed Carbon Beds with Chemically Treated Adsorbent tBACT Control Technology Capital and Annual Cost Summary		
Cost Item	Basis	Cost (\$)
Purchased Equipment Costs		
Equipment		9,880
Required Ancillary Equipment (\$10/cfm)	120	1,200
Instrumentation and Control	15% of Equipment	1,482
Freight	5% of Equipment	494
Sub-total Purchased Equipment Costs (PEC)		13,056
Direct Installation Costs		
Handling & Erection	14% of Subtotal PEC	1,828
Electrical	4% of Subtotal PEC	522
Piping and Duct Work	4% of Subtotal PEC	522
Insulation for Piping and Equipment	4% of Subtotal PEC	522
Painting	2% of Subtotal PEC	261
Sub-total Direct Installation Costs (IC)		3,656
Site Preparation Cost		20,000
Total Site Preparation Cost		20,000
Building Costs (Equipment footprint - ft ²)	Equipment Specific Not Addressed	N/A
Total Direct Costs = PEC + IC + Site Preparation		36,712
Indirect Capital Costs		
Engineering	10% of Subtotal PEC	1,306
Construction and Field Expenses	5% of Subtotal PEC	653
Start-up	10% of Subtotal PEC	1,306
Performance Tests	1% of Subtotal PEC	131
Contingencies	15% of Subtotal PEC	1,958
Total Indirect Capital Costs		5,353
Total Capital Costs (TCC) = Total Direct Costs + Total Indirect Capital Costs		42,065
Direct Annual Costs		
Utilities		
Electricity (\$/kwh)	0.06	0
Steam (\$/1000 lbs)	\$6.00	0
Water (\$/1000 gallons)	0	0
Natural Gas (\$/MCF)	\$7.51/MCF	0
Materials/Chemicals	Process Specific	0
Operating Expenses		
Operator (\$62.75/hr)	300 hours	18,825
Supervisor	15% of Operator	2,824
Secondary Waste	\$129.24/cf	162
Labor (set up, monitor, maintenance, take down) (\$62.75/Hr)	\$62.75 * 1400 hours	90,360
Materials		187
Indirect Annual Costs		
Overhead	Included in labor costs	0
Administrative	2% of TCC	841
Insurance	1% of TCC	421
Total Annual Costs (TAC) = Direct Annual Costs + Indirect Annual Costs		113,620
Rate of Return on Capital Investment	10%	
Service Life (years)	40	
Capital Recovery Factor	0.102	
Annualized Capital Investment (ACI)		\$4,291
Grand Total Annualized Costs (ACI + TAC)		\$117,911
Tons of Dimethyl Mercury/year		2.37E-10
Annualized Cost per Ton of Dimethyl Mercury		\$500,000,000,000,000
See RPP-ENV-46679, Appendix 1-C		
Assumptions		
This unit would have to be on a skid		
Water and Electricity rates from City of Richland homepage		
Natural gas price of \$0.73392/therm estimates from Cascade Natural Gas in Kennewick, WA		
Natural gas price was derived using 1 therm = 100 ft ³		
Water is provided for process use free of charge by MSA		
Rounded \$0.73 for natural gas to \$1.00		
Labor costs assumes 6 samples @ 6 weeks per sample @ 40 hour work week		
Secondary Waste was calculated by ratioing the volume of the adsorber for a 3000 cfm exhauster (314 cf) to a 120 cfm exhauster		

B6.0 IDENTIFICATION AND EVALUATION OF EMISSION CONTROL TECHNOLOGY OPTIONS FOR PARTICULATE METAL COMPOUNDS

This section covers the detailed tBACT evaluation for non-mercury metal compounds for operation of the Core Sampling System. Chromium was the only non-mercury metal compound having emissions above the de minimis level. Chromium will be present in particulate form as metals or metal salts.

*Washington Administrative Code 173-480-060, “Emission Standards for New and Modified Emission Units” and WAC 246-247, “Radiation Protection – Air Emissions” state that all new construction and significant modifications of emission units shall utilize best available radionuclide control technology (BARCT). The BARCT for release of particulate radionuclides from operation of the Core Sampling System will be a nuclear grade HEPA filter. No further technology selection or evaluation steps were performed except for the evaluation of the radiological control required filtering components efficiency for these pollutants. The collection efficiency of the nuclear grade HEPA filters used is better than 99.97% efficiency (PB-2016-0907, *Nuclear Grade HEPA Filters*).*

B7.0 BEST AVAILABLE CONTROL TECHNOLOGY FOR TOXICS RECOMMENDATION

After detailed evaluation of the four TAPs and the effectiveness and costs of emission control technologies for each, a cost (\$)/ton was determined to implement a control technology as identified in Table A7-1. All of the identified technologies were eliminated because their cost per ton exceeded the cost ceiling guidelines previously approved by Ecology and EPA as economically unjustifiable. Although the evaluated technology would remove 98 to 99% of the pollutants, the cost of the abatement becomes prohibitive on a per ton basis due to the low emission rates.

Table B7-1. Total Annualized Costs of Abatement Technologies, Emissions per Year, and the Cost of Removal per Ton Compared to the Ceiling Cost Effectiveness Threshold.					
	Total Annualized Costs (\$/year)	Emissions per Averaging Period (lbs)	Emissions per Year (tons)	Annual Cost of Removal (\$/ton)	Ceiling Cost of Effectiveness Threshold (\$/ton)
Ammonia (24-hour)					
Thermal Non-Catalytic Oxidizer	\$149,718	3.83	2.39E-02	\$12,000,000,000	\$52,500
Activated Carbon Adsorption	\$226,562	3.83	2.39E-02	\$9,700,000	\$52,500
Scrubber	\$118,056	3.83	2.39E-02	\$19,000,000	\$52,500
Toxic Organic Compounds (Year)					
Thermal Non-Catalytic Oxidizer	\$149,718	9.13E-02	4.57E-05	\$6,370,000,000	\$105,000
Activated Carbon Adsorption	\$140,155	9.13E-02	4.57E-05	\$3,200,000,000	\$105,000
Mercury and Mercury-Related Compounds (Year)					
Activated Treated Carbon Adsorption	\$113,620	3.79E-08	1.90E-11	\$6,200,000,000,000,000	\$105,000
Particulate Metal Compounds	Particulate metal compounds are removed by the required particulate filtration train for removal of radionuclides at 99.95% removal rate.				
<u>Assumption</u>					
Pounds of ammonia was multiplied by 12.5 - the number of 24 hour days in a 300 hour year					

Based on the results of this tBACT evaluation, the proposed tBACT control technology for the operation of the core sampling system in high purge gas flow mode consists of a HEPA filtration system in the exhaust.

B8.0 REFERENCES

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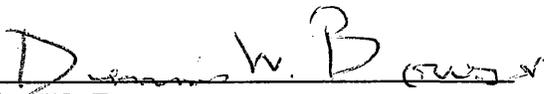
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Attachment 2
14-ECD-0031
(6 Pages)

Notice of Construction Application



Dennis W. Bowser



Notice of Construction Application

This application applies statewide for facilities under the Department of Ecology's jurisdiction. Submit this form for review of your project to construct a new or modified source of air emissions. Please refer to Ecology Forms ECY 070-410a-g, "Instructions for NOC Application," for general information about completing the application.

Ecology offers up to two hours of free pre-application assistance. We encourage you to schedule a pre-application meeting with the contact person specified for the location of your proposal, below. If you use up your two hours of free pre-application assistance, we will continue to assist you after you submit Part 1 of the application and the application fee. You may schedule a meeting with us at any point in the process.

Upon completion of the application, please enclose a check for the initial fee and mail to:

**Department of Ecology
Cashiering Unit
P.O. Box 47611
Olympia, WA 98504-7611**

For Fiscal Office Use Only:
001-NSR-216-0299-000404

Check the box for the location of your proposal. For assistance, call the contact listed below:		
	Ecology Permitting Office	Contact
<input type="checkbox"/>	Chelan, Douglas, Kittitas, Klickitat, or Okanogan County Ecology Central Regional Office – Air Quality Program	Lynnette Haller (509) 457-7126 lynnette.haller@ecy.wa.gov
<input type="checkbox"/>	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Stevens, Walla Walla or Whitman County Ecology Eastern Regional Office – Air Quality Program	Greg Flibbert (509) 329-3452 gregory.flibbert@ecy.wa.gov
<input type="checkbox"/>	San Juan County Ecology Northwest Regional Office – Air Quality Program	David Adler (425) 649-7082 david.adler@ecy.wa.gov
<input type="checkbox"/>	For actions taken at Kraft and Sulfite Paper Mills and Aluminum Smelters Ecology Industrial Section – Waste 2 Resources Program Permit manager: _____	Garin Schriever (360) 407-6916 garin.schriever@ecy.wa.gov
<input checked="" type="checkbox"/>	For actions taken on the US Department of Energy Hanford Reservation Ecology Nuclear Waste Program	Philip Gent (509) 372-7983 philip.gent@ecy.wa.gov



Notice of Construction Application

Check the box below for the fee that applies to your application.

New project or equipment:

<input type="checkbox"/>	\$1,500: Basic project initial fee covers up to 16 hours of review.
<input checked="" type="checkbox"/>	\$10,000: Complex project initial fee covers up to 106 hours of review.

Change to an existing permit or equipment:

<input type="checkbox"/>	\$200: Administrative or simple change initial fee covers up to 3 hours of review Ecology may determine your change is complex during completeness review of your application. If your project is complex, you must pay the additional \$675 before we will continue working on your application.
<input type="checkbox"/>	\$875: Complex change initial fee covers up to 10 hours of review
<input type="checkbox"/>	\$350 flat fee: Replace or alter control technology equipment under WAC 173-400-114 Ecology will contact you if we determine your change belongs in another fee category. You must pay the fee associated with that category before we will continue working on your application.

Read each statement, then check the box next to it to acknowledge that you agree.

<input checked="" type="checkbox"/>	The initial fee you submitted may not cover the cost of processing your application. Ecology will track the number of hours spent on your project. If the number of hours Ecology spends exceeds the hours included in your initial fee, Ecology will bill you \$95 per hour for the extra time.
<input checked="" type="checkbox"/>	You must include all information requested by this application. Ecology may not process your application if it does not include all the information requested.
<input checked="" type="checkbox"/>	Submittal of this application allows Ecology staff to visit and inspect your facility.



Notice of Construction Application

Part 1: General Information

I. Project, Facility, and Company Information

1. Project Name Core Sampler Systems
2. Facility Name United States Department of Energy, Office of River Protection
3. Facility Street Address 2440 Stevens Drive, Richland, WA 99352
4. Facility Legal Description Hanford Site, 200 West and 200 East Areas
5. Company Legal Name (if different from Facility Name)
6. Company Mailing Address (street, city, state, zip) P.O. Box 550, MSIN H6-60, Richland, WA 99352

II. Contact Information and Certification

1. Facility Contact Name (who will be onsite) Dennis Bowser	
2. Facility Contact Mailing Address (if different than Company Mailing Address)	
3. Facility Contact Phone Number (509) 373-2566	4. Facility Contact E-mail Dennis_W_Bowser@orp.doe.gov
5. Billing Contact Name (who should receive billing information) Dennis Bowser	
6. Billing Contact Mailing Address (if different than Company Mailing Address)	
7. Billing Contact Phone Number (509) 373-2566	8. Billing Contact E-mail Dennis_W_Bowser@orp.doe.gov
9. Consultant Name (optional – if 3 rd party hired to complete application elements) Brian Rumburg	
10. Consultant Organization/Company Washington River Protection Solutions	
11. Consultant Mailing Address (street, city, state, zip) P.O. Box 850, MSIN R1-51, Richland, WA 99352	
12. Consultant Phone Number (509) 373-3438	13. Consultant E-mail Brian_P_Rumburg@rl.gov
14. Responsible Official Name and Title (who is responsible for project policy or decision-making) Kevin W. Smith, Manager	
16. Responsible Official Phone (509) 372-2315	17. Responsible Official E-mail Kevin_W_Smith@orp.doe.gov
18. Responsible Official Certification and Signature I certify, based on information and belief formed after reasonable inquiry, the statements and information in this application are true, accurate and complete.	
Signature _____	Date _____



Notice of Construction Application

Part 2: Technical Information

The Technical Information may be sent with this application form to the Cashiering Unit, or may be sent directly to the Ecology regional office with jurisdiction along with a copy of this application form.

For all sections, check the box next to each item as you complete it.

III. Project Description

Please attach the following to your application.

- Written narrative describing your proposed project.
- Projected construction start and completion dates.
- Operating schedule and production rates.
- List of all major process equipment with manufacturer and maximum rated capacity.
- Process flow diagram with all emission points identified.
- Plan view site map.

- Manufacturer specification sheets for major process equipment components.
- Manufacturer specification sheets for pollution control equipment.
- Fuel specifications, including type, consumption (per hour & per year) and percent sulfur.

IV. State Environmental Policy Act (SEPA) Compliance

Check the appropriate box below.

- SEPA review is complete:
Include a copy of the final SEPA checklist and SEPA determination (e.g., DNS, MDNS, EIS) with your application.

- SEPA review has not been conducted:

If review will be conducted by another agency, list the agency. You must provide a copy of the final SEPA checklist and SEPA determination before Ecology will issue your permit.
Agency Reviewing SEPA:

If the review will be conducted by Ecology, fill out a SEPA checklist and submit it with your application. You can find a SEPA checklist online at www.ecy.wa.gov/programs/sea/sepa/docs/echecklist.doc



Notice of Construction Application

V. Emissions Estimations of Criteria Pollutants

Does your project generate criteria air pollutant emissions? Yes No

If yes, please provide the following information regarding your criteria emissions in your application.

The names of the criteria air pollutants emitted (i.e., NO_x, SO₂, CO, PM_{2.5}, PM₁₀, TSP, VOC, and Pb)

Potential emissions of criteria air pollutants in tons per hour, tons per day, and tons per year (include calculations)

If there will be any fugitive criteria pollutant emissions, clearly identify the pollutant and quantity

VI. Emissions Estimations of Toxic Air Pollutants

Does your project generate toxic air pollutant emissions? Yes No

If yes, please provide the following information regarding your toxic air pollutant emissions in your application.

The names of the toxic air pollutants emitted (specified in WAC 173-460-150¹)

Potential emissions of toxic air pollutants in pounds per hour, pounds per day, and pounds per year (include calculations)

If there will be any fugitive toxic air pollutant emissions, clearly identify the pollutant and quantity

VII. Emission Standard Compliance

Provide a list of all applicable new source performance standards, national emission standards for hazardous air pollutants, national emission standards for hazardous air pollutants for source categories, and emission standards adopted under Chapter 70.94 RCW.

Does your project comply with all applicable standards identified? Yes No

VIII. Best Available Control Technology

Provide a complete evaluation of Best Available Control Technology (BACT) for your proposal.

IX. Ambient Air Impacts Analyses

Please provide the following:

Ambient air impacts analyses for Criteria Air Pollutants (including fugitive emissions)

Ambient air impacts analyses for Toxic Air Pollutants (including fugitive emissions)

¹ <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-460-150>



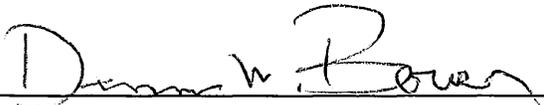
Notice of Construction Application

- Discharge point data for each point included in air impacts analyses (include only if modeling is required)
 - Exhaust height
 - Exhaust inside dimensions (ex. diameter or length and width)
 - Exhaust gas velocity or volumetric flow rate
 - Exhaust gas exit temperature
 - The volumetric flow rate
 - Description of the discharges (i.e., vertically or horizontally) and whether there are any obstructions (ex., raincap)
 - Identification of the emission unit(s) discharging from the point
 - The distance from the stack to the nearest property line
 - Emission unit building height, width, and length
 - Height of tallest building on-site or in the vicinity and the nearest distance of that building to the exhaust
 - Whether the facility is in an urban or rural location

Does your project cause or contribute to a violation of any ambient air quality standard or acceptable source impact level? Yes No

Attachment 3
14-ECD-0031
(52 Pages)

Second Tier Review Petition for the Operation of the
Core Sampler in High Purge Gas Mode



Dennis W. Bowser

Second Tier Review Petition for the Operation of the Core Sampler in High Purge Gas Mode

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-08RV14800



P.O. Box 850
Richland, Washington 99352

Second Tier Review Petition for the Operation of the Core Sampler in High Purge Gas Mode

Date Published
May 2014

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-08RV14800



P.O. Box 850
Richland, Washington

APPROVED

By marguerite washington at 1:07 pm, Jun 02, 2014

Release Approval

Date

Approved for Public Release;
Further Dissemination Unlimited

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Second Tier Review Petition for the Operation of the Core Sampler in High Purge Gas Mode

Prepared by:
Washington River Protection Solutions LLC

Date Published
May, 2014

Prepared For:
United States Department of Energy
Office of River Protection
P.O. Box 550
Richland, Washington 99352

EXECUTIVE SUMMARY

The U.S. Department of Energy and Tank Operations Contract manager Washington River Protection Solutions, LLC proposes operation of the core sampling system in high purge gas mode in support of tank waste characterization and future Tank Farm operational activities at the Hanford Site located in Benton County, Washington. All projects with emissions of air toxics defined in *Washington Administrative Code 173-460-150, Table of Acceptable Source Impact Level, Small Quantity Emission Rate and De Minimis Emission Values*, that exceed the de minimis levels are required to submit a first tier review. A first tier review, Criteria & Toxics Air Emissions Notice of Construction for the Operation of the Core Sampling System in High Purge Gas Mode, has been submitted to the Washington State Department of Ecology Nuclear Waste Program. If modeled concentrations exceed the acceptable source impact levels defined in *Washington Administrative Code 173-460-150* a second tier review or Health Impacts Analysis (HIA) is required. This document serves as a second tier petition and a Health Impacts Analysis pursuant to the requirements of *Washington Administrative Code 173-460-090, Second Tier Review*.

The estimated emissions and atmospheric modeling performed showed that only dimethyl mercury was found to be above the acceptable source impact level. The purpose of this document is to evaluate whether dimethyl mercury emissions from the proposed Core Sampling System could pose a potentially unacceptable health risk to local populations. A previous HIA was conducted and approved by the Washington State Department of Ecology for the 241-SY, 241-AP, 241-AY/AZ Tank Farm Ventilation System Upgrades (Kadlec, M., Ogulie, D., Bowman, C., *Technical Support Document for Second Tier Review 241-SY, 241-AP, 241-AY/AZ Tank Farm Ventilation System Upgrades at the Hanford Site, Benton County, Washington*). This Health Impacts Analysis follows the previous HIA regarding the dimethyl mercury emissions using the two pathways for human exposure that would result in the highest exposure to the public was inhalation and ingestion of plants. The first exposure scenario was a 30-year mother-child living at the point of maximum 24-hour concentration and deposition, the second was a 70-year resident scenario living at the location of the nearest resident. This evaluation is not intended to address all human exposure to dimethyl mercury or mercury in south central Washington State.

To ensure that the risks to the public are overestimated rather than underestimated, a conservative approach was taken. The process followed is listed below:

1. Estimate emissions from the Core Sampler ventilation systems.
2. Identify sensitive populations
3. Perform air modeling to predict ambient air concentrations from the ventilation systems
4. Perform air modeling to predict deposition onto plants from the ventilation systems
5. Calculate the total inhalation exposure from the operation of the ventilation systems
6. Calculate the total ingestion exposure from deposition on plants from operation of the ventilation systems
7. Calculate the total hazard from the ventilation systems.

This risk evaluation used conservative assumptions to ensure that the risk was an overestimation of the potential health impacts. Dimethyl mercury is a neurotoxin and studies have shown that it transforms into methyl mercury in the body (Ostlund, 1969). Due to the limited toxicological data for dimethyl mercury, toxicity data for methyl mercury toxicity data was used.

The maximum 24-hour modeled offsite dimethyl mercury concentration was $5.3E-09 \mu\text{g}/\text{m}^3$, there is limited atmospheric background data on dimethyl mercury, a mean for Antarctica was measured to be $4.0E-05 \mu\text{g}/\text{m}^3$ (de Mora et al., *Baseline Atmospheric Mercury Studies at Ross Island, Antarctica*, 1993) and a mean for Seattle was $3.0E-06 \mu\text{g}/\text{m}^3$ (Prestbo et al., *A Global View of the Sources and Sinks for Atmospheric Organic Mercury*, 1996). A previous analysis of dimethyl mercury emissions from Hanford modeled a peak offsite 24-hour concentration of $7.7E-08 \mu\text{g}/\text{m}^3$ (RPP-ENV-48231, *Second Tier Review Petition for the Operation of the 241-SY, 241-AP, and 241-AY/AZ Tank Farm Ventilation System Upgrades*). This is no more than a 0.2 percent increase above the existing background, airborne concentrations are likely to be lower due to conservative assumptions.

The National Research Council recommended a reference dose for methyl mercury of $0.1 \mu\text{g}/\text{kg}$ body weight per day to protect the most sensitive populations which are developing fetuses. The 30-year mother-child calculated exposure from the exhausters from inhalation and ingestion of dimethyl mercury is $2.6E-08 \mu\text{g}/\text{kg}$ body weight per day. The 70-year resident calculated exposure from the exhausters from inhalation and ingestion of dimethyl mercury is $2.4E-09 \mu\text{g}/\text{kg}$ body weight per day. The conservative assumptions made in this analysis resulted in an overestimation of the potential health impacts from dimethyl mercury emissions. The calculated hazard quotient for a mother-child 30-year exposure is $2.6E-07$, a level well below that threshold value of 1.0. The calculated hazard quotient for a 70-year resident exposure is $2.4E-08$, a level also well below that threshold value of 1.0. Both of these hazard quotients indicate that DMM emissions from the proposed core samplers should not pose any threat to the public.

Based upon the available literature and very low emissions and resulting ambient concentrations the emissions of dimethyl mercury from the proposed new core samplers should not pose a risk to the public.

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LIST OF TERMS

AOP	Air operating permit
ASIL	Acceptable source impact level
BACT	Best Available Control Technology
DMM	Dimethyl mercury
CAS	Chemical Abstract Service
DOE	Department of Energy
DST	Double-shelled tank
Ecology	Washington State Department of Ecology
HMS	Hanford Meteorological Station
HQ	Hazard Quotient
MeHg	Methyl mercury
SST	Single-shelled tank
TAP	Toxic Air Pollutant
tBACT	BACT for toxics
TWINS	Tank Waste Information Network System
WAC	<i>Washington Administrative Code</i>
WRPS	Washington River Protection Solutions, LLC
WTP	Waste Treatment and Immobilization Plant

Units

scfm	standard cubic feet per minute
kg	kilogram
mi	miles
ng	nanograms
µg	micrograms

1.0 PROJECT SUMMARY

The U.S. Department of Energy (DOE) and its Tank Operations Contractor (TOC) manager, Washington River Protection Solutions, LLC (WRPS) are proposing construction and operation of new Core Sampling ventilation systems for use in passively ventilated tanks at the Tank Farms at the Hanford Site in Benton County, Washington. All projects with emissions of toxics in *Washington Administrative Code* (WAC) 173-460-150 that exceed the de minimis levels are required to submit a first tier review. A first tier review, Criteria & Toxics Air Emissions Notice of Construction for the Core Sampling System in High Purge Gas Mode, has been submitted to the Washington State Department of Ecology (Ecology) Nuclear Waste Program. If modeled ambient concentrations exceed the acceptable source impact levels (ASIL) in WAC 173-460-150 a second tier review or Health Impacts Analysis (HIA) is required. This document serves as a second tier petition and a HIA pursuant to the requirements of WAC 173-460-090 and follows the format of the previous HIA that was submitted and approved by Ecology (Kadlec, M., Ogulie, D., Bowman, C., *Technical Support Document for Second Tier Review 241-SY, 241-AP, 241-AY/AZ Tank Farm Ventilation System Upgrades at the Hanford Site, Benton County, Washington*).

The previous Core Sampling Systems were beyond their useful life and are being replaced with new systems to take new samples to sample and characterize the waste in the Hanford Tank Farms. Core sampling is used to obtain a core of the waste, the high purge gas mode with an exhaustor is used when the density of the waste is such that normal low flow mode cannot remove sufficient heat during sampling. The high purge gas provides additional cooling for the drill bit and a portable exhaustor is used for passively ventilated tanks to ensure that the tanks are not over pressurized during sampling. Core Sampling in high purge gas mode is a short duration activity, the portable exhaustor is only turned on when the purge gas is turned on, the estimated total hours of operation for up to two samplers is 300 hours per year.

1.1 REPORT PURPOSE

The purpose of this report is to document the analysis and evaluation of the potential human health related impacts of dimethyl mercury (DMM) emissions and offsite ambient concentrations from the proposed Core Sampling Systems in High Purge Gas Mode ventilation systems at the Hanford Site to support sampling of the waste tanks. This study is intended to determine if the DMM emissions from the exhaustors pose an unacceptable risk to the public. This evaluation is not intended to address all human exposure to dimethyl mercury or mercury in south central Washington.

1.2 HANFORD TANK FARM HISTORY

The Hanford Site is located in south central Washington State in Benton County along the Columbia River and is approximately 586 square miles in size as shown in Figure 1. The mission of the Hanford Site from 1943 to 1988 was defense-related nuclear research, development, and weapons production. Nine nuclear reactors along the Columbia River at the site were used to produce plutonium. The site also had facilities in the Central Plateau, called the 200 Areas, used to extract the dissolved and irradiated reactor fuel for weapons production. Underground single-shell tanks (SSTs) were built to store the radiological and chemical waste from plutonium production beginning in 1943. One hundred and forty nine SSTs made of

carbon steel surrounded by concrete were built ranging in volume from 55,000 gallons to approximately 1 million gallons. Beginning in the 1960s after many of the single-shell tanks began to leak, 28 DSTs were built.

Since the last reactor was shut down in 1986 the site mission has been environmental remediation and clean up. Waste stored in the tanks consists of hazardous chemicals regulated under the *Resource Conservation and Recovery Act (RCRA) of 1976* and radioactive chemicals regulated under the *Atomic Energy Act of 1954*. In 1989 the DOE, U.S. Environmental Protection Agency (EPA) and Ecology agreed to the process and the required actions to comprehensively cleanup the Hanford Site (*Hanford Site Federal Facility Agreement and Consent Order*). The current mission to clean up the 200 Areas includes moving the waste from the SSTs to the DSTs to prevent any further leakage, retrieving and treating waste from all 177 underground tanks and ancillary equipment and disposing of the waste in compliance with applicable regulatory requirements (MGT-PM-PL-10, *Protect Execution Plan for the River Protection Tank Farms Project*).

1.3 CORE SAMPLING PERMITTING HISTORY

The first NOC for the Rotary Mode Core Samplers was submitted in 1993 (DOE/RL 93-41) and the Ecology approval order was NOC-93-04, that approval was cancelled in 1999. A NOC was submitted for two additional Rotary Core Mode Samplers and the modification of the first one (DOE/RL-94-117) were approved and the existing one modified with approval order NWP 95-RMCS(3). DOE/RL-94-117 was modified in 1998 (DOE/RL-94-117, Rev. 1) and NWP 95-RMCS(3) was replaced with DE98NWP-005 which was cancelled in 2005.

2.0 FACILITY IDENTIFICATION AND LOCATION

The tank farms are located at:

U.S. Department of Energy, Office of River Protection
Hanford Site
200 East and West Area Tank Farms
Richland, WA 99352

The waste tanks are located in the 200 East and West Areas of the Hanford Site (See Figure 1 and 2). Table 1 below lists the locations of the tank farms that are at the far north and south ends of the 200 West and 200 East Areas that were used to model the emissions due to their proximity to the site boundaries.

Table 1. Tank Farm Locations.

Tank Farm	Latitude	Longitude
A	46° 33' 12" N	119° 31' 02" W
BX	46° 33' 50" N	119° 32' 27" W
T	46° 33' 34" N	119° 37' 48" W
SX	46° 32' 14" N	119° 37' 48" W

Figure 1: Map of the Hanford Site.

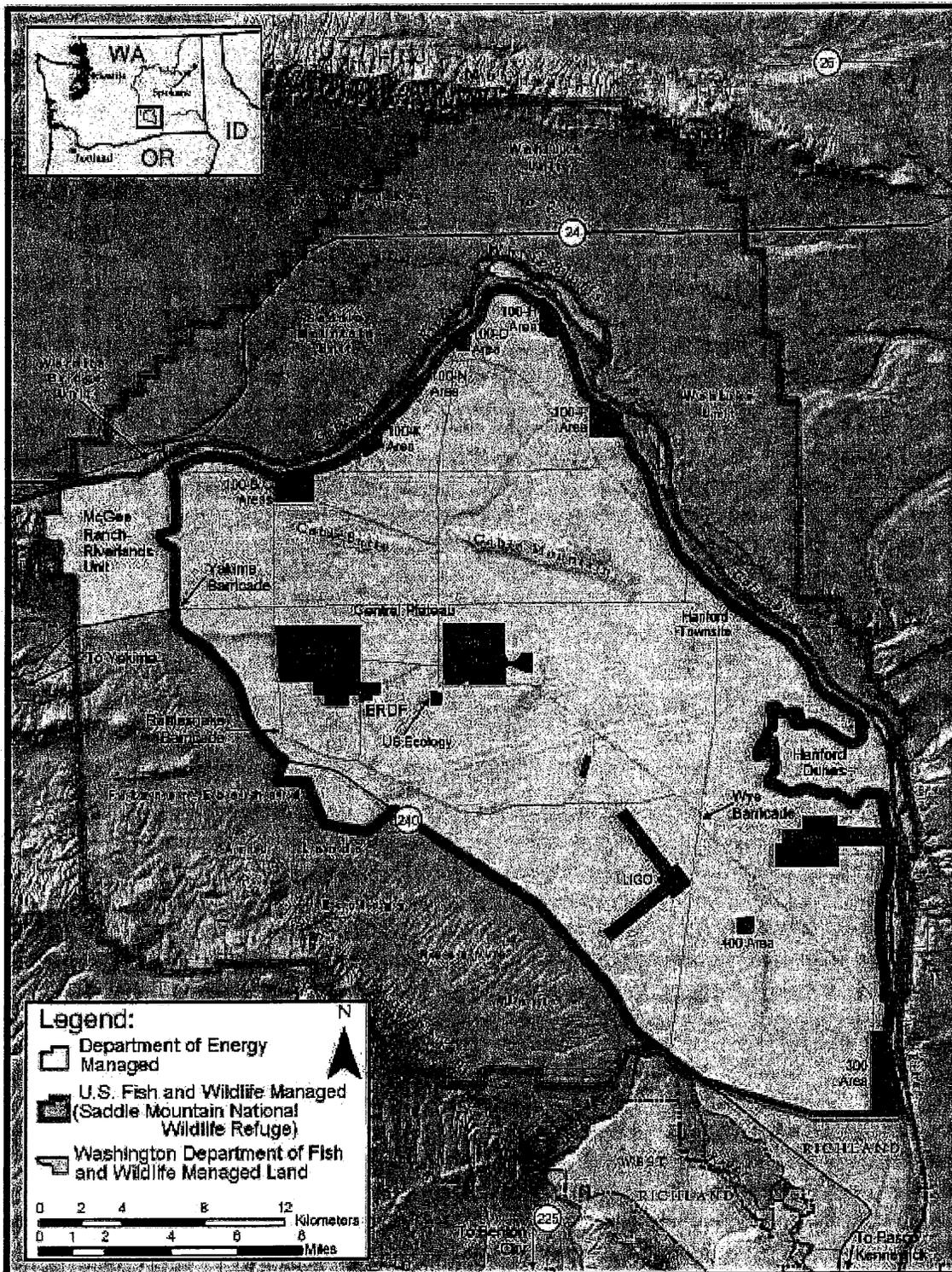
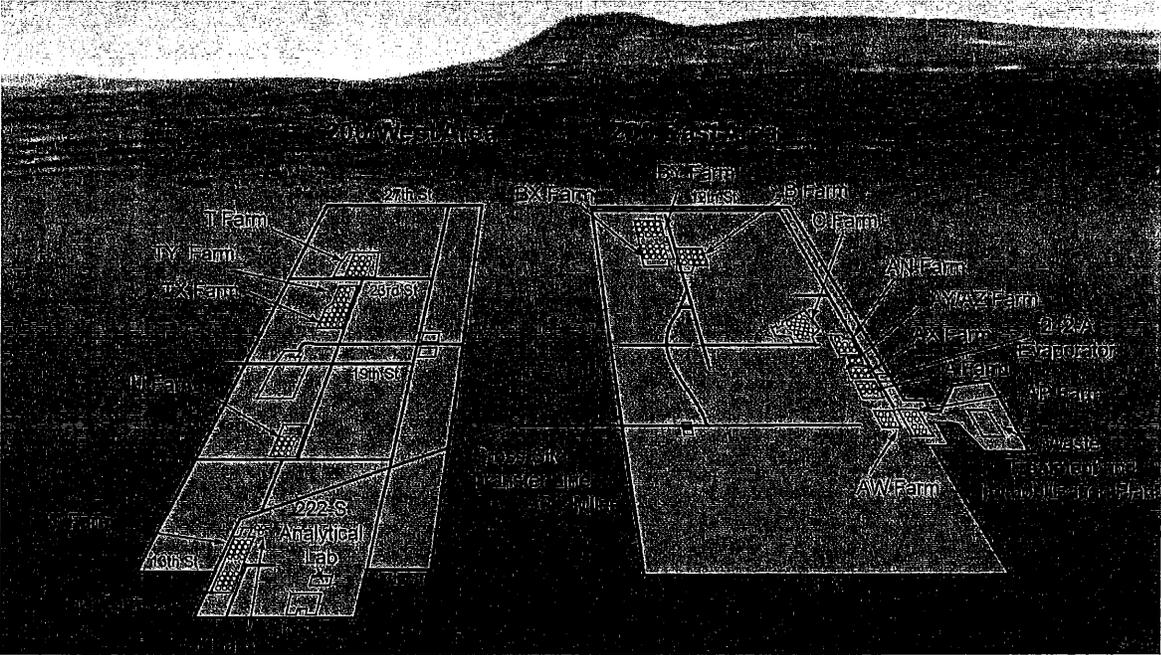


Figure 2. Location of all Single- and Double-Shell Tank Farms in 200 East and 200 West Areas of the Hanford Site.



2.1 CORE SAMPLER VENTILATION SYSTEMS

The core sampling system is a platform-mounted unit able to be set on any tank. This system can be operated in low purge gas flow mode (≤ 10 scfm) without an exhauster or high purge gas flow (> 10 scfm) mode with a portable exhauster and is capable of penetrating hardened tank wastes.

To obtain a sample, the drill string containing the sampler will be drilled or pushed into the waste. The core sampler dimensions are approximately 2-inch diameter by 40-inches long and can obtain a 19-inch sample. A core sample is made up of separate core segments (1-inch diameter) with the number of segments depending on the depth of solids. A piston inside the sampler creates a vacuum and draws the waste into the sampler. The sampler will close once the sample is obtained, trapping the sample and sealing the bottom of the core barrel. The barrier fluid and a seal on the bottom of the sampler are designed to prevent back flow of tank waste into the drill string. This protects the air pathway out of the tank.

When the system is in high purge gas flow mode, a purge gas with a flow rate up to a maximum of 120 (scfm) air will be injected to maintain pressure in the drill string for cooling and cleaning the drill bit and to prevent waste intrusion into the drill string while drilling (RPP-SPEC-42205, *Performance Specification for the Modified Core Sampling System*).

An exhauster (with a nuclear grade HEPA filter) and accompanying stack will be necessary to actively ventilate SSTs or other tanks without active ventilation to control potentially unsafe pressurization and generation of radioactive aerosols. The purge air and the exhauster will only be operated for a short duration during the sampling of the tanks; total estimated operation is 300 hours per year for all systems. If necessary to operate the core sampler system in a DST or another actively ventilated tank, exhauster capabilities will not be required and the active ventilation system will be used.

The schedule for initial operation of the core sampling system is in 2014 and sampling will continue until the end of the tank cleanup work, currently projected to be 2052. The activities proposed within this NOC will negligibly increase criteria and toxic air pollutant emissions during tank waste sampling activities.

The HEPA filters are abatement equipment required by the Washington State Department of Health (WDOE) to control particulate radionuclide emissions. The HEPA filters are nuclear grade with a minimum 99.95% efficiency for a polydispersed aerosol with an approximate droplet size distribution that is 99% less than 3.0 μm , 50% less than 0.7 μm , and 10% less than 0.4 μm . The HEPA filters are tested in accordance with ANSI N510 *Testing of Nuclear Air Treatment Systems*. Actual filter measurements with tank waste radionuclides show that individual filters are approximately 99.998% efficient which is at the limit of detection equipment (RPP-4826, *Experience with Aerosol Generation During Rotary Mode Core Sampling in the Hanford Single Shelled Waste Tanks*).

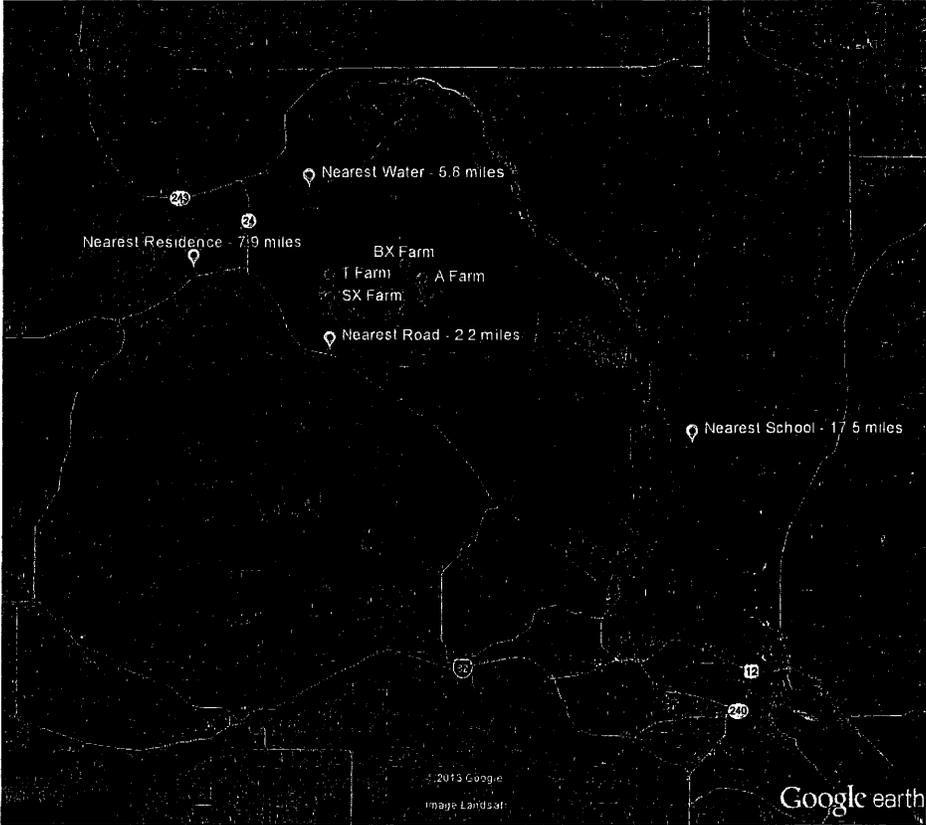
2.2 HANFORD METEOROLOGY

The Hanford Site is in the rain shadow of the Cascade Mountains and receives an average of less than seven inches of rain per year. The wind is predominately from the west, but calm wind conditions are frequent. Wind roses for the calendar years 2001-2005 were previously submitted to Ecology in RPP-ENV-48231, *Second Tier Review Petition for the Operation of the 241-SY, 241-AP, and 241-AY/AZ Tank Farm Ventilation System Upgrades*.

2.3 RECEPTORS

As shown in Figure 1, the Hanford Site is very large. The locations where the public can be exposed to the exhaust emissions are shown in Figure 3. The nearest offsite location is along Highway 240 about 2.3 miles to the south of the SX Tank Farm. The areas to the south of Highway 240 are also controlled areas and not open to the public. The nearest resident is approximately 7.9 miles to the west from the T Tank Farm. The nearest water body is the Columbia River 6.8 miles to the north of the T Tank Farm. The nearest school is 17.5 miles to the south and east of the A Tank Farm.

Figure 3. Map of the Hanford Area with Exhausters and Nearest Receptors.



3.0 RESPONSIBLE MANAGER

The current responsible facility manager is:

Kevin W. Smith, Manager
U.S. Department of Energy, Office of River Protection (ORP)
P.O. Box 550
Richland, Washington 99352
(509) 372-2315

4.0 EMISSIONS AND ATMOSPHERIC MODELING

Emissions from the new core sampling systems were estimated based on previous tank headspace and ventilation system measurements that have been documented in the Tank Waste Information Network System (TWINS). The methodology is described below. Atmospheric modeling was conducted to estimate ambient concentrations as recommended by Ecology.

4.1 EMISSIONS

The source term was submitted to Ecology in TOC-ENV-NOC-004, *Criteria & Toxic Air Emissions Notice of Construction for the Operation of the Core Sampling System in High Purge Gas Mode*, to develop the criteria and toxic air pollutant emissions for operation of the core sampling exhaust system in high purge gas flow mode was derived from NOC application RPP-ENV-48229, *Criteria & Toxics Air Emissions Notice of Construction for the Operation of the 241-AP, 241-SY, and 241-AY/AZ Tank Farm Ventilation System Upgrades* [Letter 11-NWP-121, "Re: Approval of Criteria and Toxic Air Emissions Notice of Construction (NOC) Application for the Operation of the 241-AP, 241-SY, and 241-AY/AZ Tank Farm Ventilation System Upgrades (Approval Order DE11NWP-001)"]. The methodology used for this NOC application assumed the following:

1. When the maximum value in the TWINS database is the measurement detection limit, that value is assumed to be the reported value.
2. Measurements were made over a quiescent and passively ventilated tank for all SSTs and actively ventilated DSTs. A constant emission rate was assumed as long as the tank waste remained quiescent.
3. SSTs were passively ventilated during measurements and each DST ventilation system was assumed to have a flow rate for each tank of 1,000 standard cubic feet per minute (scfm) divided by the number of tanks in the tank farm.
4. The highest emission rate for each TAP, drawn from all tanks in the 200 Area East and West Tank Farm Facility, was used to establish a "worst case" tank.

The unabated emissions of criteria and toxic pollutants were estimated based upon measured headspace concentrations in the TWINS database. This database was searched for regulated criteria and toxic pollutants by the Chemical Abstracts Service (CAS) number for all tanks.

Tank ventilation flow rates were derived from HNF-3588, *Organic Complexant Topical Report*, Rev. 1. For tanks not listed in HNF-3588, Rev. 1, or where the tanks listed in HNF-3588, Rev. 1 are known to have previously been actively ventilated, ventilation flow rates from a similar type SST were used. Flow rates were converted to per-tank fluxes.

4.2 BEST AVAILABLE CONTROL TECHNOLOGY

Pursuant to WAC 173-460-060(2), *Control Technology Requirements* an analysis of Best Available Control Technology for Toxics (tBACT) for emissions of toxic pollutants was performed and it is reported in TOC-ENV-NOC-004, Appendix B.

A tBACT analysis was performed using the “top-down” approach established for BACT. This approach is defined in detail in *New Source Review Workshop Manual – Prevention of Significant Deterioration and Nonattainment Area Permitting, EPA, 1990*. The approach consists of the following steps:

- 1) Identify all control technologies
- 2) Eliminate technically infeasible options
- 3) Rank remaining control technologies by control effectiveness
- 4) Evaluate most effective controls and document results
- 5) Select BACT

Toxics with similar chemical and physical properties were grouped together with the assumption that similar control technologies would be effective. The four groups identified were:

- Ammonia
- Toxic organic compounds
- Mercury and mercury related compounds
- Particulate metal compounds

A detailed evaluation of the emission control technologies was performed, and after an effectiveness analysis a cost per ton of pollutant removed was calculated. All of the costs per ton were above \$9,700,000 per ton which exceeded the cost ceiling estimates of \$52,000 previously approved by Ecology and EPA for the Hanford Site as economically justifiable (RPP-ENV-46679). Due to the low emission rates the cost per ton to remove the pollutants becomes prohibitively expensive.

Based upon the results of this tBACT, the proposed tBACT control technology for the Core Sampling exhaust system is a HEPA filter and a 20 foot stack.

4.3 AIR DISPERSION MODELING

Ambient air concentrations at the Hanford Site boundary and beyond were estimated using the United States EPA AERMOD dispersion model, Version 12060. EPA-454/B-03-001, *User's Guide for the AMS/EPS Regulatory Model – AERMOD* and Ecology's *Guidance Document: First, Second, and Third Tier Review of Toxic Air Pollution Sources* (08-02-025) were used as modeling guidance.

The model inputs included the physical parameters of the stack, facility property line, and digital elevation maps. The surface meteorological inputs were from the Hanford Meteorological Station (HMS) and the upper air data was obtained from the Spokane, Washington, National Weather Service. Both sets of weather data have previously been checked for quality and used for modeling on the Hanford Site. The calendar years 2001-2005 were analyzed. Terrain data was from the United State Geological Survey for the surrounding area. The regulatory default mode was used for atmospheric concentrations. For atmospheric deposition the factors used are described in section 4.4.

The receptor grid space was:

Table 2. Ecology Recommended Receptor Grid Spacing.

Distance from Source (m)	Grid Spacing (m)
0 – 350	10
350 – 800	25
800 – 4,000	50
4,000 – 8,000	100
8,000 – 30,000	200

Only offsite receptors were modeled for this analysis.

Sampling at each of the four farms A, BX, T and SX were modeled separately and the highest off site receptor was used. An emission rate of one g/s was used. Table 3 shows the highest dispersion factors for the Core Sampler at each of the four farms separately. The receptor with the highest concentration for each time period is along Highway 240 to the south and west of the 241-SX Tank Farm.

Table 3. Air Dispersion Factors for the Core Sampler System.

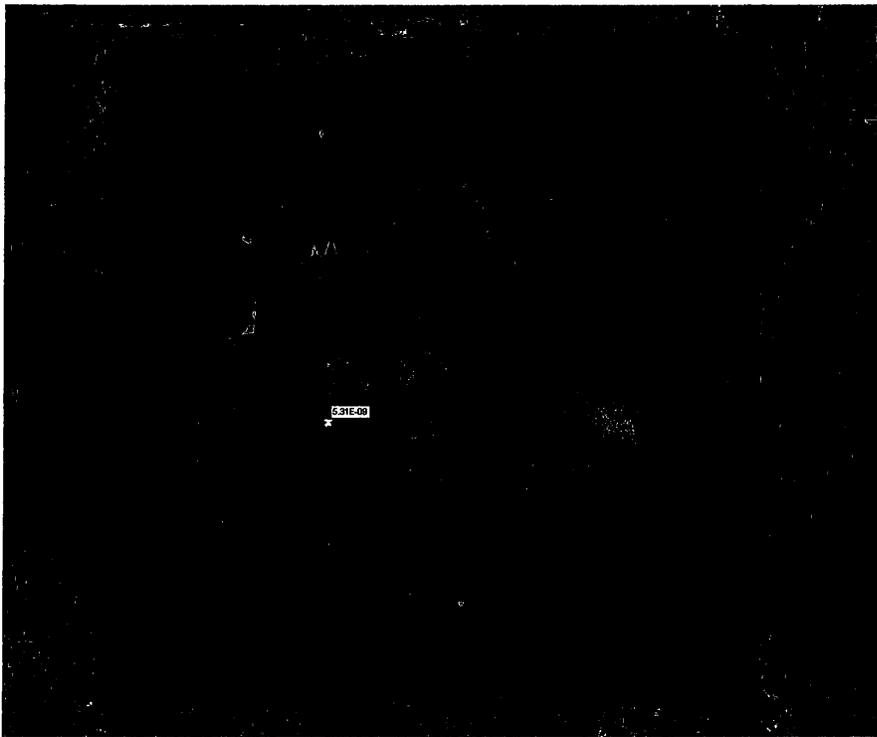
Averaging Period	Dispersion Factor ($\mu\text{g}/\text{m}^3$ per g/s)	Easting (m)	Northing (m)
1-hour (241-SX Farm)	7.88E+01	297,459	5,153,842
24-hour (241-SX Farm)	8.90E+00	297,652	5,153,793
Annual (241-SX Farm)	3.22E-01	297,264	5,153,890

The air dispersion factors, based upon the specific TAP averaging period, were multiplied by the total emission rate in g/s to calculate the ambient air concentrations shown in Appendix B.

Of the 91 toxics identified 4 were found to be above the WAC 173-460 de minimis screening levels and 3 were found to be above the small quantity emission rate. Only DMM was found to be above the acceptable source impact level. The peak 24 hour modeled concentration for DMM was $5.3\text{E-}09 \mu\text{g}/\text{m}^3$ in 2005 from 241-SX Farm. Figure 4 shows the location of the peak 24-hour concentration along Highway 240. The nearest residential receptor has a peak concentration of

1.3E-10 $\mu\text{g}/\text{m}^3$. The nearest resident is impacted more than the highest commercial receptor so the resident scenario is assumed to be more conservative. The rest of this report focuses primarily on DMM.

Figure 4. Contour Map of Peak 24-hour DMM Modeled Concentration from 241-SX Tank Farm for 2005.



Domain Geodetic Coordinates		
Corner	Easting (m)	Northing (m)
NW	277,113	5,188,386
SW	276,968	5,128,495
NE	337,005	5,188,386
SE	337,005	5,128,495

Concentration ($\mu\text{g}/\text{m}^3$)	Contour Color
5E-09	Black
1E-09	Black
5E-10	White
1E-10	Black
5E-11	Black
1E-11	Black

4.4 DEPOSITION MODELING

Since DMM can deposit on vegetation and soil and that can be ingested, deposition was modeled. Dimethyl mercury is not water soluble and does not react to form particles as described in Section 5.4. Therefore, only gaseous deposition was modeled. The AERMOD default options for gaseous dry deposition were used to model DMM deposition. AERMOD also requires seasonal parameters, surface characteristics and gas physical parameters to model deposition. The seasonal categories that AERMOD uses to calculate dry deposition are:

1. Midsummer with lush vegetation
2. Autumn with unharvested cropland
3. Late autumn after frost or winter with no snow
4. Winter with snow on the ground
5. Transitional spring with partial green coverage or short annuals.

Based upon the climate for the Hanford area category One was used for the months of May, June, July, and August. Category Two was used for September and October. Category Three was used for November, December, January, and February. Category Four was used for March and April, and Category Five was not used due to the infrequency of lasting snowfall in the area.

AERMOD also requires land use to calculate dry deposition using the following land use options:

1. Urban land, no vegetation
2. Agricultural land
3. Rangeland
4. Forest
5. Suburban, grassy
6. Suburban, forested
7. Bodies of water
8. Barren land, mostly desert
9. Non-forested wetlands

The rangeland option was used for this project due to the dominance of shrub steppe in the area.

The transport and cycling of pollutants in the atmosphere are dependent on the physical properties of the pollutant. AERMOD also requires the following physical parameters of the gas to model the deposition:

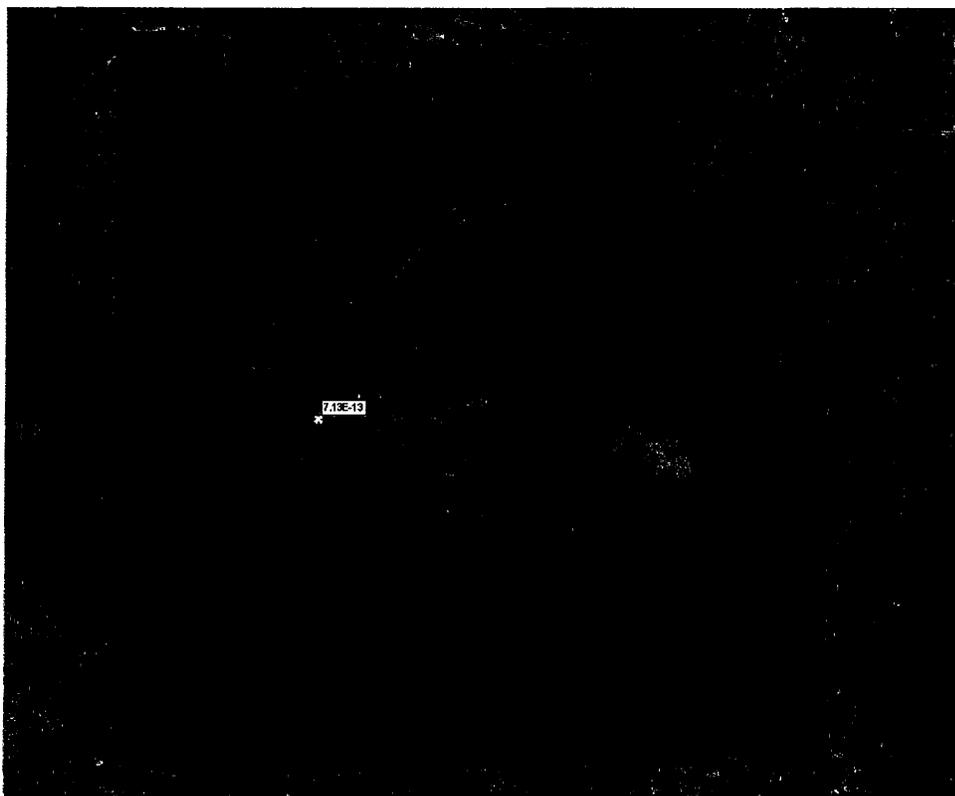
1. Diffusivity in air: $6.0E-02$ (cm^2/s) (Wesley et al., 2002)
2. Diffusivity in water: $5.25E-06$ (cm^2/s) (EPA 530-R-05-006)
3. Leaf cuticular resistance: $1.0E07$ (sec/m) (Wesley et al., 2002)
4. Henry's Law constant: $6.0E-06$ ($\text{pa}\cdot\text{m}^3/\text{mol}$) (Wesley et al., 2002).

Only the 24-hour deposition values were modeled because the ASIL for DMM is 24-hours.

The peak 24-hour DMM deposition for the five year period was $7.1E-13$ g/m^2 for 2005 from 241-SX Farm. The location of the peak deposition point is also along Highway 240 to the west

of the 241-SX Tank Farm as shown in Figure 5. The peak deposition at the nearest residence is $3.4\text{E-}14 \text{ g/m}^2$ for 2005.

Figure 5. Contour Map for the Peak 24-hour DMM Deposition for 2005 from 241-SX Farm.



Deposition Rate (g/m ² day)	Contour Color
6E-13	Black
5E-13	Black
1E-13	White
5E-14	Black
1E-14	Black
5E-15	Black

5.0 HAZARD IDENTIFICATION

Hazard identification involves evaluating toxicity data from the emissions along with the health injury or disease that may occur due to exposure. Appendix C shows the 4 TAPs that were above the SQER screening level and a brief description of potential health effects. The information was obtained from the Centers for Disease Control web site (<http://www.cdc.gov/niosh/>) and State of New Jersey Department of Health web site (<http://www.ehso.com/ehso.php?URL=http%3A%2F%2Fwww.state.nj.us/health/eoh/rtkweb/>).

Dimethyl mercury is the only TAP above the ASIL and the only neurotoxin above the SQER. Therefore the balance of this analysis will focus on DMM.

5.1 DIMETHYL MERCURY

Dimethyl mercury is an organomercury compound that is very toxic to humans. A small skin exposure of a few drops has been lethal (Nierenberg, et al., *Delayed Cerebellar Disease and Death after Accidental Exposure to Dimethyl Mercury*, 1998). Due to its high toxicity, DMM is rarely used and only a few cases of DMM poisoning have been documented.

Dimethyl mercury is a colorless liquid that is volatile and insoluble in water. The physical properties of DMM are shown in Table 4.

Table 4: Physical Properties of DMM.

Property	Value
Melting Point (°C)	-
Boiling Point (°C)	96° @ 1 atm
Vapor Pressure (Pa)	8.3 x 10 ³ @ 25°C
Water Solubility (g/l)	2.95 @ 24°C
Henry's law coefficient	646 @ 25°C

Due to the scarcity of DMM toxicity data very few toxicity level recommendations are available. While only a few cases of DMM toxicity have been studied most have been fatal. Methyl mercury (MeHg) toxicity has been studied more extensively. There are many similarities between DMM toxicity and MeHg toxicity (ACGIH, *Mercury Alkyl Compounds*, 2001). Dimethyl mercury is metabolized to MeHg in the human body before it enters the brain (Ostlund, *Studies on the Metabolism of Methyl Mercury in Mice*, 1969) and is further converted to inorganic mercury in the brain. Since DMM is metabolized to MeHg, toxicity data from MeHg can be used to estimate the toxicity of DMM. There have been a few cases of MeHg poisoning due to people ingesting MeHg that had bioaccumulated in fish and also from grain tainted with MeHg used as a fungicide (NRC, 2000). The toxicity of organomercury compounds is different from inorganic mercury compounds in that organomercury compounds pass through the blood-brain barrier and the placenta very rapidly compared to inorganic mercury compounds (ACGIH, 2001).

The National Research Council (NRC) issued *Toxicological Effects of Methylmercury* in 2000 to analyze the literature and develop a reference dose for MeHg for the EPA. Methyl mercury,

unlike DMM, is soluble in water and bioaccumulates up the food chain. There have been documented cases of mass exposure of people to MeHg due to mercury poisoning of water bodies and the subsequent ingestion of fish. Two instances occurred in Japan. There was also a mass poisoning due to the ingestion of MeHg coated wheat in Iraq (NRC, Toxicological Effects of Methylmercury).

Methyl mercury is rapidly absorbed from the gastrointestinal tract and accumulates in the adult and fetal brain. Methyl mercury can cross the blood-brain barrier and is also able to cross the placental barrier exposing the fetus. In the brain the MeHg is slowly converted to inorganic mercury. Animal studies have indicated that the developing nervous system in fetal and young animals is the most sensitive target organ for MeHg exposure. The central nervous system effects are neuronal death leading to impairment of cognitive, motor, and sensory functions. The evidence for MeHg being carcinogenic is inconsistent and inconclusive (National Research Council, 2000). The responses to MeHg exposure are variable and uncertain.

The NRC determined that the population at the highest risk is children of women who consume large amounts of fish and seafood during pregnancy. The developing brain of the fetus is most susceptible to mercury poisoning. The NRC recommended a reference dose (RfD) of 0.1 µg/kg per day to protect pregnant women and developing fetuses based upon the available toxicity data. The NRC applied uncertainty factors of 3 each to pharmacokinetic variability and uncertainty and 3 for pharmacodynamic variability and uncertainty to the data, choosing an overall factor of 10 to arrive at the RfD of 0.1 µg/kg per day (EPA 2001 IRIS, <http://www.epa.gov/iris/subst/0073.htm>).

5.2 DIMETHYL MERCURY EMISSIONS

Mercury compounds are widely used and they are commonly disposed of in municipal incinerators and landfills. Inorganic mercury under anaerobic conditions common in landfills can be transformed into methylated forms (Compeau and Bartha, *Sulfate Reducing Bacteria: Principle Methylators of Mercury in Anoxic Estuarine Sediments*, 1985). Limited studies have been conducted looking at emissions of DMM from landfills. Lindberg et al., in Methylated Mercury Species in Municipal Waste Landfill Gas Sampled in Florida, USA, 2001, found mean concentrations of 30 ng/m³ in landfill off gases in Florida. Seven landfills in Washington state were studied and landfill gas concentrations were found to be between 7.1 and 46.1 ng/m³ (Gallagher and Bennett, *Determination of Total and Dimethyl Mercury in Raw Landfill Gas with Site Screening for Elemental Mercury at Eight Washington State Landfills for the Washington State Department of Ecology*, 2003).

5.3 BACKGROUND CONCENTRATIONS

Only a limited number of atmospheric measurements of DMM have been made. Measurements of DMM were made in Antarctica and are shown in Table 5 (de Mora et al., *Baseline Atmospheric Mercury Studies at Ross Island, Antarctica*, 1993).

Table 5. Results from 196 Measurements of Atmospheric DMM in Antarctica.

Measurement	Concentration (ng/m ³)
Mean	0.04
Standard Deviation	0.08
Standard Error	0.01
Maximum	0.63
Minimum	0.00

An unknown number of ambient air concentrations in Seattle, Washington were measured to be 0.003 ± 0.004 ng/m³ (Prestbo et al., *A Global View of the Sources and Sinks for Atmospheric Organic Mercury*, 1996). Due to very limited data there are large uncertainties in background concentrations. The peak modeled 24-hour concentration is $5.3E-09$ µg/m³, much lower than the measured background concentrations. A previous analysis of dimethyl mercury emissions from Hanford modeled a peak offsite 24-hour concentration of $7.7E-08$ µg/m³ (RPP-ENV-48231). Due to the much larger background concentrations including the background concentration in this analysis would increase the health risk and not provide any project-attributable information.

5.4 ATMOSPHERIC FATE

Limited data is available about the concentration, fate, and transport of DMM in the atmosphere partly due to the very low concentrations and instrument detection limits. Reaction rate studies have shown that DMM will react with chlorine atoms (Cl), the hydroxyl radical (OH), the nitrate radical (NO₃), ozone (O₃), and fluoride radicals (F) (Sommar et al, *Rate of Reaction Between the Nitrate Radical and Dimethyl Mercury in the Gas Phase*, 1997). The reactions of DMM and Cl, OH, and NO₃ are the most dominant in the atmosphere. Given the atmospheric radical concentrations, the lifetime of DMM in the atmosphere ranges from roughly 1 to 100 hours (Sommar et al, 1997). Table 6 shows the lifetime of DMM in the atmosphere and the reaction products. Based upon this data the DMM from the Hanford Site is predicted to remain the vicinity of the Hanford Site. Therefore, no other forms of DMM were analyzed.

Table 6: Atmospheric Lifetime of DMM and Hg Containing Products.

Oxidant	Lifetime (hours)	Hg Products	Reference
Cl	1 - 100	CH ₃ HgCl	Niki et al. 1983
OH	1.2 - 30	None detected	Niki et al. 1983
NO ₃	0.8 - 150	Hg or HgO	Niki et al. 1983
O ₃	80,000 – 1,100,000	HgO	Sommar et al. 1996

6.0 SENSITIVE POPULATION ANALYSIS

The area around Hanford has been restricted from public access since 1943 when the residents of the area were moved offsite. There are a limited number of people living even within 10 miles of the center of the site. A report of the population and demographics of people living around the Hanford site was conducted in 2004 based upon the 2000 Census (PNNL-14428, *Hanford Area 2000 Population*, 2004). A map of the Hanford Site with nearby cities and towns and their populations was submitted to Ecology in RPP-ENV-48231, *Second Tier Review Petition for the Operation of the 241-SY, 241-AP, and 241-AY/AZ Ventilation Systems*.

RPP-ENV-48231 also shows the shows the land use and zoning for the surrounding counties Benton, Franklin, and Grant. Based upon the AERMOD modeling results the area to the west of the and south were the highest concentrations are is zoned agricultural.

The point of maximum impact along Highway 240 to the south and west of the 241-SX Tank Farm was chosen for the 30 year mother-child exposure scenario and the nearest resident was chosen for the 70 year exposure scenario. The mother-child scenario is conservative since no one lives at that location and it was assumed that the peak concentration and deposition for 24-hours was the concentration for 30 years. The resident exposure also used the peak 24-hour peak concentration and deposition. The project is only scheduled to last 40 years and emissions were assumed to be at their maximum.

7.0 EXPOSURE ESTIMATION

Ecology and DOE decided that inhalation and ingestion pathways of exposure needed to be investigated (10-ESQ-378). This document follows the same methodology as has previously been submitted (Kadlec, M., Ogulie, D., Bowman, C., 2011). Since DMM is not water soluble, it was agreed that the water and fish intake pathway would not be investigated. The health risk assessment protocol followed was *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (Hot Spots)* written by the California EPA in 2003.

Two scenarios were analyzed the mother-child pathway with the mother and child living along Highway 240 to the west of the 241-SX Tank Farm at the offsite receptor with the highest ambient concentration and deposition. To assess the mother-child pathway it was also assumed that the mother and child lived at that location for 30 years. The peak 24-hour concentration and deposition values were used to assess the 30-year exposure.

The second scenario analyzed was a person living at the site of the highest residential exposure to the west of the 241-SX Tank Farm for 70 years. The peak 24-hour concentration and deposition values were used to assess the 70-year exposure. Both scenarios were compared to the RfD to determine the most conservative exposure.

7.1 ESTIMATION OF EXPOSURE THROUGH INHALATION

The inhalation exposure to DMM was estimated using the CaliforniaEPA, guidance from 2003. Equation 5.4.1 was used to estimate the inhalation dose, is shown as Equation 1. The inhalation dose is a function of the air concentration and the respiration rate as defined in the following equation:

$$Dose_{inh} = \frac{C_{air} * DBR * A * EF * ED * 10^{-6}}{AT} \quad (1)$$

Where:

Dose _{inh}	= Dose through inhalation (mg/kg/d)
C _{air}	= Concentration in air (µg/m ³)
DBR	= Daily breathing rate (L/kg body weight – day)
A	= Inhalation absorption factor (unitless)
EF	= Exposure frequency (days/year)
ED	= Exposure duration (years)
AT	= Averaging time period over which exposure is averaged in days

The California EPA recommended values for Equation 1 are:

DBR	= 271 L/kg body weight/day
A	= 1
EF	= 350 days
ED	= 30 and 70 years
AT	= 10,950 and 25,550 days

The modeling results show a peak 24-hour air concentration of 5.3E-09 µg/m³ located along Highway 240 to the west of the 241-SX Tank Farm.

$$Dose_{inh} \frac{mg}{kg \text{ body weight} \cdot day} = \frac{5.3E-09 \frac{\mu g}{m^3} \cdot 271 \frac{L}{kg \text{ body weight} \cdot day} \cdot 1 \cdot 350 \frac{days}{year} \cdot 30 \text{ years} \cdot 10^{-6} \frac{mg}{\mu g}}{10,950 \text{ days}} \quad (2)$$

The result of Equation 2 for the mother-child scenario is an inhalation dose of 1.4E-12 mg/kg body weight per day which is 1.4E-09 µg/kg body weight per day. The result for the 70 year scenario is an inhalation dose of 3.4E-14 mg/kg body weight per day which is 3.4E-11 µg/kg body weight per day.

7.2 ESTIMATION OF EXPOSURE THROUGH INGESTION

The human exposure through food ingestion depends upon the amount of DMM that deposits on the plant while it is growing as well as the amount of DMM in the soil that the plant roots uptake. Next the human exposure depends upon the consumption of those plants. To calculate the human exposure it is first necessary to calculate the plant concentration.

The first step in the plant ingestion calculation is the estimation of the soil concentration. The California EPA guidance equation 5.32.A is:

$$C_s = \frac{Dep \cdot X}{K_s \cdot SD \cdot BD \cdot T_t} \quad (3)$$

Where:

C_s	= Average soil concentration over the evaluation period (µg/kg)
Dep	= Deposition on the affected soil area per day (µg/m ² * day)
X	= Integral function
SD	= Soil mixing depth (m)
BD	= Soil bulk density (kg/m ³)

The DMM deposition is from the AERMOD modeling results as explained above. The peak 24-hour deposition value was 7.1E-07 µg/m² day in 2005 located along Highway 240 to the west of the 241-SX Tank Farm. For the purposes of this analysis it was assumed that the most sensitive person was growing his/her garden at that location. For the nearest resident the deposition was 3.4E-08 µg/m² day in 2005. The California EPA recommended values for the SD is 0.15 m for an agricultural setting and the BD is 1,333 kg/m³.

The integral function described in Equation 3 is described in Equation 4 below:

$$X = \frac{e^{-K_s \cdot T_f} - e^{-K_s \cdot T_o}}{K_s} + T_t \quad (4)$$

Where:

K_s	= Soil elimination constant
T_f	= End of evaluation period (day)
T_o	= Beginning of evaluation period (day)

T_t = Total days of exposure [$T_f - T_o$] (days)

Using a 30-year exposure period the number of days for the total exposure is 10,950 assuming that the exposure began on day zero. Using a 70-year exposure period the number of days for the total exposure is 25,550 assuming that the exposure began on day zero. The soil elimination constant is given by equation 5.3.2 D in the California EPA document as:

$$K_s = \frac{0.693}{t_{1/2}} \quad (5)$$

Where:

0.693 = Natural log of 2

$t_{1/2}$ = Chemical specific soil half-life (days)

The soil specific half-life for DMM could not be found in the literature. Therefore Table 5.3 in the California EPA manual was used for inorganic mercury as 1E+08 days. The soil elimination constant then becomes:

$$K_s = \frac{0.693}{1E+08 \text{ days}} \quad (6)$$

The value of K_s is therefore 6.9E-09 /days. The integral function for the 30-year exposure then becomes:

$$X = \frac{e^{-1E+08 \text{ days} * 10,950 \text{ days}} - e^{-1E+08 \text{ days} * 0 \text{ days}}}{1E+08 \text{ days}} + 10,950 \text{ days} \quad (7)$$

The integral function is 0.42 for the 30-year exposure and 2.3 for the 70-year exposure. To calculate the soil concentration using Equation (3) the 30-year exposure calculation is:

$$C_s = \frac{1.9E-05 \mu\text{g}/\text{m}^2 * \text{day} * 0.42}{6.9E-09 /\text{day} * 0.15 \text{ m} * 1,333 \text{ kg}/\text{m}^3 * 10,950 \text{ days}} \quad (8)$$

The 30-year exposure soil concentration of DMM is 1.9E-05 $\mu\text{g}/\text{kg}$ assuming that the peak 24-hour deposition rate occurred over all 30 years of the analysis period. The 70-year exposure soil concentration of DMM is 2.2E-06 $\mu\text{g}/\text{kg}$ assuming that the peak 24-hour deposition rate occurred over all 70 years of the analysis period.

Based upon the soil concentration it is possible to calculate the plant concentration. The two pathways for the DMM to enter the plant are direct deposition and through uptake of the roots.

To calculate the root uptake the California EPA manual suggests the following equation:

$$C_{uptake} = C_s * UF_2 \quad (9)$$

Where:

UF₂ = Uptake factor based upon soil concentration

The California EPA manual lists an equation for calculating UF₂ for organic compounds, but the equation requires an octanol water partition factor as well as an organic carbon partition coefficient that could not be found in the literature. Therefore the octanol water partition coefficient for inorganic mercury was used. The highest root uptake factor was for leafy vegetables at 9.0E-02. The 30-year exposure calculation is:

$$C_{uptake} = 1.9 \text{ E} - 05 \text{ } \mu\text{g}/\text{kg} * 9.0\text{E} - 02 \quad (10)$$

The calculated 30-year exposure root uptake concentration is 1.7E-06 $\mu\text{g}/\text{kg}$. The calculated 70-year exposure root uptake concentration is 2.0E-07 $\mu\text{g}/\text{kg}$. Next the deposition concentration of the plant is needed to calculate the total burden of DMM in the plant.

The equation for the deposition onto plants from the California EPA manual is:

$$C_{dep} = \frac{Dep * IF}{k * Y} * (1 - e^{-kT}) \quad (11)$$

Where:

IF = Interception fraction (unitless)
 K = Weathering constant (days⁻¹)
 Y = Yield (kg/m²)
 T = Growth period (days)

The California EPA guidance recommended values for the interception fraction for leafy crops is 0.2 the weathering constant is 0.1 days⁻¹ and the growth period is 45 days. The 30-year exposure calculation is the following:

$$C_{dep} = \frac{1.9\text{E}-05 \text{ } \mu\text{g}/\text{m}^2 * \text{day} * 0.2}{0.1 / \text{day} * 2 \text{ kg}/\text{m}^2} * (1 - e^{-0.1 \text{ day} * 45 \text{ days}}) \quad (12)$$

The 30-year exposure plant concentration due to deposition is then 7.0E-07 $\mu\text{g}/\text{kg}$, the total plant concentration is 2.5E-06 $\mu\text{g}/\text{kg}$. The 70-year exposure plant concentration due to deposition is then 3.4E-08 $\mu\text{g}/\text{kg}$, the total plant concentration is 2.3E-07 $\mu\text{g}/\text{kg}$.

To calculate the dose from ingestion of plants equation 5.4.3.3.a C in the California EPA guidance was used as shown below:

$$Dose - p = \frac{C_f * IP * GRAF * L * EF * ED * 10^{-6}}{AT} \quad (13)$$

Where:

C_f	= Concentration in plant ($\mu\text{g}/\text{kg}$)
IP	= Consumption of produce ($\text{g}/\text{kg} * \text{day}$)
GRAF	= Gastrointestinal relative absorption factor
L	= Fraction of produce homegrown
EF	= Exposure frequency (days/year)
ED	= Exposure duration (years)
10^{-6}	= conversion factor ($\mu\text{g}/\text{kg}$ to mg/g)
AT	= Averaging time for exposure (days)

The 30-year exposure plant concentration is $2.5\text{E}-06$ ($\mu\text{g}/\text{kg}$). The 70-year exposure plant concentration is $2.3\text{E}-07$ ($\mu\text{g}/\text{kg}$). The California EPA recommended high end value for leafy produce is 10.6 g/kg body weight per day. A gastrointestinal absorption factor of one (i.e. assumes all DMM is absorbed into the body) was used as well as a factor of one for the fraction of produce homegrown. The exposure frequency was 350 days per year and the exposure duration was 30 years and 70 years. The averaging time for 30 years was 10,950 days and for 70 years it was 25,550. The 30-year estimated plant ingestion dose is $2.5\text{E}-11$ mg/kg body weight per day. The 70-year estimated plant ingestion dose is $2.3\text{E}-12$ mg/kg body weight per day.

7.3 ESTIMATION OF TOTAL EXPOSURE

The 30-year exposure total inhalation dose is $1.4\text{E}-09$ $\mu\text{g}/\text{kg}$ body weight per day and a total ingestion dose of $2.5\text{E}-08$ $\mu\text{g}/\text{kg}$ body weight per day the total dose is $2.6\text{E}-08$ $\mu\text{g}/\text{kg}$ body weight per day. The 70-year exposure total inhalation dose is $3.4\text{E}-11$ $\mu\text{g}/\text{kg}$ body weight per day and a total ingestion dose of $2.4\text{E}-09$ $\mu\text{g}/\text{kg}$ body weight per day the total dose is $6.9\text{E}-08$ $\mu\text{g}/\text{kg}$ body weight per day.

8.0 COMPARISON OF ESTIMATED EXPOSURE TO RISK

Hazard quotients were calculated for the maximally exposed individual including the residential, workplace and school receptors. A hazard quotient (HQ) is the ratio of the potential exposure of a person to a substance compared to the exposure level at which health effects are not expected.

$$HQ = \frac{\text{Total Exposure Dose } (\mu\text{g}/\text{kg body weight per day})}{\text{Corresponding Chronic Reference Dose } (\mu\text{g}/\text{kg body weight per day})}$$

Based on the reference dose recommended for MeHg of 0.1 $\mu\text{g}/\text{kg}$ body weight per day (NRC, 2000) and the 30-year exposure total dose of 2.6E-08 $\mu\text{g}/\text{kg}$ body weight per day the HQ is 2.6E-07 $\mu\text{g}/\text{kg}$ body weight per day. The 70-year exposure total dose of 2.4E-09 $\mu\text{g}/\text{kg}$ body weight per day the HQ is 2.4E-08. The 30-year and the 70-year exposure scenarios are well below the value of one indicating that the toxicological effects from DMM emissions from the Core Sampling System.

9.0 UNCERTAINTY ANALYSIS

Multiple factors of this HIA analysis contain uncertainty related to the lack of exact knowledge regarding the assumptions made to estimate the human health impacts. Due to the lack of toxicity data concerning DMM, there is a large uncertainty in the impacts resulting from exposure to DMM. Uncertainty can overestimate or underestimate the health risk.

9.1 RISKED BASED EXPOSURE CONCENTRATION

Very few instances of DMM exposure have been documented and those documented instances have been fatal therefore a dose response relationship has not been developed. For this analysis MeHg RfD was used since a RfD has been developed based upon a few studies. Since one study showed that DMM is converted in the MeHg (Ostlund, *Studies on the Metabolism of Methyl Mercury in Mice*, 1969). It was therefore concluded that the RfD for MeHg would be the best alternative RfD. The uncertainty is using a MeHg RfD instead of a DMM RfD is difficult to quantify due to a lack of data.

The MeHg developed by the NRC in 2000 listed two main categories of uncertainty: 1) biological variability in dose estimation and 2) data insufficiencies. The NRC applied a factor of 2-3 to account for biological variability and did not come up with a number for data insufficiencies but concluded that the overall uncertainty factor should be no less than 10.

9.2 EXPOSURE UNCERTAINTY

It is difficult to assess the length of time that people will be exposed to DMM emissions. The point of maximum exposure that was selected for this health impact analysis was along Highway 240, and it was assumed that someone lived at that location for the lifetime of the project. This assumption would overestimate the exposure.

The assumption that the DSTs would be sampled for the entire year would overestimate the exposure. It was also assumed that these three tank farms had DMM at the highest concentration found in all of the tanks, but only ten tanks have been found to have DMM.

The background level of DMM is also very uncertain due to its low atmospheric concentration and the limited number of measurements made.

9.3 EMISSIONS UNCERTAINTY

The exhauster emission estimates were based upon historical measurement data. The low concentrations of DMM in the headspace are near the analytical detection limits, so the uncertainty in the measurements leads to uncertainty in the emissions. The assumptions in these emission estimates represent a worst case situation.

9.4 AIR DISPERSION MODELING UNCERTAINTY

The transport and dispersion of pollutants in the atmosphere is complex and models developed to make many assumptions to solve the dispersion equations. Differences in the wind field over

the modeling domain can have large impacts on the modeled concentration. AERMOD is a regulatory model and is designed to be conservative in its estimate of concentrations.

10.0 CONCLUSIONS

A screening level risk assessment was conducted to determine whether the operation Core Sampler ventilation systems at the Hanford Site in south central Eastern Washington would likely threaten the surrounding area due to DMM emissions. A number of conservative assumptions were made to estimate the risk, so the potential impacts are likely overestimated.

- The emissions from the Core Sampling System were assumed to be at the highest emission rate from all tanks. Only 10 of the 177 tanks have had detectable concentrations of DMM.
- Two exposure scenarios were analyzed. First a 30-year exposure to a mother and child was analyzed at the point of highest atmospheric concentration and deposition along Highway 240. They were assumed to live at that location for 30 years. Second a resident living for 70 years was analyzed at the nearest residence 7.8 miles from the 241-SX Tank Farm.
- The ingestion rates were assumed to be the maximum according to guidance from the California EPA guidance.
- The maximum 24-hour concentration and deposition rates were assumed to be occurring for the entire 30 and 70 years of the analysis.
- The RfD used for the risk calculations includes a factor of 10 uncertainty factor to ensure that the hazard index is not underestimated.

These conservative assumptions made in this HIA resulted in an overestimation of the potential health impacts from DMM emissions. The calculated hazard quotient for a mother-child 30-year exposure is 2.6E-07, a level well below that threshold value of 1.0. The calculated hazard quotient for a 70-year resident exposure is 2.4E-08, a level also well below that threshold value of 1.0. Both of these hazard quotients indicate that DMM emissions from the proposed new sampling operation should not pose any threat to the public.

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APPENDIX A
Health Impacts Analysis Protocol Agreement Letters



U.S. Department of Energy
OFFICE OF RIVER PROTECTION
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

10-ESQ-378

NOV 09 2010

1003862

Mr. D. Ogulei
Air Quality Program
Washington State
Department of Ecology
P.O. Box 47600
Olympia, Washington 98504

Dear Mr. Ogulei:

**HEALTH IMPACTS ANALYSIS (HIA) FOR THE WASTE FEED DELIVERY EXHAUSTER
UPGRADE PROJECTS FOR THE HANFORD DOUBLE-SHELL TANK (DST) SYSTEM**

Thank you for coming to the Hanford Site to meet with us on September 14, 2010, to discuss the Waste Feed Delivery Exhauster Upgrade Projects for the Hanford DST System HIA. The DST exhauster upgrades are an important element to providing Hanford Tank waste feed to the Waste Treatment and Immobilization Plant for vitrification and safe environmental disposal, and this work is being accomplished by funding made available under the American Recovery and Reinvestment Act.

The primary purpose of the meeting was to continue discussions on the process for development and submittal of a HIA required for approval of the DST exhauster Notice of Construction (NOC) application. Meetings were held on November 17, 2009, and June 18, 2010 in Lacey, Washington, which formed the basis for the pre-application conference as established by the Washington State Department of Ecology's (Ecology) guidance document (publication number 08-02-025, dated May 2009) for "First and Second Tier Review of Toxic Air Pollution Sources Health Impact Analysis." All meetings were conducted between Ecology, U.S. Department of Energy, Office of River Protection (ORP), and Washington River Protection Solutions LLC (WRPS) staff. At the November 17, 2009, meeting, discussions centered on an approach for conducting a HIA for only the SY DST exhauster. After further consideration, ORP and WRPS believe it is prudent to include all the currently proposed DST Exhausters in the analysis. This would include three exhauster systems: 1) 241-SY DST Farm; 2) 241-AP DST Farm; and 3) 241-AY/AZ DST Farms.

As discussed at the June 18, 2010, meeting, attached you will find the outline of information that is to be included in the HIA. Also included are specific areas that Ecology had indicated in the November 17, 2009, meeting, as being necessary for the development of the HIA. At the September 14, 2010, meeting, Ecology was provided the preliminary results obtained following the protocol outlined in the attachment to this letter. The HIA will be based on the performance specifications for the DST Exhauster Systems. ORP appreciates the offer to meet with WRPS staff to informally review the progress and content of the HIA prior to formal submittal for your Agency's approval.

Rcvd 11/11/2010

Mr. D. Ogulei
10-ESQ-378

-2-

NOV 09 2010

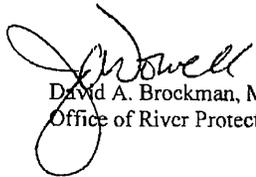
As agreed at the June 18, 2010, meeting, Ecology's Disposal Facility, located within the Hanford Site, will not be considered as an offsite receptor, as access to this site is controlled in the same manner as access to any other portions of the Hanford Site.

ORP would also like to consider how the results of this assessment can be applied to future NOC application revisions and submittals for all Hanford Site Tank Farm operations.

ORP would appreciate a response that the attached correctly outlines the guidance for a Second Tier Analysis.

If you have any questions, please contact me, or your staff may contact Thomas W. Fletcher, Tank Farms Project, (509) 376-3434.

Sincerely,


David A. Brockman, Manager
Office of River Protection

ESQ:DWB

Attachment

cc: See page 3

Mr. D. Ogulei
10-ESQ-378

-3-

NOV 09 2010

cc w/attach:

D. W. Hendrickson, Ecology
O. S. Wang, Ecology
N. A. Homan, FHI
Administrative Record
BNI Correspondence
Environmental Portal, LMSI
WRPS Correspondence

cc w/o attach:

B. G. Erlandson, BNI
J. Cox, CTUIR
S. Harris, CTUIR
B. Becker-Khaleel, Ecology
K. A. Conaway, Ecology
S. L. Dahl, Ecology
S. L. Derrick, Ecology
J. J. Lyon, Ecology
D. Bartus, EPA (Region 10, Seattle)
D. Zhen, EPA (Region 10, Seattle)
G. Bohnec, NPT
K. Niles, Oregon Energy
D. Jackson, RL
J. Martell, WDOH
J. C. Allen-Floyd, WRPS
W. T. Dixon, WRPS
J. W. Donnelly, WRPS
A. B. Dunning, WRPS
T. A. Erickson, WRPS
L. D. Garcia, WRPS
A. M. Hopkins, WRPS
G. J. Johnson, WRPS
F. Miera, WRPS
L. L. Penn, WRPS
B. P. Rumburg, WRPS
D. H. Shuford, WRPS
S. M. Sax, WRPS
R. J. Skwarek, WRPS
C. G. Spencer, WRPS
R. D. Wojtasek, WRPS
R. Jim, YN

Attachment
10-ESQ-378
(3 Pages)

OUTLINE FOR THE HEALTH IMPACTS ANALYSIS SUBMITTED
TO ECOLOGY FOR THE TIER II REVIEW AND APPROVAL FOR
THE WASTE FEED DELIVERY DOUBLE-SHELL TANK
EXHAUSTER UPGRADES NOTICE OF CONSTRUCTION
APPLICATION

OUTLINE FOR THE HEALTH IMPACTS ANALYSIS SUBMITTED TO ECOLOGY FOR
THE TIER II REVIEW AND APPROVAL FOR THE WASTE FEED DELIVERY DOUBLE
SHELL TANK (DST) EXHAUSTER UPGRADES NOTICE OF CONSTRUCTION (NOC)
APPLICATION

June 18, 2010 Lacey meeting participants:

Ecology: Dr. David Ogulei, Clint Bowman, Dr. Matthew Kadlec, Doug Hendrickson
USDOE-ORP/WRPS: Lori Huffman, Felix Miera, Todd Erickson, Dave Shuford,
Brian Rumburg

September 14, 2010 Richland meeting participants:

Ecology: Dr. David Ogulei, Dr. Matthew Kadlec, Doug Hendrickson
USDOE-ORP/WRPS: Phil Miller, Felix Miera, Todd Erickson, Dr. Brian Rumburg,
James Bingham, Rick Wojtasek

1. Project description:

- a. Project details including schedule and duration of the project.
- b. Maps of the sources and the surrounding affected areas and the distances to nearby impacted residences, businesses/occupational (LIGO and Energy Northwest facilities), roadways, water bodies.

NOTE: It was agreed that the U.S. Ecology Disposal Facility is not considered an off-site receptor as their employees are considered co-located and are badged by USDOE; access to the U.S. Ecology Facility is controlled the same as access to any other portion of the Hanford Site.

- c. Location of emission points.

2. Hazard identification:

- a. A list of the maximum concentration (in ambient air) of all new or modified emissions of toxic air pollutants (TAPs).
- b. A comparison of the TAPs to the acceptable source impact level (ASIL).
- c. A physical description of all TAPs in excess of the ASIL.
- d. The transport and fate in the environment of the TAPs in excess of the ASIL.

3. Modeling methods and results:
 - a. AERMOD model details.
 - b. Source, dates, and data quality of meteorological data used – Use 5 year meteorological data.
 - c. The averaging periods for the modeling results will include the highest 1 hour, day and 1 year.
 - d. Geographical area modeled and grid spacing.
 - e. Modeling results including contour plots.

4. Identification of potentially exposed populations and susceptible subpopulations:
 - a. Locations and distances from the source to the following exposed people:
 - i. Residentially maximally exposed individual.
 - ii. Any sensitive sub-population maximally exposed individual.
 - iii. The offsite occupationally maximally exposed individual including exposures at Highways 24 and 240.

5. Exposure assessment:
 - a. Identification of the TAP exposure pathways.
 - b. Development of a total daily intake attributable to the source.
 - c. Background concentration estimates.

6. Toxicity:
 - a. Description of the toxic effects and exposure levels from the available scientific literature.
 - b. Exposure duration and pattern of exposure of toxic effects studies.
 - c. Quantitative chronic toxicity values.
 - d. Quantitative short-term toxicity values.
 - e. Consider confounding effects on studies cited.

7. Risk/hazard assessment:
 - a. The benefits to society from the project.
 - b. Qualitative discussion of the risks.
 - c. Quantitative discussion of the risks and the toxicity.
 - d. Discussion of the modeling uncertainties. (*NOTE: Need to include a narrative discussion in this section even if projected concentrations are at very low levels*)
 - i. Emissions uncertainties.
 - ii. Exposure uncertainties.
 - iii. Toxicity uncertainties.

- e. Discussion of the acceptability of the risk with regard to the documented studies and to WAC 173-460.
- f. Discussion of potential impacts of exposure to human health based on documented studies (e.g., studies provided by Ecology in item #6 above) and WAC 173-460 as appropriate.

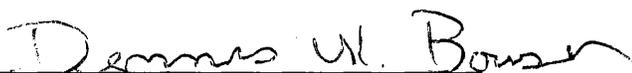
APPENDIX E
Health Effects of Toxic Air Pollutants Above the SQER

Table C-1. Health effects of TAPs above the SQER emission threshold.

Chemical Name	CAS#	Routes of Exposure	Target Organs	Acute Health Effects	Chronic Health Effects
Dimethyl Mercury	593-74-8	Inhalation Ingestion Skin Absorption	Central Nervous System	The substance is irritating to the eyes, the skin and the respiratory tract. The substance may cause effects on the central nervous system, resulting in impaired functions. Exposure may result in death. The effects may be delayed. Medical observation is indicated.	The substance may have effects on the central nervous system, resulting in impaired functions. This substance is possibly carcinogenic to humans. Causes toxicity to human reproduction or development.
n-Nitrosodimethylamine	62-75-9	Inhalation Ingestion Skin absorption Skin and/or eye contact	Liver Kidneys Lungs	Irritating to the eyes, skin, and respiratory tract. High exposure can cause headache, nausea, vomiting, stomach cramps, diarrhea, fever, and weakness.	Can damage the liver. The substance may have effects on the liver, resulting in jaundice, liver function impairment and cirrhosis. Probable carcinogen in humans, it has been shown to cause liver, kidney, and lung cancer in animals.
Chromium Hexavalent: Soluble	7440-47-3	inhalation, ingestion, skin and/or eye contact	Eyes, skin, respiratory system	May cause mechanical irritation to the eyes and the respiratory tract.	lung fibrosis

Attachment 4
14-ECD-0031
(2 Pages)

Application for Second Tier Review or Third Tier Review


Dennis W. Bowser



Application for Second Tier Review or Third Tier Review

INSTRUCTIONS

Use this form to request Ecology review of a petition for second or third tier review. Review begins when you submit your health impact assessment protocol.

Fill out all pages of this form, front and back. Attach a check for the \$10,000 initial fee to the form, and mail to:

**Department of Ecology
Cashiering Unit
P.O. Box 47611
Olympia, WA 98504-7611**

For Fiscal Office Use Only:
001-NSR-216-0299-000404

Check one box to indicate the review you are requesting.	Initial Fee
<input checked="" type="checkbox"/> Petition for Second Tier Review. The initial fee covers 106 hours of review.	\$10,000
<input type="checkbox"/> Petition for Third Tier Review. The initial fee covers 106 hours of review.	\$10,000

Read each statement, then check the box next to it to acknowledge what you have read.

<input checked="" type="checkbox"/>	The initial fee you submit may not cover the cost of processing your petition. Ecology will track the number of hours spent on your project. If the number of hours exceeds the 106 hours included in your initial fee, Ecology will send you a bill for that extra time.
<input checked="" type="checkbox"/>	Ecology will bill you \$95 per hour for each hour worked beyond the initial 106 hours.
<input checked="" type="checkbox"/>	You must pay the bill before Ecology will issue a decision on your petition.

Check one box to indicate the air agency with permitting jurisdiction over your project.

- | | |
|--|---|
| <input type="checkbox"/> Benton Clean Air Agency
<input type="checkbox"/> Olympic Region Clean Air Agency
<input type="checkbox"/> Puget Sound Clean Air Agency
<input type="checkbox"/> Southwest Clean Air Agency
<input type="checkbox"/> Spokane Regional Clean Air Agency | <input type="checkbox"/> Yakima Regional Clean Air Agency
<input type="checkbox"/> Ecology Central Regional Office Air Quality Program
<input type="checkbox"/> Ecology Eastern Regional Office Air Quality Program
<input type="checkbox"/> Ecology Industrial Section Waste 2 Resources Program
<input checked="" type="checkbox"/> Ecology Nuclear Waste Program – Hanford |
|--|---|

For more information	
Science and Engineering Section Air Quality Program Ecology Headquarters Office	<div style="text-align: center;"> Matt Kadlec (360) 407-6817 matthew.kadlec@ecy.wa.gov </div> <div style="text-align: center; margin-top: 20px;"> Gary Palcisko (360) 407-7338 gary.palcisko@ecy.wa.gov </div>



Application for Second Tier Review or Third Tier Review

Applicant Information

The applicant is the business requesting services from Ecology and is responsible for paying the costs Ecology incurs.

Name of business United States Department of Energy, Office of River Protection

Physical location of project (city, county) Hanford Site, 200 West and 200 East Areas, Richland, Benton County

Name of project Core Sampler System

Project Billing Contact Information

Ecology will send the responsible official the bills if there are any.

If the project billing contact is different from the responsible official, check this box and provide the required information.

Name, Title Dennis Bowser, Physical Scientist

Mailing address P.O. Box 550, MSIN-H6-60, Richland, WA 99352

City, State, Zip Richland, WA 99352

Phone, Fax, E-mail P (509) 373-2566, F (509) 376-1097, Dennis_W_Bowser@orp.doe.gov

Project Consultant Information

If you hired a consultant to prepare the application (or materials), check this box and provide the required information.

Consultant Name, Title Brian Rumburg, Environmental Engineer

Organization Washington River Protection Solutions

Mailing address P.O. Box 850, MSIN-R1-51

City, State, Zip Richland, WA 99352

Phone, Fax, E-mail P (509) 373-3438, Brian_P_Rumburg@rl.gov

Responsible Official Signature Block (The responsible official is the person responsible for overall operation of and ongoing compliance at the facility.)

I certify, based on information and belief formed after responsible inquiry, the statements and information in this application are true, accurate, and complete.	
Printed Name <u>Kevin W. Smith</u>	Title <u>Manager</u>
Signature <u><i>Kevin W. Smith</i></u>	Date <u>7/9/14</u>

RECEIPT
Department of Ecology (4610)
PO Box 47611
Olympia, WA 98504-7611
(360) 407-7095

Receipt Number **15CJ000812**
 Manual Receipt

Document Number **461S1623 CJ** Date **07/18/2014** FM 13

Remitter Name **US ENERGY DEPT** Receipt Name
ID TREAS 310

Check/Draw Number **NA**

Document Amount **10,000.00**

Method of Payment **Wire**

Comment Description **NSR**

REF NR	DOC NR	REF DOC SFX	INV NR	ID NR	SUB ID NR	T	C	R	FUND	MAJ GRP	MAG SRC	SUB SRC	CNTY	WORK CLS	PIC	AI	ORG	PRJ	SUB PRJ	PRJ PHS	SUB OBJ	SUB SUB OBJ	VAR GL	SUB DR	SID DR	SUB CR	SID CR	ALLOC AMT
				NWP		001			216	02	99	000404																10,000.00

RECEIVED

JUL 23 2014

DEPARTMENT OF ECOLOGY
 NWP - RICHLAND

MITIGATED DETERMINATION OF NONSIGNIFICANCE

Description of proposal The US Department of Energy, Office of River Protection submitted Notice of Construction approval request to allow emissions of toxic and criteria pollutants, including methyl mercury. The emissions would result from collecting core samples of dangerous waste managed inside underground tanks.

To obtain a sample, the drill string containing the sampler will be drilled or pushed into the waste. A piston inside the sampler creates a vacuum and draws the waste into the sampler. The sampler will close once the sample is obtained, trapping the sample and sealing the bottom of the core barrel. The barrier fluid (in this case air) and a seal on the bottom of the sampler are designed to prevent back flow of tank waste into the drill string.

Ecology reviewed the environmental analyses included in the Tank Farm Closure & Waste Management Environmental Impact Statement (<http://www.hanford.gov/?page=1117>). The latter is incorporated by reference in accordance with SEPA rules. Ecology determined that the referenced environmental analyses evaluate the potential adverse environmental impacts of the proposal, with the exception of potential impacts from methyl mercury. Ecology completed a Tier I impact analysis [insert online link to Tier I], and the proponent submitted a Tier II analysis to address the potential impacts of the methyl mercury [insert online link to Tier II]. Ecology has conditioned the proposal through requirements included in Ecology's approval order [insert link to section of approval order conditions], issued pursuant to Chapter 173-460 WAC..

Proponent _____

Location of proposal, including street address, if any _____

Lead agency Ecology _____

The lead agency for this proposal has determined that it does not have a probable significant adverse impact on the environment. An environmental impact statement (EIS) is not required under RCW 43.21C.030 (2)(c). This decision was made after review of a completed environmental checklist and other information on file with the lead agency. This information is available to the public **online** **on request**.

- There is no comment period for this **MDNS**.
- This **MDNS** is issued after using the optional **MDNS** process in WAC 197-11-355. There is no further comment period on the **MDNS**.
- This **MDNS** is issued under WAC 197-11-340(2); the lead agency will not act on this proposal for 14 days from the date below. Comments must be submitted by

Responsible official _____

Position/title _____ Phone. _____

Address _____

Date. _____ Signature _____

(OPTIONAL)

- You may appeal this determination to (name) _____
at (location) _____
no later than (date) _____
by (method)

You should be prepared to make specific factual objections.
Contact _____ to read or ask about the procedures for SEPA appeals.