

**DANGEROUS WASTE RESEARCH, DEVELOPMENT, AND DEMONSTRATION PERMIT
FOR THE NUCON THERMAL OXIDATION SYSTEM PHASE 3**

CHANGE CONTROL LOG

Change Control Logs ensure that changes to this permit are performed in a methodical, controlled, coordinated, and transparent manner. Each permit document will have its own change control log with a modification history table. The “**Modification Number**” represents Ecology’s method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the permit.

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FOR THE NUCON THERMAL OXIDATION SYSTEM PHASE 3**

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2 **DANGEROUS WASTE RESEARCH, DEVELOPMENT, AND DEMONSTRATION PERMIT**
3 **FOR THE NUCON THERMAL OXIDATION SYSTEM PHASE 3**
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TERMS

AEA	<i>Atomic Energy Act of 1954</i>
ALARA	As low as reasonably achievable
BCSO	Benton County Sheriff's Office
BEP	<i>Building Emergency Plan for Tank Farms</i>
BY Tank Farm	241-BY Tank Farm
BY-108	Tank 241-BY-108
CAM	Continuous air monitor
COPC	Chemical of potential concern
USDOE	U.S. Department of Energy
DRE	Destruction removal efficiency
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
H2C	Hanford Tank Waste Operations & Closure, LLC
HEMP	<i>Hanford Emergency Management Plan</i>
HEPA	High-efficiency particulate air
HMI	Human-machine interface
IQRPE	Independent qualified registered professional engineer
NUCON	NUCON International, Inc.
USDOE-HFO	U.S. Department of Energy, Hanford Field Office
P&ID	Piping and instrumentation diagram
PLC	Programmable logic controller
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RD&D	Research, development, and demonstration
RPMS	Radioactive particulate monitoring system
Site-wide Permit	<i>WA7890008967, Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion Revision 8C for the Treatment, Storage, and Disposal of Dangerous Waste</i>
SST	Single-shell tank
TOS	Thermal oxidation system
VOC	Volatile organic compounds

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1 **1.0 INTRODUCTION**

2 **1.1 Regulatory Basis**

3 This Permit for a Research, Development, and Demonstration (RD&D) permit is submitted to the
4 Washington State Department of Ecology (Ecology) pursuant to the provisions of 40 Code of Federal
5 Regulations (CFR) 270.65, *Research, development, and demonstration permits*; Washington
6 Administrative Code (WAC) 173-303-809, *Research, development and demonstration permits*; and
7 EPA/530-SW-86-008, *Guidance Manual for Research, Development, and Demonstration Permits under*
8 *40 CFR Section 270.65*.

9 The U.S. Department of Energy (USDOE), Hanford Field Office (HFO) is proposing to construct and
10 operate a thermal oxidation system (TOS) developed by NUCON International, Inc. (NUCON^{®1}) under a
11 RD&D permit. The NUCON TOS was tested during two of three project phases. Phase 1, proof-of-
12 concept testing, was performed at the NUCON facility in Ohio. Phase 2, engineering-scale testing, was
13 performed at Pacific Northwest National Laboratory (PNNL) in Richland, Washington. Phase 3, on-site
14 testing, will be conducted under this Permit at the USDOE Hanford Site near Richland, Washington. The
15 site selected for Phase 3 testing is Single-Shell Tank (SST) Farm 241-BY (BY Tank Farm), Tank
16 241-BY-108. Tank BY-108 was selected because an abundance of chemicals of potential concern
17 (COPC) have been detected therein, the needed utilities are nearby, and this placement will not interfere
18 with other project operations or activities.

19 An objective of the RD&D permit program is to accelerate the permitting of experimental and innovative
20 treatment alternatives in a manner that is fully protective of human health and the environment
21 (EPA/530-SW-86-008). The NUCON Phase 3 RD&D Project will evaluate the effectiveness and
22 capabilities of an innovative control technology for reducing tank vapor COPCs in air emissions from
23 Hanford waste tanks. The process will capture or destroy tank vapor chemicals using thermal oxidation,
24 carbon adsorption, and catalytic conversion of combustion products.

25 **1.2 Facility Owner and Operator Information**

26 USDOE-HFO has the operational responsibility for all administrative, operational, regulatory compliance,
27 and other responsibilities associated with activities under the proposed RD&D permit. The NUCON
28 Phase 3 RD&D Project will be managed and co-operated by Hanford Tank Waste Operations & Closure,
29 LLC (H2C) for USDOE-HFO under Contract 89303324DEM000096, *Hanford Integrated Tank Disposition*
30 *Contract (ITDC)*. All activities proposed for this RD&D permit will be conducted at the Hanford Site,
31 Richland, Washington (Figure 1). The Hanford Site is currently operated under one permit (Site-wide
32 Permit) under the *Resource Conservation and Recovery Act of 1976 (RCRA)*, U.S. Environmental
33 Protection Agency (EPA) identification number WA7890008967. In Washington State, RCRA
34 regulations are implemented by WAC 173-303, *Dangerous Waste Regulations*. The RD&D permit will be
35 a separate permit from the Site-wide Permit, but under the same EPA identification number
36 WA7890008967 that is assigned to the Hanford Site. However, because the NUCON Phase 3 RD&D
37 Project will operate within the Hanford Facility, the Permittees will use parts of the current Site-wide
38 Permit to meet RD&D permit requirements.

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

1 FACILITY NAME

2 NUCON Thermal Oxidation System Phase 3
3 U.S. Department of Energy Hanford Site
4 Tank Farms

5 FACILITY LOCATION

6 Benton County, Washington; within the 200 East Area of the Hanford Site

7 OWNER/OPERATOR

8 U.S. Department of Energy
9 Hanford Field Office
10 P.O. Box 550
11 Richland, WA 99352

12 FACILITY MANAGER/CO-OPERATOR

13 Hanford Tank Waste Operations & Closure LLC
14 P.O. Box 788
15 Richland, WA 99352

16 Table 1 provides the location of the BY Tank Farm on the Hanford Site.

17

Table 1 Coordinates of the 241-BY Tank Farm

Facility	Latitude	Longitude
BY Tank Farm	46° 33' 58"N	119° 32' 22"W

18

19 The BY Tank Farm is in the 200 East Area of the Hanford Site. The BY Tank Farm SSTs are passively
20 ventilated via high-efficiency particulate air (HEPA) breather filters associated with each tank. The
21 NUCON TOS will be connected to an available riser on BY-108.

22 The current employee's at H2C safely manage the operations of the Hanford tank farms at the Hanford
23 Site. H2C has personnel that are fully trained in accordance with Section 3.11, and experienced in
24 performing similar work at the tank farms. H2C will be responsible for the installation and operation of
25 the NUCON TOS. H2C also will perform all closure activities for the NUCON Phase 3 RD&D Project.

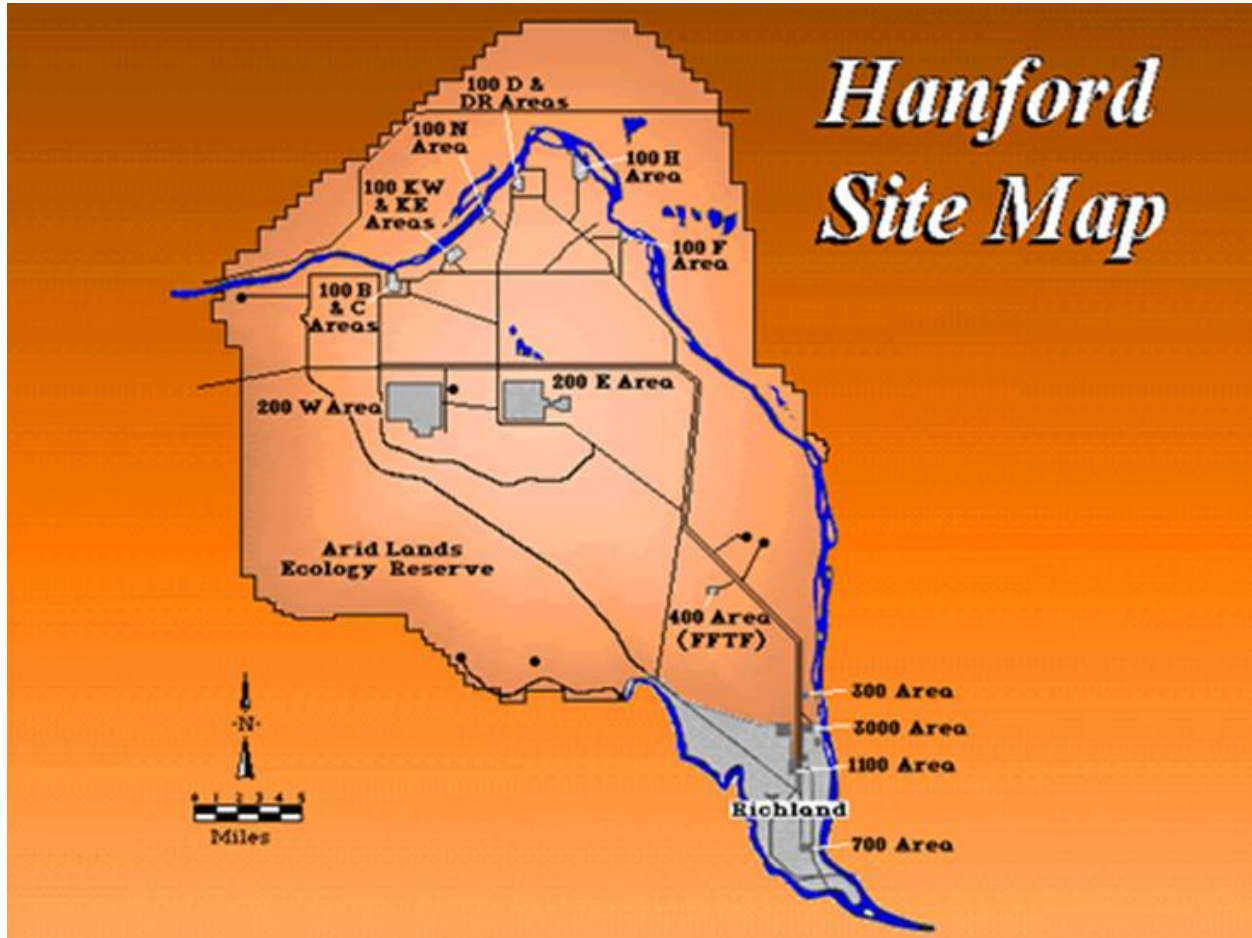


Figure 1 Hanford Site Map

1.3 Background Information

Located in southeastern Washington State along the Columbia River, the Hanford Site comprises approximately 586 square miles. Hanford's mission from the early 1940s through the late 1980s included defense-related nuclear research, development, and weapons production activities. A wide range of radioactive and chemical wastes were created during these activities. Hanford's mission is now focused on the cleanup of those wastes and ultimate closure of Hanford. USDOE-HFO currently stores approximately 56 million gallons of mixed waste² at the Hanford Site in 177 underground storage tanks, which was generated as a byproduct of recovering plutonium from spent nuclear fuel. There are 149 SSTs and 28 Double-Shell Tanks operating under interim status standards as detailed in WAC 173-303-805, *Interim status permits*.

²"Mixed waste" means a dangerous, extremely hazardous, or acutely hazardous waste that contains both a nonradioactive hazardous component and, as defined by 10 CFR 20.1003, *Definitions*, source, special nuclear, or byproduct material subject to the *Atomic Energy Act of 1954* (42 U.S.C. 2011 et seq.) (WAC 173-303-040, *Definitions*).

1 The retrieval, treatment, and disposal of tank waste is governed by the Hanford Federal Facility
2 Agreement and Consent Order (Ecology et al. 1989³). The purpose of the NUCON Phase 3 RD&D
3 Project is to demonstrate the feasibility of a process to reduce or remove toxic chemicals from Hanford
4 tank air emissions. The NUCON Phase 3 RD&D Project will evaluate a control technology for potential
5 use at the Hanford tank farms. The NUCON treatment process is designed to reduce COPCs to levels as
6 low as 10 percent of the occupational exposure limit.

7 The NUCON TOS consists of HEPA filtration (air filtration skid), a NUCON thermal oxidation skid,
8 related auxiliary equipment, and BY Tank Farm infrastructure. All equipment, including the air filtration
9 and the thermal oxidation components, will be mounted on separate but connectable skids. The air
10 filtration skid and thermal oxidation skid together make up the TOS. The NUCON TOS is designed to use
11 a combination of thermal oxidation, carbon adsorption, catalytic conversion, and filtration of combustion
12 byproducts and particulates to treat tank vapors.

13 Source, special nuclear, and byproduct materials, as defined in the *Atomic Energy Act of 1954* (AEA) are
14 regulated at USDOE facilities exclusively by USDOE acting pursuant to its AEA authority. These
15 materials are not subject to regulation by the state of Washington under WAC 173-303, RCRA, or any
16 other relevant provision of law. Where information regarding processing, packaging, management, and
17 disposal of the radioactive source, byproduct material, and/or special nuclear components of mixed waste
18 (as defined by AEA) has been incorporated into this permit, it is not incorporated for the purpose of
19 regulating the radiation hazards of such components under the authority of this permit modification nor
20 Revised Code of Washington (RCW) 70A.300, *Hazardous Waste Management*, but is presented only for
21 general knowledge in support of the project description.

22 **2.0 PROJECT OVERVIEW**

23 **2.1 Phases of Testing the NUCON Thermal Oxidation System**

24 **2.1.1 Phase 1: Proof-of-Concept Testing**

25 A proof-of-concept test of a TOS vapor abatement unit equipped with a propane-fueled generator was
26 completed at the NUCON facility in Columbus, Ohio, and preliminary analysis indicated that
27 destruction/removal efficiencies were quite good, ranging from ≥ 82 percent for furans to ≥ 96 percent for
28 formaldehyde, pyridine/toluene, ammonia, and mercury. Results of this testing are documented in
29 RPP-RPT-60211, *Trip Report – Demonstration of NUCON Vapor Abatement (Thermal Oxidation) Unit*.

30 **2.1.2 Phase 2: Off-site Engineering-Scale Testing**

31 Limitations in the test apparatus during Phase 1 led to a recommendation that more thorough and
32 controlled tests be performed in Richland, Washington. In addition, early evaluation of the safety and
33 operational issues of using propane in the tank farms led to a decision to terminate further testing with
34 propane and to have NUCON redesign and retrofit the vapor abatement unit skid with a diesel-powered
35 electrical generator. The NUCON thermal oxidation unit prototype skid was modified to use a
36 diesel-powered electrical generator. This modified skid was tested at PNNL to provide an independent
37 assessment of the vapor abatement unit prototype skid vapor destruction efficiency for a subset of the
38 COPCs. These results were documented in RPT-71248-002 (PNNL-27816), *NUCON Thermal Oxidation
39 System Performance on Hanford Tank Farm Chemicals of Potential Concern*.

³The 2010 Consent Decree has been amended five times. See Amended Consent Decree, Case No. CV-08-5085 (March 11, 2016), Amended Consent Decree, Case No. CV-08-5085 (April 12, 2016), Amended Consent Decree, Case No. CV-08-5085 (November 16, 2018), Amended Consent Decree, Case No. CV-08-5085 (December 10, 2020), and Amended Consent Decree, Case No. CV-08-5085-RMP (July 18, 2022). Note that the Amended Consent Decree did not re-publish the provisions of the 2010 Consent Decree but only published those portions of the text that were modified by each decree; consequently, it is necessary to refer to each document to determine whether a particular section has been amended.

1 **2.1.3 Phase 3: On-site Pilot-Scale Demonstration**

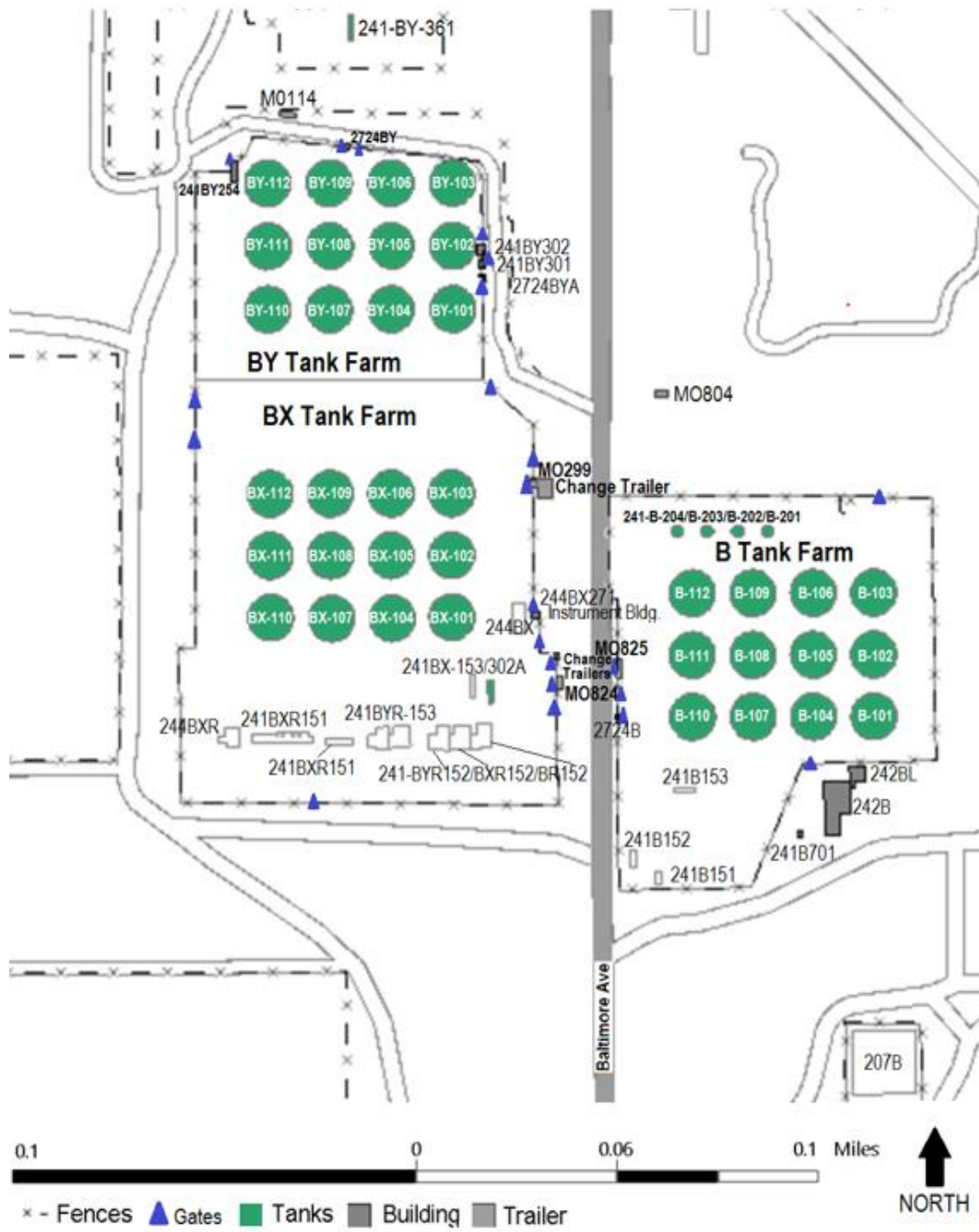
2 A new NUCON thermal oxidation unit-based system will be designed and built for placement on the
3 Hanford Site. The system will be connected to SST BY-108 to demonstrate the on-site TOS vapor
4 destruction efficiencies on an SST with known COPC levels. Tank BY-108 has been selected as the
5 location for the on-site TOS. Site selection is documented in 53005-066-RPT-002, *Site Selection Report*
6 *for the Vapor Abatement Unit On-Site Technical Demonstration*. Tank BY-108 is described in
7 WHC-SD-WM-TP-275, *Tank 241-BY-108 Tank Characterization Plan*. The tank was constructed
8 between 1948 and 1949, and was put into service in March 1951. Tank BY-108 is passively ventilated,
9 was partially isolated in December 1982, and was interim stabilized in February 1985. Layout of 241-BY
10 Tank Farm is shown in Figure 2.

11 **2.2 Purpose of the NUCON Thermal Oxidation System Phase 3 Research,**
12 **Development, and Demonstration Project**

13 The primary objective of the NUCON Phase 3 Project is to test the ability of the TOS to remove mercury
14 and destroy other COPCs found in the headspace of an SST on the Hanford Site. Specifically, the Project
15 will evaluate the efficacy of the TOS vapor treatment on an actual Hanford waste tank involving complex
16 mixtures in a tank farm operational environment under actual field conditions. Six to eight weeks of total
17 testing will take place over a four-month period to evaluate the system's effectiveness.

18 Phase 2 testing of the NUCON TOS was conducted by injecting 11 COPC surrogates (out of 61 identified
19 COPCs in total) in the inlet airstream and quantitatively measuring them at various points in the TOS
20 (RPT-71248-002). These measurements were performed using both online instruments and grab samples.
21 A key element of the Phase 3 testing is the MERSORB^{®4} bed, which is intended to remove mercury from
22 the vapor stream. The MERSORB bed was not tested in Phase 2 and instead was deferred to subsequent
23 testing. A final report will be prepared for the NUCON Phase 3 Project to document the results of the
24 RD&D Project and performance against these project objectives.

⁴MERSORB is a trademark of NUCON International, Inc., Columbus, Ohio.



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Figure 2 Layout of the B-BX-BY Tank Farms

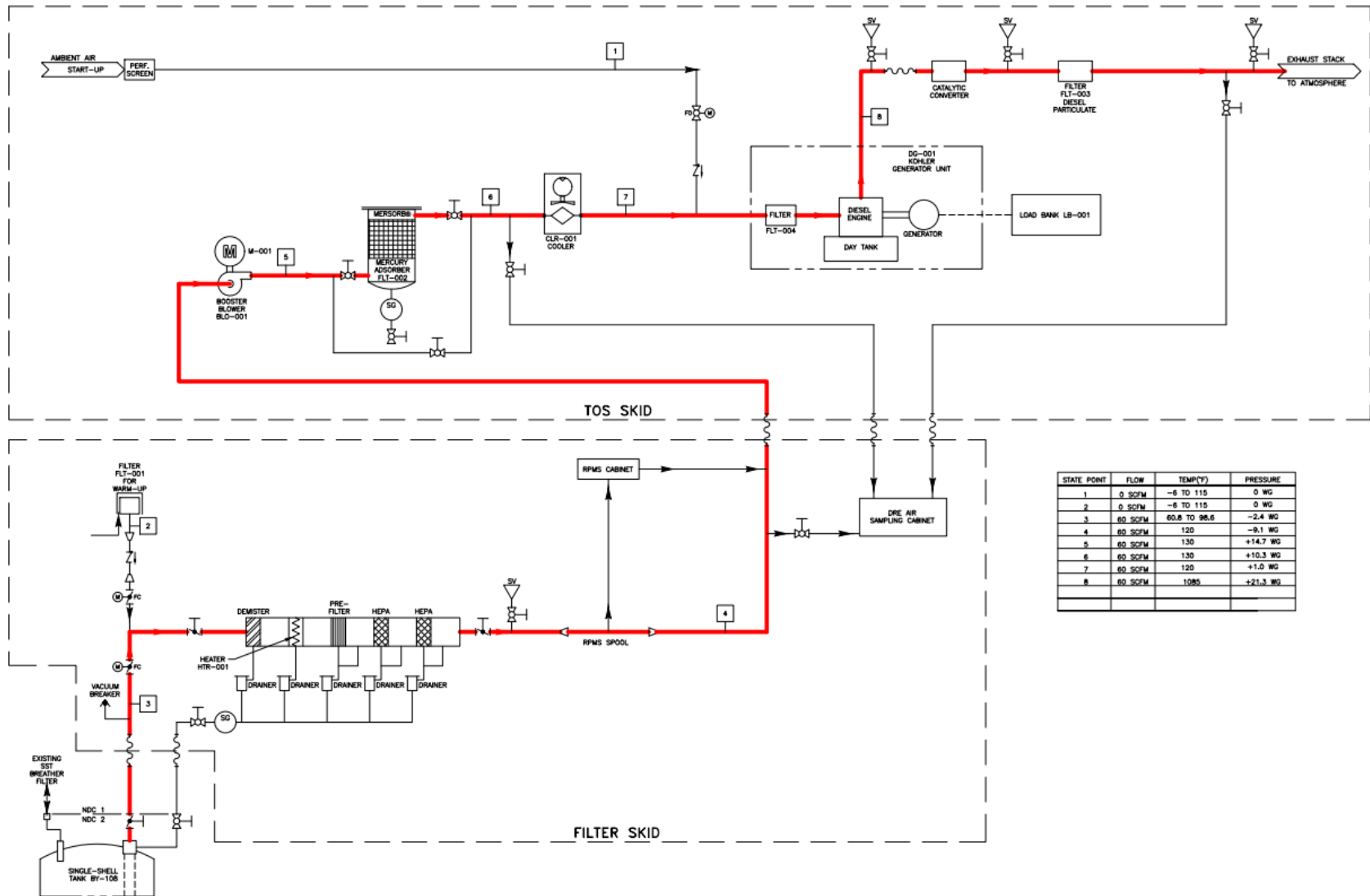
1 **2.3 Overview of the NUCON Thermal Oxidation System Phase 3 Research,**
2 **Development, and Demonstration Project**

3 The NUCON TOS consists of a thermal oxidation skid and a filtration skid. The thermal oxidation skid
4 contains the thermal oxidizer unit (diesel-fueled internal combustion engine) and other supporting
5 equipment, including a mercury absorber filter, a booster blower, and a cooler. The filter skid contains the
6 filtration unit, along with a heater, motor-operated valves, a radioactive particulate monitoring system
7 (RPMS), and a sampling cabinet. Each skid has field instruments, conduit, and wiring, with all signals
8 routed to a programmable logic controller (PLC) enclosure for monitoring and control at a local
9 human-machine interface (HMI) station.

10 The intake air (SST headspace gas) is drawn into the diesel engine by an in-line blower whose
11 performance is matched to the diesel engine air intake requirements. The exhaust gases from the diesel
12 engine are treated in an oxidation catalyst unit (catalytic converter) to destroy unburnt hydrocarbons, and
13 a diesel particulate filter for soot removal. An electrical generator is attached to the diesel engine to
14 provide a working load and enable the engine to reach and maintain a desired operating temperature. The
15 process flow configuration is illustrated in Figure 3.

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Figure 3 NUCON Thermal Oxidation System Process Flow Diagram

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1 **2.4 Justification for the NUCON Thermal Oxidation System Phase 3 Research,**
2 **Development, and Demonstration Project**

3 Pursuant to WAC 173-303-809(1), an RD&D permit is justified when the requesting entity proposes to
4 employ an "...innovative and experimental dangerous waste treatment technology or process for which
5 permit standards for such experimental activity has not been promulgated..." The technology being
6 applied to selective destruction of COPCs in an internal combustion engine is innovative and
7 experimental. This project represents a novel application of an RD&D permit in that the treatment
8 equipment being installed on BY-108 will treat uncontained vapors emitted by the waste and not the
9 waste in the tank.

10 This Permit contains the information necessary to demonstrate the NUCON TOS meets the requirements
11 for permitting as an RD&D Project. The NUCON Phase 3 RD&D Project is an on-site pilot-scale test of a
12 new process that will involve the treatment of tank vapors from the headspace of BY-108. The design,
13 operation, and maintenance of processing equipment must function in the radioactive and chemical
14 environment. The project is intended to provide COPC destruction and removal data to further
15 supplement USDOE's knowledge base and support future design, operation, and permitting of vapor
16 treatment equipment.

17 Performance standards for the TOS during Phase 2 testing were established in the settlement agreement in
18 Hanford Challenge, et al. v. United States Department of Energy, et al., NO. 4:15-cv-5086-TOR
19 (consolidated with 4:15-cv-5087-TOR) (*Vapors Settlement Agreement*),⁵ but the Vapors Settlement
20 Agreement did not explicitly define performance standards for Phase 3 testing. Phase 3 testing will adopt
21 a similar set of performance standards modified to reflect the composition of BY-108, use best available
22 measurement methods, and retain the intent of the Phase 2 criteria. The performance standards for Phase 3
23 testing are proposed as follows:

- 24 • At the point of emissions from the TOS, select COPCs⁶ will individually⁷ have a 95-percent
25 destruction rate (as measured by destruction removal efficiency [DRE]). The DRE will be
26 determined using inlet and exhaust sorbent tube or SUMMA canister samples with approved
27 analytical methods at certified laboratories.
- 28 • At the point of emissions from the TOS, volatile organic compounds (VOC) measured in
29 aggregate will have a collective concentration of less than 500 parts per million (ppm) as
30 determined using:
 - 31 • Summation of analytical results from sorbent tube and SUMMA canister samples for
32 calibrated compounds and approved methods (VOCs, aldehydes, nitrosamines), and
 - 33 • A commercial photoionization detector.

⁵Described in Section II.C.2.b of the Vapors Settlement Agreement.

⁶Select chemicals of potential concern that measured above 1 percent of the occupational exposure limit in Tank 241-BY-108 headspace and are listed in WRPS-1604188.1, "Tank Operations Contractor – Chemicals of Potential Concern," Rev. 1, memo from K.J. Way to distribution, Washington River Protection Solutions LLC, Richland, Washington.

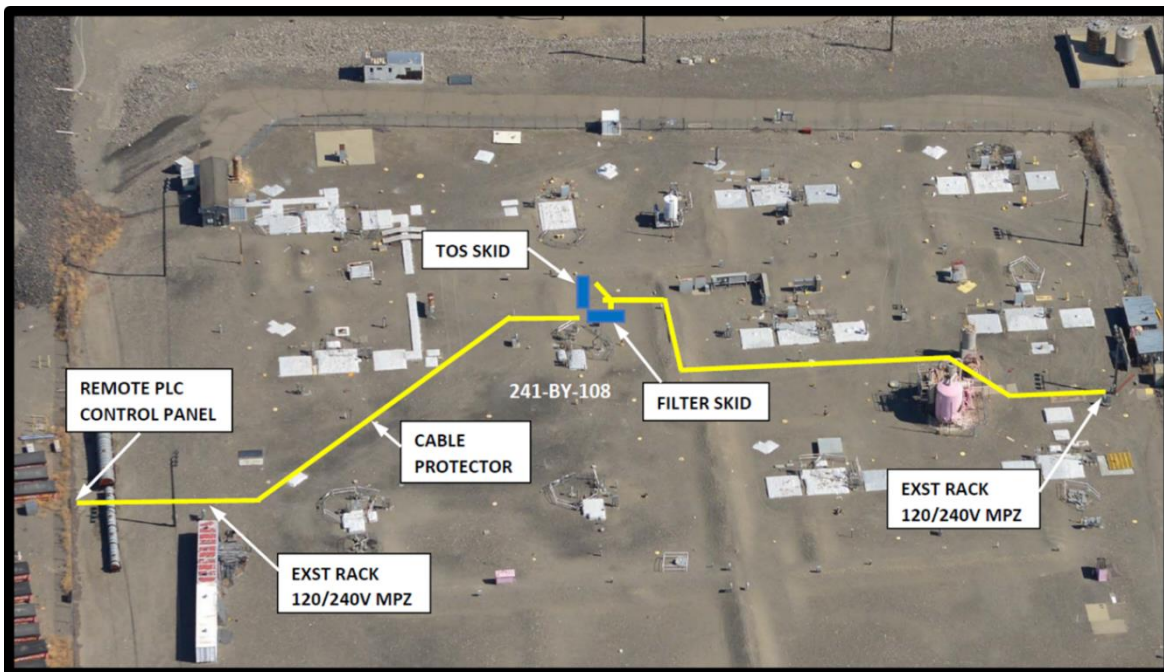
⁷The reasons for the proposed deviation from the Vapors Settlement Agreement language for this criterion are as follows:

- An aggregate DRE criterion ignores the relative toxicities of each of the COPCs and favors the COPC with the highest concentration. It is theoretically possible to satisfy the criterion while having all but one COPC above their respective OELs in the exhaust.
- Using a bulk measurement device like a photoionization detector (PID) to measure a DRE across the system is not really measuring a DRE, since VOCs are generated in the engine. It is expected that this type of measurement and calculation will yield a negative DRE as it did in Phase 2 testing (-1,580% to -4,200% destruction).
- A PID cannot truly measure a destruction efficiency of a mixture since every component has its own response factor and the response factor of the mixture changes as the makeup of the mixture changes.

- 1 • At the point of emissions from the TOS, select COPCs in aggregate will have individual
2 concentrations of ≤ 10 percent of their Hanford tank farm Occupational Exposure Limits (OEL).
3 a. Whenever the detection method makes it possible, the concentration will be quantified and
4 compared to the target level of 10 percent of the OEL concentration for that COPC.⁸
5 b. For any offline analyses with a detection or reporting limit greater than 10 percent of the
6 OEL, the concentration in the TOS exhaust will be quantified and reported as a percentage of
7 OEL.⁹
- 8 • The TOS is demonstrated to operate reliably and achieve a nominal steady state while interacting
9 with the BY-108 headspace vapors. Based on Phase 2 testing, the best real-time proxy for
10 assessing steady state is a catalytic converter temperature of at least 660 °F that is not changing
11 rapidly over a period of approximately five minutes. The exhaust temperature downstream of the
12 catalytic converter will be measured as an indicator of the catalytic converter temperature.

13 2.5 Planned Operation

14 The NUCON Phase 3 RD&D Project will be performed on headspace vapors from BY-108. The airstream
15 carrying the vapors will be conditioned, filtered, treated, and exhausted to the atmosphere in accordance
16 with a radiological air license and a toxic air pollutant permit. The prefabricated treatment equipment,
17 sampling systems, and monitoring equipment are mounted on two skids that will be situated over the tank
18 and adjacent to riser. A site plan is depicted in Figure 4.



19 **Figure 4 NUCON Phase 3 Research, Development, and Demonstration Project Site Plan**

⁸It will be assumed during the comparison that the 10 percent of the occupational exposure limit criterion is met if the detection limit is below 10 percent of the occupational exposure limit and the results are below the detection limit. Data that is below the analytical detection/reporting limits as established by the measuring laboratory will not be quantified.

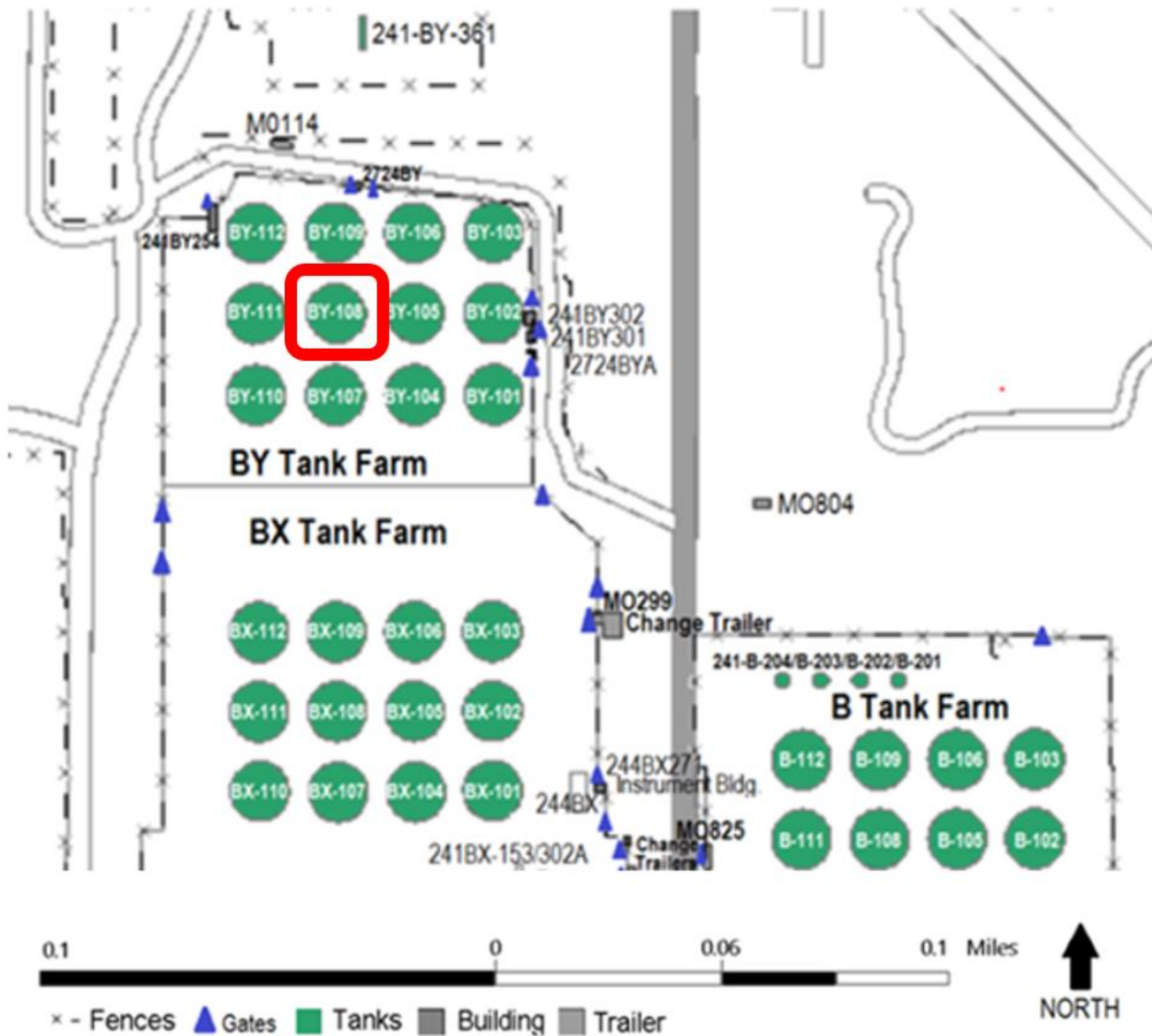
⁹Based on Phase 2 data, this is anticipated to be only a small percentage of analytes. Of the 11 chemicals of potential concern tested in Phase 2, 9 of 11 were detected at or below 10 percent of the occupational exposure limit in the exhaust using offline sampling techniques (RPT-71248-002, *NUCON Thermal Oxidation System Performance on Hanford Tank Farm Chemicals of Potential Concern*).

1 **2.6 Project Location**

2 The NUCON Phase 3 RD&D Project will be located within the BY Tank Farm, as shown in Figure 5. The
 3 BY Tank Farm is in the 200 East Area of the Hanford Site, and consists of 12 SSTs, each with a capacity
 4 of approximately 750,000 gal. The tank selected for this project, BY-108, contains 44,000 gal of sludge
 5 and 172,000 gal of saltcake (53005-066-RPT-002).

6 The surface area within the BY Tank Farm consists of soft sand and soil that will be surveyed for
 7 contamination before the TOS is set up. The site is sufficiently level to provide for equipment placement
 8 with minimum grading or excavation. In addition, the skid-mounted systems will contain integrated
 9 leveling systems. The overall layout for the TOS is depicted in drawing H-14-111795, *Civil Site Plan*,
 10 Sheet 001.

11



12

Figure 5 Location of NUCON Thermal Oxidation System

1 **3.0 SCOPE OF THE NUCON PHASE 3 RESEARCH, DEVELOPMENT, AND**
2 **DEMONSTRATION PROJECT**

3 Phase 3 of the NUCON RD&D Project implements a unit operation to reduce the level of COPCs in
4 headspace vapors from BY-108. Phase 3 testing will focus on evaluating the unit under actual field
5 conditions. Six to eight weeks of total testing will be conducted over a four-month period, with an overall
6 objective to evaluate the effectiveness in a controlled operational environment at the Hanford Site. The
7 treatment equipment will be operated on a temporary basis, removed after use, and undergo closure in
8 accordance with WAC 173-303-610(2).

9 **3.1 Process Conditions**

10 Tank BY-108 headspace and TOS processing conditions are summarized as follows:

- 11 • The COPCs are listed in RPP-SPEC-63585, *Thermal Oxidation System Procurement*
12 *Specification for On-site Testing (Project TD106)*, Appendix B, “Hanford Tank Farms Chemicals
13 of Potential Concern.”
- 14 • Not all COPCs will be present in the tank headspace and not all of those present will be in
15 significant concentrations. Maximum anticipated concentrations as percent OEL are shown in
16 TP-TOSP3-001, *NUCON TOS BY-108 Demonstration Testing*, Tables 8.1 and 8.2.
- 17 • Mercury compounds are expected to be present in the tank.
- 18 • At start of TOS operations, COPC vapors in the storage tank headspace are expected to be in
19 equilibrium with the salt content of the tank.
- 20 • COPC concentrations will reduce as equilibrium-based vapors are removed from the headspace
21 during TOS operation and replaced with incoming fresh air through the passive breather filter.
- 22 • The TOS design flow rate is 60 cfm.
- 23 • During TOS operation, the vapor headspace pressure is expected to be slightly negative.
- 24 • The vapor headspace temperature experiences seasonal variations of 55 °F to 98.6 °F.
- 25 • The headspace air delivered to the TOS will be conditioned to have a relative humidity of no
26 more than 75 percent.

27 **3.2 Thermal Oxidation System Components and Operations**

28 The general conceptual arrangement of major NUCON TOS components is depicted in Figure 3.
29 A summary of the operational sequence follows.

- 30 • Vapors from BY-108 are drawn into the filter skid by suction from the booster blower.
- 31 • Water droplets in the airstream are removed by a moisture separator (demister). Collected
32 condensation drains to the condensate return line which drains into BY-108.
- 33 • The relative humidity is decreased by warming the airstream as it passes through an in-line
34 heater.
- 35 • The airstream passes through a prefilter to capture particles that could damage the HEPA filters.
- 36 • Particulates are removed as the airstream passes through two HEPA filters in series.
- 37 • The airstream passes through a booster blower delivers the airstream to the MERSORB unit at
38 approximately atmospheric pressure.
- 39 • The airstream is directed to the thermal oxidation skid where it enters the MERSORB unit, which
40 is filled with sulfur-impregnated carbon that strips mercury compounds from the vapors.

- 1 • The airstream passes through a cooler to lower the temperature for optimal diesel engine
- 2 performance.
- 3 • The airstream passes through a filter to remove particulates that may have become entrained in
- 4 the discharge from the media bed.
- 5 • The airstream is drawn into a diesel combustion engine for thermal oxidation/destruction of
- 6 COPC vapors.
- 7 • Diesel exhaust is conveyed through a catalytic converter to oxidize unburnt hydrocarbons.
- 8 • Diesel engine emissions are exhausted through a diesel particulate filter to remove soot prior to
- 9 discharge from the stack.

10 **3.3 Vapor Characteristics**

11 Characterization data on BY-108 headspace gases relative to anticipated COPC concentrations can be
 12 found in TP-TOSP3-001, Section 8.1.

13 **3.4 Secondary Wastes**

14 The TOS may generate a minimal amount of waste in several forms during decontamination, normal
 15 operations, and maintenance. Secondary wastes that may be generated during the NUCON Phase 3
 16 RD&D Project are shown in Table 2. Additional details are provided in Section 4.9.

17

**Table 2 Secondary Waste Streams from the NUCON Thermal Oxidation System
 Phase 3 Research, Development, and Demonstration Project**

Secondary Waste Stream	Waste Designation	Disposal Pathway	Basis for Designation
Spent HEPA filters	D009 ^a	ERDF or PFNW	Letter with prior analytical test results.
MERSORB ^b (sulfur-activated carbon)	D009 ^a	ERDF, PFNW, or DSSI (Tennessee)	Sampling for Hg (SDS)
Diesel	Need correct SDS or MSDS	ERDF, PFNW, or DSSI (Tennessee)	Generator knowledge (SDS or MSDS)
Oil (spent)	Need correct SDS or MSDS	ERDF, PFNW	Generator knowledge (SDS or MSDS)
Oil filters (spent)	N/A	N/A	Drained prior to disposal.
Antifreeze (spent)	Need correct SDS or MSDS	ERDF or PFNW	Generator knowledge (SDS or MSDS)

^aWaste designation based on process knowledge. If analytical results demonstrate contaminants are below dangerous waste levels, then waste will be managed as non-dangerous waste.

^bMERSORB is a trademark of NUCON International, Inc., Columbus, Ohio.

DSSI = Diversified Scientific Services, Inc.

N/A = Not applicable

ERDF = Environmental Restoration Disposal Facility

PFNW = Perma-Fix Northwest

HEPA = High-efficiency particulate air

SDS = Safety data sheet

MSDS = Material safety data sheet

18

1 **3.5 Ignitable, Reactive, and/or Incompatible Materials**

2 Based on the design, materials, and analytical sampling results of vapors from BY-108, there are no
3 expected incompatible material issues during the NUCON Phase 3 RD&D Project (RPP-SPEC-62690,
4 *Design Specification for a Thermal Oxidation System for Phase 3 Testing on Single-Shell Tanks*).
5 Diesel fuel will be required for the diesel-fueled generator daily. The fuel stored in the closed tank
6 presents no compatibility concerns. Measures to prevent fires during refueling activities are described in
7 Section 4.4.3. Granular activated carbon in an enclosed container poses a hazard for smoldering
8 combustion when exposed to high concentrations of VOCs; however, the airstream being treated contains
9 low concentrations of VOCs, so that will not cause this reaction.

10 **3.6 Support Systems**

11 Support systems are systems that are required for NUCON operations but not directly part of the NUCON
12 TOS. These support systems may be shared with the BY Tank Farm operations. The support systems will
13 consist of:

- 14 • Shift Office.
- 15 • Personnel contamination control and survey station.
- 16 • Personal areas (e.g., lunchroom, restrooms).
- 17 • Change room.
- 18 • Safety showers and eyewash stations.

19 **3.7 Non-Regulated Materials and Utilities**

20 Management of specific materials related to the NUCON Phase 3 RD&D Project are discussed in
21 Section 4.0. The TOS is a self-contained unit; accordingly, all utilities and services required to operate the
22 system except for electrical power will be provided with the system when it is delivered. Factory
23 acceptance tests and post-installation/preoperation tests shall verify the intended services operate
24 seamlessly and perform its intended function. Utilities and services may include, but are not limited to,
25 diesel fuel and electrical service.

26 **3.8 Other Facility Permits**

27 In addition to the RD&D permit, USDOE-HFO will apply for and obtain the following prior to operation:

- 28 • Radioactive air license (Washington State Department of Health).
- 29 • Criteria and toxics air emissions approval order or permit.

30 **3.9 Security**

31 The TOS will be located within the fenceline boundary of the BY Tank Farm, which is a portion of the
32 SST System. The SST System is a closure unit group subject to interim status standards under
33 WAC 173-303-400, *Interim status facility standards*. Security provisions and signage will comply with
34 applicable portions of WAC 173-303-310, *Security*.

35 The following sections from the Site-wide Permit describe the security measures, equipment, and warning
36 signs used to control entry to the Hanford Facility in the 200 Area.

37 **3.9.1 Hanford Facility Security**

38 The Hanford Patrol maintains a continuous presence of security personnel. Hanford Patrol is comprised of
39 highly trained security personnel that are present at the facility 24 hours a day, seven days a week,
40 including holidays. Hanford Patrol monitors entry to and exit from the Hanford Facility and provides
41 security measures throughout the Hanford Facility.

1 The Benton County Sheriff's Office (BCSO) provides law enforcement support for the Hanford Facility,
2 including enforcement of traffic laws and automobile accident investigations. Activities of the BCSO
3 include Columbia River patrol by watercraft, canine units for narcotics detection operations, and warrant
4 service. The detective and deputies of the BCSO also investigate property crimes involving theft of
5 government and personal property on the Hanford Facility.

6 All personnel accessing locations on the Hanford Facility must possess and display a USDOE-approved
7 security badge indicating the appropriate access authorization. All personnel entering or exiting the
8 Hanford Facility are subject to random security badge inspections by Hanford Patrol to validate access
9 authorization. All vehicles and hand-carried items entering or exiting the Hanford Facility are subject to
10 random inspections and searches by Hanford Patrol to preclude the unauthorized introduction of
11 prohibited/controlled articles, or the unauthorized removal of government or contractor assets.

12 Employees at the Hanford Facility are trained and have the responsibility to assist in maintaining access
13 control on the facility. In general, this includes restricting access to authorized personnel only
14 (i.e., challenging personnel without a security badge and making sure entrances are secured after entry
15 and exit). Employees receive annual training on individual requirements to maintain security on the
16 Hanford Facility as part of the general facility training.

17 **3.9.2 Warning Signs**

18 The NUCON TOS will comply with the requirements found in WAC 173-303-310(2)(a) to prevent entry,
19 and minimize the possibility for the unauthorized entry, onto active portions of the Hanford Facility.
20 Signs posted around the perimeter of the BY Tank Farm bear the legend, "No Trespassing by Order of the
21 United States Department of Energy." "No Trespassing" signage is also posted every 500 ft around the
22 200 Areas. Warning signs posted for operating unit groups bear the legend, "Danger-Unauthorized
23 Personnel Keep Out," or an equivalent legend, written in English, and are legible from a distance of at
24 least 25 ft. Such warning signs are posted at entrance points to the active portions of closure unit groups
25 and along perimeter fencelines at distances of up to 250 ft between signs.

26 **3.9.3 Surveillance System**

27 Twenty-four-hour surveillance is conducted at the Hanford Facility level to control entry onto the
28 Hanford Facility and provide protection of government property, classified information, and special
29 nuclear materials. This system consists of roving patrols and video surveillance at selected locations.

30 **3.9.4 Artificial or Natural Barriers**

31 Authorized access to active portions of the Hanford Facility is always controlled through gates or other
32 entrances. Vehicular access to roads leading to the active portions of the Hanford Facility located in the
33 200 Areas is controlled through entrance points at the Yakima, Wye, and Rattlesnake Barricades, which
34 are posted with signs. These barricades are controlled on a continuous or as-needed basis by Hanford
35 Patrol. When barricades are not manned, the gates are secured to prevent access.

36 The Hanford Facility perimeter fence is installed that extends approximately 32 miles from the northwest
37 corner of the Hanford Facility, where the facility meets with the Columbia River at the Vernita Bridge, to
38 the southeast corner of the facility near Stevens Road. The perimeter fence is constructed of steel
39 fenceposts strung with barbed wire. This fence provides a barrier to vehicle access on the west and south
40 portion of the Hanford Facility. All other unimproved vehicle access roads along the facility boundary are
41 controlled by locked vehicle access gates combined with the Hanford Facility perimeter fence.

42 The 200 East and 200 West areas are each surrounded by an area fence. Many of the active portions of the
43 Hanford Facility are located within the 200 Area fences. The area fences are chain-link fencing that may
44 be topped with barbed wire in certain places. Access through the 200 Area fences is provided only at a
45 limited number of entrances.

1 **3.10 Preparedness, Prevention, Emergency Procedures, and Contingency Plans**

2 The NUCON Phase 3 RD&D Project will be located within the fenceline boundary of the BY Tank Farm.
3 The NUCON TOS will comply with provisions in WAC 173-303-340, *Preparedness and prevention*;
4 WAC 173-303-350, *Contingency plan and emergency procedures*; and WAC 173-303-360, *Emergencies*.
5 To satisfy these requirements, NUCON TOS personnel will comply with DOE/RL-94-02,
6 *Hanford Emergency Management Plan (HEMP)*, and RPP-27869, *Building Emergency Plan for Tank*
7 *Farms (BEP)*. Copies of these documents are maintained in the SST Closure Unit Group and Waste
8 Management Area B-BX-BY Operating Records.

9 **3.11 Training**

10 NUCON TOS personnel will be trained in compliance with all requirements in WAC 173-303-330,
11 *Personnel training*. General training is required for all Hanford Facility personnel that consists of both
12 initial and ongoing general facility training to prepare for working at Hanford facilities. The introductory
13 and continuing training will provide the following:

- 14 • Train Hanford Facility personnel to perform their duties in a way that ensures the Hanford
15 Facility's compliance with WAC 173-303.
- 16 • Teach Hanford Facility personnel dangerous waste management procedures, including
17 implementation of the contingency plan, relevant to the job titles/positions in which they are
18 employed.
- 19 • Ensure Hanford Facility personnel can respond effectively to emergencies.

20 Introductory and continuing training for personnel working in the BY Tank Farm on the NUCON TOS
21 consists of the following, depending on the job title/position:

- 22 • General Hanford Facility orientation.
- 23 • Contingency plan training.
- 24 • Emergency coordinator training.
- 25 • Operations training.

26 All NUCON TOS personnel must be trained to carry out duties in a manner that ensures compliance with
27 WAC 173-303 [WAC 173-303-330(1)(c)]. Training records are maintained in accordance with the
28 requirements of WAC 173-303-330(2)(c) and (3).

29 **3.12 Occupational Safety and Health**

30 The NUCON TOS structures and equipment will incorporate design features that comply with applicable
31 subparts of Occupational Health and Safety Administration Regulations found in 29 CFR 1910,
32 *Occupational Safety and Health Standards*.

33 **4.0 PROCESS DESCRIPTION**

34 The NUCON TOS provides a steady-state operation to extract a small airflow from the headspace of
35 BY-108, pass it through an air filtration system to remove particulate material, route the airstream through
36 a mercury removal component, and then route the stream to a diesel engine-based system to remove or
37 destroy COPCs to prescribed levels. The airstream will be monitored and the COPC destruction
38 efficiency will be determined from the DRE sample system, and finally vented to the atmosphere through
39 an exhaust stack.

1 The NUCON Phase 3 RD&D Project consists of two subsystems, as shown in Figure 3. The filter skid
2 subsystem will consist of pretreatment air conditioning components installed on the air filtration skid.
3 This subsystem includes a moisture separator (demister), a preheater, a prefilter, two stages of HEPA
4 filtration, and a condensate drain system. The filter skid will be connected to an available riser to draw
5 headspace vapors from BY-108, and will direct the pretreated airstream to the thermal oxidation skid. The
6 thermal oxidation skid comprises an activated carbon bed, thermal oxidation unit, catalytic exhaust unit,
7 and a diesel particulate filter.

8 Six to eight weeks of total testing is planned to be conducted over a four-month period. Following
9 completion of the testing, the NUCON treatment skids will be dismantled, removed, and disposed in
10 accordance with WAC 173-303-610(2).

11 **4.1 Filter Skid Subsystem**

12 The filter skid includes a moisture separator, preheater, prefilter, HEPA filters in filter housing with test
13 sections, condensate drain system, and radioactive particulate monitoring and sampling system. The
14 suction of a blower installed on the thermal oxidation skid draws vapors from the headspace of BY-108
15 into the filter skid. A vacuum breaker installed on the filter skid will prevent drawing too much vacuum
16 on BY-108. The filter skid will also house instrumentation for monitoring vacuum, temperature, and flow.
17 Piping and instrumentation diagram (P&ID) details of the filter skid are depicted on drawing
18 H-14-020112, *Thermal Oxd Sys VTP System P&ID POR 670 RPMS Cabinet*, Sheet 2.

19 **4.1.1 Moisture Separator (Demister)**

20 The moisture separator (demister) is a passive element that consists of a stainless-steel frame supporting a
21 stainless-steel mesh pad that collects water droplets to prevent wetting the HEPA filters. The demister
22 frame is provided with a drain pan and a low-point drain that directs collected water to the condensate
23 drain system.

24 **4.1.2 Preheater**

25 The preheater increases the temperature of the airstream before it enters the HEPA filters to reduce the
26 relative humidity and prevent condensation on the HEPA filters, which could degrade the HEPA filters.
27 The preheater frame is provided with a drain pan and a low-point drain that directs collected water to the
28 condensate drain system.

29 **4.1.3 Prefilter**

30 The prefilter consists of a glass fiber mat supported in a stainless-steel frame. The prefilter captures large
31 particles to protect the HEPA filters from physical damage. The frame of the prefilter also has a drain pan
32 and low-point drain that directs collected water to the condensate drain system.

33 **4.1.4 High-Efficiency Particulate Air Filters**

34 Two stages of HEPA filters in series will filter out radioactive particulates in the airstream. The standard
35 filter media is held in a 12-inch by 12-inch by 5/8-inch stainless-steel frame. The frames are provided
36 with drain pans and low-point drains that are connected to the condensate drain system.

37 **4.1.5 Condensate Drain System**

38 The condensate drain system is constructed of fully welded stainless-steel pipe and is sloped to direct
39 condensate back to BY-108. All pipe joints are welded and/or provided with flanged fittings. The
40 condensate drain system receives condensate from the demister, preheater, prefilter, and HEPA filters, as
41 shown in Figure 3. A seal pot, or seal loop, is installed on the condensate drain line and BY-108 to
42 prevent exchange of air between systems under different operating pressures. The condensate drain
43 system and seal pot/seal loop are located aboveground and are single-wall construction that can be
44 visually inspected for leaks daily when the TOS is operating. The maximum rate of condensate expected

1 to be generated and drained from the air pretreatment system is 0.021 gal/min (RPP-CALC-62863,
2 *Thermal Oxidation System – Condensate Line Sizing Calculation*).

3 **4.1.6 Radioactive Particulate Monitoring System**

4 The RPMS consists of a section of stainless-steel duct, a stainless-steel shrouded sampling probe, and
5 stainless-steel sample tubing. Additional detail is provided in Sections 4.3.7 and 4.7.5.8, and
6 RPP-SPEC-63328, *Procurement Specification for a Radioactive Particulate Monitoring Sampling System*
7 *for the Thermal Oxidation System at BY Tank Farm*.

8 **4.2 Thermal Oxidation Skid Subsystem**

9 The thermal oxidation skid includes a booster blower, MERSORB filter, heat exchanger, filter, thermal
10 oxidation unit with diesel fuel tank, catalytic converter, diesel particulate filter, exhaust stack, and bypass
11 systems needed for startup and shutdown. The thermal oxidation skid provides all destruction and
12 removal of COPCs and is equipped with monitoring and sampling systems, as depicted on drawing
13 H-14-020112, Sheet 3. The RPMS and DRE sampling systems are both on the filtration skid. The
14 sampled air returns to the DRE cabinet on the filtration skid for sorption tube and canister sampling.

15 **4.2.1 Booster Blower**

16 The booster blower is an in-line fan connected to a variable feed drive that regulates the speed of the fan
17 based on air demand by the thermal oxidation unit (diesel engine). The booster blower has a design
18 volumetric flow rate of 60 cubic feet per minute (cfm) (RPP-DS-58663, *Mechanical Data Sheet Thermal*
19 *Oxidation System [TOS] Skid Blower*).

20 **4.2.2 MERSORB Filter**

21 Mercury must be removed from the airstream prior to thermal treatment because it will not be rendered
22 harmless in the internal combustion engine (thermal oxidation unit) and will poison the catalytic
23 converter. NUCON produces a chemically treated carbon media called MERSORB that absorbs and holds
24 mercury compounds, effectively removing mercury from gaseous streams. The activated carbon media is
25 held in a stainless-steel housing measuring 21½ inches in diameter and 31½ inches long and is designed
26 to facilitate removal of spent media to a collection container. The MERSORB bed will be designed to
27 permit removal and disposal of the MERSORB carbon using a bag-in/bag-out concept. The MERSORB
28 housing is designed to fit in a 55-gal disposal drum. The MERSORB unit is designed and sized to
29 effectively treat a 52 to 60 cfm gaseous stream with the mercury concentration found in vapors from
30 BY-108 for the duration planned for this RD&D Project (RPP-CALC-63389, *Thermal Oxidation System*
31 *MERSORB® Bed Analysis*).

32 **4.2.3 Heat Exchanger**

33 An air-cooled heat exchanger is used to lower the temperature of the airstream after it was raised by the
34 preheater and through the booster blower. The airstream needs to be cooled because diesel engines run
35 more effectively in lower air temperatures. Specifications of the heat exchanger are in RPP-DS-58673,
36 *Mechanical Data Sheet Thermal Oxidation System (TOS) Air Cooled Heat Exchanger*.

37 **4.2.4 Filter**

38 An in-line air filter, located downstream of the heat exchanger, will remove particulates from the
39 airstream before it enters the thermal oxidation unit. This is a standard engine air intake filter and is
40 identified as FLT-004 on drawing H-14-020112.

1 **4.2.5 Thermal Oxidation Unit**

2 The thermal oxidation unit includes a diesel engine coupled to a 15-kW continuous service generator with
3 load bank, the same as used in Phase 2 testing. The electrical load is added by increasing the load bank
4 settings to establish appropriate gas flow rates and diesel engine discharge temperatures. Appropriate
5 temperatures are expected with the generator loaded to 70 percent to 80 percent of the full load
6 (RPP-RPT-62549, *System Design Description for the NUCON Thermal Oxidation System [TOS]*
7 *Demonstration*).

8 **4.2.6 Catalytic Converter**

9 The exhaust from the diesel engine passes through a standard diesel oxidation catalyst that oxidizes
10 unburnt diesel fuel. The catalytic converter consists of a stainless-steel casing that holds two ceramic
11 blocks that makeup thousands of microcellular channels that resemble a honeycomb. The ceramic blocks
12 are coated with a precious metal (e.g., platinum, rhodium, palladium).

13 **4.2.7 Diesel Particulate Filter**

14 A diesel particulate filter is an exhaust after-treatment device that traps particulate matter (e.g., soot, ash).
15 To reduce emissions from diesel engines, diesel particulate filters capture and store exhaust soot, which
16 must be periodically burned off to regenerate the filter. The regeneration process burns off excess soot
17 deposited in the filter, which prevents harmful exhaust emission and the black smoke commonly seen
18 emitting from diesel-powered equipment.

19 **4.2.8 Exhaust Stack**

20 After thermal oxidation, the treated vapor stream is vented to the atmosphere in a 20-ft-high exhaust
21 stack.

22 **4.2.9 Bypass Systems**

23 Motor-operated valves MOV-100, MOV-101, and MOV-102 are used to configure the flow path to either
24 draw ambient air for system startup and shutdown or headspace gases during system operation
25 (H-14-020112). Avoiding liquid condensate in the gas stream will require the system to heat up before
26 processing the tank headspace COPCs vapors. A diesel engine fresh air intake minimizes air inlet
27 restrictions during startup. A fresh air bypass provides ambient air to the filter skid during warmup to
28 allow temperatures and pressures to stabilize and for heating the MERSORB bed above the dewpoint of
29 the tank headspace.

30 **4.3 Instrumentation and Controls**

31 The system architecture for monitoring and control consists of field instruments, conduit and wiring, a
32 PLC enclosure, and a local HMI station. This also includes interlocks and alarms.

33 The TOS field instruments consist of devices that monitor tank pressure, transport pipe flow, transport
34 pipe temperature, and moisture on the transport pipe that is routed between BY-108 and the TOS unit.
35 Differential pressure and moisture are monitored at the HEPA filter skid located in the ducting next to the
36 point of connection on BY-108. An in-line heater located on the filter skid upstream of the HEPA filter is
37 controlled by the PLC.

38 The field devices shown on H-14-020112 will perform temperature monitoring, pressure monitoring, flow
39 monitoring, monitoring valve and switch positions, moisture monitoring, and carbon monoxide
40 monitoring.

1 **4.3.1 Temperature Monitoring**

2 Temperature monitoring and process controls include the following:

- 3 • Filter housing inlet temperature upstream of the preheater.
- 4 • Temperature of the heated air immediately upstream of HEPA filters.
- 5 • Temperature of the HEPA filter outlet. This temperature is used to provide temperature control
- 6 signal to temperature indicating controller which outputs to preheater controller.
- 7 • Temperature upstream of cooler.
- 8 • Temperature downstream of cooler.
- 9 • Exhaust temperature downstream of the catalytic converter.

10 **4.3.2 Differential Pressure Monitoring**

11 Monitoring the differential pressure at predetermined locations enables monitoring of component
12 performance and can be an indication of system tightness. The duct from BY-108 to the blower unit is
13 designed to be under negative pressure relative to ambient atmosphere and will be under positive pressure
14 downstream from the blower. Differential pressure or pressure will be monitored at the following
15 locations:

- 16 • Differential pressure in the duct at the point of connection to BY-108.
- 17 • Differential pressure across the demister.
- 18 • Differential pressure across the prefilter.
- 19 • Differential pressure across the first HEPA filter.
- 20 • Differential pressure across second HEPA filter.
- 21 • Pressure at the point of entry to diesel generator engine. This pressure is used to provide speed
- 22 control signal to the blower motor variable feed drive.

23 **4.3.3 Flow Monitoring**

24 Flow monitoring will be conducted of the duct flow downstream of the last HEPA filter. The desired
25 operating flow rate is 52 to 60 cfm.

26 **4.3.4 Monitoring Valve and Switch Positions**

27 Monitoring valve and switch positions include:

- 28 • Fault status of tank isolation valve MOV-100.
- 29 • Valve control switch position for tank isolation valve MOV-100.
- 30 • Position of warmup isolation valve MOV-101.
- 31 • Fault status of warmup isolation valve MOV-101.
- 32 • Valve control switch position for warmup isolation valve MOV-101.
- 33 • Position of fresh air isolation valve MOV-102.
- 34 • Fault status of fresh air isolation valve MOV-102.
- 35 • Valve control switch position for fresh air isolation valve MOV-102.
- 36 • Switch position for blower variable speed drive.
- 37 • Switch position for cooler variable speed drive.

38 **4.3.5 Moisture Monitoring**

39 Relative humidity in transport pipe will be monitored downstream of last HEPA filter.

1 **4.3.6 Carbon Monoxide Monitoring**

2 A carbon monoxide instrument will monitor carbon monoxide in the MERSORB bed outlet piping for the
3 intended purpose of detecting a fire in the MERSORB bed.

4 **4.3.7 Radioactive Particulate Monitoring**

5 The RPMS is a vendor-supplied packaged system, with its own control system. Inputs for radiation levels,
6 continuous air monitor (CAM) failure status, vacuum pump status, enclosure temperature, and sample
7 flow rates will be provided to the TOS PLC.

8 **4.4 Utilities**

9 **4.4.1 Electrical**

10 The TOS electrical system is designed in compliance with the requirements of the National Fire
11 Protection Association 70, *National Electrical Code*. Electrical power will be provided to the thermal
12 oxidation skid and filter skid loads via one of two sources. The electrical power to operate necessary
13 components and systems while the diesel generator set is idle will be supplied with shore power.
14 Electrical power is available at two local panels on the east side of the BY Tank Farm, so no
15 infrastructure modifications are required. Heavy-duty cable protectors will be field run on the ground to
16 supply power to the junction boxes on the skids. Drawing H-14-111811, *Thermal Oxd Sys Electrical Site*
17 *Plan*, Sheets 1-3, describe the site electrical interface.

18 Loads requiring continuous power will receive their power from the BY Tank Farm electrical distribution
19 system. These loads include the diesel engine block heater, the diesel engine battery charger, the PLC
20 power supplies, the PLC enclosure heating and cooling, filter skid drain heat trace, MERSORB bed drain
21 line heat trace, stack drain line heat trace, RPMS enclosure loads, DRE enclosure heating/cooling loads,
22 and skid convenience outlets. These condensate collection points are not expected to capture any
23 condensate. If they do, the condensate will be manually collected and returned to the tank.

24 **4.4.2 Data Acquisition System**

25 The TOS has an installed system for controlling, monitoring, and acquiring data during the operation of
26 TOS. An ethernet cable will be routed to a remote interface station outside of the fence on the west side of
27 the B Tank Farm. The NUCON TOS can communicate with a remote HMI with attached laptop/personal
28 computer located outside of the tank farm fence boundary via ethernet cable.

29 **4.4.3 Diesel Fuel**

30 The fuel required to operate the diesel engine will be diesel fuel with not more than 15 ppm sulfur. Fuel
31 consumption is expected to be between 1.0 and 1.2 gal/hr. A fuel transfer pump will be used to refuel the
32 85-gallon day tank for the generator. The engine will be shut off and cooled down before refueling. A fire
33 extinguisher, spill kit, fuel hose, drip pan, and personal protective equipment (gloves) will be available
34 before any refueling. A drip pan will be used to prevent spills to the ground. If a spill occurs during
35 fueling, the spill will be contained and the spill cleaned up. Static bonding will be maintained throughout
36 refueling process to prevent sparks.

37 **4.5 Fire Protection**

38 The TOS diesel fuel system relies on fuel storage (day tank) with daily fuel additions as needed. The
39 limited quantity of flammable liquids present does not require installation of a fire protection system
40 (16-TF-0024, "Contract Number DE AC27 08RV14800 – U.S. Department of Energy, Office of River
41 Protection Approval of Washington River Protection Solutions LLC's Application of DOE-STD-1066-99
42 for Single-Shell Tank Ventilation Systems").

4.6 Design, Fabrication, and Installation

The airstream being drawn from the BY-108 headspace has a pH range from 10 to 14 and may contain varying amounts of hydrogen, nitrous oxides, methane, and ammonia vapors (RPP-SPEC-62690). The TOS components will be in contact with the chemical composition ranges identified in RPP-22491, *Industrial Hygiene Chemical Vapor Technical Basis*. Equipment, components, and assemblies that will be in contact with toxic vapors will be compatible with the vapor's physical, chemical, and radioactive properties for the planned duration of contact. This includes all piping, filters, blower housings, and valve wetted surfaces. Metallic surfaces that will routinely contact vapors are fabricated from stainless steel. The TOS components will be designed, installed, and operated in accordance with WAC 173-303-680, *Miscellaneous units*.

Table 3 contains a list of engineering drawings that are submitted as part of supplemental information to this Permit.

Table 3 NUCON Thermal Oxidation System Phase 3 Engineering Drawings

Number	Title
H-14-020112, Sheet 1	General Notes and Legend
H-14-020112, Sheet 2	Filter Skid P&ID
H-14-020112, Sheet 3	TOS Skid P&ID
H-14-020112, Sheet 4	RPMS Cabinet P&ID
H-14-020112, Sheet 5	DRE Cabinet P&ID
H-14-030012, Sheet 24	Electrical One-Line Diagram POR670-EDS-DP-PLBD-100
H-14-030012, Sheet 25	Electrical One-Line Diagram POR670-EDS-DP-100
H-14-030012, Sheet 26	Electrical One-Line Diagram POR670-EDS-DP-101
H-14-030012, Sheet 27	Electrical One-Line Diagram POR670-EDS-PLBD-100
H-14-030012, Sheet 28	Electrical One-Line Diagram POR670-EDS-DP-100
H-14-030012, Sheet 29	Electrical Panelboard Schedule POR670-EDS-DP-101
H-14-111794, Sheet 1	Project Title Sheet – Design Document List
H-14-111795, Sheet 1	Civil Site Plan
H-14-111796, Sheets 1-6	Structural – Filter Skid Frame
H-14-111797, Sheets 1-5	Structural – TOS Skid Frame
H-14-111798, Sheets 1-3	Mechanical – Site Plan
H-14-111799, Sheet 1	Mechanical – Riser Adapter Assembly
H-14-111800, Sheets 1-3	Mechanical – Filter Skid Assembly
H-14-111801, Sheets 1-2	Piping Spools Assembly
H-14-111802, Sheet 1	Mechanical – TOS Skid Assembly
H-14-111803, Sheets 1-3	Mechanical – TOS Skid Piping Spools Arrangement
H-14-111805, Sheets 1-2	Mechanical – MERSORB ^a Bed Assembly
H-14-111806, Sheet 1	TOS Skid Pipe Support Details
H-14-111807, Sheet 1	Mechanical – Support Assembly/Details
H-14-111809, Sheets 1-2	Mechanical – Filter Skid Piping Spools
H-14-111810, Sheet 1	Mechanical-Valve List

Table 3 NUCON Thermal Oxidation System Phase 3 Engineering Drawings

Number	Title
H-14-111811, Sheets 1-3	Electrical – Site Plan
H-14-111812, Sheet 1	Electrical – Interface Thermal Encl
H-14-111813, Sheet 1-5	Electrical—Elementary Diagrams
H-14-111814, Sheet 1-2	Electrical—Wire Runs
H-14-111816, Sheet 1	Instrument – Filter Skid Plan
H-14-111816, Sheet 2	Instrument – TOS Skid Plan
H-14-111817, Sheets 1-2	Instrument List
H-14-111818, Sheet 1	Instrument PLC I/O List
H-14-111819, Sheets 1-4	Instrument Drawings
H-14-111820, Sheets 1-7	Instrument – POR670-VTP-CP-001 PLC CAB ASSY
H-14-111822, Sheets 1-5	Instrument – Loop Diagrams

^aMERSORB is a trademark of NUCON International, Inc., Columbus, Ohio.

DRE = Destruction and removal efficiency

I/O = Input/output

P&ID = Piping and instrumentation diagram

PLC = Programmable logic controller

RPMS = Radioactive particulate monitoring system

TOS = Thermal oxidation system

1 **4.7 Operational Activities**

2 The operations to start and shutdown the TOS will be automated. The operator will initiate starting from
 3 the HMI after a pre-startup checklist that will include oil level and fuel level checks among other safety
 4 checks and manual valve configuration checks. Normal shutdown will also be initiated by the operator
 5 from the PLC.

6 **4.7.1 Preoperation Testing Activities (Startup)**

7 Preoperation and startup activities (including testing and preparation of work packages) will be conducted
 8 to ensure proper performance of components and subsystems individually and as part of overall system
 9 performance, either prior to delivery or after installation in the field.

10 At a minimum, the following will be tested or verified, and documented:

- 11 • No system leakage.
- 12 • Ability to open/close valves.
- 13 • Ability to regulate blower fan speed to optimize diesel feed rate.
- 14 • Steady-state process intake air at 52 to 60 cfm.
- 15 • Flow rate.
- 16 • Ability to respond to off-normal conditions.

17 The TOS will have administrative controls in place for starting the transfer of vapors from BY-108 to the
 18 filter skid, including verification of prestart conditions. Prior to start, the operations manager will confirm
 19 that all processes are in place and document approval that operations can commence.

1 **4.7.2 System Startup**

2 Startup of the diesel engine requires a fresh air intake that bypasses most of the inlet restrictions. Intake
3 valve MOV-102 will remain in the open position in the absence of electrical power. This is important to
4 start the diesel engine with little or no inlet air restrictions. Starting the diesel engine will provide power
5 from the generator to operate the other components in the system not on shore power.

6 Once the generator power is established as determined through the Modbus communications, valve
7 MOV-101 will open to establish a path for the fresh air to flow through the filter skid components.

8 Upon confirmation that valve MOV-101 is open, the booster blower (BLO-001) will start operation
9 pulling air through the filter system and pushing air through the MERSORB bed. When the booster
10 blower control is confirmed, the startup valve MOV-102 will be closed.

11 Ambient airflow will continue through valve MOV-101. Generator power will be supplied to the heater,
12 the process heat trace, the RPMS and DRE sample system, and the cooler fan.

13 Additional electrical load will be applied using the load bank. Electrical load is added by increasing the
14 load bank settings to establish appropriate gas flow rates and diesel engine discharge temperatures.
15 Appropriate temperatures are expected with the generator loaded to 70 to 80 percent of the full load.

16 The TOS unit will be operated in the warmup mode to allow the pressures and temperatures to stabilize
17 and for heating of the MERSORB bed above the dewpoint of the tank headspace.

18 **4.7.3 System Operation**

19 Processing BY-108 headspace gases will commence after the diesel engine has reached desirable
20 operating temperature and the MERSORB bed has reached operating setpoint temperature. The TOS will
21 have a steady-state operating condition of 52 to 60 cfm.

22 Once the pressures and temperatures stabilize and the MERSORB bed reaches a temperature above the
23 dewpoint of the tank headspace, COPC vapors can be treated. The TOS will switch to the process mode
24 by opening valve MOV-100 and closing valve MOV-101 when valve MOV-100 is confirmed to be open.

25 The tank headspace gas will be preconditioned via the filter skid using a moisture separator, heater, and
26 HEPA filters. The activated carbon MERSORB bed will remove mercury from the COPC vapors prior to
27 burning in the engine. The engine exhaust passes through a catalytic device and a diesel particulate filter
28 to further destroy the COPCs chemicals and remove diesel soot.

29 **4.7.4 System Shutdown**

30 The normal shutdown process will essentially reverse the startup steps for a safe shutdown. To begin the
31 shutdown, valve MOV-101 will be opened. Upon confirmation the valve has opened, valve MOV-100
32 will be closed. The system will continue to operate with air supplied through valve MOV-101 while
33 shedding electrical load in the following sequence:

- 34 1. The load bank is turned off.
- 35 2. Process heat trace is turned off.
- 36 3. The heater is turned off.
- 37 4. There is a 30-sec time delay for cooling the heater coils, and then the cooler fan is turned off.
- 38 5. Startup valve MOV-102 is opened.
- 39 6. After confirmation that valve MOV-102 is open, the booster blower is switched off and valve
40 MOV-101 is closed.
- 41 7. After confirmation that valve MOV-101 is closed, the diesel generator is stopped.

1 Implementing the recommendations of the Fire Hazards Analysis will result in an automatic system
2 shutdown in the event of exceeding the setpoint of the carbon monoxide monitoring system. Details of the
3 revised setpoint, updated control logic to execute automatic system shutdown, and additional monitoring
4 equipment will be provided to Ecology when this information becomes available.

5 **4.7.5 Process Monitoring Limits and Interlocks**

6 The TOS field instruments consist of devices that monitor tank pressure, differential pressure across filter
7 and demister components, flow, temperature, moisture, and carbon monoxide. An in-line heater located
8 on the filter skid is controlled by the PLC. Radiation levels in the sample line are monitored by a CAM,
9 and the radiation level as well as CAM status is monitored at the PLC.

10 **4.7.5.1 Flow Measurement Setpoints and Interlock**

11 A thermal mass flow sensor is used to measure transport line flow. The flow sensor has an integral
12 temperature sensor for temperature compensation of the flow measurement. A low-flow alarm is received
13 when flow in the transport pipe is < 40 Actual Cubic Feet per Minute (ACFM). The low-low alarm and
14 interlock are set to shut down the TOS unit if a low flow rate is sensed in the duct. The low-flow interlock
15 setpoint is based on minimum air requirements for the diesel engine. The TOS is expected to operate at a
16 consistent operating flow rate of 52 to 60 ACFM, which is well above this interlock setpoint such that
17 there should be no interference with normal operation.

18 **4.7.5.2 Pressure Monitoring Setpoints and Interlocks**

19 Pressure is monitored at several locations on the TOS. Tank BY-108 pressure is monitored to ensure the
20 vacuum drawn on the tank does not exceed the tank vacuum limits of -3.5 in. water gauge (wg.). The inlet
21 pressure to the diesel generator is also monitored to ensure that proper inlet pressure is maintained to
22 ensure efficient operation of the generator engine. Pressure differential instruments are used for this
23 pressure monitoring and are referenced to atmosphere.

24 A low differential pressure (high-vacuum) alarm is set at -1.5 in. wg. for tank pressure. A low-low alarm
25 and interlock are set at -2.0 in. wg. to prevent buckling the tank sidewall. Excess vacuum will shut down
26 the TOS unit and close isolation valve MOV-100 to prevent exceeding negative pressure limits for
27 BY-108. A vacuum breaker, PRV-100, is located on the TOS duct outlet riser with a setpoint of
28 -2.5 in. wg., with 10 percent overpressure at 60 cfm. The setpoint of the vacuum breaker provides margin
29 to protect the tank vacuum limit of -3.5 in. wg. The tank low-pressure interlock setpoint is set at -2.0 in.
30 wg., such that the TOS unit is shut down before the vacuum breaker is activated.

31 **4.7.5.3 Pressure Differential Monitoring Setpoints and Interlocks**

32 Maximum differential pressure operating limits are established to maintain a margin of safety below the
33 maximum design differential pressure of 10 in. wg. for HEPA filters. The differential pressure interlock
34 setpoint is set at 5.9 in. wg. for the first HEPA filter and 4.0 in. wg. for the second HEPA filter, which
35 results in a TOS shutdown upon receipt of a high-high alarm in either of the HEPA filters. The high-high
36 differential pressure alarm on either the two HEPA filters results in a TOS shutdown and closure of
37 MOV-100. This interlock prevents operation above the maximum HEPA filter differential pressure limits.

38 **4.7.5.4 Temperature Monitoring and Control**

39 Temperature monitoring is performed to monitor heater output to prevent moisture condensation, provide
40 early indication of potential heater failure or control malfunction, monitor diesel generator performance,
41 and in conjunction with high-moisture alarm, ensure relative humidity limit of 70 percent is not exceeded.

42 Temperature element TE-106 monitors heater outlet temperature and alarms to notify operations of high
43 temperature due to excessive heater output. TE-112 monitors filter housing outlet temperature and
44 provides control input to the heater controller to maintain temperature at 120 °F.

1 The low-temperature setpoint on the filter housing outlet (TE-112) is 100 °F. The high-temperature
2 setpoint is 135 °F based on engineering judgment and is deemed appropriate based on a nominal duct air
3 temperature of 120 °F during normal operating conditions. This high setpoint selection allows for
4 deviations from the normal operating temperature but is selected to be well below the interlock setpoint.
5 The heater outlet high alarm is 135 °F to provide margin below the interlock setpoint.

6 The interlock setpoint of 150 °F is selected based on past operating experience for tank farm ventilation
7 systems, to protect the CAM temperature limit of 167 °F, as well as protect the HEPA filters from
8 exposure to high heat and degradation.

9 Temperature element TE-114 and TE-115, and TE-117 monitor airstream temperatures that have been
10 heated to prevent moisture condensation. TE-104 monitors airstream temperatures that has not been
11 preheated and this sensor is used for monitoring only.

12 The high temperature setpoint at the outlet of the TOS unit is 1000 °F, and the high-high setpoint is
13 1100 °F. These alarms provide early indication of excess fuel consumption or excessive loading of the
14 generator.

15 **4.7.5.5 Carbon Monoxide Monitoring**

16 A carbon monoxide sensor is installed in the duct on the downstream side of the MERSORB unit to
17 monitor carbon monoxide levels in the airstream. An increase in carbon monoxide downstream of the
18 activated carbon bed is an indication of combustion in the carbon bed and notifies operations of the need
19 to act. A Fire Hazard Analysis¹⁰ concluded a carbon bed fire in the NUCON system is “unlikely” and
20 there is “no expectation” that the design would create a fire hazard. Implementation of the Fire Hazards
21 Analysis will result in minor design changes that will require modification of design documents. Updated
22 design media will be provided to Ecology when it becomes available.

23 **4.7.5.6 Moisture Monitoring**

24 Moisture monitoring of relative humidity in the TOS downstream of the heater is required to ensure
25 process temperatures are maintained to prevent condensation of moisture in the airstream and loading of
26 HEPA filters with moisture. The moisture analyzer is set to alarm when moisture in the filter housing
27 exceeds 70 percent relative humidity. The high-moisture alarm provides indication of a heater
28 malfunction or that process conditions are outside design conditions, allowing operational investigation of
29 the condition and possible TOS shutdown if the condition persists.

30 **4.7.5.7 Destruction and Removal Efficiency Sampling**

31 Airstream chemical sampling points are designated on Figure 3 for the TOS. Airstream samples shall be
32 taken by the means of portable SUMMA canisters and sorbent tubes within the DRE air sampling cabinet.
33 The DRE sampling system is contained in the DRE cabinet that is mounted on the filter skid.

34 **4.7.5.8 Radioactive Particulate Monitoring**

35 The RPMS is a vendor-supplied packaged system for the TOS. Radioactive air emissions will be
36 monitored by the RPMS when the on-site TOS unit is operating. Two samples will be pulled from the
37 airstream downstream of the last HEPA filter using a vacuum pump and mass flow controllers. One
38 sample is for continuous air monitoring and one sample is for a record sample. The RPMS equipment will
39 be located within an enclosure mounted on the filter skid.

¹⁰HNF-SD-WM-FHA-020, *Tank Farms Fire Hazards Analysis*.

4.8 Post-Operational Activities

At the completion of the field demonstration, the TOS unit will be disconnected from the tank riser, dismantled, and dispositioned so the BY Tank Farm can be restored to the as-found condition. Visual inspection and radioactive surveys will be used to verify all contamination from operation and removal of the TOS unit have been removed.

4.9 Secondary Waste Stream Disposal

If any solid waste is generated during operation of the TOS, it will be designated, packaged, and disposed at an approved on-site facility.

4.9.1 Liquid Effluent Secondary Waste Streams

Liquid secondary waste (e.g., condensate) will return to BY-108 during operations.

4.9.2 Solid/Semisolid Secondary Waste Streams

Disposition of solid waste streams will be managed in accordance with applicable receiving facility waste acceptance criteria (e.g., HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*). The spent MERSORB and supporting components shall be packaged in storage containers designed to prevent radiological releases to the environment.

4.10 Criteria to Modify or Suspend Operations

The project operations staff will be trained to respond to off-normal conditions during processing and have established operating instructions in place. Off-normal conditions may include loss of electrical power, equipment registering out of specification during monitoring (e.g., high/low pressure, high/low flow), and reaching or exceeding set radiological limits. Operations staff will evaluate responses to the off-normal conditions against their operating instructions and respond accordingly based on the assessment.

If an excess of vacuum is drawn on BY-108 at any time during NUCON TOS operations, operations will be suspended and the system placed in standby mode.

The NUCON TOS operation staff will use the SST facility emergency procedures that will be in the NUCON TOS Operating Record to respond to off-normal conditions (e.g., liquid spill, personnel injury) as described in Section 8.1.

5.0 WASTE ANALYSIS PLAN

The waste analysis plan provides the basis for measuring the effectiveness of the vapor treatment system and assists in optimizing the treatment operation based on the analysis of the treated airstream. For this NUCON Project, the *Test Plan PNNL Support to Thermal Oxidation System – Phase 3 Project*, TP-TOSP3-001 (Test Plan), serves as the waste analysis plan. The Test Plan addresses the sampling, analysis, monitoring, and data collection necessary to evaluate the effectiveness of the TOS.

The function of the treatment units that comprise the TOS is to remove or destroy COPCs from the airstream. The overall goal of the NUCON TOS demonstration is to evaluate the efficacy of the TOS on an actual Hanford waste tank vapor involving complex mixtures of COPCs and in a tank farm operational environment. The purpose of the Test Plan is to ensure that all waste generated from the NUCON TOS is managed in accordance with WAC 173-303-300, *General waste analysis*.

The Test Plan specifies the sampling procedures and defines the quality assurance and quality control requirements. The Test Plan provides the approach for characterizing the pretreated vapor stream and evaluating the performance of the TOS against the project objectives identified in Section 2.2. The results of the Test Plan will provide data for waste management during the NUCON TOS Project.

1 The NUCON TOS is a novel system and a unique technology at Hanford. The Test Plan has been
2 prepared in advance of construction and will be updated to reflect changes or adaptations that may be
3 needed. The Test Plan and all revisions will be maintained in the NUCON TOS Operating Record.

4 **6.0 INSPECTION PLAN**

5 **6.1 Project Requirements**

6 The purpose for conducting inspections of the NUCON TOS to ensure that situations do not exist that
7 might cause or lead to the release of dangerous or mixed waste to the environment, or that might pose a
8 threat to human health and the environment. This inspection plan is designed to provide early warning of
9 the potential for such events to make timely corrections and/or take preventive actions. Discrepancies or
10 noncompliant conditions identified by inspections must be corrected on a schedule that helps prevent
11 hazards to personnel, the public, and/or the environment. The inspections conducted during the testing of
12 NUCON TOS Phase 3 will meet applicable regulatory requirements including: WAC 173-303-320,
13 WAC 173-303-630(6) and WAC 173-303-640(6). The NUCON TOS Phase 3 RD&D Project inspection
14 requirements are in addition to the inspection requirements for the BY Tank Farm.

15 A copy of the inspection schedule will be kept and in the NUCON TOS Operating Record,
16 (e.g., associated work package and/or testing procedure for this project). Inspections within the schedule
17 are performed by qualified personnel according to a frequency that has been developed through both
18 regulatory requirements and operating experience. Inspection requirements will continue until testing of
19 the NUCON TOS in BY Tank Farm has been successfully completed. During an inspection, inspectors
20 evaluate each inspection item against associated acceptance criteria defined in the schedule. The results of
21 the inspections are documented in inspection logs that are dated and signed (handwritten or electronic
22 signature) by the inspector or qualified individual.

23 Management-level staff responsible for implementation of the inspection plan are the shift operations
24 manager (i.e., shift operations manager, shift manager, or operations manager) or NUCON Phase 3
25 RD&D Project test director as described in TFC-PLN-187, *Single-Shell Tank Dangerous Waste Training*
26 *Plan*. Management-level staff review and concur with inspection records. All inspectors are trained in
27 accordance with TFC-PLN-187, and a copy will be placed in the NUCON TOS Operating Record.

28 **6.2 Inspection Schedule**

29 **6.2.1 General**

30 The frequency of inspection is how often (at a minimum) an inspection must be performed. The
31 frequency of inspections is based on the rate of possible deterioration of equipment and the probability of
32 a threat to human health or the environment.

33 Unless otherwise noted, inspection frequencies are defined by the following periodicities:

- 34 • Daily means once per calendar day.
- 35 • Weekly means once during the period from Sunday to Saturday.
- 36 • Monthly means once per calendar month.

37 **6.2.2 Inspection Methods**

38 The method of inspection is how an inspection is to be performed. The three primary methods of
39 inspection identified and required by this inspection plan are described below.

- 40 • Visual. A visual inspection conducted physically in person. A physical inspection requires the
41 physical presence of the inspector at the item of inspection and is not to be confused with a
42 remote inspection. Due to accessibility limitations, visual inspections may be conducted with the
43 aid of instruments (e.g., camera, mirrors, borescope, viewing windows).

- 1 • Remote. An inspection conducted by instrument monitoring via control/alarm panels, or any other
 2 inspection that is not conducted physically in person. In certain areas of the NUCON TOS, many
 3 inspections are performed remotely to maintain as low as reasonably achievable (ALARA)
 4 exposure. Monitoring instruments are connected to audible alarms and visual indicators track
 5 alarm status. The monitoring system provides monitoring data, graphics, and equipment summary
 6 displays.
- 7 • Functional. An inspection conducted by operating or testing the item being inspected to determine
 8 if equipment/instrument is operating correctly and capable of performing its function.

9

Table 4 Inspection Schedule

Inspection Item	Frequency	Types of Problems and Evaluation Criteria
Ancillary Equipment Leak Detection [WAC 173-303-640(4)(f)(i)]		
Inspect duct and condensate drain system for signs of leaks or releases to the environment	Daily, when operating	Problem: Liquid seeping out of connections; wet spots; excessive corrosion that threatens the integrity of the system.
Visual inspection of the construction materials and the area immediately surrounding the externally accessible portion of the TOS	Daily, when operating	Problem: Erosion or signs of releases of dangerous waste (e.g., wet spots, dead vegetation).
Data Gathered from Monitoring Equipment [WAC 173-303-640(6)(b)(ii)]		
Mass flow rate through the treatment system	Daily, when operating	Problem: Mass flow outside desired range of 52 to 60 ACFM.
Tank 241-BY-108 vacuum	Daily, when operating	Problem: TOS drawing excessive vacuum on Tank 241-BY-108.
Carbon monoxide analyzer Normal level: < 100 ppm carbon monoxide	Daily, when operating	Problem: Increasing carbon monoxide downstream of the activated carbon bed is an indication of combustion in the carbon bed.
MERSORB bed inlet temperature	Daily, when operating	Objective is to maintain the temperature near approximately 100 °F for moisture control.
Security Devices [WAC 173-303-320(2)]		
Verify doors and gates that provide access to the 241-BY Tank Farm are in working order and able to be secured to prevent unauthorized access	Monthly	Problem: Unsecured entrances allow unauthorized access. Gaps, holes, or other defects that allow unauthorized access.

Table 4 Inspection Schedule

Inspection Item	Frequency	Types of Problems and Evaluation Criteria
Posted warning/hazard signs	Monthly	<p>Problem: Missing or sun-faded signs that cannot be read from 50 ft or more.</p> <p>Check that signs are posted at all entrances to the 241-BY Farm the legend, “Danger-Unauthorized Personnel Keep Out,” or, “Danger-Hazardous Materials-Unauthorized Personnel Keep Out,” or “Hazardous Materials-Unauthorized Personnel Keep Out,” and are legible from a distance of at least 25 ft. Signs are posted at doors and gates that provide access to the active portions, plus the words “Hazardous Waste,” “Corrosive,” and “Toxic.”</p>
Safety and Emergency Equipment [WAC 173-303-320(2)]		
Safety shower and eyewash station in the 241-BY Tank Farm	Monthly	<p>Problem: Inadequate pressure, obstructions around and in front of safety shower/eyewash station.</p> <p>Check for adequate pressure, and no obstructions.</p>
Public address system	Monthly	<p>Problem: Inoperable handset or insufficient loudspeaker modulation.</p> <p>Verify public address system handset transmits and loudspeaker system is audible.</p>
Fire extinguishers in the 241-BY Tank Farm	Monthly	<p>Problem: Missing fire extinguisher, improper type of fire extinguisher, or inaccessible fire extinguisher.</p> <p>Ensure fire extinguishers are visible, are in proper location, are the proper type, easily accessible, and that the fire extinguishers are adequately pressurized for use (i.e., gauge reading).</p>

WAC 173-303-320, *General inspection*, Washington Administrative Code.

WAC 173-303-640, *Tank systems*, Washington Administrative Code.

6.3 Documentation

Inspection reports will be maintained in an inspection log maintained as a part of the NUCON TOS Operating Record. The inspection log will be maintained within a work package or test procedure during the testing evolution. Frequency of inspection, format and content of the inspection report forms, and the inspection log will be following the requirements of WAC 173-303-320, WAC 173-303-630(6), and WAC 173-303-640(6). Notations of observations made, and deficiencies noted during an inspection are recorded on inspection log. The inspection log will also include an account of spills or discharges in accordance with WAC 173-303-145, *Spills and discharges into the environment*, and the date and nature of any repairs or remedial actions taken.

If the inspection identifies a finding of deficiency, the inspector must specifically describe the situation on the inspection form and determine whether the condition of the item is “acceptable” for continued use pending repair or replacement or is “unacceptable” and must be repaired or replaced prior to further use.

If an inspection was scheduled or attempted but could not be performed or fully completed due to a planned event (e.g., planned power outage, waste transfer), then a reasonable attempt will be made to reschedule and complete the inspection within the identified inspection frequency. If the cause was due to an unplanned event (e.g., Hanford Site or local area emergency or injury, unplanned power outage, unexpected or radiological conditions, work, training, severe weather, or safety restrictions), the missed inspection or portions thereof that were not completed will be documented on the relevant inspection log and noted in the NUCON TOS Project Final Report described in Section 8.2.

6.4 Corrective Action for Discrepancies and Noncompliances

Problems identified by the inspector are documented on the inspection log and reported to facility management for prioritization and scheduling of remedial actions to minimize environmental or human health incidents. Problems identified during inspections are categorized into three general areas and addressed accordingly. The areas include imminent hazards to human health and/or the environment, problems that can be easily remedied with little or no planning, and maintenance items that require planning and coordination to correct.

When an identified problem poses an imminent risk to human health or the environment, actions are taken immediately to mitigate the hazard. Examples of problems that warrant immediate action include spray releases and aboveground releases of dangerous waste. Immediate action is taken in a manner that is consistent with ALARA principles and may include activation of the BEP and the HEMP when contingency plan action levels are exceeded.

Problems identified during inspection that are easily corrected (i.e., no maintenance planning required) (e.g., restocking supplies, removal of accumulated stormwater from sumps) will be corrected within 24 hours of the inspection or tracked until completion.

Other problems that cannot be easily corrected are addressed on a prioritized schedule. These problems are tracked using the Rounds Action Tracking List. Problems identified during Hanford Fire Department inspections are tracked using the Job Control System.

An overall schedule for remedying problems would include time to develop a maintenance instruction in conjunction with any schedule constraints (e.g., parts availability, fabrication, environmental conditions, facility access limitations). The time to develop a maintenance instruction is dependent on several factors, including nuclear, radiological, and industrial safety hazards associated with the task; complexity of the task; human factors and performance considerations; skill of worker(s); and risk to the worker, public, or the environment.

1 The resolution process for problems discovered during inspections may involve completing an inspection
2 data sheet, which identifies the criteria for the inspection; relaying identified problems onto an
3 action-tracking list; and developing maintenance instructions for problems based on the action-tracking
4 list. The remedies for problems identified are developed using maintenance instructions and prioritized on
5 a schedule as described. Problems pending resolution and their associated tracking number/designation
6 will be noted in subsequent inspection logs until the remedy is complete.

7 Information from the inspection problem resolution process will be maintained in the NUCON TOS
8 Operating Record.

9 **7.0 PREPAREDNESS AND PREVENTION**

10 This section documents the preparedness and prevention measures taken for the TOS, and describes the
11 required internal and external communications and emergency equipment.

12 **7.1 Notification System**

13 The TOS is equipped with communication systems to provide emergency instructions to personnel. The
14 communication systems include telephones, two-way radios, and alarms located throughout the 200 East
15 Area [WAC 173-303-340(1)(a) and (b)].

16 If assistance from Hanford Patrol or the Hanford Fire Department is required, the Hanford Emergency
17 Response Number (911 or 509-373-0911 if using a cell phone) must be used to contact the Patrol
18 Operations Center and request the desired assistance. Upon notification, the Hanford Patrol Operations
19 Center notifies and/or dispatches required emergency responders. Portable two-way radios and telephones
20 provide communication among the 200 Area shift/field offices, field personnel, and operations shift
21 managers.

22 **7.2 Personal Protective Equipment**

23 Personal protective equipment provided for workers at the TOS includes respiratory protection equipment
24 for daily use that is tested and maintained under a maintenance program. The specific type of respiratory
25 equipment required is subject to change in response to changes in field conditions and the nature of work
26 being performed. Sampling and monitoring results are used to determine the level of respiratory
27 protection that is required.

28 **7.3 Spill Kits**

29 The TOS have limited spill control kits because the waste managed inside BY-108 will not be removed
30 from the tank during this project. Spill prevention and response is integral to the work planning process.
31 Spill control equipment used to facilitate cleanup of small spills during refueling of the diesel tank will be
32 available in the BY Tank Farm [WAC 173-303-340(1)(c) and (d)].

33 **7.4 Water/Foam for Fire Control**

34 The Hanford Site relies primarily on the Hanford Fire Department to control fires. The Hanford Fire
35 Department provides rapid response to fires within the 200 East Area.

36 The Hanford Fire Department fire engines carry water to control fires that require high water volume and
37 pressure, in addition to foam. The fire engines can also connect to the fire water supply loop throughout
38 the 200 East Area if additional water is needed [WAC 173-303-340(1)(c) and (d)].

39 **7.5 Aisle Space**

40 Aisle space is maintained in the BY tank farm to allow the unobstructed movement of personnel, fire
41 protection equipment, spill control equipment, and decontamination equipment to any area of facility
42 operation in an emergency [WAC 173-303-340(3)].

1 **7.6 Preventive Procedures, Structures, and Equipment**

2 The following sections describe preventive procedures, structures, and equipment
3 [WAC 173-303-806(4)(a)(viii)].

4 **7.6.1 Loading and Unloading Operations**

5 During the work planning process that is conducted prior to operating the TOS, potential releases and
6 personnel exposure are evaluated and appropriate hazard controls are implemented based on the nature
7 and location of the work to be completed.

8 During TOS operations, pipe connections are verified to be leak-tight, and the condensate collection is
9 covered with transparent sleeve to allow visual inspection for leaks. Drip pans will be placed under
10 connections when they are being disassembled. Other preventive controls used to prevent releases include
11 visual inspection of the condensate drain system and the treatment equipment installed on the thermal
12 oxidation skid, and shutdown of the TOS if a leak is detected (WAC 173-303-806(4)(a)(viii)(A)).

13 **7.6.2 Run-on and Runoff Control**

14 The TOS design and site features help minimize run-on (i.e., storm-related events or water pipe failure)
15 [WAC 173-303-806(4)(a)(viii)(B)]. The TOS is located aboveground and is constructed and operated to
16 prevent runoff from mixed waste handling areas to other areas of the facility or environment.

17 **7.6.3 Preventing Contamination of Water Supplies**

18 The TOS is visually inspected every operating day to detect leaks or spills. The TOS is isolated from
19 Hanford Site water supply and does not have the potential to contaminate the water supply
20 [WAC 173-303-806(4)(a)(viii)(C)].

21 **7.6.4 Equipment Failure and Power Outages**

22 The TOS is designed to mitigate the effects of failure of the TOS equipment to prevent a release to the
23 environment. Shutdown criteria will be established for unexpected changes in operating conditions. The
24 shutdown criteria will identify situations when the TOS must shut down. During operations, the computer
25 system monitors the processing equipment and annunciates in the event of an alarm. The operation of the
26 TOS is monitored and compared to the shutdown criteria. If the TOS shutdown criteria are met, the
27 shutdown process begins when the inlet valve is closed, stopping active flow of untreated air into the
28 treatment system [WAC 173-303-806(4)(a)(viii)(D)].

29 **7.6.5 Personnel Exposure**

30 Design, administrative controls, and personal protective equipment are used to prevent undue
31 exposure of personnel. All operations are conducted so that exposures to dangerous and/or mixed waste
32 and hazardous material are maintained ALARA through engineering design or administrative controls
33 or with protective gear where engineering controls are not sufficient. Before the start of any operation
34 that might expose personnel to the risk of injury or contamination, a review of the operation is performed
35 to ensure the nature of hazards that might be encountered are considered and that appropriate controls are
36 selected. Administrative procedures dictate the level of protective clothing worn and can vary based on
37 the location within the BY Tank Farm and the nature of the activity being performed [WAC 173-303-
38 806(4)(a)(viii)(E)].

1 **7.6.6 Releases to the Atmosphere**

2 The TOS will be designed and operated to prevent the buildup of gases in BY-108 and the TOS
3 equipment to comply with AEA safety requirements. Tightness testing prior to initial startup will ensure
4 fittings are leak-tight and will not emit untreated air emissions. The air emissions from the TOS are
5 permitted under the *Hanford Site Air Operating Permit* (00-05-006) to ensure the health and safety of the
6 public. Engineering controls, monitoring and sampling, and administrative controls are used to mitigate
7 hazards [WAC 173-303-806(4)(a)(viii)(F)].

8 **7.6.7 Prevention of Reaction, and Handling of Ignitable, Reactive, and/or Incompatible**
9 **Waste**

10 Administrative and engineering controls ensure safe waste handling. Administrative controls include
11 prohibiting smoking near the tanks and limiting activities that could generate sufficient heat or sparks and
12 present an ignition source. Other controls to preclude sources of ignition include monitoring for
13 flammable gas, use of non-sparking tools and equipment, and/or the use of physical barriers. These
14 controls vary according to the specific activity being performed [WAC 173-303-806(4)(a)(ix)].

15 **7.7 Maintenance and Testing of Required Equipment**

16 The TOS personnel track maintenance and testing of equipment required by WAC 173-303-340(1).
17 Maintenance activities are scheduled during outages or during other times to avoid interference with
18 operations and keep radiological exposure of personnel ALARA.

19 **8.0 RECORDKEEPING AND REPORTING**

20 Recordkeeping and reporting for the NUCON Phase 3 RD&D Project has two components:

- 21 • NUCON TOS Operating Record requirements.
- 22 • Final report on the NUCON Phase 3 RD&D Project.

23 **8.1 NUCON Thermal Oxidation System Operating Record**

24 The Permittees will maintain a written operating record of activities conducted under the NUCON
25 Phase 3 RD&D Project, according to Hanford General Permit Condition II.I. The record will be
26 maintained until closure of the project.

27 The NUCON TOS Operating Record will include the following:

- 28 • Copies of the HEMP and Tank Farms BEP.
- 29 • SST facility emergency procedures as described in Section 3.10.
- 30 • A copy of the Test Plan and all revisions.
- 31 • A copy of the NUCON TOS inspection schedule.
- 32 • A copy of inspection reports and inspection log, including observations made and deficiencies
33 and date and nature of any repairs or remedial actions taken.
- 34 • Summary reports and details of all incidents that require implementing the contingency plan.
- 35 • Monitoring, testing, or analytical data, and corrective action.
- 36 • Manifests of waste shipped off-site [WAC 173-303-180(3)(iii)].
- 37 • Design documents and drawings, and an independent qualified registered professional engineer's
38 (IQRPE) integrity assessment and certifications.

1 **8.2 NUCON Research, Development, and Demonstration Project Final Report**

2 Upon completion of the NUCON RD&D Project, a final report will be prepared to evaluate the
3 performance of the experimental test that was conducted. Report content and discussion will provide
4 sufficient information and data to allow evaluation against the project objective defined in Section 2.2 of
5 this Permit, and how USDOE could use this information to support future work.

6 The final report on the NUCON TOS RD&D will present, at a minimum, process descriptions, data, and
7 results. The final report will be placed in the NUCON TOS and BY-108 Operating Records to document
8 actions taken at the tank.

9 **9.0 CLOSURE PLAN**

10 **9.1 Introduction**

11 The RCRA closure of RD&D activities differs from closure of a full-scale operating unit at the Hanford
12 Site. All equipment and facilities related to the NUCON TOS are only temporarily located at the BY Tank
13 Farm. No permanent waste storage, treatment, or disposal facilities will be constructed as part of NUCON
14 TOS. Therefore, the scope of closure activities is limited to those applicable to decontamination and
15 removal of NUCON TOS equipment; decontamination of the site, if applicable; and restoration of the site
16 to its pre-RD&D activity state. The NUCON TOS operation and removal from the BY Tank Farm will be
17 for a period of less than two years.

18 **9.2 Regulatory Compliance**

19 Clean closure of the NUCON TOS will provide for decontamination or removal and disposal of all
20 dangerous waste, waste residues, contaminated equipment, soil, or other material established in
21 accordance with the clean closure performance standards of WAC 173-303-610(2). This and future
22 closure plan revisions will provide for compliance with these performance standards. All work will be
23 performed ALARA with respect to worker exposure to dangerous and/or any other workplace hazards.

24 **9.3 Health and Safety Requirements during Closure**

25 Closure activities will be performed in a manner to ensure the safety of personnel and the surrounding
26 environment. Qualified personnel will perform closure activities in compliance with established safety
27 and environmental procedures. All work will be performed consistent with ALARA principles with
28 respect to worker exposure to radiation, dangerous waste, and other workplace hazards. Personnel will be
29 equipped with appropriate personal protective equipment. Qualified personnel are trained in applicable
30 safety and environmental procedures and have appropriate training in decontamination activities. Field
31 operations will be performed in accordance with applicable health and safety requirements.

32 This plan proposes an approach to clean closure of the NUCON TOS. If clean closure cannot be achieved,
33 or there is evidence of a release to the surrounding soils as identified in final closure actions, an amended
34 closure plan in accordance with WAC 173-303-610(3) and WAC 173-303-830, *Permit changes*, will be
35 submitted to Ecology. The amended closure plan will include numeric cleanup levels as specified by
36 WAC 173-303-610(2)(b)(i).

37 **9.4 Closure Performance Standards**

38 Closure performance standards in WAC 173-303-610(2)(a) require the unit to be clean closed in a manner
39 that protects human health and the environment, minimizes the need for further maintenance, and returns
40 the land to the appearance and use of surrounding land areas.

1 To satisfy the closure performance standards, the NUCON TOS will be clean closed by removal or
2 decontamination of all dangerous waste, waste residues, and equipment. All NUCON TOS equipment
3 will be removed from BY Tank Farm as part of closure. Preexisting contamination in and around BY
4 Tank Farm will not be part of the clean closure activities. Closure will require the removal of all
5 dangerous waste, removal of all NUCON installed process equipment and contaminated structural
6 components, and shipment of the waste containers to an authorized storage or disposal facility. Following
7 final removal of all equipment, a physical walkdown will be performed to verify that no evidence of spills
8 or leaks exist, and that the NUCON TOS has met the closure performance standards by removal of all
9 components. If evidence of spills or leaks are found, a sampling and analysis plan will be provided to
10 Ecology for review. All material, equipment, or structures removed will be designated in accordance with
11 WAC 173-303-070, *Designation of dangerous waste*, and disposed. Equipment that does not meet the
12 clean debris rule or cannot be 100 percent inspected will be managed as mixed waste and disposed
13 appropriately. All equipment from the NUCON TOC Project is expected to be removed and disposed of
14 as waste.

15 **9.5 Closure Activities**

16 For this closure plan, closure activities are outlined from activities that are authorized as part of this
17 RD&D permit. Closure activities will entail decontamination and/or removal and disposal of all
18 equipment. The general order of closure activities has been selected to minimize the potential release of
19 mixed waste constituents by removing the bulk of the mixed waste early in the closure process.

20 Closure activities consist of:

- 21 • Isolate and remove used filters and MERSORB media and package for disposal.
- 22 • Separate process equipment from Tank BY-108 and restore BY-108.
- 23 • Dismantle and remove installed process equipment and contaminated components.
- 24 • Package contaminated components for disposal at an approved on-site facility.
- 25 • Perform walkdown to inspect for evidence of spills or leaks.
- 26 • Observe or review newly generated waste management and disposition records.
- 27 • Verify that closure activities were performed in accordance with this closure plan.

28 The IQRPE will record observations and reviews in the closure certification, which will be provided to
29 Ecology.

30 Documentation supporting the clean closure certification will be submitted to Ecology with the
31 certification. At minimum, the following will be provided:

- 32 • All field notes and photographs related to closure activities.
- 33 • A description of any minor deviations from the approved closure plan and justification for these
34 deviations.
- 35 • Documentation of the removal and final disposition of all dangerous wastes and dangerous waste
36 residues, including contaminated media, debris, and all treatment residuals.

37 **9.6 Schedule for Closure**

38 Closure will begin when all analytical results are received and determined to be suitable and sufficient to
39 evaluate the performance of the experimental test that was conducted. Closure is not expected to take
40 longer than 180 days. Should additional time be needed to complete the closure process, Ecology will be
41 notified.

1 **9.7 Certification of Closure**

2 Within 60 days of completion of closure, the Permittees will submit to the department by registered mail,
3 (including applicable electronic means) a certification that the NUCON TOS has been closed in
4 accordance with the specifications in the approved RD&D permit. The certification will be signed by the
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6 **10.0 REFERENCES**

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