Comprehensive Vapor Action Plan

Date Published
September 2018

washington river protection solutions

Prepared for the U.S. Department of Energy
Office of River Protection

Contract No. DE-AC27-08RV14800

SIGNATURE PAGE

Rob Gregory
Chief Operating Officer

9/20/18
Date

EXECUTIVE SUMMARY

In response to an increase of reported tank vapor events, Washington River Protection Solutions LLC (WRPS) chartered the Savannah River National Laboratory to establish and oversee a panel of external, independent experts (Tank Vapors Assessment Team [TVAT]) to examine chemical vapor management and related worker-protection measures at the Hanford tank farms. TVAT released the *Hanford Tank Vapor Assessment Report* (SRNL-RP-2014-00791) in late 2014, which outlined recommendations to reduce the potential for chemical vapor exposures.

WRPS developed the *Implementation Plan for Hanford Tank Vapor Assessment Report Recommendations* (WRPS-1500142) to address TVAT recommendations. Implementation plan actions were planned to occur in two phases. Phase 1 was completed at the end of fiscal year (FY) 2016 and included validating and/or updating headspace characterization; research and development of new monitoring and detection equipment; developing an enhanced Industrial Hygiene (IH) program focused on creating parity with the Radiological Control program; and developing new or enhancing existing training to educate workers about the hazards of working in and around the tank farms.

During the latter part of Phase 1, multiple assessments were conducted on the implementation plan progress and/or the overall IH program. These assessments were conducted by the National Institute for Occupational Safety and Health, Office of Inspector General, Center for Toxicology and Environmental Health, LLC, and DOE-Office Environment, Safety, and Health Assessments. The assessments resulted in many positive observations and multiple recommendations for further enhancement to the vapor management strategy. Assessment results and feedback from stakeholders were incorporated into a comprehensive vapor management strategy. The strategy is focused on achieving the vision that all workers on the Hanford Central Plateau continue to be protected by and actively embrace this comprehensive approach to vapors management, so that workers both ***are safe and feel safe***. The strategy is presented in the Hanford Vapors Integrated Safety Management (HVISM) Strategy document (WRPS-1700777).

This Comprehensive Vapor Action Plan (CVAP): defines and institutionalizes chemical vapor protections to mitigate the potential for vapor incidences; presents the plan to implement the HVISM; and, replaces the *Implementation Plan for Hanford Tank Vapor Assessment Report Recommendations*. WRPS's strategy focuses on three main objectives to implement the recommendations:

1. Manage the vapor hazards through Integrated Safety Management principles
   a. Know the hazards (IH technical basis)
   b. Apply engineered controls such as active ventilation, Strobic Air Tri-Stack® dilution fan, and NUCON® International, Inc. thermal oxidation process
   c. Monitoring (vapor monitoring and detection system)
   d. Centralize command and control to be pre-emptive versus reactive
2. Employ high-quality conduct of operations
   a. Work boundary monitoring (plus mobile laboratory and increased worker communication via the use of signage, reader boards, or a public announcement system)
   b. Reduce single-shell tank farm entries
   c. Training and work planning
3. Engage the workforce

a. Continue to engage the workforce in work planning, walk-downs, and preparation of activities in the tank farm
b. Maintain frequent, open, and transparent communication using workforce meetings, written announcements, the Hanfordvapors.com website (https://hanfordvapors.com), and other communication mechanisms
c. Support medical program enhancements to ensure appropriate measures are taken when workers report symptoms.

This action plan defines and establishes chemical vapor protection actions to mitigate the potential for vapor incidences so workers *are* safe and *feel* safe while performing work in and around the Hanford tank farms. This plan supports the HVISM ***eight core principles***, which are:

1. ***Centralize command and control to monitor farms and enable pre-emptive actions***
2. ***Further demonstrate that unrestricted boundaries are safe from tank vapor exposures***
3. ***Apply defense-in-depth safety controls for increased worker protection***
4. ***Improve work sites through engineered controls and abatement technologies***
5. ***Drive continuous improvement in the IH program technical basis, qualifications, and rigor***
6. ***Continue to enhance worker involvement in determining how work is performed***
7. ***Communicate effectively with the workforce and other stakeholders to continue to build trust and credibility***
8. ***Support enhanced medical programs and systems***

WRPS will monitor and measure progress and success using key performance parameters (KPP). The KPPs were developed by an Integrated Project Team that included both ORP and WRPS staff. The eight KPPs are:

> *There continues to be increased focus at Hanford tank farms to detect, characterize, and mitigate the risks associated with chemical vapors to further protect our workforce.*
>
> Monica Regalbuto
> Assistant Secretary, EM
> October 13, 2016

1. Establish a comprehensive vapor management communication plan, engagement processes, and effectiveness measurements.
2. Maintain the *Industrial Hygiene Chemical Vapor Technical Basis* document and the chemicals of potential concern (COPC). Institutionalize a disciplined and rigorous process for updates to include new scientific findings and enhanced understandings of potential exposures.
3. Maintain Industrial Hygiene Program and institutionalize vapor program requirements, best practices and program parity, and complete necessary training to support full implementation at the beginning of FY 2018.
4. Complete engineering control concept demonstrations for Strobic Air Tri-Stack® and NUCON® International Inc. thermal combustion concepts in support of unrestricted work boundaries.
5. Define unrestricted work boundaries and implement monitoring on active stack ventilation and unrestricted work boundaries in the A farms to provide defense-in-depth.
6. Institutionalize a tank operations stewardship program that minimizes required tank farm personnel entries and establishes parameters for locating ancillary personnel and offices.
7. Provide options to promote the hierarchy of controls for chemical vapor respiratory protection beyond current use self-contained breathing apparatus.

8. Support medical program enhancements in conjunction with responsible Hanford Site organizations and establish update to WRPS process/procedures.

As this action plan progresses towards completion in FY2018, the scope identified in this plan will be institutionalized within WRPS programs and become the normal way to conduct work within tank farms. For example:

- Future installations of exhausters are to include continuous stack monitoring, which may be added to the functions and requirements document.

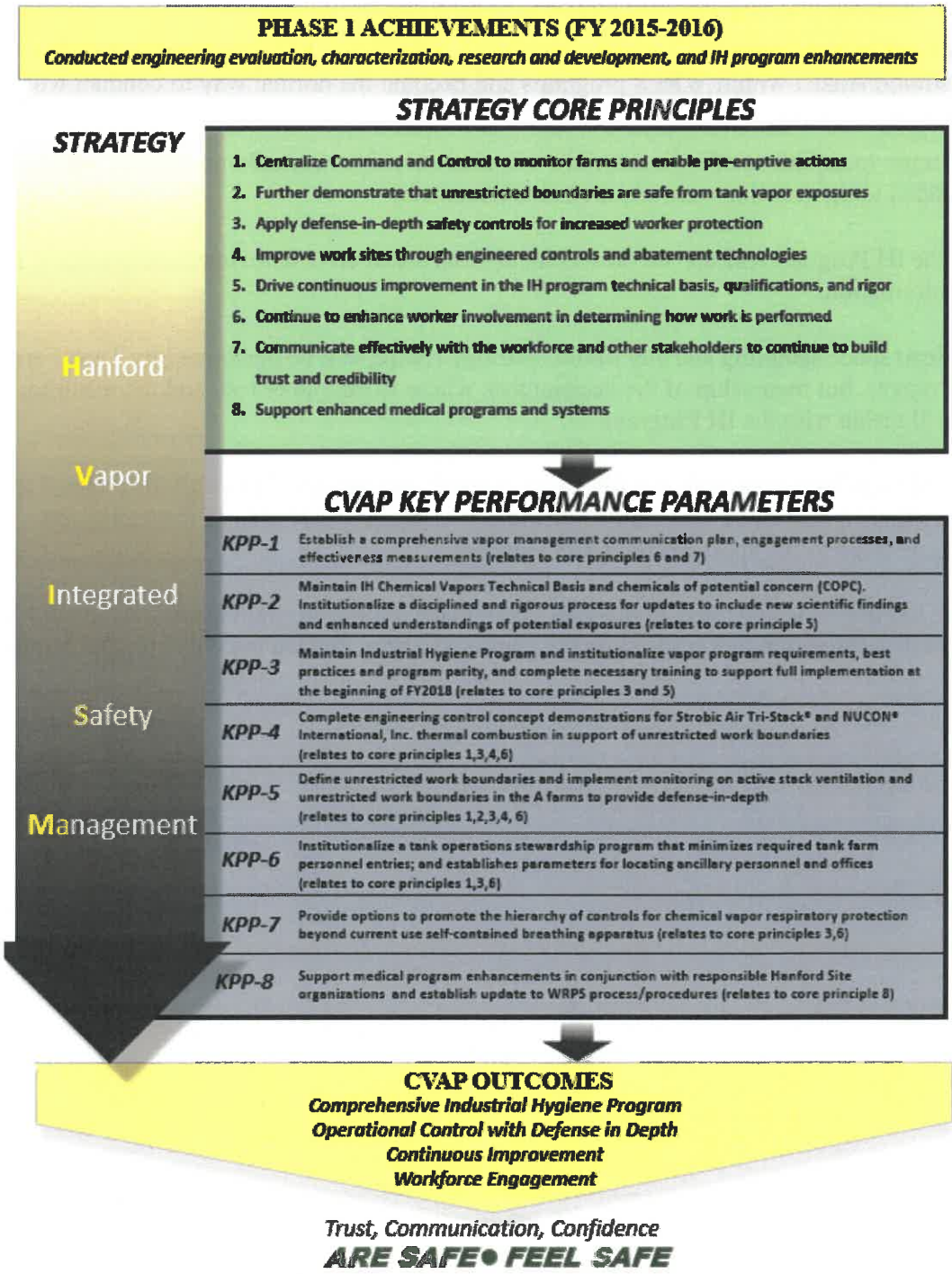
- The IH Program will update the technical basis based on data reviews and scientific industry information.

- Head space sampling and any future cartridge testing will be performed by Tank Farm Projects, but ownership of the decisions on where to sample or test, and the resulting data, will reside with the IH Program.

- CTO will have responsibility for future research and development activities related to vapor monitoring and detection; viable outcomes will, upon completion of the testing, be transferred to the appropriate WRPS Program.

WRPS has implemented the next phase of vapor management program enhancements in FY 2017-18 to realize the vision that workers on the Hanford Central Plateau not only are safe, but feel safe.

Roadmap to Complete the Comprehensive Vapor Action Plan



Core principles and KPPs provide the foundation to ensure workers are safe and feel safe.

TABLE OF CONTENTS

LIST OF FIGURES

ACRONYMS

ALARA	As Low As Reasonably Achievable
APGEMS	Air Pollutant Graphical Environmental Monitoring System
C&PR	Communication and Public Relations
CHAT	Chemical Hazard Awareness Training
COPC	chemicals of potential concern
CPPO	Chemical Protection Program Office
CTEH	Center for Toxicology and Environmental Health
CVAP	Comprehensive Vapor Action Plan
CVST	Chemical Vapors Solutions Team
DOE	U.S. Department of Energy
DST	double-shell tank
EA-32	DOE-Office of Environment, Safety, and Health Assessments
ENRAF	Enraf-nonius series 854 equipment
ES&H	environmental, safety, and health
FY	fiscal year
GPS	global positioning systems
HPMC	HPMC Occupational Medical Services
HVISM	Hanford Vapors Integrated Safety Management
IH	industrial hygiene
ISA	International Society of Automation
ISM	Integrated Safety Management
KPP	key performance parameter
NIOSH	National Institute of Occupational Safety and Health
OEL	occupational exposure limit
OIG	Office of Inspector General
ORP	DOE Office of River Protection
PA	public address
PHOENIX	PNNL Hanford Online Environmental Information Exchange
PNNL	Pacific Northwest National Laboratory
PPE	personal protection equipment
PTR MS	proton transfer reaction mass spectrometry
RadCon	Radiological Controls
RL	DOE Richland Operations Office
SCBA	self-contained breathing apparatus
SRNL	Savannah River National Laboratory
STEL	short-term exposure limit
SST	single-shell tank
TVAT	Tank Vapors Assessment Team
TWA	time-weighted average
VMEP	Vapor Management Expert Panel
VMDS	vapor monitoring and detection system
VOC	volatile organic compound
WRPS	Washington River Protection Solutions, LLC

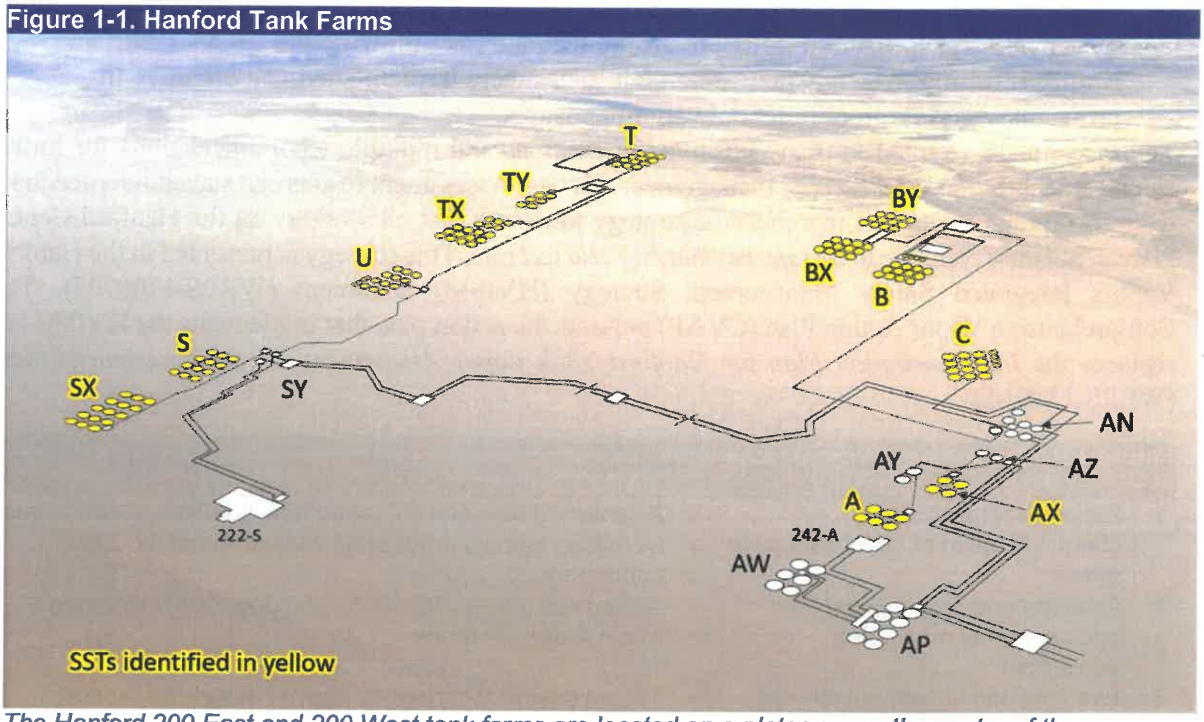
Hanfordvapors.com: https://hanfordvapors.com/
PHOENIX: http://phoenix.pnnl.gov/apps/tanks/index.html

1.0 HANFORD TANK FARM VAPOR ISSUES IDENTIFICATION

The Hanford Site tank farms (**Figure 1-1**) have a history of personnel reporting smelling odors and having symptoms from those exposures. These incidents have been reviewed and addressed by incumbent tank farm contractors for over 20 years. Extensive efforts to characterize chemicals in the tank headspaces occurred in the 1990s and early 2000s and resulted in issuing the *Industrial Hygiene Chemical Technical Basis* document (RPP-22491). The technical basis identified chemicals that exceeded 10 percent of the occupational exposure limits (OEL) within the tank head-space and provided the basis to establish proper respiratory protection for work in the tank farms.

Washington River Protection Solutions, LLC (WRPS) witnessed an increase in reported odor events in early 2014. In response to those events, WRPS reinstituted the Chemical Vapors Solutions Team (CVST) and later chartered the Savannah River National Laboratory (SRNL) to establish and oversee a panel of external, independent experts (Tank Vapors Assessment Team [TVAT]) to examine chemical vapor management and related worker protection measures at the Hanford tank farms. TVAT released their report in late 2014 (SRNL-RP-2014-00791, *Hanford Tank Vapor Assessment Report*). The TVAT report outlined recommendations to reduce the potential for chemical vapor exposures.

Figure 1-1. Hanford Tank Farms



The Hanford 200 East and 200 West tank farms are located on a plateau near the center of the 560 square mile Hanford Site.

To address TVAT report recommendations, WRPS developed the *Implementation Plan for Hanford Tank Vapor Assessment Report Recommendations* (WRPS-1500142) to be executed in two phases. The focus of Phase 1 was to expand sampling and characterization of tank headspace gases, evaluate and procure new field and personal monitoring equipment, evaluate and implement

tailored personal protection equipment (PPE), and increase hiring and training of Industrial Hygiene (IH) staff. Key program elements of Phase 1 and associated accomplishments are included in **Figure 1-2**

During the latter part of Phase 1, from FY 2015 to FY 2016, multiple independent assessments on the implementation plan progress and/or the IH program were performed. The assessments were performed by the:

- National Institute for Occupational Safety and Health (NIOSH)—Conducted a focused, programmatic review of exposure assessment, exposure control, safety and health program management, and medical.
- Office of Inspector General (OIG)—Assessed whether fear of retaliation existed and the status of actions to address risks posed by vapor emissions.
- Office of Environment, Safety, and Health Assessments (EA-32)—Analyzed technical solutions to address vapor releases and worker exposures and the extent of worker and medical personnel engagement to develop and implement actions recommended by the TVAT.
- Center for Toxicology and Environmental Health, LLC (CTEH)—Conducted an independent third-party evaluation of the IH Program technical basis.
- Vapor Management Expert Panel (VMEP)—Chartered by the U.S. Department of Energy Office of River Protection (ORP) to ensure that actions following the TVAT report and actions resulting from any new, emergent issues were implemented and effective in protecting workers from potential vapor exposures.

The assessments resulted in many positive observations and multiple recommendations for further enhancements to the WRPS vapor management strategy. Assessment results and stakeholder feedback were incorporated into a comprehensive strategy to ensure that all workers on the Hanford Central Plateau not only continue to be ***safe, but that they also feel safe***. This strategy is presented in the Hanford Vapors Integrated Safety Management Strategy (HVISM) document (WRPS-1700777). This Comprehensive Vapor Action Plan (CVAP) presents the action plan that implements the HVISM and replaces the *Implementation Plan for Hanford Tank Vapor Assessment Report Recommendations* (WRPS-1500142).

Figure 1-2. Phase 1 Key Program Elements

#	Program Element	WRPS Actions to Accomplish Program Elements
1	Expand sampling and characterization of tank headspace gases	• Established new and improved tank headspace operations • Increased sample processing capabilities at the 222-S Laboratory
2	Evaluate and procure new field and personnel monitoring equipment	• Tested new vapor monitoring and detection instruments within A and AP farms
3	Evaluate and implement tailored personal protection equipment	• Tested chemical cartridges against actual headspace gases
4	Increase hiring and training of IH staff	• Developed new training for tank farm workers. • Developed a standardized process to update chemicals of potential concern (COPC) • Increased IH staff by hiring and training over 100 workers to ensure enough monitoring personnel are available in the field

Phase 1 actions resulted in enhanced protection for workers from vapor hazards, improved sampling and detection technology options and, from FY 2015 to FY 2016 increased real-time monitoring.

2.0 PURPOSE AND SCOPE OF THE COMPREHENSIVE VAPOR ACTION PLAN

This CVAP defines and institutionalizes chemical vapor protections to mitigate the potential for vapor incidences and continues to ensure that workers *are* safe and *feel* safe while working in and around the Hanford tank farms.

ORP and WRPS commit to reducing the potential for exposure to tank farm vapor. By focusing on the following objectives, WRPS demonstrates its commitment to manage the hazards, employ a strong conduct of operations philosophy, and inform the workforce with transparent, clear, and timely communication:

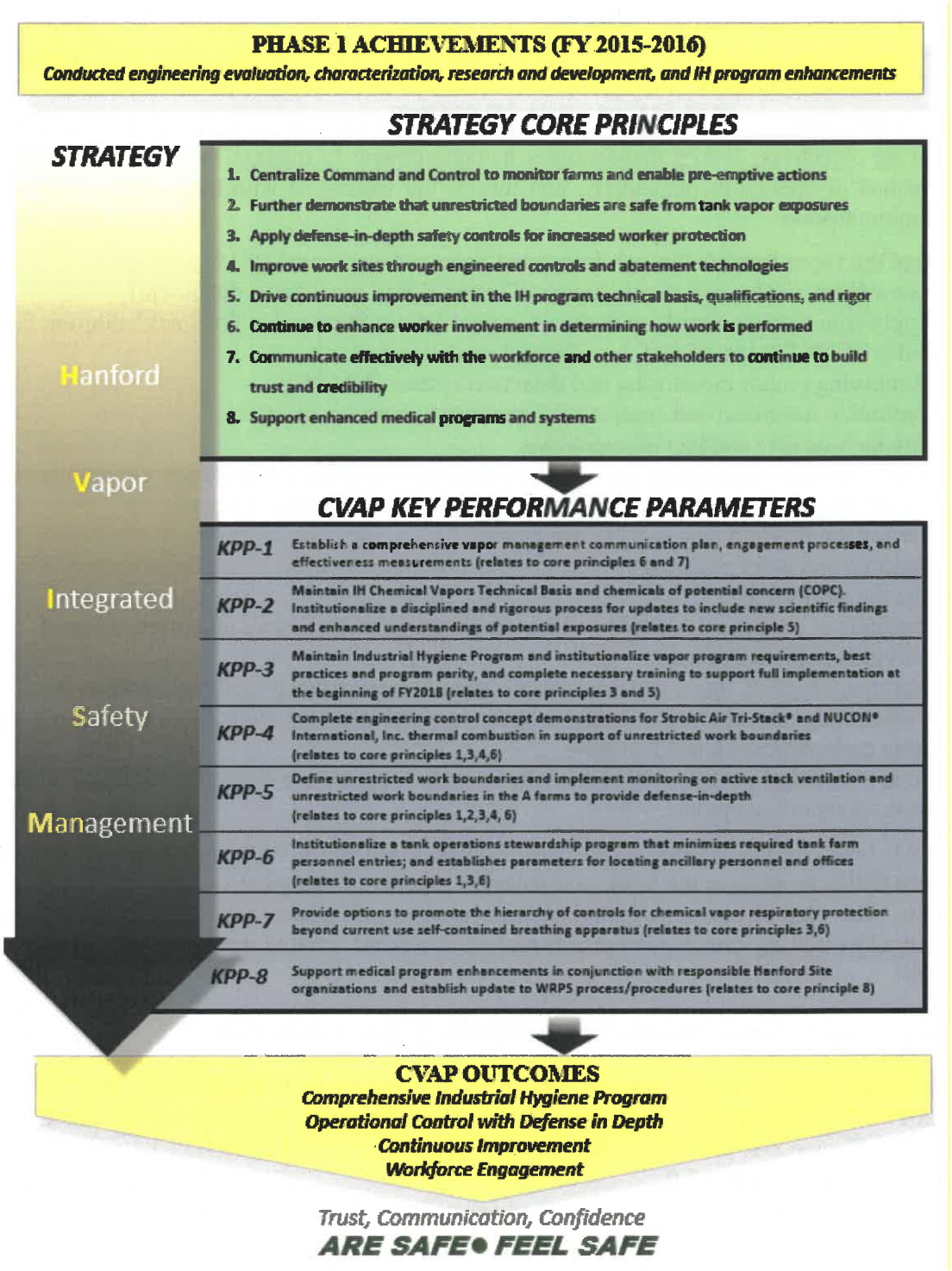
1. Manage the vapor hazards through Integrated Safety Management (ISM) principles
   a. Know the hazards (*Industrial Hygiene Chemical Technical Basis* document)
   b. Apply engineered controls such as active ventilation, Strobic Air Tri-Stack® dilution fan and NUCON® International, Inc. thermal oxidation process
   c. Monitoring (vapor monitoring and detection system [VMDS])
   d. Centralize command and control to be pre-emptive versus reactive
2. Employ high-quality conduct of operations
   a. Work boundary monitoring (plus mobile laboratory and increased worker communication via the use of signage, reader boards, or a public announcement system)
   b. Reduce single-shell tank (SST) farm entries
   c. Training and work planning
3. Engage the workforce
   a. Continue to engage the workforce in work planning, walk-downs, and preparation of activities in the tank farm
   b. Maintain frequent, open, and transparent communication using workforce meetings, written announcements, the Hanfordvapors.com website (https://hanfordvapors.com), and other communication mechanisms
   c. Support medical program enhancements to ensure appropriate measures are taken when workers report symptoms.

This CVAP relies on the HVISM eight core principles and the CVAP eight key performance parameters (KPP) to execute the work and measure success of chemical vapor protection in the tank farms. The plan covers a two-year period, however, all plans, activities, schedules, and equipment addressed by this document are subject to federal funding and contractual direction from DOE.

2.1 Roadmap to Accomplish the Comprehensive Vapor Action Plan

WRPS's overarching strategy to manage vapor hazards is contained in the HVISM. The CVAP is the FY 2017-18 execution plan to implement the HVISM. The roadmap to accomplish this CVAP is provided in **Figure 2-1**. WRPS's eight core principles are discussed in Section 2.2 and KPPs are addressed in detail in Section 3.0.

Figure 2-1. Roadmap to Complete the Comprehensive Vapor Action Plan



Core principles and KPPs provide the foundation to ensure workers are safe and feel safe.

2.2 Eight Core Principles

WRPS identified eight core principles in the HVISM to provide the basis for vapor protection in the tank farms. The eight core principles are provided in **Figure 2-2**.

Figure 2-2. Eight Core Principles	
1	**Centralize command and control to monitor farms and enable pre-emptive actions** Ensure the farms are under continuous vapor monitoring to provide vapor-related information to facilitate pro-active response or forewarn personnel of abnormal events.
2	**Further demonstrate that unrestricted boundaries are safe from tank vapor exposures** Establish that tank farm boundaries are protective and safe using source data, dispersion modeling, stack and work boundary monitoring, and IH rounds & routines.
3	**Apply defense-in-depth safety controls for increased worker protection** Provide layers of protection to the workforce using engineered controls and enhanced monitoring in conjunction with personal protective equipment, including respiratory protection when necessary.
4	**Improve work sites through engineered controls and abatement technologies** Use proven engineering controls such as exhausters with extended stacks and test alternative controls such as dilution fans and thermal abatement technologies.
5	**Drive continuous improvement in the IH program technical basis, qualifications, and rigor** Review, update, and prepare applicable IH policies and procedures to ensure continuous improvement to the IH program.
6	**Continue to enhance worker involvement in determining how work is performed** Follow the principles of the Voluntary Protection Program and Integrated Safety Management System to ensure WRPS worker engagement and involvement in all aspects of work planning.
7	**Communicate effectively with the workforce and other stakeholders to continue to build trust and credibility** Improve communication through execution of a chemical vapor communication strategy, routine communication to stakeholders, employees, and the public using the Chemical Protection Program Office working closely with WRPS Communications and Public Relations to provide an enhanced, integrated approach to program oversight and communication.
8	**Support enhanced medical programs and systems** WRPS is working closely with ORP and the U.S. Department of Energy Richland Operations Office (RL) to enhance the medical program as it relates to vapor.

WRPS's eight core principles ensure that the workforce is protected from tank vapor.

2.3 Key Performance Parameters to Accomplish the Eight Core Principles

WRPS developed KPPs to accomplish the eight core principles (Figure 2-3). Section 3.0 describes the approach to accomplish the KPPs. Each KPP has a scope, execution approach, benefits, and deliverables with schedule.

Figure 2-3. Key Performance Parameters

#	Key Performance Parameter	Relates to Core Principles
KPP-1	Establish a comprehensive vapor management communication plan, engagement processes, and effectiveness measurements. (Section 3.1)	6, 7
KPP-2	Maintain Industrial Hygiene Chemical Vapor Technical Basis and the chemicals of potential concern (COPC). Institutionalize a disciplined and rigorous process for updates to include new scientific findings and enhanced understandings of potential exposures. (Section 3.2)	5
KPP-3	Maintain Industrial Hygiene Program and institutionalize vapor program requirements, best practices and program parity, and complete necessary training to support full implementation at the beginning of FY 2018. (Section 3.2)	3, 5
KPP-4	Complete engineering control concept demonstrations for Strobic Air Tri-Stack® and NUCON® International, Inc. thermal combustion in support of unrestricted work boundaries. (Section 3.3)	1, 3, 4, 6
KPP-5	Define unrestricted work boundaries and implement monitoring on active stack ventilation and unrestricted work boundaries in the A farms to provide defense-in-depth. (Section 3.4)	1, 2, 3, 4, 6
KPP-6	Institutionalize a tank operations stewardship program that minimizes required tank farm personnel entries; and establishes parameters for locating ancillary personnel and offices. (Section 3.5)	1, 3, 6
KPP-7	Provide options to promote the hierarchy of controls for chemical vapor respiratory protection beyond current use self-contained breathing apparatus. (Section 3.6)	3, 6
KPP-8	Support medical program enhancements in conjunction with responsible Hanford site organizations and establish update to WRPS process/procedures. (Section 3.7)	8

Each KPP is a measurable benchmark to support completion of one or more core principles.

2.4 Institutionalization of Chemical Vapor Enhancements into the IH Program

The HVISM strategy is a comprehensive approach to manage vapor-related issues to further reduce or eliminate the potential for exposure to tank farm chemical vapor emissions. Central elements of the strategy are to:

- Provide effective communication with ORP, employees, the public, and regulators
- Involve workers in developing approaches for how work is performed
- Update and institutionalize the *Industrial Hygiene Chemical Technical Basis*
- Further employ engineering controls as the primary control whenever possible during tank farm activities
- Actively ventilate double-shell tank (DST) and SSTs ready for retrieval using exhausters
- Employ stack monitoring and install a stack extension on the 242-A Evaporator
- Use risk-based decision-making to achieve defense-in-depth by increasing the margin of safety
- Employ As Low As Reasonable Achievable (ALARA) best practices to minimize access into SST farms
- Use defense-in-depth safety controls such as real-time vapor and tank monitoring (successfully tested by WRPS employees in AP farm)
  - Work boundary monitoring (including use of mobile laboratory)
  - Increased worker communication via the use of signage, reader boards or a public announcement system
- Test chemical cartridges and supplied air alternatives

3.0 APPROACH TO KEY PERFORMANCE PARAMETER SUCCESS

3.1 Key Performance Parameter 1

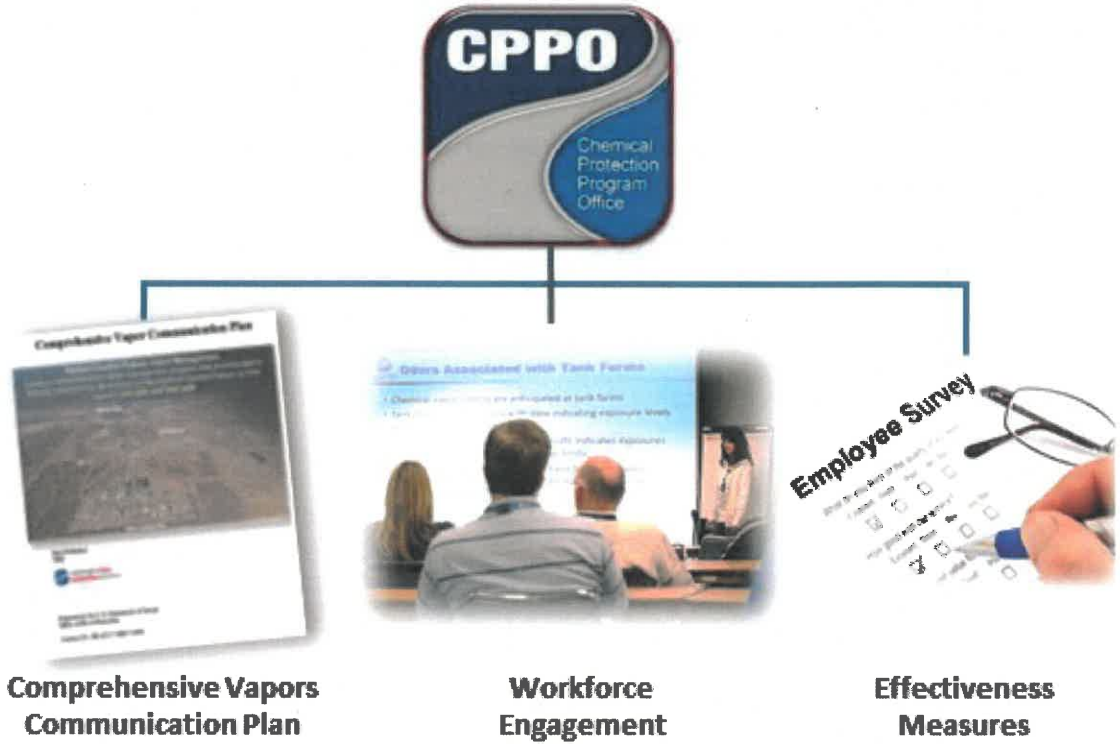
3.1.1 Scope

The scope of KPP-1 includes developing and issuing a vapor communication plan, as well as delivering enhanced workforce engagement processes and establishing effectiveness measurements.

Key Performance Parameter 1
Establish a comprehensive vapor management communication plan, engagement processes, and effectiveness measurements.

The V*apors Communication Plan*, WRPS-1703751, was developed and issued in 2017, and is being implemented. The *Vapors Communication Plan* is a high level strategic document that provides a

Figure 3-1. CPPO Mission



CPPO is the cornerstone to all vapor-related communication while tracking closure on all recommendations from various assessment teams.

generic framework for communication about the vapors remedies that are being implemented under CVAP. In addition to the plan, CPPO has developed and implemented a detailed vapors communications planning tool, *CPPO Look-Ahead* , that functions as a tactical implementation plan that is continually maintained and revised as communication needs on vapors topics change. With a

focus on transparency, vapors related information is made available through a wide variety of methods.

Additional processes to engage and educate the workforce on vapors related topics have been created and implemented along with existing engagement avenues to support the workforce knowledge of vapors-related information. In addition, ways to measure effectiveness have been developed and implemented as well.

3.1.2 Execution Approach

The *Vapors Communication Plan* is issued (WRPS-1703751) and implementation is ongoing.

The *CPPO Look-Ahead* is developed and implemented as the tactical implementation planning tool to help ensure topics delivered to the workforce are timely and effective. The focus of the *CPPO Look-Ahead* is on delivering the *Vapors Communication Plan*. As such, it highlights specific communication topics, dates, and products including itemized upcoming/planned communications from multiple organizations within WRPS and reflect the intentional transparency and wide variety of vapors information delivered to the workforce. Examples include planned C&PR communication campaigns, CPPO Notebooks, CPPO Weekly Reports and Quarterly Summary Reports, CPPO Engagement plans, CVST, IH or other vapor-related communications. The *CPPO Look-Ahead* is also used as a tool to facilitate integration and collaboration across the institution, and to promote leveraging multiple communication and distribution avenues, when possible, to provide vapors-related information to the workforce. In addition, to further support transparency, WRPS continues with timely updates of vapors-related information to the internal and external (HanfordVapors.com) websites.

The strategy for engagement of the workforce includes continuation of existing vapors-related engagement activities and development and implementation of new vapors-specific engagement initiatives.

Existing vapors-related engagement initiatives include the Chemical Vapors Solutions Team (CVST) and associated CVST sub-committees, the WRPS Safety Culture Improvement Team and worker participation in safety-related councils and committees, such as the WRPS Safety Culture Improvement Team. Additional workforce engagement initiatives developed as part of the CVAP that support workforce education about vapors include: the CPPO Subject Matter Experts workforce engagement effort and the CVST Team Vapor Representatives (TVR). The CPPO Subject Matter Experts workforce engagement effort involves regular meetings with HAMTC Safety Representatives and field teams to educate on finding vapors-related information and answer vapors-related questions. The CVST TVRs are identified to be a primary point of contact for vapors-related information for their respective teams. Also, as part of increased engagement, worker input into vapors-related products including processes, procedures, work planning, training, and participation in integrated project teams created to address specific vapors-related concerns and issues are being addressed under CVAP. Other initiatives may be developed and initiated as needs are identified.

To further support workforce communication, education, and engagement, WRPS has integrated the Pacific Northwest National Laboratory (PNNL) Data Access an Visualization (DAV) tool into the Hanfordvapors.com website. This is an interactive tool that provides vapor sampling data in various formats to all stakeholders, including the workforce.

Communication effectiveness measures have been and continue to be employed including surveys, focus groups, and metrics. Effectiveness measures include, at a minimum, bi-annual communication surveys/focus groups and tracking of vapor-related communications using metrics.

3.1.3 Benefits

Focus on and improvement of vapor-related communications bring the following benefits to ORP, the employees, and the public:

- Vapors Communication Planning – *The Vapors Communication Plan* establishes a framework for comprehensive chemical vapor related communication.
- New Vapors Related Communication and Engagement Products - Developed to support transparency and timely dissemination of vapors related information and remedies supports improved trust by the workforce.
- Workforce Engagement – Obtains improved worker education on vapors and remedies as well as involvement in planning and implementing vapors related remedies, leading to improved trust between workers and management.
- Effectiveness Measures – Monitors effectiveness of communications to allow for early identification of communication issues and revision to communications, communication strategy, and planning.

3.1.4 Deliverables

The scope of KPP-1 is largely accomplished by establishing the CPPO, whose deliverables include using established and new processes (i.e. CPPO Reports, CPPO Notebooks, *CPPO Look-Ahead*, HanfordVapors.com website maintenance, CPPO Engagement Initiatitives) to deliver vapor-related information through a variety of media, receiving feedback from workers, and continuing efforts by C&PR and Industrial Hygiene to communicate vapors-related information. Deliverables also include implementing effectiveness measures as a means to drive improvement in providing vapors information to the workforce.

CPPO, with assistance from PNNL, lead the initiative to integrate the DAV tool (supported by PNNL Hanford Online Environmental Information Exchange (PHOENIX)) into the Hanfordvapors.com website as an interactive tool to provide vapor sampling data in various formats to all stakeholders.

3.2 Key Performance Parameters 2 and 3

3.2.1 Scope

Key Performance Parameter 2

Maintain the Industrial Hygiene Chemical Vapor Technical Basis document and the chemicals of potential concern (COPC). Institutionalize a disciplined and rigorous process for updates to include new scientific findings and enhanced understandings of potential exposures.

Key Performance Parameter 3

Maintain Industrial Hygiene Program and institutionalize vapor program requirements, best practices and program parity, and complete necessary training to support full implementation at the beginning of FY 2018.

The IH Chemical Vapor Technical Basis document provides sound guidance and rationale for the IH actions that have been taken since the document was developed in 2006.

NIOSH Report
November 28, 2016

The scope of KPPs 2 and 3 includes continuous improvement in the institutionalization and implementation of the IH program chemical vapor technical basis, qualifications and competency of the IH field staff members, and discipline and rigor of the IH program. Several external assessments concluded that the IH program, technical and chemical basis, and equipment and monitoring practices were sound. It was also determined that strategies to determine COPCs and developing and implementing OELs to guide in-field decision-making were aligned with good industry IH practices. However, three overarching recommendations were suggested:

1. Implement processes for routine updates and maintenance of the IH chemical basis to include new scientific findings and enhanced understanding of potential exposures.
2. Improve the IH program by developing a centralized manual that pulls plans and procedures into a structure more readily understood by management, IH staff, and the workforce.
3. Align the IH program with best practices from other environmental, safety, and health (ES&H) programs, such as the Radiological Controls (RadCon) program.

3.2.2 Execution Approach

Improving the IH program's requirement basis, chemical technical basis, and the COPC list to institutionalize IH program; implementing program improvements; and incorporating vapor-related project outputs are the cornerstones of the FY 2017 and FY 2018 effort to drive continuous IH program improvements. WRPS is committed to establishing ongoing processes to ensure continued maintenance of the IH program in FY 2018 and beyond. The process used to complete the chemical technical basis and COPC list update is provided in **Figure 3-3.** Work progressing in FY 2019 will focus on continuous improvement of the processes established in FY 2017 and 2018, and continued implementation of processes to maintain the IH program and technical basis related to chemical vapor management.

3.2.2.1 Develop New or Revised COPCs/OELs

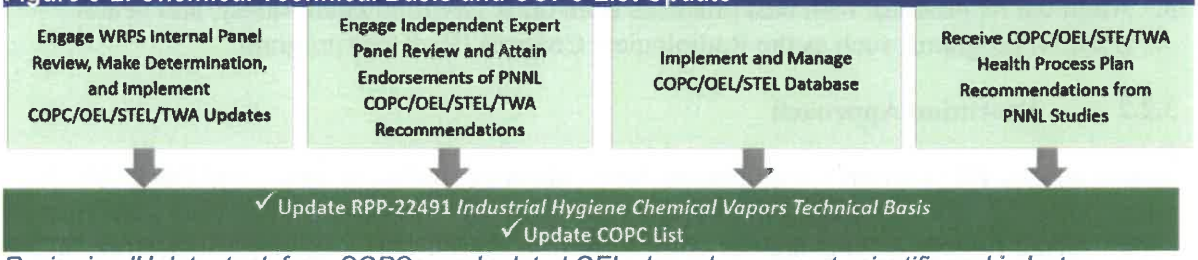
Several assessments recommended that WRPS update the chemical technical basis for COPCs and OELs. Although NIOSH stated that WRPS's process was good and technically valid, it recommended that WRPS update this basis by reviewing WRPS's data and incorporating new

scientific information from the industry. To this end, WRPS's approach to update the COPC list and OELs is four-fold.

1. Develop and proceduralize processes to evaluate ongoing data collection and analysis to revise, evaluate, and document new COPCs, and Chronic and Acute OELs through updates to the *Industrial Hygiene Chemical Vapor Technical Basis*. This evaluation includes ongoing reviews of newly acquired information and historical data, as well as near-term outputs from work conducted in the field.
2. Establish an internal multi-disciplined team to evaluate outputs and recommendations related to COPCs and Chronic and Acute OELs to understand whether updates to the technical basis are warranted. This team also evaluates operational impacts of the recommendations.
3. Subcontract an expert panel in FY 2017-18 to evaluate and validate proposed new or revised limits. These panels are described further in Section 3.2.2.2.
4. Seek ORP approval of new acceptable Hanford OELs, as the ultimate site owner responsible for dispositioning Hanford tank wastes.

During FY 2017, WRPS institutionalized a process for management and maintenance of the IH Chemical Technical Basis. This process was documented in a new governing plan TFC-PLN-174, *Industrial Hygiene Chemical Vapor Technical Basis Program Plan*, and two implementing procedures; ESHQ-S_IH-67, *Maintenance of the Industrial Hygiene Chemical Vapor Technical Basis,* and TFC-ESHQ-S_IH-C-66, *Identifying Chemicals of Concern in Hanford Tank Farms*. TFC-PLN-174 maintained RPP-22491, *Industrial Hygiene Chemical Vapor Technical Basis* as part of the fundamental basis for understanding tank waste chemistry and tank chemical vapors. It also provided necessary improvements in how the technical basis will be managed moving forward. These processes were implemented in FY 2018.

Figure 3-2. Chemical Technical Basis and COPC List Update



Reviewing IH data, tank farm COPCs, and related OELs based on current scientific and industry information results in a maintained IH chemical technical basis for the tank farms.

3.2.2.2 Health Process Plan

In FY 2016, WRPS subcontracted PNNL to develop a process to support the annual update of COPCs, and Chronic and Acute OELs. PNNL conducted a review of toxicological information and tank farm headspace data to provide a preliminary update of COPCs. PNNL recommended establishing two committees to support the annual review and update of the WRPS IH technical basis. The first committee would be led by the WRPS IH organization to assess and implement recommended changes to the IH technical basis. The second committee would provide external peer review of PNNL-developed COPCs, and Chronic and Acute OELs. In FY 2018 - 2019, PNNL will support these two review committees and continue evaluating and proposing updates to the COPCs, and Chronic and Acute OELs.

In FY 2017, PNNL explored computational methods to better understand and present mixture effects and how they influence established OELs. This computational model, the chemical mixture model, was provided within the database described below in Section 3.2.2.3 and discussed within PNNL-27089, *Assessing the Potential for Chronic and Acute Health Effects from Exposure to COPC Mixtures*. The table below represents the HPP studies conducted by PNNL and the resulting reports provided to WRPS in FY 2017 and FY 2018 for review and disposition.

Release	Report Title	Report #
May	Proposed $_{HTF}$OELs for Chronic Exposures – COPCs with Regulatory Guidelines	PNNL-26777 Rev. 0
May	Proposed $_{HTF}$OELs for Chronic Exposures - Nitrile Class COPCs and 2,4-Dimethylpyridine	PNNL-26819 Rev. 0
May	Hanford Tank Vapors FY 2017 Chemicals of Potential Concern Update	PNNL-26820 Rev. 0
June	Proposed Acute Exposure Concentration Limits for COPCs with Regulatory Guidelines	PNNL-26850 Rev. 0
June	Recommendations for Sampling and Analysis of Hanford Waste Tank Vapors	PNNL-26828 Rev. 0
July	Hanford Tank Farm Occupational Exposure and Risk Assessment Plan: Health Process Project	PNNL-25791 Rev. 1
2019	Proposed Occupational Exposure Limits for Furans	PNNL-26775 Rev. A
2019	Proposed Risk-Based Approach for Nitrosamine Chemical of Potential Concern	PNNL-26787 Rev. A
2019	Assessing the Potential for Chronic or Acute Health Effects from Exposure to COPC Mixtures*	PNNL-27089 Rev. A

In FY 2017, WRPS developed and issued a process for internal and external review of OEL update recommendations provided by the PNNL studies. This process was documented in TFC-CHARTER-71, *WRPS Internal Review Panel and External Review Panel Process for Review of Health Process Plan Recommendations*. As part of this process, WRPS will complete a technical and economic feasibility evaluation of potential OEL changes, and will provide a recommendation to ORP as a result of the process. The HPP reports produced by PNNL will be reviewed by WRPS under this process in FY 2018 and 2019. Those reports identified as Revision A will be finalized following completion of WRPS review. Additionally, a document discussing the technical basis for the high concentration / short duration event postulated in the TVAT report will be published. This report will use direct measurements, analytical analysis, and modeling to explore the likelihood of waste tank vapor emissions under all environmental conditions, and the potential for a high concentration / short duration event beyond and the operational and environmental conditions under which they could exist.

3.2.2.3 Database Implementation and Management

In FY 2016, PNNL also developed a database to support the review and update the COPC list and associated OELs. This database contains information such as current exposure guidelines, chemical and physical properties, toxicology summaries, as well as the reports and publications that support all of these data. PNNL will continue to update and maintain this database to support the periodic review and update of COPCs, and Chronic and Acute OELs. Updated COPCs, and Chronic and Acute OELs would be made available on HanfordVapors.com.

3.2.2.4 Leading Indicators

In FY 2016, PNNL evaluated the potential to use direct reading instrument measurements to pair leading indicators to a set of COPCs. The report (PNNL-25533, Rev. 0) concluded that two tank farm gases, ammonia and nitrous oxide, were the best candidates as leading indicators based on available comparison data. In FY 2017 and FY 2018, PNNL worked with WRPS to define sampling and analysis requirements to develop leading indicators for all COPCs. Using data from headspace sampling, cartridge breakthrough testing, VMDS, the proton transfer reaction–mass spectrometer (PTR MS) mobile laboratory, and IH rounds and routines, PNNL developed relationships with statistical confidence limits between COPC compounds and three proposed leading indicators; ammonia, nitrous oxide, and mercury. The report details the method used to develop these relationships. As new data is collected in the future, these relationships will be used by Industrial Hygiene to develop threshold levels to inform WRPS of potential vapor hazards and update the evaluation to expand the pairing of leading indicators to COPCs. In FY 2017/2018, this effort was documented and published in PNNL-27449, *FY18 Leading Indicator Phase 2 Report*.

In FY2018, IH will document its technical basis, using the results of the leading indicator work from PNNL, to establish an approach to implementing leading indicators as part of the IH control strategy, including supporting its basis for establishment of action levels and alarm set points.

3.2.2.5 Air Dispersion Modeling

In FY 2016, PNNL identified available modeling technologies and evaluated these models in several Hanford applications. PNNL recommended using the Air Pollutant Graphical Environmental Monitoring System (APGEMS) (**Figure 3-4**) model for mid- and far-field vapor plume analysis. In FY 2017/2018, APGEMS was upgraded to increase the model wind field resolution for tank farm applications and model plumes from multiple sources simultaneously.

The FY 2016 study was revised to include an evaluation of the Kenexis Consulting Corporation's modelling software as a potential computational fluid dynamics model for near-field evaluations and to use quantitative risk assessment results to quantify potential vapor exposure risk to employees from a potential source.

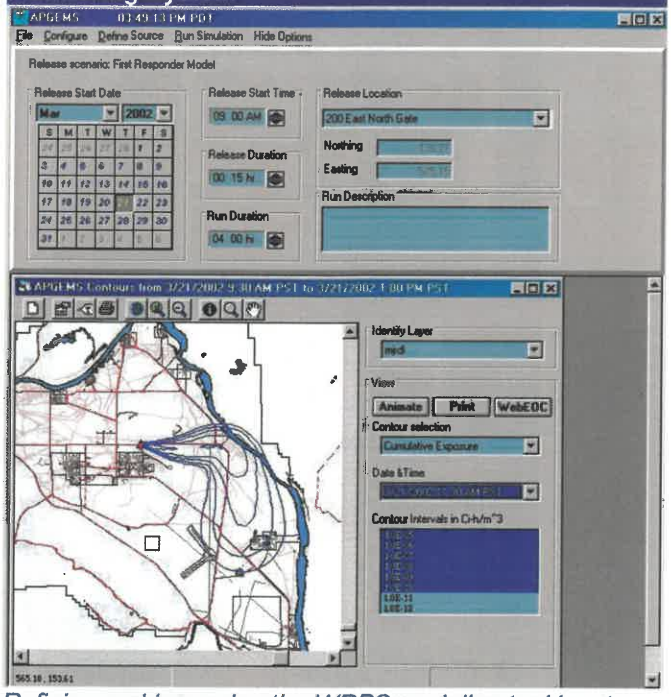
These models, and others as evaluated in PNNL-25654, *Atmospheric Dispersion Modeling Tools for Hanford Tank Farms Applications*, Revision 1, will be available within the WRPS tool box to aid in informing the IH Exposure Assessment process of evaluating tank farm chemical vapor hazards and establishing IH control strategies.

3.2.2.6 . Aerosols

In FY 2016, SRNL conducted an abbreviated aerosol study in the AP stack, A-103 passive breather filter and around the site, both up and downwind from known vapor sources. The study is documented in SRNL-TR-2016-00193, Revision 1. Data collection for this study was done for one week in the spring of the year and only during the day shift. With respect to background levels, the study did not show an elevated level of aerosols emanating from waste tank sources.

The limited nature of the FY 2016 aerosol study does not provide an adequate basis to eliminate aerosols as a worker health issue. Further work is needed to characterize diurnal and seasonal variations in aerosol production. There are also specific passive breather filters where ammonium crystals are known to form. These locations need to be evaluated and possibly tested for aerosol production. Further evaluation of the aerosols issue is planned for FY 2019.

Figure 3-3. Air Pollutant Graphical Environmental Monitoring System



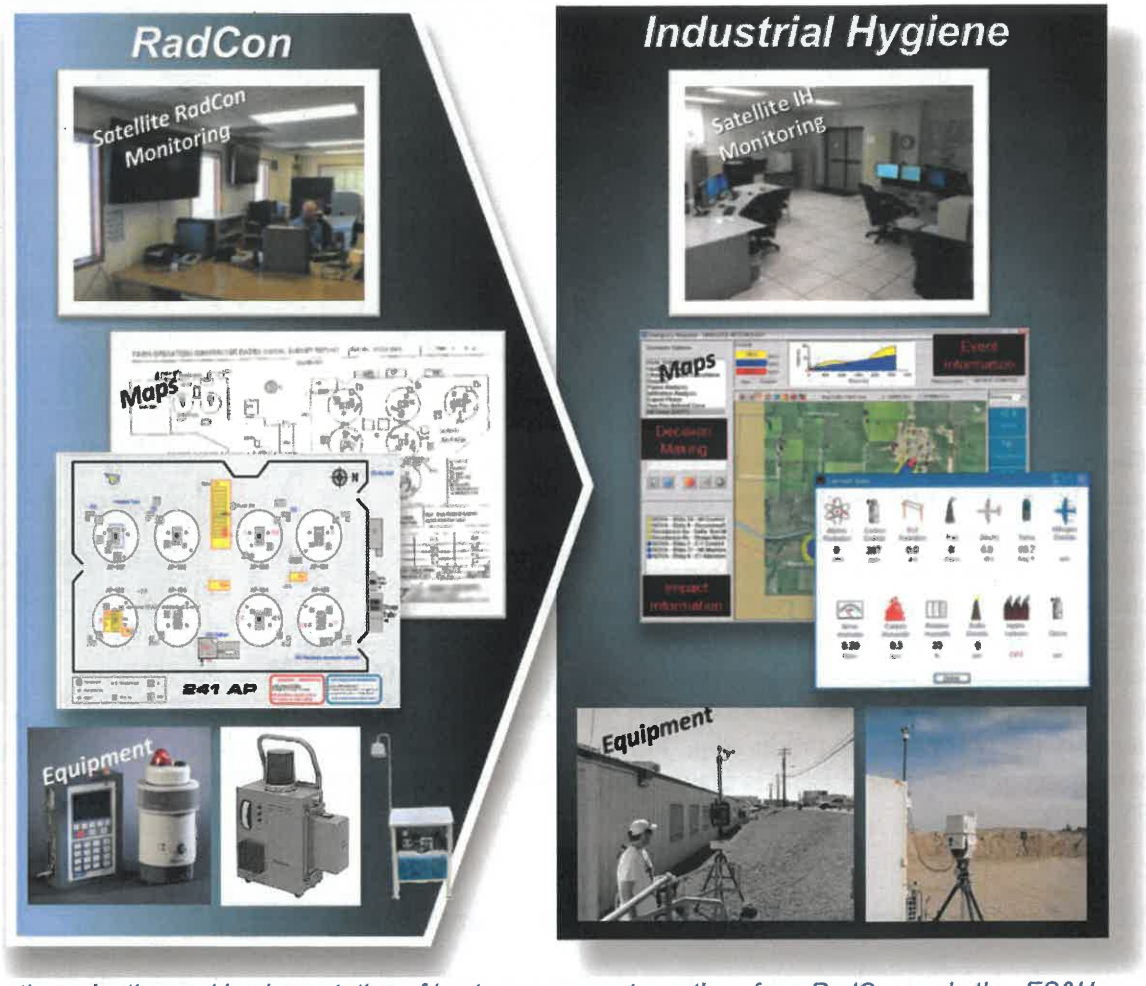
Refining and improving the WRPS modeling tool box to establish near-, mid-, and far-field models aids in developing vapor zones and work controls.

3.2.2.7 Parity Implementation with Established Programs

RadCon is a successful program with a disciplined and well-documented approach to hazard identification, work planning, and monitoring and detection. The IH program incorporates best practices from RadCon and other ESHQ programs, as is practical, to establish rigorous and disciplined processes into its program plans and implementing procedures. Examples of similar IH tools and equipment with RadCon are presented in **Figure 3-5**.

A best management practice assimilated into the IH program from RadCon is enhanced rigorous chemical worker training. This training is required for all employees who work inside the Hanford tank farms, but may also be required for those who approach the vicinity of the tank farms to ensure they understand the posted hazards.

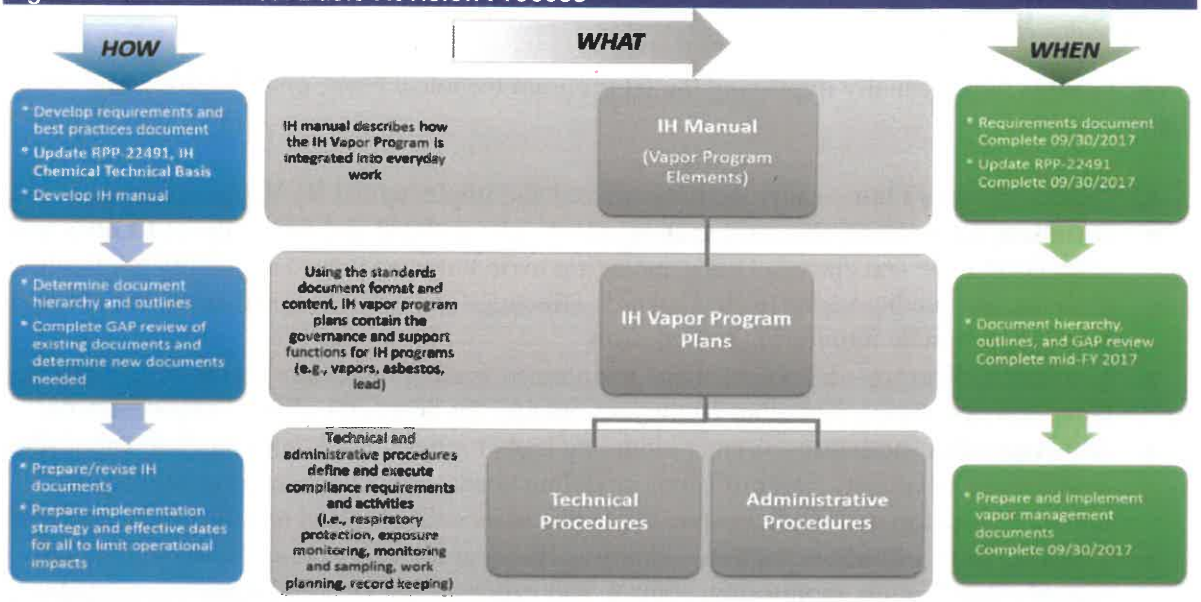
Figure 3-4. IH Program Parity with RadCon Program Tools and Equipment



Further adoption and implementation of best management practices from RadCon and other ES&H programs provide continuous improvement and rigorous processes and work practices in the IH program.

A key aspect to achieving this objective are improvements achieved in FY 2017 and 2018 in the IH documented program. In FY 2017, WRPS developed an IH requirements document and gap analysis to support IH manual and program document development. In FY 2017 and 2018, development of the IH manual focused on implementing enhanced vapor hazard control, mitigation, monitoring, exposure assessment, and recordkeeping requirements/strategies. A core element of this improvement is the IH Exposure Assessment process through revision of TFC-PLN-34 and development of an exposure assessment implementing procedure. Additional improvements to gain program parity will be improved work planning processes, such as incorporation of an IH Work Permit process into the Exposure Assessment process in FY 2018, as well as incorporating processes and procedures that integrate modeling and IH exposure assessment processes for defining worker protection zones. This effort incorporates and/or integrates existing IH program documents, procedures, and technical basis documents, and creates program-level standards and procedures. Figure 3-6 provides the process to revise the IH program technical basis.

Figure 3-5. IH Technical Basis Revision Process



The IH manual is designed to provide a roadmap for workers to the flow down of IH vapor management requirements and the standards and procedures by which they are implemented.

The WRPS IH Program group, partnered with WRPS and MSA Training organizations, completed the training development and delivery for chemical worker tier I, II and III training. Enhanced *Chemical Hazards Awareness Training* (CHAT) was developed and implemented prior to roll-out of the chemical worker tier training as a stop gap in FY 2017. All tank farm personnel are being trained to the new tier training as part of their annual tank farm worker requalification process. Qualification improvements and professional development training are ongoing activities.

Chemical safety training includes:

- Enhanced CHAT (which will be superseded by Chemical Worker Tier training) Chemical worker tier training
- Chemical Worker Tier 1: General Employee Chemical Training
- Chemical Worker Tier 2: Facility Specific Chemical Training
- Chemical Worker Tier 3: Chemical Worker Training
- IH technician training, qualification, and requalification
- IH professional development and communication training.

Tank farm training informs individuals that not all odors and/or vapors in and around the tank farms are associated with tank waste. Rather, vapors and odors may be present from other sources such as such as diesel generators, herbicide spraying, or septic cleaning. WRPS takes into account all hazards and conditions which may be present in the industrial and radiological environment when designing control strategies for chemical protection for workers.

Additionally, HAMMER was tasked, in partnership with WRPS, with developing an "Introduction to IH" training course to be delivered by "Worker Trainers" focused on the Industrial Hygiene Technicians. This IH fundamentals training development was completed in FY 2017, and is being implemented with new IH staff members as part of their initial training.

3.2.3 Benefits

The benefits of continually improving the IH program technical basis, qualifications, and rigor are:

- **Health Process Plan**—Fully institutionalized and implemented IH Vapor Program.
- **Database implementation and management**—An updated and vetted list of COPCs with associated acute and chronic OELs, including toxicology; enhanced capability to measure, monitor, and predict vapor-related hazards affecting field activities; and enhanced ability to ensure appropriate monitoring and controls.
- **Leading indicators**—Established and maintained leading indicators that inform workers, tank farm operations, and other employees outside the farms of potential vapor hazards.
- **Air dispersion/modeling**—Vetted modeling tools for near-, mid-, and far-field vapor plume applications to support Hanford vapor modeling needs; and an enhanced capability to measure, monitor, and predict vapor-related hazards with potential to affect field activities.
- **Ongoing parity implementation**—Improve IH program safety controls, work planning, hazard identification, monitoring, control, and exposure tracking and reporting related to tank farm vapor hazards; and implement a fully institutionalized and implemented IH Vapor Program.

3.2.4 Deliverables

KPP-2 goes well beyond studies to understand the chemical basis at tank farms. This KPP resulted in a revision of IH technical basis to address:

- Output from the Health Process Plan efforts regarding COPC/OEL updates and acute exposure limit recommendations
- Institutionalized IH Chemical Technical Basis and processes to maintain the technical basis
- Chemical Mixture Model to aid IH in evaluating the exposure impacts of tank farm mixtures in developing exposure assessments
- Modeling tool box for IH to support and inform the exposure assessment process
- Development of an IH sampling and monitoring strategy in FY 2019 for tank head space and source emissions supporting continued maintenance of the IH chemical technical basis

To fulfill KPP-3, WRPS plans to enhance the existing IH program by incorporating vapor management processes and practices with support from the workforce and to implement requirements, best practices, and technical rigor throughout the IH standards, administrative, and technical procedures. WRPS maintains the institutionalized IH Vapor Program to ensure vapor management and mitigation factors are proceduralized and effective.

3.3 Key Performance Parameter 4

3.3.1 Scope

Key Performance Parameter 4
Complete engineering control concept demonstrations for Strobic Air Tri-Stack® and NUCON® International, Inc. thermal combustion in support of unrestricted work boundaries.

The scope of KPP-4 is to enhance work sites through engineered controls and abatement technologies. In response to a June 20, 2016, request from ORP regarding worker health issues, NIOSH conducted a focused, programmatic review of exposure assessment, exposure control, safety and health program management, and medical. One of their overarching recommendations was to install engineering controls in and around the Hanford tank farms to further enhance the protection of workers from tank vapor emissions. WRPS started four projects in FY 2017 to meet this recommendation:

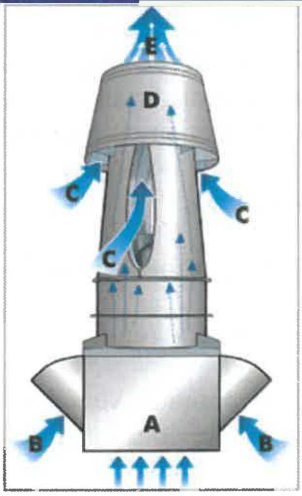
1. Extend the 242-A Evaporator exhaust stack from 65 ft to 111.5 ft (**Figure 3-10**); **completed in FY 2017**
2. Evaluate Strobic Air as an alternative (**Figure 3-11**)
3. Operate AX exhauster in FY 2017 and install new exhausters in A farm in FY 2018/19.
4. Initiate NUCON thermal oxidation tests for potential application in a tank farm (**Figure 3-12**).

Figure 3-6. 242-A Evaporator Stack Extension

Stack extensions raise the discharge point even further away from worker breathing zones.

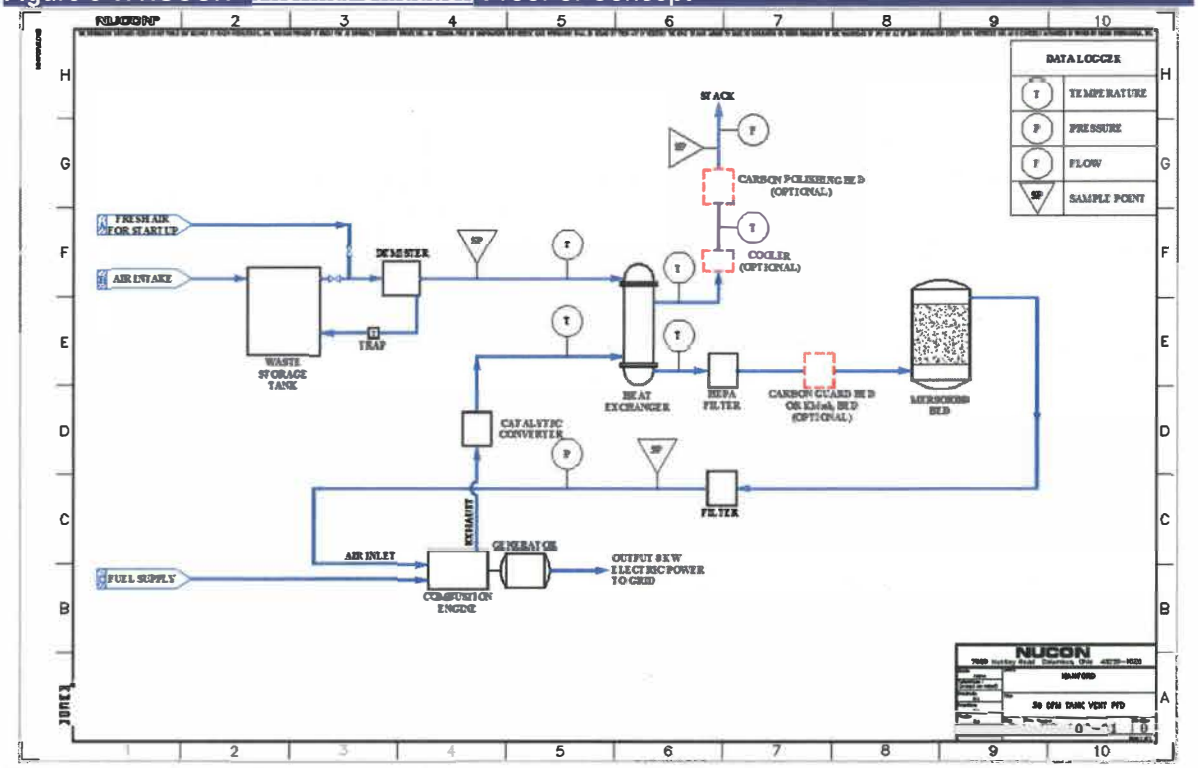
As part of engineered controls in the tank farms, new exhausters are installed on farms prior to conducting waste retrieval activities. Additionally, stack extensions have been installed on exhausters to reduce localized vapor emission impacts.

Figure 3-7. Strobic Air Tri-Stack® Fan



Strobic Air combines outside air with vapor emissions to propel chemicals away from workers.

Figure 3-8. NUCON® Thermal Oxidation Proof-of-Concept



Thermal oxidation destroys vapor emissions, mitigating potential vapor hazards to workers.

Strobic Air fans are being evaluated for an application in a tank farm. The Strobic Air fan combines outside air with exhaust discharge, creating a virtual stack extension and sending a jet plume of exhaust gases high above the stack and even further away from worker breathing zones.

The NUCON thermal oxidation system was recommended for further maturation by a vapor abatement vendor workshop conducted in FY 2016, led by the Savannah River National Laboratory (SRNL) and documented in SRNL-STI-2016-00484, Rev. 0, *Hanford Tank Farm Vapors Abatement Technology and Vendor Proposals Assessment*. This system destroys/reduces tank vapor emissions in an internal combustion engine where tank vapor are drawn into the engine through the induction system and combusted with fuel in the engine cylinders. Exhaust is then processed through a catalytic converter to complete the destruction/reduction of vapor and other normal compounds.

3.3.2 Execution Approach

3.3.2.1 Stack Extensions

The 242-A Evaporator vessel vent stack extension was completed in FY 2017. The stack was raised from its previous height of 65 ft to a height of 111.5 ft. The AW Farm exhauster is being redesigned to accommodate a stack extension in FY2018. The AN Farm exhauster will also be evaluated for an extension for potential future installation.

3.3.2.2 Strobic Air

While stack extensions will continue to be a primary engineering control improvement, Strobic Air is also being comparatively evaluated as an additional engineering control option. As an off-the-shelf component, Strobic Air is used worldwide as an alternative engineering control to constructing tall exhaust stacks. The unit operates through a powered air boosting system that drives additional ambient fresh air into exhaust vapors and increases the exhaust height. WRPS has procured a Strobic test unit and developed a test plan with a variety of operational configurations for offsite mock-up testing. Off-site testing is currently scheduled to be completed in FY2018. A decision may be made to proceed with an onsite design, long-lead procurements, installation, and testing in the field. Additional applications are contingent on performance of the test unit.

Figure 3-9. AP Farm Exhauster

Exhauster with stack extension further reduces the potential for exposure to tank farm vapors.

3.3.2.3 Exhausters

Upgrading existing or installing new exhausters (**Figure 3-13**) is the primary and fundamental engineering control for vapor emissions. Exhausters control the build-up of gases within the tanks by continuously removing the head space gases and keeping the tanks under a slight negative pressure. WRPS recently installed and operated two exhausters with stack extensions in the AX farm for future waste retrievals. Two more exhausters with stack extensions have been designed for A farm. These exhausters will be fabricated in FY 2017 and installed in FY 2018/19.

3.3.2.4 NUCON® Thermal Oxidation Proof-of-Concept Test

The NUCON thermal oxidation proof-of-concept test in 2017 was successful enough to warrant further testing of the system. The proof of concept test unit employed a propane powered generator as the main internal combustion engine. The unit was retrofitted with a diesel powered generator for use in the engineering scale testing scheduled in FY2018 at the PNNL test facility. The results of the engineering scale test will determine whether a larger scale NUCON unit will be deployed for pilot testing on a SST in the future.

3.3.3 Benefits

The benefits of improving work sites through engineered controls and abatement technologies are:

- **Stack extension**—Vapor emissions are reduced or eliminated at near- and mid-field receptors.
- **Strobic Air fan**—Vapor emissions are diluted before being jet-plumed approximately 40 ft above where work is being performed.
- **Exhausters**—Provides permitted, elevated emissions and negative pressure within the tanks.
- **NUCON thermal oxidation technology**—Vapor concentrations are reduced; provides flexibility to target abatement on specific tanks of concern.

3.3.4 Deliverables

Continued investment in infrastructure and engineered controls such as stack extensions, Strobic Air fan, and NUCON thermal oxidation proof-of-concept testing provide the primary means of protection to Hanford workers.

3.4 Key Performance Parameter 5

3.4.1 Scope

The scope of KPP-5 is to further demonstrate that boundaries provide safe work areas. This scope includes:

Key Performance Parameter 5
Define unrestricted work boundaries and implement monitoring on active stack ventilation and unrestricted work boundaries in the A farms to provide defense-in-depth.

- Permanently installing VMDS pilot-scale test equipment in AP Farms.
- Installing monitoring equipment on active exhausters and procuring perimeter monitors to be installed along the A complex corridor.
- Installing PA speakers and reader boards throughout the tank farm areas and access points
- Establishing the criteria for unrestricted boundaries around the tank farms.

3.4.2 Execution Approach

3.4.2.1 Permanent Installation of VMDS Equipment in AP Farm

After completing the VMDS pilot-scale testing in FY 2017, equipment identified to provide safe and reliable monitoring and detection is to be permanently installed in the farms. This entails finalizing designs, updating drawings, developing procedures, conducting training, and developing maintenance schedules for the new equipment.

3.4.2.2 Stack and Boundary Monitors

Exhausters are the primary source of tank vapor emissions in the actively ventilated farms when they are operating. Installing monitors on the exhaust stacks provides real-time identification of chemical concentrations coming from the stack. Operational exhausters in A-Complex may be equipped with monitors and connected into the VMDS by FY2018/19.

In tandem with installing exhaust stack monitors, WRPS has procured monitors for future installation along the A complex corridor. Boundary monitors are to be connected into the VMDS and monitored at the central shift office. To ensure proper sensor placement and boundary location, WRPS will conduct quantitative risk assessment modeling based on international standards (IEC 61511) and International Society of Automation guidance (ISA 84.00.07).

3.4.2.3 Establishing Safe Unrestricted Boundaries

Initially, establishing unrestricted work boundaries depends on the work being conducted in the tank farms. Unrestricted boundaries for routine work during non-waste disturbing conditions would be defined as the farm fence lines. To monitor and validate the current fence lines are appropriate safe boundaries, WRPS plans to deploy VMDS equipment in and around the DST farms.

Equipment placement will be determined by an independent risk assessment subcontractor using industry proven ISA-84 design for risk mitigation. Monitoring equipment is expected to be tied into the VMDS system and monitored by the central shift office supporting centralized command

and control. The results from the ISA-84 design, area sampling and/or VMDS system monitoring may justify an adjustment to the tank farm boundaries.

Location of portable equipment may change or additional units may be installed during waste disturbing activities. IH will conduct case-by-case assessments of waste disturbing activities to determine if unrestricted boundaries are safe or need to be expanded.

3.4.2.4 Public Address System

WRPS is designing and installing a PA system comprised of speakers and reader boards in and around the tank farms to provide timely notification of off-normal events. Notification over the PA system is partnered with written notifications/warnings on reader boards. Reader boards are positioned near individual farms and road intersections used by general Hanford Site employees. The PA system is planned to be completed by the end of FY2018 with emphasis placed on heavily used farms in the 200 East Area. Additionally, WRPS is installing IH communication boards inside of each change trailer to provide up-to-date information on vapor control zones and vapor reduction zones.

3.4.3 Benefits

The benefits of the specific technologies are:

- **VMDS components**—Real-time monitoring of exhaust stacks, unrestricted work boundary perimeters, and cross sections of farm interior spaces; identification and characterization of known and unknown chemical vapor sources; detection and notification to workers of chemical vapor emissions; and ISA-84 based design for risk mitigation of chemical vapor in tank farms.
- **Establishing safe unrestricted boundaries**—Placing real-time monitoring in and around the tank farms provides quantitative data to back up dispersion modeling, establishes vapor control zones, and further demonstrates that unrestricted work boundaries are safe.
- **PA system**—Timely notifications of events to personnel working in and around tank farms.

3.4.4 Deliverables

Installation of stack and fence line monitors ensures WRPS understands the plant conditions at the emission points and potential receptor areas, and that the concentrations are within the established limits for safe work boundaries. The monitors have the ability to detect an upset condition which can be quickly relayed to the work force via the PA system.

3.5 Key Performance Parameter 6

3.5.1 Scope

Key Performance Parameter 6
Institutionalize a tank operations stewardship program that minimizes required tank farm personnel entries; and establishes parameters for locating ancillary personnel and offices.

The scope of KPP-6 is to apply defense-in-depth safety controls to ensure worker protection. The hierarchy of controls has the elimination of the hazard as the first option. The tanks cannot be eliminated, but the need to send people into the tank farms may be eliminated or reduced. The SST Stewardship Program approach is to identify and evaluate procedures requiring entry into SSTs and determine whether those requirements can be eliminated or reduced. The first step towards establishing the Tank Farm of the Future for SSTs is to use remote monitoring in lieu of farm entry to obtain tank waste levels and temperatures. WRPS will design the equipment for the first remote-monitored SST in FY 2018. The installation of the equipment may be done in FY2019.

In response to a NIOSH recommendation, WRPS has established guidelines to determine appropriate work locations for personnel in the tank farm areas. These guidelines consider ISA-84 risk modelling, air dispersion modeling, hazard reduction determinations, and other appropriate inputs.

3.5.2 Execution Approach

In FY 2016, WRPS evaluated and identified several actions to reduce or eliminate SST workforce entries. WRPS evaluated if entries could be consolidated into a single event (i.e., enter SST farms on an annual basis over a one- to two-week period). WRPS plans to work with respective ORP and WRPS Nuclear Safety and Environmental programs and regulatory agencies to achieve reduction in tank farm entry requirements.

The SST Stewardship Program includes conduct of a pilot test by installing remote-monitoring capabilities to record tank levels using Enraf-nonius series 854 equipment (ENRAF) and/or temperatures (thermocouples). The pilot test is intended to demonstrate the need to routinely enter the farm to take temperature and level readings can be eliminated. This effort is another element toward establishing the Tank Farm of the Future. Additionally, the Program considers exploration of autonomous inspection devices to support vapor detection.

3.5.3 Autonomous Inspection

As discussed in the *SST Stewardship Project's Project Execution Strategy*, RPP-RPT-60443, Rev.0, WRPS is exploring the use of autonomous inspection devices. The Execution Strategy identifies the use of both aerial drones and Remote Operated Vehicles (ROV) to provide this capability. The use of drones needs additional investigation into the site requirements for deployment, but WRPS has initiated an Autonomous Inspection Vehicle (AIV) program with Washington State University (WSU) in the Tri-Cities.

Work started in FY 2017 on the AIV project, with a search for an ROV that could navigate in a tank farm autonomously or with manual remote operability. For FY 2018, WRPS and WSU have been working to complete this initial phase with a commercially available vehicle, which will be deployed in a tank farm with limited vapor detection capability and inspection capability in FY 2019 or FY 2020.

As this initial capability is proven, additional monitoring techniques and functionality can be investigated for deployment with the vehicle in a phased approach. Once the site requirements are addressed, the drone program will progress in a similar fashion as that used by the AIV.

3.5.4 Benefits

The SST Stewardship Program benefits include:

- Reduced potential for personnel exposure to hazards within the SSTs
- Eliminated or reduced entries into the SST farms, improving productivity by reducing entry requirements and consolidating tank farm activities within a specific period of time
- Document that assigned work locations are appropriate.

3.5.5 Deliverables

While the DST farms are actively ventilated and monitored, SST farms are passively ventilated so the SST Stewardship's priority is to reduce SST entries by installing remote automation and implementing defense-in-depth measures. Future priorities within the Single Shell Tanks will dictate when engineering controls and infrastructure improvements are advantageous.

3.6 Key Performance Parameter 7

3.6.1 Scope

Key Performance Parameter 7
Provide options to promote the hierarchy of controls for chemical vapor respiratory protection beyond current use self-contained breathing apparatus.

The scope of KPP-7 is to apply defense-in-depth safety controls to ensure worker protection. WRPS's approach to define and implement controls in the Hanford tank farms is based on the hierarchy of controls in which the effectiveness of vapor-related controls are ranked hierarchically and achieved by:

- Elimination/substitution of the hazard (e.g., vapor abatement)
- Application of engineering controls (e.g., stack extensions)
- Using administrative/work practice controls (e.g., unrestricted work boundaries)
- Using PPE (e.g., self-contained breathing apparatus [SCBA], air line manifolds).

Defense-in-depth actions improve the personnel safety factor associated with working in and around the farms. WRPS's defense-in-depth actions include testing respirator cartridges against chemical vapor sources to reduce the use of SCBAs; providing a state-of-the-art mobile laboratory and other investigation tools and processes to locate and identify fugitive vapor sources; development and implementation of advanced tools for vapor-related data analysis; and,testing/using new personal monitoring/sampling equipment.

3.6.2 Execution Approach

3.6.2.1 Cartridge Testing/SCBA Alternatives

While the goal is to use engineering controls to reduce the need for respiratory protection equipment, there are times that respiratory PPE is the most effective way to perform work inside the farms.

Figure 3-10. Cartridge Testing Apparatus

In-field cartridge testing to reduce SCBA usage.

Cartridge testing (**Figure 3-17**) is conducted using a specially designed test apparatus connected to the headspace of a tank or exhaust stack of a DST exhauster. Gases are passed through the cartridge media at a rate equal to or slightly higher than the breathing rate of a large male for 18 hours. During the test period, samples are taken from the upstream and downstream side of the cartridge to measure incoming gas concentrations and the levels and rate at which breakthrough is identified. This test method provides a very conservative result for cartridge use because it is testing the cartridges on direct head space for 18 hours.

WRPS conducted cartridge testing on eight sources in FY 2016 and contracted PNNL to prepare test reports in September 2016, which were complete in February 2017. The reports are being evaluated

by a third party, The Center for Construction Research and Training, Stoneturn Consultants, on behalf of the Hanford Atomic Metal Trades Council, in accordance with the memorandum of Agreement between WRPS and HAMTC.

Cartridge testing conducted in FY 2017 and 2018 may qualify additional cartridges, specifically powered air-purifying respirators, for use in tank farms that have been approved for air-purifying respirators. Future testing will be conducted during waste disturbing activities to determine whether respirators can be worn in place of SCBA.

In addition to cartridge testing, WRPS is evaluating using air hoses and more lightweight, ergonomic SCBA.

3.6.2.2 Mobile Laboratory

In FY 2016, WRPS subcontracted the RJ Lee Group, Inc. mobile laboratory (**Figure 3-18**) to measure chemical vapor concentrations in and around the tank farms. Results in FY 2016 indicated that plumes are typically short in duration (a few seconds to a few minutes) and that vapor concentrations outside of the tank farms are well below OELs for all vapor components.

Figure 3-11. Mobile Laboratory

The mobile laboratory uses start-of-the-art technology to provide real-time vapor analysis.

To enhance monitoring capabilities in FY 2017, the mobile laboratory has installed new instruments to detect ammonia measurements in the low parts per billion range. The ammonia equipment can recognize whether a vapor plume is from a tank farm source. The mobile laboratory also takes air quality measurements around the tank farms during waste disturbing activities and responds to abnormal events. The mobile laboratory provides further understanding of fugitive sources and background levels from non-tank source emissions.

In FY 2018, TerraGraphics was contracted to design and fabricate a new Mobile Laboratory. This new lab incorporates all the capabilities of the previous lab. In addition, the PTR-MS will be upgraded to the latest Ionicon instrument (TOF 6000) and a Cerex UV-FTIR will be installed. The new instrumentation significantly improves sensitivity and mass resolution, as well as enabling quantitative measurements for all COPCs, including mercury and nitrous oxide.

3.6.2.3 Fugitive Emission Investigation

In FY 2018, a CVST sub-team was established to evaluate potential tank farm areas where fugitive emissions may be present. A demonstration of the tools and processes needed to identify and characterize the fugitive emission vapor sources and tank farm work areas will be conducted starting in FY 2018 and continue into FY 2019. The initial investigation will focus on the area surrounding the 200 East 244AR building where various vapor odors have been reported. The investigation will include use of VMDS and existing IH vapor monitoring equipment including open path UV-FTIRs, flame ionization detectors (e.g., TVA2020), direct reading instruments (DRIs), routine IH air sampling methods, the Mobile Laboratory (PTR-MS), and various IH portable detectors. In addition, air dispersion modeling will be performed utilizing the vapor concentration data and local meteorological data. The forensic methods and processes used in the

investigations will be developed and demonstrated and eventually proceduralized to establish the basis for future investigations.

3.6.2.4 Tank Vapor Data Analysis

A tank vapor data analysis "expert advisor" application will be developed with AECOM to provide the analytics/learning platform which will be integrated and piloted (in FY 2018/2019) for Hanford-specific vapor related cases and conditions. The application will provide risk-based predictive capabilities that can be used to integrate meteorological data, sensor-based vapor concentration data, resulting plume models, and other pertinent information. The application will enable the "expert advisor" to inform Hanford operators in a manner that they can perform risk-based decision making for tank farm vapor generating activities, decreasing potential of vapor interactions with Hanford workers.

The work will be performed in two phases. Phase 1 (FY 2018) will include the work to develop an operational pilot-solution(s) and include analysis of Hanford systems, design of the Hanford specific solution, integration/customization of the Hanford solution to the "expert advisor" platform, and demonstration of the Phase 1 results. Phase 2 (FY 2019) will bring the solution(s) to a production ready and operational state and will include deploying, testing, and staging the platform for field use.

3.6.2.5 Personal Vapor Monitor

DOE-EM subcontracted C_2Sense to develop an ammonia sensor based on single walled carbon nano-tube technology. Upon completion of the base technology, DOE requested WRPS to fund development of a personal monitor to be worn by tank farm workers. The C_2Sense design is a personal vapor monitor that provides real-time warnings to workers in the field and also communicates ammonia concentrations for each worker to the central shift office. C_2Sense used actual waste tank vapor to test a prototype, demonstrating the ability to measure ammonia levels at less than one ppm. Five prototype devices are being tested by Hanford workers at the A-103 passive breather filter. Assuming successful testing, C_2Sense expects to offer these monitors for sale in FY 2019. WRPS is also testing off the shelf personal monitors for ammonia detection. Based on this testing, WRPS will make a final determination and selection and, in FY 2019, WRPS intends to purchase and implement personal ammonia monitors for normal operations.

Figure 3-12. Ion Science Cub Monitor

Personal vapor monitors provide early warnings of chemical vapor to workers.

Another personal vapor monitor, Ion Science Cub (**Figure 3-19**) is a personal volatile organic compound (VOC) detector capable of detecting in the parts per billion range. This device provides early warning to personnel entering the farms. This device was tested in FY 2017 and is available for IH incorporation as necessary.

An additional instrument tested was a personal global positioning system (GPS) unit identifying where personnel are located in the farms. If an event occurs, the GPS locator can be used in conjunction with local meteorological data to potentially determine the source of the event.

WRPS completed testing personal SUMMA® sample canisters, which would be activated in real-time during a potential vapor event to capture a sample of the air from the event location.

WRPS will continue testing several personal monitoring and detection instruments and a personal sampling system to determine feasibility for full-scale deployment.

3.6.3 Benefits

The benefits of defense-in-depth safety controls are to enhance the safety and worker protection for personnel working in and around the farms.

- **Cartridge testing**—Determines cartridge breakthrough time within tank farms; reduces SCBA requirement in ventilated farms and improves personnel safety and productivity. Additional cartridges, including powered air-purifying respirators, have been tested against actual tank vapor.
- **Mobile laboratory**—Provides the best available method to measure short-duration, low-concentrations of the majority of COPCs; can measure nitrosamines at concentrations at or below 10% of OELs; identifies fugitive vapor sources emanating outside of the tank farms.
- **Personal vapor monitor**—Provides real-time monitoring for ammonia vapors and is capable of transmitting results to the Central Shift Office or other locations, if needed.
- **SCBA and airline evaluation**—Provides potential options for improved working conditions in tank farms with reduced risk of injuries.
- **Fugitive Emissions**–Provides indication of vapor sources and vapor concentration in tank farm work areas and provides information to establish disposition.
- **SmartSite and Data Analysis**–Provides capability to support Hanford operator decision-making with respect to risk profile for tank farm activities and how best to provide employee safety and support overall integrity of the site.

3.6.4 Deliverables

The main deliverable for KPP-7 is to find, test, and implement the most effective PPE equipment for respiratory safety and work efficiency. This KPP also produces a weekly preliminary vapor concentration report and a monthly vapor concentration/source identification report.

3.7 Key Performance Parameter 8

3.7.1 Scope

The scope of KPP-8 is to support RL medical program enhancements in conjunction with other Hanford Site organizations, and update WRPS's processes/procedures as appropriate.

Key Performance Parameter 8
Support medical program enhancements in conjunction with responsible Hanford Site organizations and establish update to WRPS process/procedures.

3.7.2 Execution Approach

WRPS, either through existing agreements or newly established agreements, is supporting RL and its medical management corrective action plan to enhance the vapor-related medical program. Because HPM Corporation (HPMC) is contracted to RL, WRPS's support is limited to primarily coordination and integration with RL and its prime contractors. WRPS will support:

- Timely and accurate injury/illness information to support effective case management and to ensure appropriate services to workers
- ORP, RL, and HPMC assessment of HPMC communication protocols for worker medical evaluations, medical protocols associated with reported symptoms, and tank farm surveillance and acute exposures
- Support the Hanford occupational medical providers as they consult with an occupational medical professional to comprehensively review medical data that are available for tank farm workers, and to provide expert advice on collection, analysis, and interpretation of these data and their potential to help assess any relationship between medical findings, reported health effects, and/or exposures
- Work with ORP, RL, and HPMC to ensure that tank farm workers are designated on their employee job task analysis; confirm that processes are in place to track tank farm access; and continue to encourage workers to report tank farm vapor-related symptoms
- RL and ORP to expand Hanford workers' awareness of the existence and role of the Washington State Labor & Industries Office of the Ombudsman for Injured Workers of Self-Insured Businesses.

3.7.3 Benefits

Supporting medical program enhancements in conjunction with other Hanford Site organizations:

- Improve communication and trust between the ORP, RL, WRPS, HPMC, other site contractors, and the workers

- Provide worker understanding regarding medical evaluation activities when workers report symptoms from vapor-related events
- Improve information and data collection, leading to ongoing or future studies or evaluations of potential acute or chronic health effects from exposure to hazardous material related to tank farm operations.

3.7.4 Deliverables

WRPS provides support to DOE-led initiatives and programmatic requirements to support collection of data for future RL/HPMC-led health studies.

4.0 REFERENCE

Downing, K.A., 2017, "Contract No. DE-AC27-08RV14800 – Washington River Protection Solutions LLC - Submittal of the Change Proposal for the Comprehensive Vapor Action Plan Key Performance Parameters Implementation – CP-17-009," (Letter WRPS-1700039 R1 to W.E. Hader, U.S. Department of Energy, Office of River Protection, June 8, 2017), Washington River Protection Solutions, LLC, Richland, Washington.

Letter, L. D. Olson, WRPS, to K. W. Smith, ORP, "Washington River Protection Solutions LLC Submits Implementation Plan for Hanford Tank Vapor Assessment Report Recommendations," WRPS-1500142, dated February 9, 2015.
Letter, K. A. Downing, WRPS, to W. E. Hader, ORP, "Contract Number DE-AC27-08RV14800 – Washington River Protection Solutions LLC Transmittal of Washington River Protection Solutions LLC Communication Plan / Hanford Vapors Management Communication Plan," WRPS-1604608 REISSUE, dated November 17, 2016.

SRNL-RP-2014-00791, "Hanford Tank Vapor Assessment Report," October 30, 2014; http://srnl.doe.gov/documents/Hanford_TVAT_Report_2014-10-30-FINAL.pdf

Letter, K. A. Downing, WRPS, to W. E, Hader, ORP, "Contract Number DE-AC27-08RV14800 – Washington River Protection Solutions LLC - Submittal of the Hanford Vapors Integrated Safety Management Strategy," WRPS-1700777, dated March 2017.

RPP-22491, 2006, "Industrial Hygiene Chemical Vapor Technical Basis," Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington