

**Office of Enterprise Assessments
Follow-up Assessment of Progress on Actions
Taken to Address Tank Vapor Concerns
at the Hanford Site**



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**Office of Worker Safety and Health Assessments
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Acronyms

AIHA	American Industrial Hygiene Association
AOP	Abnormal Operating Procedure
APGEMS	Air Pollutant Graphical Environmental Monitoring System
COPC	Chemical of Potential Concern
CPPO	Chemical Protection Program Office
CTEH	Center for Toxicology and Environmental Health
CVAP	Comprehensive Vapor Action Plan
CVST	Chemical Vapor Solutions Team
DOE	U.S. Department of Energy
EA	Office of Enterprise Assessments
FES	Field Execution Schedule
FY	Fiscal Year
HAMTC	Hanford Atomic Metal Trades Council
HPMC	HPM Corporation
HPP	Health Process Plan
HVISM	Hanford Vapors Integrated Safety Management Strategy
IH	Industrial Hygiene
IHT	Industrial Hygiene Technician
IP	Implementation Plan
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
OJT	On-the-Job Training
OR	Overarching Recommendation
ORAU	Oak Ridge Associated Universities
ORP	Office of River Protection
OSHA	Occupational Safety and Health Administration
PBI	Performance-based Incentive
PER	Problem Evaluation Request
PNNL	Pacific Northwest National Laboratory
PTR-MS	Proton Transfer Reaction Mass Spectrometry
QRA	Qualitative Risk Assessment
RL	Richland Operations Office
SCBA	Self-contained Breathing Apparatus
SME	Subject Matter Expert
SRNL	Savannah River National Laboratory
TPA	Third-Party Administrator
TVAT	Tank Vapor Assessment Team
TVR	Tank Vapor Representative
VMEP	Vapor Management Expert Panel
VMDS	Vapor Monitoring and Detection System
WC	Workers' Compensation
WRPS	Washington River Protection Solutions, LLC

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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) Office of Worker Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), conducted a follow-up assessment of progress on actions taken to address concerns about vapors in and around the Tank Farms at the Hanford Site, with a focus on actions taken to address recommendations from the previous EA assessment, *Office of Enterprise Assessments Follow-up Assessment of Progress on Actions Taken to Address Tank Vapor Concerns at the Hanford Site – January 2017*. EA conducted the onsite portions of this assessment September 25-28, October 30 – November 2, and November 13-16, 2017.

Concerns about tank vapors at the Tank Farms have existed since at least July 1987 and have been the topic of numerous assessments. In 2014, Washington River Protection Solutions, LLC (WRPS), the prime contractor for Tank Farm operations, commissioned Savannah River National Laboratory to conduct an assessment to take a broad look at the issue and offer independent analysis and recommendations. The Tank Vapor Assessment Team (TVAT) report provided overarching recommendations addressing cultural and technical aspects, along with supporting recommendations that were designed to improve communication, trust and improve the tank vapors related safety and health management program.

After a series of reported events in the spring of 2016 and complaints from several labor bargaining units and other stakeholders, the Secretary of Energy directed EA to perform an assessment of progress by the DOE Office of River Protection (ORP) and WRPS in addressing recommendations from the TVAT report. In January 2017 EA issued its report, which included seven recommendations intended to “provide an independent perspective for consideration by ORP, WRPS, and others to adjust their focus on addressing tank vapor issues.” The seven recommendations in the report addressed technological and cultural aspects of Tank Farm vapor issues and worker concerns and focused on key areas including communications, engineering controls, the industrial hygiene program, and workers’ compensation/occupational medicine.

Managing Tank Farm vapor issues continues to be a challenge because of longstanding, complex issues in vapor characterization, the identification and control of fugitive releases (vapor sources that are not associated with known emission points, such as ventilation stacks or breather filters), and continued events. To further compound the challenge, the current environment involving multiple lawsuits continues to be another barrier to open communication on key issues.

Notwithstanding these challenges, ORP and WRPS senior management have demonstrated their commitment to addressing and implementing the EA recommendations, as well as the recommendations from the 2014 TVAT report and subsequent recommendations from the National Institute of Occupational Safety and Health, DOE Office of Inspector General, and Center for Toxicology and Environmental Health reports. ORP continues to provide effective oversight as evident by assessments they have completed in 2017 and their demonstrated focus on engineering, technological, and industrial hygiene program improvements. WRPS has effectively implemented a number of the planned actions related to the EA recommendations, and success has been achieved in some areas. However, in other areas, progress has been either slow or not evident.

A key improvement since January 2017 was the development of the draft Hanford Vapors Integrated Safety Management Strategy (HVISM) and the companion draft Comprehensive Vapor Action Plan

(CVAP). The overarching goal of the draft HVISM is to “implement a strategy that both protects and is actively embraced by all workers on the Hanford Central Plateau so that workers are safe and feel safe.” The draft CVAP is designed to roll up all of the combined recommendations into one comprehensive action plan. For the most part, this overall strategy presents a reasonable path forward. However, integration of some key vapor issues and the associated logistical relationships remain to be resolved.

The amount and timeliness of vapor-related information available to Hanford employees has improved dramatically. A key element of this effort has been the establishment of the Chemical Protection Program Office. The Chemical Protection Program Office “facilitates the flow of information between operational elements of WRPS, to promote understanding, clarity and transparency of Hanford vapors” and has proven to be effective in fulfilling its mission. WRPS has also been successful in evaluating the effectiveness of communications about tank vapor issues via their own focus groups and surveys. EA conducted a focus group study¹ as a part of this assessment and found that, compared to EA focus group ratings obtained in August 2016, current ratings regarding communications improved in each case and are significantly more positive.

WRPS has increased worker involvement relating to vapor issues by promoting greater attendance and participation in the Chemical Vapor Solutions Team and its subcommittees, primarily through the establishment of Tank Vapor Representatives from each work group. Tank Vapor Representatives have been effective in their mission, which is to “facilitate the timely exchange of information and ideas between Chemical Vapor Solutions Team members and tank farm workers.” EA focus group ratings indicate that positive changes have occurred with respect to: (1) workers’ belief that management desires their input about tank vapor issues, and (2) a reduction in fears of retaliation for reporting unusual odors.

WRPS has achieved some success with new technology and with improvements to the industrial hygiene program. New engineering controls have been installed, including the new AX Tank Farm Exhauster and the extension of the AP Tank Farm Stack from 20 feet to 40 feet and extension of the 242-A Exhaust Stack from 65 feet to 111 feet, with additional new exhauster installations planned for fiscal years 2018 and 2019. New technologies have been piloted and continue to be explored, including evaluation of an air dispersion system (to provide a potential alternative to stack extensions) and a system designed to destroy through combustion certain tank gases preventing their release. Draft processes have been developed for updating the industrial hygiene Chemical Vapor Technical Basis, chemicals of primary concern, and occupational exposure limits, with the help of increased Pacific Northwest National Laboratory involvement. Third-party reviews of elements of the industrial hygiene program have been completed. The number of industrial hygiene technicians has been significantly increased (over 100 were hired in 2017), including completion of initial training and qualifications. A pilot industrial hygiene fundamentals course has been developed utilizing the Volpentest Hazardous Materials Management and Emergency Response Federal Training Center and is currently being implemented, and WRPS has made some progress in pursuing operational and cultural parity between the industrial hygiene program and the radiological control program. Operational parity refers to equivalency in areas such as program requirements and rigor of training and qualification programs, and cultural parity refers to workforce perceptions of the IH program as a credible safety program similar to the radiological control program and acceptance of the industrial hygiene technician expertise similar to that of a radiological control technician.

Although most aspects of the vapor issues identified to date are addressed in the draft HVISM and the schedules are broadly addressed in the draft CVAP, integration of some key vapor issues and the

¹ A focus group study is a carefully planned series of discussions designed to obtain opinions and perceptions on a defined area of interest in a permissive, nonthreatening environment. Each group is conducted with 5 to 10 people led by a skilled interviewer.

associated logistical relationships (how it all comes together) are not resolved. At the time of the EA assessment, WRPS recognized the need for an integrated plan and schedule, and the CVAP Integrated Project Team had initiated a working draft of a high level integrated schedule. While this problem manifests itself in multiple areas, it is perhaps most visibly evident in the effort to assess the need for self-contained breathing apparatus (SCBAs) in the Tank Farm. Based on a Memorandum of Agreement between WRPS and the Hanford Atomic Metal Trades Council (a workforce union), SCBAs are currently required for all employees working in the Tank Farm (with two limited exceptions). However, this mandate to use SCBAs is not risk-based, and future sound decisions on respirator use cannot be made until key sequential steps are completed, including adequate tank headspace vapor characterization, industrial hygiene exposure assessments, respiratory hazard assessments, and satisfaction of the requirements of the MOA, as appropriate. Workers have expressed that SCBA use has increased musculoskeletal injuries, and management acknowledges that the mandated use of SCBAs for Tank Farm work has resulted in an increase of first-aid injuries.

WRPS has implemented, or is in the process of implementing, a number of promising changes to improve the exchange of information regarding injury and illness reporting and case management and improve the communication and trust between RL workers' compensation representatives and WRPS (and other contractors). These changes include making the State Ombudsman for Workers' Compensation available to the workforce; reviewing annually the contents of medical surveillance examinations; developing and implementing new procedures intended to improve the transfer of injury and illness information; participating in meetings of prime contractors, HPMC, and RL (workers' compensation administrator) to address recordability and workers' compensation issues; and providing one-on-one feedback to employees on whom blood draws are performed (to ensure affected employees understand the meaning, purpose and limitations of the tests). However, these improvements have not yet been institutionalized to ensure continuity of the improvements, and there are no plans in place to benchmark the effectiveness of changes that have been implemented.

Overall, WRPS has made progress in addressing the January 2017 EA assessment report recommendations. However, much work remains to complete the suite of open tank vapor tasks. A fully mature and effective vapors management program will require full integration and implementation of key program areas including technology, industrial hygiene, medical, and communications.

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1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Worker Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), conducted a follow-up assessment of progress on actions taken to address concerns about vapors in and around the Tank Farms at the Hanford Site, with a focus on actions taken to address recommendations from the previous EA assessment, *Office of Enterprise Assessments Follow-up Assessment of Progress on Actions Taken to Address Tank Vapor Concerns at the Hanford Site – January 2017* (hereafter referred to as the 2017 EA Follow-up Report). EA conducted the onsite portions of this assessment September 25-28, October 30 – November 2, and November 13-16, 2017.

2.0 SCOPE

This follow-up assessment evaluated the progress on actions taken at Hanford to address recommendations from the previous EA assessment. The scope also included evaluation of the effectiveness of both the contractor and field office programs in managing and maintaining performance in relation to tank vapors. The scope of this follow-up assessment is further described in the assessment plan, *Plan for the Office of Enterprise Assessments Follow-Up Assessment of Progress on Actions Taken to Address Tank Vapor Concerns at the Hanford Site, October – November 2017*.

3.0 BACKGROUND

The DOE Office of River Protection (ORP) was established in 1998 to manage the 56 million gallons of liquid or semi-solid radioactive and chemical waste stored in 177 underground tanks at the Hanford Site. ORP serves as DOE line management for the Tank Farms, which maintain the 177 underground storage tanks in 18 groups or “farms” of 2 to 16 tanks each, and the Waste Treatment and Immobilization Plant, which is under construction and will be used for retrieval, treatment, and disposal of the waste stored in the underground tanks. The Tank Farms are managed and operated by Washington River Protection Solutions, LLC (WRPS) under contract to ORP. As of November 2017, WRPS employed 2,289 personnel, 991 of whom are represented by labor organizations that belong to the Hanford Atomic Metal Trades Council (HAMTC). The ORP Office of the Assistant Manager for Tank Operations provides Tank Farm oversight.

Concerns about tank vapors have existed since at least July 1987. The previous EA assessment provided a detailed background of the history of tank vapor concerns; that history is not repeated in this report. Management of the Tank Farm vapor issues continues to be a challenge because of longstanding, complex issues in vapor characterization, identification and control of vapor sources, and potential exposures to personnel.

4.0 METHODOLOGY

The DOE independent oversight program is described in and governed by DOE Order 227.1A, *Independent Oversight Program*. EA implements the independent oversight program through a

comprehensive set of internal protocols, operating practices, assessment guides, and process guides. Organizations and programs within DOE use varying terms to document specific assessment results. In the 2017 EA Follow-up Report, EA used the term “recommendation” as defined in DOE Order 227.1A. The recommendations from that report were derived from the aggregate consideration of the results of the assessment and were provided for senior line management’s consideration for improving program or management effectiveness. This 2018 report provides an assessment of the actions ORP and WRPS took to address those recommendations.

This EA follow-up assessment was performed in accordance with the *Plan for the Office of Enterprise Assessments Follow-up Assessment of Progress on Actions Taken to Address Tank Vapor Concerns at the Hanford Site, October – November 2017*. The plan outlines the activities specific to this assessment. EA’s assessment team included experts in worker safety and health, safety management, industrial hygiene (IH), occupational medicine, and organizational/safety culture. Assessment activities included review of key documents; interviews with workers who reported symptoms; interviews with subject matter experts (SMEs), including technical SMEs on engineering and abatement controls; and interviews with ORP and WRPS project management and leadership regarding the broader perspective and the path forward for resolution of tank vapor problems. EA also interviewed Richland Operations Office (RL) leadership and staff assigned to workers’ compensation, HPM Corporation (HPMC) staff, the Penser workers’ compensation administrator, the RL workers’ compensation administrator, and the union presidents from HAMTC and the Central Washington Building and Construction Trade Council (CWBT). Additionally, EA set up a “hotline” telephone number for workers wishing to contribute any information to the assessment. EA conducted a focus group study¹ of 16 focus groups with employees and administered a questionnaire to focus group participants. As in the previous EA assessment, the focus groups targeted populations most likely to work in and around the Tank Farms, such as HAMTC and CWBT union members with job assignments in the Tank Farms; employees who reported symptoms during vapor events since the last EA assessment; Mission Support Alliance (Hanford’s integrated infrastructure contractor) support workers; WRPS supervisors; engineers; and ORP Facility Representatives. A total of 100 contractor employees participated in the focus groups.

EA’s assessment of ORP and WRPS responses to EA’s recommendations from the previous assessment are presented in Section 5.0. The members of the EA assessment team, the Quality Review Board, and EA management responsible for this assessment are listed in Appendix A. Appendix B includes additional EA observations related to topics from Appendix B of the 2017 EA Follow-up Report that are not directly related to responses to the previous EA recommendations (the focus of the current EA assessment). Appendix C includes focus group participant ratings with regard to the tank vapor issues.

5.0 OVERALL RESULTS

Following the issuance of the Tank Vapor Assessment Team (TVAT) report, WRPS initially developed WRPS-1500142, *Implementation Plan (IP) for Hanford Tank Vapor Assessment Report Recommendations*, to address TVAT recommendations. Phase 1 of the IP addressed actions taken from 2015-2016. Phase 1 was scheduled to be completed at the end of fiscal year (FY) 2016. During the latter part of Phase 1, multiple assessments were conducted on IP progress, including assessments by the National Institute of Occupational Safety and Health (NIOSH), DOE Office of Inspector General (OIG), Center for Toxicology and Environmental Health (CTEH), and DOE EA. These assessments resulted in multiple additional recommendations for improvements, prompting ORP and WRPS to develop a more

¹ A focus group study is a carefully planned series of discussions designed to obtain opinions and perceptions on a defined area of interest in a permissive, nonthreatening environment. Each group is conducted with optimally 5 to 10 people led by a skilled interviewer.

effective strategy for addressing the vapor issues. WRPS drafted the Hanford Vapors Integrated Safety Management Strategy (HVISM) with the intent of presenting a comprehensive approach to manage vapor-related hazards through integrated safety management (ISM) principles. WRPS also drafted a Comprehensive Vapor Action Plan (CVAP) to implement the strategy, goals, and objectives of the draft HVISM. In the draft CVAP, WRPS integrated the recommendations resulting from the various assessments with the remaining Phase 1 and Phase 2 TVAT actions. WRPS has not finalized the draft documents due to continuing comment resolution and because the substance of the draft documents may be affected by the result of ongoing settlement discussions between the litigation parties. However, WRPS has proceeded with addressing the vapor issues in part through the concepts and actions presented in the HVISM and CVAP drafts. The following section provides a more detailed assessment of WRPS and ORP responses to the EA recommendations presented in the 2017 EA Follow-up Report, including more detailed assessments of the HVISM and CVAP drafts.

5.1 ORP and WRPS Responses to EA Recommendations

5.1.1 2017 EA Recommendation: ORP and WRPS should establish and implement strategies that include enhanced, empathetic dialogue regarding ongoing actions, along with notification of and response to events, to promote better communication and improved trust among workers with respect to tank vapor issues. Consider the following actions:

a. Reinforce and reassure workers that managers want and need to hear their ideas and input on Tank Farm vapor issues and that management will not tolerate any form of retaliation for raising concerns or for providing input or feedback, either from peers or managers. Use safety culture tools and assessments as necessary to address these concerns and to determine whether concerns about retribution or retaliation reach beyond expressing concerns about vapors.

During FY 2017, WRPS gathered feedback from its employees on various tank vapor issues and communications using surveys and focus groups. WRPS also contracted with Oak Ridge Associated Universities (ORAU) to conduct a large-scale safety culture evaluation including gathering data on (1) the prevalence of employee perceptions of retaliation for raising safety concerns, (2) whether employees believe WRPS management wants to hear their input on Tank Farm vapor issues, and (3) whether they have the opportunity to be engaged in Tank Farm vapors solutions. WRPS managers and staff have repeatedly communicated to workers, using multiple methods, that management wants to hear their ideas and input on Tank Farm vapor issues. Efforts have been made to promote greater attendance and participation in the Chemical Vapor Solutions Team (CVST) and its subcommittees. In July 2017, Tank Vapor Representatives (TVRs) were established for most Tank Farm work teams. The purpose of establishing TVRs is to facilitate the timely exchange of information and ideas between CVST members and Tank Farm workers.

EA primarily used focus groups to assess WRPS actions addressing this recommendation. 100 contractor employees participated in the focus groups, and each focus group discussion lasted about 80 minutes. At the conclusion of the discussion, participants were asked to fill out a questionnaire. They rated the extent to which they agreed or disagreed with 28 statements concerning various issues related to tank vapors. In Appendix C of this report, Table 1 presents the mean values of focus group participants' rating scale responses to each statement, as well as the corresponding mean values of rating scale responses obtained 15 months earlier from 119 focus group participants. Both last year's and this year's focus groups were specifically targeted to include all subgroups of the workforce most likely to work directly within and/or near the Tank Farms. EA's sample is not meant to be representative of all WRPS employees. Individuals invited to the focus groups were randomly selected from lists of all people currently working in the identified subgroups. EA compared the responses from last year's and this year's focus groups to identify

changes. EA also reviewed numerous documents and websites, conducted interviews, and attended meetings that took place while on site.

Compared to the focus groups conducted in 2016, the mean value of the 2017 focus group participants' ratings of the extent to which they agree that "Management desires and seeks out worker input about tank vapor issues" was more positive by a statistically significant amount. In 2016, focus group participants were asked to rate the statement, "I would not be subjected to retribution or retaliation for expressing concerns about vapors." 76% agreed with this statement. In order to better determine the source of the perceived fear of retribution or retaliation of the remaining 24%, EA's current survey replaced this statement with two separate statements; the first identifies the potential source of the retribution or retaliation as management, and the second identifies the retribution or retaliation as coming from co-workers. In the current assessment, 86% agree with the first statement and 85% agree with the second, indicating that WRPS has made progress in eliminating worker fears of retaliation from both managers and co-workers.

Compared to 2016, the mean value of the 2017 focus group participants' ratings of the extent to which they agree that "If I had concerns about vapors I would feel free to stop work" was significantly more positive. However, EA heard participants in multiple focus groups say that construction workers are reluctant to report unusual odors because they could be sent home without pay if their worksite has to be evacuated. This perception represents a significant disincentive for some Tank Farm workers to report important information that management needs to know. WRPS management stated that this has been a longstanding issue with construction activities. WRPS recently took two preliminary actions to reduce the potential for building trades workers to not identify issues. The first was to increase the number of building trades safety representatives from one to two to demonstrate commitment to safety. The second is increased investment of open communications with building trades leadership through regular all hands with craft and WRPS participation in the building trades council. WRPS management stated that they recognize that part of the problem are contract requirements. They also stated that they are continuing to examine this concern through review of existing contract requirements and potential contract changes within the bounds of Federal acquisition regulations.

WRPS has effectively evaluated communications about tank vapor issues via their own focus groups and surveys. They also hired an independent organization, ORAU, to assess their safety culture, which demonstrated a strong commitment to improvement. The ORAU report provides valuable data and insights about the numbers and types of employees who perceive that they might be subject to retaliation for raising safety concerns, and potential actions that could be taken to rebuild trust between labor and management. WRPS's efforts to promote greater attendance and participation in the CVST and its subcommittees have been effective. EA focus group ratings indicate that positive changes have occurred with respect to: (1) workers' belief that management desires their input about tank vapor issues, and (2) a reduction in fears of retribution or retaliation for reporting unusual odors.

b. Clarify information and briefings regarding vapor events to include an explanation that measurements taken well after the event are not indicative of what was present during the event.

The draft CVAP states that, by September 30, 2018, WRPS will address communications regarding vapor events through requirements for either: (1) a presentation to the CVST and/or a Chemical Protection Program Office (CPPO) Notebook article describing why the samples are not always indicative of the event, or (2) an event investigation report supplying a timeline. As of September 27, 2017, the draft CVAP Action Status Detail Report lists these actions as pending. The WRPS CPPO manager stated that management has not yet prepared any type of formal communication to Tank Farm workers explaining that (1) management understands that odors often dissipate quickly, before industrial hygiene technicians (IHTs) arrive to take samples, (2) that measurements taken well after the event may not be indicative of

what was present during the event, and (3) the primary point of taking air samples is not to refute that any odors were actually present, but to establish whether/when the air is safe enough for people to reenter the affected area.

c. Establish a feedback loop with employees to be used after management meetings, fairs, and other communication efforts in order to determine what employees heard and whether communications were effective. Issues raised by workers during such meetings should be collected and tracked to completion. The status should be provided to the individual who asked the question to ensure that it was answered satisfactorily, and then shared with all workers on a regular basis.

WRPS conducted three surveys in the past year to address this recommendation. CPPO conducted an effective survey to assess the effectiveness of their communications about vapor issues. The ORAU safety culture assessment was administered to a large representative sample of WRPS employees. This survey included six questions specifically about Tank Farm vapor issues. The WRPS external affairs manager conducted a small survey concerning the effectiveness of the Hanford Vapors website. He also stated that he regularly asks members of the CVST Communications subcommittee for feedback about new information added to this website. Several improvements to the website have been made in the past year to improve clarity and ease of finding information. All of these efforts represent valuable feedback loops.

EA focus group and WRPS survey results indicate that, in some cases, actions to make tank vapor information easier to understand have not been fully effective, especially for those with limited knowledge/technical background on this issue. Some employees report being inundated with too much information. An important limitation to the information in the WRPS survey results is that the data is not broken down by responses from employees who work at the Tank Farms versus those who work off site where exposure to tank vapors is unlikely to occur. Those who work in offsite offices (outside the Hanford Site) may not be as interested and might want to opt out of receiving some or all of the vapors information. Consequently, the WRPS survey results may not accurately reflect what tank farm workers believe about WRPS's efforts to communicate about tank vapors.

WRPS has also taken steps to better track and respond to issues raised by workers. Issues raised during CVST meetings are collected and tracked to completion. WRPS has created an e-form for the workforce to use in asking vapors-related questions. The questions are submitted to an IH SME, and answers are posted online. To improve opportunities for workers to communicate with SMEs, the CPPO has arranged for four experts from CTEH to spend half of their time in the field addressing workers' questions and concerns, and training IHTs to improve their ability to provide satisfactory answers to workers about tank vapors.

d. Implement a system of holding regular focus group meetings with representative cross-sections of employees to obtain real-time feedback on progress in communication initiatives. As stated in the TVAT report summary for overarching recommendation (OR) 9, "holding focus group meetings on a regular basis will help WRPS evaluate the effectiveness of its communications, encourage participation, and assure transparency across interested parties."

WRPS has obtained feedback from its employees on the effectiveness of vapors communications. The CPPO sponsored a lean rapid improvement event in May 2017 to identify more effective ways to deliver vapors information to the workforce. A lean rapid improvement event is an improvement methodology that brings a diverse group of people together to solve a specific problem in a defined amount of time. The members of the lean team represented a cross-section of the workforce, including maintenance, radiological controls, IH, operations, and the CPPO team. The team identified 19 actions that could be taken to improve vapors communications. Most have been implemented including:

- Identification of TVRs to attend CVST meetings
- Additional training on chemical hazards and how to find web-based vapors resources
- Providing IH information in work planning
- As previously discussed, hiring four SMEs from CTEH to spend half of their time in the field addressing workers' questions and concerns about tank vapors.

Overall, WRPS CPPO has effectively responded to this recommendation by conducting multiple surveys and focus groups during FY 2017. The draft CVAP also lists plans to conduct at least two additional sets of communication survey/assessment/focus groups in FY 2018.

e. Promote, encourage, and reward greater worker involvement in the CVST and any other mechanisms for obtaining worker input on formulating and implementing strategies to address tank vapor issues, including the development and deployment of new technologies in the Tank Farms. Ensure that worker involvement is an integral part of new vapor control strategies as Phase 1 results from vapor detection and characterization are finalized and addressed.

The 2017 EA Follow-up Report assessed employee input and involvement in teams and programs associated with Tank Farm vapor issues and found that WRPS did not have effective mechanisms for routinely involving the workforce in the selection of new technologies. EA recommendation 5.1.1.e expanded worker involvement to include obtaining worker input on formulating and implementing strategies to address tank vapor issues. As previously mentioned, WRPS has made a concerted effort to promote greater attendance and participation in the CVST. Both the frequency of CVST meetings and attendance at these meetings have increased. The CVST subcommittees have also become more active. In July 2017, WRPS management established TVRs for approximately 18 Tank Farm work teams. TVRs serve as a direct conduit for two-way communications between the CVST and most of the Tank Farm workforce. Tank Farm managers and supervisors promoted and encouraged this role and selected (or asked for volunteers) TVRs from the workforce. Each work team is expected to send a TVR to all bimonthly CVST meetings. Following each meeting, the TVR reports back to his/her team on what transpired at the CVST meeting. TVRs represent all levels of employees, including bargaining unit workers, managers, and professionals. The initiation of TVRs is a positive step toward increasing worker involvement in formulating and implementing strategies to address tank vapor issues. However, EA did not observe any reward mechanism or specific recognition for TVRs or for members of the CVST.

EA's observation of a CVST meeting and review of minutes from 18 FY 2017 meetings provided evidence that the CVST meetings keep CVST members up to date on planned actions to address TVAT findings, new vapor detection and measurement technologies being implemented in the Tank Farms, and development of the CVAP and HVISM. CVST leadership and other presenters ask for questions and worker input at the conclusion of their presentations. In addition, the CPPO provides weekly Tank Farm information updates (including odor events), together with notebooks (more detailed information) on special issues (e.g., vapor monitoring and detection system, or VMDS, vapor technologies). WRPS also provided well-written communications, including Messages from Mark (routine emails from the WRPS President) in FY 2017 that are available online to all Tank Farm workers.

Multiple examples of worker involvement were evident in the deployment of a new technology during the final design phase of the respirator cartridge filter testing station. Approximately 65 workers were engaged in building the test station and were encouraged by the design engineer to provide recommendations on how to improve the test station. Approximately 10 workers suggested improvements, with the following 4 innovative suggestions being adopted:

- IHTs enhanced the design of the media box to allow easier exchanges (swap outs), thereby saving time between exchanges and ensuring that the media was protected.

- Operators added quick disconnects and valves to allow easy installation of tubing.
- Health physics technicians developed a design for a radiological filter stand that allows for easy filter exchange and surveys during testing.
- Workers developed an adaptor that allows any respirator cartridge to be tested.

One example of obtaining worker input on formulating and implementing strategies to address Tank Farm issues exists in the draft charter for the CVST subcommittee on fugitive emissions. The draft charter specifies, in part, that the subcommittee will provide recommendations to senior management (via the CVST) related to long-term monitoring, abatement, and/or procedure and process updates to ensure worker safety related to fugitive emissions.

The draft HVISM includes engaging the workforce as an objective of the strategy. This engagement includes worker involvement during work planning, walkdowns, and preparation of activities in the Tank Farms. This approach is also reflected in the draft CVAP core principle #6 and in key performance parameter (KPP)-1. The main worker involvement focus in both draft documents is on obtaining worker input to successfully implement the strategy, but the focus does not include worker involvement in actual formulation of the strategy. The intent of the above recommendation was to also include worker input during formulation of the strategy.

Overall, WRPS has made improvements in worker involvement through the expansion of the CVST and enhanced communications provided by the CPPO organization. Worker input is solicited regarding improvement and implementation of work procedures. Compared to 2016 ratings, EA focus group ratings obtained in 2017 are significantly more positive with respect to each of the following four statements:

- Management desires and seeks out worker input about tank vapor issues.
- Effective mechanisms exist for workers to provide ongoing input about tank vapor issues.
- Management responds appropriately to worker input about tank vapors.
- Workers receive timely responses to their ideas and suggestions about reducing exposure to tank vapors (see Appendix C Table 1).

Although many aspects of worker involvement have improved, involvement at the early levels of strategy formulation and technology development was not evident. There are currently no approved strategies, policies, charters, or procedures that formally address worker involvement at this level. The 2017 Vapor Management Expert Panel (VMEP) report's assessment of WRPS efforts to increase worker involvement in formulating and implementing strategies to address tank vapor issues is very similar to EA's assessment. Specifically, the VMEP report states, "offering and obtaining worker feedback or allowing workers to participate on teams, will not, in and of itself, achieve the desired result – workers 'feel safe.' To achieve 'feel safe,' workers must be actively and substantively engaged in all stages of an effort or project, including discussions regarding risk concerns related to decision-making, such that they can better understand and support or accept leadership's decisions. To feel safe, they must be partnered with management in the development of the work product and (personally or collectively through their union reps) support or accept the residual risk."

f. Expedite improvements to the system for notifying all affected workers of vapor releases. At a minimum, WRPS needs to increase the number of radios available so that every worker entering a Tank Farm can receive timely Shift Office Event Notifications of Abnormal Operating Procedure (AOP)-15 events.

WRPS recently installed and tested a new public announcement (PA) system at the AP Tank Farm, and work is underway to install additional PA systems. Reader boards are used to help notify all WRPS and

contractor employees of areas that should be evacuated/avoided due to vapor releases. Several EA focus group participants stated that they believe these steps help ensure that everyone is notified quickly in the event of a vapor release. The new PA system has been tested, and workers say it is loud enough for all to hear. They also say that, due to ambient noise levels in the Tank Farms, it is sometimes difficult to hear alerts that come over their radios or cell phones.

WRPS has made good progress in addressing this recommendation. Unlike last year, EA focus group participants did not say that they lacked access to radios. Compared to 2016, the mean value of the 2017 EA focus group participants' ratings of the extent to which they agree with the following two statements was more positive by a statistically significant amount:

- WRPS keeps me well informed about vapor releases.
- I understand how the Shift Office Event Notification warning system works.

g. Document the overarching goals and objectives for the integrated suite of vapor control measures with respect to the site ISM process, including existing and planned engineering controls as well as the implementation of new detection, abatement, and respirator cartridge testing technologies, and communicate this information to workers.

This EA recommendation addressed a concern in Section B.6 of the 2017 EA Follow-up Report that stated “there is no documented overarching plan that identifies the goals and objectives for the design of new technologies with respect to ISM,” and that “the overarching goals and objectives for the selection and implementation of new technologies have not been adequately communicated to the workforce.” In August 2016, there was no communication plan with respect to new and emerging technologies, and WRPS had limited mechanisms for routinely involving workers in the selection of new and emerging technologies, except for field IH monitoring instrumentation.

Since the 2017 EA Follow-up Report, the WRPS HVISM was drafted with the intent of presenting a comprehensive approach to manage vapor-related hazards through ISM system principles. The HVISM provides the following statements as ISM system principles:

- Know the hazards (IH Chemical Technical Basis)
- Apply engineering controls (e.g., exhausters, dilution fan, thermal oxidation)
- Monitoring (VMDS)
- Centralize command and control to be preemptive versus reactive.

The overarching goal of the draft HVISM is to “implement a strategy that both protects and is actively embraced by all workers on the Hanford Central Plateau so that workers are safe and feel safe.” The overall strategy of the draft HVISM is three-fold: manage the vapor hazards through ISM principles, employ high-quality conduct of operations, and engage the workforce. With these objectives in mind, the HVISM is built on eight core principles, with the draft CVAP being the plan to implement the strategy, goals, and objectives of the draft HVISM. Within the construct of the draft CVAP, the development and deployment of new detector technologies are now addressed under KPP-5, the scope of which includes permanently installing VMDS pilot-scale test equipment in A and AP Tank Farms; installing monitoring equipment on active exhausters and perimeter monitors along the A complex corridor and SY Tank Farm; and establishing the criteria for unrestricted boundaries around the Tank Farms. This overall strategy presents a reasonable path forward and is also a path supported by the VMEP.

The combined draft HVISM and CVAP provide a useful and well-written description of the many and varied elements of the integrated suite of vapor control measures, such as existing and planned engineering controls, as well as the implementation of new detection, abatement, and respirator cartridge testing technologies. Most of these vapor control measures are interconnected and co-dependent. For

example, the Qualitative Risk Assessment (QRA) is an example of an element within the integrated suite of vapor control measures. The performance of a successful QRA is dependent on an accurate Chemicals of Concern list, which is a short list of the most significant chemicals extracted from the larger Chemicals of Potential Concern (COPCs) list; this COPC list is derived from an IH Chemical Vapor Technical Basis that consolidates and updates historical headspace sampling results.

Although WRPS has developed a Field Execution Schedule (FES) for completion of each of these individual elements in the QRA chain (e.g., developing procedures for updating the COPC list or revising the IH Chemical Vapor Technical Basis), there is no WRPS integrated schedule that identifies the interrelationship and time-sequencing of the various CVAP tasks (how it all comes together) such that long-term priorities and critical paths can be determined and appropriate resources allocated. At the time of the EA assessment, the CVAP Integrated Project Team (IPT) was developing a high level integrated schedule.

Although most aspects of the vapor issues identified to date are addressed in the draft HVISM and the schedules are broadly addressed in the draft CVAP, integration of some key vapor issues and the associated logistical relationships are not well documented. At the time of the EA assessment, WRPS recognized the need for an integrated plan and schedule and the CVAP IPT had initiated a working draft logistical diagram. A significant issue that is not well documented in the HVISM is the overarching goal of the assignment of respiratory protection commensurate with hazards and risk, in lieu of the current approach that mandates the use of supplied air (e.g., self-contained breathing apparatus, or SCBA) regardless of risk. The core functions of ISM, which would include an integrated strategy to analyze the respiratory hazards and tailor the hazard controls appropriate for the tasks (which may be less than SCBA), are not addressed in the draft HVISM and draft CVAP. In addition, as discussed in the previous paragraph, WRPS lacks an integrated schedule that identifies and describes the sequential list of activities that must be achieved in order to reach this overarching goal for respiratory protection (headspace vapor characterization, respiratory cartridge testing, respirator hazard assessments, QRAs, personal monitoring, etc.). In December 2017, on a pilot-scale basis, WRPS applied ISM principles to reduce respiratory protection requirements for a limited number of work activities in the SY Tank Farm. However, the overall goals and integrated schedule to achieve this outcome on a vapor project level have yet to be documented. At the time of the EA-32 visit, the path forward from cartridge testing and third party review/approval was undefined and could not be built into a schedule. See later sections for detailed discussions regarding IH exposure and respiratory hazard assessments and headspace characterization.

With the exception of the integration of activity-specific work planning and control goals associated with Tank Farm tasks (as discussed above) and the inclusion of a discussion of overarching goals for respiratory protection, the draft HVISM and draft CVAP meet the intent of the first part of this EA recommendation. The draft documents provide a constructive and well-documented set of overarching goals and objectives for the integrated suite of vapor control measures with respect to the ISM process, including existing and planned engineering controls, as well as implementation of new detection, abatement, and respirator cartridge testing technologies.

Although elements of the draft HVISM and draft CVAP have been communicated to the work force through the CPPO and CVST, both documents are in draft form, and according to WRPS, neither document has been finalized due to continuing comment resolution and because the substance of the draft documents may be affected by the result of ongoing settlement discussions between the litigation parties. However, while the strategy and plan were under development, WRPS shared them with the workforce through the use of a CVST sub-team formed for this purpose, and once developed, WRPS management presented the CVAP to the CVST.

Overall, the quantity and quality of vapors information available to WRPS employees has significantly improved. More workers believe that WRPS is headed in the right direction with respect to the steps being taken to reduce worker exposure to tank vapors. Although some hotline and focus group participants still express distrust and doubt in management, WRPS has made good progress in restoring workers' trust in management and has increased workers' involvement in formulating strategies to address tank vapor issues.

h. Ensure summary reports from HPMC evaluating laboratory results related to group health status in present Tank Farm workers are flowed down to the workforce.

HPMC's annual medical surveillance report and the study of four years of epidemiology data on Tank Farm workers (see Section 5.1.7) are examples of information from which the Tank Farms workforce could benefit. WRPS plans to use their Communication Plan to distribute the study to Tank Farm workers. The CPPO was aware of the four-year study, and EA made them aware of the annual report. CPPO representatives stated that the CVST and associated TVRs, tailgate talks, and all-hands emails are some of the tools used for information dissemination. These tools are effective mechanisms for information flowdown. However, CPPO has not yet formally documented plans to distribute the report to the workforce. In addition, HPMC and CPPO are still evaluating the ability to provide the annual medical surveillance reports to the general workforce population.

5.1.2 2017 EA Recommendation: WRPS should enhance its management processes for responding to the TVAT recommendations to clearly identify details of the actions, action owners, action status, and objective evidence for closure.

The Technical Aspects section of the Executive Summary in the 2017 EA Follow-up Report stated that, "with regard to the implementation plan for addressing TVAT recommendations, WRPS has not included the recommendations in their existing formal processes, such as the WRPS Problem Evaluation Request (PER) system, to verify and document corrective action completion and effectiveness." EA provided the following actions for consideration as part of recommendation 5.1.2 above.

a. Include all Phase 1 actions and Phase 2 actions as they are developed.

All of the TVAT actions were entered into the PER system (i.e., the WRPS issues management system), which provides actions cross referenced to the original TVAT action identification number. The PER system also provides action owners, due dates, deliverables, completion criteria, closure statements, closure documentation, and a discussion of any ongoing elements pertaining to actions being carried forward. In addition, WRPS has transferred the remaining incomplete TVAT-related actions to the draft CVAP. Entering the TVAT actions into the PER system and the draft CVAP provides the information needed for corrective action management. The draft CVAP actions also identify action owners and provide a space for due dates, but some of the items, such as item 76 (IH Manual) and items 78 and 103 (Chemical Worker Training), do not have action due dates entered. These specific actions were not completed within the timeframes originally indicated in the FY 2017 Performance Evaluation and Measurement Plan (i.e., Special Emphasis Area 10 regarding completion of the IH Manual) and Figure 3-7 of the draft CVAP, *Field Execution Schedule Training*, regarding Tier II and Tier III Chemical Worker Training.

Overall, the WRPS action management processes in place within the PER system and the draft CVAP provide information appropriate for tracking TVAT action status. Progress has not always met the original CVAP timeframes and Performance Evaluation and Measurement Plan goals, and WRPS has not entered CVAP action due dates for some important items (i.e., IH Manual and Chemical Worker Training completion).

b. Include the recommendations of the Parity Gap Analysis described in Appendix B, Section B.2 (e.g., the recommendations concerning design and controls).

An overarching recommendation in the TVAT report recommended that WRPS achieve “operational and cultural parity” between aspects of the industrial hygiene program and the radiological control program. Operational parity refers to equivalency in areas such as program requirements and rigor of training and qualification programs, and cultural parity refers to workforce perceptions of the IH program as a credible safety program similar to the radiological control program and acceptance of the industrial hygiene technician expertise similar to that of a radiological control technician. Section B.2 of the 2017 EA Follow-up Report noted that WRPS had tasked a subcontractor to develop a Parity Gap Analysis. The subcontractor completed *A Parity Review of the WRPS Industrial Hygiene Program Relative to Radiological Protection Program* and issued it on April 16, 2015. At the time of the 2017 EA Follow-up Report, WRPS was still in the process of evaluating many of the recommendations contained in the TVAT report.

WRPS has since developed a Summary of Disposition Table that lists recommendations from the April 16, 2015, parity review and provides responses by the IH program to address each recommendation. The table also provides the current status for each response. Many of the responses indicate that actions are in process, draft status, or implementation phase. No due dates or action owners were listed.

Overall, it is evident that WRPS is pursuing parity of the industrial hygiene program with the radiological control program in areas such as IHT training, chemical worker training, and IH Manual development. WRPS management was consistent in stating that parity-related actions fell under KPP-3, but there is no way (e.g., a parity action plan) to identify which of the actions being taken are for the purpose of achieving parity. In addition, the actions for KPPs 2, 3, and 8 have not yet been loaded into the PER system.

c. Include quality assurance elements and assessments in accordance with DOE Order 414.1D, *Quality Assurance*, to ensure the effectiveness of project plan deliverables.

DOE Order 414.1D provides the principle that “performance and quality improvement require thorough, rigorous assessments and effective corrective actions.” Section B.2 of the 2017 EA Follow-up Report noted that WRPS had not conducted TVAT-related effectiveness reviews (e.g., of the revised IHT training program).

With respect to the IH assessment program, WRPS has assigned a manager and allocated appropriate staff resources to initiate a periodic assessment program for all IH program elements, to include effectiveness reviews and independent assessments. The assessment team is newly formed and in the process of preparing governing processes and procedures. The IH assessment program will include review of the revised IHT training program as well as other IH program enhancements developed as a result of TVAT action deliverables (e.g., IH rounds and field measurement protocols/processes).

WRPS is planning a midpoint management assessment for FY 2018 (Assessment number FY2018-PI-MD-0330), entitled *Evaluation of Implemented and Proposed Actions in Response to the Hanford Tank Vapor Assessment Report*. The stated purpose of this assessment is to determine whether planned or completed actions are responsive to recommendations identified in the Savannah River National Laboratory (SRNL) 2014 TVAT report. An additional purpose of this assessment is to determine whether any of the TVAT recommendations remain unresolved. This planned assessment has many of the elements of a formal effectiveness review.

Overall, WRPS has the quality assurance elements in place to ensure rigorous assessments and corrective action effectiveness, but has not yet completed effectiveness reviews of TVAT-related corrective actions.

d. Ensure that action status is regularly communicated to and easily accessed by the workforce.

Section B.9 of the 2017 EA Follow-up Report stressed the importance of communicating vapor exposure issues, findings, and actions in a timely fashion to employees.

WRPS has addressed this recommendation through an expanded CVST and successful CPPO communications. The CVST has an expanded membership, which now includes TVRs from Tank Farm work teams. The agendas and meeting minutes provide effective examples of briefings on new technologies, medical protocols, and odor events. CVST meetings are conducted approximately every two weeks and provide timely information for members to carry back to their work teams and organizations. The CPPO organization was formed in October 2016 and immediately began providing vapor-related information to the workforce. Their weekly update reports are available online and routinely include updates for the status of actions being taken to address TVAT findings. These weekly update reports are an effective means of communicating vapor project information to the workforce. The first annual CPPO summary report was published on October 5, 2017, and provides an effective and easy-to-read summary of completion status for external assessment recommendations. The CPPO also offers, via direct email and the HanfordVapors.com website, its weekly updates on the broad vapors mitigation efforts mapped out in the draft CVAP. Focus groups conducted by EA were generally positive about improved communications and indicated that workers generally believed that WRPS was doing a better job of keeping the workforce informed of vapor-related issues and actions.

Overall, WRPS has improved its vapor-related communications and is effective in providing TVAT action status on a regular basis that is easily accessed by the workforce.

5.1.3 2017 EA Recommendation: WRPS should expedite improvements in the IH program as recommended by the TVAT, including additional tank headspace sampling with a focus on the waste tanks that pose the greatest risk to workers, further development of short-term chemical vapor exposure limits, and update of the COPC list. Consider the following actions:

a. Establish and implement a strategy to identify the sequence of additional tank headspace sampling based on the tanks that pose the greatest risk. Continue involving Tank Farm workers in developing headspace sampling strategies.

Both the TVAT and WRPS recognized the need for continued sampling and characterization of the tank headspace chemical vapors, which are the source term and basis for IH monitoring, sampling, and exposure assessment programs. EA provided an assessment of near-term actions proposed by WRPS (Phase 1 TVAT IP) to address the TVAT recommendations with respect to headspace sampling in Section B.3 of the 2017 EA Follow-up Report.

Since August 2016, WRPS completed the following activities with respect to headspace sampling and related support activities:

- Intrusive headspace sampling was performed in one tank (BY-108) in FY 2017 (October 2016) using the methodology described in TFC-PLN-163.
- The 222-S onsite laboratory completed the laboratory analysis of headspace samples collected in FY 2016 from the six single shell tanks (SSTs) in A Tank Farm (Tanks A-101 through A-106) and one double shell tank (SY-102) in FY 2017, and provided the results to WRPS IH and Pacific Northwest National Laboratory (PNNL) for further analysis.

- PNNL completed the analysis of the aforementioned laboratory samples and issued PNNL reports in FY 2017 and FY 2018.
- WRPS IH conducted stack sampling in the AP and A Tank Farms.
- The proton transfer reaction mass spectrometry (PTR-MS) mobile van (owned and operated by RJ Lee Group, under contract to WRPS) completed stack sampling in the AP exhaust stack.
- In October 2017, PNNL was contracted to assist in the development of a headspace sampling strategy.

Within the construct of the new draft CVAP, headspace sampling programs and activities are now addressed under KPP-2. However, neither the draft CVAP nor the draft HVISM addresses a headspace sampling strategy, which is the focus of this EA recommendation. The only mention of headspace sampling within these two documents is in Section 3.2.3 of the CVAP, which indicates the commitment to institutionalize processes for headspace sampling in a revision to the IH Chemical Technical Basis in FY 2016-17; this change has not yet occurred. WRPS identified only one action for this EA recommendation in the CVAP Action Plan (CVAP Action Item 259), which was “to establish and implement a schedule that supports headspace sampling and institutionalizes the head space sampling.” WRPS has not assigned a date for completion of this action, since the institutionalization of head space sampling and other CVAP related scope is in FY19, and WRPS does not have contract guidance/direction for FY19 and beyond.

Since the 2017 EA Follow-up Report, independent reviews performed by Stoneturn Consultants and CTEH have emphasized the importance of characterizing the chemicals within the headspace and have recommended to WRPS the pursuit of this activity. The importance of headspace sampling and headspace vapor characterization was designated a priority by the TVAT and incentivized by ORP in FY 2015 and FY 2016, as further discussed in Section B.3 of the 2017 EA Follow-up Report. There were no performance-based incentives (PBIs) associated with headspace sampling provided by ORP in FY 2017 or FY 2018.

The current headspace sampling process is resource and time consuming, requiring a team of up to 20 Tank Farm operators, industrial hygienists, IHTs, and radiological control technicians, and results in impacts on current Tank Farm operations. As a result, WRPS is investigating new methods and techniques for headspace sampling, such as the use of the respirator cartridge test station for performing headspace sampling in future campaigns, greater emphasis on stack sampling, and the use of the PTR-MS mobile van.

Since 2016, the methods and practices of headspace sampling have shifted from intrusive tank headspace sampling (as performed in 2016 and prior years, and described in TFC-PLN-163, *Industrial Hygiene Sampling and Analysis Plan for Tank Head Space and Exhaust Stack Sampling*) to a greater reliance on non-intrusive sampling, by sampling stack exhausts (IH stack sampling or via the PTR-MS mobile van) and through the sampling of headspace gases via the respirator cartridge testing station program. As a result, intrusive headspace sampling was performed in only one tank since the previous EA visit. WRPS is developing an alternate approach to attaining head space samples that could be used during waste disturbing events and potentially result in a more efficient means of obtaining samples. However, there are potential issues with the proposed method, such as sample line chemical losses. In FY 18, WRPS plans to perform a side by side comparison of the two sample methods in BY-108 to determine if the new methods provide similar results. In order to obtain sufficient data points to compare the two methods, six head space sampling events for FY18 are planned for BY-108. Awaiting the outcome of these BY-108 tests, WRPS plans to formalize a strategy, a path forward, and procedures for future headspace sampling (intrusive and/or non-intrusive). As a result of these uncertainties, WRPS has not addressed a headspace

sampling strategy or plan in either the draft CVAP or the draft HVISM, and the current sampling plan (TFC-PLN-163) remains outdated.

Overall, this EA recommendation to develop a strategy to identify the sequence of additional tank headspace sampling based on the tanks that pose the greatest risk with respect to future priorities has yet to be addressed, although PNNL was recently tasked in October 2017 to initiate such a strategy.

b. Establish and document a technical basis for the current 59-chemical COPC list to account for the 11 additional COPCs added since the IH Chemical Vapor Technical Basis was last updated in 2006. Consider including the data on dimethyl mercury from the ORP mercury and dimethyl mercury exposure assessment report in the next update of the COPC list.

Section B.3 of the 2017 EA Follow-up Report assessed WRPS actions to update the IH Chemical Vapor Technical Basis and COPC list. At the time of the 2016 EA assessment, the development of a process to update the COPC list had been deferred to a later date (Phase 2 of the WRPS IP). In the 2017 EA Follow-up Report, EA noted that, conceptually, the 2006 IH Chemical Vapor Technical Basis was an excellent document that incorporated the development and listing of the COPCs, but was outdated in a number of areas.

Since the 2016 EA assessment, WRPS, with the assistance of PNNL, has embarked on two tasks with respect to implementing this EA recommendation: (1) updating the COPC list from the 2006 list contained in the 2006 IH Chemical Vapor Technical Basis; and (2) developing a process for periodically (i.e., annually) updating the IH Chemical Vapor Technical Basis and associated COPCs.

In 2006, the COPC list was populated with 48 chemicals, as documented in the 2006 IH Chemical Vapor Technical Basis. This list of COPCs had expanded to 59 COPCs at the time of the 2016 EA assessment, but with no documented technical basis for the addition of the 11 chemicals. In 2016, PNNL, under contract to WRPS, initiated the Health Process Plan (HPP) Project to define the strategy and plan for routinely reviewing and updating the COPC list, as well as occupational exposure limits (OELs), through individual HPPs. OELs may change over time or may not exist for some chemicals. However, for a hazardous chemical that is found in the headspace to be added to the COPC list, the concentration of the chemical in the headspace must have exceeded 10% of its current OEL (current screening value). In 2016, PNNL issued a report to provide the technical basis (PNNL-25880, *Hanford Tank Vapors COPC Update, 2016*) for adding 11 additional chemicals to the COPC list, including dimethyl mercury and acrolien. In September 2017, the COPC list was again updated by PNNL (PNNL-26820, *Hanford Tank Vapor FY 2017 Chemicals of Potential Concern Update*), which removed some prior COPCs and added new chemicals to the COPC list, resulting in the current list of 61 COPCs. EA has reviewed this process and finds the technical bases for the current list of COPCs to be adequate, with exceptions as described in Appendix B, Section B.2 of this report.

Within the construct of the new draft CVAP, development of processes to update and maintain the IH Chemical Vapor Technical Basis and COPC list is sufficiently described under KPP-2. With respect to the COPC list, Section 3.2.2.1 of the draft CVAP identifies a workable fourfold process to updating the COPC list and OELs:

- Develop and proceduralize processes to evaluate ongoing data collection and analysis to revise, evaluate, and document new COPCs/OELs/short-term exposure limits (STELs) through updates to the IH Chemical Vapor Technical Basis.
- Establish an internal multi-disciplined team to evaluate outputs and recommendations related to COPCs/OELs/STELs time-weighted averages to understand whether updates to the technical basis are warranted.
- Subcontract an expert panel in FY 2017-2018 to evaluate and validate proposed new or revised limits.

- Seek ORP approval of new acceptable Hanford Tank Farm OELs.

This fourfold process to maintaining and updating the IH Chemical Vapor Technical Basis and COPC list is workable, although the approach has yet to be fully implemented. While the aforementioned approach is documented in the draft CVAP, this has not precluded WRPS from further developing the process. For example, WRPS has drafted the following three procedures for implementing Step 1:

- TFC-PLN-174, *Industrial Hygiene Chemical Vapors Technical Basis Program Plan*
- TFC-ESHQ-S-IH-C-67, *Maintenance of the Industrial Hygiene Chemical Vapor Technical Basis*
- TFC-ESHQ-S-IH-C-66, *Determining Chemicals of Concern in Hanford Tank Farms*.

Overall, WRPS has or is in the process of addressing the fundamental elements of this EA recommendation, having established and documented a technical basis for the former 59-chemical COPC list to account for the 11 additional COPCs added since the IH Chemical Vapor Technical Basis was last updated in 2006. In addition, WRPS considered the data on dimethyl mercury and added dimethyl mercury, as well as acrolien, to the COPC list in 2016. WRPS has also been developing procedures to maintain and update both the IH Chemical Vapor Technical Basis and the COPC list. These procedures are currently in draft form, and their effectiveness in adequately maintaining and updating the IH Chemical Vapor Technical Basis is not yet known. In addition, PNNL has developed a useful and systematic, but flexible, process for documenting the basis for existing chemicals and changes to the COPC list through the publishing of HPPs. To date, eight HPPs have been issued by PNNL. WRPS has addressed three of EA's previous concerns with respect to the COPC list and the IH Chemical Vapor Technical Basis, as described in Section B.3 of the 2017 EA Follow-up Report; however, three other concerns remain as a work in progress, as further discussed in Section Appendix B, Section B.2.

c. Expedite the revision and updating of the IH Exposure Assessment Strategy to make it more useful and consistent with the American Industrial Hygiene Association (AIHA) *Strategy for Assessing and Managing Occupational Exposures*, including further implementation of ceiling limits as a hazard control as recommended by the TVAT.

Section B.4 of the 2017 EA Follow-up Report assessed WRPS actions to accelerate development and implementation of a revised IH Exposure Assessment Strategy that is protective of worker health and establishes stakeholder confidence in the results for acute, as well as chronic, exposures. Of note, the WRPS revision of TFC-PLN-34, *Industrial Hygiene Exposure Assessment Strategy Procedure*, was deferred to a later date (Phase 2 of the WRPS IP). This deferment was due to needing further development and implementation of prototype detection technologies for short-term tank vapor releases, development of postulated exposure limits for transient chemical events, and results from headspace sampling.

The 2017 EA Follow-up Report concluded that the IH rounds and routines program, in combination with the enhanced vapor monitoring program, would be potentially beneficial in identifying and documenting the transient elevated vapor events.

Within the new draft CVAP, the steps for revising and implementing TFC-PLN-34 are embedded as parts of and dependent on the completion of actions within Section 3.2.2.4, Leading Indicators; Section 3.2.2.5, Air Dispersion Modeling; and Section 3.2.2.6, Parity Implementation with Established Programs, which are part of KPP-2 and KPP-3. With respect to the revision of TFC-PLN-34, the sections referenced above detail effective approaches that are slated to be included in the strategy (whether in TFC-PLN-34 or an embedded part of the overall IH Manual) once they are completed.

Since the issuance of the 2017 EA Follow-up report, WRPS has revised TFC-PLN-34, the *Industrial Hygiene Exposure Assessment Strategy*, and has initiated a draft revision to TFC-ESHQ-S-IH-C-48, *Managing Tank Chemical Vapors*, to be more consistent with elements of the *AIHA Strategy for Assessing and Managing Occupational Exposures*. Collectively these two procedures provide the basis and framework for the performance of IH exposure assessments in support of tank farm work activities. Although progress in the refinement and implementation of an IH exposure assessment strategy is evident since the prior EA follow-up assessment, much remains to be completed. For example, WRPS recognizes the need for development of implementing procedures for the IH Exposure Assessment Strategy procedure, which are currently being drafted. For the IH exposure assessment process to be effective, the process must be integrated with other ongoing CVAP initiatives such as the VMDS, performance of respirator hazard assessments, and the results from the QRA process which may require revisions to existing baseline exposure assessments. The IH exposure assessment process is also impacted by other CVAP factors such as changes to the IH Manual and the IH Chemical Technical Basis, and the development of and/or changes to chronic and acute OELs. Each of these documents was under revision at the time of the EA assessment.

WRPS and its subcontractor, Kenexis, are completing QRAs to model and investigate the extent of impact of each of the emission sources using a computational fluid dynamics air dispersion model, the Fire Dynamics Simulator. The QRAs are intended to be used by IH as an input, along with empirical data to develop baseline exposure assessments for the individual tank farms. Other integrated source data includes information from VMDS sensor output and the Air Pollutant Graphical Environmental Monitoring System (APGEMS). These initiatives provide analysis of specific information that is essential in developing appropriate exposure assessment strategies. The Kenexis dispersion model runs multiple meteorological conditions and identifies conditions which may pose risk to workers from transient exposures. For example, when using this model for AP Tank Farm, it shows an inversion layer occurring 1% of the time for nitrosamines above the OEL, which indicates a potential increase in the probability for workers to be exposed to contaminants above the OELs inside and outside of the AP Tank Farm boundary. See Appendix B, Section B.5, for further discussion.

With respect to the segment of this EA recommendation regarding the need to further implement ceiling limits as a hazard control; WRPS has contracted PNNL to identify, collect, and evaluate information available in the scientific community with respect to short-term acute OELs, including ceiling limits, for COPCs that do not have a regulatory basis for acute OELs. During CY 2017, PNNL performed this evaluation and issued a draft report indicating that at the time of their review only 11 of 59 (now 61 COPCs) have acute exposure guidelines established by authoritative sources. The PNNL report also indicated that of the remaining 48 COPCs, only 6-7 compounds have sufficient toxicity data to support the development of an acute OEL, but further review would be required. WRPS is currently reviewing the data to determine a path forward.

Overall, WRPS is making good progress to address the fundamental elements of the EA recommendation to expedite the revision of the IH Exposure Assessment Strategy procedure. The development of leading indicators regarding further definition of sampling and analysis requirements to determine potential vapor hazards is underway and is allowing for further development of IH exposure assessment strategies. WRPS is integrating the APGEMS and Kenexis models' analyses in order to quantify vapor exposure risks to employees from possible sources via results of quantitative risk assessments. As the IH Chemical Vapor Technical Basis revision process progresses, the draft IH requirements document and draft IH Manual are becoming more defined.

During interviews, WRPS discussed the need for and benefits of coordination between IH and engineering initiatives, based on the dispersion modeling analysis methodologies that demonstrate the conditions and locations where exposures are likely to occur inside and outside of the Tank Farm fence

lines. In 2018, WRPS plans to integrate results of the QRAs, VMDS instrumentation, and unrestricted work boundary definition into their Industrial Hygiene exposure assessment process and demonstrate integration of these initiatives through the revised exposure assessment process. ORP plans to closely monitor this integration effort to ensure it is being implemented as committed in the CVAP. WRPS discussed plans to include an IH Exposure Assessment Strategy that creates work planning criteria based on the environmental conditions presented in the engineering models that simulate possible exposure locations, and to limit worker activity during those specific conditions in which workers may experience a transient odor or exposure event. This plan is a step in the right direction; however, it is not documented with actions and timelines. Finally, in the second quarter of FY 2018, WRPS has plans for IH, engineering, and the communications team to begin development and implementation of a worker communication plan that explains the dispersion models in relation to the Tank Farm work activities and the IH strategy moving forward in terms of limiting worker exposure under such conditions that the model shows possible odor events from intermittent transient vapors.

d. Obtain ongoing feedback from IH trainers and recent trainees (IHTs and industrial hygienists) to improve the quality of classroom presentations and field on-the-job training (OJT) for new staff.

Section B.2 of the 2017 EA Follow-up Report assessed the IH program operational and cultural parity with other safety programs such as radiological control (see previous discussion in Section 5.1.2.b). EA found that IH management was aware that training needs to be continually improved, but had not made a concerted effort to obtain feedback from trainers and recent trainees to improve the classroom presentations and field OJT for the IHTs.

The WRPS IH governing document for training evaluations, TFC-BSM-TQ-MGT-P-07, *Training Evaluation*, Rev C-1, June 26, 2017, provides an acceptable approach to gather IH staff input on training. Recent samples of training evaluations indicate that this approach is effective. The approach incorporates three levels of review that adequately capture students' initial reactions to classroom training, evaluate learning at the conclusion of initial training (and periodically thereafter), and review student performance in the field.

On October 18, 2017, IH initiated weekly Material Review meetings (suggested by two trainers) to discuss material reviews of courseware and proposed procedure changes (initiated by trainees and instructors) that could impact training. IH staff also record edits/changes made to training as a result of Post Pilot Reviews of training on IH instrumentation. Both of these efforts (Material Review Meetings and Post Pilot Reviews) provide valuable information for training improvement. An example of a recent improvement resulting from a Material Review Meeting conducted on November 8, 2017, is the revision of a training note regarding Drager gas tubes to clearly specify that the Drager pump must be "squeezed several times away from the breathing zone in order to clear residual gases and vapors out of the pump bellows."

One formal management observation conducted in AX Tank Farm on October 31, 2017, specifically observed IH staff conducting OJT and qualification of IHTs. This observation listed the IHT OJT as a good practice and recognized the quality of the briefings provided by IH staff to new IHTs. This observation reflects one example of effective management involvement in the IH training process.

Overall, WRPS has implemented the processes needed to obtain ongoing feedback from IH trainers and trainees to improve classroom training and OJT.

5.1.4 2017 EA Recommendation: As Phase 2 actions are developed, WRPS should consider refocusing and documenting the analysis and use of engineered controls to reduce the potential for

vapor exposures to workers, such as increasing the stack heights for selected tanks. Ensure the participation of IH and other key professionals in the selection and evaluation process.

Section B.7 of the 2017 EA Follow-up Report for OR 7 assessed WRPS previous actions to “accelerate implementation of tailored engineering controls to control vapor emissions and exposures.” Although some engineering controls had been completed (e.g., the first stack extension project in C Farm was completed in 2001, and the extension of the AP Stack from 20 feet to 40 feet was completed in August 2016), the WRPS IP in 2016 was not explicit in defining or assessing the effectiveness of the ongoing efforts with respect to engineering controls or in defining the path forward and priorities (if any) for engineering controls. WRPS had not documented or communicated to the work force a strategy for the implementation of engineering controls. As a result, worker perceptions in 2016 were that insufficient attention was being applied to expedite the development and implementation of engineering controls.

Within the construct of the new draft CVAP, the scope of KPP-4, discussed in CVAP Section 3.3, is to enhance work sites through engineering controls and abatement technologies. Since the 2016 EA assessment, WRPS has pursued three engineering controls and one abatement project to achieve this scope:

- Extending the 242-A Evaporator exhaust stack from 65 feet to 111.5 feet.
- Evaluating the Strobic Air Corporation air dispersion system as an alternative to stack extension.
- Designing and installing new stack exhausters. Operating the AX Tank Farm Exhauster in FY 2017 and installing new exhausters in A Farm in FY 2018/19 and replacing the SY Tank Farm exhauster in FY 2019.
- Initiating NUCON International, Incorporated (NUCON) thermal oxidation tests for potential application in a Tank Farm.

During FY 2017 and early FY 2018, Tank Farm engineering controls (i.e., exhaust stack extensions, Strobic Air Dispersion System, and ventilation exhausters) were in various stages of evaluation, design, and/or construction. The 242-A Evaporator stack extension was completed in June 2017, the AP Farm stack extension was recently completed, and the AW Farm stack extension is in engineering design.

During this same period, the Strobic Air Dispersion System, a commercially available stack air dilution system that drives ambient fresh air into exhaust vapors as an alternative to increasing stack heights, has been under evaluation, design, and early stages of procurement. In FY 2017, WRPS completed the feasibility study on the Strobic Air Dispersion System, a procurement specification and statement of work were finalized in July 2017, and WRPS’s current plan is to complete factory and offsite testing in FY 2018.

According to Section 3.3.2.3 of the draft CVAP, upgrading and installing new exhausters is the primary and fundamental engineering control for vapor emissions. Exhausters, which control the build-up of gases within the tanks by continuously removing headspace gases and keeping the tanks under a slight negative pressure, are also being designed and installed. WRPS recently installed and operated two exhausters with taller stacks in the AX farm for future waste retrievals. Two more exhausters with stack extensions have been designed for the A farm and are planned to be installed in FY 2018.

During FY 2017, and as a result of the 2016 SRNL Vapor Control Technology workshop, as discussed in Section B.7 of the 2017 EA Follow-up Report, the NUCON thermal oxidation system was recommended by SRNL for further consideration. This vapor abatement system, which is not commercially available, destroys/reduces tank vapor emissions in an internal combustion engine with the exhaust being processed through a catalytic converter to complete the destruction/reduction of tank vapors. A prototype of the NUCON system was completed in May 2017 and is now on site for testing. Bench-scale testing of the

NUCON system with a mersorb column is scheduled to begin in FY 2018, and a technology demonstration in the Tank Farms is tentatively scheduled for FY 2021.

Overall, WRPS has made noteworthy progress in addressing this EA recommendation during the past year in two respects. First, WRPS, through the draft CVAP, has provided a clear and understandable description of the goals and objectives of engineering and abatement controls for the Tank Farms, which did not exist during the previous EA assessment in 2016. For example, of the eight draft KPPs, KPP-4 is focused on “improving work sites through engineered controls and abatement technologies,” and Section 3.3 of the draft CVAP provides a clear, logical, and concise description of the path forward for developing and implementing engineering controls and abatement technologies for FY 2017, FY 2018, and beyond. In addition, the draft HVISM also emphasizes engineering controls (e.g., increasing stack heights) as a key element of the WRPS risk-based control strategy, and appropriately reiterates the focus on engineering controls and abatement technologies consistent with the CVAP. Second, WRPS has made observable progress in the evaluation, design, and implementation of new engineering controls and abatement technologies, as described in the previous paragraphs. During the past year, ORP has also encouraged expediting the design, development, and installation of engineering and abatement controls through performance-based incentives(s). For example, of the seven PBIs associated with “Comprehensive Vapor Action Management” in the *Fiscal Year 2018 Performance Evaluation Measurement Plan*, three PBIs were associated with engineering or abatement controls (i.e., NUCON Vapor Abatement Unit, Strobic Air Dispersion System, and AW stack extension). The emphasis on the design and implementation of engineering controls is also reflected in the current WRPS FES, which has an extensive section devoted to “Tank Farm Engineering Controls Implementation.” Collectively, all of these actions have resulted in considerable improvements on the focus of engineering controls when compared to the previous EA assessment.

With respect to the importance of the participation and involvement of IH and other key professionals in the selection and evaluation of engineering and abatement controls, as stated in this EA recommendation, EA has also observed that the CVAP Integrated Project Team and the CVST New Technologies Subcommittee have provided an effective means for involving workers; environment, safety, and health professionals (e.g., industrial hygienists); and other key professionals in these activities.

5.1.5 2017 EA Recommendation: RL, ORP, Penser, HPMC, WRPS, and other Hanford Site contractors should work together to expeditiously address the obstruction in the flow of injury/illness information. WRPS (and presumably other Hanford Site contractors) need timely and accurate injury/illness information to conduct effective case management to determine recordability/reportability under the Occupational Safety and Health Administration (OSHA) and DOE injury reporting processes and, most important, to provide the appropriate services to the workers. Consider the following actions:

a. Improve communication and trust between the RL WC manager and WRPS (and other contractors’) WC representatives.

The 2017 EA Follow-up Report identified problems regarding TVAT issues in the flow of information to contractors for workers’ compensation (WC)/OSHA recordability issues. This concern was also expressed in an assessment by NIOSH and the second annual report of the VMEP. Without access to appropriate information, prime contractors could not fulfill their legal requirement of maintaining an accurate OSHA 300 log. The assessments discussed above also noted dissatisfaction among the workforce for WC service.

RL took several actions to address the issues. RL acted on a recommendation by NIOSH to make the State Ombudsman for WC available to the workforce. The office of the Ombudsman for WC made

presentations to the Tank Farms workforce to enhance awareness of the WC processes and mechanisms of redress through the Washington State Department of Labor and Industries paradigm. The NIOSH recommendation further indicated that their review found issues of concern within RL's administration of WC. In response to these recommendations, RL has focused on process improvements that have resulted in better customer orientation and openness of information flow within WC administration.

Another action taken by RL was a renewed effort to create an environment of helpfulness/service to facilitate necessary information flow to contractors and customer service to employees. RL initiated a series of meetings between the WC administrator, HPMC, and the third-party administrator (TPA) Penser to address information flow improvements. Representatives from HPMC and Penser indicated that they viewed these meetings positively. The WC administrator is planning to establish an office at the TPA's place of business to better facilitate employee navigation through the WC arena and to ensure quality control over the process. The process changes are in their infancy and have not yet been validated for effectiveness.

HPMC has initiated regular meetings between the RL WC administrator, prime contractors, and the HPMC Medical Director to address mutual concerns of recordability/WC issues. The initial meeting occurred on November 7, 2017. This step of improving communication and information transfer potentially facilitates the fulfillment of OSHA requirements. Such meetings had not occurred in the past. Ensuring information relating to treatment categories (e.g., use of prescription medication, splints intended to immobilize), as well as changes to treatment categories, that originate from community providers and impact OSHA 300 requirements is an important function of an occupational medicine program. HPMC's intent to continue these meetings demonstrates a positive attitude for improvement to the process.

WRPS is in the process of writing procedures that are intended to institutionalize the transfer of the Self Insure Accident form (SIF2) to HPMC. This WC form contains the employee's consent to the release of information to those with a need to know relating only to the pertinent WC case information. It also allows for obtaining necessary information for WRPS from Penser, as well as pertinent information held by treating external physicians. This form is designed to allow for procuring accurate and timely information for completing OSHA 300 requirements. In addition, WRPS is participating in the recently created meeting of prime contractors, HPMC, and RL (WC administrator) to address recordability/WC issues. WRPS improvement for accurate OSHA record keeping is dependent on actions from RL and HPMC, as is employee satisfaction of delivery of WC benefits. The plan to implement procedures that facilitate uniform transfer of the SIF2 form from WRPS to HPMC indicates the intent to capitalize on the new and improved environment of information flow.

Although promising, these improvements have not yet been institutionalized to ensure continuity of the improvements. For example, RL has not formally initiated changes via contract change or letters of record with the TPA, as appropriate. The development of objective means to demonstrate effectiveness of information flow to contractors and employee recipients of WC benefits would be helpful to RL senior management. HPMC is not yet fulfilling its role as a facilitator between contractors and the outside medical community to obtain and transfer pertinent medical information that allows for accurate and timely OSHA recordability.

b. Benchmark policies affecting contractors' access to pertinent information for case management and to categorize recordability/reportability issues against other DOE sites with multiple prime contractors. Ensure that the ORP and/or RL legal department is involved in policy improvements.

As discussed in 5.1.5.a above, RL is still in the early stages of institutionalizing new approaches to the WC processes. RL has not yet performed any benchmarking, and interviews with RL indicated that after

the new processes are more mature, benchmarking with other sites may not be needed. Current RL policy dictates that improvements involving contract changes or between RL and other contractors would require legal department review.

c. Further develop medical and exposure surveillance programs by collecting and maintaining a database of information for all worker health and safety including exposure levels, locations of exposures, and worker reactions to exposures. This information could then be utilized for future epidemiological studies to assist in determining adverse health outcomes to workers exposed to chemical vapors at levels found at the tank farms.

HPMC continues to collect data and monitor the (short-term) health of Tank Farm workers via the medical surveillance program. HPMC's annual medical surveillance report compares Tank Farm workers to a standard (non-exposed) population, by screening short-term changes in Tank Farm workers' organs of detoxification. In addition, a longer study is being compiled of Tank Farm worker lab data from 2012 to 2016, comparing Tank Farm workers to a standard population. This longer study is scheduled to be completed in 2018. A replacement electronic medical record, which will aid in data collection, is being evaluated and scheduled to be implemented in 2018.

All of the mechanisms discussed in this section (5.1.5) better allow for a long-term study of Tank Farm workers' health status, if such a study is commissioned. The study design and parameters would be under the purview of those commissioned to carry out such a study. It should be noted that such a study would likely reside with a larger entity than WRPS or RL.

5.1.6 2017 EA Recommendation: The DOE Office of Environment, Health, Safety and Security should consider including the Tank Farm worker designation in its health studies to determine worker health effects from exposure to hazardous materials associated with DOE operations and in its medical surveillance and screening programs for current and former workers.

The Office of Worker Screening and Compensation Program has added the query "Are you a former tank farm worker?" to their Former Worker medical screening program. The answer to that question populates a data field that can be used to flag Tank Farm workers should a future study be commissioned to determine whether Tank Farm workers demonstrate a commonality of (any) manifest pathology as a consequence of their work. If a nested cluster of pathology becomes manifest in the future, a nexus to Tank Farm workers could be evaluated. The possible linking of outcome (end organ damage) to exposure may be made by querying the Site Wide Industrial Hygiene Data System for exposure data. The Department of Labor also has Site Exposure Matrices for DOE sites, which lists buildings and associated chemicals that may prove helpful in determining whether pathology was related to an exposure external to Tank Farm work. Even though there is not a single repository of the data, the collection of data in these sundry sources allows for future studies to be instituted.

5.1.7 2017 EA Recommendation: HPMC should reassess communication protocols to ensure that workers fully understand the medical evaluation activities when workers report symptoms from vapor exposures.

a. Describe the purpose of the tests being performed.

b. Describe the limitations of the tests and procedures for determining potential long-term effects.

EA validated that HPMC provides one-on-one feedback to employees on whom blood draws are performed. During these sessions, the meaning and purpose of the tests are explained as well as the limitations of those tests. Whether samples are drawn for a defined medical surveillance or as part of an

acute vapor event, individual counseling is given with time allowed for addressing questions and concerns, including any questions relative to potential long-term effects from any exposures.

c. Better utilize the dedicated risk communicator to have regular, scheduled interactions with the workforce regarding vapor-related activities.

In 2016, HPMC instituted risk communicator presentations at the CVST as a regular agenda item, thereby providing regular, scheduled interactions with the workforce. The risk communicator is also made available to any work group involved in a vapor event to ensure that questions and concerns can be addressed. It is incumbent on prime contractors to make requests for these resources, and because there have been few vapor events since all work inside Tank Farms has been in SCBA, there have been few requested work group sessions. HPMC has not yet determined the effectiveness of the new risk communicator processes for communication to site employees and has not yet instituted an assessment plan or process to ensure continued improvement in this area.

5.1.8 2017 EA Recommendation: HPMC should reassess the laboratory test panel for acute exposures and annual monitoring of Tank Farm workers. Consider the following actions:

a. Draw samples acutely and 24-48 hours post-event to allow for post-event comparison.

HPMC has instituted the recommended changes concerning the timing of obtaining blood samples post vapor event. HPMC also provides face-to-face interactions with individuals when all pertinent lab work is returned to the clinic. Institutionalization of the process has occurred by written protocol.

b. Eliminate tests that replicate parameters in other laboratory tests.

HPMC has in place a policy of annually reviewing the contents of medical surveillance examinations. Part of this process includes a review of protocols to ensure the appropriate protocols are in place. EA reviewed actions taken in the most recent annual review; HPMC appropriately identified no tests that needed to be removed. HPMC noted one test to be of little value in the acute evaluation but determined that the test needed to be maintained to satisfy other commitments.

c. Implement a heavy metal screening if such elements may be present in an exposure from certain activities (e.g., filter changeout).

HPMC, in coordination with WRPS IH, evaluated the implementation of a heavy metal screen. The only heavy metal of concern for the Tank Farms is mercury, for which an appropriate lab test is part of the post-exposure protocol. Therefore, HPMC has in place the appropriate lab work to be drawn to screen for exposure to that element. Protocols exist for the lab results to be obtained for the annual surveillance of Tank Farm workers, as well as AOP-015 events.

d. Routinely reassess the content of exposure laboratory evaluation, recognizing that medical evaluation is an evolving process.

As part of the policy of annually reviewing the contents of medical surveillance examinations as discussed in 5.1.8.b above, the review also covers the yearly reassessment of the laboratory panel for each surveillance, including Tank Farm workers. EA validated that the most recent yearly reassessment of the laboratory panel appropriately determined that no changes were needed in the laboratory panels.

Overall, the newly instituted changes, as well as already implemented processes, provide acceptable mechanisms for appropriate monitoring of Tank Farm workers.

Appendix A Supplemental Information

Dates of Assessment

Onsite Assessment: September 25-28 2017, October 30 – November 2, 2017, and November 13-16, 2017

Office of Enterprise Assessments (EA) Management

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Appendix B

Additional Observations related to TVAT Overarching Recommendations

In addition to assessing the status of actions specifically related to previous EA recommendations, EA performed a limited assessment of the status of the TVAT overarching recommendations as reported in Appendix B of the 2017 EA Follow-up Report. The status and evaluation of the topics discussed in Appendix B of the 2017 EA Follow-up Report directly related to previous EA recommendations have already been discussed in Section 5.1 of this report. However, the following paragraphs provide additional EA observations related to topics from Appendix B of the 2017 EA Follow-up Report which are not directly related to responses to the previous EA recommendations.

B.1 Headspace Sampling

EA's overall evaluation of WRPS progress with respect to headspace sampling during the past year is summarized in EA recommendation 5.1.3.a. However, in addition to this EA recommendation, EA previously identified seven potential limitations with respect to headspace sampling in Section B.3 of the 2017 EA Follow-up Report. Four of these limitations have been or are being addressed since the previous EA assessment, although, in some cases, WRPS acknowledges that more work remains. The four limitations are:

- The limitation noted by EA, regarding the bias for sampling SSTs with a limited volume of waste as not being reflective of other SSTs, has been addressed in the draft revision to the IH Chemical Vapor Technical Basis (RPP-22491) with respect to general observations of the headspace gases in SSTs.
- During the 2016 EA assessment, waste-disturbing activities were on hold as a result of stop-work actions and ongoing litigation. As a result, all of the seven tanks sampled in FY 2016 were in a static quiescent state. Therefore, the impact of waste transfers and waste mixing on headspace vapors, a concern expressed by the TVAT, was not well understood. Although based on a limited number of waste-disturbing activities, Section 3.5 of the revised draft of the IH Chemical Vapor Technical Basis on *Effects of Waste Disturbing Activities* now adequately addresses this concern.
- EA previously reported on the six-week backlog of headspace samples awaiting processing in the 222-S lab. During recent interviews, managers of the 222-S lab indicated that changes in laboratory processes and procedures, as well as improved interface with field sampling personnel, have been effective in reducing sample analysis turn-around times.
- During the previous EA assessment, intrusive headspace sampling was limited to those tanks for which there were ongoing, concurrent Tank Farm operations. With the use of alternative and less intrusive methods to headspace sampling, such as stack sampling via the PTR-MS mobile van, and the use of the respirator cartridge testing station, these operational constraints have lessened.

Although progress has been achieved in addressing the previous limitations noted by EA on headspace sampling, three limitations, as paraphrased in the following bullets, have yet to be fully addressed:

- As noted in Section B.3 of the 2017 EA Follow-up Report, although various means for headspace sampling have been employed since FY 1997, of the 177 tanks in the Tank Farms, only seven tanks have been sampled for conformance to the headspace sampling requirements defined in TFC-PLN-163. For headspace data obtained from sampling methods that do not fully conform to TFC-PLN-163, the validity or limitations in using such data to characterize the chemical constituents of a tank's headspace are not well defined. For example, headspace sampling data has been derived from a variety of data sources over the years, including the Hanford Tank Waste Information Network System headspace characterization (TWINS-HS database), the TWINS IH system (TWINS-IH database), and the Site Wide Industrial Hygiene Database. Data in these three databases varies considerably with respect to sample collection and analysis methodology, quality assurance controls, and how the data is presented in the databases. In 2017, PNNL reviewed the three databases in

preparing the *Hanford Tank Vapor FY 2017 Chemicals of Particular Concern Update* (PNNL-26820 Rev. A). From this review, numerous data set errors were identified in each of the databases, resulting in changes to risk-based screening ratios in 21 of the 59 COPCs. As a result, WRPS cannot confirm that the current COPC list is founded on sufficient and reliable headspace sampling data. PNNL is continuing to review the historical headspace sampling data in an effort to resolve this concern and to recommend a future headspace sampling strategy to WRPS. This concern is being addressed, but more work remains.

- During the 2016 EA assessment, there were no plans for sampling additional tank headspaces before the end of IP Phase 1, and some of the previously planned headspace sampling campaigns had been deferred to Phase 2, for which there was no plan. The plans for future headspace sampling (intrusive and/or non-intrusive) are awaiting the outcome of comparison headspace sampling techniques being tested at tank BY-108 in FY2018. The current draft CVAP and Draft HVISM do not address headspace sampling (see further discussion in Section 5.1.3.a.). WRPS has not assigned a date for completion of this action, since the institutionalization of head space sampling and other CVAP related scope is in FY19, and WRPS does not have contract guidance/direction for FY19 and beyond.
- Potential reactive chemicals (e.g., ozone) have been postulated through chemical analysis to be in the tank headspace. WRPS has not concluded whether or not such chemicals could be present in sufficient quantities to impact worker safety, or whether there is sufficient need to sample them in the headspace.

B.2 Chemicals of Potential Concern

EA's overall evaluation of WRPS progress with respect to COPCs during the past year is summarized in EA recommendation 5.1.3.b of this report. However, in addition to this EA recommendation, EA previously identified six potential concerns regarding COPCs in Section B.3 of the 2017 EA Follow-up Report. Three of these concerns have been addressed since the previous EA assessment, although, in some cases, WRPS acknowledges that more work remains. The three concerns that have been addressed are:

- With respect to potential worker exposures to chemical carcinogens in the tanks not being addressed, in 2017, IH drafted a revision to the WRPS *Carcinogen Control* Procedure TFC-ESHQ-IH-STD-11 to inform workers that some COPCs have been identified as carcinogens and to provide references to those WRPS procedures that identify and manage COPCs that are carcinogens.
- With respect to the lack of a technical basis for the 11 additional chemicals that had been added to the COPC list since the publishing of the 2006 IH Chemical Vapor Technical Basis, since the previous EA assessment, PNNL has developed and implemented the HPP Project to periodically review and update the COPC list as described in 5.1.3.b.
- With respect to the previous EA concern that a number of the COPC OELs had changed since the issuance of the initial IH Chemical Vapor Technical Basis in 2006, in September 2017, PNNL issued PNNL-26777, *Proposed HTP OELs for Chronic Exposures – COPCs with Regulatory Guidelines*. In September 2017, PNNL issued PNNL-26850, *Proposed Acute Exposure Concentration Limits for COPCs with Regulatory Guidelines*.

The remaining three EA concerns from the 2017 EA Follow-up Report have not been addressed and/or are not fully resolved. These three concerns include:

- Synergistic effects on worker exposures (i.e., the effect of exposure to multiple chemicals that is potentially greater than the sum of their individual effects) have not been addressed, although PNNL is currently investigating this concern.
- Skin effects of chemicals are not addressed in the technical basis.
- WRPS has not updated the technical basis for the continued use of a two parts per million alarm limit for volatile organic compounds, nor has WRPS documented how this alarm limit is reflective of the

mix of known or postulated COPCs in the Tank Farms. WRPS indicates that current PNNL work with respect to developing leading indicators, when completed, may provide a resolution to this concern.

B.3 Vapor Monitoring and Detection System (VMDS)

In FY 2015, WRPS initiated the Vapor Monitoring, Detection and Remediation (VMD&R) project to develop measures to enhance Tank Farm worker protection. A key objective of the VMD&R project was the development of a VMDS to include a suite of chemical vapor and meteorological sensors, sampling technologies, and data management and evaluation software. The VMDS was implemented in two phases. Phase 1 consisted of bench-scale testing of commercially available VMDS components in a field setting at the PNNL test facility and initial testing within selected Tank Farms. Phase 2 continued pilot-testing of VMDS components within the AP (double shell tank) and A (SST) Tank Farms. Section B.6 of the 2017 EA Follow-up Report reviewed the progress of ongoing Phase 1 actions. WRPS is currently documenting VMDS progress since the 2016 EA assessment in the WRPS draft report RPP-RPT-60386, *Vapor Monitoring and Detection System Pilot-Scale Test Phase 2 Report*.

During this assessment, EA observed the operation of the VMDS control station and discussed the status of VMDS installation and testing with the VMDS staff. In general, progress continues with the development and implementation of the VMDS. However, there has been mixed success in chemical sensor testing in the field, with 4 of the 12 VMDS components being judged as not viable or only partially viable according to the draft Phase 2 VMDS report. These testing results, combined with the emerging viability and importance of the QRA dispersion modeling process in predicting potential vapor sites, have resulted in a change of direction for the VMDS from the installation of an extensive array of permanently mounted chemical sensors in the field to a greater reliance on stack-mounted chemical monitoring sensors and portable skids of chemical sensors in the field that are placed at locations selected using the results of the QRA modeling. Based on the limitations of some of the installed chemical sensors to communicate with the central control station, this revised approach may be more effective in identifying and quantifying tank waste vapors. However, the change in approach has not been well communicated with the workforce.

B.4 Respirator Cartridge Testing

With respect to the development of new respirator cartridge testing technologies, EA observed, during both the prior EA follow-up assessment and the current EA assessment, continued progress in developing and testing respirator cartridges with tank headspace vapors. ORP also continues to incentivize respirator cartridge testing with a FY 2018 PBI to complete six cartridge tests by September 30, 2018. Since the 2016 EA assessment, some of the milestones achieved in respirator cartridge testing include:

- Greater involvement of PNNL technical staff in the analysis of 222-S laboratory respirator cartridge testing results.
- Construction of a second respirator cartridge testing station, which has been operated in parallel with the original station, thereby increasing the volume of testing and introducing new capabilities to test cartridges from other manufacturers, as well as testing powered air purifying respirator cartridges.
- Involvement of a third-party reviewer (Stonetrun Consultants) to provide periodic reviews of the respirator cartridge testing program.
- Completion of additional respirator cartridge testing at the AX, AW, and AN stacks and the breather filters associated with two SST tanks within the SX farm. In January 2017, the 702 AZ stack was also sampled during a waste-disturbing event.

The 2017 EA Follow-up Report identified seven potential limitations with the respirator cartridge testing system. Progress has been made in informally addressing aspects of each of these potential limitations during the past year; however, WRPS has not yet performed the additional cartridge testing and analysis needed to fully assess the impact of these limitations. In addition, several of the limitations previously identified by EA (e.g., impact of variability in humidity and temperature on cartridge test results), as well as new concerns and potential limitations, have also been identified by Stoneturn Consultants.

B.5 Atmospheric Dispersion Modeling

Previously, EA reported in Section B.7 of the 2017 EA Follow-up Report that WRPS engineering had completed a report on atmospheric dispersion modeling of the 200 East Area Tank Farm ventilated stacks and structures to determine their potential for contribution to vapor exposure/odor events, and the prospects for using dispersion modeling for evaluating the effectiveness of engineering controls, such as increasing stack heights, and for identifying likely locations for sampling equipment placement. Since the 2016 EA assessment, WRPS engineering has achieved significant progress with respect to atmospheric dispersion modeling through the APGEMS. More recently, WRPS contracted Kenexis to conduct an assessment of the risk of chemical vapor exposure to workers and to provide technical guidance related to vapor chemical sensor placement in the Tank Farms. The Kenexis process examines the risk of exposure to chemical vapors from emissions within a Tank Farm. Preliminary results from the application of the QRA process at three Hanford Tank Farms identified a potential increase in the probability for workers to be exposed to contaminants above the OELs inside and outside of the Tank Farm boundaries, under certain meteorological conditions, for some hazardous tank chemical vapors. The QRA process has considerable potential value in the design of engineering controls, placement of chemical sensors, and identification of those meteorological or environmental conditions that could result in acute worker exposures to tank vapors. However, the potential worker exposure results of the QRA application in three Tank Farms (AP, AW, and A) have yet to be communicated to the workforce.

B.6 Fugitive Emissions

As indicated in Section B.7 of the 2017 EA Follow-up Report, EA identified a concern that WRPS efforts in identifying, monitoring, and controlling fugitive vapor emissions (i.e., vapor sources other than known waste tank release points, such as stacks and breather filters) focused only on fugitive emission sources associated with Tank Farm waste tanks (i.e., valve pits, waste tank piping connections). The TVAT report and Section B.7 of the 2017 EA Follow-up Report also cited the need to investigate fugitive vapor emissions from non-waste tank vapor sources, such as those emanating from underground waste cribs, sewers, ground water monitoring wells, paint shops, and the spraying of herbicides. The TVAT report stated that such non-waste tank vapor sources could be contributing to Tank Farm odors and worker exposures to vapors. At the time of the EA assessment in 2016, WRPS had no formalized plan to identify, characterize, or monitor non-waste tank fugitive emissions. However, at the time of the 2016 EA assessment, capabilities to monitor for such sources were being prototyped in the PTR-MS mobile van.

During FY 2017 and early FY 2018, the PTR-MS mobile van has been routinely employed to sample ventilation stack and breather filter emissions, as well as on occasion to investigate non-waste fugitive emission sources, such as sewers and oil tanks. In addition, installed chemical sensors in both the AP and A Tank Farms have been used on occasion to validate that odors reported from AOP-15 events outside the Tank Farms were not from tank waste sources. For example, WRPS and WRPS construction subcontractors initiated an AOP-15 event on June 13, 2017, at the intersection of 4th and Buffalo Avenue during a period where there was no waste-disturbing or tank intrusive activities occurring. WRPS later reported “rotten egg like/sulfur” odors were attributed to the pumping of sanitary tanks (fugitive

emissions), and both the use of installed chemical sensors and the PTR-MS mobile van were employed to aid in the investigation.

Although a comprehensive mapping of non-waste tank fugitive emission sources and a strategy for characterizing and monitoring these sources, as envisioned by TVAT, have yet to be formalized, in October 2017, the CVST formed a Source Apportionment and Fugitive Emissions Identification and Investigation Team (SAFEIIT) as a new CVST subcommittee. The mission of the SAFEIIT is to “develop a prioritized phased-approach for areas to investigate to identify fugitive emissions and COPCs,” and to “develop a site map indicating known or potential vapor emission sources to inform the control room when determining the appropriate response to reported odor events in and around the tank farm.” Although the charter for this subcommittee is in draft form, the varied composition of the team, including IH, workers, operations engineering, and technical representatives, and stated mission goals adequately address earlier fugitive emission concerns identified by TVAT and expressed by EA in the 2017 EA Follow-up Report.

B.7 IH Program Parity with the Radiological Control Program

As discussed in Section 5.1.2.b, WRPS has made progress in IH improvements relative to other programs. For example, WRPS has partnered with the Volpentest Hazardous Materials Management and Emergency Response Federal Training Center to conduct a pilot course on IH fundamentals. This initiative is a positive development by union representatives and WRPS management worthy of recognition.

However, cultural parity with the radiological control program has not yet fully matured. EA focus group participants indicated that some IHTs and supervisors cannot effectively respond to workers’ questions and concerns about vapors. Focus group participants did consistently acknowledge positive improvement in IHT acceptance by work teams. Participants believe more time is needed for new IHTs to be fully accepted.

Additionally, WRPS currently has no plans to continue risk communication training beyond the initial training conducted in FY 2016. New managers, industrial hygienists, and supervisors have been hired since the original training was provided. These personnel are in positions involving interaction with Tank Farm workers to answer questions pertaining to odors and possible vapor exposures. Management has not determined whether risk communication training will be required for these new personnel.

B.8 Interaction with Community Physicians

Although RL and contractors working with the medical case evaluation process and reporting procedures have made substantial improvements, as described in Section 5.1.5 above, the present process of passing IH information to community physicians is still problematic. The data is often part of the information used to determine the work relatedness of a WC claim. A claim relating to an AOP-015 event results in the IH event data being passed to community medical provider(s)/subspecialist(s) via the following mechanism: the WRPS WC administrator sends the AOP-015 documentation to the RL WC administrator, who sends it to Penser; and the AOP-015 event, with the associated IH data, is then forwarded to the community physician(s). No explanation of the data accompanies the event description.

AOP-015 documentation is lengthy and difficult to understand for someone not familiar with the Tank Farm or IH sampling processes. Timing from exposure to sampling activities is not readily apparent and may lead to a conclusion that a credible exposure did not occur. The unfiltered AOP-015 event documentation is being presented to treating physicians without a cover letter to aid outside medical consultants in navigating to pertinent areas, such as the timeline (from event to sampling), the IH data

itself (with caveats as to the interpretation of such data), any mitigating (e.g., environmental or physical) parameters, or additional information that would be helpful to a clinician that HPMC deems important.

B.9 IH Program Staffing

Overall, WRPS has made substantial improvements in IH program staffing since the last EA assessment. WRPS has maintained and, in some cases, increased its IH staff to meet Tank Farm needs. Although 4 industrial hygienists and 6 IHTs left in FY 2017, the IH program was able to hire one IH program manager, 11 industrial hygienists, and 35 more IHTs. WRPS also hired a vapor integration manager to oversee implementation of the CVAP.

B.10 Other Communications Problems Mentioned in Focus Groups

During the focus groups, some participants raised issues not directly related to WRPS actions in response to the EA recommendations. Multiple focus group participants raised each of the following issues:

- Important vapors information is not consistently transmitted between companies, and/or does not get passed along to the workers.
- Some bargaining unit workers aren't given sufficient time and access to computers to review vapors information.
- Opportunities for two-way communications between Tank Farm workers and managers are insufficient. Managers seldom visit the worksites.
- Some IHTs and supervisors cannot effectively respond to workers' questions and concerns about vapors.
- Some workers have a poor understanding of the IH monitoring strategy, results, and the term "similar exposure groups."
- Vapor release evacuation protocols/training are inadequate for certain scenarios. One scenario involved workers being told to go through a vapor cloud to evacuate, rather than being sent to an alternate escape route that would have kept them in clean air. Another scenario involved workers being told to wait until everyone had assembled, so that the whole crew could evacuate together. This decision meant that some of the workers had to continue breathing a strong unusual odor for 20 minutes before they were told they should leave.

Recent WRPS surveys have already identified most of the concerns listed above. These issues have potentially important implications for future efforts to improve vapor release evacuations planning and training, tank farm workers' understanding of various vapor exposure issues, and workers' level of trust in management. WRPS may want to consider further exploring/validating these concerns in their future surveys and focus group discussions.

B.11 ORP Oversight

ORP continues to provide effective oversight through vapor management oversight plans, formal assessments/surveillances, and routine ORP Facility Representative oversight. Assessments completed in FY 2017 covered respiratory protection, pilot-scale test for new vapor detection technologies, and vapor control zone/vapor reduction posting. FY 2017 fee-bearing milestones were appropriately focused primarily on engineering and technological improvements, such as stack monitoring and respirator cartridge testing. Special emphasis areas focused on IH program improvements, completion of the IH Manual, and effective communications. With the exception of no milestone for developing a headspace sampling strategy, the FY 2018 fee-bearing milestones and emphasis areas are similarly appropriately structured and focus on engineering controls, technological improvements, cartridge testing, and improvement and institutionalization of the IH program.

Appendix C
Focus Group Participants' Ratings of Tank Vapor Issues

Both last year's and this year's focus groups were specifically targeted to include all subgroups of the workforce most likely to work directly within and/or near the Tank Farms. EA's sample is not meant to be representative of all WRPS employees.

A total of 100 employees participated in focus groups conducted between October 30 and November 13, 2017. EA invited approximately 10 individuals to attend each focus group. These individuals were randomly selected from lists of all people currently working in each identified subgroup, e.g., nuclear chemical operators, building trades, Tank Farm shift office, IHTs, etc. As part of the focus group sessions, participants were asked to read 28 statements and to rate the extent to which they agreed or disagreed with them. Statements pertained to: (1) worker training, (2) worker involvement, (3) employee briefings, and (4) other issues, including communications and trust in management. Response options ranged from 1 (strongly agree) to 6 (strongly disagree). In addition to these six options, EA included an option labelled "Don't Know or Not Applicable." Participants were asked to use this option if "you don't know how to answer because you don't have sufficient knowledge or experience with the issue, or it does not apply to you."

The mean values of their rating scale responses to each statement were calculated, as well as the corresponding mean values of rating scale responses obtained 15 months earlier (August 2016) from 119 focus group participants. EA compared the responses from last year's and this year's focus groups to look for changes. Table 1 shows the mean value of the ratings for each statement in 2016 and 2017, and the difference between these two values. Because response scale options ranged from 1 (Strongly agree) to 6 (Strongly disagree), the higher the mean value, the greater the disagreement with the statement. Thus, decreases in the mean values between 2016 and 2017 always reflect positive change. Independent samples t tests of the difference between the mean values for 2016 and 2017 were performed. This test is used to determine whether the difference in the average values of the two groups is large enough to be considered statistically significant. The mean value of 2016 focus group members' ratings of each statement is higher than the corresponding mean value of 2017 focus group members' ratings on every question, and the difference is usually statistically significant. This data consistently shows improvement in responses to questions about tank vapor issues since the prior EA assessment conducted 15 months earlier.

Table 1. Differences between 2016 and 2017 Focus Group Participants' Ratings

WORKER TRAINING	Mean 2016	Mean 2017	Difference 2016 – 2017
1. I understand the precautions and actions I should take to avoid being harmed by chemical vapors	2.38	1.64	0.73**
2. I understand how the Shift Office Event Notification warning system works	2.83	1.95	0.88**
3. I know how to find information about tank vapors on the HanfordVapors.com website	No data	2.19	No data
4. I am encouraged to report odors that I do not recognize as "normal" in my work area	1.84	1.56	0.27*

WORKER INVOLVEMENT	Mean 2016	Mean 2017	Difference 2016 – 2017
5. Management desires and seeks out worker input about tank vapor issues	2.87	2.44	0.43*
6. Workers accept new procedures and practices that are put in place to protect them from hazardous vapors	2.59	2.40	0.19
7. Effective mechanisms exist for workers to provide on-going input about tank vapor issues	2.85	2.21	0.64**
8. Management responds appropriately to worker input about tank vapors	2.94	2.43	0.50*
9. Workers receive timely responses to their ideas and suggestions about reducing exposure to tank vapors	3.78	3.05	0.73**
10. If I had concerns about vapors, I would feel free to stop work	2.08	1.71	0.37*
11. I would not be subjected to retribution or retaliation from management for expressing concerns about vapors	No data	2.11	No data
12. I would not be subjected to retribution or retaliation from my co-workers for expressing concerns about vapors	No data	2.05	No data
12a. I would not be subjected to retribution or retaliation for expressing concerns about vapors	2.61	No data	No data

EMPLOYEE BRIEFINGS	Mean 2016	Mean 2017	Difference 2016 – 2017
13. The results of vapor incident investigations are clearly communicated to workers	3.61	2.66	0.96**
14. The individuals conducting the briefings are honest, frank and open	2.73	2.35	0.38*
15. The individuals conducting the briefings are easy to understand	2.83	2.29	0.54**
16. The individuals conducting the briefings are good listeners	2.74	2.34	0.31
17. The individuals conducting the briefings are sincerely concerned for workers' health and well-being	2.50	2.28	0.22
18. Briefings include sufficient opportunity for employees to ask questions and voice their concerns	2.31	2.02	0.29

OTHER	Mean 2016	Mean 2017	Difference 2016 – 2017
19. WRPS keeps me well informed about vapor releases	3.17	2.34	0.83**
20. WRPS keeps me well informed about what is currently being done to measure and control tank farm vapors	3.08	2.49	0.58**
21. WRPS keeps me well informed about the status of efforts to identify new technologies to measure and control tank farm vapors	3.20	2.51	0.69**
22. WRPS management openly acknowledges risks of tank vapor exposures	3.20	2.46	0.74**
23. WRPS management honestly acknowledges uncertainty when it exists	3.07	2.69	0.39
24. WRPS management is sincerely concerned about tank farm workers' health and safety	2.67	2.25	0.42*
25. My immediate supervisor actively encourages workers' input on identifying and resolving workplace safety issues	2.11	1.81	0.30
26. WRPS is headed in the right direction with respect to the steps being taken to reduce worker exposure to tank vapors	2.82	2.11	0.71**
27. Compared to a year ago, it is easier for me to express my ideas and thoughts about tank vapors	No data	2.19	No data
28. Compared to a year ago, I am better informed about tank vapor issues	No data	2.06	No data

*p < 0.05 (significant); ** p < 0.01 (highly significant)

The values in Table 1 are based on responses from 119 focus group participants in 2016 and 100 focus group participants in 2017. (Table 1 excludes responses from ORP employees.)

Response scale options ranged from 1 (Strongly agree) to 6 (Strongly disagree).

Questions 3, 11, 12, 27, and 28 are in addition to questions administered in 2016.