

United States Government

Department of Energy
Office of River Protection

memorandum

DATE: FEB 17 2017

REPLY TO
ATTN OF: SHD:RLU 17-SHD-0005

SUBJECT: MEMORANDUM TO FILE - VAPOR MANAGEMENT EXPERT PANEL REPORT,
NOVEMBER 2016

TO: Safety and Health Division Office File

The attached Vapor Management Expert Panel Member report addresses the observations and recommendations associated with the implementation of the Tank Vapor Assessment Team Report of October of 2014. The Vapor Management Expert Panel report spans the period of activities from February 2015 through September 2016.


Robert M. Irwin, Deputy Assistant Manager
Technical and Regulatory Support

Attachment

cc w/attach:
E.J. Millikin, North Wind Solutions, LLC

**Attachment
17-SHD-0005
(55 Pages Excluding Cover Sheet)**

**Vapor Management Expert Panel Member Report
February 2015 through September 2016
Implementation of the Tank Vapor Assessment Team's
Report Recommendations**

Keith A. Klein, Chairman
Vapor Management Expert Panel
Richland, Washington 99352
November 30, 2016

Mr. Robert G. Hastings, Assistant Manager
Office of Technical and Regulatory Support
United States Department of Energy
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

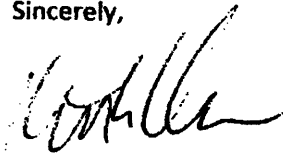
Dear Mr. Hastings;

On behalf of the Vapor Management Expert Panel, I am pleased to provide the attached first periodic report of the Panel for your consideration. Panel members have varying areas of expertise and experience, which include toxicology, occupational medicine, industrial hygiene, occupational safety, toxic gas ventilation and controls, management, regulatory processes, engineering, communications, and risk-informed decision-making. The Panel is not, however, a consensus group and does not provide consensus recommendations.

The Report is organized under the following six major headings: Technical Basis and Validation; Exposure Control; Health Effects Data, Studies, Results and Conclusions; Education and Communication Strategy; Institutionalization of Improvement Changes; and Cross-Cutting Areas and General Observations by Individual and/or Several Vapor Management Expert Panel Members on Improvement Opportunities. I or any of the other Panel members would be pleased to meet with you to discuss further the observations and suggestions presented in the Report.

On behalf of the Panel members, I would like to commend the professionalism and dedication of the federal and contractor staff with whom various of us have had contact, and to thank you for the opportunity to assist the Department of Energy in dealing with these important and challenging issues.

Sincerely,



Keith A Klein

**Vapor Management Expert Panel Member
Report
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Team's Report Recommendations**

Date Published
November 2016



**P.O. Box 450
Richland, Washington 99352**

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ACRONYMS AND ABBREVIATIONS

CVST	Chemical Vapors Solution Team
DOE	U.S. Department of Energy
EA	U.S. Department of Energy, Office of Enterprise Assessments
HAMMER	Hazardous Materials Management and Emergency Response
HAMTC	Hanford Atomic Metals Trade Council
HPMC	HPM Corporation
IH	industrial hygiene
IHT	industrial hygiene technician
NIOSH	National Institute for Occupational Safety and Health
OMS	Occupational Medical Services
ORP	U.S. Department of Energy, Office of River Protection
PNNL	Pacific Northwest National Laboratory
PPE	personal protective equipment
SCBA	self-containing breathing apparatus
TVAT	Tank Vapor Assessment Team
VMEP	Vapor Management Expert Panel
WRPS	Washington River Protection Solutions LLC

1.0 INTRODUCTION

The Vapor Management Expert Panel (VMEP) was chartered to:

...help provide assurance to the Department of Energy Office of River Protection (ORP) that actions committed to following the Tank Vapor Assessment Team's (TVAT) report and actions resulting from any new, emergent issues are being carried out and effective in protecting workers from potential vapor exposures.

The VMEP consists of members selected for their respective expertise in various areas needed to enable assessing progress in implementing the Tank Vapor Assessment Team (TVAT) recommendations and the effectiveness of actions in resolving vapor issues (SRNL-RP-2014-00791, *Hanford Tank Vapor Assessment Report*). Members are listed in Appendix A along with their respective areas of expertise and experience, which include toxicology, occupational medicine, industrial hygiene (IH), occupational safety, toxic gas ventilation and controls, management, regulatory processes, engineering, communications, and risk-informed decision-making. The VMEP is not a consensus group and does not provide consensus recommendations. The VMEP's work scope is established by the U.S. Department of Energy (DOE), Office of River Protection (ORP) on an "as-needed basis." Individual members have served as expert resources for various ORP staff on different issues. VMEP meets periodically with ORP and Washington River Protection Solutions LLC (WRPS) representatives individually, in subgroups, and occasionally all together to receive information, receive progress reports, and provide individual feedback. In addition, VMEP has regular conference calls with ORP representatives to stay current and plan and discuss assignments. To help ensure understanding of and continuity with the TVAT recommendations, two VMEP members were on the original TVAT. In addition, a Hanford Atomic Metals Trade Council (HAMTC) safety representative has been designated to be a resource for and observer of VMEP interactions.

WRPS describes their two-phase process for implementing the TVAT recommendations in their *Implementation Plan for Hanford Tank Vapor Assessment Report Recommendations* (WRPS 2015) as follows:

A primary focus of Phase 1 (FY 2015-2016) will be data collection to determine the validity of the hypothetical bolus exposure or identify other exposure mechanisms. Key program elements in Phase 1 include, but are not limited to, expanded sampling and characterization of tank head space gases; evaluation and procurement of new field and personnel monitoring equipment; evaluation and implementation of tailored personal protection equipment; and increased hiring and training of industrial hygiene staff. These actions will mitigate potential hazards on a tank farm-specific basis; enhance characterization of chemical constituents in the waste; improve sampling and detection technology; and increase real-time monitoring.

Depending on information gathered and analyzed in Phase 1, Phase 2 actions, costs and schedules (FY 2017-2019 and beyond) currently identified in the plan will be reviewed and, as needed, revised to reflect any updates to the technical basis, as well as the ongoing deployment of new technology and/or findings from

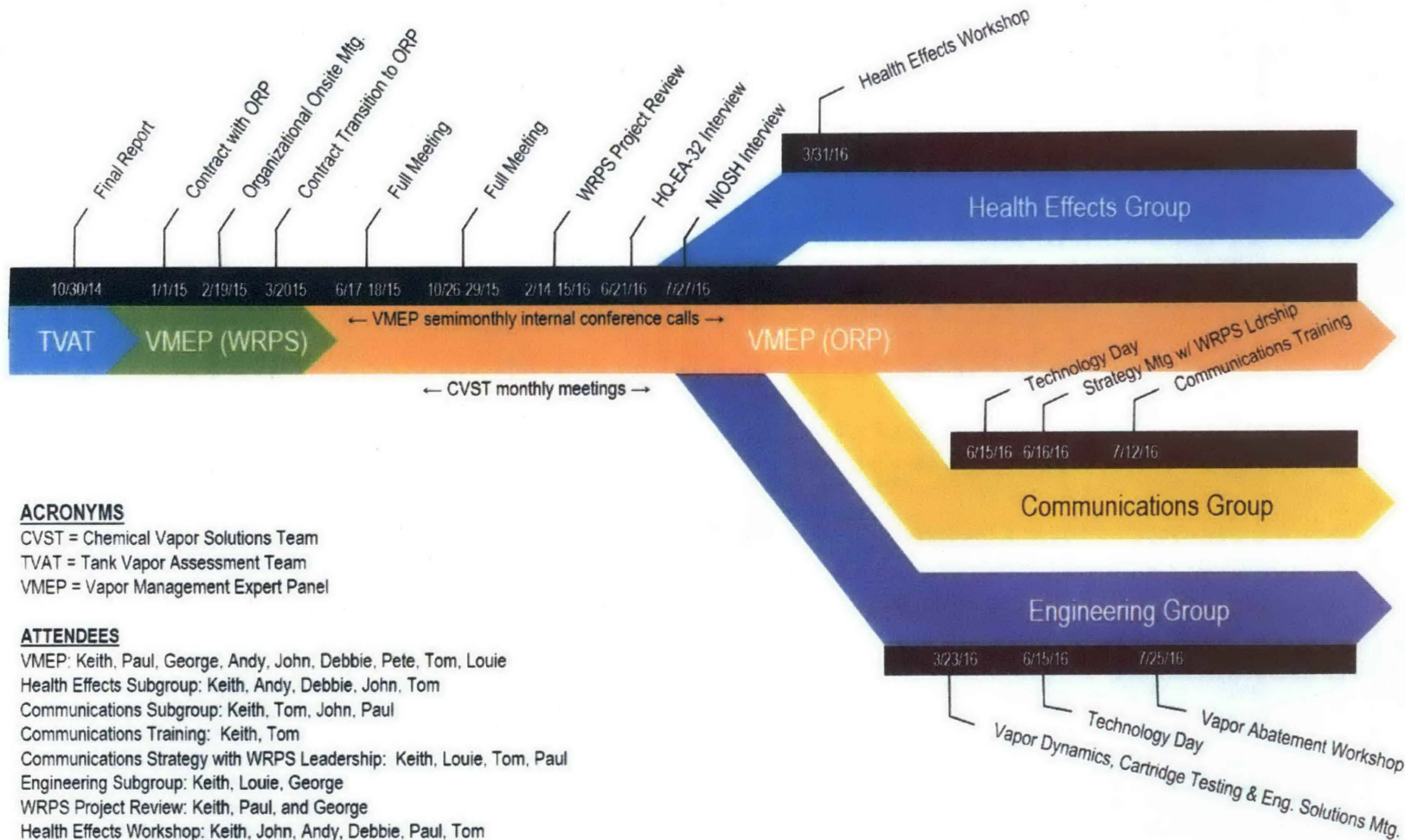
research and development activities. A second major part of Phase 2 is the institutionalization of an enhanced industrial hygiene program. This enhanced program includes attributes of a standard process for ongoing monitoring, continued sampling for changing conditions, and the incorporation of vapor management controls into new projects.

Phase 1 is nearing completion and will result in a report from WRPS to ORP. This is the first VMEP report, and is intended to help provide additional perspective prior to release and consideration of the WRPS report as well as an accounting of VMEP members' activities during this phase. During Phase 1, VMEP members primarily focused on supporting ORP requests for opinions from various members on different issues, possible plans, topics, or developments. Evaluating the effectiveness of various approaches WRPS has, or will have, taken to satisfy many of the TVAT recommendations (SRNL-RP-2014-00791) will not be possible until they are actually implemented in Phase 2. The filing of two lawsuits against DOE on vapor issues since the VMEP was formed has affected the VMEP members' activities and information flow due to the need for additional reviews and/or approvals concerning communications on matters subject to litigation as well as interactions with individuals and groups participating in the lawsuit.

VMEP members began their efforts in February 2015 with some members attending an orientation visit to Hanford. Presentations were made by ORP and WRPS. A tour of Hanford tank farms occurred as part of this orientation. Subsequently most all of the VMEP met twice at Hanford with representatives of WRPS and ORP (June and October 2015). As focus areas emerged within VMEP individual expertise areas and as ORP requested topic area insights, VMEP subgroups were formed in communications, health effects, and engineering. These subgroups have participated in a number of meetings and conference calls more directly with staff and in specific focus areas. Additionally, individual members met with Hanford Advisory Board representatives, union leadership, and representatives from various assessment teams. Individual members also attended various ORP or WRPS meetings and briefings as observers. At various times, different materials were provided to various VMEP members depending on their expertise, and observations or advice were provided in response depending upon the ORP request. The timeline shown on Figure 1 summarizes many of these activities, and Appendix B contains a more detailed description.

Since ORP has a defined comprehensive system to oversee and track the implementation of the TVAT recommendations (SRNL-RP-2014-00791), 47 in all, members of the VMEP did not endeavor to duplicate that system. Instead, the VMEP members were periodically briefed on the status of Phase 1 implementation, and on several occasions individual members offered comments on the timing and approaches WRPS has undertaken to implement Phase 1, which ultimately will lead to considered implementation of all the TVAT recommendations. In the areas being followed by individual VMEP members, it became clear ORP was diligently and objectively tracking progress. While all VMEP members agree good progress is being made in implementing Phase 1 and the TVAT recommendations, no attempt is made herein to report on, critique, or credit progress in any comprehensive or systematic manner. Instead, this report focuses on member observations where there have been particular challenges in implementing the recommendations, particularly in areas where ORP asked VMEP members to focus.

Figure 1. Vapor Management Expert Panel Key Activities.



ACRONYMS

CVST = Chemical Vapor Solutions Team
 TVAT = Tank Vapor Assessment Team
 VMEP = Vapor Management Expert Panel

ATTENDEES

VMEP: Keith, Paul, George, Andy, John, Debbie, Pete, Tom, Louie
 Health Effects Subgroup: Keith, Andy, Debbie, John, Tom
 Communications Subgroup: Keith, Tom, John, Paul
 Communications Training: Keith, Tom
 Communications Strategy with WRPS Leadership: Keith, Louie, Tom, Paul
 Engineering Subgroup: Keith, Louie, George
 WRPS Project Review: Keith, Paul, and George
 Health Effects Workshop: Keith, John, Andy, Debbie, Paul, Tom
 Technology Day: Keith, Louie, Tom, Paul, George
 Vapor Abatement Workshop: Keith, George
 Hanford Atomic Metals Trade Council Rep, Pete Graham, supports all VMEP activities as available

What follows is a compilation of salient observations and comments offered to ORP by various VMEP members over the course of this last year and a half. These observations are grouped in six areas as follows:

- Technical bases and validation
- Exposure control
- Health effects data, studies, results, and conclusions
- Education and communication strategy and implementation
- Institutionalization of improvement changes
- Cross-cutting areas and general observations on improvement opportunities.

As an overall, general comment, a number of VMEP members have commented on the existing challenges and difficulties aligning perspectives on the risks posed by the Hanford tank vapors among the various entities directly affected by or involved in understanding, articulating, and resolving the issues. Given the current emotion, controversy, legal challenges, and widely divergent views on these risks, and the commitment to worker safety professed by all, the current trend is toward increased conservatism. This approach translates into minimizing work in and around tank farms, and requiring workers to use self-contained breathing apparatus (SCBA) when in and around these areas regardless of whether waste disturbing activities are taking place or tanks are under active ventilation. Given all that is known and unknown regarding the risk of tank farm vapors, all unknowns or uncertainties will never be eliminated. Some VMEP members believe that Federal and state officials responsible for defining the tank farm cleanup scope, schedules, and priorities should begin reevaluating some aspects of the cleanup effort. Specifically, these officials should consider at what point does the increasing costs associated with the cleanup scope, schedules, and priorities, and the risk to workers (perceived or otherwise) outweigh the estimated longer-term benefits of a cleanup to the current extent prescribed and on the current timetable? The increased use of SCBA, while providing additional respiratory protection, introduces other risks for workers and significantly decreases productivity. A more comprehensive risk-informed approach is desirable at Hanford, which appropriately integrates all issues including risks to workers (actual and perceived), technical uncertainties, long- and short-term controls, and risks to the community and the environment. Beginning the process of developing a comprehensive risk-informed decision-making process or approach to frame and state even the current issues of costs, risks, and benefits would likely be useful since such an approach also serves to document uncertainties that are the barriers to sound decision-making. It is believed sufficient information already exists to better utilize more rigorous, risk-informed decision-making processes using worker input and incorporating that into larger cleanup decisions such as "how clean is clean enough," mandated schedule milestones, and resource allocation priorities.

2.0 TECHNICAL BASES AND VALIDATION

The TVAT spent considerable effort developing "plausible scenarios that could explain the relationship between potential exposures in the tank farm environment and the health effects reported by the Hanford tank farm workers." They then "developed a hypothesis that vapors coming out of tanks in high concentrations (bolus) plumes sporadically intersected with the breathing zones of workers, resulting in brief but intense exposures to some workers." The

TVAT made several recommendations related to actions to test this hypothesis, including work in further characterizing the gases and their movement in the tank headspace gas; in detecting, characterizing, and monitoring for any tank vapors or abnormal gases in the air outside the tanks in areas where workers could be exposed to either tank vapors or other gases that could be responsible for the odors and/or symptoms being reported by workers; and in further modeling or other efforts to validate the “bolus” hypothesis (SRNL-RP-2014-00791).

Considerable work has been done and progress made in many areas to address these recommendations during the Phase 1 effort. This includes developing new adaptations of existing technologies (and in some instances, what might be considered new technologies themselves) to help characterize, detect, and monitor gases. These technologies were tested in local laboratory and field settings, and are now being tested in and around selected tank farms in a more comprehensive way to permit integration of data and evaluation of results. This includes the following:

- Infrared and ultraviolet cameras for scanning large areas real-time in an effort to “see” vapors not visible to the naked eye
- Transportable infrared/ultraviolet sensors to detect chemical vapors and determine concentrations
- “HAZ” scanners for real-time air quality monitoring
- Stack monitors using ultraviolet and infrared light to continuously measure vapors going out the tank exhaust
- Meteorological stations for measuring and monitoring localized meteorological conditions
- An array of portable direct reading instruments that can be used by industrial hygiene technicians (IHT) or devices worn by workers to get real-time information on the air immediately around workers and any vapors to which they may have been exposed.

In addition, a Mobile Organic Monitoring Laboratory is being tested that:

- Uses state-of-the-art air monitoring instrumentation to detect a wide range of chemicals – potentially up to 46 of the 59 chemicals of potential concern
- Provides real-time chemical vapors monitoring
- Locates and monitors potential vapor plumes
- Monitors general tank farm areas for volatile organic compounds
- Monitors exhaust stack and passive breather filters.

The intended application of the collective instrumentation is to provide a process for early vapor detection and warning; emissions trending relative to meteorological conditions, optimal atmospheric air dispersion modeling, and confirmation of control sets.

A group of VMEP members attended a demonstration of many of these technologies at various stages including at Pacific Northwest National Laboratory and within a demonstration area

accessible to tank farm workers in the 200 East Area. Many positive, encouraging comments were noted and are not reported here.

The WRPS Phase 1 report is expected to provide a complete description of the results of these various efforts to further detect, characterize, and monitor for vapor releases that could intersect worker breathing zones. This should include the results of testing the new technologies and plans to use them as well as a more definitive answer to whether the TVAT hypothesized "bolus" or other scenarios explain the health effects experienced by workers (SRNL-RP-2014-00791). Below, are some observations, comments, suggestions, and questions posed by one or more VMEP members during the course of observing or discussing WRPS efforts to date.

Observations regarding the development of better means of detecting and monitoring releases in and around the tank farms in general and around potential breathing zones of workers:

- It was noted by Mr. Louis Kovach, a VMEP member with many years of relevant experience in this area, it will be extremely difficult or even impossible to have direct reading instruments that can correctly identify the currently suspected organic compounds without a collection and concentration step. Due to the many other components of the samples gas stream (e.g., water vapor, ammonia, nitrogen oxides, non-toxic organic compounds, and the other target toxics), the identification in the field of a particular toxic organic compound is far more difficult than current "simulant" based single or limited number of mix studies indicate. Creating false hopes of immediate and direct hazard condition identification could have further diminishing effect on worker morale.
- Bulk atmospheric measurements may give immediate and helpful safety information to workers by indicating wind direction; intensity and changes in atmospheric pressure, which can result in significant pressure changes between the dome space and the tank farm environment; and cause potential vapor releases.

Observations and comments on utilizing or leveraging current activities to obtain additional information pertinent to organic source term issues:

- Mr. Kovach has noted that the total organic compounds in the waste are decreasing for several reasons:
 - Chemical decomposition.
 - Radioactive decomposition.
 - Partitioning into Effluent Treatment Facility streams during evaporator runs.
 - Release into the dome space.

Better monitoring of total organic compound behavior during evaporator runs could be helpful because any organic partitioning in that process has significant impact for the tank waste organic content also and it is easier to identify potential hazard concentrations due to the elevated temperature and the lowered pressure. Both the vacuum pump and the Effluent Treatment Facility streams should be carefully analyzed for relevant toxic organics and mercury.

- In addition, he points out that the organic content of the stored unevaporated waste is decreasing slowly, due to lower radiation fields and decreasing reactant concentrations which exist now. The site should consider accelerated oxidative decomposition of the organic materials in the waste to accelerate the organic decomposition and modification of the evaporator process to partition a much larger fraction of the organics and mercury into Effluent Treatment Facility streams, rather than returning them with the concentrated waste into the double-shell tanks. Both of these steps would significantly lower potential vapor issues in the tank farms. The steps can be accomplished individually or jointly for major impact.
- In addition to decreasing the vapor hazards, this action would also cause to decrease or eliminate insoluble chromium in the waste and also convert technetium to pertechnetate. These, conversions do not currently take place in wastes containing organics, because the organics decomposition reactions consume oxygen preferentially. Both the insoluble chromium and the insoluble technetium greatly influence high-level waste glass making process/quantity and performance assessments predicting performance of low-activity waste logs disposed onsite at Hanford in terms of potential releases over the long-term and the resultant consequences.
- Mr. Kovach has further observed the evaporation process would be an ideal operation stage to chemically oxidize the relevant waste being evaporated by ozone, hydrogen peroxide, or other oxidants. Doing so would further reduce potential total organic compound source terms since chemicals decomposed and/or removed for the waste are not going to contribute to vapor exposures, and any residual organic material would be at much lower vapor pressure, thus less volatile.

The site has invested, and continues to invest, significant resources to further understand and characterize how the various gas components in the tank headspace (the presumed source of the vapors being released) interact. Mr. Kovach noted the following regarding tank vapor mixing issues:

- A large number of studies (e.g., RPP-7249, RPP-6655, RPP-4941, and RPP-7771) were made on tank dome space vapor mixing in relation to the flammable gas safety issue. Those studies indicated relatively fast dome space mixing and lack of stratification. Various mixing studies of the past should be reviewed to avoid unnecessary duplication.
- Hydrogen (and several other) gas spontaneous releases studied in the past (RPP-7249; RPP-4941; HNF-SD-WM-TI-797, Rev. 6; and PNNL-11391) show that any spontaneous release results in mixing with extant dome space air, any release from the tank would be at lower concentrations than at the waste release point, and the duration of the higher organic concentration in the dome space would be longer than assumed, many hours or days. This observed behavior should be considered in relation to the currently postulated "bolus" phenomenon.
- The largest non-air component in the dome space is water vapor, and in some cases condensed water droplets forming fog. The change in percent relative humidity from the in-dome space environment to the outside environment should be considered in the evaluation of adsorption-based personal protective equipment (PPE) and any engineered

vapor control, because many failures of the past (such as the water logging of the high-efficiency particulate air filter only vent system, the water logging of the applied carbon vessels and the water logging of the power reactor Standby Gas Treatment System type system, which all failed and subsequently were disconnected) were caused by lack of consideration of these changes in relative humidity. This change should be also considered in any analytical studies related to the vapor hazard issue.

- One of the stated aims for the current extensive analytical work is that the information is needed to design and build any engineered control system. While true for some systems, Mr. Kovach believes that extant knowledge would be sufficient for the design of the engineered controls for several unit operations. Many of the engineered controls can be designed without detail knowledge of the full composition of the gas stream to be treated. Incineration, oxidative destruction, and adsorption processes do not require the detailed gas composition knowledge for the low concentration components. Currently, many large critical off-gas treatment systems operate with variable low concentration and some unidentified component input. Such are municipal waste incinerator offgas systems, medical waste incinerator offgas systems, etc.

3.0 EXPOSURE CONTROL

In accordance with the requirements of 10 CFR 851, "Worker Safety and Health Program," WRPS uses a four-part hierarchy of controls to manage chemical vapors in Hanford's tank farms:

1. Eliminate vapor sources
1. Install engineered controls
2. Establish administrative controls
3. Provide PPE.

Efforts are underway exploring improvements in each of these areas to varying degrees, and it is again expected that the Phase 1 report will make recommendations regarding improvements examined or reevaluated during the Phase 1 efforts.

VMEP members noted early on that the TVAT report (SRNL-RP-2014-00791) recommended further ongoing evaluation of engineering controls to address vapor issues and expressed concerns regarding the lack of external visibility as to what improvements WRPS was considering, how and to what extent, in these areas. Specifically, VMEP members asked for and received a briefing in March 2016 (see Appendix B). At that time, it appeared that WRPS believed it had already examined fairly thoroughly the engineering controls previously recommended by a Chemical Vapors Solutions Team (CVST) subteam and planned to make incremental improvements in certain areas, which would be addressed in the Phase 1 report. More recently, VMEP members attended an outbrief from a WRPS vendor forum focused on abatement technologies, and were encouraged that this area is getting renewed attention and that several technologies appeared to show promise.

On the PPE front, WRPS has been investing considerable effort, with active involvement of the CVST, in testing the ability of respirator cartridges to protect workers from what would likely be

worse case conditions, namely direct exposure to tank headspace gases. A testing rig was designed and tested bench scale and has recently been attached directly to a tank headspace and exhaust.

In addition, sample data from respirator cartridge manufacturers is being evaluated by Pacific Northwest National Laboratory (PNNL) for effectiveness for select chemical mixtures. The testing is conducted on select tanks, representative of headspace vapor composition, with some tanks selected per the request of worker representatives as relevant to upcoming retrieval work activities. The Phase 1 report is expected to provide the results of the above testing and consultations.

A few VMEP members are skeptical given the potentially ever-changing nature of tank farm vapors and the potential for varying concentrations of complex mixtures in the environment, it will not be possible to answer all questions around the effectiveness of chemical cartridges for every possible scenario. There is no absolute process for testing cartridges in every conceivable work environment. National Institute for Occupational Safety and Health (NIOSH) respirator certifications per 42 CFR 84.190, "Chemical cartridge respirators: description," are in fact based on a far more limited set of test conditions. Nonetheless, it appears there has been good worker engagement in the cartridge testing effort through the CVST, and since it is the workers who will be using chemical cartridges, it was good to witness their involvement in the process of determining their effectiveness. It is also presumed they will be active participants in the decision making process associated with moving away from SCBAs and into other forms of PPE, including the use of chemical cartridges.

On the administrative controls front, it is obvious that considerable effort is being devoted by WRPS to reexamine and strengthen the basis for determining vapor control zones and vapor reduction zones. These are areas around known emission sources such as stack exhausters and passive breather filters wherein access is particularly restricted and controlled, and within which special PPE such as supplied air is required if workers need to be in these areas. The basis for how, when, and where to establish the boundaries for such zones is of obvious importance. Various types of computer models for predicting how emissions from such sources move, diffuse, and disperse were being tested, validated, and peer reviewed as a basis for establishing boundaries. Outside such boundaries, in theory, workers could have access with fewer restrictions and with appropriate PPE.

VMEP members provided comments on some of the details of the modeling and its limitations within the context of an overall control strategy (see Appendix B). It remains unclear to VMEP members how and/or to what extent these questions and limitations will be answered as part of the Phase 1 report addressing the "bolus" question posed by the TVAT (SRNL-RP-2014-00791).

4.0 HEALTH EFFECTS DATA, STUDIES, RESULTS, AND CONCLUSIONS

Considering the importance of understanding as objectively as possible what is known about the health effects of the Hanford exposures; what is not known; and how the gaps are being, can, or should be addressed, this section of the report is organized around those areas starting with a summary statement addressing what is known. A more detailed discussion of these points is

being developed in a report by Dr. Cherry and Dr. Maier further summarizing and evaluating the health effects situation and possible next steps to advance understanding and consensus in this area.

4.1 SUMMARY STATEMENT REGARDING WHAT IS KNOWN

Aggregate health data specifically related to tank farm workers and associated with self-reported odors and symptoms does *not* suggest pervasive or systematic chronic health effects associated with exposure to tank farm vapors. Aggregate data that has already been compiled includes:

- AOP15 (WRPS Abnormal Operating Procedure 15) incidents and worker evaluations at the time of the incidents, with active followup of exposed workers and linkages to retrospective and prospective annual exams (Phillips 2016; S-15-SHD-TANKFARM-001, *Health Surveillance of Vapor Exposure Concerns*)
- Tank farm worker annual surveillance exams and annual health trending reports summary of results (HPMC 2016)
- Worker's compensation claims data for exposure claims related to tank farm vapors (there are few relative to the overall number of claims for all types of injuries across Hanford for the period October 1, 2012, through June 30, 2016) (NIOSH 2016)
- Return to work exams after exposure incidents (generally cleared to return without restrictions)¹
- Recordable injury and illness rate (low for tank farms according to data presented in an internal reportspreadsheet assembled by ORP staff and provided to VMEP in September 9, 2016,²)
- Health effects panel evaluation of tank farm workers in 2006 , with national leaders in occupational medicine from prestigious universities as authors (found no pattern of occupational disease) (RPP-30560, *Health Effects Panel Evaluation of Pulmonary Function and Liver Enzyme Levels Among Hanford Tank Farm Workers*).

Aggregate data from Hanford workers over the decades does *not* suggest any pattern of chronic disease emerging later in life. Long-term studies include:

- Cohort mortality studies (Schubauer-Berigan et al. 2015, "Cancer Mortality through 2005 among a Pooled Cohort of U.S. Nuclear Workers Exposed to External Ionizing Radiation"³)

¹ Internal Report, "DART Case Rate Comparison, General Industry vs. DOE vs. WRPS, 2010–June 2016." (DART stands for days away, restricted or transferred. Report reflects how many workplace injuries and illnesses required employees to miss work, perform restricted work activities, or transfer to another job.)

² Internal Report, "TRC Case Rate Comparison, General Industry vs. DOE vs. WRPS, 2010 – June 2016." (TRC stands for total recordable cases. Recordable criteria include any work-related injury or illness that results in loss of consciousness, days away from work, restricted work, or transfer to another job or requires medical treatment beyond first aid; and any work-related diagnosed case of cancer, chronic irreversible diseases, fractured or cracked bones or teeth, and punctured eardrums.)

³ Though many Hanford cohort mortality studies have been published, this is the most recent one known to the authors of this report.

- Former worker surveillance exams (DOE and EHSS 2015).

In fact, Hanford historically has lower rates of recordable injuries and illnesses than comparable DOE sites⁴, and former Hanford workers live longer than the general population (Schubauer-Berigan et al. 2015) and experience fewer cancer deaths (DOE and EHSS 2015). Even though tank farm worker surveillance *has* identified a few abnormalities, such as newly detected signs of asthma on breathing tests, the rate of abnormal breathing tests among tank farm workers has been the same for the last 5 years, and tank farm workers have demonstrated better lung function on average than a comparison group (the Washington Closure Hanford workers, who do not work on tank farms) (Phillips, K. 2016; S-15-SHD-TANKFARM-001).

4.2 WHAT IS NOT KNOWN

To describe the health patterns at Hanford, it is important to distinguish exposure-related health effects that are transient, reversible, and non-specific from illnesses associated with objective, persistent clinical findings. Health effects associated with odors from the tank farms have increased in the last 3 years. Such health effects reported by employees include symptoms such as headache, nausea, watery eyes, runny nose, and burning sensations. These symptoms are generally transient and reversible, with no objective findings on exam. Since such effects are non-specific, it is difficult to determine the precise cause. Many different chemicals, bad odors, naturally occurring allergens, or other factors may cause such symptoms.

In contrast, accidental chemical release such as spilled liquid waste or sudden release of trapped gas resulting in clinically apparent adverse health effects with objective findings has occurred relatively rarely at Hanford. The rate of such events is lower than in other chemical industries⁵ but may raise more concern due to the complexity of hazardous waste stored at Hanford. It is important not to confuse the health effects from an accidental release with the health related effects of a minor reversible nature associated with most cases of tank farm vapor exposures.

Given that aggregate data are not designed to capture every individual case of effects, some significant segment of the worker population is understandably concerned about vapor-related health effects. The level and intensity of these concerns has been sufficient to prompt a lawsuit from the Attorney General of the State of Washington, a strong demand letter from the head of HAMTC (2016), and numerous emotional “investigative” or accusatory media reports from the Seattle area in addition to more moderate, but still disturbing, reports locally. For example, an excerpt from the Tri-City Herald (2015) read:

More than 50 workers have received medical checks for possible exposure to chemical vapors in recent months. The fact is all of these workers were cleared to return to work. But Hanford workers are concerned that breathing in chemicals associated with chemicals from the waste held in tanks could cause serious lung and neurological illnesses.

It is possible for the standard onsite worker exams and the worker’s compensation claim system to miss cases of occupational illness related to tank vapors, if such cases exist. Individual health

⁴ <http://energy.gov>, “Illness and Injury Dashboard.”

⁵ DART Case Rate Comparison.

records from outside providers are not combined with the Hanford onsite clinic records, and furthermore, some workers may never seek professional treatment from a health care provider or may leave employment without having been evaluated for such exposure-related effects. A more in-depth review of health effects was recommended by the TVAT report (SRNL-RP-2014-00791). The work being discussed, including reviewing the worker's compensation records in greater detail and compiling all the available prospective and retrospective health data of AOP15 filers, will help determine whether any cases of persistent, observable adverse health effects from tank vapor exposure have occurred. Developing a systematic ongoing approach to collating and examining these data for individuals who have reported a vapor exposure would be highly valuable to address the open questions about health effects. Thus, while overall health data trends from among health information for tank farm workers does not suggest an overall pattern of adverse health outcomes, there remain relevant open questions specific to vapor exposures.

Contrary to some news reports, VMEP members have observed ORP taking concerns of workers about long-term health effects seriously. Any worker who detects an unusual odor from the tank farm is encouraged to have a medical exam immediately. All tank farm workers are required to have a thorough medical exam annually, including blood tests and lung tests. In addition, all workers are encouraged to get continued annual exams after retirement through the former worker surveillance program. All protocols in place for medical evaluations after a possible chemical exposure and for annual surveillances have been reviewed and approved multiple times by national organizations and special panels. HPM Corporation's (HPMC) Occupational Medical Services' (OMS) *Chemical Exposure Evaluation Procedure* (2014) is about the same procedure a patient might receive at Harborview in Seattle for the initial diagnostic evaluation. Individuals from ORP, WRPS, and HPMC OMS have also expressed concern about potential risk from supplied air, including greater cardiovascular and musculoskeletal burden from carrying a tank and the quality of the supplied air, which is, for instance, very dry.

There is no question a number of Hanford former and current workers are suffering from serious respiratory, neurological, and other conditions, which occur at some rate in any human population. It is not clear however, to what extent those health effects are a direct result of tank farm vapors or other possible exposures or conditions. Even the most current technology, science, and medicine is limited in its ability to discern, delineate, and predict health effects from myriad chemicals, particularly at low levels of exposure or where non-specific transient symptoms occur. As discussed above, there are also challenges in getting complete relevant medical histories due to privacy laws and use of both site and private health providers. This further complicates efforts to distinguish possible health effects from Hanford exposures from health effects that more likely may have resulted from other factors or exposures in a person's history. Accessing and evaluating compensation claims to get a clearer picture of correlations between Hanford related incidents and health effects is similarly constrained.

4.3 CLOSING THE GAP

Options to help close the gap on at least the question of how many of the workers reporting under the AOP15s have or may be expected to experience consequences from those exposures other than the observed or reported short-term symptoms include much of what is already being done, particularly the annual surveillance exams and return to work exams after an absence. In

addition, linking the health data from worker's compensation claims to the existing AOP15 and annual surveillance data would add a dimension of follow through for the AOP15 incidents. In order to access the health records needed, exposed workers may need to sign waivers or releases, and other entities such as DOE, Penser, and the institutional review boards of external reviewers may need to grant permission. A series of case history or other similar studies is being planned by ORP and WRPS that may shed more insights relating worker symptoms to tank vapors or other factors.

From a systems level, better tools for tracking, integrating, and aggregating data would be extremely useful for informing health decisions and providing the best care for workers. For instance, an electronic medical record at HPMC OMS easily integrating exposure data from WRPS relative to AOP15 incidents and easily producing customizable reports would be ideal. Upgrading the electronic medical record for DOE facilities such as Hanford, similar to how the medical community has been migrating to electronic records over the last several years, seems like an essentially high priority from the perspective of VMEP members knowledgeable in this area. Any barriers to linking exposure and outcome data should be addressed. If HPMC OMS has legal access to external medical provider notes from both accepted and denied worker's comp claims, this information should be provided automatically, not requiring a substantial effort from staff and management.

Other options to close the gap include efforts to better monitor the atmosphere in and around the tank farms and tank farm workers on a continuous basis and/or right when workers smell something to get more or better information on what exactly workers are smelling or were exposed to and for how long. Efforts to improve real-time or grab sampling technologies are under active development by WRPS as part of Phase 1 activities.

Recommendations from other entities are in process. PNNL is preparing a Hanford Tank Farm Occupational Exposure and Risk Assessment Plan, which will refine and update chemicals of potential concern and associated exposure limits. The PNNL plan may include a recommendation to establish an external panel consisting of both medical providers and exposure scientists to monitor implementation of the new plan over time. A NIOSH Health Hazard Evaluation Team visited Hanford in August 2016; the VMEP and others eagerly await their recommendations. The DOE Office of Enterprise Assessments (EA) also visited Hanford in August 2016 on behalf of DOE. The EA team included an occupational medicine physician. The EA report and recommendations are pending.

5.0 EDUCATION AND COMMUNICATION STRATEGY AND IMPLEMENTATION

All VMEP members, and particularly those with expertise in organizational and risk based communications, believe progress is being made to inform workers and interested parties about the facts and challenges related to vapors and the strategies and activities related to worker safety. However, this communication effort is occurring in an extremely challenging context due to media attention, some of which is based on a slanted "investigative" perspective; ongoing and volatile litigation; and changing data and understandings about the vapors issue. As a result, the progress and engagement needed to stabilize the situation and turn the corner toward trust and positive participation by the full workforce has not been attained.

The ORP and WRPS leadership teams clearly recognize the significant importance of improving education, communication, and engagement of workers and how critical these needed improvements will be in addressing the vapor issue. During the past year, several attempts to address this challenge have been initiated with some success, included:

- Chemical Hazard Awareness Training
- CVST outreach
- IH team buildup
- Frequently updated website accessible without a Hanford computer with information on the latest events and issues
- Management team outreach.

These efforts need to be continued consistently as a base step in gaining greater credibility with the work force and developing the trust and confidence needed to collectively address the vapor issues.

VMEP members believe the recent development of a formalized vapors communication strategy and the designation and dedication of a vapor issues high-level manager for implementing that strategy is an important step. The engagement of Dr. Covello helping to address communication and engagement issues and train staff in communication approaches and tools is another important progress step. Further development of fact-based and risk-based consistent messaging; however, needs to be developed and key staff need to better understand and use it in daily operations. VMEP members have consistently offered observations about stepping up actual engagement of workers in the situation and relying less on one-way, top-down communications. While WRPS is making strides toward the level of engagement envisioned by various VMEP members, open communications on matters subject to litigation and where litigants are part of the audience has hindered these efforts. Moreover, progress is further impeded because only imperfect and incomplete information exists about odors, irritants, and exposures, and obtaining up-to-date and complete information regarding the actual health effects of workers reporting incidents is challenging due to privacy laws and the fact that medical histories are split between site providers and private providers. Regardless of these challenges, the VMEP members strongly encourage ORP and WRPS to stay the course of building the relationships and communication tracts needed to ultimately achieve a fully informed and positively engaged work force. This includes ORP and WRPS efforts to communicate with each other and labor constantly, consistently, and at all levels and at both the planning and execution phases of addressing vapor issues. In some cases, there may be other factors beyond tank vapors getting in the way of open and honest communications needed to expand mutual trust. Various VMEP members have heard, but have not attempted to verify, that some issues are being driven by a highly vocal and passionate minority, with many workers reluctant to engage lest they interfere with efforts by their leadership to deal with issues. If there are other issues underlying or exacerbating the vapor issues, they need to be surfaced and addressed.

While there are currently significant efforts to improve mechanisms for communicating with the workers, several VMEP members believe however that what is communicated is far more important than how.

WRPS is making efforts to integrate other Hanford Site contractors (e.g., Mission Support Alliance, LLC; CH2M HILL Plateau Remediation Contractor; Bechtel National, Inc.; etc.) into planning, evaluating, and communicating activities, but more work in this area seems needed. While representatives from other contractors have attended CVST meetings at various times it is not clear to what extent representatives from these other contractors have been encouraged to attend, be a regular part of the CVST efforts, or as a more comprehensive liaison with the rest of their respective organizations. Attendance of representatives of Mission Support Alliance, LLC Site Emergency Services in these forums (Fire Department and Hanford Patrol) for example might be helpful. Further use of the website being developed to help communicate "real-time" program and monitoring information is expected to help this situation both internal and external to WRPS.

A number of worker engagement activities are obviously occurring to varying degrees at various times and places with what appears to be varying degrees of effectiveness. Examples of actions discussed among VMEP members that could be used or monitored in a more deliberate, systematic, or comprehensive manner to improve field level worker engagement/communication include:

- Ensure that persons in charge and field work supervisors are sufficiently trained and versed on the current status of the vapor effort to be able to discuss and incorporate that information in daily job planning and to discuss the vapor hazard, along with the other hazards, in planning each job. IHTs and health physics technicians should be active participants in daily work planning. Persons in charge/field work supervisors should have the qualifications needed to make frequent entries to the hazard zones with their workforce. Work debriefs should be active to address worker concerns, some which will have been viewed by the "field involved" persons in charge/field work supervisor.
- To help improve confidence and trust at the work setting, middle managers should be qualified to enter work zones inside the fence lines, with applicable PPE, currently SCBA based on current requirements. These entries would be to observe work and discuss with workers what is working and what is not, what is known versus what is not, and to address questions.
- Similarly, WRPS leadership should be qualified to enter work zones, inside the fence lines, and make these entries with the workforce from time to time to provide the workforce more direct access to leadership in the work setting. This could help get the hazard program clarified, have leadership address questions as necessary, and help further build a "we are all in this together" credibility.
- Senior and middle WRPS management meetings with HAMTC steward's and safety representatives should be evaluated in terms of frequency and effectiveness.
- The Hazardous Materials Management and Emergency Response (HAMMER) training center might be better used as a vehicle to educate the workforce on actions being taken on vapors, and discuss the technology for abatement and control as well as protective actions for the workforce. HAMMER "Worker Trainers" have considerable credibility with the workforce, and when provided with program data, help transfer program confidence and credibility to the workforce just as they do for radiation protection and emergency response preparedness and actions. For the worker trainers to provide

accurate information on the current status of the vapor program, workshops among WRPS technical experts and HAMMER trainers and staff may prove useful. Such workshops could also contribute to improved communication/engagement and trust building among Union worker trainers and DOE/contractor technical and management staff. A process to keep the trainers current as the vapor program evolves should also be established. Middle managers and leadership should also participate in the pre-training workshops, as well as periodically appear at actual training sessions, to show leadership engagement and willingness to address program questions.

- In summary, while progress is being made in field level worker engagement, a number of VMEP members believe, considering the persistence of issues, that WRPS should strengthen their efforts on worker engagement at the field level as well as with HAMTC leadership.

6.0 INSTITUTIONALIZATION OF IMPROVEMENT CHANGES

WRPS has implemented many of the TVAT recommendations (SRNL-RP-2014-00791) and other improvements while continuing to explore additional ones through its Phase 1 efforts. As these and other changes are implemented and experience is gained, they become “institutionalized” by being documented and incorporated into revised requirements documents, written and controlled work and reporting procedures, training programs, and other vehicles. Since its formation, the VMEP has observed and commented on many changes including policies for working in farms during waste disturbing and non-waste disturbing activities, establishment and use of vapor control zone and vapor reduction zone boundaries as described above, abnormal event response and reporting actions, worker training and qualifications, use of temporary exhausters in the single-shell tank farms, and much more. It is expected that the Phase 1 report will provide further insight into these activities.

One area that has been the focus of considerable WRPS effort has been the followup to the TVAT recommendation on further developing and institutionalizing changes to the IH program to achieve “parity” with the radiation control program (SRNL-RP-2014-00791). Many new IHT positions were created and personnel recruited and trained. New and improved IH detection, analysis, and monitoring equipment has been acquired or is being developed for their use. New protocols for more extensive and aggressive rounds and routines are similarly being developed and evaluated. These efforts have already produced some successes including the identification, tagging, and mitigation of fugitive emissions sources (e.g., locations where chemical vapors have migrated from the tank headspace into the work areas through openings in the tank dome for pipes, instrument cables, and openings in valve pits). In addition, new reader boards are under development and being tested to display up-to-date and/or real-time information on activities and conditions within and around a particular farm. As the new IHTs gain experience and the new equipment is deployed, it is expected that the workforce can gain increased confidence in the ability of the IH program and IHTs to help advise and protect workers from harmful vapor exposures to the same degree the much more mature radiation control program and technicians help provide confidence in protecting workers from harmful levels of radiation exposures.

6.1 SALIENT VAPOR MANAGEMENT EXPERT PANEL MEMBER OBSERVATIONS AND COMMENTS

Considering all the different areas of improvement (e.g., new technologies, new requirements and procedures, new information, and the introduction of new personnel with limited tank farm experience), VMEP members believe an updated integrated control strategy should be documented incorporating the results of the new hazard understandings, abatement technologies, engineering controls, administrative controls, and PPE examined or implemented during Phase 1.

Soon after the VMEP was formed, it was pointed out to the VMEP members by the assigned HAMTC safety representative observer that many workers feel much safer working in and around tank farms with PPE less than SCBA when the tank or entire farm is being actively ventilated. In that case, the tanks are under negative pressure, the direction of gas flows from any leakage spots into the tanks, and the only emissions from the tanks can then be presumed to be out through filtered and monitored stacks at known locations. Workers find solace in hearing the "hiss" around locations of potential leak spots as a reliable, audible indication gases are moving from outside the tank to inside in their proximity.

In exploring this, VMEP members were informed all double-shell tank farms are normally under active ventilation, but there are times when the systems are down for maintenance or other reasons. Single-shell tanks become actively ventilated with portable exhausters during waste disturbing and other select activities. The members were told it would be prohibitively expensive to upgrade all the single-shell tanks and associated infrastructure to actively ventilate them continuously like the double-shell tanks, although there are plans to actively ventilate certain single-shell tanks or farms prior to retrieval activities. The above recommended control strategy could take into account, as a primary engineered control mechanism of choice, the state of ventilation and worker confidence in the ability of themselves and their support team to reliably monitor tank headspace air flow direction. This could help assuage concerns that any odors smelled in the areas where tanks are being actively ventilated are not tank vapors if nothing is detected in or around controlled exhaust points.

Policies regarding the discretionary versus non-discretionary use of SCBA have, in the meantime, become driven by legal orders and heavily influenced by a "demand" letter from HAMTC (2016).

Another observation or concern expressed by VMEP members relative to institutionalization of improvement changes is the frequency and degree of turnover or reassignments affecting key WRPS managers. Lack of stability among senior and mid-level managers makes it more difficult to maintain institutional knowledge of lessons learned, what has been tried and the outcomes, what was not tried and why, etc. In addition, management turnover typically works against resolution of trust, confidence, communication, and engagement issues between the workers and management that appears to underlie some of the vapor issues and be key to their resolution.

7.0 CROSS-CUTTING AREAS AND GENERAL OBSERVATIONS BY INDIVIDUAL AND/OR SEVERAL VAPOR MANAGEMENT EXPERT PANEL MEMBERS ON IMPROVEMENT OPPORTUNITIES

7.1 MANAGEMENT AREAS

There is still much that needs to be done to resolve the non-technical issues impeding resolution of vapor issues. This is evidenced by worker concerns, lawsuits, the HAMTC "demand letter" (2016), emotional or inflammatory news reports, intervention by senators, and continuous calls for new investigations and assessments. Management credibility among certain segments of the workforce seems low and there are a number of possible contributing factors. Significant management personnel turnover is among those, and it is not clear how this is being addressed. The temporary assignment of the chief operating officer to the field is a good step forward in enhancing two-way communications from the top of WRPS management down to the field worker level, but that move alone is clearly not enough.

On several different occasions, workers mentioned anger and mistrust as a result of the real or perceived treatment of them by Penser North America, Inc., the site's third-party administrator for worker compensation claims. Limited exploring of this by VMEP members made it unclear whether the source of the problem was the compensation claim process itself (e.g., unrealistic understandings or expectations of the process as governed by state laws) versus Penser North America, Inc. itself or other factors.

The entirety of the efforts to address the "vapor issue" still seems lacking in the definition of succinct goals, critical decision points, and decision strategies governing the various initiatives. This may be resolved with the issuance of the Phase 1 report. Absent this definition, it will be challenging to know how much is enough whether applied to technology development, characterization work, health effect studies, work control strategies, engineering controls, communication initiatives, etc. Application of SMART (Specific, Measurable, Achievable, Relevant, and Time-bound) elements to ongoing work may help further focus and bound future initiatives.

Better performance indicators that measure improvement actions taken and that can drive future changes and actions should be developed.

Improvements to AOP15 and/or other procedures could help avert undue over-reactions to reports of odors emanating for sources outside the tank farm (e.g., diesel fumes, septic systems, fertilizers, insecticides, high level of allergens, etc.).

Progress is being made in the education and communication arena as evidenced by WRPS initiating formal communications training, use of the CVST, and efforts to improve worker involvement. Continuous improvement in these areas is expected to further improve trust and confidence in the workforce. It is believed that increased involvement of the HAMMER training center in educating workers on the WRPS vapor program would also advance the communications and engagement effort, as it has done in dealing with beryllium and other Hanford issues. Continuing to increase the field presence of knowledgeable, experienced, and trustworthy IHTs, health physics technicians, supervisors, and managers will likely be the most

important step in further enhancing the trust and confidence of the workforce in the vapor program and vapor controls, exposure protections, and appropriate risk management.

7.2 FITNESS FOR DUTY OR SPECIAL QUALIFICATIONS FOR TANK FARM WORK

ORP and WRPS should consider options for changing criteria for who may work in farms and under what circumstances (e.g., fitness for duty requirements considering workers varying sensitivity to odors, risk understanding and tolerance, increased needs to wear heavy SCBA during hot weather, etc.).

7.3 BETTER UNDERSTANDING OF RISKS AND HOW THEY FACTOR INTO DECISIONS AT THE WORKER LEVEL

Efforts should continue to reach understandings among workforce, medical community, union leadership, elected officials, media, stakeholders, and others regarding the prospect that there will always be a likelihood that some odors and health risks will persist in the tank farms as in everyday life and other work areas. A major challenge at Hanford is developing confidence in the ability to define what are acceptable odors and potential health risks (it can be highly dependent on the individual worker) and provide reasonable confidence that if something is smelled, it is not tank vapors that are likely to cause short- or long-term health effects. Current technologies, systems, and personnel have clearly not yet attained that level of confidence with a significant portion of the workforce as demonstrated by the HAMTC “demand” letter (2016). Recent reports suggest some progress is being made through discussions between the HAMTC and WRPS leadership.

Implementation of Phase 2 recommendations may provide the confidence described above, but the process by which worker buy-in that implementing those recommendations will be sufficient is not clear.

It should be realized that no one may ever be able to prove all the toxicants in the tank vapors are known, or that short of supplied air, no one will ever be exposed to them. In view of similar circumstances in everyday life, people tend to resort to informed decision making and accept those risks they deem reasonable considering other alternatives. People understand the probability and consequences of the risk of such activities such as driving a car, flying, smoking, etc. and make informed decisions based on these understandings. One VMEP member believes more needs to be done to define the risks and consequences of vapor exposure and quantify them using probabilistic risk assessment methods to support informed decision making. The results would be presented to the workforce and input solicited to develop a path forward. That VMEP member believes that the TVAT report authors were thinking of or recommending something like this in Sections 7.0–9.0 of the report (20 of the 55 content pages of the report). The commenter further noted that the VMEP has not seen much effort to date in this area. Such an approach is contrasted to what that member believes is the deterministic risk and reaction approach currently be followed, which is less likely to succeed. A second panel member, who was on the TVAT agreed that this type of risk-informed decision approach should be strongly encouraged.

There is a need to better articulate the difference between odors and toxic vapors to better enable worker education and training and help reduce concerns that anything being smelled is potentially toxic. A simple example might be ammonia, it has a detectable odor threshold well below health effect levels and the odor may produce symptoms or reactions in some people well below long-term health effect levels. One could estimate the amount of ammonia in each tank and the probability of the odor being detected (smelled) and the probability of exposure in an amount that could cause a long-term health effect. All of this could be done as part of the job planning activity for each real potential exposure chemical for that tank and/or farm and communicated during the pre-job brief. The job plan, controls, and PPE could then be adjusted based on worker input at the brief.

7.4 BETTER UNDERSTANDING OF RISKS AND HOW THEY FACTOR INTO HIGHER LEVEL DECISIONS AFFECTING WORKERS

It is unclear, when and how larger risk assessment and cost/benefit decisions driving the tank farm activities have been or are being made. As the perceived risk to tank farm workers increases and risk tolerance of the workers decreases, it gets harder and harder to do work in the tank farms. The cost and schedule of cleanup accordingly continue to escalate. Significant changes in how DOE and regulators decide what work must be done, when, and how may be in order. Risks to the environment posed by potential for leaks from certain tanks may not justify the risk or stress to the workforce of certain tank farm activities, but it remains unclear how those risk/benefit decisions have been or are being made, by whom, and when.

Given today's circumstances and new understandings, it would be highly desirable to further refine a workable, higher-level, risk-informed, decision-making process that better takes into account the risks to workers of working in the tank farms. Unfortunately, those risks are still perceived differently, sometimes even dramatically so, among workers, between some workers and most of management, and among stakeholders. News reports, the rhetoric underlying the lawsuit, and statements by union officials remain significantly at odds with what many, if not most in the ORP and WRPS management chain seem to believe, supported by their personal observations and studies of the situation. Further, the medical and health professionals cannot prove or guarantee the absence of future health effects related to Hanford exposures based on existing information, even though that same information as summarized above suggests the risks are well within accepted industry norms. Underlying this difference in views appears to be distrust of the information upon which views of the absence of directly related health effects is based. As a first step in further refining a risk-informed decision-making process informing decision-makers with respect to what work in the tank farms justify even the mitigated risks to workers and associated costs, some sort of reconciliation between the varying views of worker risk is needed.

7.5 LITIGATION IMPACTS

Communications on matters subject to litigation are sensitive and understandably require a great deal of coordination and legal involvement. However, this works against the objectives of timely and open information, in addition to creating a chilling and divisive environment.

Several members believe the current legal morass only delays the resolution of the problem.

Media coverage of reported tank farm vapor incidents, particularly outside the local area, further illustrates the dilemmas, challenges, and opportunities facing the site.

One member of the panel believes some of the TVAT recommendations on areas needing further study need to be further vetted due to lack of adequate Hanford experienced personnel on that team (SRNL-RP-2014-00791). Any recommendations found to be relevant, should then be evaluated for priority and sequencing using a Program Evaluation Review Technique type method (commonly known as a PERT chart) before establishing and performing a number of – at times – disjointed studies.

A second panel member (who was a member of the TVAT) agrees that the intent of the individual recommendations should be considered, rather than using them as a detailed prescriptive checklist.

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APPENDIX A
VAPOR MANAGEMENT EXPERT PANEL MEMBERSHIP

Vapor Management Expert Panel Membership (2 pages)

Name	Affiliation	Specialization/Expertise
Keith Klein (Chair) Richland, Washington	Longenecker & Associates; former Manager DOE Richland Operations Office; former member of Environmental Management Advisory Board (EMAB); electrical and nuclear engineering	Hanford technologies, challenges, and dynamics; community liaison and continuity; labor relations; engineering and technology; program management
Dr. Andrew Maier (Vice Chair) Cincinnati, Ohio	Prof., University of Cincinnati College of Medicine, NIOSH Toxicology Fellow	TVAT continuity, occupational and environmental health, chemical risk assessment, toxicology/exposure levels, industrial hygiene
John Henshaw Sanibel, Florida	Cardno Chemrisk, former OSHA Administrator, former President of American Hygiene Association	TVAT continuity; OSHA regulatory; industrial hygiene, safety and environmental health; risk management and communication
Tom Fitzsimmons Seattle, Washington	Independent Colleges of Washington; former Director of Washington State Department of Ecology; former Chief of Staff to Governors Chris Gregoire and Gary Locke	Regulatory experience; understanding of Olympia, understanding of Hanford; liaison with state entities
Dr. Debra Cherry Seattle, Washington	Physician, Harborview/Occupational and Environmental Health Clinic; Associate Professor, Environmental and Occupational Health Sciences at University of Washington	Physician; care provider at Harborview Occupational and Environmental Clinic (followup care/case management expertise); liaison with other medical specialties and local health care providers
George Jackson Richland, Washington	Former Fluor Hanford executive, engineer	Facility operations and safety; Hanford experience; senior management and facility operations experience with Rockwell, Burns and Roe, Westinghouse

Vapor Management Expert Panel Membership (2 pages)

Name	Affiliation	Specialization/Expertise
Dr. Joseph Iannelli (former VMEP)	Professor and Executive Director, Engineering and Computer Science, Washington State University	Computational fluid dynamics (gaseous), engineering, technology, meteorology, modeling, plumes/bolus behavior, liaison with universities, and national laboratories as needed; institutional credibility with state
J. Louis Kovach Columbus, Ohio	Nucon International; former President of International Society of Nuclear Air Treatment; Chairman, ASME Technology Subcommittee of Committee on Nuclear Air and Gas Treatment; Visiting Scientist, Harvard T.H. Chan School of Public Health	Recognized expert in research, design, analysis, construction, and proof testing of gaseous and liquid phase treatment, filter, and control systems, including toxic vapor and particulate controls, instrumentation, modeling, source term/accident analysis; consultant to industry, national laboratories, and various federal and international agencies; prior experience with Hanford tank waste
Paul Kruger (Executive Director) Columbia Falls, Montana	Former government and industry executive positions in environment, safety, health, quality assurance, and training	Experience with both DOE and Hanford contractors, labor/worker relations, worker compensation programs, and employee concern programs

- ASME = American Society of Mechanical Engineers.
- DOE = U.S. Department of Energy.
- NIOSH = National Institute for Occupational Safety and Health.
- OSHA = Occupational Safety and Health Administration.
- TVAT = Tank Vapor Assessment Team.

APPENDIX B
MEETINGS AND INTERACTIONS

Summary

The Vapor Management Expert Panel (VMEP) has conducted several meetings and various interactions since its inception in early 2015. The VMEP has a routine conference call among all members and the U.S. Department of Energy (DOE), Office of River Protection (ORP) the first and third Wednesday of every month. Keith Klein and/or George Jackson of the VMEP also typically attend a Chemical Vapors Solution Team (CVST) meeting twice a month. Specific full and/or partial VMEP meetings have occurred in Richland, Washington and on the Hanford Site. These meetings and interactions are summarized below, and where applicable, meeting minutes/summaries follow in sequence:

- February 19, 2015, VMEP Organizational Onsite meeting
- June 17 and 18, 2015, first full VMEP meeting – summary notes follow
- October 26 through 29, 2015, VMEP meeting – summary notes follow
- February 14 and 15, 2016, select VMEP members (KK, PK, GJ) attend the Washington River Protection *Solutions* LLC (WRPS) Vapor Project Review
- March 23, 2016, select VMEP members attend Vapor Dynamics, Cartridge Testing, and Engineered Solutions meeting (KK, GJ, LK) agenda follows
- March 31, 2016, select VMEP members attend Health Effects Workshop with WRPS and ORP (JH, AM, DC, PK, TF, and KK) – summary notes follow
- June 15 and 16, 2016, select VMEP members attend Technology Day (LK, KK, GJ, and TF)
- July 12 and 13, 2016, select VMEP members attend Dr. Covello Communications Training/Workshop (TF and KK)
- July 25, 2016, Vapor Abatement Workshop closeout session (select VMEP members attended (GJ and KK).

MEETING MINUTES OR NOTES WHERE APPLICABLE

Vapor Management Expert Panel June 17 and 18, 2015, Meeting Summary

INTRODUCTION

This Vapor Management Expert Panel (VMEP) meeting was the first formal VMEP meeting since an earlier "indoctrination/introduction" meeting. The VMEP plans to meet quarterly to gather information, share VMEP member insights with ORP and WRPS, and discuss topics pertinent to our VMEP Charter. As a first meeting, this meeting was focused on developments since formation of the VMEP, overview of progress in implementing the TVAT recommendations, review of general plans and schedules, management approaches, priorities and challenges. In attendance were Keith Klein (Co-Chair), Andrew Maier (Co-Chair), John Henshaw, George Jackson, Tom Fitzsimmons (present day 1 in person, day 2 via telephone for key discussions), Mike Urie (HAMTC Safety Rep/Observer) and Paul Kruger (Executive Secretary). Dr. Joseph Ianelli and Dr. Deborah Cherry were on international travel and could not attend. The ORP Manager and many of his key leadership team and staff relative to the vapor topic attended as shown in the agenda, as did Dave Olsen, WRPS President, and several of his leadership and key staff relative to vapor matters. The DOE-ORP Director of the Safety and Health Division was present throughout our sessions and supported our agenda by facilitating meetings and keeping us well coordinated from a time/schedule perspective. The formal meeting agenda is attached (Attachment 1). The VMEP is not a consensus body. This meeting summary represents a compilation of notes and comments from various members as recorded by Paul Kruger as Executive Secretary.

DAY 1

General Comments

- In our opening discussions, the ORP Manager provided additional clarity on the VMEP Charter. This clarification has the VMEP focusing its activities differently in 2 phases coinciding with the phases of work described in the TVAT Implementation Plan. The first phase for the VMEP will be largely inwardly focused on ORP and WRPS, and the second phase expanding to broader worker and stakeholder involvement. A final version of the refined charter statement as presented to the VMEP members following discussion is attached (Attachment 2).
- Additionally, Mike Urie, WRPS HAMTC Safety Rep, was presented as an observer and resource for the VMEP. Mikes presence was much appreciated, and contributed to an enhanced understanding of HAMTC workers perspectives on vapor issues.
- Andy and John, former members of the TVAT, attended and provided valuable perspectives regarding TVAT intentions and progress since the TVAT report.
- WRPS has been focusing on the Proposal to ORP adding more details beyond the TVAT Implementation Plan (IP) wrt implementing the TVAT recommendations.

- Much effort has gone into formation/strengthening of the Vapor IH Program and on exploring and developing new and/or improved technologies to characterize, detect, abate, and protect.
- Threat of lawsuits is affecting means and modes of communications (presentations were mostly oral with few handouts).

Specific Agenda Topic Comments

- **Risk based decision-making:** This part of the agenda was an open discussion of the various factors involved in deciding how to make decisions about vapor management strategies in a way that considers all relevant factors and minimizes overall health risk. Considering the complexity of issues, influence of non-technical factors, and wide range of persons involved and potentially affected, planning for who will make decisions, when and how is still underway. A Project Execution Management Plan (PEMP) is under development by WRPS. Various VMEP members considered it should provide the following:
 - A clear organizational structure with well-defined Roles, Responsibilities, Authorities and Accountabilities (R2A2s),
 - A decision tree and/or plan for arriving at decisions,
 - Criteria for acceptable “risk” in decision-making,
 - Consideration of the behavioral science component of risk based decision-making,
 - Use of a suite of engagements/interactions/education in addition to the CVST to achieve worker/stakeholder buy in to decisions,
 - Further definition of how “defense in depth” is being used,
 - The addressing of “odors” v. “vapors,” (distinguishing between olfaction (odor), chemesthesis (chemical feel), sensory irritation, and cytotoxic irritation),
 - Plans for addressing short term compensatory actions (i.e. WRPS plans to maintain the SCBA compensatory action, and under what circumstances or criteria, would WRPS leadership allow a “step-down” from currently imposed compensatory protection requirements).
- **Tank Farms of the Future presentation:** VMEP members were generally supportive and appreciative of the vision and framework for what the tank farms of the future would look like and how it would operate. The vision includes new and better technologies for characterization, abatement, detection, monitoring, control and personal protection. Members were interested in a better sense of how short term actions will be connected to the long term vision, such that an integrated flow from today’s operations and concerns to future operations can be easily shown. The PEMP could form a solid basis for defining near term actions that ultimately will lead to the “Tank Farms of the Future.”
- **WRPS TVAT Implementation discussion:** Considerable progress is being made in several areas. Detailed plans and schedules exist implementing the various TVAT recommendations, but elements of the strategy and how the various pieces come together

appear much better framed in key persons oral articulations than is currently expressed on paper. The Project Management Execution Plan under development to provide R2A2s, decision trees and criteria, and clear organizational functionalities should help bridge the gap and facilitate a better assessment of progress on a macro-scale.

- ORP Oversight function: There is clearly an active, disciplined and comprehensive ORP oversight program being put in place whose early observations appear consistent with VMEP observations.
- Discussion with Labor leadership (Dave Molnaa-HAMTC and BC Smith-Building Trades). BC Smith was unable to make the meeting due to illness. Dave Molnaa indicated that he had respect for the approach being taken by Kevin Smith and Dave Olsen, and that communication and engagement at their level was excellent. However, he also indicated that at the worker/field level a lack of trust exists between the workers and their immediate supervision and layers of management. The sources or causes for some of this goes back a long time and may not even be related to the vapors issues per se, but nonetheless contribute to, or exacerbate, them. Progress is being made, but it will take time to deal with the various factors and influences affecting communications and trust and confidence between and among all the various levels of supervision and management. Dave articulated that having more management and leadership visible in the field, even using SCBA to better understand the workers' perspectives and issues, and some tangible progress in the field (i.e. SCBA removal at select farms, technology being put into place, more responsive IH program) would help with restoring trust and credibility.

DAY 2

General Comments

Day two consisted of a number of internal VMEP meetings to discuss topical area assignment focus areas and a discussion of what we learned in day one. The signing of Conflict of Interest (COI)/Non-Disclosure Agreements (NDA's) for VMEP members was presented to the VMEP by ORP Contracts and Legal. VMEP questions on the NDA's were ultimately resolved off line and most the COI/NDA's have been now all signed.

Day 2 also included a number of small group meetings between VMEP members and key ORP and WRPS staff and members of the workforce:

These small group meetings were:

- Kruger/Klein/Jackson with a technical support specialist and the Tank Farms Program Manager to discuss ORP oversight activities.

Specific Comments: ORP is forming an active oversight program. They are currently reviewing the WRPS Tank Vapor proposal, and providing general feedback to DOE-ORP. The ORP oversight group appears well organized, qualified and staffed to follow the detailed implementation of the TVAT recommendations, and their areas of focus and observations parallel the VMEPs.

- Henshaw/Maier with industrial hygiene professionals to discuss developments on technical aspects of the implementation plan. Specific Comments: ORP IH communicated their interactions and oversight role related to the site. WRPS IH professionals gave updates on new technology including a device for grab sampling using an evacuated bottle, personal monitoring, and updates on cartridge breakthrough testing. Updates on IH staffing and training were also discussed.
- Becky Holland, Hanford worker, former TVAT member, and Hanford Advisory Board Health and safety committee chair

Specific Comments: A general discussion was held regarding follow-up on the TVAT report. The progress in taking forward steps was noted, although translation of these to changes in the field appear to need additional development.

- Klein/Kruger/Jackson (with Maier and Henshaw joining later) with Roland Creighton (WRPS IH Vapor Program Manager) to discuss the WRPS Vapor Project and organization. Specific Comments: The Tank Vapor organization is undergoing some changes both in structure and personnel. While the appropriate topical areas are being addressed by WRPS, the organization to address vapor matters needs further definition, as there is confusion on how the structure works vis a vis a project and matrix staff (i.e. R2A2s are not clear, even to WRPS staff involved in the effort).

VMEP Members Overall Observations at the Conclusion of Day 2 (Note -- comments were provided verbally to the ORP Manager/Key Staff and Dave Olsen/Key Staff and are not consensus based).

Observation: Progress has been made on addressing both short term compensatory actions as well as defining and working toward a long term "Tank Farms of the Future" over the past several months. The commitment and energy to resolve the tank farm vapor issues is clearly evident in the leadership at ORP and WRPS, as well as their managers/supervisors and staff.

Observation: Many strategies and the rationale for them appear to be much stronger as expressed and explained by various managers than is currently articulated in writing. ORP and WRPS were encouraged to complete efforts to strengthen the clarity of stated project objectives and holistic evaluation/decision strategy. This should include:

- Further development of succinct goals and steps to reach critical decision points (decision tree). It is understood that WRPS staff (Carol Slack) is working on such an effort.
- Further development and identification of how individual Implementation Plan actions address TVAT Technical Assessment Areas and recommendations (e.g. TVAT Line of Inquiry).
- Key performance parameters to guide project measurement and management decision; e.g. SMART elements: Specific, Measurable, Achievable, Relevant, and Time-bound.

Observation: It is apparent that the different efforts underway to build trust and engage project personnel and stakeholders beyond just improved downward “communications” need to continue. These include:

- Develop opportunities for “engaging” communications (e.g. CVST, Meetings with labor stewards, Vapor program website). While the CVST is an excellent engagement/communication tool, a suite of opportunities for engagement and education should be used beyond just use of the CVST. The education component involves better explaining to workers the technical matter of vapor control, the difference between odors and vapors (sense v. toxicity) and the rudiments of risk-based decision making. The engagement component involves requesting comments on key documents, decision parameters, and decisions themselves and showing how comments were honored, or not included for appropriate reasons.
- Begin a cultural paradigm shift towards a transparent and engaging/iterative decision process.
- Actions speak louder than words. Workers looking to see an enhanced presence of management in the field interacting with the workforce, including in the SCBA environment.
- It is important to appropriately demonstrate progress in addressing pressures to “step down” from the SCBA Compensatory Measure in tank farms. At some point the risks and productivity losses from working in SCBA will outweigh the risks of working without SCBA. The process, including the rationale/decision criteria, analysis, and decision-making process itself for “stepping down” are opportunities for further strengthening trust, confidence and communications through all the layers of workers and management. This is an area where a good risk management approach coupled with engagement, education, and communication with the workforce is needed. The matter of “odors” v/ “vapors” must also be addressed.

Observation: There is a need to have some tangible near-term accomplishment(s) to demonstrate progress to the field employees and engender credibility of the plan to address vapor matters.

- Quickly adjust/improve IH routines/work planning enhancements.
- Move expeditiously to conducting chemical cartridge evaluation at key tank farms to facilitate shift away from SCBA.
- Develop transparent documented basis to move from SCBA Compensatory Interim Control and/or to support sustained SCBA interim control.

Observation: The members of the VMEP noted that as they make observations, there are likely to be specific technical or process issues for which additional inputs and resources might be helpful. To the degree that individual members have knowledge of specific resources in these areas, they can be shared with ORP for consideration as implementation plans are developed. Two examples of such topics might be resources related to 1) methods in risk-based decision making; 2) distinguishing between olfaction (odor), chemesthesis (chemical feel), sensory

irritation, and cytotoxic irritation. There are likely to be other topics for which the VMEP members can share resource ideas as we continue our activity.

- The VMEP members with such technical background will offer to provide these technical insights at appropriate times, and ORP/WRPS may avail themselves of these opportunities as they deem appropriate.

Lessons learned for VMEP team:

- Early iteration on draft agendas w/ORP and WRPS to ensure agenda topics are well understood in terms of the information being requested.
- Small group sessions develop more candid and detailed information

Next VMEP at Richland tentatively September 9-10.

**Vapor Management Expert Panel Meeting Notes for October 28-29, 2015 Meeting
Richland, Washington**

October 28th (Wednesday)

7:15-8:00

- General discussions about the status of activities and the process for the day took place.
- Brian Stickney briefed VMEP indicating:
 - Olson
 - ORP is suggesting that the semiannual written VMEP report be postponed for several months since it is premature for the report to be written

8:00-9:00

- The Tank Farms Program Manager, from ORP provided perspective on progress and reported on DOE specific TVAT actions/DOE Oversight activities. The big question that needs to be answered is “what are the metrics for success?”
- ORP staff laid out their view of the sequencing of all the vapor projects and how they will become programs over time (Characterization, R&D testing at bench and then pilot scale, Define Controls related to worker safety, Build programs into Parity between RAD and Chemical Vapor.
- ORP suggested that their overall goal is to have Phase I activities inform Phase II and it is too early to say exactly what Phase II would look like.
- IH program staff discussed their perspectives on the status of the Vapor controls and suggested there are several split mentalities on how best to proceed centering on how much data is needed and how to handle interim controls.
- In answer to Keith’s question about how can the VMEP can help, and what would improve things, staff suggested:
 - Encourage contractors to implement more robust interim controls
 - Define more tailoring of interim controls
 - IH folks should participate more in work planning
 - Encourage greater trust and confidence by the workforce

9:00-10:30

- WRPS Staff provided an update on Project Execution Plan (PEP)
- VMEP members asked questions related to how engineering controls fit into the PEP and commented that it is mostly focused on the IH program

- Discussion took place related to the reasons why it took so long for WRPS to produce a PEP and answers included staffing issues and focus on activities and not on paper. ORP said improvements are expected.
- Rob Gregory provided an overview of the Roles/Responsibilities/Authorities and Accountabilities (R2A2s) in the PEP. VMEP asked a series of clarifying questions and then commented that it is not yet clear who is ultimately in charge.
- The Risk Based decision-making approach was presented and as well as a Cross Walk from the TVAT recommendations to the PEP actions.
- VMEP was asked to comment of the criteria for step down from SCBA and provided a status report on how the criteria are being reviewed.
- WRPS suggested that the criteria for overall success, the overall goal of the project was to make sure the workforce is and feels safe. This overall goal was supported by VMEP and suggestions were made as to how it should be more clearly adopted and communicated.
- A general discussion about the status of worker/labor involvement, engagement and communication activities took place with VMEP members strongly suggesting the need for embarking on a robust engagement strategy with the workforce. Progress of the CVST group was noted.
- IH Program improvements and strategies were presented by Rob Gregory and Kliss McNeel. VMEP members commented on how much progress has been made and suggested that a full IH plan designed to define and get to Parity needed to be developed. WRPS IH staff agreed and commented that the key parts to getting to Parity are trust, consistency, implementation and communication. Others commented that training, quality control, management oversight and resources are also needed.

10:45-11:45

- A general discussions about sense of progress, roadblocks, and future with the DOE ORP Assistant Manager for Tank Farms (AMTF) and WRPS President Lindholm took place.
- The DOE ORP AMTF reiterated the Goal for the Vapor project as getting to a place where workers are and feel protected. The DOE ORP AMTF stated
 - There is not a fine line between Phase I and II
 - The unknowns of the political and legal environment are having a big effect on the project
 - It is believed what we are doing is the right approach
 - The DOE ORP AMTF wants to make sure that we are balancing risk protection and safety with the costs
- Overall, VMEP members supported the goal and approach as laid out by the DOE ORP AMTF.

- VMEP members postulated that there are technical problems and non-technical (people) problems and challenges with the project and several commented on the need to give greater attention and effort to the people side including communications and engagement.
- Possible engineering ideas were discussed including concepts related to keeping the tanks under negative pressure. Commitments were made to look at all reasonable engineering possible solutions in the sequence after better characterization of the tanks.

11:45-12:15

- VMEP met with HAMTC Labor Leader Dave Molnaa and discussed the status of things from labor's perspective. Generally speaking, Dave state that he believes workers are feeling more a part of the process and that the CVST is being productive.
- The VMEP discussed issues of trust, communications, beliefs about the litigation and engagement with Dave.

12:45-1:15

- VMEP held a Working Lunch.
- Discussions about the progress and challenges of the IH program, access to health data, risk management decision making, worker confidence in the IH program, engineering solutions, HPMC Program, and communication and engagement improvements took place.

2:00-3:00

- The VMEP traveled to and observed the CVST Meeting at 2704HV.
- The focus of the meeting was on the protocols for tank waste sampling and the risk decision criteria for step down from SCBA.
- Several observations about tank waste characterization sampling were made by VMEP member Louis Kovach.

3:00-5:00

- The VMEP traveled AP Tank Farm and observed the new AP Communication Boards followed by a discussion about the new program.
- The VMEP traveled PNNL to get a briefing on the bench and pilot testing of tank farm monitoring and chemical measuring technologies that will be tested as part of the technology portion of the Vapor program.

October 29th (Thursday)

7:30-8:30

- The VMEP held group discussions getting ready for the day. Members focused on reactions from what was learned the previous day and defined a series of questions and comments to be discussed in the upcoming smaller group discussions.

8:30- 12:15

VMEP members met with smaller groups for group discussions according to the following;

- Group One- Medical Monitoring/Communications (Debbie/Andy/Tom/John/Paul) to discuss:
 - Implementation of TVAT medical monitoring recommendations
 - Medical follow-up/surveillance
 - Health/Epidemiological studies
 - L&I and Penser processes
 - Roadblocks – laws vs regulations vs policies vs bureaucracy vs lawsuits
 - External and stakeholder communications
 - Risk based communications to workers and
 - Workforce engagement activities
- Group Two- Engineering and Source Term Forensics & Control (Keith/George/Louie)
 - Source term identification, monitoring and control E
 - Engineering changes being made or considered
 - Engagement w/other contractors w/tank issues and process knowledge
- Group 3- IH Program (John/Paul/Andy/Debbie)
 - Progress of TVAT recommendation on IH program parity to Rad Con program
 - Training and effectiveness of IH new hire cadre
 - IH hardware upgrades
 - IH upgrades to monitoring activities/rounds
- Project Management (George/Keith/Tom/Louie)
 - Structure, progress, and barriers in “projectizing” the IP work

12:15-3:15

- VMEP held a Working Lunch followed by a preparation session for the out-brief to ORP/WRPS

3:30-5:00

- VMEP out-brief to DOE-ORP and WRPS focused on the VMEP members thoughts and comments on the following issues:

- Positive progress on nearly all activities
 - Overall strategy and integration of all elements and decision making into a comprehensive and cohesive plan
 - Health evaluation and response issues and observations (better case definition, increased data mining and understanding of health effects, review Bio marker approaches, clarify differences between HPMC and Harborview protocols and capacities
 - IH program progress and challenges
 - Engineering options to address vapors, and
 - Communications and engagement.
- Next steps include VMEP review of the step down risk decision criteria and review of the tank farm Technical evaluation

Vapor Dynamics, Cartridge Testing, and Engineered Solutions
March 23, 2016
2704 HV Rm G229, Hanford Site, Richland, WA

7-7:30 AM

Badging for guests

2440 Stevens, Lobby

NOTE: Meeting will be held on site. Members need to bring lunch to this meeting

8-8:15 AM

Introductory Comments (Keith Klein, VMEP; ORP Director SHD,
ORP Tank Farms Program Manager)

2704HV (on-site) Rm G229

- Participant Introductions – ORP Tank Farms Program Manager
- VMEP's Purpose and Year End Reporting – ORP Director SHD
- Workshop Objectives and Desired Outcomes – VMEP chair

Goal - Are the Vapor Implementation Plan actions meeting the TVAT/IP objectives within the current limitations of science?

Objective –

- This workshop will serve multiple purposes including an update to key VMEP members in support of their technical oversight role, input into ORP assessments, and an opportunity for a general consultative exchange to review vapor mixing/characterization, cartridge evaluations, and engineering considerations.

8:15-9:45 AM

I) Dome Space Vapor Mixing & Emissions Characterization (John Gasper and Ron Calmus)

- WRPS introduction on Headspace and New Technology
- How was prior knowledge incorporated into action plan?
- Theoretical basis for stratification assumption.
- Current available data
- Plan forward

9:45-10:00 AM - Break

10:00-11:00 AM

II) Gas Mask Cartridge Evaluation (WRPS: Mike Schmoldt/Mike Gallagher)

- WRPS introduction on Cartridge Evaluation.
- Basis for cartridge evaluation and what is to be evaluated?

- Best Basis Inventory use in analyte selection
- What is the program for off-site studies, i.e. single or combination challenges?
- To determine cartridge efficiency (or life), accurate inlet and outlet concentrations are needed.
- How will the various vapor concentrations be detected in the presence of all of the other components being present?
- There is a great variety in the toxicity of the trace vapors, how are innocuous compound issues resolved?
- How is the actual tank vapor tests to be performed?

11:00-12:00 PM

Working Lunch

12:00-1:50 PM

III) Engineered Solutions. (Dan Baide, Troy Farris, Tim Moberg, Steve Ellingson)

- WRPS introduction on engineering controls.
- Preference for single tank, tank farm and other potential vapor release (evaporators, etc.) engineered solution.
- Availability and relevance evaluation of existing site documents on engineered controls.
- Why is it assumed, that for engineered controls, the exact composition of toxic vapors is needed?
- Simple engineered controls aimed at treating tank dome space vapors and keeping dome space pressure negative to atmosphere.
- Design options for above engineered controls and cost approximation.
- Is continuous control operation preferred to demand based control operation?

1:50-2:00 - Break

2:00-4:00 PM

IV) CVST Meeting

2704HV G206 (Optional for VMEP/ORP/WRPS Attendees)

IVa) Alternative Option to continue discussions

Health Effects Workshop Suggestions/ORP Response/Workshop Summary:

Suggestions in Health Effects Arena (Final) For ORP, WRPS and HPMC

- It is not apparent that a full literature search of all relevant health studies has been accomplished and catalogued. The VMEP is now aware of 4 studies. 1) Annual Worker Health summary, 2) A Cohort mortality Study, 3) A CH2MHill Study on PFT/Liver function for all Tank Farm Workers, and 4) Specific neurological case reports. VMEP Health expertise members (Andy Maier and Debbie Cherry) suggest the following:

Conduct a thorough literature search on all health studies completed on Tank Farm workers over the past 20 years, and catalogue these studies. It is further suggested that a timeline of Tank Farm major events since 1985 be developed, with key events that resulted in alleged/potential exposures in health affects keyed to the timeline as well as the above discussed studies. This effort should be helpful to ORP, WRPS and the workforce in understanding the various tank farm health events and past responses to these events

- The above noted four studies do not appear to be sufficient to answer the TVAT recommendations for additional epidemiological studies. The sample size is too large (all Tank Farm workers), and this large sample size would likely mask information on more directly affected individuals. A new study should be considered with a design to help answer questions on Tank Farm exposure health effects to the extent it has not been done to date. The following is suggested for consideration:

An epidemiological study of workers directly affected or reporting significant systems, including PFT and liver enzyme tests on a higher frequency (once per month), be considered. The workforce should be engaged in the design of this study both to gain from their insights, and to enhance the studies credibility with the workforce.

- The matter of discriminating between “odors” with no symptoms, versus odor events with actual symptoms needs to be addressed. It is suggested:

A review be initiated to address this matter.

The VMEP members with health effects expertise further suggest that ORP and WRPS consider accomplishing item #1 in early 2016. Following the completion of item #1, it is suggested that an ORP/WRPS/HPMC workshop, with appropriate VMEP members on health effects participating, be convened. The workshop would address work done to date; new health effects study design, and the odor v. irritant matter.

ORP Response to VMEP Health Effects Suggestions:

-----Original Message-----

From: K A Klein <kaklein@frontier.com>

To: Andy (Michael) Maier <michael.maier@uc.edu>; Debra Cherry <cherryd@uw.edu>; George Jackson <lin578@charter.net>; John Henshaw <john.henshaw@cardno.com>; Louis Kovach <louis_20032@msn.com>; Paul Kruger <pdogkrug@aol.com>; Roy_D_Pete_Graham <Roy_D_Pete_Graham@rl.gov>; Tom Fitzsimmons <tbrenfitz@comcast.net>

Sent: Fri, Apr 15, 2016 10:57 AM

Subject: FW: ORP response to VMEP Recommendations: Health Arena

fyi From: Tank Farms Industrial Hygienist

Sent: Friday, April 15, 2016 9:07 AM

To: 'K A Klein' <kaklein@frontier.com>

Cc: ORP Director of Safety and Health Division; Director of the Tank Farms Operations Division; Phillips, Karen K <Karen_K_Phillips@rl.gov>; Medical Officer (AU-1); CIH, Director, Office of Worker Safety and Health Policy (AU-11)

Subject: ORP response to VMEP Recommendations: Health Arena Keith, our thanks to the team for providing the 3 overarching recommendations in the Health Effects Arena. We have/are taking the following actions in response to those recommendations: #1: ORP, WRPS, and HPMC should conduct a thorough literature search on all health studies completed on Tank Farm workers over the past 30 years, and catalogue these studies. It is further suggested that a timeline of Tank Farm major events since 1985 be developed focused on the key events that resulted in changes in the incidence of alleged/potential exposures in health effects, as well as actions taken such as changes in respirator policy, keyed to the timeline as well as the above discussed studies. This effort should be helpful to ORP, WRPS and the workforce in understanding the various tank farm health events and past responses to these events, as well as inform the development of new epidemiological studies. ORP concurs – The DOE Chief Medical Officer is coordinating a search and compilation of relevant health studies. WRPS has agreed to take the first swag at compiling a timeline. ORP also has information to support that effort. #2 It is understood that an epidemiological study of workers affected workers is being considered. Select VMEP members should be asked to review this study design for perspective on the extent to which it addresses the TVAT recommendations and/or intent related to effects of acute vapor exposure incidents. Similarly, it is advised that the workforce be engaged in the design of this study (if this has not already been done) both to gain from their insights, and to enhance the studies credibility with the workforce. ORP concurs in part. VMEP has and will continue to be involved in the development of any epidemiology study design. Workforce involvement will occur from the perspective of informing and soliciting input to the objectives and conceptual design for consideration and transparency. However, personnel not otherwise trained in the health sciences will not be solicited for peer review of the study design as non-scientific input – consistent with the approach used and discussed by the Chief of the National Toxicology Program at the 2016 Toxicology and Risk Assessment Conference. #3 VMEP members who have been following developments in this area further suggest that ORP and WRPS consider accomplishing item #1 in early 2016. Following the completion of item #1, it is suggested that an ORP/WRPS/HPMC workshop, with appropriate VMEP members on health effects participating, be convened. The workshop would address work done to date; new health effects study design, and the odor v.

irritant matter. ORP Concur. · Workshop was held on March 31, 2016 and viewed by numerous participants as a useful and successful endeavor. However, please note in the future as additional preliminary and sensitive medical information is acquired, participation in a subsequent health effects workshop may be limited to core VMEP SME staff and health/Safety professionals, in order to facilitate a forum for an uninhibited-candid, technical discussion. Results may then be crafted for sharing with workers in follow up communications or CVST presentation, please.

Industrial Hygiene Program Representative
US Department of Energy, Office of River Protection
PO Box 450, MSIN H6-60
Richland, WA 99352
509 376-9730 office
509 318-5341 cell

April 12, 2016

Notes from VMEP Workshop on Health Effects held March 31, 2016⁶

BACKGROUND

This Workshop was conducted to gather further information on progress being made to understand and resolve various issues in the area of known or potential health effects from exposure to tank vapors and to provide an opportunity for information sharing among particular members of the VMEP and various ORP and contractor personnel (WRPS and HPMC) involved in these efforts. Due to various sensitivities, handouts were not provided, nor were comprehensive notes made of the discussions. VMEP members John Henshaw, Andy Maier, Dr. Debbie Cherry, Tom Fitzsimons, Keith Klein and Paul Kruger provided input to these general notes. Individual VMEP members may provide recommendations to ORP on different aspects of the topics discussed at any time (Dr. Cherry's individual notes are currently attached to these notes), but the primary purpose of the workshop was information gathering and education to assist in evaluating progress in implementing the recommendations of the TVAT report. TVAT summary info was provided by TVAT members Dr. Maier and Dr. Henshaw.

1. Key issues and concerns (perceived – not necessarily representative) from workforce pertinent to workshop:
 - Management engagement in the field, including management presence at pre-jobs and in zones involving use of SCBA. Inclusion and engagement of workers in process
 - Communication and consistency in treatment among local providers – HPMC and Kadlec
 - Records for effective tracking of health experiences
 - Information resources available to care providers that ensures they have proper insights into exposures and work at Hanford
2. Summary of TVAT Recommendations re Health Effects:
 - Use the Hill Criteria and alternative hypotheses (acute irritant, allergy, hypersensitivity, anxiety due to odor, other non-health motivations) – note language of “primarily” because reality is a mix of all these causes
 - Acknowledge medical data limitations: 1) Due to nature of the acute effects, signs may be absent at the time of care even if symptoms were experienced. (Note that signs and symptoms mean different things to health professionals whereas the general population may not recognize the distinction) 2) The lack of a validated biomarker to “prove” exposure has led to “mistrust” – need to clarify for workers what medical science can and cannot do or does and does not know.

⁶ These notes were compiled based on notes and recollections from various Tank Vapor Management Expert Panel (VMEP) members. In some cases, they reflect information or ideas provided by workshop participants who are not members of the VMEP. Individual Panel members' input to this work product can be provided separately as needed. The VMEP is neither a consensus group nor an Advisory Committee chartered under the Federal Advisory Committee Act. Statements, observations and any recommendations are solely the responsibility of each member

- Improve medical tracking issues: 1) not clear that data on follow-up for latent effects is tracked – need an epidemiology study to answer the questions related to relevant vapor effect, 2) exposure information given to care providers not clear with regard to use and limitations – need info resource for providers, and greater records transparency, 3) ensure that private physicians somehow get their data into the system, and 4) research data that relates to long term affects building on the existing mortality studies. (note that Dr. Karen Phillips (HPMC) is coordinating on approaches to this from NIOSH in this area)
 - Medical Effects communication: need to have a stronger communication and engagement process with workers on health effects. Knowing and using what we do and do not know
3. Exhaled Breath as a biomarker (Reported by Dr. Maier):
- Why do we want a biomarker? Usually where external samples not adequate? E.g. mixed exposures? Acute or chronic exposure?
 - Biomarkers of exposure are different than biomarkers of effect - markers that measure internal dose or effect.
 - Need for validation of biomarkers and specificity – Have one of the best groups here at PNNL.
 - Without significant new research effort – steps 1) identify COPCs with current exposure biomarkers (breath, blood, urine), 2) calculate limit of detection for bolus or task based exposures, 3) this can be done with kinetic estimations.
 - Unlike for most uses of exposure biomarkers – measuring rapid transient exposures may be problematic because VOCs would or can be breathed off rapidly without a significant body burden (would need to have a capture bag with you), for most irritants they are tissue reactive and not revitalized, and the number of COPCs reflect highly variable exposures.
 - Consider “biomarker of effect” that relates to the health issue and integrate across chemicals. Examples include exhaled nitric oxide, IL6 and other “inflammatory markers” (see THF paper), but not specific to the chemical.
4. Odor versus Irritation – State of the Science
- Odor (olfactory nerve stimulation) and irritation (trigeminal nerve stimulation) are physiologically and psychologically connected.
 - What we know: 1) irritants are rated “more irritating” when test material is characterized by negative label (Dalton acetone work); In people who have lost sense of smell this also occurs so not just olfactory nerve based.
 - Odor pungency does not predict irritant pungency.
 - Chemesthesis (chemical feel) is a precursor to irritation. Sensory irritation, vs tissue irritation.

- Irritant responses often reversible but high acute or low chronic irritants can lead to neurogenic inflammation with longer term effects.
- Odor sensitivity is much more variable than irritant sensitivity (Shusterman study) – but since they are connected perceived irritant sensitivity can be high as well.
- Most current OEL frameworks either overtly control for “strong odors” as the OEL basis or have a mechanism to account for this in interpretation of effects.

DISCUSSION NOTES

5. Management Engagement:

- MOPS program – good idea but poor implementation. Refreshing the MOPS program could help with worker engagement and worker trust of management/supervision.
- To make MOPS better need managers and supervisors who are out there in the field and who understand all the activities to report.

6. Health Effects Information Sharing:

- Mechanism to link HE info across providers
- Mechanism for worker volunteer to release information
- Do we have medical information flow map?

7. IH & Medical Exchange:

- Marriage of exposure data and medical assessment critical to make decisions about causality
- Diagnosis requires “enough” exposure data to move from presumptive program to “evidence-based” approach.

8. EPI (Note that ORP shared data of various studies from the past 10 years

- What is the outcome we want to measure?
- What is the communication plan?
- HPMC – conducted an initial review of results from those “with a tank vapor exposure event (e.g., AOP-15 events). Preliminary numbers were reported (based on approximately 470,000 entries into the farms over the period 2009 to 2014) for the number of individuals reporting vapor exposures (odors, irritations or other indications), and of those how many resulted in precautionary exams and then medical follow-up or claims. Because of the preliminary nature of this reporting and lack of a documented report to date, the numbers presented are not repeated here. Meeting participants were encouraged that HPMC was pulling together the information available to them which appears to be very useful in setting a context regarding of number of workers reporting concerns or going to HPMC following a potential incident, the number of those who had post event Pulmonary Function Tests (PFTs), and of those how many had indications of reactive airways disease possibly

attributed to exposure. Meeting participants suggested looking at annual PFT pre and post AOP and getting more 7-day post exposures PFT measures.

- See Urie summary of events provided in workshop.
 - See CDER
 - No current EPI studies of tank farm workers that deal specifically with vapor exposures are underway. Such studies typically rely on a much larger population sample than is available here. Case series studies though are under discussion (see below) with various entities to help discern any latent health effects that might be attributed to exposure events
9. Risk Communication:
- Training has been used: 4-hr session
10. Biomarkers:
- Examine feasibility for exposure and effect biomarkers
 - Can NIOSH help with this? Talk with Gayle DeBord.
11. What type of data are needed:
- In terms of communication – here are the studies we have, what we do not have , and where we are going to new studies
 - SNRL - 2 studies are underway...
 - OEL development task

Future Actions:

- Studies:
 - Develop clear communication on ongoing studies on how these efforts are being integrated
 - HPMC is developing analysis of data for cases vs control group – extend to all “cases of exposed”
 - NIOSH is being approached about case series
 - Build from ongoing mortality study
 - New AOP data, nuanced information on symptoms, and exposures
 - Summarize the availability of predictive biomarkers? E.g., Inflammatory markers?
- Refine AOP triggering definition and response actions:
 - AOP due to tank vapors when someone has a symptom or experiences an abnormal smell. ...But not known source or anticipated odors...
 - If AOP then all (full crew) go to HPMC and complete odor response card

- Currently have a CVST sub-team working on this. Continue and develop workers engagement from each project team.
- Address what is an AOP event vs odor event?
- Develop a translation approach starting with a tiered approach (e.g., MARSEC analogy), but since challenge in field implementation need binary approaches so two separate methods (irritant vs odor). One idea start moving from AOP to grades/levels of AOP (odor, irritation, etc.), then separate procedures to improve the process reflecting evolution in formation. Need to summarize what is known. Supported by new modeling data and availability of DRI to separate effects from odors.
- Health Effects Information Communication:
 - Implement Lean Six Sigma type of approach that leads to process system improvements to increase effectiveness of information and operational flows related to medical and exposure information among health related providers and ultimately to the workers.
 - Improve Health provider information resources. Add to IH data letter statement that health providers are encouraged to contact IH to clarify the situation.
- Follow-up workshop on risk communication: The commitment by WRPS to hold a workshop on risk communication is good. As part of the workshop the following should be considered:
 - Identify key person(s) as Engagement person(s) or champions assigned to assist in implementing the learnings from the communication workshops and continue the training and continuous improvement. Attempt to identify such person in the IH program. Increase use of HAMTC safety reps, first line supervisors and IHTs as communication advocates/champions.
 - Utilize existing tools such as MOPS, tailgate meetings, etc. to also enhance management/worker engagement
 - Ensure communication on current health effects studies is provided such that all workers are aware of current efforts and results.
 - Utilize the previously discussed Lean Six Sigma on medical/exposure info across systems to improve processes and infuse better communication into these processes.
 - Utilize the AOP evolution roll-out as a component of the communication process.

Additional Comments from Debbie Cherry, MD

Regarding historical, ongoing, and future studies of health effects:

The internal health study by HPMC, which Dr. Phillips presented at the workshop, reviewing a series of TF workers who filed AOPs over apx. 2 years may be adequate to determine if certain types of health effects have occurred. No written results were provided to panel members. My recollection of the oral presentation is that PFTs, liver functions tests, and CBCs collected post-incident and at annual exams both before and 1-2 years following the incident were compared to similar data in a control group of Hanford workers. Notably, 2-3 workers developed asthma-like patterns on pulmonary function testing after the AOP incident. This data is NOT linked to personal health care records of the affected individuals, which could reveal if these workers developed occupational asthma as a result of the exposure. With the HPMC data alone, it is impossible to determine whether the changes on PFTs were due to occupational exposure.

If Dr. Phillips or someone equally qualified could view all the relevant data, including the HPMC surveillance and triage data, the exposure data, and the worker's comp data, key questions could be answered without commissioning a large scale epidemiological study. For instance, linking this data on the 2-3 cases with a new obstructive pattern on PFTs would reveal whether anyone developed occupational asthma from tank vapor exposure.

Another internal review that was presented verbally included enumerating all the worker's comp claims that had been initiated and accepted from tank farm workers over a longer period (apx. 5 years). A few claims have been accepted. It would be informative to know the accepted diagnoses and circumstances of exposure on the few claims that have been accepted. This is not an easy task. For instance, there could be tank farm workers with claims that are not related to tank vapors per se.

Many historical and ongoing studies are available that show Hanford workers have better health than the general population, including fewer cases of cancer. These include cohort mortality studies, former worker surveillance, and the low rate of recordable injuries and illnesses at DOE facilities.

Regarding health care outside HPMC for Hanford workers for occupational injuries, illnesses, and exposures of unknown significance:

I would endorse a process improvement study for workers getting care from outside facilities. It should include interviews of workers who have navigated the system to identify opportunities for improvement as well as follow up to see if any process improvements have been effective. Ideally, the working group would include providers from HPMC, Kadlec, and possibly Harborview; IH from Hanford; the worker's comp carrier; and HAMTECH representatives.

One part of this process that could be improved is providing appropriate, relevant exposure data to health care providers that is easy to access and interpret. Perhaps the worker could carry a business card with contact information for the HPMC clinic and a link to DOE's Site Exposure Matrices.

Regarding the use of exhaled breath as a biomarker of effect:

Exhaled nitric oxide is a non-specific marker of airway inflammation that remains elevated for up to 24 hours after exposure. It is elevated, for instance, after exposure to diesel exhaust from riding in a truck. I would like to know if HPMC has considered measuring exhaled nitric oxide after an AOP event. It has become easier to measure with new sensor devices.

Workshop Attendees:

- WRPS: Pete Graham, Chris Thursby, George Weeks, Stacy Thursby, Kliss McNeel, Tina Tabor, Joel Hebdon, Ken Way, Jeff Peterson
- Brandon McFerran (shift operations)
- Brian Ivey Safety Rep
- Rick Ennis Safety Rep
- HPMC: Karen Phillips, MD John Franco, Sandy Rock,
- DOE Headquarters: Medical Officer (AU-1); CIH, Director, Office of Worker Safety and Health Policy (AU-11)
- DOE ORP: Director of the Safety and Health Division, Tank Farms Industrial Hygienist, Tank Farms Program Manager, Technical Support
- VMEP: Debra Cherry (M.D.), Tom Fitzsimmons, John Henshaw, Andy Maier, (PhD), Keith Klein, and Paul Kruger.