TOC-IH-58451

Industrial Hygiene Basis for Defining the Unrestricted Work Boundary

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Executive Summary

The Unrestricted Boundary described within this document is the area where potential exposures to general (co-located) workers or members of the public (with escort) to Tank Farm vapors greater than 50% of an Occupational Exposure Limit (OEL) are considered unlikely and where no specific training, qualifications and PPE are required to be protected from the vapor hazard. For the purpose of this discussion, when an OEL concentration is referenced (i.e., 50% of an OEL) it is intended that it is based on a time weighted averaged exposure (i.e., 8 hr., 15 min. as applicable) and not an instantaneous concentration.

- Based on requirements affecting worker safety and health, an unrestricted boundary could be placed at the point in which the potential for exceeding 50% of an OEL is considered unlikely (i.e., at the VCZ or exclusion zone boundary).
- Current operational controls and facility access controls are in place that aid in complying with other regulations including WAC 173-303 and the Hanford Site RCRA Permit, as well as 29CFR1910.120/29CFR1926.65, Hazardous Waste Operations and Emergency Response.
- The Unrestricted Boundary related to Tank Farm vapors will be established where practical at a Tank Farm fenceline.
- Where a tank vapor hazard potentially exists outside of a Tank Farm fenceline, appropriate controls will be established to prevent access and to maintain exposures to unauthorized personnel below 50% OEL.
- The area from the unrestricted boundary to the site boundary will be considered the unrestricted area for which the co-located worker and members of the public under trained and authorized escort can be assured that while they likely may experience odors, they will not be exposed to tank vapor hazards at levels that could place them at risk of exceeding an OEL.

The Unrestricted Boundary will be controlled using a hierarchy of controls established by the Industrial Hygiene Program and implemented through integrated administrative and work processes managed by WRPS Production Operations, Retrieval Operations and Industrial Hygiene.

Introduction

WRPS-1700022, Draft *Comprehensive Vapor Action Plan (CVAP)*, defines and establishes chemical vapor protection actions to mitigate vapor incidences so workers *are safe* and *feel safe* while performing work in and around the Hanford Tank Farms. The CVAP defines eight core principles providing a vision to achieve the CVAP objectives. Principle #2, *Establish/confirm unrestricted boundaries are safe from tank vapor exposures*, is defined as the establishment of a defensible Tank Farm boundary to prevent against overexposure to tank vapors using source data, dispersion modeling, stack and fenceline monitoring, and IH rounds and routines. This definition was intended to draw a distinction between co-located workers (i.e., general workers that may have access to the Hanford Site and the industrial locations within the 200E and 200 W Areas of the Central Plateau as well as members of the public under trained escort) and Tank Farm workers meeting the requirements for Tank Farm access which may work directly in contact or near a source of Tank Farm vapor emissions.

Unrestricted boundary is not a term that has been used at Tank Farms previously nor is it a term defined specifically by regulations applicable to Tank Farms operations. Therefore, this paper will define the term through the use of regulatory definitions and best operational practices employed at Hanford and the Tank Farms for the protection of workers, and will ultimately define boundaries based on a decreasing level of risk from the hazard or source to the site boundary and will describe the commensurate level of controls based on traditional IH Hierarchy of Controls associated with these work boundaries. The terms Exclusion Zone (EZ), Contamination Reduction Zone (CRZ), Support Zone, and Industrial Zone will be used moving forward within the IH program.

Regulatory Basis

Maintain employee exposures to chemicals below established occupational exposure limits (OELs)

10CFR851, *Worker Safety and Health Program* provides the overarching regulatory framework for implementing DOE's safety and health program for the Tank Farms Operating Contractor (TOC). This regulation provides for a worker safety and health program that reduces or prevents occupational injuries, illnesses, and accidental losses to DOE contractors and their workers. 10CFR851 requires DOE contractor compliance with Occupational Safety and Health Administration (OSHA) regulations 29CFR1910, *Occupational Safety and Health Standards*, 29CFR1926, *Safety and Health Regulations for Construction*, and incorporates by reference American Conference of Governmental Industrial Hygienists (ACGIH) "*Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*" (2005).

29CFR1910 sets *Permissible Exposure Limits* (PELs) established as 8-hour time weighted averages for substances listed within the regulation and has also established short term exposure levels referred to as *Ceiling Values* or *Short Term Exposure Limits* for a specific list of air contaminants listed in 29CFR1910.1000, Table Z-2. For those chemicals listed in Table Z-2, OSHA also has established Action Levels which is a concentration, calculated as a time weighted average (generally lower than a PEL and typically around 50% of a PEL) that initiates certain required activities such as exposure monitoring and medical surveillance.

The Tank Operations Contract utilizes the term Occupational Exposure Limit (OEL) as a general term describing allowable exposure limits to which employees may be exposed, but may not be exceeded, from several regulatory and technical sources. Occupational Exposure Limits at the TOC include those PELs

established in OSHA regulation, Threshold Limit Values (TLVs) established in the 2005 ACGIH handbook, and TOC specific Acceptable Occupational Exposure Limits (AOELs) established by the TOC in RPP-22491 R1 2006, *Industrial Hygiene Chemical Vapor Technical Basis*. Tank Operations contract OELs include 8-hour time weighted average (8-Hr TWA), Short Term Exposure Limits (STELs) and Ceiling Values. The TOC Industrial Hygiene Department Manager serves as OEL interpretive authority.

In 1988, Hanford was divided into four National Priorities List (NPL) sites, including the 100, 200, 300, and 1100 Areas. Cleanup activities at the US Department of Energy (US DOE) Hanford Federal Facility (EPA RCRA Site ID Number WA7_89000_8967) are the joint responsibility of EPA Region 10 and the Washington State Department of Ecology, Nuclear Waste Program (Ecology) under the federal Superfund (CERCLA) program and the state Hazardous Waste Management Act, and respective implementing regulations. Management and treatment of tank wastes, stored in the Tank Farms within the 200E and 200W areas is overseen principally by Ecology under the state dangerous waste program and regulated under the state authorized dangerous waste requirements of WAC 173-303 and the Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste. As such, the requirements of 29CFR1910.120/29CFR1926.65, *Hazardous Waste Operations and Emergency Response* also apply to TOC operations. These standards establish employer responsibilities for managing the Tank Farm. These requirements also establish standards for hazard elimination, engineering controls, access controls, personnel exposure monitoring, worker training, employee medical monitoring, and PPE selection.
In complying with regulatory requirements and applying an As Low As Reasonably Achievable (ALARA) approach to worker exposures, WRPS has self-imposed a more restrictive requirement by establishing an action level for all chemicals of potential concern (COPCs) at 50% of the OEL. The TOC IH Program maintains the Tank Farm COPC list within the IH program.

Hanford Boundaries

Under the framework of the Hanford RCRA Permit established under the requirements of WAC 173-303 and RCRA, the Tank Farms have established facility boundaries that are defined in the *DST System Dangerous Waste Part B permit application* and the *SST System Part A*. Each Tank Farm has a fenceline and gates with key control access that prevent unauthorized and untrained personnel entry into the TSD/Closure Site boundary and is posted with appropriate signage to identify to workers that hazards related to hazardous waste management are present beyond the fenced boundary. This fenced boundary, along with controls such as verification of specialized training requirements and mandatory use of personal protective equipment (PPE), is utilized to prevent access by unauthorized/unmonitored workers and protect workers from chemical and radiological hazards.

Additionally, 29CFR1910.120 defines terms applicable to the Tank Farms that may also help us understand the basis for controls within and outside of the unrestricted boundary. These include Exclusion Zone, Contamination Reduction Zone, and Support/Administrative Zone. For the purpose of the discussion below, when an OEL concentration is referenced (i.e., 50% of an OEL) it is intended that it is based on a time weighted averaged exposure (i.e., 8 hr., 15 min. as applicable) and not an instantaneous concentration.

The **Exclusion Zone** is the area in which workers are most likely to encounter the hazard present in the highest concentrations. In terms of Tank Farm vapors, this Exclusion Zone is established at some distance based on modeling and empirical data around the source of vapor emission (i.e., ventilation stack in the case of a DST, or a breather filter in the case of an SST, or point of breach of the tank system for maintenance or construction). This distance varies based on the characteristics of a given tank or headspace concentration contributing to the aggregate emission point, as well as relevant meteorological

data, but is established based on potential exposure risk at >50% of OEL. At Tank Farms historically we have referred to this zone as a vapor control zone (VCZ). TFC-ESHQ-S_IH-C-48, *Managing Tank Chemical Vapors*, establishes the boundary of a VCZ to be set at a radius of five feet or at a distance necessary to maintain exposure outside the boundary to less than the action level (AL) (i.e., <50% of OEL), whichever is greatest, from the emission point based on the following sources of information: existing physical boundaries, personal/area sampling data, monitoring data, management input, modeling data, and empirical data. This procedure also provides two definitions for VCZs: Permanent Vapor Control Zone and Temporary Vapor Control Zone. The term VCZ will be replaced with Exclusion Zone.

> Permanent Vapor Control Zone (VCZ): An administrative control boundary established around continuous exchange emission points (e.g., passive breather filters, exhauster stack openings during exhauster operation) where farm COPCs have the potential to exceed a respective AL utilizing an appropriate evaluative method in accordance with TFC-PLN-34.
>
> Temporary Vapor Control Zone (VCZ): An administrative control boundary established when a temporary open path to tank headspace is created, Ventilation Tank Primary System (VTP) is off, or fugitive emission source is discovered.

The **Contamination Reduction Zone** is the transition area between the Exclusion Zone and the clean area or Support Zone. In terms of Tank Farm vapors, this area represents a decreased potential for exposure to the chemical hazard and based on the prior definition of a VCZ, would be <50% OEL. At Tank Farms historically we have referred to this zone as a vapor reduction zone or VRZ, however the term VRZ will no longer be used. The outer boundary of the contamination reduction zone has typically relied upon the Tank Farm boundary fence and radiological buffer zones around the Tank Farm and within the Tank Farm change trailer. TFC-ESHQ-S_IH-C-48, *Managing Tank Chemical Vapors*, defines this zone as an administrative notification boundary established to inform personnel of activities that may result in increased vapors or odors not expected to exceed a respective AL. While the levels of potential exposure are the same as the Support Zone described below (i.e., <AL or <50% OEL), the Contamination Reduction Zone is differentiated based on 1910.120 requiring specialized training regarding the hazards present, trained on PPE required to access the area, and medical training and monitoring. This training is also supported by the Hanford Site Wide Permit to include training required by the Tank Farms Dangerous Waste Training Plan. Medical qualification and surveillance examinations are provided by the Hanford Occupational Medical Contractor and are triggered through identification on an employee's Employee Job Task Analysis (EJTA) as a Tank Farm Hazardous Waste Worker or Tank Farm Entry. Employee training requirements are established through training plans and minimum training requirements for unescorted access to the Tank Farms and includes 24/40 Hour Hazardous Waste Operations and Emergency Response (HAZWOPER) established in 29CFR1910.120/29CFR1926.65.

The **Support Zone or Administrative Zone**, is the location of the administrative and other support functions. Within this area, the "co-located worker" is allowed to perform their work unmonitored, with minimal training required for general workers (i.e., HGET) and are not required to be within an exposure monitoring program or medical monitoring program. These workers in fact include workers from other site contractors or the Department of Energy performing work outside of a Tank Farm such as work to maintain roads and infrastructure, inspections of non-Tank Farm areas such as support buildings, maintenance shops, equipment storage locations, or may be general office workers as well as members of the public on site for tours under the control of a trained escort.

The fenceline of the 200 E Area and 200 W Area demarks the boundary in which co-located workers are made aware of the presence of increasing industrial hazards within the area including the presence of odors, and Tank Farm vapors. This boundary is proposed to be identified as the **Industrial Zone**, equivalent to the radiological controlled area.

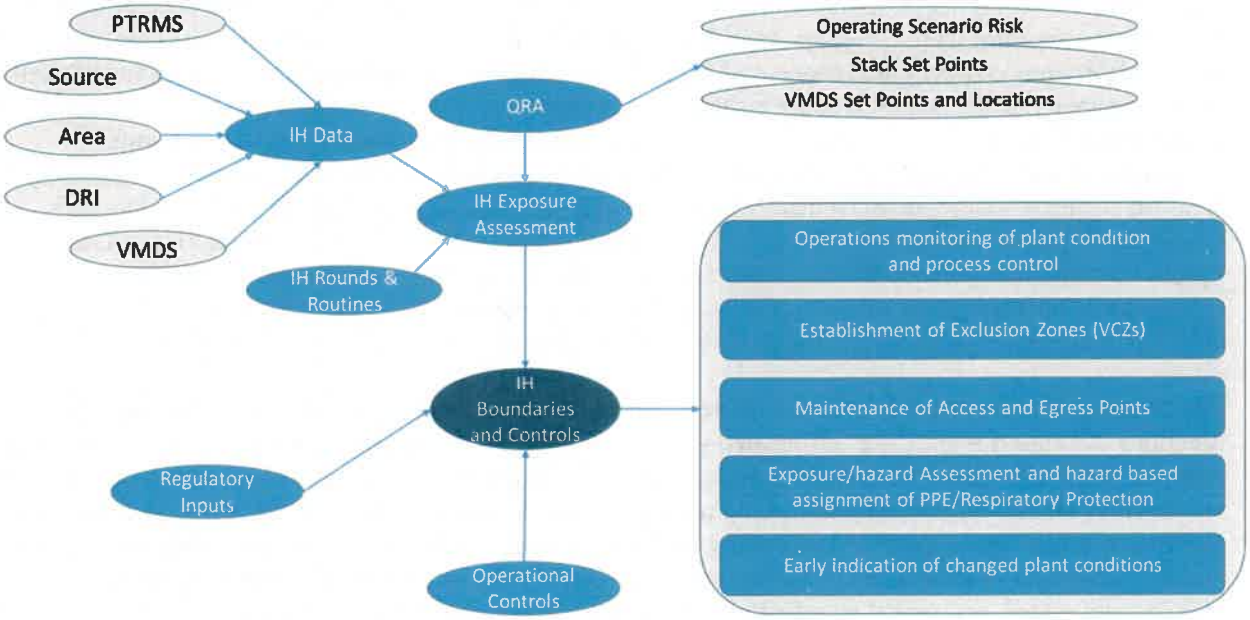
The **Site Boundary**, is a demarcation of public access to the Hanford Site. While the Hanford Site includes areas adjacent to Richland WA such as the 300 and 400 Areas, this definition is intended to identify those boundary locations which provide assurance that members of the public may not proceed into the industrial area without appropriate permissions and without the oversight of trained and authorized escorts. Site boundary locations include Hanford's Wye, Yakima, and Rattlesnake barricades.

Inputs to Defining the Unrestricted Boundary

As established by CVAP Core Principle #2, the unrestricted boundaries are to be defined as a defensible Tank Farm boundary to prevent against overexposure to tank vapors using source data, dispersion modeling, stack and fenceline monitoring, and IH rounds and routines. This paper has established above that regulations governing the Tank Farms Operation Contract also provide input into where boundaries are established. The following discussion provides explanation of the inputs to boundaries not previously described but that are identified within Principle #2. Each of these inputs informs the Industrial Hygiene Exposure Assessment (EA) regarding the presence and extent of the hazard beginning at the source to allow appropriate control measures (i.e., Hierarchy of Controls) and boundaries to be established to prevent over exposure of workers, both Tank Farm workers and the co-located worker, from the Tank Vapor hazard as well as to minimize worker exposures ALARA through the conduct of day to day work activities. An additional critical input involved in establishing boundaries is area and receptor data.

Figure 1. *Inputs to the Industrial Hygiene Exposure Assessment Process* is provided to aid in understanding the inputs to the Industrial Hygiene EA process that will be used to identify IH boundaries and hazard controls.

Figure 1. Inputs to the Industrial Hygiene Exposure Assessment Process



Source, Area and Receptor Data

Data collected to characterize the source of Tank Farm vapor emissions from the tanks, as well as data collected through area monitoring and personnel monitoring is critical to IH decisions regarding

establishment of boundaries and development of control strategies. Source data provides bounding information regarding the extent to which chemicals found in the head space of the tanks have the potential to impact workers in the breathing zone. However, area and receptor data, validated by modeling, provides historical information regarding the "real" impact or potential impact to workers from the hazard based on the dynamic conditions attributed to each tank and each Tank Farm as well as the environmental conditions (i.e., wind, temperature, etc.) that influence dispersion of the source once emitted from the emission point.

This data coupled with dispersion modeling will enable IH to identify those areas where potential exists to exceed 50% of an OEL on a regular basis during routine operations enabling establishment of EZs, and in the case of planned work activities to identify where temporary EZs must be established. From an ALARA standpoint, this boundary also provides some assurance that beyond the EZ that workers can expect that based on the hierarchy of controls moving outward towards the site boundary that there is little likelihood of experiencing Tank Farm vapors that would approach levels that would result in a time weighted exposure greater than the OEL (i.e., 8-hr., ceiling or short term), thus ensuring compliance with regulatory standards and limiting the health risk from exposures ALARA.

Dispersion Modeling

Dispersion modeling for both the actively ventilated tanks as well as the passively ventilated tanks provides a critical input to the Industrial Hygiene EA process and in determining placement of boundaries and controls to protect Tank Farm workers and co-located workers from Tank Farm vapor hazards. A wide variety of air dispersion models exist and could be used to inform the EA process. While a few are described below, this discussion is not intended to limit WRPS IH use of models to only these few.

As a key aspect of the CVAP work scope, WRPS and its subcontractor are completing quantitative risk assessments (QRAs) to model and investigate the extent of impact of each of the emission sources using a computational fluid dynamics model, Fire Dynamics Simulator (FDS). The FDS model is capable of predicting concentrations within the breathing zone (i.e., ~5 to 6 ft) and within 100 meters from the source unlike many models such as AERMOD which is used as a regulatory model to predict air emission impacts beginning at ~100 meters from the source to many kilometers. Also, unlike IHMOD, currently used by IH to do case by case evaluation, the FDS model can interrogate both ground level and elevated release points and because of its complexity can utilize years' worth of meteorological data providing a more comprehensive investigation of risks posed by the source.

Results from FDS modeling of the Tank Farms active and passive emission points will provide useful information regarding the potential for concentrations of chemicals to be present from the source outward based on air dispersion (i.e., distances from emission point outward where potential exists to see concentrations at 50% of an OEL, OEL, PAC 1, PAC 2, and PAC 3 levels) that may be coupled with source, area and receptor data by IH to evaluate the appropriate control strategies using the hierarchy of controls, including defining boundaries, placement of barriers and access controls, and to verify if existing boundaries are sufficient to prevent overexposure of workers to the Tank Farm vapor hazard.

The results from the QRAs/FDS modeling will also be used to specify area and fenceline monitoring locations to provide early detection of abnormal conditions resulting from tank emissions present in work locations and to alert workers and the central shift office to the conditions so that appropriate actions can be taken and exposures to workers in the areas of concern can be minimized.

Stack and Fenceline Monitoring

Stack and fenceline monitoring to enhance monitoring of the source and within designated areas around the source, can provide critical inputs regarding the status of the operating plant condition (i.e., are conditions in the Tank Farm as expected or is something out of the normal occurring that might present a need for operational controls or actions). Stack monitoring also provides a critical tool in continued improvement of emission characterization as waste transfers between tanks occur and to support maintenance of the IH Chemical Vapor technical basis.

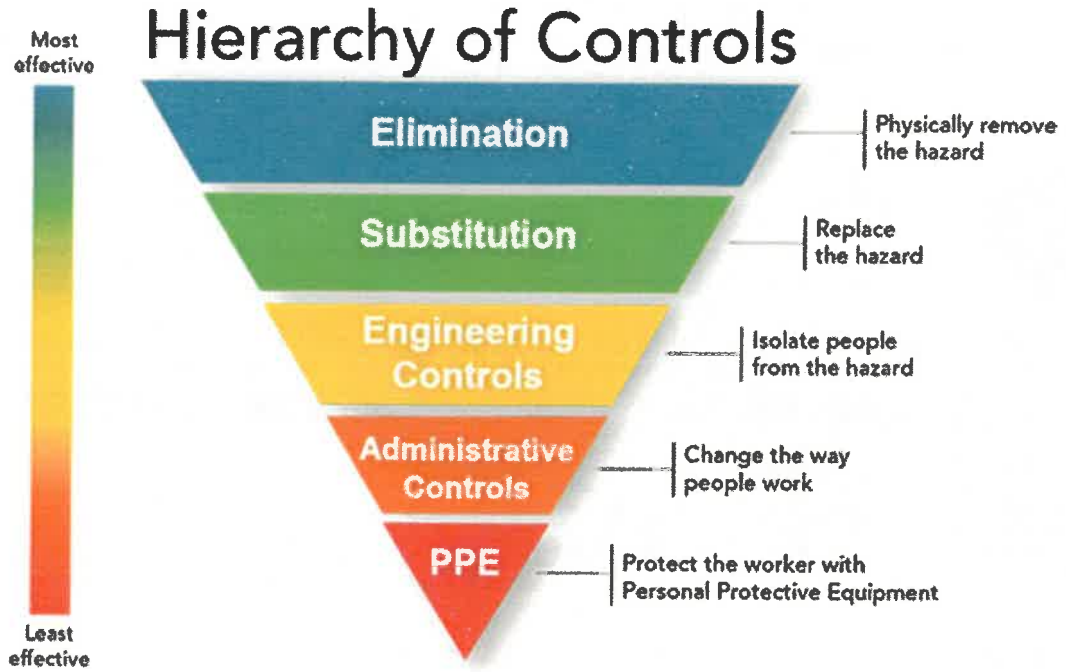
IH Rounds and Routines

IH Rounds and Routines provide additional input to operations and Industrial Hygiene that the plant conditions are as expected and that unmonitored or uncontrolled hazards are not present within the Tank Farm work area. By design, IH Rounds and Routines area established to periodically inspect and to detect and monitor the areas within the Tank Farm fenced boundaries, as well as select areas outside of the Tank Farm boundaries looking for "fugitive" emissions of tank vapors that could present an unrecognized hazard to the worker. When found, these hazards are mitigated and where practical eliminated or otherwise controlled to prevent inadvertent access to the areas in which the hazard is present. Focus outside of the Tank Farm fenced boundaries is to detect and prevent exposure and to ensure exposure to the co-located worker well below occupational exposure limits. In doing so, an ALARA approach to identifying areas at risk and prioritizing IH surveillances or monitoring in these areas on a greater frequency is applied.

IH Hierarchy of Controls to Maintain Worker Exposures ALARA

Above we discussed regulatory drivers for controlling worker exposure to Tank Farm chemical vapors as well as how these drivers influence limits of potential exposure within and beyond the "unrestricted work boundary." We also discussed the many inputs into understanding the hazards associated with Tank Farm vapors. We know from our regulations that we are required to prevent exposures to all workers to less than the OEL. We do this by implementing a hierarchy of controls through the WRPS Integrated Safety Management System process. This hierarch of controls is represented by Figure 2.

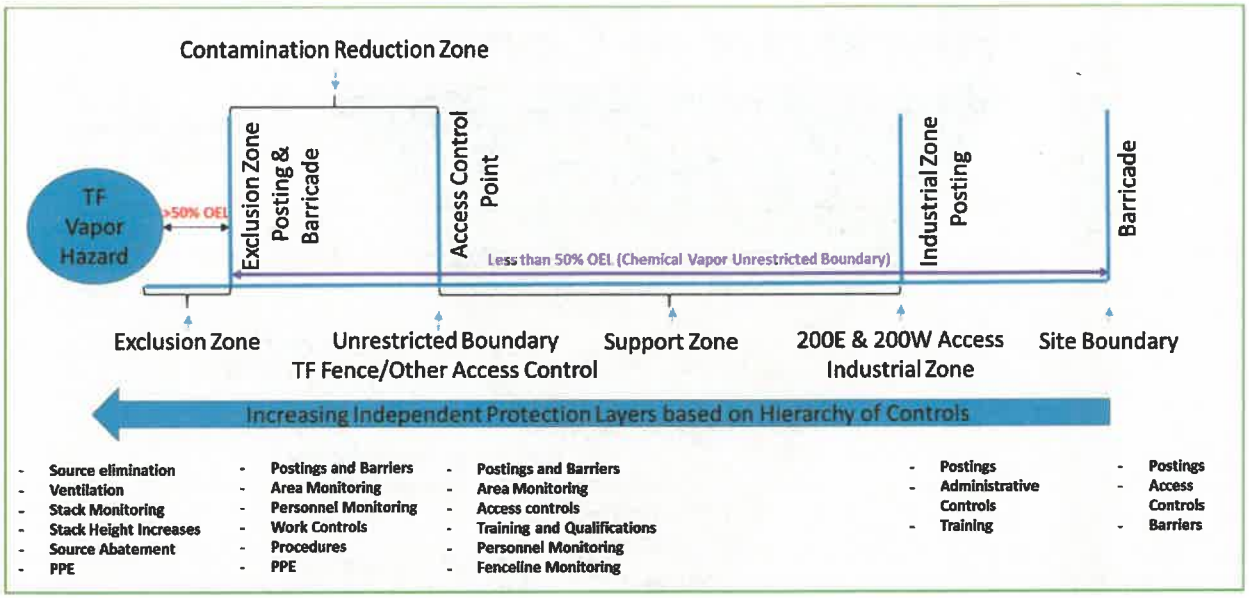
Figure 2. Hierarchy of Controls



We also know that based on these regulations OSHA requires that, for a specific list of chemicals in 29CFR1920.1000 Table Z-2, if an "Action Level" is exceeded, the requirements for specialized training, monitoring/exposure assessment, and medical monitoring are triggered. WRPS has implemented a conservative approach for its COPCs and has defined an action level for all COPC at 50% of an OEL based on 8-hour time weighted average unless an acute exposure limit is established by regulation (i.e., ceiling value, etc.). Further, TOC IH has implemented action levels based on leading indicators, principally ammonia and total volatile organic compounds (VOCs), at concentrations considered conservative and predictive of any emerging/unanticipated condition. Ammonia and VOC action levels are monitored by stationary and/or handheld direct read instrumentation and coupled with pre-established response protocols, provide additional defense in depth to allow personnel working in/around controlled areas have opportunity to take timely protective action. This approach aids in defining the unrestricted boundary since within the Tank Farm IH Control Strategy, worker exposures should be managed at <50 % of OEL. Furthermore, controls must be established to ensure the co-located worker or member of the public under trained escort cannot normally access areas in which their risk of exposure would be greater than the limits described above.

At the Tank Farms, hierarchy of controls are established in a strategic way based on identified hazards, providing layer upon layer of protections for workers both inside and outside of the "unrestricted boundary" minimizing the risk of exposure, and applying ALARA to non-radiological chemical vapor hazards meeting regulatory limits. This control strategy is depicted in Figure 3, Tank Farm Boundaries and Controls.

Figure 3. Tank Farm Boundaries and Controls



Conclusions

Defining the unrestricted boundary must take into account several factors:

- Worker safety regulatory/requirement basis
- Potential for worker/co-located worker exposure
- Basis of compliance with other applicable regulations and operational efficiency

Based on requirements affecting worker safety and health, an unrestricted boundary could be placed at the point in which the potential for exceeding 50% of an OEL is considered unlikely (i.e., at the VCZ or exclusion zone boundary). However, current operational controls and facility access controls are in place that aid in complying with other regulations including WAC 173-303 and the Hanford Site RCRA Permit, as well as OSHA HAZWOPER regulations. Operational systems such as ACES and key control used to prohibit untrained and unqualified personnel from entry into the Tank Farms are in place and are controlled at the Tank Farm fenceline.

Therefore, it is recommended that the Unrestricted Boundary related to Tank Farm vapors be established where practical at a Tank Farm fenceline. Where a tank vapor hazard potentially exists outside of a Tank Farm fenceline, appropriate controls will be established to prevent access and to maintain exposures to unauthorized personnel below 50% OEL. The area from the unrestricted boundary to the site boundary will be considered the unrestricted area for which the co-located worker and members of the public under trained and authorized escort can be assured that while they likely may experience odors, they will not be exposed to tank vapor hazards at levels that could place them at risk of exceeding an OEL.