EVENT INVESTIGATION REPORT

U Farm Change Trailer AOP-015 Event

Event Investigation 2019-019

[redacted]

[redacted] Event Investigation Team Lead — 5/14/2019 Date

[redacted]

[redacted] Responsible Manager — 5/14/2019 Date

Executive Summary

On Monday, April 22, 2019 at 1000, while performing monthly GFCI outlet maintenance adjacent to the U Farm Change Trailer (MO297), odors were noticed by two electricians. A Health Physics Technician (HPT) who was accompanying them did not notice an odor. The electricians reported an “onion-like” odor.

The lead electrician notified their supervisor via cell phone. The Field Work Supervisor (FWS) instructed the group to stop work activities and return to 272WA. The FWS notified the Central Shift Office (CSO). The CSO declared and AOP-015 and made notifications per procedure. The CSO initiated and Event Investigation

One of the two electricians experienced watery eyes that coincided with detecting the odor. That electrician went to HPMC for evaluation and was subsequently released back to work with no restrictions. Neither the second electrician nor the HPT exhibited any symptoms. Both of these individuals declined medical evaluation.

Interviews with the affected individuals were conducted in lieu of an event investigation meeting. The results of the investigation were indeterminate. *Potential* sources were outlined in the APGEMS report; however, tank vapors were considered an *unlikely* source. The *plausible but indeterminate* source was the recent servicing of portable toilets nearby.

Investigation Summary

On Monday, April 22, 2019 at 0700, a pre-job brief was held at 272WA for monthly GFCI (Ground Fault Circuit Interrupter) electrical outlet checks in U Farm. In attendance were all the assigned personnel. This included two electricians, an HPT, and the FWS. The brief covered the work scope, job hazards, required PPE, and response to potential abnormal conditions. It also covered duties and responsibilities of each of the personnel. During the brief, one of the electricians mentioned that in the past there have been odors detected at U Farm in the early hours of the day probably from barometric breathing. The brief was concluded at 0710, and the individuals travelled together to the mask station to get SCBA equipment for the farm entry.

At 0900, the work group arrived at the U Farm change trailer. The team entered the change trailer, donned their gear, and entered U farm to complete checks on 12 GFCI outlets spread throughout the Farm. At 0930, they returned to the change trailer, having completed their GFCI checks without incident. The first electrician doffed his gear, was surveyed out by the HPT, and then proceeded to exit the change trailer for a break.

At 0917 until 0925, the GPS on the portable toilet pumper truck indicates it was located at MO-297 pumping the portable toilets just north of the building. This is a potential source of the onion odors.

As the HPT continued to perform material and equipment surveys on both the SCBA equipment and the second electrician, an Instrument and Control (I & C) specialist and another HPT entered the change trailer. They were there to perform repairs to the non-functional whole-body detector (ARGOS) inside the change trailer.

At 0950, the first HPT had completed the survey of the second electrician and a majority of the SCBA gear. The second electrician gathered the surveyed gear and took it to the truck.

At 0955, as the second electrician started walking back to the change trailer, he was joined by the first electrician. As they moved toward the stairs for the change trailer, they both detected an

onion-like odor. The first electrician experienced watery eyes that coincided with detecting the odor. Both individuals climbed the stairs and re-entered the change trailer. They informed the HPT that they had detected odors outside. Their HPT had just completed the material and equipment survey on the remaining SCBA gear and was gathering it to take to the truck. The lead electrician called the FWS on his mobile phone and notified him of the odor. The FWS directed the crew to secure from their activities and return to 272WA. The other workers heard the conversation, secured from work activities, and prepared to leave the change trailer. The electricians located odor response cards in the change trailer and filled them out as their HPT finished gathering up the SCBA gear.

At 1000, all five individuals departed the change trailer together. As they departed, the lead electrician again detected the odor as they were transiting from the change trailer door to the truck. No other individuals reported detecting odors during this transit. Each group loaded their respective trucks and departed the area. The first work group drove back to 272WA. The second work group drove to the S-Farm complex to continue their work assignments.

At 1005, the electricians returned to 272WA and gathered in the conference room. They submitted their odor response cards to the FWS. They were asked if anyone had exhibited symptoms. One electrician told the FWS of his irritated, watering eyes. He agreed to be evaluated, and at 1020, that electrician arrived at HPMC. At 1130, he was released with no restrictions. The other individuals indicated that they had no symptoms and declined evaluation.

At 1019, the CSO sent out a SOEN declaring an AOP-015 at U Farm Change Trailer, and at 1023, the odor response cards were received at the CSO.

In lieu of an event investigation meeting, individual interviews were conducted with key personnel. They were able to confirm an already detailed timeline of events, which was put together in real time by the responding IHTs and the CSO.

The results of the investigation were indeterminate. *Potential* sources were outlined in the APGEMS report; however, tank vapors were considered an *unlikely* source. The *plausible but indeterminate* source was the recent servicing of portable toilets nearby.

Event Timeline (Edited from IHIR Timeline)

4/22/2019

0900: Work group arrives at MO-297
0917: Pumper truck arrives at MO-297 to pump two portable toilets just north of the building.
0925: Pumper truck completes pumping portable toilets north of MO-297
1017: Entered TF-AOP-015 Response to Reported Odors or Unexpected Changes to Vapor Conditions. x2 electricians reported smelling an onion like odor west of U Farm change trailer. One electrician reported symptoms of watery, irritated eyes, and was taken to HPMC for evaluation by . The second electrician did not report symptoms and declined medical evaluation. Odor response cards completed. Access to U farm change trailer and immediate upwind area restricted
1018: Production Operations (PO) Safety and Health (S&H) Manager Notifies AN Team Field Industrial Hygienist (IH) and Central Operations and Maintenance (COMs) Field IH of Tank Farms Abnormal Operating Procedure 015 (TF-AOP-015) entry
1019: AN Team Field IH and COMs Field IH arrive at Central Shift Office (CSO)
1019: Central Shift Manager (CSM) Briefs AN Team Field IH and COMs Field IH:
- 2 Electricians smelled onion odor
- 1 Electrician reported symptoms and is in route to on-site medical provider (HPMC)
- 1 Electrician decided to "self-treat" and reported no symptoms

1019: Shift Operations Event Notification (SOEN): "Entering AOP-015 for odors reported west of U Farm change Trailer. Access restricted to U farm change trailer. All personnel stay upwind of the area. CSM"
1023: Odor Response Cards (ORCs) are delivered to CSO
1039: AN Field IH and COMs Field IH brief PO Shift IHTs on response actions:
- Respiratory Protection Equipment (RPE) will be worn in accordance with Respiratory Protection Form (RPF) TF-AOP-015 task 2
- Make contact with TGIHRV TGETs and coordinate placement of sampling equipment as close to event scene as possible (limited by 208ft hose)
- Monitor North towards MO297 and sweep area
- Collect grab sample of source if identified
- Collect grab sample of ambient atmosphere in area of concern in no sources are identified

1040: IHTs depart CSO to perform response actions
1054: CSM contacts PFP CSO to acquire access permission for PO Shift IHTs

1104: FWS contacts CSM to notify that HPT is about to be offered voluntary medical evaluation, but did not notice any odor or experience any symptoms

1105: Event Investigation Report (EIR) Point of Contact (POC) contacts CSM:

- EIR POC is assigned
- EIR-2019-019 "U Farm Change Trailer AOP Event" is being initiated

1112: FWS contacts CSM to notify that HPT has declined voluntary medical evaluation at HPMC and has declined submitting an odor response card as no odor was encountered and no symptoms were experienced

1118: PO Shift IHTs contact CSM via radio for guidance on grab sample collection. CSM notified PO Shift IHTs that grab sample should be collected outside of MO297

1128: PO Shift IHTs contact CSM via radio to notify that all readings were less than detectable (<DL) and grab sample was collected

1152: PO Shift IHT Supervisor updates COMs IH:

- Rock salt and portable bathrooms were in the immediate vicinity of the area of concern
- All readings (ammonia [NH_3], volatile organic compounds [VOC], Hg, nitrous oxide [N_2O]) from grab samples were <DL
- Grab samples are in route to 2704HV IHT Lab

1450: Closing TF-AOP-015. IHP-09001 response actions are complete and no hazards were detected. Response action analysis results are at or below background levels. Exiting TF-AOP-015.

1502: SOEN: "Response actions for the TF-AOP-015 event have been completed and the results are at or below background levels. Exiting TF-AOP-015. CSM"

Meteorological Data

<table>
<tr><td>Event</td><td>U Farm Change Trailer AOP-015 Event</td></tr>
<tr><td>Date/time of event</td><td>April 22, 2019 1000</td></tr>
<tr><td>Location</td><td>Outside U Farm Change Trailer (MO 297)</td></tr>
<tr><td>Odor</td><td>“Onion- like” Odor</td></tr>
<tr><td>Symptoms</td><td>1 worker reported irritated, watering eyes, 1 other reported no symptoms</td></tr>
<tr><td>DRI results during event</td><td>Less than the Level of Detection (LOD) for ammonia (NH3) and Volatile Organic Compounds (VOCs) on sweep of reported odor location</td></tr>
<tr><td>Possible source(s)</td><td>Unknown</td></tr>
<tr><td>Weather conditions on April 22, 2019 1300 (data from Weather Station 19)</td><td>
<table>
<tr><th>Time</th><th>Wind Dir (From)</th><th>Wind Speed</th><th>Ave Temp</th><th>Bar</th><th>Relative Humidity</th></tr>
<tr><td>0930</td><td>143.0</td><td>4.0mph</td><td>59.0F</td><td>29.5</td><td>46%</td></tr>
<tr><td>1000</td><td>143.0</td><td>2.0mph</td><td>57.6F</td><td>29.5</td><td>54%</td></tr>
</table>
</td></tr>
<tr><td>Waste disturbing or tank work in adjacent area</td><td>No waste disturbing activities or tank work occurring in U Farm or adjacent areas.</td></tr>
</table>

IH Response Team Sample Results (Adjacent to U Farm)

Agent	Result*
NH_3	<IDL
H_2S	<IDL
N_2O	<IDL
Hg	<IDL
VOC	<IDL

*Instrument Detection Limit

Compensatory Measures

- The affected in-field workers called the FWS who had them stop their activities and return to 272WA.

Preliminary Extent of Condition Review

- No extent of condition exists for this investigation.

Discussion of Potential Sources

- Vapors from the U Farm tanks are a potential source.
- Pumping of the two portable toilets north of MO-297 are a potential source

Discussion of Barriers That Could Have Impacted the Cause

- There were no barriers identified that could have impacted the cause

Recommendations/Proposed Corrective Actions

- No recommendations or proposed corrective actions.

Positives aspects from the event

- The event response was well coordinated from the CSO.
- Electricians immediately informed their supervisor of the odors.
- Industrial Hygiene was very effective in coordinating personnel to assist in the initial odor response.

Figures:

1. Aerial View of U farm.

Attachments:

1. Industrial Hygiene Investigation Report (IHIR) (Includes Odor Response cards)
2. APGEMS-TF Plume Modeling Report

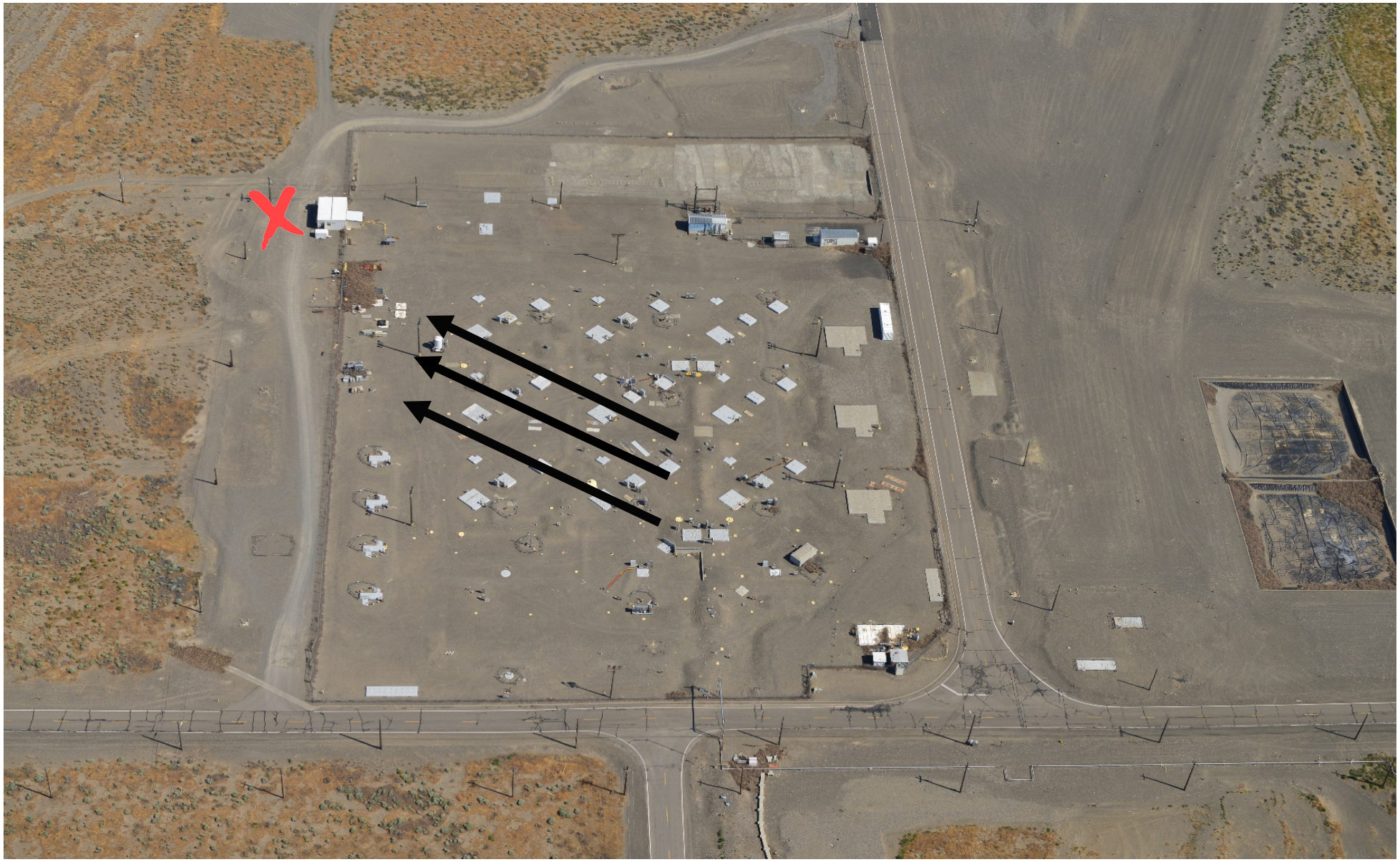


Figure 1 - Aerial View of U Farm – Red "X" shows location of detected odors, black arrows show wind direction

Attachment 1
Industrial Hygiene Investigation Report

Washington River Protection Solutions **TF-AOP-015 INDUSTRIAL HYGIENE INVESTIGATION REPORT**	**PER Number:** WRPS-PER-2019-0781
Time/Date & Event location: 1007 04/22/2019 near 241-U Farm West of MO297	**EIR Number:** EIR-2019-019

1. **Event Summary** *(including number of workers involved and activity in progress):*

   2 Electricians performing Ground Fault Circuit Interupter (GFCI) inspections outside of Mobile Office 297 (MO297) encountered an "onion-like" odor. One electrician reported experiencing "watery/irritated eyes/trouble with vision". 1 Health Physics Technitian (HPT) supporting the Electricians did not experience the odor or symptoms.

   - Was an IHT Present during initiating event? [ ] Yes [X] No

   IH Monitoring/ Sample Survey Reports:

   Event response: 19-02890 "U-Farm AOP 015 response"

   Weather Conditions at Time of Event:

   Ambient outside conditions:

   - Weather station: 19 @1000
   - Wind Direction and Speed: NW @ 2 mph
   - Barometric Pressure *(steady/rising/falling)*: 29.50" and steady
   - Temperature (F°): 57.6
   - Humidity: 54%

Field Response Timeline:

1018: Production Operations (PO) Safety and Health (S&H) Manager Notifies AN Team Field Industrial Hygienist (IH) and Central Operations and Maintenance (COMs) Field IH of Tank Farms Abnormal Operating Procedure 015 (TF-AOP-015) entry
1019: AN Team Field IH and COMs Field IH arrive at Central Shift Office (CSO)
1019: Central Shift Manager (CSM) Briefs AN Team Field IH and COMs Field IH:
- 2 Electricians smelled onion odor
- 1 Electrician reported symptoms and is in route to on-site medical provider [Hollie P. Mooers Corporation (HPMC)]
- 1 Electrician decided to "self-treat" and reported no symptoms

1019: Shift Operations Event Notification (SOEN): "Entering AOP-015 for odors reported west of U Farm change Trailer. Access restricted to U farm change trailer. All personnel stay upwind of the area. CSM"
1020: PO S&H Manager arrives at CSO
1020: Terra-Graphics Industrial Hygiene Response Van (TGIHRV) in route to CSO
1023: Odor Response Cards (ORCs) are delivered to CSO
1023: PO Shift Industrial Hygiene Technicians (IHTs) arrive at CSO
1024: Terra-Graphics Engineering Technicians (TGETs) arrive at CSO in TGIHRV and are briefed by AN Team Field IH and COMs Field IH:
- Proceed to 16th St. and MO297 access road (access restriction boundary) and prepare instrumentation and equipment
- PO Shift IHTs will make contact and place sampling equipment

1025: PO Shift Nuclear Chemical Operators (NCOs) briefed for access restriction placement
1026: CSM informs COMs Field IH response actions were initiated as per TF-AOP-015 3.1.12
1027: PO Shift NCOs depart CSO to perform access restriction actions
1027: PO Shift IHTs notify AN Field IH and COMs Field IH that instruments are warming up
1036: TGETs leave CSO to take TGIHRV to access restriction boundary
1038: PO Shift IHT Supervisor arrives at CSO
1039: AN Field IH and COMs Field IH brief PO Shift IHTs on response actions:
- Respiratory Protection Equipment (RPE) will be worn in accordance with Respiratory Protection Form (RPF) TF-AOP-015 task 2
- Make contact with TGIHRV TGETs and coordinate placement of sampling equipment as close to event scene as possible (limited by 208ft hose)
- Monitor North towards MO297 and sweep area
- Collect grab sample of source if identified
- Collect grab sample of ambient atmosphere in area of concern in no sources are identified

1040: IHTs depart CSO to perform response actions
1044: COMs Field IH requests PO Shift IHT Supervisor contact IH Programs IHT Lead to ensure HAPSITE® is prepared to support analysis of grab samples
1044: PO Shift IHT supervisor contacts IH Programs IHT Lead to request HAPSITE® be prepared to support analysis of grab samples
1050: AY/AZ Field IH contacts SY Field IH to request support
1053: PO Shift IHTs contact CSM for permission to enter Plutonium Finishing Plant (PFP) restricted access zone
1054: CSM contacts PFP CSO to acquire access permission for PO Shift IHTs
1055: PO Shift IHT Supervisor inquires if, and is informed that elemental Mercury (Hg) analysis by Ohio Lumex is requested for grab samples
1102: COMs Field IH requests that the CSM make contact with the Field Work Supervisor (FWS) for the initiating work evolution to inquire as to the status of the 3rd individual (HPT) referenced in the ORCs
1104: FWS contacts CSM to notify that HPT is about to be offered voluntary medical evaluation, but did not notice any odor or experience any symptoms
1105: Event Investigation Report (EIR) Point of Contact (POC) contacts CSM:
- EIR POC is assigned
- EIR-2019-019 "U Farm Change Trailer AOP Event" is being initiated

1112: FWS contacts CSM to notify that HPT has declined voluntary medical evaluation at HPMC and has declined submitting an odor response card as no odor was encountered and no symptoms were experienced

1118: PO Shift IHTs contact CSM via radio for guidance on grab sample collection. CSM notified PO Shift IHTs that grab sample should be collected outside of MO297

1122: COMs Field IH requests PO Shift IHT Supervisor notify COMS Field IH and AN Field IH of sweep completion, survey number, and post-use function check status when available

1128: PO Shift IHTs contact CSM via radio to notify that all readings were less than detectable (<DL) and grab sample was collected

1152: PO Shift IHT Supervisor updates COMs IH:

- Rock salt and portable bathrooms were in the immediate vicinity of the area of concern
- All readings (ammonia [NH_3], volatile organic compounds [VOC], Hg, nitrous oxide [N_2O]) from grab samples were <DL
- Grab samples are in route to 2704HV IHT Lab

1206: PO Shift IHT Supervisor confirms that grab samples have arrived at 2704HV IHT Lab for HAPSITE® analysis

1207: COMs Field IH confirms with PO Shift IHT that post-use function tests passed

1213: COMs Field IH updates CSM:

- Post-use function check passed
- Grab samples have been delivered to 2704HV for HAPSITE® analysis
- Site Wide Industrial Hygiene Database (SWIHD) survey #19-02890

1502: SOEN: "Response actions for the TF-AOP-015 event have been completed and the results are at or below background levels. Exiting TF-AOP-015. CSM"

Field IH Author:

[redacted] [redacted] [redacted] 04/23/2019

Print First and Last Name *Signature* *Phone No.* *Date*

2. **GCMS Sample Results:**

See Attachment A for HAPSITE (GCMS) results.

3. Additional Information:

- Odor Response Cards received:

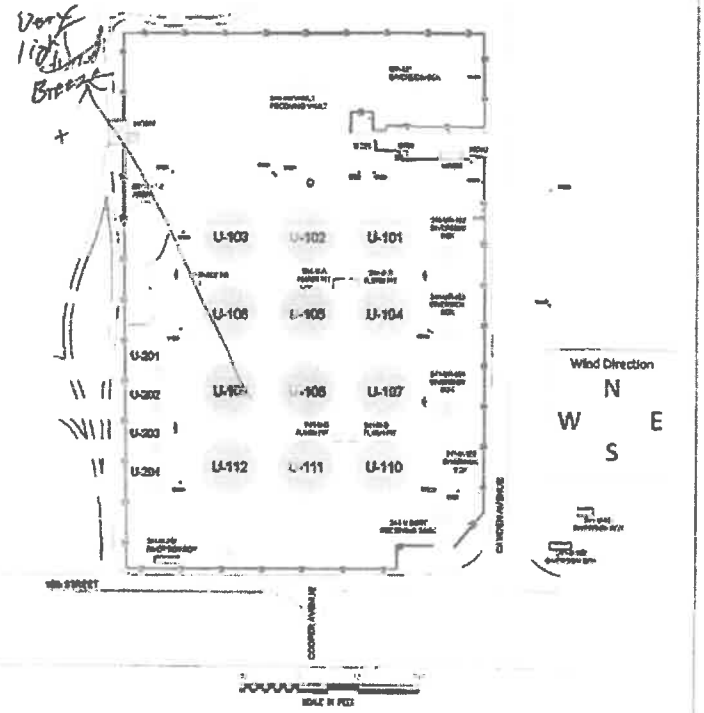
ODOR RESPONSE CARD - 241-U FARM

Odors Detected with *NO* Immediate symptoms

1. Notify Immediate Supervisor.
2. Contact Central Shift Manager, [redacted] Provide the bulleted information below.
3. Complete map, return to Central Shift Office as soon as practicable.

Odors Detected *WITH* Symptoms

4. Notify Immediate Supervisor.
5. Contact CSM, [redacted] complete below bulleted information and map.
   - Your name and the work you were performing
   - Your symptoms *(if any)*
   - Date and time odor was noticed
   - Location of odors *(mark area on map and the wind direction)*
   - Describe the odor
   - Name of other in or near the affected area
   - Was an IHT present?
   - Possible source
6. Provide information on the back of card.
7. Send this card immediately to the Central Shift Office.



Page 1 of 2 — OFFICIAL USE ONLY (when filled in) — A-6008-944 (REV 1)

ODOR RESPONSE CARD - 241-U FARM

1. Contact CSM, Complete below bulleted information and map.

- Date and time odor was noticed 4/22/19 0955
- Your name and the work your were perfoming [redacted] GFCI Monitor
- Location of odors *(mark area on map and wind direction)*
- Name(s) of others in or near the affected area [redacted] [redacted]
- Was an IHT present? No
- Describe the odor ☐ Sweet ☐ Sour ☐ Musty ☐ Earthy ☐ Metallic ☐ Smoky ☐ Rotten ☒ Onion ☐ Cleaning Solution ☐ Ammonia ☐ Other:
- Possible Source Tank Farm
- Your symptoms *(If any)* ☐ Headache ☐ Dizziness/Light-Headed ☐ Nausea ☐ Cough ☐ Fatigue/Drowsiness/Weakness ☐ Sore/Burning Throat ☐ Difficulty Breathing ☐ Watery/Irritated Eyes/Trouble with Vision ☐ Tingling/Numbness/Paralysis ☐ Rash/Itching ☐ Other: Not at this Time

2. Send this card to the Central Shift Office.

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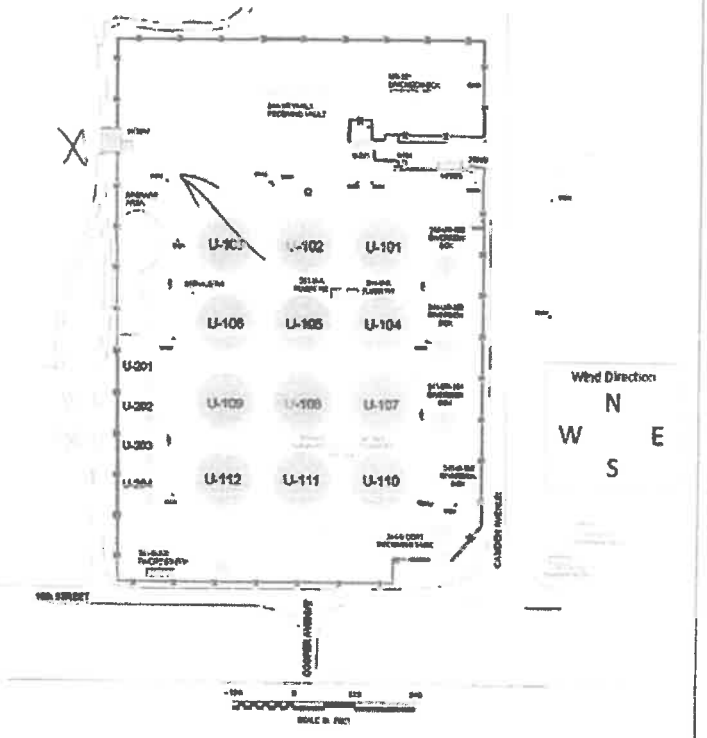
ODOR RESPONSE CARD - 241-U FARM

Odors Detected with *NO* immediate symptoms

1. Notify immediate Supervisor.
2. Contact Central Shift Manager, [redacted] Provide the bulleted information below.
3. Complete map, return to Central Shift Office as soon as practicable.

Odors Detected *WITH* Symptoms

4. Notify immediate Supervisor.
5. Contact CSM, [redacted] complete below bulleted information and map.
   - Your name and the work you were performing
   - Your symptoms *(if any)*
   - Date and time odor was noticed
   - Location of odors *(mark area on map and the wind direction)*
   - Describe the odor
   - Name of other in or near the affected area
   - Was an IHT present?
   - Possible source
6. Provide information on the back of card.
7. Send this card immediately to the Central Shift Office.



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A-6006-944 (REV 1)

ODOR RESPONSE CARD - 241-U FARM

1. **Contact CSM, Complete below bulleted information and map.**

- Date and time odor was noticed 4/22/19 9:55 AM
- Your name and the work your were performing [redacted] GFCI ✓
- Location of odors *(mark area on map and wind direction)* Outside Change Trailer
- Name(s) of others in or near the affected area [redacted]
- Was an IHT present? No
- Describe the odor ☐ Sweet ☐ Sour ☐ Musty ☐ Earthy ☐ Metallic ☐ Smoky ☐ Rotten ☒ Onion ☐ Cleaning Solution ☐ Ammonia ☐ Other: _____
- Possible Source Tank Farms
- Your symptoms *(if any)* ☐ Headache ☐ Dizziness/Light-Headed ☐ Nausea ☐ Cough ☐ Fatigue/Drowsiness/Weakness ☐ Sore/Burning Throat ☐ Difficulty Breathing ☒ Watery/Irritated Eyes/Trouble with Vision ☐ Tingling/Numbness/Paralysis ☐ Rash/Itching ☐ Other: _____

2. Send this card to the Central Shift Office.

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A-6006-944 (REV 1)

- Summary of IH Monitoring and Sampling Data:

  a. Monitoring:

  Event Response: 19-02890 "U-Farm AOP 015 response"
  DRI field readings:

VOC:	<DL
NH_3:	<DL

  Grab samples:

VOC:	<DL
NH_3:	<DL
N_2O:	<DL
Hg:	<DL

  b. Sampling:
  N/A

4. Summary of Employee Reported Information *(e.g., symptoms)*

One employee reported experiencing "watery/irritated eyes/trouble with vision"

5. Recommendations/Conclusions:

Identification of Source of the Concern: [ ] Yes [X] No

6. Other:

S&H Program Management:

[redacted]	[redacted]	[redacted]	4/23/19
Print First and Last Name	*Signature*	*Phone No.*	*Date*

Attachment A

GCMS Laboratory Results

HAPSITE GC-MS Bag Sample Results Survey 19-02890: AOP-15 at U Tank Farm Trailer Rev 1.

A bag sample was collected in response to an odor reported at the U-Farm Change Trailer. These samples were analyzed using an Inficon HAPSITE GC-MS on April 22, 2019. Data was interpreted on April 23, 2019, and reported the same day. Results for the Air Blank Sample were satisfactory. The compounds listed below were found in Bag #1 U-Farm Trailer at concentrations consistent with sample bag contaminants. **No compounds were found at concentrations of concern. No compounds were found at concentrations above background.**

Compounds Found in Samples

Compound	Clean Air Blank	Bag #1 U-Farm	Sample Bag Contaminant	Comments
Internal Standard #1	X	X		Added by instrument during analysis
Toluene		X	X	Not found above background
Internal Standard #2	X	X		Added by instrument during analysis
D-Limonene		X	X	Not found above background
Silane Compound		X	X	Not found above background
C11-15 Alkane Hydrocarbons		X	X	Not found above background

If you have questions contact [redacted] CIH at [redacted]

[redacted]

Attachment 2
APGEMS-TF Plume Modeling Report

On Monday, April 22, 2019 at 1000, while performing monthly GFCI outlet maintenance adjacent to the U Farm Change Trailer (MO297), odors were noticed by two electricians. A Health Physics Technician (HPT) who was accompanying them did not notice an odor. The electricians reported an "onion-like" odor.

One of the two electricians experienced watery eyes that coincided with detecting the odor. One electrician went to HPMC for evaluation. The electrician was released back to work with no restrictions. Neither the second electrician nor the HPT exhibited any symptoms. Both of these individuals declined medical evaluation.

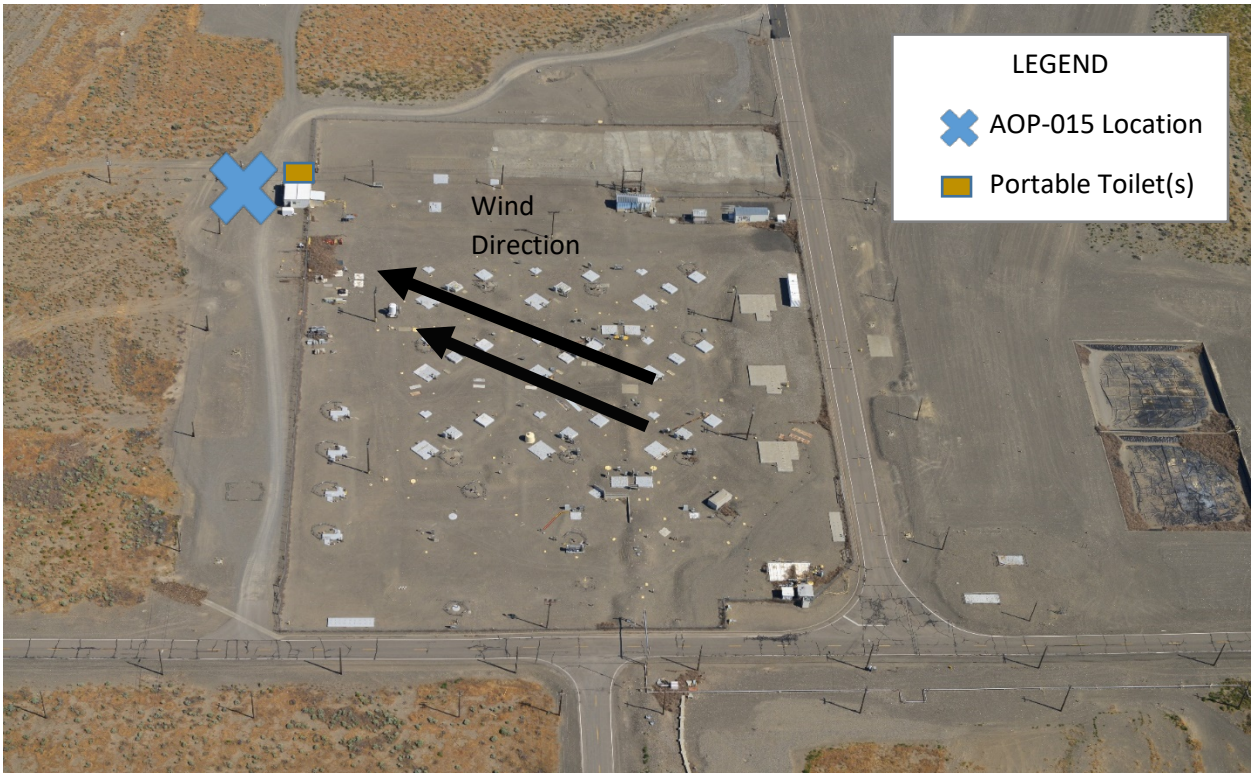

Figure 1. AOP-015 Locations in Relation to Potential Vapor Sources.

Potential Vapor Sources:

Onion smells are associated with thiols (sulfur-containing analog of alcohol where sulfur replaces oxygen, R-S-H - also called mercaptans) and other sulfur containing compounds[1, 2]. Mercaptans are most commonly found in sewer emissions and are products of microbial decomposition of organic matter. The portable toilets on the north side of MO297 were serviced (pumped out) on the same day of the AOP-015 odor event. GPS on the pumping truck indicated the truck was at MO-297 from 0917 until 0925. Anecdotal experience indicates that the area around these pumping activities are quite "smelly" during the service but resume to normal sometime after the service. Though the portable toilet service was performed approximately 35 minutes prior to the AOP-015 event, this is a potential source.

Search of the TWINS database indicates three sulfur-containing compounds are present in the U-Farm tanks as follows: carbon disulfide, n-Butyl-benzenesulfonamide, and butanethioic acid, S-decyl ester.

Pure carbon disulfide has a pleasant odor that is like the smell of chloroform; however, impure carbon disulfide has an unpleasant odor like that of rotting radishes. N-Butyl-benzenesulfonamide is used as a plasticizer in polymers (Nylon 11, 12, polyacetals, polycarbonates), but has no available odor data. Based on the structure of n-butyl-benzenesulfonamide, it could decompose over time to benzenethiol, which has a pungent odor and very low odor threshold. Butanethioic acid, S-decyl ester also has no available odor data, but based on its structure could decompose to butanethiol, which exhibits an extremely foul 'skunk' odor. The maximum concentrations of these two postulated thiol compounds in U-Farm are 1.5 to 2 orders of magnitude above their odor thresholds (see Table 1). Carbon disulfide concentrations in the tank headspaces are below its odor threshold and are thus not a potential source of the odor event.

Table 1. Odor Causing Chemicals in the U-Farm Tanks (Concentrations and Odor Thresholds)

	Maximum Reported Concentration in U-Farm Tank Headspaces (ppm)	Odor Characteristic	Odor Threshold (ppm)[a]	Most Recent Analysis	OEL (ppm)	NIOSH REL (Recommended Exposure Limit in ppm)
Ammonia	2,502	pungent	5	2005	25	25
Butanethioic acid, S-decyl ester	0.022	- -	- -	1995	NA	- -
Butanethiol (potential degredation product)	- -	garlic, skunk	0.0014	NA	NA	0.5
Benzenesulfonamide, N-butyl-	0.03	- -	- -	1995	NA	- -
Benezenethiol (potential degredation product)	- -	unpleasant, pungeant	0.00031	NA	NA	0.1
Carbon disulfide	0.053	chloroform, foul	0.095	1997	NA	1

[a] Devos, M., F. Patte, J. Rouault, P. Laffort, L.J. Van Gemert; Standardized Human Olfactory Thresholds, Oxford University Press, New York, NY, 1990.

U-Farm tanks are interim stabilized, but still have significant liquid waste and vapors left in them. U-Farm is known for having high concentrations of ammonia in the headspace, up to 2,500 ppm recorded in the TWINS database. Although ammonia is not typically associated with an onion smell, it is pungent and could contribute to an odor event. Ammonia and other chemicals of potential concern (COPCs) in the U-Farm tanks were modeled using APGEMs-TF to ensure that concentrations were below levels of concern.

Site maps indicate that there are no dumpsters or stationary sewer systems in the area of U-farm and thus do not constitute potential vapor sources.

APGEMS-TF Modeling Results Conclusions:

The APGEMS Tank Farm plume model (APGEMS-TF) was used to support investigation of the AOP-015 event and evaluate nearby sources as potential culprits. Results of the modeling are summarized as follows:

- **Tank waste vapors are an unlikely source of the AOP-015 odors**. The reasoning for this conclusion is as follows:
    - Modeling results indicated that odiferous compounds in the tanks were at least two orders of magnitude below their odor thresholds at the AOP-015 location.
    - Modeling results indicated that all COPCs were ≤ 0.01% of OEL at the AOP-015 location.
    - Meteorological conditions at the time AOP-015 event were consistent with possible exhaling of the tank vapors through passive breather filters, but these conditions are accounted for by using maximum emission rates as inputs to the models.

- **Servicing of the portable toilets at MO297 is a plausible but indeterminate source of the AOP-015 odors**. The reasoning for this conclusion are as follows:
    - The toilets were pumped about ½ hour prior to the AOP-015 event.
    - The AOP-015 location was directly downwind and very close to the serviced toilets.
    - Onion smell is consistent with mercaptan compounds common to sewers and degradation of biological waste.
    - Meteorological conditions were consistent with a slow dispersion of heavy compounds emanating from the fresh sewage.
    - The source is indeterminate because the duration between pumping of the toilets and the AOP-015 event is normally long enough for the sewer vapors to disperse below odor thresholds.

Mechanisms for Vapor Emissions from Passive Breather Filter Tanks:

Passively ventilated tanks in U-Farm periodically emit vapors under certain meteorological conditions. The three mechanisms and corresponding meteorological conditions for vapor emissions from passively ventilated tanks are as follows: 1) equilibration of headspace pressure with outside pressure (falling barometric pressure), 2) buoyancy effect due to differences in headspace gas and outside air density (ambient temperatures cooler than headspace temperatures), and 3) venturi effect around passive breather filters (wind velocity). At the time of this AOP-015 event, the barometric pressure was stable, the ambient air temperature was 61°F and the wind speed was 3.7 mph. Based on the buoyancy mechanism and a lack of an increasing barometric pressure, which would drive air into the tank, it is possible that the passive breather filters were emitting vapors prior to and during the AOP-015 event.

APGEMS-TF Modeling:

The APGEMS-TF model generates a 3-dimensional wind field utilizing meteorological data from 30 weather stations on the Hanford site. The model then utilizes measured mixing heights and stability classes to estimate mixing and dispersion of contaminants within the wind field. The model estimates dispersion of chemical contaminants from a source and estimated concentrations downwind of the source, but does not estimate a source location based on a receptor location.

At 10:00 AM on 4/22/19, the Hanford meteorological station located in the 200W area (Station 19 near PFP) had a wind speed of 3.7 mph (light and variable) and wind direction from the E/SE (116 deg.). One would expect relatively low levels of mixing due to the low wind speed, but horizontal plume widths would be relatively wide due to variable wind direction. The stability class was neutral, so vertical mixing is expected to be minimal.

APGEMS-TF Modeling of Ammonia PBF Emissions as a Potential Vapor Source:

APGEMS-TF modeling was performed to predict the maximum release of ammonia from U-Farm tanks at the time of the AOP-015 event. The APGEMS-TF model uses source terms equal to the highest measured headspace concentration for each chemical and each tank and an upper bound emission rate for passive breather filters. Results from APTGEMS-TF modeling for ammonia are provided in Figure 2. The image includes predicted ammonia concentrations at the time of the AOP-015 event as shown by concentration contour lines with the innermost contour line equal to the highest concentration shown in the right-hand legend. Each successive contour line moving out from the center is 1/10 the

concentration of the prior. The highest contour line shown in Figure 2 is 100 ppb and the worker location is consistent with a concentration contour of 0.1 ppb indicating that worker exposure to ammonia was several orders of magnitude below the odor threshold and occupational exposure level (OEL). Therefore, U-Farm ammonia emissions are a highly unlikely source of the odors smelled by the workers during the AOP-015 event.

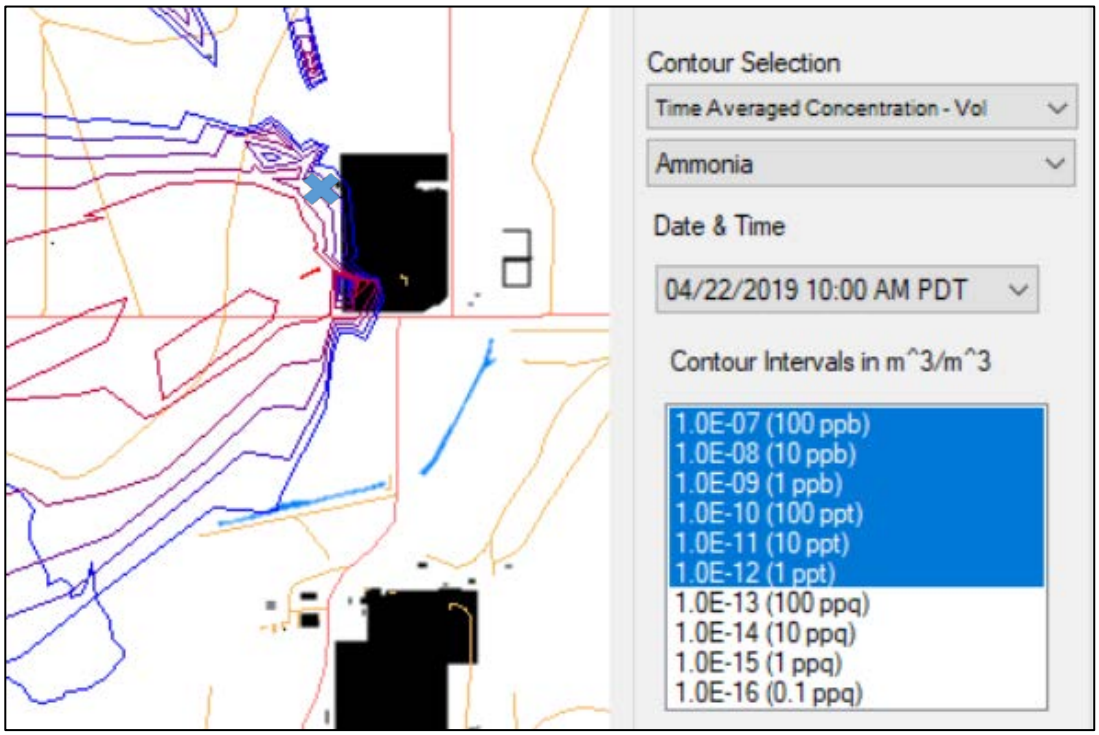

Figure 2. APGEMS Modeling of U-Farm PBFs at Time of AOP-015 Event, Predicted Ammonia Concentration at AOP-015 Location (blue X) is several Orders of Magnitude Below its Odor Threshold

<u>APGEMS-TF Modeling of Thiol PBF Emissions as a Potential Vapor Source</u>:

APGEMS-TF modeling was performed for U-Farm tanks using benzenethiol to represent a possible degredation product of n-Butyl-benzenesulfonamide. Figure 3 shows APGEMS-TF modeling results for U-Farm passive breather filters (PBF) emissions corresponding to maximum observed headspace concentrations of n-Butyl-benzenesulfonamide for each tank and maximum PBF release rates. Concentrations of benzenethiol at the AOP-015 location are estimated at <0.01 ppt, which is at least 3 orders of magnitude below its odor threshold. Therefore, it is highly unlikely that the U-Farm tanks are the source of the AOP-015 vapor event.

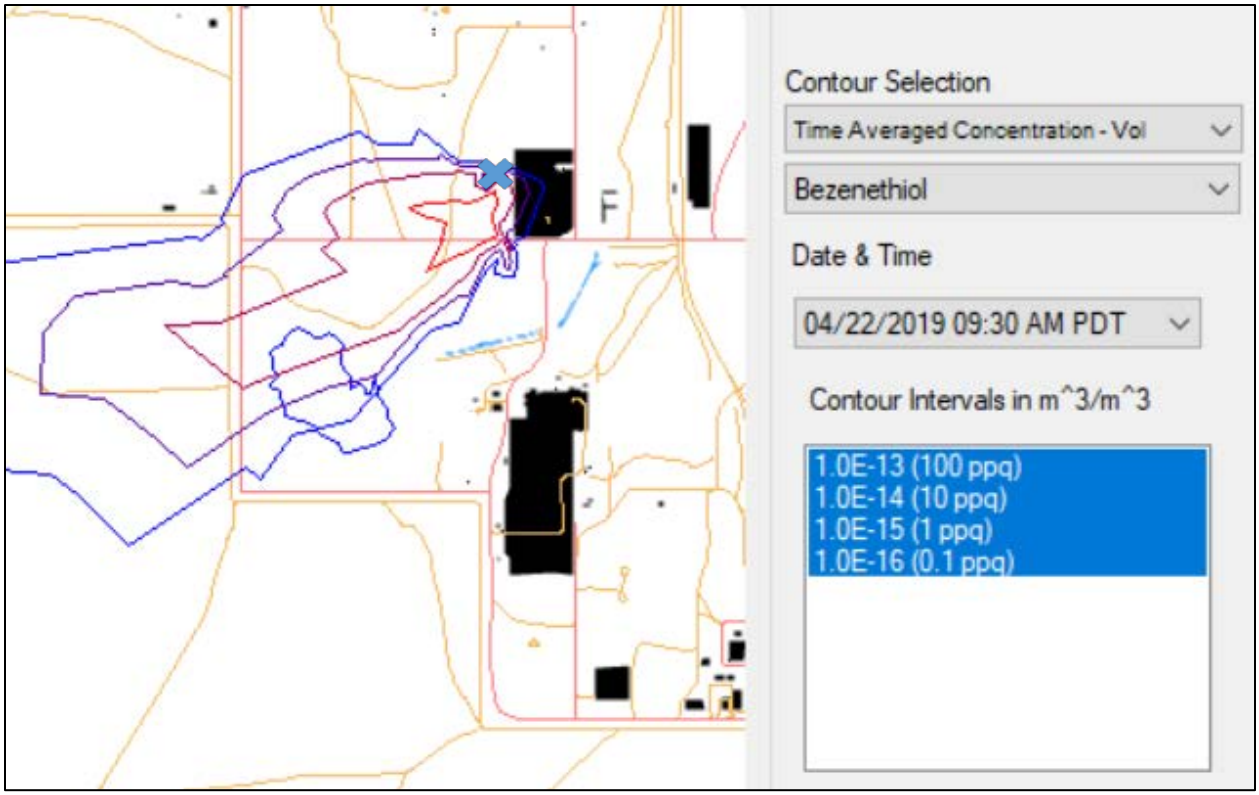

Figure 3. APGEMS Modeling of U-Farm PBFs at Time of AOP-015 Event, Predicted Ammonia Concentration at AOP-015 Location (blue X) is at Least 3 Orders of Magnitude Below its Odor Threshold

APGEMS-TF Modeling of U-Farm COPCs:

APGEMS-TF modeling was performed for U-Farm tanks for all COPCs present in the headspace above their occupational exposure limits (OELs). Per TWINS data, five compounds have been observed above their OELs in U-Farm headspaces as follows: ammonia up to 100 x OEL, nitrous oxide up to 96 x OEL, 2,5-dihydrofuran up to 1.6 x OEL, NMDA up to 290 x OEL, and NMOR up to 19 x OEL. APGEMS-TF modeling was performed for the COPCs based on emissions corresponding to the maximum observed headspace concentration for each tank and the maximum PBF release rates. Concentrations for all COPCs at the AOP-015 location are estimated at < 0.01% of OEL. Therefore, the breathing spaces at the AOP-015 location were safe with respect to tank vapors.

References:

1. https://www.atsdr.cdc.gov/odors/search_results.html , Agency for Toxic Substances and Disease Registry (ASTDR), U.S. Department of Health and Human Services database for odor causing chemicals.
2. EPA600/R-92/047, Reference Guide to Odor Thresholds for Hazardous Air Pollutants Listed in the Clean Air Act Amendments of 1990, Mary 1992