Using Direct Reading Instruments

Tank Farm Maintenance Procedure

Industrial Hygiene

USQ # N/A-4

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CHANGE HISTORY (≤ LAST 5 REV-MODS)

<table>
<thead>
<tr>
<th>Rev-Mod</th>
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<tr>
<td>D-2</td>
<td>10/09/2017</td>
<td>Industrial Hygiene Request</td>
<td>Modified “Radiological and Contamination Control” section to current standard. Modified Notes within procedure in addition to Tables and Attachments.</td>
</tr>
<tr>
<td>D-0</td>
<td>07/24/2014</td>
<td>Periodic Review comment incorporation</td>
<td>In general: Updated Terms and Definitions. Deleted Section 3.1 in conformance with GHA determination. Deleted TMX412 references. Updated references. Deleted WARNINGS to be consistent with GHA. Changed “sampled” to “monitored”. Added word “gases” to vapors. Changed to Project Industrial Hygienist. Tweaks to many steps to make procedure flow better. Added new Step 5.2.11. Deleted Step 5.3.4.</td>
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<tr>
<td>C-0</td>
<td>06/07/2012</td>
<td>Periodic Review comment incorporation</td>
<td>Incorporated changes identified in Periodic Review and update procedure to current procedure format.</td>
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</table>
1.0 PURPOSE AND SCOPE

1.1 Purpose

This procedure provides instructions for selection and general use of direct reading instruments such as multi-gas meters, combustible gas meters, oxygen monitors, photo-ionization detectors (PID), flame ionization detectors (FID), colorimetric indicator tubes, etc. in support of field monitoring performed in accordance with this procedure and an applicable industrial hygiene sampling plan.

This procedure is used in conjunction with other technical instrument procedures to ensure industrial hygiene information is accurately, consistently and systematically collected, maintained, distributed, and retained, and that the data is representative of the monitoring event.

1.2 Scope

This procedure involves the functional checks associated with direct reading instruments and their use in radiological areas.

2.0 INFORMATION

2.1 Terms and Definitions

Breathing zone. The breathing zone is an area approximately 5 to 6 feet from the ground or around the employee’s face which consists of a hemisphere forward from the shoulders with a radius of approximately 6 to 9 inches, i.e., the OSHA definition.

Functional (bump) test. A functional (bump) test is defined as a brief exposure of the monitor to a concentration of vapors/gas(es) in excess of the low alarm set-point for each sensor installed in the instrument for the purpose of verifying sensor and alarm operation. Functional tests are to be used to determine if the instrument is operating within the accuracy tolerances between the recommended periodic calibrations.

Source monitoring. Monitoring one or two inches from potential sources (e.g., a breather filter) for at least two times the instrument response time. The maximum reading noted should be the measurement that is recorded on the survey form.

Instrument response time. The time needed for an instrument’s sensor(s) to respond accurately to a concentration of vapor or gas. Typically, this is indicated as “t90,” that is, the time it takes to read 90% full-scale of the true concentration.
3.0 PRECAUTIONS AND LIMITATIONS

3.1 Equipment Safety

**CAUTION** - Instruments vary in their requirements for proper operation and the manufacturer’s instruction manual should be consulted for these details. For example, an ammonia concentration of 250 ppm or greater should be avoided for the MIRAN 205B SapphIRe since this can affect the gold coating used in its optical system. Multi-gas meters such as the MultiRAE PRO should avoid exposure to silicone vapors and lead fumes since this can negatively affect the operation of the combustible gas sensor.

3.2 Radiation and Contamination Control

3.2.1 Planned work in radiological areas must be approved by Radiological Control personnel per the Radiological Risk Screening procedure TFC-ESHQ-RP-RWP-C-01.

3.2.1.1 When performed without a formal work package or approved procedure (i.e., Level 3 or 4 work), this procedure is limited to radiological areas and work activities permitted by a low risk Radiological Work Permit (RWP).

3.2.2 Filtration requirements for air monitoring equipment.

- A radiological particulate pre-filter (1~3 micron pore size, 25 mm diameter) when monitoring in a Contamination Area (CA), High Contamination Area (HCA), or Airborne Radioactivity Area (ARA), if instrument is capable. Not required, but encouraged in posted Radiological Buffer Areas (RBA).

- The “Bacterial Air Vent” filter (manufactured by Pall – Galman Laboratory) ahead of the radiological filter when monitoring from unfiltered tank systems. This is a sealed filter that cannot be opened for radiological survey purposes, in this case, dispose of as low level radioactive material waste if needed.

- The use of parallel, sacrificial sorbent tubes or sample media, or multiple filters may be necessary depending on intended use and equipment parameters. A specific radiological Release Survey Plan (RSP) would need to address this allowance.
3.2 Radiation and Contamination Control (Cont.)

3.2.3 Before conducting sampling or monitoring, contact the responsible Radiological Control personnel for the facility or area to determine any specific survey or monitoring requirements.

- Pre, during, and post contamination survey requirements.
- Any applicable RSP’s for your specific equipment or task.
- Alternative survey or monitoring needs to support the radiological release survey process.

3.2.4 Comply with the requirements set forth by the RWP, HPT coverage, Release Survey Plan (RSP), and any other applicable procedures as determined above.

3.2.5 When exiting radiological areas where no HPT coverage was provided, inform the radiological control personnel of the use/history for the equipment being presented (e.g., only sampled air in the Contamination Area, No known history of contamination based on use, etc.) to aid them in properly evaluating the radiological release criteria needed.

3.2.6 Samples collected in a radiological area shall not be removed from the facility, transported by personnel, or submitted to an analytical laboratory until they have been evaluated by an HPT in accordance with approved procedures.
4.0 PREREQUISITES

4.1 Special Tools, Equipment, and Supplies

Consult the manufacturer’s operating manual for details, e.g., the TVA 1000B requires the use of a portable hydrogen cylinder to operate the flame ionization detector.

4.2 Performance Documents

The following documents may be needed to perform this procedure:

- Site Form A-6003-860, “IH DRI MONITORING FIELD LOG” or approved equivalent
- Site Form A-6003-861, “IH DRI FUNCTIONAL TEST DATA” or approved equivalent
- Thermo Electron Corporation MIRAN 205B SaphiRe XL Analyzer Instruction manual
- Thermo Electron Corporation TVA 1000B Toxic Vapor Analyzer Instruction manual
- RAE Systems AreaRAE Multi-Gas Monitor PGM-5020 Operation and Maintenance manual
- RAE Systems MultiRAE PRO Multi-Gas Monitor PGM-6248 MultiRAE User’s Guide
- OhioLumex Co. RA915+ Mercury Analyzer Operation and Maintenance manual
- Drager Accuro Gas Detector Pump Instructions for use
- INFICON’s HAPSITE SMART Operating manual.

4.3 Field Preparation

4.3.1 ENSURE a review of applicable industrial hygiene sampling plan has been completed before using direct reading instruments.
5.0 PROCEDURE

5.1 General Requirements for Direct Reading Instrument Use

5.1.1 DETERMINE the procedures, work instructions, and applicable industrial hygiene sampling plan required to perform field monitoring during a specific work activity.

5.1.2 CONSULT with the Field Work Supervisor (FWS) to plan for special entry requirements, safety hazards, and scheduling information.

NOTE – An example of a decision logic for routine monitoring is given in Attachment 1.

5.1.3 SELECT the direct reading instrument for the contaminants to be monitored considering:

- Instrument specificity – This indicates how accurately the sensor identifies the contaminant of interest. For example, a photoionization detector with a 10.6 eV lamp such as the Multi RAE PRO can detect a broad range of organic compounds and some inorganic ones. In contrast, an infrared spectrophotometer such as the MIRAN SaphIRE 205B can be set up to detect a very specific chemical such as nitrous oxide.

- Instrument accuracy – This indicates the magnitude of error the sensor displays when challenged with a known concentration of the chemical of interest.
5.1 General Requirements for Direct Reading Instrument Use (Cont.)

- Instrument sensitivity – This shows how the sensor responds to changes in contaminant concentration. For example, can the sensor read changes in contaminant concentration at the tenth’s of a part per million (ppm), one ppm or greater?

- Instrument limitations – Instrument limitations can include items such as: temperature, relative humidity, lack of field portability due to its weight or bulk, not easy to setup or operate, not having a data logging capability, etc.

- Instrument power sources – This criteria includes such questions as: does it run on AC, batteries or both?, how long is the expected battery life?, how long does it take to completely charge a dead battery?, is its intrinsic safety approval affected by whatever power source is chosen?

- Instrument operating temperature ranges – Items to consider under this criteria include: what is the manufacturer’s recommended operating temperature range for the sensor?/for the instrument? and does the meter have the capability of measuring this? and how is that indicated to the instrument operator?

- Instrument response and purge time/rate – Indicated typically by the “t90” value and often given with the instrument/sensor’s specification, what is the fastest instrument response time given among competing instruments?

- Potential interferences – Considered along with instrument specificity, potential interferences are an important consideration when measuring the desired contaminant among a mixture of different gases and vapors. The instrument’s manufacturer will often indicate this information in a table showing what common gases/vapors will interfere with the accuracy of the reading. Some contaminants will interfere positively, i.e., add to the true reading, some negatively, i.e., subtract from the true reading and others may not affect the true reading.

- Intrinsic safety – This designation indicates whether or not an instrument can be used in a flammable atmosphere and, if so, what kinds of atmospheres apply.

- Refer to Table 1 and the instrument operating manuals for additional information.
5.1 General Requirements for Direct Reading Instrument Use (Cont.)

5.1.4 WHEN sampling for organic compounds,

    OR

    WHEN performing remote sampling, USE Teflon-coated Tygon tubing because some gases/vapors can be absorbed by uncoated plastic tubing and result in less accurate readings.

5.1.5 SELECT the proper tubing to ensure an accurate reading by the instrument.

5.1.6 WHEN sampling in radiological areas, ATTACH filter media and associated housing in accordance with Section 3.2.

5.1.7 ENSURE the maintenance calibration date on the sticker from Industrial Hygiene Equipment Service (IHES) is current for the instrument.

5.1.8 IF the maintenance calibration date is not current (past due), RETURN the instrument to the equipment custodian with a completed green tag, i.e., “IH INSTRUMENT SERVICE TAG” (BT-6004-019) checking the box titled “Scheduled Maintenance Calibration.”

NOTE - Setting and checking flow rates shall be performed as soon as is practical before and after use, respectively, on the same shift, unless approved by IHT Supervisor, Project IH or Manager to deviate.

- Approval to deviate shall be documented in writing on the applicable IH Sampling Plan, dated & approving authority’s name printed & signed on this form.

5.1.9 PERFORM a functional check, and span tests for the selected direct reading instrument in accordance with the instrument-specific procedures and operation manuals.

5.1.10 PERFORM a leak test for sampling pumps prior to use in the field in accordance with the instrument-specific procedure, OR

    ENSURE that the flow rate is adequate for the direct reading instrument and that the radiation filter, if used, is not being bypassed.

5.1.11 ENSURE that alarm settings on the monitor are set correctly, referring to Table 2 - Action Levels for IH Monitoring Readings of Tank Vapors for settings.
5.1 General Requirements for Direct Reading Instrument Use (Cont.)

**CAUTION**

Instruments vary in their requirements for proper operation and the manufacturer’s instruction manual should be consulted for these details. For example, an ammonia concentration of 250 ppm or greater should be avoided for the MIRAN 205B SapphIRe since this can affect the gold coating used in its optical system. Multi-gas meter such as the MultiRAE PRO should avoid exposure to silicone vapors and lead fumes since this can negatively affect the operation of the combustible gas sensor.

5.1.12 **CONDUCT** field monitoring in accordance with the work instructions in the approved work package, procedure, industrial hygiene sampling plan, or at the Project Industrial Hygienist’s direction.

5.1.13 **ALLOW** sufficient warm-up and response time, i.e., t90, for the instrument prior to taking field measurements.

5.1.14 **ENSURE** that the sample line does not become obstructed and its inlet is located in the space containing the atmosphere of interest.

5.1.15 **CAREFULLY CONSIDER** the interpretation of data considered in terms of direct reading instruments' limitations regarding specificity, accuracy, correction factors, etc. (See Attachment 2)

5.1.16 **RECORD** the sample results in accordance with TFC-ESHQ-IH-STD-03 AND

**PROVIDE** diagrams or pictures to document the employee exposure, sources of gases/vapors, controls, etc.
5.1 General Requirements for Direct Reading Instrument Use (Cont.)

5.1.17 IF an instrument reading exceeds a pre-set alarm limit as listed in Table 2:

5.1.17.1 DIRECT workers to move upwind.

5.1.17.2 EVALUATE the cause of the alarm.

5.1.17.3 CONTACT the responsible personnel (i.e., the Project Industrial Hygienist or Field Work Supervisor).

5.1.17.4 FOLLOW corrective actions given in Table 2 or for other contaminants, seeking guidance from the Project Industrial Hygienist for alarms reaching pre-set limits.

5.1.17.5 CLEAR AND RESET alarms before allowing workers to resume work.

5.1.17.6 REFER to instrument-specific procedures and operation manuals for additional information on alarms.

5.1.18 IF time allows, PROVIDE completed sampling forms and associated field records to the Project Industrial Hygienist within two working days.
5.2 Performing Direct Reading Instrument Monitoring

5.2.1 **ENSURE** the instrument has warmed up per the instrument-specific procedure prior to conducting monitoring to ensure instrument readings are accurate.

5.2.2 **ENSURE** that no environmental conditions, e.g., temperature and relative humidity extremes, are present that would interfere with the operation of the instrument.

**NOTE** - As a general rule, use two seconds per foot of tubing as a purge time and two minutes for instrument response time. An example calculation for purge time is provided in Attachment 3.

5.2.3 **WHEN** performing remote monitoring, **FOLLOW** the instrument manufacturer’s recommendation regarding sampling tube length, tube diameter, etc.

5.2.4 **IF** sampling requires a purge time calculation, **REQUEST** the Project Industrial Hygienist to perform a calculation for purge time.

5.2.5 **PRIOR** to recording any measurements, **ALLOW** adequate time for the gas/vapor sample to reach and react with the sensors.

**NOTE** - When using colorimetric tubes for monitoring airborne contaminant concentration levels, the instrument response time is the time it takes to complete the stroke cycle that is recommended by the manufacturer for that contaminant.

5.2.6 **REFER** to Table 1 or the instrument-specific procedure or operation manual for information about instrument response time.

5.2.7 **PERFORM** source monitoring to evaluate the concentration of airborne contaminants that could migrate to the work area by:
- Monitoring one to two inches from potential sources
- Monitoring long enough to exceed the instruments’ response time and detect maximum concentrations or those exceeding an action limit.
Using Direct Reading Instruments

5.2 Performing Direct Reading Instrument Monitoring (Cont.)

5.2.8 RECORD the maximum reading on the survey form in accordance with TFC-ESHQ-IH-STD-03.

5.2.9 IF readings indicate airborne contaminant concentrations greater than the action levels listed in Table 2 or concentrations of other compounds as determined by the Project Industrial Hygienist, IDENTIFY the source.

5.2.10 IF gas/vapor concentration levels from a source exceed an action level listed in Table 2 or others determined by the Project Industrial Hygienist, PERFORM breathing zone monitoring AND RECORD the maximum reading on the survey form in accordance with TFC-ESHQ-IH-STD-03.

5.2.11 FREQUENTLY MONITOR the breathing zone of the worker(s) closest to the contaminants of concern when performing their specific work activity, especially in the event of changing conditions in the work area.

5.2.12 IF breathing zone monitoring indicates levels greater than the action levels listed in Table 2, FOLLOW the requirements listed therein.
5.3 Records

5.3.1 PERFORM the following for records identified within this procedure.

5.3.1.1 RECORD the number of times the record was generated in applicable column

OR

PLACE a check mark (✓) in the N/A column.

5.3.1.2 SUBMIT the package to IH.

<table>
<thead>
<tr>
<th>Records Submittal Checklist</th>
<th>Number of times completed</th>
<th>N/A (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FORMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Hygiene surveys (including applicable forms and data)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEND the completed records with Records Submittal Checklist attached to the Safety and Health Program for records retention.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>__________________________/ _________________________ / __________________</td>
<td>Signature / Print (First and Last) / Date</td>
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<tr>
<td>IH</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The record custodian identified in the Company Level Records Inventory and Disposition Schedule (RIDS) is responsible for record retention in accordance with TFC-BSM-IRM_DC-C-02.
Table 1 - Direct Reading Instrument Capabilities and Limitations

<table>
<thead>
<tr>
<th>Instrument Name</th>
<th>Capabilities</th>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
</table>
| Thermo Electron Corporation MIRAN 205B Series SapphRe XL Analyzer | Gases and vapors, including nitrous oxide, ammonia, benzene, xylene, acetonitrile, acetone | • Continuous reading  
• High repeatability  
• High sensitivity (sub-ppm)  
• Good selectivity  
• Good accuracy  
• Linear digital response  
• Logging capability  
• Fast response time  
• Variable ranges depending on chemical of interest | • Complex set-up  
• Fragile  
• Expensive  
• Short battery life (4 hours)  
• Heavy (24 pounds)  
• Long warm-up time (30 minutes)  
• Only detects chemicals with an infrared response |
| Thermo Electron Corporation TVA 1000B Toxic Vapor Analyzer | Gases and vapors particularly volatile organic compounds (VOCs) | • PID and FID capabilities  
• High sensitivity to hydrocarbon vapors  
• Very stable and repeatable results  
• High sensitivity to aromatics, unsaturated hydrocarbons, and chlorinated hydrocarbons  
• Ability to measure some inorganic gases | • Cumbersome  
• Short battery life (8 hours)  
• FID requires >16% oxygen for flame to burn  
• Wide dynamic range (0.5-2000 ppm PID)  
• Susceptible to interference from water vapor (PID) |
| RAE Systems Multi-RAE PRO Multi-Gas Monitor | VOCs, ammonia, oxygen, flammable gasses, and carbon monoxide | • Wide measurement range  
• Radio Transmission Capability  
• Datalogs | • Complex Configuration  
• Long warm-up time for PID sensor |
### Table 1 - Direct Reading Instrument Capabilities and Limitations (Cont.)

<table>
<thead>
<tr>
<th>Instrument Name</th>
<th>Capabilities</th>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
</table>
| RAE Systems AreaRAE Multi-Gas Monitor | VOCs, combustible gases, oxygen, carbon monoxide and ammonia | • Remote sampling with real-time data transmission capability  
• Weatherproof, rugged  
• Logging capability  
• Customizable for other gases (one to five sensors)  
• Range varies with chemical of interest | • Slow response time for ammonia (60 seconds)  
• Moderate sensitivity (ppm)  
• Heavy (9 pounds) |
| OhioLumex Co. RA-915+ & 915M Mercury Vapor Analyzer | Mercury vapor | • Portable  
• Continuous reading  
• Range 2 to 50,000 ng/m³  
• Minimize interferences | • Heavy (16 pounds)  
• No differentiation for organic mercury |
## Table 1 - Direct Reading Instrument Capabilities and Limitations (Cont.)

<table>
<thead>
<tr>
<th>Instrument Name</th>
<th>Capabilities</th>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drager colorimetric tubes</td>
<td>Over 500 gases and vapors to monitor</td>
<td>– Simple operation</td>
<td>• Two year shelf life for most tubes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Low cost</td>
<td>• Requires color visual dimension to read concentration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Low maintenance</td>
<td>• Broken glass hazard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Accurate, repeatable results</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Hand-held size</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Wide range of detection (depending on tube selection)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Fast response time (depending on number of strokes required)</td>
<td></td>
</tr>
<tr>
<td>INFICON HAPSITE GC/MS</td>
<td>Organic vapors</td>
<td>– Simple operation</td>
<td>• Heavy instrument</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Quick turnaround time</td>
<td>• High cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Field portable</td>
<td>• Limited mass range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Accurate identification</td>
<td>• Significant warm-up time.</td>
</tr>
</tbody>
</table>
## Using Direct Reading Instruments

### Table 2 - Action Levels for IH Monitoring Readings of Tank Vapors

<table>
<thead>
<tr>
<th>CONTAMINANT</th>
<th>MONITOR BREATHING ZONE if SOURCE indicates levels are exceeded</th>
<th>FULL FACE MASK APR WITH GME-H/GME-P100 CARTRIDGE Required if ANY of the following Breathing Zone Levels are Exceeded</th>
<th>SUPPLIED AIR RESPIRATOR Required if ANY of the following Breathing Zone Levels are Exceeded</th>
<th>STOP WORK and EVACUATE AREA if ANY of the following Breathing Zone Levels are Exceeded*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Vapors</td>
<td>2 ppm</td>
<td>2 ppm</td>
<td>N/A</td>
<td>25 ppm</td>
</tr>
<tr>
<td>Ammonia</td>
<td>12.5 ppm</td>
<td>12.5 ppm</td>
<td>N/A</td>
<td>300 ppm</td>
</tr>
<tr>
<td>Nitrous Oxide</td>
<td>25 ppm</td>
<td>N/A</td>
<td>25 ppm</td>
<td>N/A</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.0125 mg/m$^3$</td>
<td>N/A</td>
<td>0.0125 mg/m$^3$</td>
<td>N/A</td>
</tr>
</tbody>
</table>

NOTE: Other contaminants may be added to the required monitoring and assigned action levels per sampling strategy, work document, or Job Hazard Analysis. Refer to the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs) handbook or the OSHA Permissible Exposure Limits (PELs) (whichever is less) for additional information on action levels.

* Unless workers are protected by supplied air respirators and other necessary PPE.
Attachment 1 - Decision Logic for Routine & Non–Routine Monitoring

I. Routine Monitoring

The decision logic for routine monitoring of Chemicals of Potential Concern is incorporated into the selection of direct reading instruments (see Table 1). For example, in listing the iTX as an instrument capable of monitoring for ammonia, the following selection criteria were met as listed in Step 5.1.3.: (1) Specificity – The Multi-RAE PRO is specifically equipped with an electrochemical sensor designed for ammonia gas. (2) Accuracy – With a listed accuracy of ±15%, the Multi-RAE PRO meter is in line with other comparable instruments. For example, the Drager ammonia 5/a tube has a standard deviation of ±10 to 15% (Drager’s surrogate measurement for accuracy) while the ammonia sensor for the RAE Systems AreaRAE (P/N: 008-1125-000) has a listed accuracy from IHES of ±10%. (3) Sensitivity – The meter detects changes in the ammonia concentration at 1 ppm increments – sufficient for this contaminant since the action level is 12.5 ppm and its occupational exposure limit is 25 ppm. (4) Instrument power source – Currently equipped with a lithium – ion battery, the listed run time for a fully charged battery is 12 hours, well beyond what is needed for the normal work shift. (5) Operating temperature range – Is –4 to 122 F. This range is sufficient for all but the coldest days during winter at Hanford whose average low temperature in January is around 22 F. (6) Instrument response time – Typically measured as the t90 value, the sensor has a t90 value of 60 seconds which is comparable with other ammonia sensors. The Drager ammonia 5/a tube has a measurement response time of about 1 minute and the RAE Systems ammonia sensor (P/N: 008-1125-000) also has a t90 of 60 seconds. (7) Potential interferences - Include hydrogen sulfide in which a 20 ppm concentration produces a positive interference of 2 ppm. Of particular importance are the negative interferences such as formic acid and carbon dioxide concentrations around 40%. (8) Intrinsic safety – The Multi-RAE PRO is rated intrinsically safe by UL (Underwriters Laboratories) for Class 1, Division 1, Groups A, B, C and D atmospheres and with a temperature code T4. (8) Other considerations – Include such options as data logging capability, remote transmission, instrument weight, ease of use, etc. The Multi-RAE PRO has data logging capability and remote transmission capability. It is a portable, hand – held meter (~31 oz. in weight) whose ease of operation is in line with other instruments of comparable sophistication.
II. Non – Routine Monitoring

Non – routine monitoring for exposures should follow the same guidelines listed in Step 5.1.3, i.e., (1) Specificity, (2) Accuracy, (3) Sensitivity, (4) Instrument power source, (5) Operating temperature range, (6) Instrument response time, (7) Potential interferences, (8), Intrinsic safety requirements and (9) Other considerations to include ease of use, portability, data logging capability, radio transmission, etc. To help ensure this when evaluating new industrial hygiene instruments for purchase, TFC-ESHQ-S_IH-CD-38, (“Evaluation and Procurement of Industrial Monitoring Instruments”) should be followed, which incorporates criteria listed in the previous paragraph.

In addition, consultation with the Technical Authority for industrial hygiene instruments should be part of the evaluation process prior to selecting the direct reading instrument of choice.

Document the decision logic used for non – routine monitoring (form # A-6003-896, i.e., “EVALUATION OF INDUSTRIAL HYGIENE MONITORING INSTRUMENTS FORM” will be sufficient for this purpose when considering purchasing new equipment). In addition to addressing the nine criteria above, include the date of the decision logic and any notes from conferring with the Technical Authority for industrial hygiene instruments.
Attachment 2 - Direct Reading Instrument Data Interpretation

Data interpretation should follow the instructions given in the operation manual and/or documented technical guidance from the equipment manufacturers’ website or Technical Department. As an example regarding correction factors, when using the ppbRAE photo–ionization detector, the manufacturer–RAE Systems published “Technical Note TN–106: A Guideline for PID Instrument Response” at their website, i.e., www.raesystems.com. This allows the Project Industrial Hygienist to correct the reading if the chemical being measured is different from its calibration gas, i.e., isobutylene. Because of the uniqueness of chemical hazards at Tank Farms, these correction factors may not be provided by the manufacturer for all the chemicals encountered. In situations where a correction factor needs to be derived outside of what is provided by the instrument manufacturer, it must be peer reviewed by someone out of the Industrial Hygiene Program Office and have concurrence from the IH Programs Manager prior to use.

Some items to consider regarding the instrument’s limitations include:

1. Specificity – Is the chemical that the meter is reading the gas/vapor of interest or are there possible cross - interferences that could influence this measurement? For example, using the MultiRAE PRO equipped with an ammonia unbiased sensor in an atmosphere that contains both ammonia and 20 ppm hydrogen sulfide may see a positive interference of 2 ppm added to the reading. Since the hydrogen sulfide concentration is adding to the ammonia reading, it is “overestimating” the actual ammonia concentration and, therefore, conservatively protecting the workers. Negative interferences of particular importance since they underestimate the actual exposure. No caught examples of gas/vapor negative interferences are listed for the ammonia sensor.

2. Accuracy – Tolerances are typically listed in the specifications section of each direct reading instrument’s operation manual. When a reading is obtained, these tolerances are used to establish the range where the true value of the actual concentration lies. For example, the MultiRAE PRO’s accuracy specification for the PID sensor lists a tolerance of 10 % in the operation manual. This should be used with the measurement obtained to calculate the range of the true value.
Using Direct Reading Instruments

Attachment 2 - Direct Reading Instrument Data Interpretation (Cont.)

3. Correction or response factors – These factors are usually applied to such broad spectrum instruments like the combustible gas sensor and photo-ionization detectors. The reasoning is that they are function tested with a gas such as pentane and isobutylene, respectively, but the gases/vapors they are often measuring are different from these test gases. These response factors allow the Project Industrial Hygienist to correct the reading obtained in light of the sensitivity of the measured gas/vapor to the gas that was used to function test it. For example, RAE Systems, manufacturer of the AreaRAE and the MultiRAE PRO, published “Technical Notes” numbers 156 and 106 at their website that addresses correction factors for combustible gas and the photo-ionization detectors, respectively, and shows how to apply them.

Other considerations regarding data interpretation can include the linear response of the instrument when measurements exceed its upper range, application of the accuracy tolerance at the limit of detection, etc. For these issues, consultation with the Technical Authority for industrial hygiene instruments, the instrument’s operating manual and/or the Technical Department for the instrument manufacturer would be appropriate.
Attachment 3 - Purge Time Calculation

Follow the manufacturer’s instructions regarding maximum sampling tube length, inner tube diameter, minimum flow rate etc, before employing the example below. For example, RAE Systems recommends the Multi RAE PRO use a maximum sampling tube length mode of metal on teflon of 300 feet with an internal diameter of 0.127 in. to be able to maintain a flow rate of approximately 0.3 Lpm.

If using sampling lines of a different dimension than that specified by the instrument manufacturer, perform the following sample calculation:

Purge Rate (PR)

\[ PR = \frac{1829\pi r^2}{Q} \text{ in sec./ft} \]

Q, Flow Rate = 300 cc/min.
d, Internal diameter of sample tube = 0.476 cm. (\(\frac{3}{16}\) in.)
r, Internal radius of sample tube = d/2 in cm = 0.476/2 = 0.238 cm.
l, Metal on teflon sample tube length = 914 cm. (30 ft.)

\[ PR = \frac{1829\pi (0.238)^2}{300} = 1.08 \text{ sec./ft} \]

Purge Time (PT), = PR x 30 ft.

= 1.08 sec./ft x 30 ft.

= 32.4 sec.

Be sure and add the instrument response time and instrument tube length to the purge time. Consideration also needs to be given to the condition of the internal sampling tube (i.e., crimps, bends, etc.). In the example above, it may be appropriate to round up the purge time by 1 or 2 sec., depending on the tubes condition.