WORKSHOP SESSION SUMMARY
NIEHS NATIONAL TRAINERS' EXCHANGE
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1. Session Title and Presenter's Contact Information:

"Air Monitoring Instrument Exercise"

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2. Workshop Summary

The objective of this exercise is to have the participants practice using air monitoring instruments with an emphasis on learning the capabilities and limitations of basic equipment. The 1-hour exercise immediately follows a presentation outlining the basic procedures of measuring chemicals, the function of basic sensor types, calibration, relative response, and using detector tubes. A demonstration of pH using pH paper to gather initial information about corrosion hazards was presented.

The instrument exercise uses specific atmospheres produced from specialty gas cylinders and from commonly available materials to produce certain expected results that are then discussed in a group review. The discussion reinforces and demonstrates points made during the initial presentation.

3. Materials and Methods

<u>pH Deonstration</u>

<u>Materials Required</u>

Ph paper (preferably full range paper)
Glass sampling vials – qty 5 (20-40 ml)
Protective eye wear and gloves for the demonstrator
NIOSH Pocket Guides
Sulfuric acid (10 ml)
Muratic acid (10 ml)
Sodium hydroxide solution (10 ml)
"Sudsy" ammonia (10 ml)

Procedures

Break the class into groups or tables and have someone at each group to be responsible for looking up chemicals in the NIOSH PG. If necessary, give a brief discussion on Ph & interpreting Ph paper results. Review common chemical and physical properties used as standards. (MW of Air is ≈ 29; BP of water is 212ºF; VP of water is ≈ 20 mm Hg @ ≈ 70ºF; 1 ATM = 760 mmHg) As you prepare to demonstrate each vial, ask the groups individually to look up the following properties:

- Boiling point
- Vapor pressure
- Molecular weight or Relative Gas Density

After the trainees have looked up the chemical/physical properties for the specified chemical, ask them to help determine the "attitude" of the chemical in question.

- Do they expect vapors to be given off?
- If not, why?
- If yes, a lot?
- If they expect vapors, where should they expect them – rising or falling?

After the groups have stated their answers, you may wet the paper with distilled water (not necessary, but helps increase the intensity of color change due to vapors) and perform the demonstration. Discuss the observations. Also, you may want to ask them "What environmental conditions may alter or influence the expected results?"

Repeat for the next chemical. The preferred order is to start with "sulfuric acid", then "hydrogen chloride" (muriatic), then "sodium hydroxide", then "ammonia".

Depending on the context of the class, you should quiz them on where these chemicals may be encountered and under what conditions. You may also want them to look up synonyms or give you examples of common products or trade names these chemicals can found in. Some products are:

- Sodium hydroxide = Red Devil Lye drain opener or degreasing solutions
- Sulfuric acid = battery acid
- Hydrogen chloride = dilute hydrochloric acid = muriatic acid = concrete cleaner
- Ammonia = "sudsy ammonia" household cleaner

Instrument Exercise

MATERIALS:

- Air monitoring instruments with calibration accessories
- Multigas with flammables, oxygen, and carbon monoxide sensors
- Photoionization detector (PID)
- Detector tubes and pumps
- MSA – Hexane and Carbon Monoxide
- Dräger – Alcohols and Ammonia
- Tubing to connect instruments to bag
- Gas bags (# needed for groups, plus 2), hypodermic syringe, SCBA cylinder, chemicals (isopropyl alcohol, ammonia, etc.)
- Prepared gas cylinders (cal gas, hexane, methane)
- Exercise worksheets
- Instrument manuals and/or quick-reference guides

PROCEDURE:

Preparation

- Inject a drop or two of the isopropyl alcohol and/or ammonia solution with the syringe through the septum into a gasbag and fill with air from an SCBA cylinder
- Inflate bags from the prepared cylinders
- Calibration gas (MSA – 58% LEL Pentane, 15% Oxygen, and 60 ppm Carbon Monoxide
- Hexane ~100 ppm and/or 10% LEL (1200 ppm)
- Set out detector tubes and pumps

Exercise

- Distribute one bag per group. Do not tell them what chemical is in each bag. The group will need to try to identify their chemical and estimate the concentration.
- Each group will need to use each of the instruments and one of each kind of detector tubes.
  Review the results when all groups are finished. Confirm that any relative response calculations are done correctly.

4. Main Points

pH Demonstration

Results Expected

- Sulfuric acid – no color change in vapor space, distinct positive acid response to liquid only (high BP, low VP, high MW or heavy VD)
- Muriatic acid – no color change in elevated vapor space, but distinct positive acid response inside the vial above the liquid, distinct positive acid response to the liquid (low BP, high VP, high MW or heavy RgasD)
- Sodium hydroxide – no color change in the vapor space, but distinct positive alkaline response to the liquid only (high BP, low VP, high MW or heavy VD)
- Ammonia – distinct alkaline response above the vial, and distinct positive alkaline response to the liquid (low BP, high VP, low MW or light RgasD)

<u>Summary</u>

This demonstration exercise is beneficial in illustrating properties of chemicals that are crucial in hazard assessment. It also helps them to realize such a simple technology can give them good information while possibly protecting expensive vapor detection equipment.

Instrument Exercise

<u>MSA Instrument Calibration Gas</u>

- Instruments calibrated to another gas (e.g., propane, methane) will typically read lower than the labeled 58% LEL, but will still be more than 10% LEL, the evacuation level for most agencies. If the flammable reading were 0, the oxygen level could be addressed by the use of SCBA.
- Photoionization detector will give no reading if the gas used is methane. I explain that MSA uses methane formulated to a concentration that would simulate 58% LEL of *pentane*, the standard for many instruments. Methane is not detectable by PIDS because its Ionization Potential is 12.6 eV.
- Carbon Monoxide detector tubes and the CO sensor usually show good agreement

<u>Hexane</u>

- If ~100 ppm is used, typical multigas instruments without PID will not alert to the presence of chemical
- 10% LEL formulation will give a lower reading by the flammable sensor (4 – 6% LEL, depending on the calibration gas of the instrument)
- Hexane detector tubes tend to read pretty accurately.
- Carbon Monoxide detector tubes will give a response because of cross-sensitivity or interference (see the instruction sheet for the tubes). The fact that the sensor in the multigas meter did not respond should be a clue. Emphasize that using more than one means to measure a hazard is helpful.
- PID response is lower than the actual concentration. If you have a relative response factor for your instrument to hexane, use that to convert the reading to an estimate of the actual concentration and compare this to the detector tube reading.

Alcohol and Ammonia

- Typically a very slight reading of the flammable sensor (~1-2% LEL) is the only response of the multigas instrument
- Detector tubes for alcohols and ammonia will give estimates for the respective concentrations.
- PID readings are typically much lower than the combined concentrations of alcohol and ammonia as estimated by the detector tubes. However, unlike the hexane bag, a relative response factor cannot be applied to the reading, because more than one chemical is present.

Summary Points:

- Even though the same bag (and hence, the same concentration) is being measured, different instruments will provide different readings, even after relative response differences are taken into account.
- Ignoring (or being unaware of) the concept of relative response can result in serious underestimating of the concentration of a chemical in the air. You must know the chemical's identity to be able to estimate a concentration
- Common direct reading instruments are not able to identify unknowns or selectively measure the components of a mixture of chemicals. Other hazard assessment tools such as containers, labels, placards, etc. are needed.

Without air monitoring, responders cannot determine whether or not a chemical is in the air and, if so, how much. It is necessary to understand the capabilities and the limitations of the team's instruments to protect responders.

5. References

Hawley, C. *Hazmat Air Monitoring and Detection Devices,* Clifton Park, NY: Delmar Learning, 2001.

Maslansky, C. J. and S. P. Maslansky, *Air Monitoring Instrumentation: A Manual for Emergency, Investigatory, and Remedial Responders,* Hoboken, NJ: John Wiley & Sons, 1993.

Oldfield, K. W., D. A. Veasey, L. C. McCormick, T. H. Krayer, B. N. Martin, S. Hansen, E.R. Stover, and B. M. Hilyer, *Emergency Responder Training Manual for the Hazardous Materials Technician*, 2nd edition, Hoboken, NJ: John Wiley & Sons, 2005.

6. Handouts

Handout: Brief PowerPoint outlining key points of Air Monitoring as taught before the exercise in courses.