

Lessons Learned
Arsine Exposure Incident
March 2024

What Happened:

On Monday, March 11, 2024, around 12:30 pm, a compressed gas vendor was in an Engineering lab to calibrate hydrochloric acid (HCL) and arsine gas sensors and was accompanied by a project manager from Facilities Management (FM) and three student graduate researchers from the PI's lab. After completing the HCL calibration, the vendor suggested that the researchers should also receive training on the calibration of the recently installed arsine detector.

The vendor conducted the gas calibration training inside the walk-in fume hood in the PI's lab. Two of the three graduate student researchers and the vendor stood inside the walk-in fume hood for training. The vendor began the calibration training using the oxygen gas to zero out the sensor. The sensor sampling port was connected to the gas cylinder, and the vendor controlled the release of the calibration gases (oxygen and arsine gas). One graduate student researcher was positioned at floor level at the gas sensor sampling port level to view the calibration procedure, and another graduate student researcher was standing about three feet away to make a video of the training process. When the correct concentration was indicated on the sensor reading, the vendor disconnected the oxygen cylinder from the sensor sampling port and continued calibration training with the arsine gas cylinder*.

During the calibration training/process, the vendor disconnected and connected the cylinder tubing several times because the sensor did not appear to detect the arsine gas. It was observed that the tubing connections were not checked for leaks before the calibration process began. It is believed that the arsine gas flowed openly into the workspace during this time. According to one of the graduate student researchers, this became evident when she reconnected the two tubes, and without turning the valve, she saw the gas sensor reading increase from 10 to 140 parts per billion (ppb). At this time, she realized that the arsine cylinder valve was open while the tubes were disconnected. The graduate student researcher indicated that the vendor said he "forgot to turn off the valve." The graduate student researcher also indicated that she did not detect the distinct odor of arsine gas (garlic or fish-like) or hear a hissing sound associated with the gas flow through the tubing. The duration of the calibration process in the walk-in fume hood was approximately 10 to 15 minutes.

The vendor then directed the graduate student researcher to remove the arsine gas cylinder from the walk-in fume hood and place it on the benchtop to teach them how to remove the cylinder regulator. When they removed the regulator for the gas cylinder, they received a "puff" of gas at the breathing zone level. According to the graduate student researcher, the vendor indicated that "he neglected to purge the residual arsine gas between the closed valve and the regulator."

After the incident, the vendor and the FM project manager left the lab. The graduate student researchers were unsure of the next steps and reported the incident to the PI after ten minutes. The PI directed them to seek medical attention at Newport Urgent Care.

The PI notified the EHS School Coordinator of the incident. Upon arrival at the scene, the EHS School Coordinator activated the Aircurity ventilation system to maximize ventilation in the space and posted a “Do Not Enter” sign on the door. The EHS School Coordinator observed that the arsine gas had not been detected by the gas monitoring system outside the lab room. The EHS School Coordinator let the Aircurity ventilation system run for about 30 minutes before deactivation.

*Note: The vendor used an arsine gas cylinder (cylinder content was 28 cubic feet) with a concentration of 100 ppb for the calibration training. Cal OSHA’s Permissible Exposure Limit (PEL) Time Weighted Average (TWA) for arsine gas is 50 ppb.

Root Cause of the Incident:

Lack of a written standard operating procedure (SOP) for the gas calibration process and review of this SOP with the participants was the root cause of this incident.

Primary factors that contributed to the incident:

1. The vendor did not provide or follow a written Standard Operating Procedure (SOP) for the gas calibration process. No process was reviewed with the graduate student researchers or others before the training activity began. SOPs must be reviewed by lab members before working with toxic gases, such as arsine.
2. The vendor used an arsine calibration gas with a concentration of 100 ppb for calibration and training. The Cal OSHA PEL TWA for arsine gas is 50 ppb.
3. The vendor did not use appropriate tubing connections, which contributed to the leaking of the arsine gas during calibration training. The vendor did not inspect the cylinder tubing for any leaks or loose connections before starting the calibration process.
4. The vendor neglected to turn off the arsine gas cylinder valve after noticing no response on the gas sensor. Arsine gas continued to flow when he disconnected the tubing. They also did not purge the residual arsine gas that was present in the tubing, between the closed valve and regulator.
5. The gas cylinder regulator was placed on the bench instead of inside the fume hood.
6. PPE (face shield) was not worn during the regulator removal.

What steps can be taken to prevent this type of incident from occurring again:

- For any vendor work, request a written SOP for any process that involves using a toxic gas or any gas. The written SOP should be reviewed with the participants in the activity before the activity is initiated.
- Use a surrogate gas such as sulfur dioxide (SO₂) with 5 ppm (Cal OSHA PEL TWA is 5 ppm for SO₂) to calibrate gas sensors during training.
- All lab members should review all written SOPs for toxic gases and gases under pressure for all operations involving toxic gases and gases under pressure.
- Provide training for all lab members on gas calibration procedures.
- Use a plastic hose barb reducer to provide tight tubing connections to prevent leaking from tube connections.
- Purge the residual arsine gas that was present between the closed valve and regulator inside the enclosure before removing the regulator. Ensure that this process is included in the SOP.

- Ensure that removing regulators for small gas cylinders occurs inside a fume hood and for larger gas cylinders, this process occurs inside gas cabinets.
- Wear appropriate PPE for the task. When changing out gas cylinder regulators, a face shield should be worn to protect the eyes and reduce the potential inhalation exposure.
- Periodically hold group safety meetings to discuss safety concerns and near misses and emphasize the importance of safe work practices.
- Train researchers on the appropriate protocol for incidents, including contacting EHS and their supervisor (PI) immediately.

Where to Get Help or More Information:

For more information or assistance, please contact EHS at (949) 824-6200 or at safety@uci.edu.