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Pyrophoric Materials Cause Chemical Fume Hood Fire

Last December, a DOE scientist at the National Renewable Energy Laboratory (NREL) was performing general lab cleanup inside a helium-filled glove box. The glove box is maintained under an inert atmosphere to prevent the reaction of pyrophoric materials.

The scientist followed the lab's procedure to inert waste pipettes left in the glove box. To do so, he drew a solution of indium trichloride ($InCl_3$) into the pipettes to react with any residual tris(trimethylsilyl)phosphine (TTMSP), a pyrophoric liquid. The pipettes were then transferred from the inert glove box to the left front area of a chemical fume hood. (See photos 1 and 2.)

In addition to the pipettes, hexane and methanol in plastic squeeze bottles and waste cleaning wipes damp with hexane and methanol were located inside the fume hood.

Photo 1. Fume hood illustrating position of experimental equipment.

Photo 2. Example of a 2 ml pipette.

Facility maintenance personnel discovered a fire in the fume hood shortly after the scientist left the laboratory. The building fire alarm system was activated and the facility evacuated. The room's fire sprinkler system did not activate, as the fire did not escape the hood. The hood was not equipped with a fire detection or suppression system, resulting in property damage to the fume hood and its contents. (See photo 3.)

Photo 3. Fume hood after the fire. The arrow indicates the location of pipettes and cleaning wipes left by the researcher.

Analysis

- The verbal procedure for inerting and transferring pyrophoric material in pipettes was ambiguous and lacked the detail needed to safely perform the procedure.
- The $InCl_3$ was either not drawn far enough into the pipettes, or was not drawn in an amount needed to react with the entrained pyrophoric liquid. As a result, unreacted pyrophoric TTMSP remained in the pipettes when they were transferred to the hood.
- The pipettes were placed near combustible materials, although the established procedure calls for placing pipettes in an isolated area of the hood.
- Once air came in contact with the TTMSP inside the pipettes, the liquid ignited and burned the cleaning wipes, plastic bottles, hoses, and tubing located in the immediate area.
- The presence of the plastic squeeze bottles containing hexane and methanol directly contributed to the severity of the fire.
- The highly flammable hexane expelled from the plastic squeeze bottle produced a "torch" effect, which burned a crater in the bottom of the photo tray. (See photo 4.)

Photo 4. Crater in the bottom of a plastic spill tray, produced by a squeeze bottle containing heated hexane.

Recommended Action

1. Establish written procedures for handling extremely hazardous materials (e.g., highly toxics, highly reactives, pyrophorics) so that their handling is performed in a consistent manner and hazards are properly controlled.
2. Assess research activities on a continual basis to ensure the hazards posed, including post research clean up and waste collection activities, are adequately identified, evaluated, and controlled. Complacency can occur once the primary focus of the research has been completed.
3. Use high-walled stainless steel containment trays to store plastic squeeze bottles containing flammable liquids.
4. Minimize fire hazards within the hood by removing all unnecessary materials (especially containers of wastes or solvents) when conducting experiments.
5. Isolate combustible materials (e.g., waste cleaning wipes) from pyrophoric materials.
6. Do not use the hood as a storage cabinet for chemicals.
7. Keep the hood sash at the proper height and, if procedures allow, closed when leaving chemicals or experiments unattended.
8. Assess whether existing fire detection and suppression systems maintain an acceptable level of risk, and if early fire detection capability upgrades should be installed.

Where to Get Help or More Information

- Your ES&H Team Industrial Hygienist and Fire Protection Engineer.

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