

TO: Director, National Institute for Occupational Safety and Health

FROM: California Fatality Assessment and Control Evaluation (CA/FACE) Program

SUBJECT: Research Associate Dies from Burns Sustained While Working with a Pyrophoric Chemical

SUMMARY
California FACE Report #09CA001

A 23-year-old female research associate died from burn injuries sustained in a research laboratory fire. The victim was using a syringe and needle to extract a pyrophoric chemical (t-butyl lithium) from a bottle. The plunger came out of the syringe barrel and the t-butyl lithium ignited on contact with room air. The chemical splashed onto the victim's clothing and set them on fire. She was not wearing a laboratory coat at the time of the incident. There was no written documentation that the victim had received formal training on the safe use of pyrophoric chemicals. The CA/FACE investigator determined that in order to prevent future incidents, employers with research laboratories should ensure that:

- Laboratory personnel follow proper procedures when using pyrophoric chemicals.
- Laboratory personnel wear appropriate clothing and personal protective equipment (PPE) when working with pyrophoric chemicals.
- Whenever possible, laboratory personnel consider the use of alternative chemicals that are not pyrophoric.

INTRODUCTION

On Friday, January 16, 2009, at approximately 5:00 p.m., a 23-year-old female died from burn injuries sustained on December 29, 2008, while working in a university laboratory as a research associate. The CA/FACE investigator was notified of this incident on January 23, 2009 by the Los Angeles Office of the Division of Occupational Safety and Health (Cal/OSHA). On January 28, 2009 the CA/FACE investigator interviewed the university director of environmental health and safety. On February 11, 2009, the CA/FACE investigator interviewed the university legal counsel, principal investigator of the research laboratory, university safety manager, and two postdoctoral students. The CA/FACE investigator requested to inspect the laboratory where the victim was working, but was informed that all materials had been removed and the laboratory was no longer in operation. The CA/FACE investigator inspected a laboratory hood, chemical storage area, syringe, needles, reagents, and tubing similar

to that used in this incident. The safety manager demonstrated with similar equipment the methods for handling t-butyl lithium he believed the victim followed at the time of the incident. The CA/FACE investigator reviewed reports from fire department investigations (university and Los Angeles), the Los Angeles County Coroner, university laboratory safety manual, and the Aldrich Technical Bulletin AL-134 "Handling air-sensitive reagents."

The victim was born in Pakistan and had been in the United States for four years. She had a college education and spoke fluent English. The employer of the victim was a public research university with approximately 24,000 employees. The university director of environmental safety and health was unable to provide the number of laboratories that use pyrophoric chemicals. The victim had been employed with the university for eleven weeks when the incident occurred.

The employer had a written Injury and Illness Prevention Program (IIPP) and laboratory safety manual. According to the laboratory safety manual, each research laboratory was required to have a written safe operating procedure (SOP) for the use of each hazardous chemical or substance. The principal investigator for each laboratory was responsible for preparing the SOP and training their employees and research staff on the safe handling of chemicals. The laboratory in this incident followed the Aldrich Technical Bulletin AL-134 "Handling Air-Sensitive Reagents" as the SOP for the use of t-butyl lithium.

The employer had a written laboratory safety training program including first aid and emergency response information. According to the principal investigator, the victim had received verbal instruction on the safe use of pyrophoric chemicals, and had been observed using pyrophoric chemicals on at least two occasions. However, there was no written evidence that the victim received any laboratory safety training on these topics or on the SOP for the use of pyrophoric chemicals.

INVESTIGATION

The chemical involved in the incident was t-butyl lithium, a clear liquid that spontaneously ignites on contact with air (pyrophoric). On the day of the incident, the victim was working on a research study requiring organic catalytic reactions. The victim was working during the December holidays when most employees were not working in the laboratory. Two other research staff members were working in the laboratory at the time of the incident. The victim was working under a chemical fume hood with a sliding glass window that allowed use of the hands and arms under the hood while protecting the face. The position of the glass window at the time of the incident was not known. The hood was plumbed with regulator controlled nitrogen gas lines pressurized to one to three pounds per square inch (PSI). The victim was using a 60-milliliter plastic syringe with a 2-inch, 20-gauge needle to extract a solution of t-butyl lithium and pentane (Aldrich 186198) from a 4 ounce sealed bottle that was pressurized with nitrogen gas. According to the principal investigator, there was a bubbler between the nitrogen gas supply and the reagent bottle to prevent over pressurization of the reagent

bottle. The victim was wearing safety glasses and had on nitrile gloves. She was not wearing a laboratory coat or appropriate non-synthetic clothing for working with pyrophoric chemicals.

The victim informed the Los Angeles County Fire Investigator that as she withdrew the t-butyl lithium from the bottle into the syringe, the plunger came out of the housing and the chemical spilled out and ignited. The victim further stated that the t-butyl lithium ignited some hexane that spilled on her clothes and ignited them. It is unknown if the victim was using hexane as part of the reaction she was performing. A safety shower was present in the laboratory, but was not used by the other research staff member who extinguished the fire on the victim using his laboratory coat. The victim was treated at the scene by paramedics, and transferred to a local burn unit. She sustained approximately 40% total body surface area burns of the torso, arms, hands and thighs. She died of complications of her burns 18 days later.

CAUSE OF DEATH

The cause of death according to the death certificate was sequelae of thermal burns.

RECOMMENDATIONS / DISCUSSION

In order to prevent future incidents, employers with research laboratories should ensure that:

Recommendation #1: Laboratory personnel follow proper procedures when using pyrophoric chemicals.

Discussion: In this incident, the victim was withdrawing t-butyl lithium using a 60 ml syringe and a 20-gauge 2-inch needle. It is not known exactly what caused the plunger to withdraw from the housing of the syringe. The victim was using a needle that required her to lift and tilt the bottle in order to withdraw the t-butyl lithium. This would have required her to use one hand to hold the bottle, thereby limiting her control of the syringe as she withdrew the t-butyl lithium. According to one published article on the handling of pyrophoric chemicals, the reagent bottle should be clamped in place, and a long needle used to reach the chemical so that both hands can control the syringe. It is unknown why the victim was not using the recommended procedure. There was no documentation that the victim had received formal training on safe work procedures to follow when using pyrophoric chemicals, or what degree of supervision she was receiving when using these chemicals. Appropriate training and supervision for the safe use of pyrophoric chemicals should include:

- Hazard recognition for pyrophoric chemicals;
- Procedures for safe handling and use (**see Exhibit 1**);
- Use of personal protective equipment, including chemical splash goggles or safety glasses, appropriate clothing, and fire-resistant laboratory coats;

- Direct high-level experienced supervision during safety training and all transfers of pyrophoric chemicals;
- Emergency response procedures in the event of a spill, leak or fire, including shower drills.

Had the victim received comprehensive training and/or supervision, she may have clamped the reagent bottle and used a long needle for the reagent extraction. This would have provided additional control over the syringe and reduced the possibility of a spill. Additionally, the victim may have immediately moved or been moved to the safety shower, reducing the extent of her burns.

Recommendation #2: Laboratory personnel wear appropriate personal protective equipment when working with pyrophoric chemicals.

Discussion: In this incident, the victim was wearing nitrile gloves and synthetic clothing, and was not wearing cotton clothing or a fire-resistant laboratory coat that would have provided additional protection from the burning chemicals. In all laboratory settings where chemicals are used, the principal investigator or laboratory director should always provide proper personal protective equipment, train employees in their use, and provide proper supervision to ensure personal protective equipment are used by research staff. In particular, fire-resistant gloves (such as Nomex), chemical splash goggles or safety glasses, and a fire-resistant long-sleeve laboratory coat should be worn at all times when using pyrophoric chemicals. In addition, fire-resistant clothing such as cotton or wool should be worn. In this case, had the victim been wearing fire-resistant gloves, appropriate clothing and a long-sleeve laboratory coat, her clothing would not have ignited resulting in the extensive burns to her skin.

Recommendation #3: Whenever possible, laboratory personnel should consider the use of alternative chemicals that are not pyrophoric.

Discussion: In this incident, the victim was using the pyrophoric chemical t-butyl lithium for an experiment. Pyrophoric chemicals have long been recognized as a hazard in research laboratories, and specific work procedures must always be followed to minimize the risk of a spill, leak or fire. In general, the use of alternative chemicals that can completely eliminate the risk of life-threatening exposures is the most preferable method to prevent health problems in the workplace. While pyrophoric chemicals may need to be used for certain chemistry experiments, the principal investigator and laboratory staff should always consider the use of alternative reagents that are not pyrophoric. Had the victim been using a non-pyrophoric chemical in this incident, a spill of the chemical would not have ignited a fire that eventually resulted in her death.

References

Subchapter 7. General Industry Safety Orders

Group 1. General Physical Conditions and Structures Orders Introduction §3203. Injury and Illness Prevention Program.

Group 16 Control of Hazardous Substances Article 109. Hazardous Substances and Processes §5191. Occupational Exposure to Hazardous Chemicals in Laboratories. §5194. Hazard Communication.

J.A. Schwindeman, C.J. Wolterman, R.J. Letchford: Chem. Health & Safety, May/June p. 6-11, 2002.

See:<http://membership.acs.org/c/chas/techarchive/organolithium%20paper.pdf>

EXHIBIT:

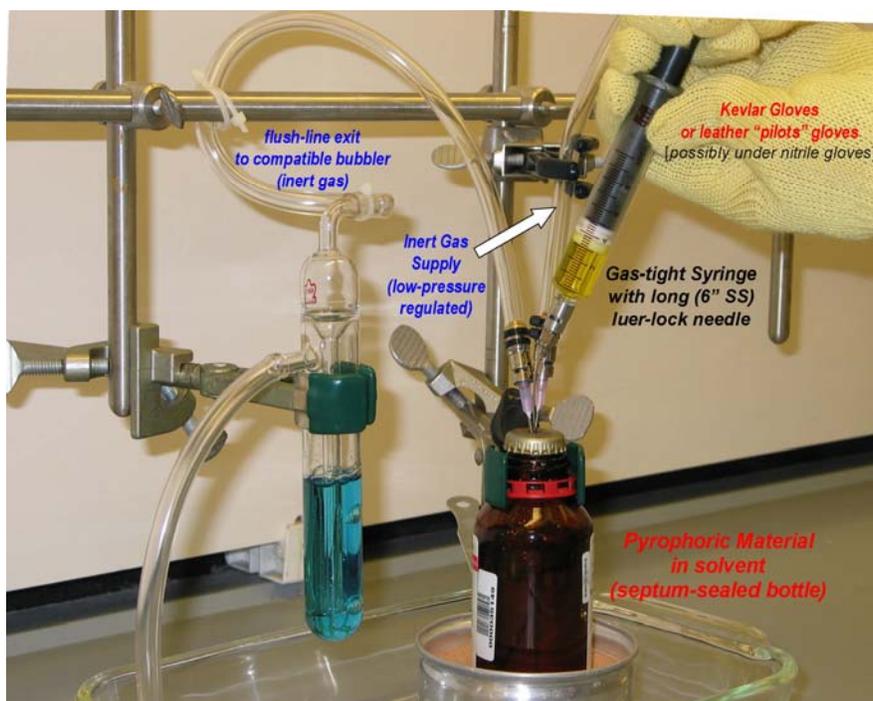


Exhibit 1. Example of setup for extracting pyrophoric chemical from reagent bottle. Exact setup will depend on specific requirements. (Photo provided courtesy John Palmer of UC San Diego)

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FATALITY ASSESSMENT AND CONTROL EVALUATION PROGRAM

The California Department of Public Health, in cooperation with the Public Health Institute and the National Institute for Occupational Safety and Health (NIOSH), conducts investigations of work-related fatalities. The goal of the CA/FACE program is to prevent fatal work injuries. CA/FACE aims to achieve this goal by studying the work environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact. NIOSH-funded, State-based FACE programs include: California, Iowa, Kentucky, Massachusetts, Michigan, New Jersey, New York, Oregon, and Washington.

Additional information regarding the CA/FACE program is available from:

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