SAFETY ALERT:

Laboratory Explosion at University of Hawaii Results in Loss of Arm

On March 16, 2016, Thea Ekins-Coward, a 29-year-old post-doctoral researcher at the University of Hawaii, Manoa, lost her arm in a laboratory explosion.

UPDATE AS OF JUNE 2016

The reports from the UC Center for Laboratory Safety independent investigation are now available online.

Report 1: Technical Analysis of Incident

Report 2: Recommendations for Improvements in UH Laboratory Safety Programs

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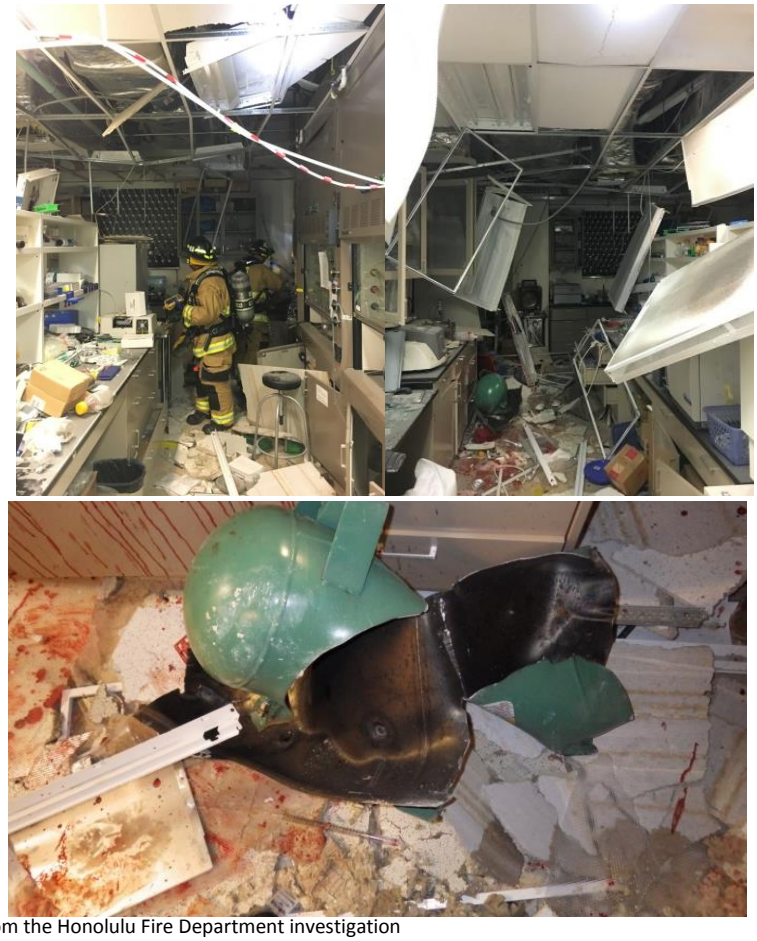

Images from the Honolulu Fire Department investigation

Cause of the Explosion

Dr. Ekins-Coward's experiment used a mixture of hydrogen, carbon dioxide, and oxygen gases as feedstock for a bacterial culture inside of a low-pressure tank. The investigation report from the Honolulu Fire Department

concluded that an electronic gauge, which was used to measure the pressure inside the gas-mixing vessel, created a spark when Dr. Ekins-Coward pressed the "off" button. The spark ignited the gas inside the tank, triggering the explosion. The electronic gauge was not designed to be used in a system containing a flammable mixture of gas.

What Went Wrong?

The immediate cause of the explosion is described above. However, this incident is a critical warning to all researchers, regardless of whether or not you use flammable gas in your research.

A safety inspection a few months before the explosion found the lab "met all requirements", and Dr. Ekins-Coward had taken all of her required safety training at UHM. So how could this seemingly compliant lab have suffered such a tremendous safety incident?

A full report by the Hawaii OSH Division and an independent investigation by UC Center for Laboratory Safety will conclude by the end of May 2016. However, based on the Honolulu fire department report and press statements made by the UH Environmental Health & Safety Office, we already know the following:

- There was no written safety plan (Hazard Control Plan) for this experiment.
- Dr. Ekins-Coward was modifying a procedure based on her PI's previous experimental protocol[1], and had built a new apparatus to do this.
- The new apparatus had not been evaluated by a safety professional or engineer.
- A smaller explosion had occurred the week prior[2]. This was a "near miss" incident (no injury or equipment damage resulted); and the event was ignored.

Assuring Your Safety

A commitment to research safety means more than just wearing your PPE and completing your safety training courses. Your safety relies on lab workers, faculty, and EHRS working together to *recognize* hazards and *design* safer experiments.

Following these procedures when planning your experiments will help assure the safety of yourself and your lab mates:

Hazard Assessments

- Perform a **hazard assessment** whenever you design or reproduce an experiment involving high-hazard materials or equipment.
- Write a Hazard Control Plan (HCP) to document the safety controls that you'll use in your design to reduce the likelihood and/or severity of an adverse event.
- Take into consideration how changes in the procedure, such as scale or equipment, will affect the safety of the experiment.
- Contact EHRS for assistance with your hazard assessments and HCPs.

Approvals

- Before conducting hazardous work, ask yourself, "Does my PI know I'm doing this?" The use of hazardous materials and equipment require the approval of the PI.
- Make sure your PI and EHRS has reviewed *all lab-built equipment* involving hazardous energy (electricity, high pressure, etc.) and/or hazardous chemicals. The design must be reviewed before you start construction and the completed apparatus must be reviewed before initial use.
- Inform EHRS of any installations of hazardous or flammable gases prior to use so the equipment can be inspected. (See: Hazardous and Highly Toxic Gas SOP)

Reporting

- Report all adverse incidents, even seemingly minor ones, to EHRS and your PI before repeating the experiment.
- Notify your PI and/or EHRS if you believe that someone in your lab is working unsafely or may not be following the above procedures.

Notes:

1. A bioreactor of the type Dr. Ekins-Coward had assembled is described in a 2013 article published in the International Journal of Hydrogen Energy by Ekin-Coward's PI, Dr. Jian Yu (DOI: 10.106/j.ijhydene.2013.04.153). In Dr. Yu's article the gauge specified is an "intrinsically safe" model (read: non-sparking). However, the article contains no reference to this safety feature and provides no warnings about the potential hazards. Dr. Yu's article describes an apparatus in which gases are delivered directly to a 600-mL reactor tank. Dr. Ekins-Coward had purchased components and assembled an apparatus in which gases were to be premixed in a 49-L tank before delivery to the bioreactor.

2. The fire department report includes Dr. Ekins-Coward's account of a "small internal explosion" that she experienced the week before. This event occurred when she pushed the OFF button on the gas pressure gauge. That near-miss incident occurred in a 3.8-L reactor. The vessel that exploded on the day Dr. Ekins-Coward lost her arm was 49-L.

Additional information about this incident

The Safety Zone, CE&N chemical safety blog

- http://cenblog.org/the-safety-zone/2016/04/uc-center-for-laboratory-safety-is-investigating-u-hawaii-explosion/
- http://cen.acs.org/articles/94/web/2016/03/Explosion-University-Hawaii-seriously-injures.html
- http://cenblog.org/the-safety-zone/2016/04/we-felt-the-explosion-rattle-the-floor-and-walls-eight-floors-up/
- http://cenblog.org/the-safety-zone/2016/03/researcher-loses-an-arm-from-lab-explosion-at-the-university-of-hawaii/
- http://cen.acs.org/articles/94/web/2016/04/Spark-pressure-gauge-caused-University.html

Local News article

- http://khon2.com/2016/04/19/investigating-entity-hired-by-uh-founded-after-similar-laboratory-explosion/

Science Magazine

- http://www.sciencemag.org/careers/2016/04/university-hawaii-lab-explosion-caused-inappropriate-gauge

EHRS 2016 Safety Alert (KB)
UPDATED 8/4/2016

Royal Society of Chemistry

- http://www.rsc.org/chemistryworld/2016/04/hawaii-university-accident-explosion-cause-safety-failings

Information and tools on hydrogen safety

- Hazardous and Highly Toxic Gas SOP in the University of Pennsylvania's Chemical Hygiene Plan
- Hydrogen Tools website, sponsored by Pacific Northwest National Laboratories and the U.S. Department of Energy