



Revising CHED's "Minimum Safety Guidelines for Chemical Demonstrations"

Monique Wilhelm, University of Michigan-Flint

Irene Cesa, Flinn Scientific (retired)

Dave Finster, Wittenberg University

Sammye Sigmann, Appalachian State University



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How To Make Chemistry Classroom Demonstrations And Experiments Safer

Fires that injure students prompt calls for safety assessments of demonstrations or experiments, plus teacher training

By Jyllian Kemsley

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AFTERMATH

Firefighters investigate Biery's chemistry classroom at Western Reserve Academy after the 2006 fire that injured her and others.

Credit: AP

U.S. Chemical Safety Board: Key Lessons for Preventing Incidents from Flammable Chemicals in Educational Demonstrations

<http://www.csb.gov/key-lessons-for-preventing-incidents-from-flammable-chemicals-in-educational-demonstrations/>

Kemsley, J. How to Make Chemistry Classroom Demonstrations And Experiments Safer. *Chemical & Engineering News*, Nov 23, 2015, p 37-39.



Where to Start

- Existing Document
- Audience?
- What is missing?
- Priorities?



Audience?

- Professionals with some science training
 - K-12 teachers
 - Informal educators (museums)
 - College instructors
 - College science students
- Not intended for
 - General public



What is Missing?

- Limited planning steps
- Performing in non-lab locations
- Risk assessment
- Restricting quantities of hazardous materials



NFPA 45 – 2015 Edition

Fire Protection for Laboratories Using Chemicals

- 12.2 Instructor Responsibilities

Where instructors are performing demonstrations or students are conducting experiments using hazardous materials, the instructor shall be **required** to perform a documented hazard risk assessment, provide a safety briefing to students, provide adequate personal protective equipment (PPE), and place a safety barrier (as required) between students and the demonstration or experiment to prevent personal injury.

- 12.3 Chemical Storage and Handling

Quantities of chemicals in an instructional lab shall be limited to the **lowest possible level** necessary



Priorities?

- Focus on planning
 - Consideration of locale
 - Risk assessment
- Add info to avoid additional methanol incidents
 - Info specific to combustion demos
 - Audience distance
 - Fire extinguisher on hand



The New Document

- Reviewed by
 - multiple chemical safety professionals
 - Safety Committee of Division of Chemical Education
- Presented for review at Spring 2016 CHED Executive meeting in San Diego
- Final adoption anticipated in Philadelphia



The New Document

6 sections

- Intro
- Before the demo
- During the demo
- Special notes for outreach
- References
- Disclaimer



Intro

Physical and chemical demonstrations in the classroom or in a public venue can have both educational and motivational value and are a long-standing pedagogy in chemical education. All individuals who are planning chemical demonstrations have an **ethical and legal responsibility** to follow and document safe laboratory practices for each demonstration. These guidelines have been created based **on current best practices** and provide a checklist of key issues for demonstrators to assure that chemical demonstrations are conducted safely and without incident. Because no such list can address all possible uses and hazards of chemicals in this application, **these guidelines are intended for use by persons who have appropriate education and experience** in chemistry and chemical safety.



Before the Demo

1. Always follow a **tested, written procedure** that includes comprehensive safety precautions. Plan the demonstration at the smallest scale possible for the location and viewers.
2. **Review the safety precautions** which will help you identify the potential hazards involved in the demonstration and understand the risks due to exposure and/or improper handling of a chemical, process, or procedure. Effective safety precautions provide easy-to-follow instructions to minimize risk and prevent unplanned incidents that could result in injury or property damage.
3. If a written procedure is not available, or safety precautions are not clear, perform an independent **hazard and risk assessment** to identify the possible hazards and evaluate the risks. In the risk assessment, consider the pedagogical value compared to the risk. Write the demonstration procedure with appropriate safety precautions to protect against the hazards and reduce risk. Refer to these guidelines as you write the demonstration procedure, and retain the procedure on file for future use.
4. Always **practice** a demonstration before presenting it before students or an audience for the first time.



Before the Demo

5. Ensure that all **demonstrations are appropriate for the room** being used and the available safety equipment. Keep all exit paths clear. Check the **ventilation** in the demonstration area to ensure that participants and audience members will not be exposed to harmful quantities of toxic gases or chemical vapors. The use of a **fume hood** is required for any demonstration that uses or produces a substance with a TLV less than 50 ppm (check the SDS for the TLVs of all chemicals).
6. Consult current **Safety Data Sheets** (SDS) and review the safe handling information for all chemicals used in the demonstration.
7. Prepare and follow a safety checklist for all **combustion demonstrations** involving the use of a flammable liquid. Dispense only the amount of the liquid required BEFORE beginning the demonstration. Cap the solvent bottle and REMOVE it from the demonstration area before applying the ignition source. NEVER add more flammable liquid to a combustion demonstration once it is underway.



Before the Demo

8. Ensure that observers will be a **safe distance** (10 feet or more) or are protected by a physical barrier, such as a polycarbonate shield, from the demonstration area when working with flammable, corrosive or toxic substances. In a small setting such as a classroom or lab, all participants and observers must wear **appropriate eye protection** at all times.
9. Ensure there is an appropriate **fire extinguisher** on hand whenever the slightest possibility of fire exists and that you have the knowledge, experience and training to use it properly in the event of an emergency.
10. Keep a **spill kit** nearby to contain, absorb, and neutralize any spilled chemicals.
11. **Plan for appropriate handling or disposal** of reaction byproducts or excess chemicals in accordance with institutional policies.



During the Demonstration

12. Wear appropriate **personal protective equipment** (PPE) for the level of risk as determined by the assessment, such as chemical splash goggles, chemical-resistant gloves, and a lab coat, to protect against the hazards. Active participants must also wear appropriate PPE.
13. Provide **safety shield** protection whenever there is the slightest possibility that a container, its fragments or the contents could be propelled with sufficient force to cause exposure and/or personal injury.
14. **Warn** members of the audience to cover their ears if a loud noise is anticipated.
15. Participants and spectators must **not taste** any food or non-food substances used in the demonstration.
16. Do not perform demonstrations in which parts of the **human body** will be placed in danger (such as placing dry ice in the mouth or dipping hands into a hazardous liquid).



Special Notes for Outreach

17. Ensure proper packaging and secondary containment for the **safe transport** of all chemicals to and from off-site locations. Materials of Trade (MOT) exceptions to Department of Transportation requirements allow for the transport of certain hazardous materials without a license or shipping papers provided certain guidelines are met. There are strict limits on the amounts of material, depending on the hazard. Visit the links below for more information about hazard classes, packaging requirements, and restrictions on the amounts of chemicals.

https://hazmatonline.phmsa.dot.gov/services/publication_documents/MOTS05.pdf

<http://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/safetypractices/transporting-chemicals.pdf>



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https://hazmatonline.phmsa.dot.gov/services/publication_documents/MOTS05.pdf
<http://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/safetypractices/transporting-chemicals.pdf>
18. **Notify** security and/or administrators that you will be performing demonstrations. If public space will be used for demonstrations involving fire, **contact the local fire department** to determine if the demonstrations meet local fire and building use codes.
19. Provide a **written demonstration procedure**, including comprehensive safety precautions and risk assessments, whenever the audience will be encouraged to conduct the demonstration at another time.



References

- Kemsley, J. How to Make Chemistry Classroom Demonstrations And Experiments Safer. *Chemical & Engineering News*, Nov 23, 2015, p 37-39.
- U.S. Chemical Safety Board: Key Lessons for Preventing Incidents from Flammable Chemicals in Educational Demonstrations
<http://www.csb.gov/key-lessons-for-preventing-incidents-from-flammable-chemicals-in-educational-demonstrations/>
- American Chemical Society: Safety Guidelines for NCW and Community Activities.
<https://www.acs.org/content/acs/en/education/policies/safety.html>
- NFPA 45: Standard On Fire Protection For Laboratories Using Chemicals
<http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=45>
- Prudent Practices in the Laboratory
<http://www.nap.edu/catalog/12654/prudent-practices-in-the-laboratory-handling-and-management-of-chemical>