

Role of communications in laboratory safety: “Rainbow” flame tests

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Senior Editor, *Chemical & Engineering News*

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c&en

THE
SAFETY **ZONE**

Incidents were adding up

	A	B	C	D	E	F	G	H	I
1	Collected by C&EN, ACS Division of Chemical Health & Safety, U.S. Chemical Safety & Hazard Investigation Board, and Chemjobber								
2	TOTAL INJURED					72			
3	Date	Facility	City	State	Total injured	Students	Adults	Description	
14	11	11/25/2013	Lincoln Park High School	Chicago	Illinois	5	5	"On November 25, 2013, defendant Joy Walter was performing the ignition of elements in said chemistry class ... Walter was performing the demonstration and attempted to ignite cobalt in a petri dish with a match. Because the cobalt did not ignite, defendant Joy Walter poured an unmeasured amount of methanol over said cobalt and match, causing an outward explosion."	
15	12	1/2/2014	Beacon High School	New York	New York	2	2	"Poole continued that, as she lit each Petri dish, a different color flame appeared. When the flames died out, the students asked Poole to conduct the experiment again. Poole explained that, this time, after she added the nitrates to the Petri dish, she reached for the one gallon container of methanol to add to the Petri dish and, all of a sudden, a fire ball--like a blowtorch--erupted and shot across the room. Poole did not hear anything, but saw a white flame shoot across the room, and then Student A was on fire."	
16	13	9/3/2014	Terry Lee Wells Discovery Museum	Reno	Nevada	13		"Our investigative team determined that the incident occurred during a 'fire tornado' demonstration where salts of different elements were combusted in a dish in the presence of alcohol-soaked cotton balls, while spinning on a lazy Susan-type rotating tray. ... When the cotton failed to ignite it was realized that it had not been adequately wetted with methanol. More methanol was added to the cotton from a four-liter (one gallon) plastic bottle. Unknown to personnel, the cotton ball was likely continuing to smolder, and it ignited the freshly added methanol and flashed back to the bottle. Burning methanol then sprayed from the bottle toward the nearby audience of adults and children visiting the museum." (9 people transported to hospital--8 children, 1 adult)	
17	14	9/15/2014	SMART Academy	Denver	Colorado	4	4	"The teacher lit a small pool of methanol to demonstrate its flame properties. When the flame didn't rise as high as desired, he added more methanol from a 4 L container. The fire flashed back into the container, then emerged as a 'jet fire' that traveled 15 ft to hit a student in the chest."	
18	15	10/20/2014	Cub Scout event	Raymond	Illinois	4	3	"the Scouts were outside a multi-purpose building owned by the Community of Faith Presbyterian Church attempting to mix boric acid and Heet antifreeze in a metal fire pit to produce a green flame when the substance exploded about 7:20 p.m."	
19	16	10/31/2014	UIC College Prep	Chicago	Illinois	3	3	"The lawsuit alleges that Donati was attempting to mix boric acid and methanol inside a pumpkin to demonstrate the effects of the combined chemicals. At some point, there was an explosion"	
20	17	5/22/2015	Lincoln High School	Tallahassee	Florida	3	3	"A flame test being demonstrated by an experienced teacher during an AP chemistry class resulted in the accident. ... A flammable solvent -- in Friday's accident it was alcohol -- is used to ignite the flame. But it also creates the conditions for a flash fire."	

And then one in ACS's backyard



6 injured in **chemistry** classroom fire at **Woodson High** in Fairfax
Washington Post - Oct 30, 2015

A **chemistry** demonstration at a Fairfax County **high school** went out of control Friday morning, with a flash of flame engulfing a group of students, leaving two ...

Chemistry Experiment Sparked Explosion in Va. **High School** That ...
NBC4 Washington - Oct 30, 2015

5 WT **Woodson** HS students, teacher injured in **chemistry** lab fire
FOX 5 DC - Oct 30, 2015

Students come together at WT **Woodson High School** after **chemistry** ...
WJLA - Oct 30, 2015

5 students, 1 teacher injured in Virginia **high school chemistry** lab fire
New York Daily News - Oct 30, 2015



NBC4 Washin...



FOX 5 DC



WJLA



New York Dail...



WTOP



wtvr.com

Initial news reports

WJLA/ABC 7: S

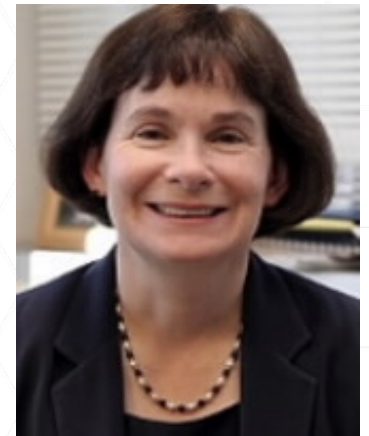
Students come together at WT Woodson High School after chemistry class fire injures 6



After a difficult day, WT Woodson High School wins football game 35-28. (ABC7/ Richard Reeve)

Communicating via general media

- ACS communications office provided CCS information about flame tests to media
- Tried unsuccessfully to find an ACS member to appear on camera
- Scheduled interviews for Mary Kirchhoff, then director of education division
 - Two on-camera interviews, Saturday & Monday
 - Little information, had to be careful with language: "If it was a rainbow demo..."



Main message:

Live demos and hands-on experiments are valuable and necessary, but they must be done in a way that's safe.

NBC4: [American Chemistry Society Warns Against Some Classroom Experiments](#)

Mary Kirchhoff, the director of education for the ACS, says both experiments are dangerous because they involve using methanol and an open flame.

Kirchhoff says other experiments can be dangerous, but the vast majority can be conducted safely with proper training and conditions.

"We need to make sure teachers and student are aware of the potential dangers," Kirchhoff said.

- **Chem Class Fire Victim Will Have Surgery**

But she adds the fire at Woodson High School shouldn't lead to calls against hands-on experimentation.

"Experimenting is vital," Kirchhoff said. "I think the essential thing is teachers have the right safety training and that they've been properly educated."

WJLA/ABC7: 7 ON YOUR SIDE investigates potentially dangerous rainbow experiment

- Kristen Kulinowski, Chemical Safety Board
- Kim Duncan, ACS
- Mary Kirchhoff, ACS

Kristin Kulinowski with the U.S. Chemical Safety Board says, "It's pretty dramatic. It's colorful. And it's beautiful."

But she and other experts say the Rainbow Experiment is also extremely dangerous if it's done using flammable chemicals and an open flame. Kim Duncan, Professional Learning Associate with American Chemical Society, tells 7 ON YOUR SIDE, "They can cause really serious injury if they're not handled properly."

Communicating via video

- Concurrently, group effort within ACS to produce a video for YouTube showing safer procedure, tagged to turn up in searches
 - Education: Actual demo in lab space
 - Communications: Video filming & editing, publicity
 - C&EN and CHAS: Procedure review

From: Jyllian N. Kemsley [mailto:J_Kemsley@acs.org]
Sent: Thursday, November 05, 2015 1:52 PM
To: Debbie M. Decker <dmdecker@ucdavis.edu>
Subject: FW: ChemSafetyColorBurn Final v1 is ready for your feedback
Importance: High

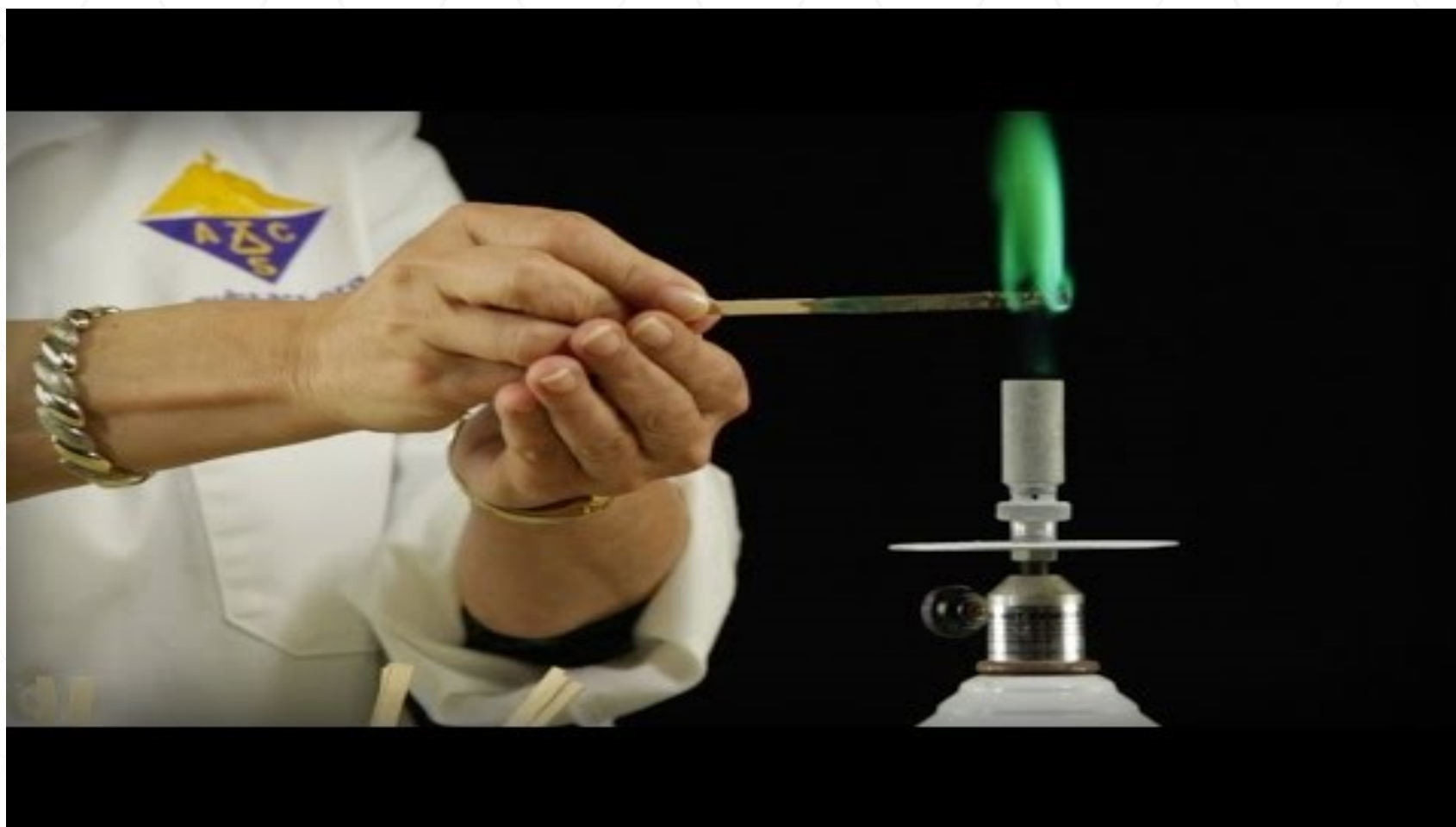
Do you have time to look at this and let me know what you think? I didn't find out they were filming this morning until it was already in progress, and they want to release it live tomorrow.

From: Debbie M. Decker [<mailto:dmdecker@ucdavis.edu>]
Sent: Thursday, November 5, 2015 5:55 PM
To: Jyllian N. Kemsley <J_Kemsley@acs.org>
Subject: RE: ChemSafetyColorBurn Final v1 is ready for your feedback

Yes! I'm in a meeting with my lab safety work group and I'm going to show it and get their feedback. Stand by – I'll have something to you in the next half hour or so.

The warning to not use etoh/meoh should be up front, along with a little bit of narrative of why this is important – several serious incidents in the past two years, etc.
The burner should be restrained – it looks very tippy.
The match should be lit first and then the gas opened.
Her hand is in the way of the flame – should be to the side.
Jars should be turned around initially or the label on both sides of the jar.
For "Christmas" flame – should be copper and lithium, not calcium and lithium.
The soaked splints can be allowed to dry out and used in the same way. Don't throw them out! Dry splints actually work better.

A Safer "Rainbow Flame" Demo for the Classroom



Communicating via print

- NFPA Standard 45 presentation at ACS National Meeting in Boston
- Turn that into infographic, package with story:
 - # of incidents, people injured
 - Effects on people
 - Recommendations from NFPA, CSB, etc.
 - Comments from teachers of teachers

Chapter 12 Educational and Instructional Laboratory Operations

12.1 General. This chapter provides fire protection and safety requirements for new and existing educational and instructional laboratories where experiments are conducted or demonstrations are performed using hazardous materials.

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.

12.2.1* Instructors in teaching labs shall be trained and knowledgeable in fire safety procedures, emergency plans, the

hazards present in the lab, the appropriate use of PPE, and how to properly conduct a hazard risk assessment.

12.3 Chemical Storage and Handling.

12.3.1* Bulk quantities of chemicals shall be stored in a locked room outside of the classroom in educational labs. Chemicals stored and in use in an educational lab classroom shall be limited to the amount needed for one day's use, preapportioned to the amount needed for each class session. The amount of chemical that is not in use during an individual class session shall be kept in an appropriate, locked cabinet.

12.3.1.1 Quantities of chemicals in an instructional lab shall be limited to the lowest possible level necessary and in no case shall exceed the per-laboratory unit quantities specified in 9.1.1 or the maximum allowable quantities specified in fire or building codes.

12.3.1.2 Dispensing of bulk quantities of chemicals for an experiment or demonstration shall be performed in a prep room outside of the classroom.

12.3.1.3 For existing educational and instructional laboratories that do not have a separate preparation room, the dispensing of bulk quantities of chemicals for experiments or demonstrations shall be performed prior to the arrival of the students in the classroom.

12.3.1.4 The minimum amount of chemical(s) needed to perform the experiment or demonstration shall be transferred to a small, appropriately labeled, scalable bottle(s) or dropping bottle(s).

12.3.1.5 Bottles of chemicals shall only be open in the classroom only when the experiment or demonstration is being performed.

Preparing for demos or experiments:

- Determine educational goals and how the activity will meet them.
- Perform hazard and risk assessments.
- Provide a safety briefing to students.

Store bulk quantities of chemicals in a locked separate room or cupboard. Dispense only necessary quantities to labeled, sealable bottles before students arrive.

Do not block exit.

PREP

EXIT



Use a fume hood if possible. If not, place an impact-resistant barrier between the demo and students. If a barrier is not possible, ensure students are at least 10 feet (3 meters) away from the demo.

NOTE: Instructors in teaching labs shall be trained and knowledgeable in fire safety procedures, emergency plans, the hazards present in the lab, the appropriate use of personal protective equipment, and how to properly conduct a hazard risk assessment.

SOURCE: National Fire Protection Association Standard 45, 2015 Edition

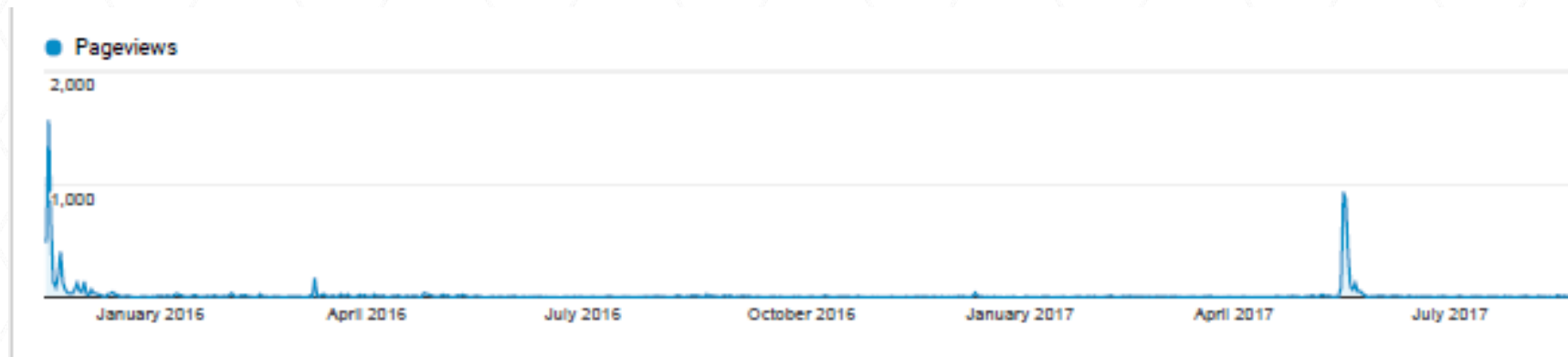
How to make chemistry classroom demonstrations and experiments safer



- Photo from Calais Weber Biery incident
- List of free resources
- Embedded ACS flame test video
- Embedded CSB video
- PDF of print
- Outside paywall
- cenm.ag/labdemo

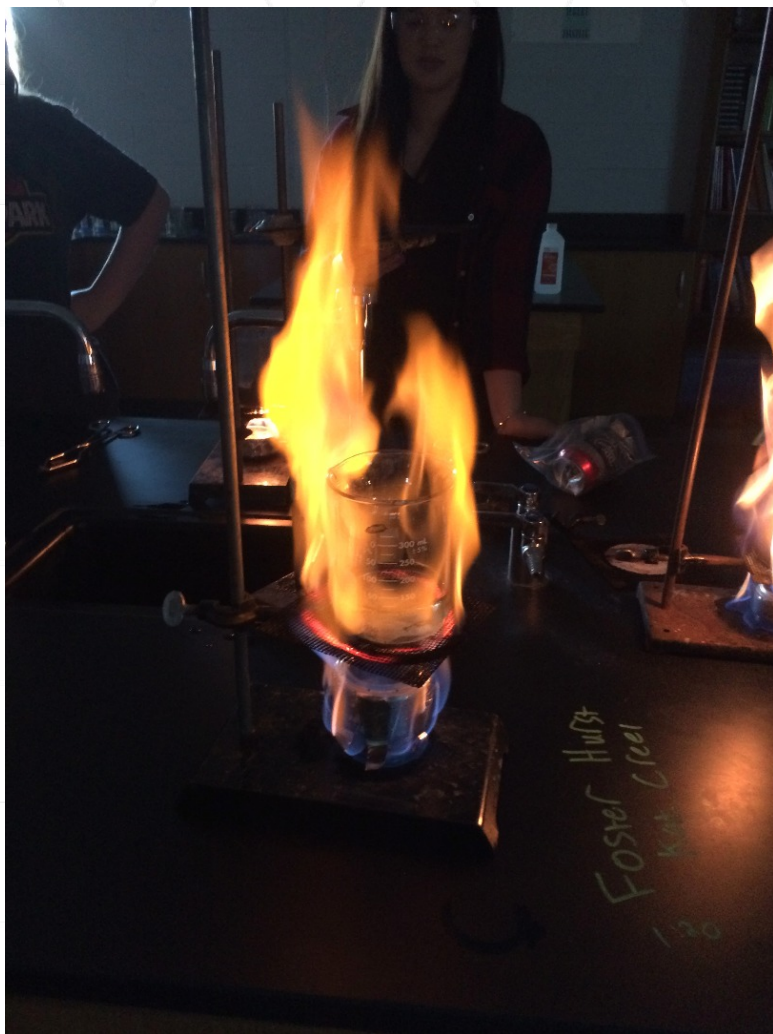
Effectiveness?

- C&EN circulation: ~300,000
- Web analytics: 12,613 views, 4m55s on page



- PDF shares: ???
- Feedback from readers: Comments and emails
- News reports: Fewer? (but preschool!)

On the other hand...



Students in my high school chemistry class were tasked with trying to develop an alcohol burner/stove that could boil 100 mL of H_2O in a 400 mL [beaker] the fastest. This group used denatured alcohol and had a dual burner system. Water boiled in 2 min and 38 seconds. Students learned to cut aluminum cans, develop a plan, and implement it.

Thank you

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