The Safety Net: Lessons in Sharing Safe Laboratory Practices

Alexander J. M. Miller 21 August 2022



THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

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Dondering the Future, ca. 2011



Pondering the Future, ca. 2011



Pondering the Future, ca. 2011



- How will I keep my group safe?
- How can I help my students think proactively about safety?
- What resources are available if we're not sure about a procedure?

Early Safety Initiatives in the Group

Opened each group meeting with a "safety scenario"

Started building an internal database of Safe Operating Procedures (SOPs)

Thinking at the departmental level: better training? safety course? safety team?



NAME OF PRIMARY PLACE OF PERF University of North Carolina at Chapel Hill	ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE University of North Carolina at Chapel Hill Department of Chemistry Chapel Hill ,NC ,275993290 ,US.					
IS AWARDEE ORGANIZATION (Check All That Apply) SMALL BUSINE (See GPG II.C For Definitions) FOR-PROFIT O	SS I MINORITY BUSINESS RGANIZATION WOMAN-OWNED BUSINESS	☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE				
TITLE OF PROPOSED PROJECT CAREER: Pincer-crown-ether Ligands for Cation-controlled Catalysis						

2013 NSF CAREER proposal — **DECLINED**

Paying attention to safety at UNC is laudable, of course, but seems to be something that ought to be done as part of modern graduate education. Perhaps if the PI developed safety-related materials and **made the[m] accessible to the public and/or our professional community, then the activity would have a broader impact**. Done well, it actually would be quite useful.

Surveying Safety Web Resources...



Not Voodoo Demystifying Synthetic Organic Laboratory Technique

Created by <u>Alison J. Frontier</u> <u>Department of Chemistry, University of Rochester</u>

Not Voodoo X.4

Demystifying Synthetic Organic Chemistry since 2004



plus journals, C&EN, etc

Surveying Safety Web Resources...



Prof. lan Tonks Univ. Minnesota





On May 26, 2014, at 8:27 AM, Miller, Alexander James Minden <a>ajmm@email.unc.edu> wrote:

Hey lan -

Awesome. One thing I've been chewing around is a website that can collect the kinds of documents you mentioned (possibly including videos). The organic chemists have Not Voodoo, but maybe synthetic inorganic chemists need something a little bit more like that, but with a focus on safe practices. My group about 25 SOPs now, from the mundane to the complex. (The name <u>sopstop.com</u> came to mind, which made me think of Bob Loblaw's Law Blog...).



safetynet.web.unc.edu



A curated collection of information and resources on safe practices in academia

Goal: increase communication on lab safety

Splash page art backstory...



Around the walls...

in Monsanto's "Hall of Chemistry"... see how chemistry works wonders for you in food, clothing, shelter and health today, and some of the exciting possibilities chemistry has in store for you tomorrow ...





MONSANTO CHEMICAL COMPANY

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What's on the site?

- Safe Operating Procedures (and available templates and submission forms)
- Laboratory resources (signage, checklists, safety minutes, templates etc)
- Published synthetic procedures that address safety concerns
- Physical properties tables (links to important data sets)

- Step-by-step instructions for routine tasks
- Part of a holistic approach to training in research laboratories
 - Not a replacement for comprehensive training and mentoring

- Step-by-step instructions for routine tasks
- Part of a holistic approach to training in research laboratories
 How the Miller lab uses SOPs





Key questions

- Does this procedure **need a SOP**?
- Who will write the SOP? Who will check & revise? What is the "right" way to perform the procedure?
- What information & details are essential? What makes a great SOP?





Miller group observations

- Student leadership and participation is essential; the more detail & photos, the better
- Group-wide **review and checking** always leads to improvement
- Treating SOPs as **living documents** promotes critical reading & revision
- Sharing widely/publicly provides a forum for feedback and discussion
- Redundancy sparks dialogue: The Safety Net has multiples of "same" SOPs

Safe Operating Cards (SOCs)

Informational cards posted at fume hoods during unattended reactions





Promote Hazard Assessment

 Filling out a SOC requires thoughtful assessment of potential hazards

Increase Communication

• Promotes dialogue about potential hazards

Increase Awareness

- Researchers are aware of ongoing processes
- Researchers engage beyond their project

SOCs are easy to implement and easy to use

Templates available on The Safety Net





Reaction	eaction		Expt#		
Contact Phone Haza	rds	Intended Conditions T:P:Atm: Stirring (Y/N), Dark (Y/N)			
 Acid Base Oxidizer Elammable 	 Temp Hi/Lo Pressure Hi/Lo Heavy Metal Inhalation Hazard 	Emerg	gency S	hut Down	
 Air Sensitive Moisture Sensitive Light Sensitive Shock Sensitive Heat Sensitive 	 Innalation Hazard Toxic Biohazard Radioactive Low Hazard 				



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If checklists help save lives in the operating room or during aircraft emergencies, maybe they can help in a research lab!

SECTION 4

NORMAL PROCEDURES



SECTION 4

NOTE

Visually check airplane for general condition during walk-around inspection. In cold weather, remove even small accumulations of frost, ice or snow from wing, tail and control surfaces. Also, make sure that control surfaces contain no internal accumulations of ice or debris. Prior to flight, check that pitot heater (if installed) is warm to touch within 30 seconds with battery and pitot heat switches on. If a night flight is planned, check operation of all lights. and make sure a flashlight is available.

Figure 4-1. Preflight Inspection

MODEL 172N

CHECKLIST PROCEDURES

PREFLIGHT INSPECTION

()CABIN

CESSNA

- Control Wheel Lock -- REMOVE.
- Ignition Switch -- OFF.
- Avionics Power Switch -- OFF. Master Switch -- ON.
- Fuel Quantity Indicators -- CHECK QUANTITY.
- Master Switch -- OFF. 7. Baggage Door -- CHECK, lock with key if child's seat is to be occupied.

2 EMPENNAGE

- Rudder Gust Lock -- REMOVE. Tail Tie-Down -- DISCONNECT.
- Control Surfaces -- CHECK freedom of movement and security.

(3) RIGHT WING Trailing Edge

1. Aileron -- CHECK freedom of movement and security.

(4) RIGHT WING

- Wing Tie-Down -- DISCONNECT.
- Main Wheel Tire -- CHECK for proper inflati Before first flight of the day and after each re 3.
- cup and drain small quantity of fuel from fu
- drain valve to check for water, sediment, and Fuel Quantity -- CHECK VISUALLY for desi
- 5. Fuel Filler Cap -- SECURE.

(5) NOSE

- I' Engine Oil Level -- CHECK, do not operate quarts. Fill to six quarts for extended flight. Before first flight of the day and after each
- strainer drain knob for about four seconds to possible water and sediment. Check strainer of is observed, the fuel system may contain a further draining of the system at the strainer, fuel selector valve drain plug will be necess







Essential Reminders

- Critical information, readily available during routine operation or in an emergency
- Not a how-to guide or replacement for SOP, just key reminders

Increase Communication

- Clear communication of important information
- Frequent reminders help lock in "muscle memory"

Increase Awareness

- Helps combat complacency, forgetfulness, or panic in an emergency
- Locks in learning accumulated during training/mentoring

Example Checklists

Changing Gas Cylinders

Obtain consistinguistor, Check CCAA (See SCP)
 Check special gas (SG) latelling an hood ports
 Dreck status of valves and connections
 Dependion

Dylinders should be deate shapped to will while in use
 Never force a connective I bo not overlighter net!
 Delivery pressure. Shi P pil
 Delivery pressure. Shi P pil
 Delivery between the should be before
 text of the should be bound be bounded before

Leak check connections from cylinder to bubbler before a
 Never pressurize a Schlerk line — keep bubbler open

Changing Gas Cylinders

Preparation

- □ For toxic gasses, take proper precautions
- □ Obtain correct regulator. Check CGA# (See SOP).
- □ Check special gas (SG) labelling on hood ports
- Check status of valves and connections

Operation

- Cylinders should be double strapped to wall while in use
- □ Never force a connection! Do not overtighten nut!
- Delivery pressure: 5-10 psi

Gauge reading won't decrease in a closed system!

- $\hfill\square$ Leak check connections from cylinder to bubbler before use
- Never pressurize a Schlenk line keep bubbler open



Leaving Lab – Checklist

1. Hood Status

- □ Check traps and pumps
- □ Check waste containers

□ Check sashes

- □ Check lights
- 2. Glovebox Status
 - □ Check traps
 - □ Check O₂ levels
 - □ Check purifier/circulation
 - □ Check N₂ tank levels
- 3. General Equipment Status
 - □ Check UV-vis lamps
 - □ Check rotavap

4. Security Status

□ Lock all doors (both side doors, front door, and breakroom)
 □ Have a nice day ♥



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Statistical Overview

- Launched in 2017
- 54 SOPs (36 Miller, 16 Tonks, 1 Yang, 1 Saouma)
 - Dozens of researcher-developed resources
 - Average of ca. 175 visitors per month
 - Peaks above 1,000 visitors per month



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Weekly visitors (last 90 days)



The Safety Net

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Alex Miller @DocAJMM · Jun 13

Heartbreaking and inspiring story in @cenmag on Karen Wetterhahn. I never knew she was preparing a 199Hg chemical shift standard. Super important to emphasize: dimethylmercury need never be used for that purpose again. 1/3



cen.acs.org

25 years after Karen Wetterhahn died of dimethylmercury poisoning, ... Chemist left legacies in lab safety, the scientific method, and women in science

108

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Alex Miller @DocAJMM · Jun 13

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In past 25 years, "absolute referencing" methods have improved to the point that heteronuclear NMR spectra can all be referenced to the 1H reference (TMS). Here is a primer at The Safety Net (cc: @ianatonks). safetynet.web.unc.edu/wp-content/upl... 2/3

Impressions (i) Engagements (i) 1.171 22,034 New followers (i) 0 ılt ...

...

490



Detail expands (i)

477

Link clicks (i)



300

250

200

150



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- 1. Be creative in promoting a culture of safety
- 2. Refine and test internally with students leading
- 3. Share widely and invite dialogue

Lab Resources

An array of laboratory safety resources are collected on this page.

<u>SOCs (Safe Operating Cards)</u>. Reusable placards that can be placed near a fume hood to provide details of ongoing reactions or processes.

<u>Check-in Checklist</u>. Example from the Miller group showing how a lab can organize aspects of safety as part of new researcher training for an in-person walkthrough tailored to a specific lab.

<u>Safety Minutes</u>. A safety minute is a short, interactive activity designed to foster regular discussions about a relevant safety topic.

<u>Lab Safety Field Day Resources</u>. These annual refreshers on key techniques can help preserve knowledge of safe procedures over time.

<u>Checklists</u>. Checklists provide visual cues and reminders of protocol. Checklists do not replace proper training or SOPs, but prompt the researcher to recall specific hazards or oft-forgotten steps in the procedure.



Our Twitter Feed





Lots of ways we can improve The Safety Net

Fostering communication

How can we efficiently share innovations across institutions and between industry and academia?

Expanding scope

How can we find new partners and diversify portfolio of SOPs and other resources?

Reaching a broader audience

How can we reach more researchers?

One way is to write in chemical research venues...

pubs.acs.org/Organometallics

Let's Talk About Safety: Open Communication for Safer Laboratories

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dimethyl sulfide

dimethyl sulfite

dimethyl sulfoxide

dimethyl sulfone

dimethyl sulfate

dimethyl disulfide















dimethyl sulfide dimethyl sulfite dimethyl sulfoxide ∠S、 dimethyl sulfone _o-^{\vec{v}}_o-dimethyl sulfate _\^{\vec{v}}_ ۲٫۰ -^s dimethyl disulfide - ۰٬۰۶٬۰۰ **Dietary** supplements or /S___/ food additives spectrun spectrum **Dimethyl Sulfoxide** Reagent **Dimethyl Sulfate** Reagent frad and understand the label and Safety Data Sheet (\$25) 108618-1006 head and understand the label and Safety Date Sheet (526 Dimethyl sulfite 99% Chemical Emergency: (800)424-9300 Chemical Emergency: (800)424-9300

