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Environmental Health & Safety

Safety Matters

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Environmental Health & Safety

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Formaldehyde Safety Training: Changes in 2017

by Katie Bolger, Health & Safety Specialist

Formaldehyde, typically in solution (e.g., formalin), is used ubiquitously in academic research laboratories, including across all Columbia University campuses. It is a chemical with unique properties, and individuals exposed above 0.1ppm are required by the Occupational Safety & Health Administration (OSHA) to participate in an annual training program focused on hazard recognition and control. Historically, all Columbia University research personnel who work with formaldehyde, irrespective of quantity or control measures employed to minimize exposure potential, have been required to attend the University's *Safe Use of Formaldehyde* training, presented by EH&S.

In 2016, EH&S set out to "right-size" the number of University personnel required to participate in the annual training program by conducting an extensive exposure assessment strategy and validating that University research personnel are not exposed to formaldehyde at or above OHSA's 0.1ppm limit. Throughout 2016, EH&S performed exposure assessments in a representative sample of more than 50 Columbia University laboratories where formaldehyde compounds (e.g., formalin) and paraformaldehyde are utilized. EH&S's findings confirmed that those who work with these chemicals exclusively within a certified chemical fume hood, or who work with small quantities (< 0.1mL) on a laboratory bench, do not have measureable airborne exposure to vapors from these chemicals and therefore fall below the 0.1ppm OSHA limit that mandates training.

With these findings, EH&S has made changes to the formaldehyde safety training program. Effective February 2017, Safe Use of Formaldehyde training is no longer required for personnel who work with formaldehyde and paraformaldehyde within certified chemical fume hoods or who work with small quantities (< 0.1mL) on a laboratory bench. The requirement remains for all laboratory personnel to attend Laboratory Safety, Chemical Hygiene and Hazardous Waste Management training offered monthly and available on rascal (TC0950). This module now includes a brief overview of the safe use of formaldehyde, and will reinforce the criteria under which users of formaldehyde and paraformaldehyde are exempt from also attending additional Safe Use of Formaldehyde training. Please refer to EH&S's website for the dates and locations of all in-person trainings: http://www.ehs.columbia.edu/SafetyTrainingSchedules.html.

For those working with formaldehyde or paraformaldehyde in quantities > 0.1 mL outside of a certified chemical fume hood, please contact occusafety@columbia.edu and EH&S will perform a task-specific exposure assessment to determine whether the OSHA limit of 0.1ppm is or could reasonably be exceeded.

If you have any questions about formaldehyde training, please reach out to EH&S at occusafety@columbia.edu.

EH&S website offers enhanced navigation http://ehs.columbia.edu

When working in the laboratory, eating, drinking or applying cosmetics is prohibited.

Proper work attire (long pants, closed toe shoes) and PPE (e.g., laboratory coat, gloves and eye protection) must be worn when working in the laboratory.

Remember to periodically flush your laboratory cup sinks and floor drains with water to prevent sewer gases from migrating into your laboratory.

Closing Out Corrective Actions by O'Dane Wint, Research Safety Specialist

Laboratory surveys are EH&S's most fundamental means of communicating observed risks and potential hazards to the University research community. Since its launch in early 2016, the Laboratory Information Online Network (a.k.a. LION) database has emerged as a central correspondence platform between EH&S and the research community for the exchange of laboratory safety information. Following any survey, when notified of EH&S's observations via LION, it is essential that laboratories address and report their corrective actions. First and foremost these corrective actions are intended to eliminate a potential risk or hazard. In addition, reporting corrections aids EH&S in tracking safety performance and compliance across the University. Certification of corrective actions is accomplished through a few simple clicks in LION as demonstrated in the brief tutorial @ http://www.ehs.columbia.edu/DBTutorials/Corrective-Actions/Introduction.mp4.

At the completion of the 2016 laboratory safety survey cycle, EH&S conducted over 1,200 laboratory surveys and issued as many reports. Over the course of the cycle, many surveys included required or suggested corrective actions related to food and beverages in laboratories (approximately 20%), Personal Protective Equipment (PPE; approximately 30%) and approximately half of labs were notified of various topical criteria in key areas of safety, such as fume hood use and training.

EH&S extends a sincere "Thank You" to those who have already been active users of the LION system in 2016, new users in 2017, and to those who have offered feedback on their experience. If you have not already done so, please log in today (www.ehs.columbia.edu/lion) to review your laboratory's recent survey reports and certify any open corrective actions.

EH&S continues to work diligently with the LION system's vendor, *SafetyStratus*, to customize LION to fit the evolving laboratory safety landscape. Increased user participation and feedback is necessary to make the most of this powerful database. As always, please reach out to EH&S (labsafety@columbia.edu) with any questions, suggestions or comments about your experience with the LION system.

Controlled Substances Information Sessions

by Jessica Kuang, Associate Biological Safety Officer

Laboratories that use controlled substances in research are regulated by New York State Department of Health and Federal Drug Enforcement Administration requirements, along with Columbia University's Policy for the Acquisition, Use and Disposal of Controlled Substances in Research (http://ehs.columbia.edu/ControlledSubstances.html). In an effort to help keep laboratories in compliance with the myriad regulations and University policy requirements, EH&S is hosting three Controlled Substances Information Sessions.

Campus	Date	Time	Location
Medical Center	March 29, 2017	12:00 PM – 1:00 PM	Hammer Health Sciences LL103
Medical Center	March 30, 2017	12:00 PM – 1:00 PM	Hammer Health Sciences LL103
Morningside	May 18, 2017	2:00 PM – 3:00 PM	Havemeyer Hall 209

These sessions will focus on key points in the life cycle of use and management of controlled substances, including licensing, procurement, proper storage and recordkeeping, and the Appendix I submission process, and will also cover the most common issues identified by IACUC and EH&S during laboratory surveys. Since controlled substance license/registration holders are personally responsible for compliance, useful tips in maintaining and improving regulatory compliance will be discussed. Complimentary informational binders with resources and links will be provided for all attendees, along with refreshments. Due to limited seating, please RSVP for the event @ http://ehs.columbia.edu/ControlledSubstancesInformationSessions.pdf.

Peroxide-Forming Chemical Compounds: How to Manage Safely in Your Laboratory

by Laszlo Virag, Research Safety Specialist

Organic peroxides, considered structural derivatives of hydrogen peroxide, are one of the most hazardous classes of compounds used in the laboratory due to their flammability and extreme sensitivity to heat, mechanical shock, friction, impact and light. They can be hydroperoxides containing the –O—O—H moiety, or peroxides containing the –O—O—moiety. In addition, some commonly used organic solvents can undergo a slow reaction with elemental oxygen under normal conditions (autoxidation) resulting in hydroperoxide and peroxide formation. For a list of common peroxide-forming chemicals used in most laboratories, see Table 1, right.

Peroxide Hazard	Handling/Testing	Common Examples
Forms explosive levels of peroxides without concentration	• Before use, test for peroxide formation • Discard after 3 months	Diisopropyl ether Divinyl ether 1,1-Dichloroethene
Peroxide hazards when concentrated	• Test before distillation or evaporation • Test periodically • Discard after 12 months	1,4-Dioxane Diethyl ether 1,1-Diethoxyethane (acetal) Cyclohexene Cyclopentene Decahydronaphtalene (decalin) Isopropylbenzene (cumen) 2-Hexanol 2-Pentanol Tetrahydrofuran Vinyl ethers
Liquid state storage increases peroxide-forming hazard; Hazardous due to peroxide initiated autopolymerization	• Test periodically • Discard liquids after 6 months	Chloroprene Styrene Vinyl acetate Vinyl chloride

The rate of autoxidation and hence the shelf-life of a peroxide-forming organic compound is determined by its molecular structure, and is greatly influenced by functional and/or structural moieties. Thus, ethers with α-hydrogen (hydrogen atom situated adjacent to an ethereal oxygen or to a carbonyl group) and vinyl-halides, -ethers and -esters are most likely to form dangerous peroxides, while secondary alcohols, aldehydes and ketones are the least likely to form such compounds. A hydrogen atom of a vinyl (H2C==C<) derivative is also a readily auto-oxidizable activated hydrogen.

Peroxidation is generally characteristic to the liquid state and is less likely to affect potential peroxide formers in solid, vapor or gaseous state. The autoxidation reaction proceeds at a low rate but can be accelerated by oxygen or air, high temperature, and light. Therefore, storage of peroxide-forming chemicals in partially empty, open or transparent containers significantly increases the risk of peroxidation. Further, evaporation or distillation of such chemicals not only increases the peroxide concentration but also dangerously extends the exposure to oxygen. Many organic solvents pose peroxide hazards on concentration. Others form explosive levels of peroxides – even without concentration – after prolonged storage, and especially after exposure to air (see Table 1, above).

What should a laboratory do to mitigate risks when possessing these chemicals? Besides proper storage in tightly sealed containers, away from light and heat, laboratories should perform periodic testing to detect peroxides. This is a requirement of the Fire Department of the City of New York (FDNY) regulations as described in the November 2016 edition of EH&S's *FDN(wh)Y Me* bulletin: http://www.ehs.columbia.edu/FDNYMe.html.

Before testing or using a known peroxide-forming chemical, visual inspection of the container is essential. Visible crystals, precipitate, or a viscous oily layer present in the container are indicators of dangerously high peroxide content. In such instances, DO NOT open the container and immediately contact EH&S. When handling peroxide-forming materials use a properly functioning chemical fume hood with the sash as low as possible.

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The presence of peroxides in organic solvents/compounds can be tested with a variety of methods. For convenience, use commercially available peroxide test strips that are semi-quantitative and give readings usually in the 0 – 100 mg/L H_2O_2 range (for example the Macherey-Nagel QUANTOFIX® Peroxide 100). EH&S recommends selecting a test strip that measures hydrogen peroxide and peroxides in solutions, as well as organic and free inorganic hydrogen peroxides, and that is suitable for testing the peroxide-forming solvents most commonly used in laboratories. Although there is a lack of consensus on a "safe" level of peroxide concentration, several references point to 100ppm as a control level for discontinuation of use. DO NOT test solvents that are of unknown age or that exhibit visible signs of peroxide formation, as described previously.

There is a way to chemically slow peroxide formation. Autoxidation is a chain reaction which proceeds by free radicals, therefore a manufacturer may add low concentrations of free-radical scavengers to peroxide-forming solvents to inhibit peroxidation e.g., diethyl ether stabilized with 2,6-di-tert-butyl-para-methylphenol (BHT). Free radical scavengers or antioxidants can slow but not prevent peroxidation. Therefore, the safety rules outlined previously must still be followed when "stabilized" or "inhibited" solvents are used.

Laser Safety Program

by Konstantinos Georgiou, Health Physicist – Deputy Laser Safety Officer

One of the most significant technological breakthroughs in history was the invention of a new device that emits coherent and collimated light. This light can be red, yellow, green, blue or have no color. It can be used as toy or as a weapon. It can cause a fire or bring smiles. It can make you blind or it can improve your vision. What is it? The LASER!

LASER stands for "Light Amplification by Stimulated Emission of Radiation" and the first operational laser was invented in the 1950's. Ever since, laser technology has continually improved, resulting in a wide range of applications.

Columbia University currently hosts more than 300 "high power" (Class 3b and Class 4) lasers in research laboratories. The term "high power" refers to lasers that have the ability to cause harm to individuals. In response to the rapid expansion in the use of these lasers throughout the University, EH&S established a Laser Safety Program, through which a number of services are provided, with the overall goal of ensuring and supporting the safe use of lasers in all laboratories. Approval of new laser registrations, general laser safety training, ongoing support and guidance, response to laser incidents and laser disposal/recycling are some of these services. The backbone of the Laser Safety Program is the performance of annual laser safety audits.

The goal of the annual laser safety audits is to ensure compliance with experiment-specific laser safety practices and provide guidance based on target-use specifications in addition to the general manufacturer's specifications. Following experiment-specific specifications is especially important, as it has been shown that the hazards associated with laser use are highly dependent on the setup of the laser system. Two identical lasers with different setups and applied engineering controls have to be considered as two totally different systems, and the related hazards have to be examined separately. In the context of a laser audit, information including the applicable control measures, operational output and wavelengths, beam path, alignment, and personal protective equipment used is collected, documented and discussed. This improves EH&S's and the laboratory's understanding of the safety needs and potential hazards of each laser based on its applicable use.

The completion of the first year of the audits showed tremendous growth and progress in the laser safety program. The vast majority of lasers on campus were appropriately equipped with engineering controls and most were covered by written standard operating procedures (SOPs). Going forward, EH&S is working with laser owners to enhance SOP coverage to all labs, provide additional training, and update signage, where needed.

If you have any question regarding laser safety, please contact: lasersafety@columbia.edu or (212) 305-0303.

Chemical Waste Identification and Segregation

by Vincent Vagnone, Hazardous Materials Specialist

Nearly a decade ago, EH&S simplified for the University research community the bulky and complex Federal and State hazardous waste regulations with the development of the Columbia University 5Ls of Hazardous Waste Management. The 5Ls, which are intended to provide laboratories with the basics of managing hazardous waste in compliance with the regulations, do not address every detail about the safe management of hazardous waste. Anyone who has attended *Laboratory Safety, Chemical Hygiene and Hazardous Waste Management* training presented by EH&S (and this should be everyone who works in a "wet" laboratory!) will appreciate that hazardous waste management is a little more involved than just the 5Ls and should recall that safety is a major component of proper chemical waste management. In training, for example, EH&S speaks to issues of chemical compatibility, which is crucial to safety. The decisions laboratory staff must exercise when containerizing chemical waste are predicated on each individual chemical's characteristics. Some of the more common characteristics of chemicals found in laboratories across the University include ignitability, corrosivity, toxicity and reactivity. When managed properly, these chemicals should pose little to no danger in the laboratory. When not managed properly, incompatible chemicals can react, sometimes violently. The reactions may generate heat or toxic/flammable gasses and vapors, violent polymerizations, or shock sensitive compounds. Proper chemical waste management includes only adding compatible chemicals to the same waste containers (also ensuring that the chemicals are compatible with the container type and anything that may have been stored previously in the container), segregating incompatible chemicals into separate waste collection containers, and further separating the waste containers in secondary containment bins in the laboratory. These steps will help avoid unintended chemical reactions in waste collection containers and subsequent release of hazardous waste from container(s) through breakage, spills, or leaks.

A quick segregation reference guide for many common chemicals used in laboratories can be found in the University's Chemical Hygiene Plan @ http://www.ehs.columbia.edu/chemSegChart.pdf. Note, some chemical categories have a broad list of incompatibilities (e.g., explosives, oxidizers and water reactive chemicals) and should be reviewed carefully. For additional guidance with waste storage, contact EH&S at hazmat@columbia.edu or consult the applicable chemical Safety Data Sheet (SDS) @ http://www.ehs.columbia.edu/sds.html.

FDNY - N.O.V. Update

by Harry J. Oster, Manager of Fire/Life Safety Programs

Research staff at Columbia University are familiar with the weekly presence of the FDNY laboratory inspection unit, which conducts weekly rounds of safety visits on the University's New York City campuses. In the event an inspector observes a safety or compliance hazard, violations may be written. These violations follow a two-stage process, beginning with a Violation Order and proceeding to a Notice of Violation. Effective December 19, 2016, FDNY changed the name of its "Notice of Violation (NOV)" to "Summons", however the rules of this violation instrument remain unchanged. In addition to the name change, the court where one appears to answer to a Summons has also changed. The court is now named OATH - Office of Administrative Trials & Hearings, instead of ECB - Environmental Control Board, but the court locations remain the same. The violation codes that will appear on a Summons, the compliance dates (35 days) for corrective action and hearing dates (10 to 21 days later) are also unchanged. The one significant difference in the process is that repeat offenders (i.e., those that receive a Summons) can submit documents to OATH in advance of their hearing date to help mitigate some of the penalties that might be assessed.

A Summons is most likely to be issued when a Violation Order (VO) for a non-compliance is not corrected upon re-inspection by the FDNY, typically within 30 days from the initial VO issuance date. EH&S's Laboratory Fire Safety team remains at the ready to assist your laboratory in maintaining a safe work environment. Please feel free to contact us at: fire-life@columbia.edu with any questions you may have.

Spotlight on Safety – Safety Sentience

by Christopher Aston, Manager of Biological Safety Programs and
Jessica Kuang, Associate Biological Safety Officer

Dr. Ellen Lumpkin's laboratory in the CUMC Russ Berrie Pavilion seeks to elucidate molecular mechanisms of the senses of touch, temperature and itch. The laboratory employs a number of tools including viral vectors and biological toxins. Other potential chemical and physical hazards include formaldehyde and microtome blades. With such diverse hazards, and given the laboratory's strong performance on recent EH&S laboratory safety surveys, *SafetyMatters* spoke to MD/PhD student Blair Jenkins and Postdoctoral Fellow Yalda Moayedi about what makes them so sentient in matters of safety.

***SafetyMatters*: Why does your laboratory have such a strong safety record?**
Blair and Yalda: Our Principal Investigator has a primary role in propagating a culture of safety in the laboratory. Dr. Lumpkin is a strong safety advocate and holds her investigators to a high standard. In the laboratory, appropriate personal protective equipment is always worn with designated lab coats and protective eyewear. Eating and drinking is forbidden, even to the point that gum must be deposited in a waste container outside the laboratory, prior to entry. Furthermore, the application of cosmetics is also prohibited, not only because of the risk of touching mucous membranes with contaminated hands but because we perform sensitive assays on skin sensation and, and postulate that hand lotion may sequester laboratory chemicals ambient in the air.

***SafetyMatters*: What safety provisions are in place for your work with viral vectors?**
Blair and Yalda: To understand the circuits that underlie touch, Adeno-Associated Virus (AAV) is used to express gene products in skin cells, while modified Rabies Virus (RV) and Vesicular Stomatitis Virus (VSV) are employed to trace neurons from the periphery into the central nervous system. These viral vectors are administered to animals subcutaneously in a biosafety cabinet. We also use bleach to decontaminate hazardous biological materials at the work surface and before waste material leaves the biosafety cabinet for disposal.

***SafetyMatters*: What are the issues associated with working with biological toxins?**
Blair and Yalda: Other potential biological hazards in our laboratory are diphtheria and tetrodotoxins. Since University policy requires a protocol to be written prior to use, Dr. Lumpkin asks the users of the material to write these protocols so that they consider the associated risks and the measures to mitigate them. EH&S reviews our protocols and we appreciate that Biosafety Officers have assumed a partnership role. For example, they provide guidance on the inventory limits for possession of tetrodotoxin or indicating when vaccinations are required that provide protection against accidental exposure to rabies virus and diphtheria toxin. Occupational Safety Officers have performed formaldehyde monitoring and our laboratory has moved some fixation procedures from the bench to the fume hood as a result of their guidance.

***SafetyMatters*: What physical hazards are present in your laboratory?**
Blair and Yalda: Microtome blades are one example. They are more than razor-sharp and hands can be cut while retrieving slices, and removing or cleaning the blade. We employ a series of administrative controls to reduce the likelihood of injury such as ensuring the machine guard is in place while in use, using a brush to retrieve ribbons and slices, and ensuring the hand crank is locked before placing hands near the blade. We emphasize the importance of asking for assistance if one is unfamiliar with certain procedures. To that end, newcomers to the laboratory are always paired with someone who can guide and watch over them to ensure necessary safety procedures are followed. We believe this emphasis on training plays a large role in maintaining a successful safety record.

SafetyMatters thanks Blair, Yalda, Dr. Lumpkin, and the members of the Lumpkin Laboratory for sharing their practical application of safety culture. As the laboratory develops a deeper understanding of how sensory neurons work, EH&S will be there to offer continued support to ensure the health and safety of all investigators.

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