Safe Use of Syringes, Cannulas, and Needles with Hazardous Chemicals

Standard Operating Procedure

Revision Date: 8/31/2023

# Description [Provide additional information as it pertains to your research protocol]

This standard operating procedure encompasses hazards associated with use of syringes, cannulas, and needles for manipulation of hazardous chemicals. While needles and other sharps are widely used across many laboratory disciplines, chemistry laboratories in particular are notable for the use of these tools with hazardous chemicals. Some common examples includes handling of air and moisture sensitive chemicals, transfers involving highly toxic chemicals, gas chromatography (GC) and high-performance liquid chromatography (HPLC) applications, and syringe filtering of liquids. Note that this SOP is intended to provide general safety guidance towards these practices, not to provide detailed instruction on lab techniques. Particularly when applied to high hazard and complex procedures, detailed risk assessment of the operation in its entirety is necessary.

EHS provides additional reference materials broadly addressing use of sharps across laboratory disciplines. Additional precautions and documentation may be necessary when using sharps in conjunction with biohazardous materials or radioisotopes. Be sure to refer to the following documents if applicable to your research.

* [EHS Use of Sharps Webpage](https://ehs.umich.edu/research-clinical/equipment-tools/use-of-sharps/)
* [Bloodborne Pathogens Exposure Control Plan](https://ehs.umich.edu/wp-content/uploads/2016/02/ECP.pdf)
* [Needle Recapping and Handling Standard Operating Procedure](https://ehs.umich.edu/wp-content/uploads/2016/02/NeedleRecapping.docx)
* [Work Practice Controls When Using Sharps](https://ehs.umich.edu/wp-content/uploads/2016/06/Sharps-WPC.pdf)
* [Responding to a Needlestick or Biological Exposure](https://ehs.umich.edu/wp-content/uploads/2016/06/BS_EmerProc_Exp-to-Infect-Agent-Sharp_Splash.pdf)
* [Preparing Biohazardous Sharps Waste for Collection](https://ehs.umich.edu/wp-content/uploads/2016/05/HMM-Collect-BioHaz-Sharps.pdf)
* [Preparing Sharps Low-Level Radioactive Waste for Collection](https://ehs.umich.edu/wp-content/uploads/2018/05/HW_Proc-Sharps-LLRW.pdf)

All laboratory workers must read and understand the [Laboratory Emergencies SOP](https://ehs.umich.edu/wp-content/uploads/2022/05/LaboratoryEmergencyProceduresSOP.docx) prior to commencing any work in a laboratory.

## Process [Write the steps for using the chemical in your research protocol]

# Potential Hazards [Provide additional information as it pertains to your research protocol]

* Lacerations and punctures are possible with needles, cannulas, and other sharp objects in the laboratory. This type of injury often relatively minor in severity, but constitutes a significant percentage of reported injuries in academic laboratories. These injuries can be significantly more severe if hazardous chemicals are involved.
* Injection of hazardous materials resulting from puncture or laceration from contaminated sharps. Injection of hazardous chemicals under the skin can pose more severe health effects than typical dermal exposures that do not penetrate the skin. A [recent case study published by the American Chemical Society](https://pubs.acs.org/doi/full/10.1021/acscentsci.0c00100) details an event in which a researcher inadvertently injected dichloromethane into his finger, resulting in severe necrosis around the injection site. Toxicological data pertaining to injection exposures is often overlooked in Safety Data Sheets and other resources. It is imperative to treat any subcutaneous exposure seriously and seek medical attention if such an injury should occur.
* Chemical spills and personal exposure to hazardous chemicals may result from mechanical failure of the syringe connection or plunger
  + Pulling the plunger too far, causing the plunger to separate from the syringe barrel and the contents to spill out.
  + Separation of the syringe hub from needle, cannula, filter tip, or other device attached to the syringe. This causes the contents to spray out unpredictably, often towards the user.
  + Applying too much pressure to the syringe can cause both types of failure mentioned above. Excess pressure can also cause backsplash from the receiving vessel.
* When working with air or moisture sensitive reagents outside of a glovebox, syringe or cannula failure may result in unintended exposure of the chemical to normal air. This can result in highly exothermic reactions and fire.
  + Considerations of the aforementioned mechanical failures are particularly critical when working with syringes/cannula for air- and water-sensitive chemistry. The inert gas pressure from the reaction headspace can push the plunger up the syringe barrel, ultimately dislodging it, and inserting a cannula needle too far into a reaction vessel can lead to inadvertently spraying the reaction mixture out of the cannula.

# Engineering Controls [Provide additional information as it pertains to your research protocol]

**Syringe fittings**

Syringe fittings can be classified as either locking or slip fitment. Most syringes use Luer style tips as the industry standard. This connection standard is also commonly used for cannulas, filters, valves, chromatography instrumentation, and other related techniques.

Slip fittings: Rely on friction to attach to the syringe tip. Slip fittings are quicker to attach than locking syringes but are more likely to come detached during use. Excessive pressure on the syringe can force the fitting off and some liquids can reduce friction holding the fitting in place. Because of the increased likelihood of fitting detachment, slip fittings are generally discouraged for use with hazardous materials and strictly prohibited for high hazard chemicals like pyrophoric and highly toxic chemicals. Even with less hazardous operations, like syringe filtering alcohols, face and eye exposures have occurred when these fittings fail. Holding the syringe fitting between your thumb and forefinger with the barrel of the syringe held in the palm of your hand can help prevent accidental separation.

Locking fittings: Whenever possible, use locking syringe fittings when handling hazardous materials. Often referred to as Luer-Lock, these securely lock to the syringe hub and are far less likely to come disconnected than friction fit slip tips. Luer lock options are typically available for any type of laboratory grade syringe fitting. Locking fittings are required when manipulating pyrophoric materials. Ensure that the locking fitting is properly threaded; cross threading leads will result in leaks and can permanently damage syringes with fixed Luer-type adapters.

**Syringe selection**

Ensure compatibility with your syringe and the chemicals and processes with which it will be used.

**Disposable polyethylene barrel syringes** are a convenient and versatile option, but have some limitations.

These syringes are compatible with most chemicals. However, some polyethylene syringes are fitted with a rubber plunger that may degrade or swell when exposed to chemicals, particularly organic solvents. This can cause the plunger to jam or the rubber to detach inside the syringe barrel. Full polyethylene syringes are a better choice for these applications. Even fully polyethylene syringes may degrade when exposed to some chemicals, especially over longer periods. Strong acids (such as triflic acid) should never be dispensed with plastic syringes. These reagents can corrode the syringe side wall and lead to serious chemical exposure events. Consult a chemical compatibility chart to correctly select an appropriate syringe. Rubber tipped plungers are not recommended for use with highly reactive or pyrophoric chemicals.

**Glass syringes** are available for a variety of specialty applications, with the primary disadvantages being greater upfront cost and increased care and necessary cleaning of the syringe.

**Ground glass syringes** feature a precision fit glass or metal plunger precisely fitted to within millionths of an inch to the syringe barrel. Extremely low friction and tolerances of these syringes enable extremely precise measurement of liquids and easy actuation of the plunger. This facilitates use but concomitantly increases the likelihood of separating the barrel and plunger. Abide by the following precautions with ground glass syringes:

* Liquid use only, not gas tight.
* Plungers are not interchangeable between syringes and usually irreplaceable if lost or damaged.
* Reagents that contain dissolved particles may clog or increase friction and potentially damage the syringe.
* Corrosive chemicals should not be used with metal plungers, unless the plunger has a non-reactive surface coating (e.g. Teflon).
* These syringes should never be used with pyrophoric liquids. The plunger has no locking mechanism at maximum draw and combined with the low friction, can easily slide completely out of the barrel. Additionally, liquid can be drawn by capillary action into the minute gap between plunger and barrel and potentially exposed to air.

**Gastight syringes** permit manipulation of gaseous chemicals, including reactive gases that require air free technique. Typical construction consists of a glass barrel, metal plunger, and polymer plunger tip. These syringes are suitable for use with most liquids and gases, including air and moisture sensitive reagents.

**Needle/Cannula selection**

Ensure your needle or cannula selection is appropriate for your syringe and application. Appropriate bore size and length are important to prevent clogging or over pressurization.

Plastic-hub disposable needles provide convenience, but are not reusable and cannot be oven dried.

Stainless steel needles and cannulas are reusable, but require cleaning between uses. Since they can be oven dried and have a wide selection of sizes, they are a good choice for transfers involving larger volumes of pyrophoric or air/moisture sensitive reagents. Monitor the integrity if the device becomes bent or pinched over repeated uses.

It is common to bend needles prior to use to better facilitate liquid uptake and the removal of bubbles via inversion of the syringe. Do not try to bend low-gauge needles and generally be aware of the tension metal tubing exerts when practicing this technique.

**Containment devices**

The necessity to perform work in a fume hood, glove box, or other containment device is highly dependent on the nature of the procedure and chemicals involved. Air and moisture reactive chemicals should always be handled in a glovebox with inert atmosphere, or in a fume hood with air-free technique. Gloveboxes are effective at mitigating the hazards of pyrophoric materials and can eliminate the need for needles in some cases. Use extra care when handling sharps in a glovebox to avoid puncturing the gloves.

# Work Practice Controls [Provide additional information as it pertains to your research protocol]

Maintain situational awareness. Most incidents related to syringe and needles are not caused by defective or malfunctioned equipment. Human error can often be cited as a primary factor.

The American Chemical Society Division of Chemical Health and Safety provides a heavily detailed overview in their publication [Safe Handling of Cannulas and Needles in Chemistry Laboratories](https://pubs.acs.org/doi/10.1021/acs.chas.1c00069). Please review this document for a thorough overview of chemistry specific applications.

Review [other EHS SOPs](https://ehs.umich.edu/research-clinical/chemical/) as necessary for your application. If working with hazardous chemicals, refer to chemical/hazard specific information and follow all work practice controls as applicable. Follow EHS procedures for needle recapping, handling, and disposal.

Inspect all syringes and needles before use. Ensure there are no leaks or clogs and that the needle is not broken or bent. Particularly for long cannula needles, confirm that solution can pass freely through the length of the tubing prior to use. Do not reuse disposable needles. When handling highly reactive chemicals, reusable needles should only be used once for a single transfer, then cleaned before further uses.

Appropriately clean and decontaminate needles and syringes for reuse. Wash with water, solvent, or dilute acid as applicable. Oven dry as needed.

**When working with pyrophoric or moisture sensitive chemicals** never fill a syringe over 50% of its maximum capacity and never take the plunger to full draw. An over extended plunger can separate from the barrel and release the syringe contents. **This can be extremely dangerous.** Exercise increased caution when working with sealed vessels under an overpressure of inert gas.

Use with reactive materials requires special precautions. Overall adherence to air free technique throughout the procedure is critical to the reaction integrity and safety. For packaged chemical reagents, follow the manufacturers’ instructions for their proprietary air-free packaging systems. See the safety alert from EHS for additional guidance.

* [Safety Alert: Packaging for air, oxygen, and moisture sensitive reagents](https://ehs.umich.edu/wp-content/uploads/2021/06/SAPackagingSensitiveReagents.pdf)

# Personal Protective Equipment [Provide additional information as it pertains to your research protocol]

PPE requirements vary and are largely dependent on the individual user’s needs. Review the chemical-specific SOPs related to your procedure and assess potential risks and necessary controls. Gloves, lab coat, and eye protection are the minimum PPE requirements for any operation involving hazardous chemicals.

Safety glasses provide the minimum required eye protection when working with hazardous chemicals. However, standard safety glasses offer limited protection against splash and spray exposures. EHS has documented chemical eye exposures that occurred while the affected person was wearing standard safety glasses. For this reason, splash protective goggles are recommended whenever working with pressurized liquids.

Flame resistant lab coats are required when working with highly reactive and pyrophoric reagents.

# Transportation and Storage [Provide additional information as it pertains to your research protocol]

Keep unused needles in their original packaging until ready to use.

Storage of uncapped and unprotected needles and cannulas, whether in a drawer or benchtop, is prohibited. Styrofoam, cork, or rubber stoppers can be used to temporarily store needles safely and to make them readily accessible when needed. Using one-handed technique, insert the needle tip to hold in place until needed. Unpackaged reusable needles must be otherwise stored in a rigid container to protect from accidental needle sticks. Commercial syringe holders are available from lab supply vendors.

Collect and store all used needles in accordance with the waste disposal procedure below.

# Waste Disposal [Provide additional information as it pertains to your research protocol]

All sharps waste must be collected in an appropriate sharps container for disposal. Sharps and other solids contaminated with hazardous chemicals must be treated as hazardous wastes. Affix a completed hazardous waste label to any sharps container containing chemical contaminants. List all chemical contaminants on the waste label. Sharps contaminated with biohazardous materials are required to be dated with an accumulation start date and collected by EHS within 60 days of the start date. Sharps containers contaminated **ONLY** by chemicals and not biologicals are not subject to the accumulation start date and collection requirements.

Do not bend, shear, break, or recap used disposable needles. Place directly into the sharps container immediately following use.

Equipment exposed to air or moisture sensitive reagents may require quenching following use. Use an appropriate solvent to rinse the affected equipment and quench before disposal. Reactive solutions/liquids can commonly form salts upon decontamination/quenching. Be mindful of the reagent(s) being employed and choose an appropriate rinse solvent (or series thereof) that will avoid clogging the needle.

Reusable implements may be washed with water, detergent, or a suitable solvent. Collect rinsate for hazardous waste disposal.

**Do not dispose of chemical wastes by dumping them down a sink, flushing in a toilet or discarding in regular trash containers, unless authorized by Environment, Health & Safety Hazardous Materials Management (EHS-HMM)**. Contact EHS-HMM at (734) 763-4568 for waste containers, labels, manifests, waste collection and for any questions regarding proper waste disposal. Also, refer to the EHS [Hazardous Waste](http://ehs.umich.edu/haz-waste/) Web page for more information.

# Exposures/Unintended Contact [Provide additional information as it pertains to your research protocol]

Refer to the [Laboratory Emergencies SOP](https://ehs.umich.edu/wp-content/uploads/2022/05/LaboratoryEmergencyProceduresSOP.docx) for general guidance on incident response, medical treatment, and incident reporting. Contaminated needle sticks and subdermal injection of hazardous chemicals may present additional complications when compared to dermal exposures. Rinse the wound at a sink, drench hose, or safety shower. Seek medical attention.

# Training of Personnel

All personnel shall read and fully adhere to this SOP when handling this chemical.

# Certification

I have read and understand the above SOP. I agree to contact my Lab Director if I plan to modify this procedure.

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### Major Revisions (Tracking purposes only -- Do not print as part of SOP)

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| Date | Revision |
| 7/27/23 | Initial Publication (JW) |
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