**Laboratory glassware - hazards and handling**

 Glass cuts are one of the most common kinds of accidents in laboratories. Glass cuts can be as serious as extremely severe lacerations. This document overviews important aspects of dealing with laboratory glassware. Common operations and hazards with glass are covered. This list is not comprehensive.

1. Glass refers to silicate materials that are by definition is amorphous. When it breaks, it forms irregular and very sharp edges and points. There are a great many types of glass. The most common type is borosilicate glass, also known as Pyrex®. It has a low coefficient of thermal expansion, which makes it useful in applications where heating is required. It can be softened and formed at high temperatures (>820°C).

2. Broken, chipped or cracked glass apparatus should not be used. It must be taken out of service and repaired or discarded (see below on glass disposal). A qualified glassblower can sometimes repair damaged glassware. Cracks in glass under strain can propagate extremely quickly and result in catastrophic breakage without warning. This can include microscopic cracks.

* Chipped or cracked glass chemical containers must be removed from service. If possible transfer the chemical to a new container and label with a workplace label. Treat the old container as dirty broken glass; see below for instructions on disposal.
* If the container is too badly damaged to recover the chemical be prepared to treat it as a spill. If the glass can be recovered treat it as dirty broken glass.
* Chipped glassware can sometimes be repaired by sanding sharp edges/faces with rough sandpaper. Wear heavy duty work gloves if you want to attempt this. Fire polishing of chipped surfaces can also be performed to smooth out sharp faces and edges. This should be done only by a suitably trained person.

3. Rapid chilling of very hot Pyrex® glass can cause thermal shock and breakage; for instance, flame-heated glass that is rapidly cooled (e.g. through contact with metal or water). Pyrex® can withstand temperature differentials of about 165°C without breaking.

4. Reduced pressure puts glass under bending stresses. Ordinary lab glassware is not designed to withstand such stresses and may readily break. Under reduced pressure breaking glass can disrupt violently and cause shard of glass to erupt from the broken apparatus. For reduced pressure applications use only thick-walled glass apparatus designed for the purpose.

5. Likewise pressures greater than ambient on the inside of a glass apparatus can cause it to rupture violently. Some commercial apparatus are made for positive pressure service. The pressure used must not exceed the manufacturer's specifications.

6. It is sometimes necessary to cut glass tubing or rods. There are diamond saws in the department that can be used. If the glass is not too think (<1 cm) one can also do this by hand. You should be trained by someone experienced in this operation first! Wear heavy work gloves. Use a glass knife or a metal file to score (deeply scratch) the tube or rod. A circumferential score is better, but a single short score will suffice for thinner pieces (roughly 7 mm or less). Wet the score. (This induces corrosion at the crack tip, narrows it and greatly improves stress concentration.) Hold the piece between thumbs and forefingers of both hands (wear the gloves!), with each hand just on either side of the score. Push the piece away from you to "open up" the score (a short score must be facing away from you). Apply force. The piece should break cleanly in two with a little force. The fresh cut edges will be very sharp. The ends can be sanded with coarse sandpaper, a metal file or can be fire polished.

7. One of the most common types of glass cuts occurs when someone tries to insert a piece of glass tubing into a rubber stopper. The friction can be strong, resisting the entry of the tube into the stopper. Then people push hard and the glass breaks, with one or both pieces forcefully entering the hand(s). The result is a serious cut. The following procedure is much less likely to cause injury:

* Make sure the ends of the glass tube are smooth. Apply a thin coat of grease or oil to the end of the glass tube to be inserted. Wear heavy work gloves! Push the tube gently into the stopper. The grease or oil will make it much easier to insert. If there is strong resistance the hole in the stopper may be too small, or too little lubricant may have been used. Clean excess grease/oil off the tubing and stopper.

8. Glass is attacked by strong alkalis and acidic fluoride solutions. Over time this can weaken the glass and contaminate contained solutions. Plastic lab ware is more suitable.

9. Magnetic stir bars if run too fast can become erratic and start to jump around in the container. This can crack or break glass apparatus if the stir bar is massive enough.

10. Glass apparatus in active use should be suitable clamped or secured to prevent it from tipping over. Tipped over graduated cylinders are a common incident and often break.

11. Volumetric flasks are made from a single piece of glass tubing. The bulbous part is blown from the heated tubing. Consequently the bulbous part of a volumetric flask is thin and particularly fragile.

12. Volumetric apparatus should not be dried in a hot oven for long periods of time. This can change the contained volume.

13. Ground glass jointed apparatus is intended to permit close-fitting connections between various glass parts. If at all possible these joints should be greased with a grease that is compatible with the solutions/chemicals involved. Avoid excessive use of grease. Teflon sleeves can also be obtained to help provide a seal. Ungreased ground glass connections can "freeze" and become difficult to separate. If this occurs, the outer part of the joint can be heated with a hot air blower to try to expand the outer part of the joint. Then the parts can be twisted to try to loosen them. Wear heavy work gloves to protect against hot and potentially breaking glass. Avoid excessive force that can break the glass.

14. Broken glass should be swept up with a brush and dust pan. Larger pieces can be handled by hand when wearing heavy work gloves.

15. Glass waste (including unbroken glass) may NOT be disposed of to the regular garbage. Janitorial staff have been seriously injured by glass in the regular trash. Clean, unbroken glass waste (i.e. rinsed free of chemical contamination) needs to have the cap removed (dispose of to the regular trash if it's not glass).

* Clean unbroken glass can be collected into double plastic bags, tied off and placed in the dumpster.
* Clean broken glass needs to go into double-bagged metal containers marked as "Clean broken glass". No other waste or garbage may be included. Materials intimately associated with the glass that cannot be safely separated can go with the glass into the waste container. When these are 3/4 full they need to be tied off (e.g. a cable tie) and the contact info for the person disposing of it (building name, address, person's name, phone number) needs to be affixed to the outer plastic bag. Bring it to the Stores area for pick-up and disposal. Obtain new cans and bags from Stores.
* Dirty broken glass has chemical contamination. The pieces must be collected into a suitable container and cleaned, e.g. with soap and water or solvent, etc., observing precautions for handling chemicals and broken glass.

16. Pyrex® glass when heated to soften it gives off intense light which can damage the eyes. Suitable light-blocking glasses should be used. Very hot glass must be permitted to cool slowly in the air. A cold end can be clamped to suspend the piece. Alternatively the hot glass piece can be set down on an insulating material that can withstand the temperature. Glass hot enough to cause a serious burn may appear to be just like room-temperature glass. Glass working at high temperatures requires training. If you need to do this, seek suitable training from your supervisor.