What are the Safety Issues Associated with Glass Beadmaking?

Introduction:

Making glass beads can be a very rewarding activity. Beadmaking does entail using equipment and materials which need to be handled properly so that your experience is as safe as possible. Keep in mind that you, the beadmaker, need to take responsibility for practicing safe behavior. ***You*** are the one who knows all the details of your set-up – what kind of torch you use, what kind of fuel gas, the size of your studio, your local and state regulations, building codes, and so on. The guidelines that follow will be very helpful, but understand that there may be individual circumstances where you need to do more research to ensure your operation is safe. A list of suggested sources for additional safety information has therefore been included.

To make glass beads, you need a source of heat sufficiently hot that it can melt glass. Torches using a variety of gases are by far the system in greatest use, since they are fairly simple, compact, and relatively inexpensive. Beginner kits often employ a fuel gas mixture known as "MAPP" gas (MAPP™ is a trademarked mixture of methylacetylene, propadiene, and other hydrocarbons which has been stabilized[1]). This burns sufficiently hot in air (which is about 21% oxygen[1]) that a separate tank of oxygen is not needed. Most beadmakers advance to torches that use propane and oxygen; a minority of folks use natural gas and oxygen. Torches and associated materials constitute the source of the most significant safety issues associated with glass beadmaking.

Risk is an interesting concept. Most people have no fear of jumping in their car and driving to work, shopping, or wherever. It is an activity which is very common, but it is also one in which we have a great degree of control. Yet being in an automobile is a much higher-risk activity than many other things people fear, statistically. As you become accustomed to doing something, the caution you may have felt initially begins to wear off. This has many parallels to beadmaking. Just as in driving, you may not always have an accident when you engage in unsafe behavior. But sometimes, the unsafe behavior can lead to terrible consequences. I have used the ***nature of the consequences*** to rank the beadmaking safety issues in importance, starting with potentially catastrophic events and ending up with the merely irritating.

Highest Risk Safety Issues:

Fuel Gases

Whether you use MAPP™ gas, propane, or natural gas, you are dealing with highly flammable and potentially explosive substances. Proper handling of your fuel gas is therefore absolutely essential. Fuel gas tanks should be transported in a vertical position (valve up) and be secured. If possible, keep the tank out of the passenger compartment of your vehicle during transportation.[2]

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Originally published in The Bead Release, Vol. IX, No. 1, Winter 2002

Avoiding leaks in your fuel gas set-up is relatively easy. Visually inspect all connections to be sure that threads, nuts, and sealing surfaces are not nicked or damaged. Components are very inexpensive and should be replaced if not in good condition. After making connections, an appropriate leak detecting solution can be brushed onto each junction. The solution will normally make bubbles if gas is escaping at any point. Retighten the connection and then re-check. Teflon™ tape can be used on threads to help seal connections. You can also check entire hoses by immersing in a bucket of water and looking for bubbles. An odorant is added to most fuel gases, but since people have widely different sensitivities, it is better to not rely on your sense of smell to detect leaks. If your gas delivery kit did not come with flashback arrestors, these are relatively inexpensive additions which should be added to both gas lines.

Propane and MAPP™ are liquids when compressed, so the tank pressure is partially dictated by the equilibrium between gas and liquid. The safety consequence is that the tank pressure is not particularly high (125 pounds per square inch gauge, psig, is typical for propane) so the potential energy from pressure is of less concern than a high-pressure compressed gas like oxygen. In many locations the fuel gas may not be propane per se, but a mixture known as LPG (Liquefied Petroleum Gas, which is typically a mixture of propane, butanes, and other hydrocarbons[1]). LPG has very similar flame and other properties to propane alone, and therefore for the rest of this discussion both LPG and propane will be collectively referred to as propane.

Most portable fuel gas tanks, especially the larger ones, will have pressure relief valves. These devices are set to release the contents if the pressure at the relief valve exceeds a certain value. While this would prevent the tank from exploding due to excessive pressure, it also presents a risk in itself since the contents are highly flammable. This is the basis for recommending that if at all possible, your fuel gas should be stored outside, especially if you use a fairly large tank. Some jurisdictions prohibit indoor storage or use of fuel tanks. Avoid exposure of your tank to rapid fluctuations in temperature which could cause a pressure build-up – for example, getting your propane tank filled on a cold winter day, bringing it home, then placing in a hot location. Most tank manufacturers recommend that tanks not be stored in direct sunlight for the same reason.

The specifications required for propane tanks in the 4 – 40 pound range were changed in 1998. Tanks made after September 1998 were required to have an "Overfilling Protection Device", or OPD. Cylinders which meet the OPD requirement "have a unique, trilobular handwheel".[3] ***You may not be able to get your old tank (without an OPD) refilled after April 1, 2002.*** Some states or jurisdictions have not adopted the 1998 version of NFPA 58, and/or are not enforcing OPD usage, so in these areas you may be able to use your old tanks for a bit longer. Even though I have 3 older model tanks, I will probably get new ones since an OPD device protects me from a potentially dangerous error by the person filling the tank.

Finally, keep in mind the consequences of equipment failure. These can range from a small release of fuel (cracked hose) up to the entire fuel tank contents venting (regulator failure, pressure relief valve). If your whole tank vents, and there is a spark or flame

nearby, the consequences can truly be terrible.[4] One of the first rules to keep in mind is that "bigger is not necessarily better". Most of the time larger tanks end up being less expensive in terms of fuel cost, but in the event of a failure the consequences can be far worse. Arrange your studio so that you have a clear exit in case of emergency, and keep a fire extinguisher by the exit for use on small fires.

Oxygen

A common misconception is that oxygen is "flammable". It is not. It does, however, greatly accelerate combustion of many other materials. Pure oxygen combined with fuel gas results in higher flame temperatures than air alone (recall air only has 21% oxygen), and this is why it is used in conjunction with propane and natural gas for beadmaking. The ability of oxygen to accelerate combustion, and the form in which it is usually obtained (compressed gas cylinders) are the areas to be aware of from a safety standpoint.

Special equipment and precautions are required for oxygen. The gas regulator must be of materials suitable for contact with oxygen. Never use a regulator which has been used for other applications or gases. Do not allow the cylinder outlet or the valve area to become contaminated with any type of organic material, such as oil or grease. Contact of these materials with high-pressure oxygen can result in fire or explosion[5].

Oxygen can be supplied in both steel and aluminum gas cylinders in various sizes. These are all under ***high pressure***, and thus the cylinders must be handled with great respect. Compressed gas cylinders can literally become "rockets" if the valve breaks off. Therefore, every tank comes with a threaded cap to protect the cylinder valve. Be sure to inspect the cap for tightness prior to attempting to load or move the cylinder. (Note, some oxygen suppliers will deliver tanks to your home or studio; however, others may not because of insurance restrictions, company policy, etc. Therefore I cover the issues involved with picking up cylinders at a supplier, as well as for those fortunate enough to get their oxygen delivered).

If you pick up your own oxygen tanks, be sure you get a tank size which can be safely handled. While a larger tank provides a lower cost per amount of oxygen, most of the larger tanks are very difficult for one person to handle. If you have a studio which is not on the ground floor, have steps you need to ascend, and so on, it may be very difficult to move the tanks to your studio. Also keep in mind the vehicle that you will be picking up your tanks in – can you use proper lifting techniques to avoid straining your back? You should also be able to secure the cylinder or cylinders in the vehicle to prevent damage to them or your vehicle during transportation. Oxygen cylinders can be transported either horizontally or vertically, again taking care that the cylinder cap is on securely. Safety shoes with steel toes are highly recommended whenever you move cylinders.

At your home or studio, cylinders should be stored upright and secured. Cylinder clamps are available from suppliers, or the cylinders can be retained by a chain. As with fuel tanks, it is best to avoid a location in direct sunlight or subject to temperature extremes. Carts specifically for gas cylinders are available if you must move a tank or tanks some

distance to your storage location. Of course, if you keep your oxygen tank in your studio, it should also be secured properly.

Connecting your regulator to a "fresh" oxygen tank and checking for leaks requires a slightly different approach than for your fuel tank. All of these steps should be carefully adhered to. ***First, point the outlet to the oxygen tank away from you***. Then gently "crack" the valve (open slightly then close) to blow any dust or particulate out of the regulator seating area. Taking care to avoid getting any oil, grease, or dirt onto the threads or regulator, install the regulator with a wrench securely. The regulator should be dialed out so that there will be no oxygen released (it should have been bled of pressure and set to "no pressure" setting when taking off the old tank). Keeping your face away from the tank and regulator, gently open the tank valve slightly to pressurize the regulator. Close the tank valve. Note the high pressure reading on your regulator, which differs depending upon your tank size but will typically be in the range of 2000 psig or greater for a full tank. Allow several minutes to elapse. Then note the regulator reading again. If it has decreased significantly, this indicates you have a leak in your regulator connection. This may require you to tighten the connection further, or sometimes to change the orientation of the regulator seating area and retighten. Repeat the procedure of pressurizing the regulator, noting the reading, and checking several minutes later. In rare cases the tank fitting may be damaged and should be returned to the vendor for replacement with a different tank. This procedure is highly recommended for the oxygen regulator connection to ensure contamination of the high-pressure area with soap or other organics does not take place. ***Oxygen-safe*** leak detecting solutions are available, and are a safe alternative to checking the regulator-tank connection, and hoses and connections downstream from the regulator.[6] When using your oxygen, always open the tank valve gently and slowly. Then proceed to open the valve fully, as otherwise the valve may leak some oxygen during use[5,7]. Teflon™ tape can be used for threads to help seal low-pressure connections.

Fuel gas and oxygen suppliers will provide you with a Manufacturer's Safety Data Sheet (MSDS) upon request. These provide additional safety information on the nature of the specific hazards. Many of the compressed gas suppliers (Praxair, Matheson, Air Products) also have safety information and/or MSDSs available on their websites.

Oxygen generators are gaining increased attention as alternatives to compressed oxygen tanks. These are often used pieces of equipment, having been first utilized for medical applications. From a safety standpoint, use of an oxygen generator alleviates several of the potential safety concerns of tanks: Oxygen is never at high pressure; one need not transport tanks; and one need not handle the heavy cylinders. Be sure to ask about the electrical power consumption, cost of consumables, and so on to see if this option is better than compressed oxygen tanks for you.

Lastly, a word on the proper order for lighting your torch is appropriate. Most books on lampworking teach the acronym "POOP", for ***P***ropane first, then ***O***xygen (when lighting the torch); and ***O***xygen first, then ***P***ropane when shutting the torch off[8,9,10]. Always read the information provided by the manufacturer of your torch on the proper procedure to

follow. At the end of the day, shut off your tanks at the tank valve, and bleed any pressure from the regulator and hoses. Leave your ventilation on for a short time after your session to be sure all traces of bled fuel gas and combustion by-products are removed. For the interested reader, the book by Kervin has a very good discussion of equipment and gases used in beadmaking.[9]

Ventilation

Great, you now have your fuel and oxidizer all hooked up to your torch safely. From the very moment you light your torch, you are now creating combustion by-products which must be removed by ventilation.

The combustion gases released when your torch is burning include: Carbon dioxide, water, nitrogen oxide, nitrogen dioxide, and carbon monoxide, as well as trace amounts of unburned fuel and other contaminants. One of the most popular "urban legends" of beadmaking is that carbon monoxide is the principle agent to be worried about. However, in general this is not supported by actual measurements. The chief "bad actors" are the nitrogen oxides, especially nitrogen dioxide, which are produced by any high-temperature flame.[11,12] In addition to producing the familiar "torch smell", nitrogen dioxide is a severe respiratory irritant with a very low acceptable air concentration.[13]

Your ventilation system should be ***actively*** pulling fumes away from the place they are generated – at your torch. Additionally, fresh air should be entering your beading area so that uncontaminated air is in your breathing zone. I prefer a push-pull fan arrangement to accomplish both: Air is exhausted from the room with one fan, while a second fan is used to push air toward the torch area. To make this method work, your exhaust fan should be located fairly close to the torch, and the exhaust directed or ducted outdoors. It is much easier to use a fan to push air a long distance at a reasonable velocity than it is to pull it, thus the need for the exhaust fan to be fairly close to the torch.[14]

It is usually possible to orient your workbench and torch placement in a room so that you can maximize ventilation. If you live in a climate where your house is closed up, be sure to open a window in another room to allow make-up air to enter the house. This is especially important in cases such as a basement studio – if you do not provide a means for clean make-up air to enter, the depressurization of your house by your exhaust fan will pull air through any crack or opening. And one of the largest openings in your home may be a furnace or hot water heater flue, or fireplace chimney. Combustion gases that should be leaving your house may now be pulled into it, leading to the potential for issues such as build-up of carbon monoxide.

A great variety of ventilation solutions are possible depending upon the size and layout of your studio, number of windows and doors, and so on. The amount of exhaust air you need will be very dependent upon these factors. Research on the recommended exhaust needed for analytical instruments using high-temperature flames and plasmas found a range of 250-350 cubic feet per minute (cfm). Based on differences between the orientation of torches, size of hoods, and so on, the middle of this range (300 cfm) was

recommended as the ***minimum*** for ventilating a beadmaking torch.[15] If you decide to use a hood over or behind your torch, the hood dimensions (face area), number of bends and constrictions, and the duct size you use are critical parameters which may dictate more exhaust airflow is needed.[15,16]

"Another consideration is the velocity of the stream of combustion products from the torch itself. The torch gasses are under pressure, are directed through narrow nozzles and are ignited outside the torch. The resultant stream has quite a high velocity and may exceed the velocity of the airflow in the capture zone of your ventilation system. This will allow the bulk of the combustion products to escape the ventilation system and contaminate the ambient air in your working space. Depending on the placement of your torch and your exhaust system, you may need to install a baffle that interrupts the stream from the torch and allows it to be captured by the exhaust system or direct an auxiliary stream of air that redirects the torch stream directly into the capture zone of the exhaust system." [6]

You can test your set-up by placing a source of smoke (such as a piece of smoldering paper, incense cone, or a cigarette) near the torch. Do this with the torch operating. Watch to see whether the smoke is drawn away from your breathing zone by the exhaust fan. Adjust fan placement, fan speed, and your workstation layout as needed to achieve the best ventilation possible. Pay attention to other clues, such as the presence of odors due to nitrogen oxides or the odorant in the fuel gas. Any problems with eye, nose, or throat irritation may indicate that your ventilation system still needs improvement.

A final comment is in order on emissions and oxygen generators. Oxygen generators typically produce lower purity oxygen than that delivered in compressed gas tanks. As the balance of the gas being delivered to the torch by the generator is very likely to be nitrogen, there ***may be*** higher levels of nitrogen oxide emissions from a torch using an oxygen generator. Keep this in mind if you switch from an oxygen tank to a generator and notice any changes in irritation, odors, and so on.

Eye Protection

Protecting your eyes is essential, as beadmaking presents several different hazards. The primary reason for including eye protection in the "high risk" category is the potential for shards of glass or hot fragments to be released from glass when it "thermal shocks" due to over-rapid heating in the torch. These pieces can fly a considerable distance, and represent an acute hazard.[17]

Other hazards to the eyes are of a more chronic nature, and are due to the radiation emitted by glass heated in a torch. Most beadmakers use soda-lime glasses, commonly called "Moretti", "Effetre", "Czech" and so on. These glasses melt at comparatively low flame temperatures, meaning less radiation is emitted than higher-melting glasses, such as borosilicate. Most of the published literature on radiation hazards from glass making concentrates on infrared (IR) radiation.[17,18,19] Soda lime glasses also produce a bright yellow glow when heated, the so-called "sodium flare" in the visible portion of the

radiation spectrum.[17,20] Eyeglasses should be worn which are protective of the IR radiation (IR reducing glasses with ANSI Shade 2.0 or equivalent). Many beadmakers prefer to wear lenses designed for beadmaking which also filter out the "sodium flare", although this is not necessary for health reasons, but because they can see their work more clearly in the torch.

The size of the bead is one factor in how much IR radiation is emitted (larger glass beads emit more IR than smaller glass beads when hot). Other sources of IR radiation may be much more significant than the bead/torch combination. These sources include the heating devices used, especially kilns and glory holes. The highest IR exposure found during the NIOSH work at Corning was from placing an article in a kiln. You can greatly decrease your exposure by increasing the distance between you and the source of radiation, since intensity falls off as the inverse square of distance.[21] For example, if you have an exposure of "1" in arbitrary units of intensity at a distance of 1 foot, then if you move to a distance of 2 feet, your exposure will be cut to about $1/2^2$, or one-fourth the intensity. Thus, substituting long tongs for short tongs will keep you further away from the IR given off by a kiln. Even room lighting can be a source of radiation, for example halogen work lights, but the levels are generally low.

Glasses are available from several manufacturers, and can be ordered with prescriptions for vision correction. There are a variety of protective lenses, with different levels of attenuation for different glass activities.[22] An alternative my wife prefers is to wear her glasses for correcting farsightedness, paired with a beadmaking visor which has a filter for IR and sodium flare, and also provides better side protection against flying shards.

There is very little evidence of any kind of ultraviolet (UV) radiation hazard from glass beadmaking. This includes recent investigations by the National Institute of Occupational Safety and Health (NIOSH) as part of an SGB initiative.[17, 23] Measured UV levels were found to be well below recommended exposure standards. Most common materials used in protective glasses absorb UV radiation, so even if there were slight UV emissions from some unusual operations, the glasses and visors in general use would likely provide adequate protection for the beadmaker. The books by Kervin[9] and Dunham[10] both include extensive discussion of eye protection from a lampworker's perspective in their sections on Safety. For operations which produce intense radiation, the American Welding Society website in "Recommended Reading" is a good source of information.

Etching Solutions and Cremes

While generally not used by beginners, many beadmakers like the appearance of etched beads. Available chemical agents typically rely on the ability of fluoride to solubilize silica, the main oxide present in glass. The fluoride in commercial etching agents is usually in the form of either dilute hydrofluoric acid or ammonium bifluoride. Both of these materials can readily penetrate the skin, and cause damage even as dilute solutions. Fluoride burns have very poor warning properties, and the solutions can penetrate deep into the body causing severe injury. Eye exposure can have the same devastating effects.

Always wear protective gloves and eye protection when handling etching agents. Keep these materials in secured storage so that children and pets cannot gain access to them. Be sure that containers used for etching beads are never used for eating or drinking (a plastic container such as high-density polyethylene is a good choice for fluoride etching solutions).

There are commercially available antidote creams (calcium gluconate or equivalent, also cold saturated magnesium sulfate solution) which can be used for first aid for fluoride burns.[24] Calcium antacid tablets can be used to stabilize etching solution prior to disposal (the calcium forms an insoluble fluoride salt).[25] Note that lapidary techniques such as tumbling may provide an alternative to chemical etching, depending upon the bead and its features. Etching solutions are but one of a host of chemicals which may find use in beadmaking. They are a good example of the need to understand the specific hazards of each chemical, and to use appropriate protective equipment and/or controls such as ventilation.

Moderate Risk Safety Issues:

First, keep in mind that every safety issue I cover is important. Items in this section, if ignored, can still cause considerable trauma or property damage.

Burns and Cuts

Burns from hot glass, followed by cuts, were the most common health complaints of SGB members who filled out a survey for NIOSH during the 1998 SGB Gathering in Corning, NY.[17] Working with a flame whose temperature can be thousands of degrees means you must exercise extreme care when manipulating your work in the torch. Avoid situations where it is difficult to see the flame (for example, working outside, or wearing too dark a lens). Many beadmakers keep a container of water by their work space so they can immediately cool any burned area. Burns can also happen when you accidentally touch hot glass. Here is where good work habits help – always lay the hot end of a glass rod on a rod rest, with the hot end away from you. Be sure you don't place the rods directly on a surface where they can roll off and burn you or your studio. Exercise the same good habits when using tools such as a tungsten pick, mashers, pliers, and so on – always place the hot end away from you, on a rest, or in a holder. Cotton clothing, a leather apron, or similar materials are preferred over synthetics like polyester or acrylic.[8,9,10]

Damage to property can be avoided by an appropriate work surface and flooring. A non-flammable cover for your table or bench, such as sheet metal, stainless steel, ceramic tile, etc. are preferred.[8,9,10] A metal plate can be used to cover carpeting or wood floors. Floor surfaces such as ceramic tile, concrete, or brick are also excellent. In general, select materials for your studio which are non-flammable. Kilns may be placed on bricks, concrete pavers, etc. both to elevate them to a convenient height and to protect flooring. Always follow manufacturer's directions concerning clearances from walls and other surfaces. A smoke detector is highly recommended for your studio. (And even though it is my opinion that your ***beadmaking*** will not produce dangerous levels of

carbon monoxide if you follow the ventilation guidelines above, carbon monoxide detectors are readily available and inexpensive, so they should certainly be in every home).

Glass is usually ordered as rods, and these often have sharp ends. Also, after pulling stringers or lattticinos, the ends can be pointed and sharp. When unpacking rods, it is best to wear gloves (leather, also special cut-proof gloves are available). Have your glass rod and stringer storage arranged so that you can't be cut by protruding ends. If you need to cut glass, again protect your hands and wear eye protection. Watch out for small pieces or shards of glass on your floor (it always amazes me how many of these I find when I venture into my wife's studio!).

Electrical Hazards

Most beadmakers start out with just a torch, glass rods, some mandrels, and a bucket of vermiculite or fiber blanket. If they stay with beadmaking for any length of time, a host of electrical devices begin to be added to the studio. The most important is the kiln, used to anneal glass beads and to warm rods up. Be sure to select a kiln whose electrical load (measured in amperes, A) is not greater than the circuit you will be connecting it to. Keep in mind any other electrical devices you already have that are sharing that circuit. It may be necessary to add a circuit just for your kiln.

Other appliances which use electricity to heat generally have fairly high electrical loads – hot plates, crock pots, space heaters, and so on. These devices, added to things like lighting, your ventilation fan(s), a television, or stereo, can quickly use up the rated load capacity of the circuit or circuits in your studio. Never substitute a larger fuse for the rated fuse if your electrical system uses fuses. If your house uses circuit breakers, constantly tripping breakers are a warning that you may be exceeding the capacity of your circuits and should have additional circuits installed by a qualified person.

Note that some electrical devices, such as a kiln, also may present shock hazards due to exposed elements. And of course, devices which heat can inflict painful burns. It may be possible to switch elements to the kind that are silica-encased, or at a minimum place barriers between the elements and where your beads on mandrels go. The solution may be as simple as raising or lowering the surface within your kiln that you place beads on – most ceramic stores sell spacers, supports, and so on.

Ergonomic Concerns

"Ergonomics" is defined as "the study of human characteristics for the appropriate design of the living and working environment".[21] In the context of beadmaking, it includes a whole host of factors – the height of your chair and table or workbench; how your studio is lit; the manner in which you make beads; the angle you have your torch set at; diameter of mandrels you use, etc.

The repetitive twirling of beads on mandrels, coupled with the "pinch grip", can eventually cause problems for some people.[26] Some references recommend a mandrel holder or wooden handle, giving you a wider diameter to grip. It is also important to take frequent breaks, and to "listen to your body" if you experience numbness in your fingers, hands, or arms. If you experience such symptoms, this may indicate you are overdoing it. Check to be sure you are not resting on hard surfaces – cushioned armrests at the right height are available. An adjustable height chair with comfortable seat is highly recommended. Proper posture can help alleviate neck and back strain. The book by Dunham[10] has an Appendix with exercises and advice to avoid "stiffness, aching, or pain".

Just as staring at a computer all day can give you eyestrain, so can extended sessions at the torch. Good lighting can help in this regard, and the protective eyewear mentioned earlier can deal with the light from the torch.

There are numerous other areas that can bear on how comfortable and safe a workplace you have. By organizing your glass, tools, and accessories so they are easy to reach, you can avoid awkward postures or over-reaching. Analyzing how you work, or having someone watch you, can help identify ergonomic issues.

Pregnancy - Special Precaution

Since the majority of glass beadmakers are women, it is not surprising that the question comes up of whether it is safe to continue making glass beads while pregnant. If you have followed all of the previous safety guidelines, especially ensuring your studio has adequate ventilation, then it ***may*** be permissible for you to continue beadmaking. ***This should only be done after you discuss this with your doctor***. Be sure to fully describe any chemicals, special techniques, and so on that are part of your repertoire. Pregnancy is not the time to get fancy and try, for instance, metal fuming for the first time. The developing fetus is particularly sensitive to exposure to many agents, and thus any decision must be carefully considered by the pregnant woman in consultation with her physician.

Children and Pets

Use caution in allowing children and/or pets near your beadmaking area. Many of the areas where you need to be careful can be downright dangerous for your children or pets. They may also distract you enough that you accidentally burn yourself in the torch, or perhaps them. Bear in mind that some things, such as etching solution, can cause severe injury or death.

<u>Minor Safety Issues:</u>

Skin Rashes and Skin Irritation

A number of individuals have described skin rashes, blotches, or other reactions to their skin, usually on their face, when making beads. Some people have attributed this to UV radiation, but as noted above, actual measurements do not support significant UV emissions from most beadmaking processes. Therefore, wearing sunblock is unlikely to help with these symptoms, although the moisturizers present may help somewhat. In my opinion, there are several potential causes of skin irritation. First, the rash may be an indicator that some aspect of your studio set-up needs attention. If your ventilation is inadequate, then reactive gases such as nitrogen dioxide, or heat from your torch and electrical appliances, may build up. These can lead to simple heat rash, or to a more complex interaction of the combustion gases and /or heat with your skin. This may also be compounded by use of some personal products, such as make-up and prescription medicines.[17] In rare cases of individual sensitivity, there may be reactions to factors which normally do not cause problems for the majority of people. You may need to study your working habits for clues (for example, when making beads do you sit so that your face is very close to the torch?). Experimentation with protective equipment such as a full faceshield, barrier creams, and so on may provide solutions. Medical advice may be necessary in extreme cases.

Dusts and Nuisance Particulates

Vermiculite and ceramic fiber blankets are often used to slow-cool beads during beginning beadmaking. As with any particulate, excessive exposure should be avoided. Particle size, as well as the chemistry of the particle, are very important determinants of the hazard posed by an inhaled particulate. The human body has multiple lines of defenses since we must inhale air to stay alive. Our defenses are poor against very fine particulate, and once the particles get to less than 10 microns, they are increasingly able to be drawn deep into the lungs. Fibers are a special case, and there has been tremendous advancement in the understanding of fiber toxicity in the last 15 years.

At least one location where vermiculite was mined was found to also contain asbestos. But in general vermiculite does not contain appreciable levels of asbestos fibers. It is normally considered a nuisance dust by industrial hygienists. As most beadmakers advance to kilns to properly anneal their beads, irritation from vermiculite dust becomes a non-issue. Bead release materials are mostly clay-based[17], and therefore also classified as nuisance dusts. Your glass itself may contain significant amounts of heavy metals to get the rich colors.[23] But this glass is usually not present in a form that can be inhaled (see, however, enamels and frits note below).

Ceramic fibers may be used as blankets to cool beads, as well as in kilns for insulation. ***One should be careful to avoid exposure to refractory ceramic fibers or dusts from kiln insulations***. The degree of hazard depends on the fiber dimensions, as well as fiber chemistry, durability, and inhaled amount. Fibers which are relatively large get stopped by the body's defenses. Fibers which are sufficiently small may bypass the defenses, and then may cause harm depending upon their chemistry and how long it takes the body to clear them. The International Agency for Research on Cancer recently completed a comprehensive review of several fiber types. While the rating was downgraded for

fiberglass and rock and slag wool fibers, the rating for refractory ceramic fibers was left unchanged as "possible human carcinogens (Group 2B)".[27] The most insidious hazard of high-temperature insulations for kilns and glory holes is the slow formation of crystalline silica at the high use temperatures. Crystalline silica is a known human carcinogen, and therefore activities such as rebuilding a kiln ***must*** be done with appropriate personal protective equipment.

Exposure to many sources of dusts can be minimized by having these operations take place where your ventilation system can draw the dust away from your breathing zone. Clean-up should be done by vacuuming, preferably with a HEPA (high efficiency particulate air) filter-equipped vacuum, mopping, or wet wiping, as opposed to blowing off with compressed air, to avoid re-suspending the dust in the air.[9]

Special Note: Enamels and Frits

Some materials are used as powders or finely ground materials, and may have a fairly high fraction present as fine particulate.[23] Often heavy metals may be used in these substances to obtain the colors, and therefore one should be careful to avoid inhalation.[28] Depending upon how you use these materials, you may need to wear a respirator during these operations. (Note, preferably a half-face respirator with HEPA particulate cartridges, this type is more likely to achieve a good seal. A "dust mask" may suffice, but it is usually more difficult to ensure an adequate seal around the face. Men, it is almost impossible to get an adequate respirator seal if you have facial hair. The NIOSH website in Recommended Reading has additional information on respirators).

<u>Insufficient Data To Rank The Hazard - Specialized Techniques and Tools:</u>

I have tried to present a balanced and comprehensive review of the safety issues that the ***majority*** of glass beadmakers need to be aware of. But there are certainly numerous examples of beadmakers doing specialized work. In these cases, I am unaware of sources of reliable information to adequately assess the relative risk. Sometimes the operation and materials used may indicate the need for special care – for example, fuming with metals. While not directly related to fuming in beadmaking, a recent article looked at "copper exposure and metal fume fever".[29] If you do fuming, this article has a large number of references to literature on metal fume exposure. The book by Dunham includes some information on other lampworking techniques besides beadmaking, as well as use of chemicals to color glass.[10] If you are using any chemicals, for example, tetraisopropyl titanate (and similar mixtures) be sure to fully understand the specific hazards of the material: Is it corrosive? An inhalation hazard? Is it flammable? An MSDS from the manufacturer, or the sources in Recommended Reading, can help you find this information.

In other situations, for example using lapidary tools to cut, shape, and polish glass, you should consult existing literature in this field for specific safety information. Where I felt there were already ample references available (jewelry, lapidary, glassblowing) I did not repeat this information in the glass beadmaking context. Finally, the NIOSH report from

the Corning Gathering includes a number of references to studies of health effects on glass workers and art glass workers.[17]

Summary and Disclaimer:

I hope you will find this information useful and that it will help keep you safe. As I mentioned in the introduction, the person who bears full responsibility for the safety of your operation is **you.** Virtually everything in your studio is under your direct control, and except for rare instances of equipment failure, ***your safety depends upon you***. In short, give the same interest and focus to safety as you do to new beadmaking challenges, and you can look forward to a lifetime of fun and reward from making glass beads.

Extra care has been taken to provide references for the facts and opinions in this safety overview. This will enable you to consult the references, and also to do additional research if needed. I invite you to question, to challenge, to do further reading. One area to keep in mind is that I do not personally make beads, but rather strive to keep my wife's studio accident-free. Any errors or omissions are unintentional, and any responsibility associated from these or other assertions in this overview are specifically disclaimed.

Dedication:

This effort is dedicated to my wife, Pamela, and to all of those other beadmakers out there who use their time to be creative and bring beauty and art into the world. We need more people like you!!

Special Thanks:

Thanks to ***Vince Henley*** for taking the time to review this information and sending me his comments. Vince has been a great resource for safety and technical information to the beading community on the SGB (now ISGB) Forum. I appreciate your help Vince, and in virtually all cases followed your sage counsel!

Stan Wolfersberger

January 2002

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6. Personal Communication, Vince Henley, 2002.

7. Gas Data Book, 6th Edition, Matheson Corp, 1980.

8. Making Glass Beads, Cindy Jenkins, 1997.

9. More Than You Ever Wanted to Know About Glass Beadmaking, James E. Kervin, 1996. (There is a 2nd Edition available now, but it's not on our bookshelves yet!)

10. Contemporary Lampworking – A Practical Guide to Shaping Glass In the Flame, 2nd Edition, Bandhu Scott Dunham, 1997.

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16. Industrial Ventilation – A Manual of Recommended Practice, 18th Edition, American Council of Governmental Industrial Hygienists, 1984.

17. NIOSH Health Hazard Evaluation Report HETA 98-0139-2769, The Society of Glass Beadmakers, Corning, NY, C. Eugene Moss and Nancy Clark Burton, December 1999.

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20. The Bead Release, Volume IV, Issue 4, Fall 1997, "Letter re: Proper Eye Protection", E. Weisbart.

21. Fundamentals of Industrial Hygiene, 3rd Edition, B. Plog, Ed., 1988.

22. The Bead Release, Volume IV, Issue 3, Summer 1997, "Your Health and Safety re: Eye Protection", Bob Aurelius. (The Aura Lens website has some very useful information, including spectral transmission characteristics of their protective eyewear. See the ISGB website below for a link to the Aura Lens site)

23. NIOSH Health Hazard Evaluation - Pamela Wolfersberger, C. Eugene Moss and Nancy Clark Burton, March 2000.

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25. Destruction of Hazardous Chemicals in the Laboratory, George Lunn and Eric Sansone, 1990.

26. Lapidary Journal, Vol. 53, No. 7, "Special Tools, Special Care", Kristina Logan, October 1999.

27. International Agency for Research on Cancer, see press release at their website, http://www.iarc.fr/

28. MSDS for Thompson Enamel, Thompson Enamel Corp.

29. Journal of the American Industrial Hygiene Association, Vol. 61, No. 6, "Copper Exposure and Metal Fume Fever: Lack of Evidence for a Causal Relationship", J. Borak et al., November/December 2000.

Recommended Sources for Further Reading or Research:

The most readily available information for the average person will be found via the Internet. Be very sure that the site you are using is reliable. Anyone can put anything out there, so if possible stick to organizations such as those listed below:

http://www.cdc.gov/niosh/homepage.html = National Institute for Occupational Safety and Health, the research arm of OSHA (these folks did investigation at Corning in 1998).

http://www.osha-slc.gov/html/subject-index.html = Index to the U.S. OSHA (OSHA= Occupational Safety and Health Administration).

http://www.epa.gov/iaq Environmental Protection Agency, Indoor Air Quality

http://www.ccohs.ca Canadian Center for Occupational Health and Safety

http://www.aiha.org American Industrial Hygiene Association

http://www.aws.org American Welding Society (Go to Technical Department, then Safety and Health Fact Sheets)

http://www.nsc.org National Safety Council

http://www.nfpa.org National Fire Protection Association

http://www.asse.org American Society of Safety Engineers

http://www.who.org World Health Organization

http://www.iarc.fr/ International Agency for Research on Cancer, a branch of the World Health Organization

http://www.acgih.org American Council of Governmental Industrial Hygienists

http://www.naima.org North American Insulation Manufacturer's Association, good source of literature on man-made mineral fibers

http://www.npga.org National Propane Gas Association

http://physchem.ox.ac.uk/MSDS/ Oxford University "across the pond"; I ran across their Safety Information site in 1999, and it is still there, and very good.

http://www.lni.wa.gov/wisha/p-ts/Ventilation/default.htm A nice site with ventilation basics overview that I mentioned in my article, Ref. 15.

http://www.safetyonline.com Safety Products and such

http://www.isgb.org International Society of Glass Beadmakers (of course!) They have links to resources, suppliers of protective eyewear, and so on.

Books (in addition to those in References):

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Managing Indoor Air Quality, S. J. Hansen, 1991.

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