Superstorm Sandy: Frontline Advice for Dealing with Mold and Salvaging Electronic Devices

compiled by Chris Stavroudis

The following procedures are the result of discussions and collaborations by conservaors responding to damage from Superstorm Sandy. They are offered as suggestions worth sharing.

Treatment for Mold

(Thanks to Elise Rousseau and her post to the CIPP list, David Goist, Mary-Lou Florian, Jane Bassett, Rustin Levinson, and Marc Williams for their thoughts and contributions.)

Killing it

For surfaces that can be exposed to a small amount of bleach (0.2% hydrogen peroxide) and are stable to alcohol solutions, the following solutions should be our best chance of killing the mold with the least collateral damage. Of course, use your best judgment but these solutions should be able to be safely applied to surfaces such as the reverse of paintings, secondary support materials that will not be replaced, stretchers, frames, documentary materials, etc.

Careful consideration should be given before using any solution, particularly ones with oxidizing bleaches on works on paper or textiles. Remember that furniture finishes, coatings on frames, and many painting varnishes are soluble in or blanched by alcohol solutions.

47 ml 100% isopropanol
23 ml 100% ethanol
7 ml 3% hydrogen peroxide
23 ml distilled water

The same recipe can be made from materials available from any well stocked pharmacy as follows:

44 ml 91% isopropanol rubbing alcohol
30 ml 70% ethyl alcohol rubbing alcohol
7 ml 3% hydrogen peroxide
19 ml distilled water

or even more simply (for a large batch):

3 16 oz bottles (or 1 ½ 32 oz bottles) of 91% isopropanol rubbing alcohol
2 16 oz bottles 70% ethyl alcohol rubbing alcohol
½ 16 oz bottle 3% hydrogen peroxide
1 ¼ 16 oz bottles (measured in one of the empties) distilled water

Hopefully, as we gain experience with this formulation, we will get a better sense of under what circumstances it poses a risk to an artwork.

For surfaces that can be exposed to alcohol/water solutions but there are concerns about the bleach, use:

70% isopropanol or 70% ethanol

or, to parallel the above recipe,

3 parts 70% isopropanol to 2 parts 70% ethanol

With any of these solutions, the surface must become wet -- only very slightly wet or well dampened -- but a mist that doesn't really touch the surface will not be effective.

Remember that these solutions should kill mold that is wetted by them. The solutions are not 100% effective but seem to be the best that can be used around artwork. Multiple applications are more effective than a single spray, so multiple applications interspersed with HEPA vacuuming will be most effective.

Application methods

Hydrogen peroxide is catalytically decomposed into water and oxygen in the presence of many metals and metal ions. (That's why drugstore hydrogen peroxide bubbles so satisfyingly on a bloody wound – I've always assumed it was the iron in the hemoglobin causing the reaction.) So, the use of a metal sprayer is not advised.

I found that an inexpensive garden sprayer – 1 or 2 gallon capacity with a plastic body, hose, wand and pump unit - worked surprisingly well. Some have a metal spray nozzle tip, which is probably okay. Avoid sprayers with metal wands, tanks, or pumps. The ones I have purchased recently ran between $18 and $35.

Removing dead mold

The dead mold still poses a health risk, so its removal by HEPA vacuuming remains critical. [Obviously, you must wait to vacuum until after the solution has evaporated completely.]

The general recommendation is to HEPA vacuum first, then spray, possibly multiple times, and then vacuum again. [My inclination would be to spray first, HEPA, spray, and HEPA again at a minimum.]

After spraying and vacuuming, soot sponges (eg. Absorene) and/or Groom/stick can be used to remove more difficult to get at mold residues. Remember that the sponges and Groom/stick will be contaminated with the fungal bodies and spores, so handle and dispose of them properly.

For non-art surfaces that are porous, or porous artwork that are not attacked by an oxidizing bleach, a much more aggressive solution can be made by substituting 30% hydrogen peroxide for the 3% in the above recipe. This gives a final concentration of 2.1% hydrogen peroxide.

Trapping / encapsulating residues

My further recommendation is to apply dilute shellac to non-art, wooden surfaces. (I have used commercial bleached shellac solution (Zinsser) cut 1:6 with denatured alcohol.)

However, Marc Williams, much more knowledgeable than me in these matters, suggested "a coating of dewaxed, non-bleached shellac." He further notes that "bleached shellac is

chemically degraded and does not last as long. Yes, it may impart less of a color, but not only is its degradation accelerated, but an unknown amount of bleach residues exist that may affect substrates.

The ideal solution is super blonde dewaxed shellac flakes dissolved by the user in ethanol. It imparts very little color, is much more stable, and has high resistance to softening with heat. Most woodworking suppliers sell this. If a commercial (big box store), off-the-shelf product is needed, orange shellac is a better choice than bleached (white) shellac, but is significantly inferior to dewaxed shellac."

The additional application of alcohol will help kill any mold (and certainly will not activate it as would a water-based sealant). The solution will penetrate relatively deep into the wood (as opposed to water-based materials or low polarity polymers in solvent solution).

Sources and comments on the recipes

The recommendation of 70% isopropanol or 70% ethanol is from Mary-Lou Florian. Higher and lower concentrations of alcohol are less effective than 70%. See her book *Fungal Facts: Solving fungal problems in heritage collections***.** Archetype Publications: London. 2002.

The other recipe is a slightly modified version posted to the CIPP NEWS list by Elise Rousseau (Art Conservation de Rigueur et Anoxia Abatement Solutions, Conservator Textiles & Historic Objects, San Francisco) in late November in relation to Superstorm Sandy response. [My modification was to increase the total alcohol content in the solution she listed from 60% to 70% based on Mary-Lou Florian's research.]

Elise Rousseau's original post on the CIPPNEWS list was (here slightly edited):

> "Last year I participated in a course being offered by the Page and William Post-Graduate School at Mount Sinai School of Medicine in conjunction with the 6th International Scientific Conference on Bioaerolsols, Fungi, Bacteria, Mycotoxins in Indoor & Outdoor Environments & Human Health.
>
> Nearly all of the current scientific and medical research shows that fungicides are ineffective in killing mold, or branching mycelium. It only appears to kill the mold topically, however, while the blooms may shrivel or be vacuumed from the surfaces, the mycelium branches are actually shocked into an accelerated reproduction phase.
>
> This is why when people use mildew stain removers or bleach in their showers at home--it returns two weeks later. Just as we have created super bacterias with antibacterial soaps and hand sanitizers, we have done the same with supposed anti-fungal agents.
>
> Please refrain from using Thymol, Dimethyl Ammonium Chloride, Borate, and bleach--and UV exposure is really only good for your own bed sheets.
>
> "The solution I have found most effective in treating active mold growth is the same as what is now the accepted formula used in hospital surgical rooms that must be kept as close to sterile as is possible. After the initial HEPA-vacuuming of all surfaces in a quarantined and isolated space… Of course it is not intended for painted surfaces, but this formula can be used on some non-colorfast textiles or other cellulose materials.
>
> "Recipe for pressurized air pump spray bottle: set spray volume to very small aerated mist, smooth into surface with a soft disposable brush.
>
> 3 oz. 91% isopropanol
> 2 oz. ethanol
> 0.5 oz. hydrogen peroxide (3% if bleaching is a consideration, 33% if deep wood penetration, unfinished, is the objective)
> 1.5 oz. distilled h2O
>
> "After the surface has evaporated, repeat treatment, perhaps up to 3x. Once completely dry repeat HEPA-vacuuming, clean all of the vacuum tools with this solution, including the long hose which should also be flushed with very hot water, blow out with a hair dryer and flush again with pure 91% isopropyl alcohol."

[You will notice that the above recipe appears to be 70% alcohol, but it doesn't account for the water present in the isopropanol and ethanol. My assumption is that the hospital folk were shooting for 70% but got it wrong. Their formula is actually 60% alcohol. I would strongly recommend the 70% alcohol recipes above.]

Salvage of Machines with Electronic Controls

(Thanks to Polly Darnell who co-wrote the following)

General notes

While written specifically in response to a question on electronic control systems for power equipment, the following tips can be applied to many water-damaged electrical devices. Keyboards (soda spills), computers, cell phones with removable batteries, etc.

First and foremost: Do not use any of these techniques on anything with a CRT (cathode ray tube). The very high voltages can quite literally be lethal.

It's always best to contact the manufacturer first, especially if the equipment is under warrantee or the manufacturer will

deal with it gratis due to the circumstances. An alternative is whoever has serviced the device recently. They will usually recommend that the whole unit be replaced. With older equipment this may be difficult or cost-prohibitive.

It is worth noting that most manufacturers and electronics folk don't know about distilled water rinsing, which we have outlined below. I would further venture to guess that they don't really know what distilled water is and have only ever tried rinsing with tap water which has too much ionic content to work.

In general, if an electronic component wasn't wet for too long and it doesn't contain certain problematic components - which many devices don't - **the electronics can often be salvaged as long as they are *not* powered up until after treatment.** If they are turned on and short out - all is most likely lost.

The majority of the problem for water damaged electronics is the salt content in the water - even tap water. It allows short circuits to form between the very closely spaced traces on circuit boards and between the pins on ICs. Dust and dirt on the components make this problem much worse

To attempt to salvage an electronic device:

- Make sure it's unplugged!
- Open the device as much as possible. Void warrantees and remove access covers, panels and even escutcheon panels (with the exception of hard drives).
- Remove any batteries/internal battery backup/clock batteries/power-on circuit batteries.
- Any hard drives should be removed and treated very carefully separately. Follow all rules for avoiding static discharge while handling the drive.
- Remove as much dust, mud and crud as is possible. A soft brush, preferably static free, can help. Do not scrub aggressively as there are often small wires and fragile traces were you least expect them.
- Rinse everything thoroughly in distilled water (not tap water). If they were heavily inundated, rinse in two or three baths/sprays. If salt water, perhaps even more. The exposure to the distilled water doesn't have to be long, just thorough.
- Make sure all dust and mud has been washed away. If not, remove and rinse again.
- When rinsed, allow to dry. Probably blowing with air or the canned air for cleaning computers is a good first step.
- Allow to dry for a long time - perhaps a week or two. Warming with a hair drier may speed things along. Drying in a sealed container with desiccated silica gel should also speed the final drying process.

  (My theory is that the capacitors absorb small amounts of water and the water has to be given time to diffuse out. I've seen this effect on timing circuits where the interval was way off at first and after some time returned to normal.)
- If possible, plug the device into a GFCI outlet or plug-in unit. Make sure the GFCI has a rating high enough for the appliance. If you can't use the GFCI, just plug it in while standing back, ready to shut the power off if something should spark, smoke, or obviously go wrong. Don't touch any part of any of the equipment when performing this initial test.
- Once you are convinced that nothing really bad has happened, touch the equipment quickly to make sure there is no current leak to ground.
- Then, if everything seems okay, try turning it on. Again, don't touch the equipment for any longer than necessary in case there is a short to ground.
- Hopefully, you will be back in business.

Hard drives

If the information on the drive is critically important, send the drive to a facility like Drive Savers and have them duplicate it onto a new drive. (This is horrifically expensive.)

If a hard drive is going to a vendor for recovery, only do what the vendor says, which is usually absolutely nothing.

If you are trying it on your own, follow the guidelines above. Never open the drive, this is sure to destroy it. Be really careful with the washing. Tape up any breather holes you can find and focus the washing on the circuit-board side of the drive. Definitely dry with pressurized air or canned "air". Avoid shaking the drive (i.e., to remove excess moisture).

If it's a PC/Mac drive, best practice would be to test the drive in an external drive enclosure –these can be purchased for between $20 and $60. Make sure you get an enclosure to match your drive type, the older IDE/EIDE or the currently-used SATA.

Attach the external drive to a computer: Mac drive to Mac, PC drive to either PC or Mac. If the information looks like it's still there, power the drive down. Install a replacement drive and use software to copy the entire contents of the drive onto a new drive. On a Mac you can use SuperDuper!, Carbon Copy Cloner, or similar. I suspect the same type of software is available for Windows PCs.

The goal is to get all the information off the drive as quickly as possible with as few movements of the heads as is possible. For this reason, you don't want to test the drive by using it as a start-up drive or copy the files off one at a time.

[This is all based on my very limited experience with these sorts of devices and my misspent youth as an amateur computer hardware geek. RCA CDP1802 COSMACs rule!]