

Cleaning Flooded Buildings

Hurricane Sandy Recovery Fact Sheet No. 1

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The impact of Hurricane Sandy extended far beyond the structures destroyed by the storm surge. Although the water has receded and most structures have been pumped out, the large number of properties that need repair means that restoration will go on for months.

Therefore, this Fact Sheet was developed to help building owners, operators, contractors, and volunteer assistance groups deal with the challenges of working in structures that were not fully cleaned and dried shortly after the flooding. Remember that when first returning to a flood-damaged building, responders should follow the initial precautions and restoration steps detailed in the FEMA Recovery Advisory, *The ABC's of Returning to Flooded Buildings* (Appendix E of FEMA 549, 2005).

When a flooded home has not been cleaned and dried within a few weeks of the flood event, mold contamination should be expected, and specific steps are needed to clean and restore the home. Basic cleaning and drying information is presented in the FEMA Recovery Advisory *Initial Restoration for Flooded Buildings* (FEMA 549, 2005), which specifies five steps for post-flood building restoration, including (1) air out, (2) move out, (3) tear out, (4) clean out, and (5) dry out. This Fact Sheet builds on the last two of these steps and assumes that the majority of the muck-out and gutting process has been completed and the home is ready for cleaning and drying.

Key Issues

- Floodwaters carry a variety of contaminants such as bacteria, oil, heavy metals, and pesticides. While first responders' initial evaluations of Hurricane Sandy floodwaters indicated that exposure to such items are below current limits for safe occupancy, proper cleaning and preparation for rebuilding is critical to protect workers and occupants from both short-term hazards and long-term risk.
- Other hazards are present in addition to the substances brought in with the floodwaters, especially in homes that were not dried out within a week of the flooding. Safety issues related to wet mechanical and electrical systems, exposure to lead and asbestos released from building materials, and mold growth need to be addressed.
- Mold is a serious health hazard if the home is reoccupied without proper cleaning. Although a variety of products and techniques can reduce and control mold, the cleaning and drying process described in this Fact Sheet also helps to remove other floodwater contaminants.

Personal Safety

Flooded buildings can pose a number of health and safety risks, for both individuals who wish to maintain occupancy and those who work to repair them. Eliminating hazards is the best way to protect occupants and workers; however, until conditions can be returned to normal, anyone working in a flooded building should use appropriate personal safety equipment and take appropriate safety precautions. The Occupational Safety and Health Administration (OSHA) Fact Sheet, *Hurricane Sandy Cleanup PPE Matrix*, provides information on personal protective equipment (OSHA-FS-3612, 2012).

Protection from electrical shock: Because of the danger of shocks and fire, electrical receptacles that were flooded should not be used to operate cleaning or drying equipment. An electrician should evaluate the condition of flooded components prior to use. As a rule, all flooded receptacles should be removed and replaced after the appropriate circuit breakers or fuses are deactivated and the interruption of power to the receptacle confirmed.

Protection from mold contamination: Anyone entering a house with visible mold growth should wear a disposable suit to prevent contamination of their clothes and vehicle, rubber gloves or other hand protection, and respiratory protection. A disposable respirator marked with an N-95 rating (when used in accordance with the manufacturer’s instructions) offers the minimum lung protection that should be used when in the presence of mold. A full-face respirator is recommended for mold cleaning to protect both the eyes and the respiratory system. If a full-face respirator is not used during cleaning, goggles or a face shield should be worn with the disposable respirator. The OSHA Fact Sheet, *Mold Hazards During Hurricane Sandy Cleanup*, provides information on mold (OSHA-FS-3619, 2012).



Figure 1: Mold (on wood) and asbestos (yellow arrows) hazard in flooded house

Protection from asbestos and lead paint: Asbestos in floor tile, pipe and boiler insulation, and electrical wiring is common in many homes built before 1980 (Figure 1). Breathing asbestos fibers released from building products can increase the risk of cancer and cause a number of serious lung diseases. Similarly, paint in homes constructed prior to 1978 may contain lead. If lead paint is aerosolized during muck-out or gutting activities it can damage a person’s health and is especially dangerous to child occupants if not cleaned up properly. If asbestos or lead paint is suspected, obtain the services of a specialist to perform material testing, and do not disturb the material until testing has been completed. If testing confirms the presence of lead, remediation should be conducted by a licensed professional. If materials containing asbestos are present, remediation must be performed in accordance with applicable State and Federal regulations.

Cleaning Flood-Damaged Homes

If not already installed as part of the muck-out and gutting process, plastic barriers should be set up between affected and unaffected areas of the premises (typically between the first and second floors at the base of the stairs). The barriers will reduce the potential of mold spores spreading to unaffected areas.

Because of the wide range of contaminants that can be present in floodwaters and grow on wet surfaces, all objects that came into contact with the floodwaters should be cleaned and sanitized. Generally, water-damaged porous materials are difficult to properly clean and should be discarded.

Selecting a Cleaner or Sanitizer

There is a wide variety of products that help eliminate mold and bacteria growth. The Environmental Protection Agency (EPA) registers products that are approved as a disinfectant and sanitizer for water damage restoration. It is critical to choose products registered with the EPA, as they have been proven to be effective for such biological contaminants. For information related to registration of chemicals as antimicrobials suitable for work with mold, access the EPA’s pesticide product label system (PPLS).¹ EPA’s Web site allows searches by chemical name,

¹ EPA Web site: <http://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1>

manufacturer, or EPA registration number. Regardless of the chemical selected, it must be used in accordance with the label directions.

Moldy surfaces should be cleaned first and then disinfected; some products do both in a single step. In all cases, mold spores should be removed as completely as possible since killing them does not eliminate their toxicity or allergenic properties.

Application of Cleaners

Cleaners are most efficiently applied using a combination of foam cleaning processes and brush cleaning, followed by pressure washing.

Foam cleaning: Foam cleaning processes have many advantages over spraying or wiping because foaming allows the product to stay on the surface (dwell) long enough for the chemicals to kill the mold or bacteria. Foam cleaning also reduces the amount of liquid used, making drying easier. Pump-up, air operated, and motorized foam generators are commercially available (Figure 2). Brushes improve decontamination of wooden studs and other surfaces by scrubbing the foam into affected surfaces. The combination of foam and scrubbing also helps to remove waterborne contaminants other than mold that get absorbed into wooden materials. The foam should sit on the surface for 3 to 5 minutes before scrubbing (refer to the label of the EPA-registered product for minimum dwell time).

Water-damaged porous materials should be removed. Non-flooded gypsum board and plaster walls that remain after gutting that are dirty or harboring mold growth can be cleaned using the foam solution. Care should be taken to inspect both the front and back side of the non-flooded gypsum board and plaster walls for remaining dirt and mold to ensure all affected areas are cleaned. These semi-porous surfaces should not be scrubbed, but should instead be wiped off with disposable towels.

Pressure washing: Residual foam on wall studs, floor joists, and other surfaces can be rinsed off with clear water. The fastest and most efficient rinse method that minimizes the amount of water used is a residential-type pressure washer set at low pressure so that the spray is a light mist (Figure 3). Squeegees can be used to control or direct remaining liquid. High-Efficiency Particulate Air (HEPA) vacuums designed for wet use can be used to collect the residue.

Drawbacks of Bleach

While bleach is convenient as a cleaner and stain remover for hard, non-porous items, it has distinct drawbacks when cleaning flood-impacted buildings. Many types of bleach are not EPA-registered as a disinfectant. Further, its effectiveness in killing bacteria and mold is significantly reduced when it comes in contact with residual dirt, which is often present in flooded homes. Also, if bleach water comes into contact with electrical components and other metal parts of mechanical systems it can cause corrosion. Bleach water can also compromise the effectiveness of termite treatments in the soil surrounding the building.



Figure 2. Pump-up or motorized foam generators can apply a wide range of cleaning chemicals



Figure 3. Using a pressure washer to rinse surfaces cleaned with a foam solution

Cleaning in Weather Extremes

Although cold weather poses challenges for restoring flooded buildings, it also has some advantages. In particular, cooler weather slows down the spread of mold. However, buildings need to be warmed to 50° to 75°F to provide for worker comfort, improve the effectiveness of cleaning and sanitizing agents, and allow commercial drying equipment to operate efficiently.

Hot and humid weather conditions also pose challenges. Mold and bacteria spread more quickly under such conditions, and natural drying of building materials slows significantly. In such circumstances, the use of drying equipment or air conditioning is critical to lower the moisture content of structural materials prior to any rebuilding activities.

Cleaning Crawlspace

Crawlspaces must be accessed to complete the decontamination of a home. Removing the flooring is the simplest way to enter these areas. Once access is obtained, solid contamination should be removed from under the building, along with any remaining water. Application of cleaning foam followed by agitation should be conducted on all exposed sides of floor joists, foundation walls, and remaining structural elements. After cleaning and eliminating standing water any exposed ground in the crawlspace not already covered with intact plastic sheeting (vapor retarder) should be covered with plastic sheeting and held in place with landscape fabric pins to minimize potential mold growth and future moisture migration into the house.

Proper Drying Prior to Rebuilding

After the cleaning process has been completed, the building and any salvageable contents need to dry. The decision to allow the building and contents to dry naturally or to accelerate the drying by using equipment (Figure 4) often depends on whether power is available, whether the home's heating and ventilation systems have been restored, and the moisture content of the affected materials.

Once the electrical and HVAC systems have been restored and sanitized, the moisture content of wetted salvageable building materials should be checked to determine whether drying equipment will be necessary (see Figure 5 and Table 1). Drying equipment includes fans, dehumidifiers, air conditioners, and auxiliary electric heaters. Moisture content should be checked using an intrusive/penetrating (pin-type) moisture meter (Figure 5) because moisture content is difficult to assess accurately using only touch or sight. The materials must be rechecked after drying before doing any rebuilding. Wetted materials are presumed to be dry when their moisture content is less than or equal to 15 percent (Table 1).

Failure to allow adequate drying prior to reconstruction can trap moisture in the building, which can cause structural damage and potential health problems.



Figure 4: Drying equipment



Figure 5: Use of a penetrating (pin-type) moisture meter to verify that wood frame has a water content of less than 15 percent

Natural drying can be sped up by opening windows and doors. If structural materials are allowed to dry naturally, the moisture content must be checked before doing any rebuilding. Natural drying can take a long time, especially in cold weather. Verifying that materials are sufficiently dry before rebuilding is the key to minimizing future problems such as fungal growth.

Resources and Useful Links

Centers for Disease Control and Prevention. “Storm, Flood, and Hurricane Response: Guidance on Personal Protective Equipment and Clothing for Flood Cleanup Workers.” Web site: <http://www.cdc.gov/niosh/topics/emres/ppe-flood.html>. Accessed February 12, 2013

FEMA. 2006. *Initial Restoration for Flooded Buildings*. FEMA Recovery Advisory, initially published in November 2005 and also included in Appendix E of FEMA 549, *Mitigation Assessment Team Report: Hurricane Katrina in the Gulf Coast*. July 2006, Washington, DC. Available at <http://www.fema.gov/library/viewRecord.do?id=2633>

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Occupational Safety and Health Administration (OSHA). 2012. *Hurricane Sandy Cleanup PPE Matrix*. OSHA Fact Sheet OSHA-FS-3612. December 2012, Washington, DC. Available at <http://www.osha.gov/Publications/OSHA-FS-3612.pdf>

OSHA. 2012. *Mold Hazards During Hurricane Sandy Cleanup*. OSHA Fact Sheet OSHA-FS-3619. December 2012, Washington, DC. Available at <http://www.osha.gov/Publications/OSHA-FS-3619.pdf>

U.S. Department of Housing and Urban Development. 2008. *Rehabbing Flooded Houses: A Guide for Builders and Contractors*. Bilingual guide. Washington, D.C. Available at http://www.huduser.org/Publications/pdf/Rehab_FloodedHouses.pdf

U.S. Environmental Protection Agency. 2012. *Flood Cleanup: Avoiding Indoor Air Quality Problems*. Fact Sheet, revised November 2012. Washington, DC. Available at <http://www.epa.gov/iaq/pdfs/floods.pdf>

Table 1. Level of Drying Required Before Rebuilding

Summary of Moisture Reading Results for Wood Framing Materials	
Moisture Reading	Results
> 20%	Wet, no good
15–20%	Partially dry, caution
< 15%	Dry, ok

The FEMA Region II Web page provides useful information and links for disaster survivors and recovering communities, including available FEMA assistance and recovery initiatives. Please refer to <http://www.region2coastal.com>.

For more information, see the FEMA Building Science Frequently Asked Questions Web site at <http://www.fema.gov/frequently-asked-questions>.

If you have any additional questions on FEMA Building Science Publications, contact the helpline at FEMA-Buildingsciencehelp@fema.dhs.gov or 866-927-2104.

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