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NIOSH Recommendations for the Cleaning and Remediation of Flood-Contaminated HVAC Systems: A Guide for Building Owners and Managers

Introduction

During flooding, systems for heating, ventilating, and air conditioning (HVAC) can become submerged in flood waters. As a result, these systems may contain substantial amounts of dirt and debris and may also become contaminated with various types of microorganisms such as bacteria and fungi. The following recommendations will help ensure that HVAC systems contaminated with flood water are properly cleaned and remediated to provide healthy indoor environments.

Microorganisms may grow on all surfaces of HVAC system components that were submerged in flood waters. In addition, moisture can collect in HVAC system components that were not submerged (such as air supply ducts above the water line) and can promote the growth of microorganisms. Therefore, all components of the HVAC system that were contaminated with flood water or moisture should be thoroughly inspected, cleaned of dirt and debris, and disinfected by a qualified professional. The following recommendations will help ensure that HVAC systems contaminated with flood water are properly cleaned and remediated to provide healthy indoor environments.

These recommendations will be reassessed periodically and updated as appropriate.

Steps Before Cleaning and Remediation

- If the building is to remain partly occupied (for example, on upper floors not affected by flood waters), isolate the construction areas where HVAC systems will be cleaned and remediated by using temporary walls, plastic sheeting, or other vapor-retarding barriers. Maintain the construction areas under negative pressure (relative to adjacent non-construction areas) by using blowers equipped with HEPA filters (high-efficiency particulate air filters) to exhaust the area. To ensure complete isolation from the construction areas, it may be necessary to pressurize the adjacent non-construction areas and temporarily relocate the outdoor-air intake for the HVAC system serving the occupied areas.

- Take precautions to protect the health of workers who are cleaning and remediating the HVAC system. Make sure that workers wear at least an N-95 NIOSH-approved respirator to protect against airborne microorganisms. Increased levels of respiratory protection (for example, powered, air-purifying respirators equipped with HEPA filters) may be appropriate depending on the level of visible contamination. In addition, when using chlorine bleach or other disinfectants in poorly ventilated environments, it may be necessary to use appropriate chemical cartridges in addition to the particulate filters to protect workers from breathing the chemical vapors. Employers must implement a complete respiratory protection program that meets the requirements of the OSHA respiratory protection standard (29 Code of Federal Regulations 1910.134). The minimum requirements for a respiratory protection program include a written standard operating procedure for the following: selecting and using respirators; the medical evaluation of workers to determine whether they are physically able to wear the respirator selected for use; training and instructions on respirator use; the cleaning, repair, and storage of respirators; the continued surveillance of work area conditions for worker exposure and stress; and a respirator fit-testing program. For tight-fitting respirators, fit-testing is necessary to help ensure that the respirator fits tightly, reducing the potential for

HVAC Cleaning and Remediation

- Remove all flood-contaminated insulation surrounding and within HVAC system components. Discard these contaminated materials appropriately following applicable Federal, State, and local regulations.

- Remove contaminated HVAC filter media and discard appropriately following applicable Federal, State, and local regulations.

- After removing any insulation and filters, clean all flood-contaminated HVAC system component surfaces with a HEPA-filtered vacuum cleaner to remove dirt, debris, and microorganisms. Pay special attention to filter racks, drain pans, bends and horizontal sections of air ducts where debris can collect.

- After removing any insulation or debris, disinfect all HVAC system component surfaces while the HVAC system is not operating. Use a solution of 1 cup of household chlorine bleach in a gallon of water. Do not mix bleach with other cleaning products that contain ammonia.

- Conduct the cleaning and disinfection activities in a clean-to-dirty work progression. Consider the use of auxiliary fans to supply "clean" air to the worker position and carry aerosolized contaminant and disinfectant in the clean-to-dirty direction, away from the worker's breathing zones and towards the point of filtration and exhaust.

- Follow the disinfection procedure with a clean water rinse. Depending on the amount of debris present, it may be necessary to mechanically clean the HVAC system component surfaces with a steam or a high-pressure washer before using the disinfectant. Gasoline powered pressure washers should be used outside or with adequate exhaust ventilation to prevent carbon monoxide hazards. (See NIOSH topic webpage, "Carbon Monoxide Hazards from Small Gasoline Powered Engines" at: http://www.cdc.gov/niosh/topics/co/)

  Note: Remove and discard HVAC system components that are contaminated with flood water, and cannot be effectively cleaned and disinfected. Replace them with new components.

- After cleaning and disinfecting or replacing the HVAC system components, replace the insulation – preferably with an external (i.e. not in the air stream) smooth-surfaced insulation to help prevent debris and microorganisms from collecting in the future.

- Make sure that the HVAC system fan has been removed and serviced (cleaned, disinfected, dried thoroughly, and tested) by a qualified professional before it is placed back into the air-handling unit.

- During the cleaning and remediation process, consider upgrading the HVAC system filtration to the highest efficiency filters practical given the static pressure constraints of the HVAC system fan. This step has been shown to be one of the most cost-effective ways to improve the long-term quality of the indoor environment, since it reduces the amount of airborne dusts and microorganisms.

Resuming HVAC Operations

- After cleaning and disinfecting or replacing HVAC system, have a qualified professional thoroughly evaluate its performance and correct it as necessary before the building is occupied again. The HVAC system performance should conform to the recommendations contained in ASHRAE Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality.

- Before the building is occupied again, operate the HVAC system continuously in a normal manner at a comfortable temperature for 48 to 72 hours. During this period, it may be beneficial to open the HVAC outdoor air dampers to the maximum setting that still allows you to provide the desired indoor air temperatures. If objectionable flood-related odors persist after this "flush out" period, reassess by looking for flood-contaminated areas that were not identified earlier and continue the flush-out process until odors are no longer apparent. Replace the HVAC filters used during the flush-out prior to building occupancy.

- After a building is occupied again, make frequent (for example, weekly) checks of the HVAC system to ensure that it is operating properly. During these checks, inspect the HVAC system filters and replace them when necessary. Gradually reduce the frequency of the HVAC system checks to monthly or quarterly inspections, depending on the routine operation and maintenance specifications for the HVAC system.

- If no routine operation and maintenance program is in place for the HVAC system, develop and institute such a program. At a minimum, include the following routine procedures: inspection and maintenance of HVAC components, calibration of HVAC system controls, and testing and balancing of the HVAC system.

- After the building is occupied again, maintain the interior temperature and relative humidity to conform with the ranges recommended in ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy.

Additional Resources

Additional information about the cleanup and restoration of water-damaged and mold contaminated HVAC systems is available from the Institute of Inspection, Cleaning and Restoration Certification (IICRC) and the National Air Duct Cleaners Association (NADCA). Their pertinent documents (Standard and Reference Guide for Professional Mold Remediation [IICRC S520] and Assessment, Cleaning and Restoration of HVAC Systems [ACR 2006]) are available for purchase at www.iicrc.org/ and www.nadca.com/publications/, respectively. The University of Minnesota also has a document titled, "HVAC System Decontamination" available for free off the internet at www.dehs.umn.edu/iaq_hsd.htm.

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