Best Practice Guidelines

Filtration for Higher Education Complexes

This guideline is provided courtesy of:

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NAFA® National Air Filtration Association

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Table of Contents

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NAFA guidelines provide advice on achieving the cleanest air possible based on the design limits of existing HVAC equipment and with consideration of the impact on energy and the environment. Our guidelines are created and updated to collect and supplement existing information. However, we go beyond the "bare minimum," publishing best practices based on the experience and expertise of our membership, as well as current mandates and research provided by governmental and scientific communities.

For a more complete explanation of principles and techniques found in this guideline, visit www.nafahq.org to purchase the NAFA Guide to Air Filtration. If you have any questions or comments about this publication, please contact NAFA Headquarters.

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About Us

Our Mission:

The National Air Filtration Association (NAFA) mission is to be the global source for expertise, education & best practices in air filtration.

What can NAFA membership do for you?

NAFA brings together air filter and component manufacturers, sales and service companies, and HVAC and indoor air quality companies. By becoming a member, you can:

- Meet with industry thought leaders
- Strengthen your network
- Share best practices
- Receive up to date industry information
- Access professional development, certification and education

Be a part of something bigger

As a NAFA member, you are a part of a support system that shares the common goals of supporting industry growth and creating healthier communities. Following the coronavirus pandemic, we are more aware than ever of the important role that our members play in a well society. We know that our work is important to maintaining healthy, happy communities.

Benefits of Membership

As a member of NAFA, you'll have access to a host of benefits that offer networking, learning, and advertising opportunities. Here are just a few of our most popular benefits:

- Annual conferences and webinars
- Professional development programs (CAFS and NCT Level I & II certification)
- Air Media magazine
- Best practices guidelines
- Clean Air Award recognition program
- Library of resources, manuals, seminars, and training.
- NAFA advertising and sponsorship programs
- Exposure through NAFA social media and a listing on the NAFA website
- NAFA volunteer and leadership opportunities

...and more!

Click here to become a member today!

CAFS & NCT Certifications

Educate your team
Attract new customers
Be known as a leader in your industry

Now more than ever, customers seek professionals with the credentials for quality assurance and knowledge to ensure that their complex needs will be met. Addressing this concern, NAFA offers two certification programs to increase the level of education and professionalism in the industry.

The NAFA Certified Air Filter Specialist (CAFS) program

CAFS is the first education and certification program offering an extensive examination on the principles, methods and applications of air filtration. It differentiates professionals who have demonstrated a high level of professionalism and a thorough, up-to-date understanding of air filtration technology. The CAFS exam is pass/fail, and is based on the NAFA Guide to Air Filtration.

NAFA Certified Technician (NCT) Program

This open-book exam is based on the NAFA Installation, Operation, and Maintenance of Air Filtration Systems manual. This program was designed to increase the knowledge of technicians, facility managers, and building owners.

Both certifications are renewable on an annual basis pending successful completion of continued education requirements. While the exams are open to members and nonmembers alike, test fees are dramatically reduced for members. To find out more about the cost, study aids, test dates/locations, and requirements, visit the weblinks below.

CAFS information page

NCT information page

About This Publication

1 PURPOSE

This NAFA guideline provides filtration best practices for the removal of particulate and molecular contaminants, the improvement of indoor air quality and the protection of HVAC equipment in Higher Education facilities. It serves to provide the facility managers with the necessary tools to make measurable improvements in air quality and in the operation of the HVAC systems on their campus.

2 SCOPE

This publication will address the filtration practices associated with the complex systems and applications found in today's Higher Education buildings. It will take into consideration indoor environment and equipment protection. It will look at operating and maintenance of filtration systems as well as conditions such as renovations, internal construction and localized exhaust. This will include the many different building types found on a Higher Education campus. This includes, but is not limited to classrooms, science buildings, libraries, student living, offices, and sports complexes. Finally, this document will address issues related to COVID-19, utilizing rapidly evolving knowledge provided by available research and government guidelines.

3 BETTER EDUCATION, BETTER BOTTOM LINE

With new research showing the benefits of cleaner environments on learning, we can all agree that our students and faculty should have the cleanest air possible to breathe.

Higher Education institutions are always under constraints to achieve high quality education at affordable cost. Increased training and knowledge can help keep indoor air quality (IAQ) affordable and achievable. While cutting small costs for proper air filtration may have short term financial benefits, keeping up with proper preventative maintenance and scheduled air filter changes will have a more sustainable impact in the long run. Without proper maintenance and filtration, key components of HVAC systems will deteriorate, resulting in costly repairs and or increased operating costs.

System Approach: Mechanical Equipment Recommendations

1 CENTRAL AIR HANDLING UNITS

Central Air Handling Units (CAHU) condition the largest percentage of outside air (OA) entering a building, providing thermal comfort (temperature and humidity), ventilation and the removal of contaminants. These units contain all, or some, of the following components: particulate filters, heating and cooling coils, humidification systems, molecular filtration systems, UV lights, fans, dampers and motors. This introduction of outside air necessitates the removal of a variety of contaminants to maintain the effective operation of the system, its components, and to provide a healthy environment for its occupants. In some instances, the air being returned to the CAHU is more contaminated than the OA, requiring the need for particulate, and sometimes, odor/gaseous removal at the source. NAFA's best practice for a CAHU is a MERV 13 filter or higher at prescribed airflow. MERV 13 filters are recommended because of their ability to capture most fine particulate matter (PM 2.5) that can be dangerous or have adverse health effects for building occupants.

2 ROOFTOP AIR HANDLING UNITS

A Rooftop Air Handling Unit (RAHU) maintains comfort conditions in a zone by providing a constant volume of air that varies according to load. Rooftop units can be the entire source of heating and cooling for a building, or a supplemental system to the existing Heating, Ventilating and Air Conditioning (HVAC) system. A MERV 13 filter or higher is recommended.

3 MAKE-UP AIR UNITS

Make-up air (MUA) units are designed to provide ventilation air into a space or replace air exhausted from the building. It may be used to prevent negative pressure within the building or to control the contaminant level in the space. An example of MUA units for educational use is the parking garage where the units provide replacement outside air when contaminated vehicle air is exhausted. An MUA unit operates on 100% outside air and a MERV 13 filter or higher is recommended.

4 UNITARY UNITS

Unitary units are factory made systems that normally include heat/cool coils, fan, motor, humidification, filtration, and ventilation components. Unitary systems are commonly used as compartmental floor units where return air from the indoor space is mixed with outside air from the CAHU to provide conditioned air. The best practice recommendation is a MERV 13 filter or higher. The task for this filter is to remove the contaminants which are primarily generated within the indoor space.

System Approach: Mechanical Equipment Recommendations (continued)

5 UNIT VENTILATORS

Unit ventilators are an assembly of elements whose principal function is to condition a space. They are often used in Higher Education facilities to provide an air current for windows to prevent condensation. Components of unit ventilators include a fan, motor, coil or heating element, filter and an enclosure. No central air is provided to a unit ventilator so air is taken from the space and conditioned at the unit. A unit ventilator can also be supplied with an outdoor air damper for ventilation. A MERV 13 filter or higher is recommended for this application.

6 FAN COIL UNITS

Fan coil units are small unitary systems that provide a combination of heating or cooling to condition a space. The units can sometimes be supplied with outdoor dampers for ventilation. Fan coils are often used to supply conditioned air to areas such as elevator machine rooms, electrical vaults, telecommunication rooms etc. Recommended filtration is MERV 13 or higher.

7 SELF-CONTAINED UNITS

Self contained units are typically constant volume heat/cool units. Outside air to meet ventilation requirements is usually provided by a dedicated outside air duct. Higher Education facilities are often served by multiple self contained units. Recommended filtration is MERV 13 or higher.

8 HEAT PUMPS

Commercial heat pumps are unitary systems that can operate either in heating or cooling mode. Conditioned air is discharged directly into the zone or into a ducted system. Recommended filtration is MERV 13 or higher.

9 INDUCTION UNITS

Induction Units are used to save space and give temperature control for each room in which they are installed. Induction units are made for handling the different cooling and heating loads in the perimeter areas of larger buildings. They can be used in combination with a central HVAC system or as a stand-alone system recirculating air within the space. Some induction units have the ability to bring in outside air. They are commonly used in hospitals, hotels, apartments, office buildings, schools, and universities. Recommended filtration is MERV 13 or higher.

Application Approach

1 LOCALIZED SUPPLY AND EXHAUST

The complexity of operating a Higher Education facility necessitates the use of special ventilation, cooling, and filtration strategies for operational activities such as: elevator machine rooms, electrical vaults, telecommunication rooms, data rooms, and specialized mechanical equipment. In these applications equipment protection and their ultimate performance are paramount. A MERV 13 filter or higher is recommended for these applications.

2 INTERNAL CONSTRUCTION

Renovation and internal construction present a major operational challenge for the facility management (FM) group. The FM team is responsible to maintain operation of the building while activities such as painting, carpet replacement, and complete floor overhauls are taking place. For small renovations on an individual floor, consideration must be made for the other tenants on that floor. In these situations, if possible, the work should be performed during off hours and the contaminants removed at the source. A negative air HEPA fan unit, in conjunction with barrier isolation, will remove the particulate from the area under renovation before it is exhausted outside or returned to the occupied space. Any odors/gaseous contaminants created during this process will need to be addressed with the addition of molecular contaminant removal filters.

For larger projects, such as complete floor overhauls, consideration for contaminants returning to the central air handling system will need to be addressed. Additional filters of a minimum MERV 13 or higher should be temporarily installed at each return air grill on the individual floor under construction. These filters will need to be removed immediately prior to tenant occupancy. During construction, filters need to be monitored and possibly changed more frequently due to the higher particulate load generated within the space. Any odors created during this process may need to be addressed with the addition of molecular contaminant removal filters. For additional information see SMACNA – IAQ "Guideline for Occupied Buildings Under Construction."

3 FOOD PREPARATION

Many Higher Education buildings contain restaurants, cafeterias, and specialty food and beverage providers. Minimizing the food odors within a building requires these areas be kept under a negative pressure with respect to adjacent spaces. Kitchen air should be exhausted to a location remote from outside air intakes. In many instances the air from food preparation is contaminated with grease, particulate, and odor necessitating removal before exhausting.

Application Approach (continued)

FOOD PREPARATION (CONTINUED)

On all kitchen exhaust hoods, a primary filtration system consisting of a washable baffle filter is installed. In certain situations where exhausting to the outside, or exhausting remote from the OA intake, is not possible some combination of ultraviolet germicidal irradiation system, high efficiency particulate filters, and gas phase filters are recommended. Consult with a NAFA CAFS for design recommendations.

4 BUSINESS PROCESSING CENTER

Rooms designated and dedicated for activities such as printing, photocopying, document shredding, or other specialized office activity may lead to the generation of gaseous and particulate contamination. This issue requires special consideration to limit the spread of the contamination to the rest of the building. Air from these activities should be filtered for particulate and odor removal at the source or exhausted directly outdoors. A particulate filter of MERV 13 or higher is recommended along with molecular contaminant removal filters for odor and gaseous removal.

5 HEALTH & SAFETY

Certain buildings and geographic locations may be more at risk for bioterrorism attacks. For information on filtration for these types of buildings, please refer to the NAFA Position Statement on Bioterrorism.

In addition, an excellent resource for health and safety issues is ASHRAE's Risk Management Guidance for Health, Safety, and Environmental Security under Extraordinary Incidents. In the words of NAFA Board President-Elect Michael Corbat...

> "Now more than ever, following the COVID-19 pandemic, we are keenly aware that indoor air quality is not just a box to be checked -- it's a codified mandate and an important health and safety concern for us all."

Installation, Operation & Maintenance

The following identifies some of the more important factors to consider when installing, operating and maintaining an HVAC Filtration system. As a supplement to manufacturers' guidelines, see NAFA's Installation, Operation and Maintenance of Air Filtration Systems manual or consult a NAFA CAFS.

Installation of Filters & System Integrity

Maintaining integrity of the filter system is vital for the efficacy of the HVAC system and imperative for air filtration performance as unfiltered air by-pass is a key contributor to poor IAQ.

A positively sealed filtration system will prevent unfiltered air bypass, maintain system pressure, and provide consistent filtration system efficiency. After each filter installation, the system must be checked to ensure that there are no possible leaks or gaps in and around the filters. This includes filter frames, fastening devices, caulking and gaskets.

NAFA recommends having a NAFA Certified Air Filtration Specialist (CAFS) inspect the installation for system integrity at least annually.

When changing or modifying the model or design of a filter system consult the manufacturer's specifications of the air handling system. Consideration must be given for:

- Size
- Fit
- Media area
- Airflow rate
- Initial and final pressure drop of the new filter system

Maintenance

A preventive maintenance program should include a monthly inspection of the filtration system. Use the following checklist as a starting point:

_____ Filters
_____ Filter hardware
_____ Fastening devices
_____ Caulking
_____ Gaskets
_____ Ductwork

Removing and replacing damaged or defective filters, filter hardware, gaskets, and duct insulation will keep unfiltered air from bypassing the filter system. Keeping the coils and blower clean and free from dirt and debris will improve airflow, increase system efficiency, reduce electrical consumption, and maintain overall design performance. Scheduled filter maintenance will keep the HVAC system working efficiently with clean, conditioned air and a reduction in contaminant levels.

Additional information regarding maintenance of HVAC and filter systems may be found in the ANSI/ASHRAE/ACCA Standard 180, "Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems."

Installation, Operation & Maintenance (continued)

Monitoring of Airflow and Pressure Drop

As a filter loads with contaminants the resistance to air flow through the filter increases. This increase is referred to as "pressure drop" or "differential pressure."

As an example, in a draw-through system, as the filters load and the resistance increases, the fan pressure is lower on the downstream side. Hence the pressure "drop" downstream of the filters.

This drop or differential can be measured with a pressure sensing device such as a manometer or magnehelic gauge. All HVAC units should have a pressure-sensing device installed to accurately monitor the pressure drop across the filter bank. In extreme temperature conditions, a magnehelic gauge is recommended over a manometer. When a filter has exceeded its useful life based on pressure drop or Life Cycle Costing, it should be replaced. Leaving a filter in service after this point may increase operational and energy costs and could damage the HVAC system.

Most molecular filters, over time, will not increase in pressure drop. Some particulate media, when impregnated with sorbent, could increase in pressure drop. This is not indicative of the service life of the sorbent. Service life of a molecular filter is a function of types and concentration of contaminants and filter design. Most manufacturers offer testing services to determine remaining filter service life. It is important to note that as the media life decreases, so does the efficiency of the molecular filter. Molecular filters are often recommended for change out before media is 100% spent.

Filter Service

The servicing of filtration products is a dirty business. It is best practice that service technicians have a safe work environment and use the correct personal protective equipment (PPE). Outer layer clothing should be weather appropriate in line with the climatic conditions. PPE includes:

- Eye protection
- Masks
- Gloves
- Coveralls
- Safety Boots
- Hearing Protection
- Hard Hat

In addition, service technicians should have a good working knowledge of:

- HVAC systems
- Ladder safety
- Confined space entry
- Risk management
- Shut down procedures
- Lock-out procedures

The use of specialized procurement devices (pictured above) should be used for safely adding, and removing product from difficult access points, such as a roof.

Installation, Operation & Maintenance (continued)

Training

The servicing of air filtration products is becoming more technical and requires specialized skills. It is for this reason that NAFA introduced the Certified Technician (NCT) Program in 1999 to increase expertise and professionalism to the air filtration industry. The NCT enables facility managers and building owners the opportunity to certify their employees on all aspects of filtration service and Indoor Air Quality.

For additional information visit the NAFA website: www.nafahq.org or contact a local NAFA member.

Disposal

Particulate filters should be assumed to be contaminated with viable organisms, possibly hazardous in nature, and need to be disposed of in a careful and safe manner. Spent carbon in molecular filters may sometimes be returned to the manufacturer for reactivation. NAFA recommends that technicians performing the work be certified to NAFA Certified Technicians (NCT) standards.

You care about your employees and your students.

You care about the environment and your community.

You care about the fiscal health of your institution.

Indoor air quality matters.

COSTS OF POOR AIR QUALITY
Lost productivity
Decreased Health
Increased absenteeism
Increased Equipment
Maintenance/Replacement
Increased Energy

BENEFITS OF IMPROVED AIR QUALITY
Reduced absenteeism
Better learning
Increased productivity
Improved health, wellness and satisfaction

KEY RECOMMENDATIONS FOR YOUR HVAC SYSTEM

- Run the HVAC whenever the space is occupied.
- Direct the clean/cleaned air into the breathing zone in each occupied space.
- Return air vents should pull air from the room and not directly from the clean air inlet.
- Maintain temperature and humidity design set points.
- Set the HVAC system to bring in as much outside ventilation air as possible.

KEY RECOMMENDATIONS FOR FILTER MAINTENANCE

- To achieve the recommended MERV 13-equivalent or better levels of performance (which removes ≥85%of 1-3 µm particles), a combination of filters/air cleaners can be used.
- Use only air cleaners for which evidence of effectiveness and safety is clear.
- When upgrading filters, carefully monitor to ensure your current system can handle the upgrade (e.g. pressure drop).
- Upgrading both pre-filters and filters may cause unacceptable pressure drop. It may not be necessary to upgrade both.
- Consider using the AHAM Clean Air Delivery Rate (CADR) for sizing air-cleaners for your space.
- Confirm filters are sealed in their frames, preferably with gaskets to prevent filter bypass.
- Personnel changing filters should wear PPE. Dispose of spent filters immediately and in a safe manner.

DID YOU KNOW?

Studies with SARS CoV-1 have shown that toilet flushing can generate airborne droplets and aerosols that could contribute to transmission of pathogens. Remember to:

- Keep toilet room doors closed, even when not in use.
- Encourage putting the toilet seat lid down, if there is one, before flushing.
- Keep bathroom fans running continuously and vent separately, where possible.

Glossary

Air Filter/Air Cleaning: A device used for the removal of particulate or gaseous impurities from the air.
AHAM: Association of Home Appliance Manufacturers.
AHU: Air handling unit describes the unit or units supplying a building with conditioned air. It can be described as the lungs of a building.
ANSI: American National Standards Institute – As the voice of the U.S. standards and conformity assessment system, ANSI empowers its members and constituents to strengthen the U.S. marketplace position in the global economy while helping to assure the safety and health of consumers and the protection of the environment.
ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers. ASHRAE is an international organization that sets standards and guidelines for the heating, ventilating, air conditioning, and refrigeration industry.
ACH: Air changes per hour computed by taking the cubic area of a space and dividing by the cubic feet per hour of air supplied to it.
CAFS: Certified Air Filter Specialist accreditation granted by NAFA to those who pass an exam on air filtration.
CSA: Canadian Standards Association.
DOP: Dioctyl Phthalate is a chemical used to challenge HEPA filters. Factory testing involves heating DOP to produce a monodispersed particle challenge and distribution through a Laskin nozzle produces a polydispersed particle challenge.
FPM: Feet per minute describes velocity of air. FPM is always positive and always measured in one direction.
HEPA: High Efficiency Particulate Air filter – describes a filter that achieves a minimum of 99.97% efficiency on 0.3 micrometer particles or similar challenge.
HVAC&R: Heating, Ventilating, Air Conditioning and Refrigeration.
IAQ: indoor air quality describes the quality of air supplied to an interior space. The goal of IAQ is to provide air that is clean and healthy to building occupants.
In-situ: translated means "in position." This refers to measuring a filter installed in a system.
Life Cycle Costing (LCC): the investigation and valuation of the use of air filters.
Makeup Air: Air supplied to a space for the purpose of replacing exhausted air from a space.
MERV: Minimum Efficiency Reporting Value refers to the efficiency of a filter when tested in accordance with ANSI/ASHRAE Standard 52.2 2012.
NAFA®: Registered acronym for the National Air Filtration Association, the trade association for air filter manufacturers and distributors, worldwide.
OSHA: Occupational Safety and Health Administration, the group that is charged with enforcement of health and safety legislation.
PM 2.5: Particles less than 2.5 um (microns) in size. Excess levels of PM 2.5 have been shown to be damaging to human health.
PPM: Parts per million refers to the concentration of a substance within another substance. One ppm is equivalent to 1 milligram of something per liter of air (mg/l).
Pressure Drop: Describes the drop in static pressure of the air from the upstream side of a filter to the downstream side.
OA: Outdoor air.
SMACNA: Sheet Metal & Air Conditioning Contractors Association.

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