

NAFA[®]
**National Air
Filtration
Association**

Guidelines

Recommended Practices for
Filtration for Libraries, Archives and Museums



About this publication

Why NAFA Guidelines?

The National Air Filtration Association (NAFA) provides “Best Practice Guidelines” to help supplement existing information on the control and cleaning of air through proper filtration. Many organizations recommend “minimum” air cleaning levels. NAFA publishes best practice based on the experience and expertise of our membership along with information and research of the governmental, medical and scientific communities showing the short and long term impact particulate and molecular contaminants have on human health and productivity.

This Guideline provides 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. For a more complete explanation of principles and techniques found in this Guideline, go to the website www.nafahq.org and purchase the *NAFA Guide to Air Filtration*, 4th Edition.

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Disclaimer

The information contained in this Guideline is intended for reference purposes only. NAFA has used its best efforts to assure the accuracy of information and industry practice. NAFA encourages the user to work with a NAFA Certified Air Filter Specialist (CAFS), to assure that these Guidelines address specific user equipment and facility needs.

Issues regarding health information may be superseded by new developments in the field of industrial hygiene. Users are therefore advised to regard these recommendations as general guidelines and to determine whether new information is available.

NAFA does not guarantee, certify or assure the performance of any products (other than those bearing the NAFA Certified Product label), components, or systems operated in accordance with NAFA Guidelines.

NAFA®

**National Air Filtration Association
(NAFA)**

22 N. Carroll St, Ste 300

Madison, WI 53703

(608) 310-7542

nafahq.org

Committee members and contributors

- Committee Chair :*
Paula Levasseur, CAFS
Cameron Great Lakes, Inc.
- Joseph Benoit, CAFS**
Filtration Group, Inc.
- Joseph Brennan CAFS**
AFS - Dallas
- Stevan Brown, CAFS, NCT II**
TEX-AIR Filters/
Air Relief Technologies
- Carol Christensen, CAFS**
The Filter Man, Ltd.
- Bill Cawley, CAFS**
CLARCOR Air Filtration Products
- Kevin Delahunt, CAFS**
B.G.E. Service & Supply Ltd.
- Leonard Duello CAFS**
Ahlstrom Air Media
- Alisa Edmunds, CAFS**
Filtration Group, Inc.
- Dave Hurd, CAFS**
PlymoVent Canada Inc.
- Rupert Langston, CAFS**
Air Flow Technology, Inc.
- Phillip Masters, CAFS**
R. P. Fedder Corporation
- William Matkins**
Aeolus Corporation
- Phil Maybee, CAFS**
The Filter Man, Ltd.
- Bill Palmer**
AeroMed, Inc.
- Bill Patterson, CAFS**
Dave Downing & Associates
- Thomas Riddell, CAFS**
Air Filter Sales & Service

Table of Contents

Filtration for Libraries, Archives and Museums.....2

 Purpose.....2

 Scope.....2

 Background.....2

 NAFA Best Practices Recommendations.....3

 Recommended Limits.....4

Ventilation System.....5

Operation and Maintenance.....6

 Installation of Air Filtration Framing Systems.....6

 Installation of Filters.....6

 System Integrity.....6

 Maintenance.....6

 Monitoring of Airflow and Pressure Drop.....6

 Disposal6

 Summary.....7

Glossary.....8

Bibliography.....9

Footnotes.....9

Filtration for Libraries, Archives and Museums

Purpose

This best recommended practice establishes air filtration guidelines for the removal of particulate and gaseous contaminants for the protection and long-term preservation of historical documents and artifacts. The recommendations in this guideline are considered by NAFA to be “best practice” in contrast to “minimum standards” put forth by other organizations. They serve to provide the conscientious Facility Manager with the necessary guidelines to make measurable differences of air quality in his/her building.

Scope

This best recommended practice identifies air quality issues associated with libraries, archives and museums. It also establishes design criteria and performance specifications for new construction, as well as existing ventilation systems. This shall include methodology for contaminant removal by filtration and associated system maintenance.

Background

The owners and operators of libraries, archives and museums (LAM) are facing challenges for the preservation of the contents due to industrialization and urbanization, which are causing increased amounts of molecular and particulate contamination. Degradation of artifacts over the years has led to the recognition of the need to improve the quality and cleanliness of the indoor air environment in these type facilities.

Research has led to the development of new measuring techniques that allow for more specificity in filtration requirements. At the same time, technological advances have allowed for increased filtration efficiencies within existing HVAC system limitations. Utilization of these changing technologies allows for effective system upgrades.

The primary focus of this guideline is the removal of molecular and particulate contaminants known to be of concern in the degradation of articles stored within a facility. It must be noted that relative humidity and the number of air changes per hour also play an integral part in the overall performance of the HVAC system¹.

Molecular Contaminants

The primary contaminants of concern are sulfur dioxide, nitrogen dioxide and ozone. These contaminants are known to chemically attack artifacts, causing permanent, irreversible damage. The type of damage and severity depends upon the amount of contamination and the artifacts’ materials of construction. There may be other molecular contaminants present that are specific to individual applications and/or geographic locations that are not currently thought to be detrimental in LAMs. For example, in new construction, there could be levels of formaldehyde that would require additional controls.

Particulate Contaminants

There are two major concerns with particulate contaminants: non-viable and viable particles. Non-viable particles cause soiling of the artifact. Cleaning of many artifacts is not an option, as it can often result in damage. Viable particles, usually in the form of airborne fungal spores, bacteria, and molds can also deteriorate artifacts, especially if temperature and humidity are not maintained at proper levels. There is also the potential that molecular contaminants could attach to particulates as a transport mechanism². The size range of particles of concern is the “accumulation” size particulate defined as ranging from 0.1 to 2 microns³.

1. *American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) 1999 Handbook*, Chapter 20.

2. *The Museum Environment*; Second Edition, Garry Thomson CBE; Butterworth-Heinemann, Oxford, England, 1986.

3. Footnote # 296 Same as A, Ibid Kadowalki Size Distribution of Total Aerosols, 1976.

The table below shows possible preservation targets for most collections⁴.

Building Air Quality Control	In Rooms	Potential Preservation Target (Years)*			
		In Enclosures with Emissive Materials		In Enclosures without Emissive Materials	
		without sorbent	with sorbent**	without sorbent	with sorbent**
Natural ventilation or HVAC system with moderate-efficiency particle filter, no gas filter	1-10	<1	10-100	10-100	>100
HVAC system with gas and good-efficiency particle filters, building membranes that are good gas barriers, and basic control of visitor flow	10-100	<10	10-100	>100	>100
HVAC system with gas and high-efficiency particle filters.*** Building membranes that are good to very good gas barriers, and limited access.	>100	<10	10-100	>100	>100
Notes: * Adverse effects of water vapor and hypersensitive materials are excluded, e.G. Cellulose acetate, cellulose nitrate, certain dyes (such as alizarin crimson, turmeric yellow and basic fuchsin), lead, natural rubbers, silver, and polyurethane magnetic tapes. **Efficient sorbent (enclosures are assumed to have an air exchange rate of once per day). *** Assuming periodic replacement of the filters.					

NAFA Best Practice Recommendations

Pre-filtration should achieve a MERV 8 or higher, as tested in accordance with ASHRAE Standard 52.2-1999 at system rated airflow.

Molecular filtration should consist of a media bed(s) that is capable of reducing contaminants of concern to the levels listed below. Air flow through the molecular filter bed may vary with filter type, for proper reduction of molecular contaminants do not exceed manufacturer's maximum rated air flow. This media bed would consist of both an activated carbon media and a media capable of removing sulfur dioxide and formaldehyde. This can be accomplished in various ways, but most commonly with a potassium permanganate impregnated media or a specialty-treated carbon media.

4. Tetreault, J. 2003. *Airborne Pollutants in Museums, Galleries, and Archives: Risk Assessment, Control Strategies and Preservation Management*, Canadian Conservation Institute.

Recommended Limits⁵

It is important to note that there is no known level of molecular contamination that is considered “safe.” The recommendations below are based upon levels which can be achieved and measured and can operate within the constraints of the current HVAC system. While accurate measurements of these levels can be achieved with various types of gas monitors, in use measurement of pollutant levels in LAM’s is very seldom seen due to its expense and need for a skilled operator. The manufacturer of the molecular filtration system can often provide the information on monitoring if desired, and may also offer alternative methods for determining system performance. In the absence of a recognized test standard for molecular filters, determination of system performance may vary with the manufacturer. Consult your NAFA Certified Air Filter Specialist to determine the type of molecular filtration system suitable for your HVAC system.

Fine particulate filters should achieve a MERV 15 or higher, as tested in accordance with ASHRAE Standard 52.2-1999. Refer to NAFA 52.2 User’s Guide for further information.

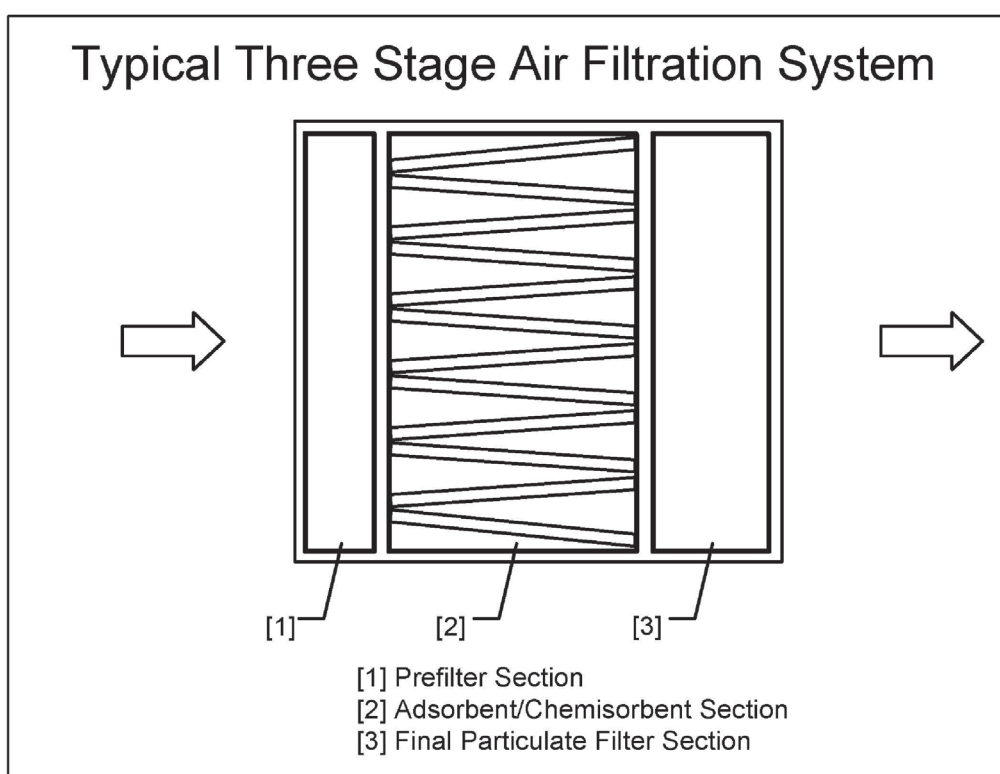
Contaminant	Recommended limits	Parts per billion
Nitrogen Dioxide	5 micrograms per cubic meter	2.6 ppb
Ozone	4 micrograms per cubic meter	2.0 ppb
Sulfur Dioxide	2.7 micrograms per cubic meter	1 ppb
Formaldehyde	5.0 micrograms per cubic meter	4 ppb

4. *Architectural and Design Standards for Presidential Libraries.*

Ventilation System

A properly designed LAM HVAC system consists of three stages of filtration. The first stage involves some form of pre-filtration, the second stage is molecular filtration and the third stage is high efficiency filtration. The purpose of the pre-filtration stage is two-fold: first, to remove large particulates thereby protecting the rest of the HVAC components and second, to protect the molecular filters from particulate contamination, which would reduce their effectiveness. The molecular filter is designed to reduce the level of chemical contaminants of concern. A high efficiency filter is used to remove those contaminants in the accumulation size range of 0.1 to 2 microns.

Proper installation of filters is critical to achieving the desired level of performance. Reference NAFA publication Installation, Operation and Maintenance of Air Filtration Systems for proper methods and component manufacturers' guidelines.



Operation and Maintenance

It is recommended that the manufacturer's guidelines be followed in all circumstances when retrofitting an existing system. What follows is a list of some of the more important factors to consider when operating and maintaining an HVAC system. As a supplement to manufacturers' guidelines, see NAFA Installation, Operation And Maintenance Of Air Filtration Systems manual.

Installation of Air Filtration Framing Systems

These systems may consist of built-up filter banks, side access housings, or modular tracks. While very few systems have HEPA filtration, those that do require specially designed framing systems. A qualified HVAC system designer should be consulted to specify the required number, arrangement, airflow and pressure drop requirements of the HEPA filters.

Installation of Filters

Refer to the manufacturer's instructions when installing filters into the HVAC system. An understanding of the entire HVAC system is helpful to ensure that the air filters are properly installed.

System Integrity

Start Up - Maintaining the HVAC system's integrity is vital to proper air filtration. After installation, the system, including filter frames, fastening devices and gaskets should be checked to insure that there are no leaks or gaps. A properly sealed system will prevent bypass and maintain system pressure.

Maintenance

A preventive maintenance program should be in place and should include inspection of filter frames, fastening devices, gaskets and ductwork. Removing and replacing damaged or defective gasketing and duct insulation will keep air from bypassing the filter banks. Keeping the coils and blower free from dirt and debris by regular cleaning will improve airflow, increase system efficiency and maintain overall integrity. In summary, good housekeeping will keep the HVAC system in proper working order and will provide the facility with air that is not only heated and cooled, but also clean with a reduction in contaminant levels.

Monitoring of Airflow and Pressure Drop

All filters increase the resistance to the flow of air in an HVAC system. This increase is called "pressure drop" because 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 can be measured with a pressure sensing device. All HVAC units should have a pressure-sensing device installed to accurately monitor the airflow and pressure drop across the filter bank. When a filter has reached its recommended final pressure drop, it should be replaced. Leaving a filter in place 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 medias when impregnated with sorbent could increase in pressure drop, however, it is not indicative of 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.

Disposal

Filters should be disposed of in accordance with all local, state and federal regulations. Spent carbon in molecular filters may sometimes be returned to the manufacturer for reactivation.

Summary

Molecular and particulate contaminants are the focus of this guideline. There are many contributing factors involved in the degree of filtration needed in these facilities; however, the recommendations provided are considered best practice.

In order to maintain the degree of filtration needed, an active maintenance program is essential. Problems arising from poor filter maintenance can create a degradation of artifacts in a short period of time.

Facility surroundings can change. New construction nearby or occupant changes in nearby existing buildings could affect the environmental air. As these changes occur, the HVAC system will need to be re-evaluated and possibly updated. Filter types and certain design parameters, including outside air requirements, may need some adjustments.

Glossary

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.

CAFS: Certified Air Filter Specialist accreditation granted by NAFA to those who pass an exam on air filtration.

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.

LAM: Libraries, Archives and Museums.

MERV: Minimum Efficiency Reporting Value refers to the lowest 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.

Nitrogen dioxide: NO₂

Non-viable: not capable of living,

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).

Sulfur dioxide: SO₂

Viable: capable of living, developing or germinating under favorable circumstances.

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Thomson, Garry CBE. *The Museum Environment*. Second Edition. Butterworth-Heinemann in association with The International Institute for Conservation of Historic and Artistic Works, 1986.

Installation, Operation and Maintenance of Air Filtration Systems. First Edition, National Air Filtration Association. 1997.

NAFA Guide to Air Filtration, 3rd Edition, National Air Filtration Association. 2001.

Architectural and Design Standards for Presidential Libraries. Part 3 Sec. 43.B., Sec 45.a.b.



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National Air Filtration Association
22 N. Carroll St, Ste 300, Madison, WI 53703
(608) 310-7542
nafahq.org