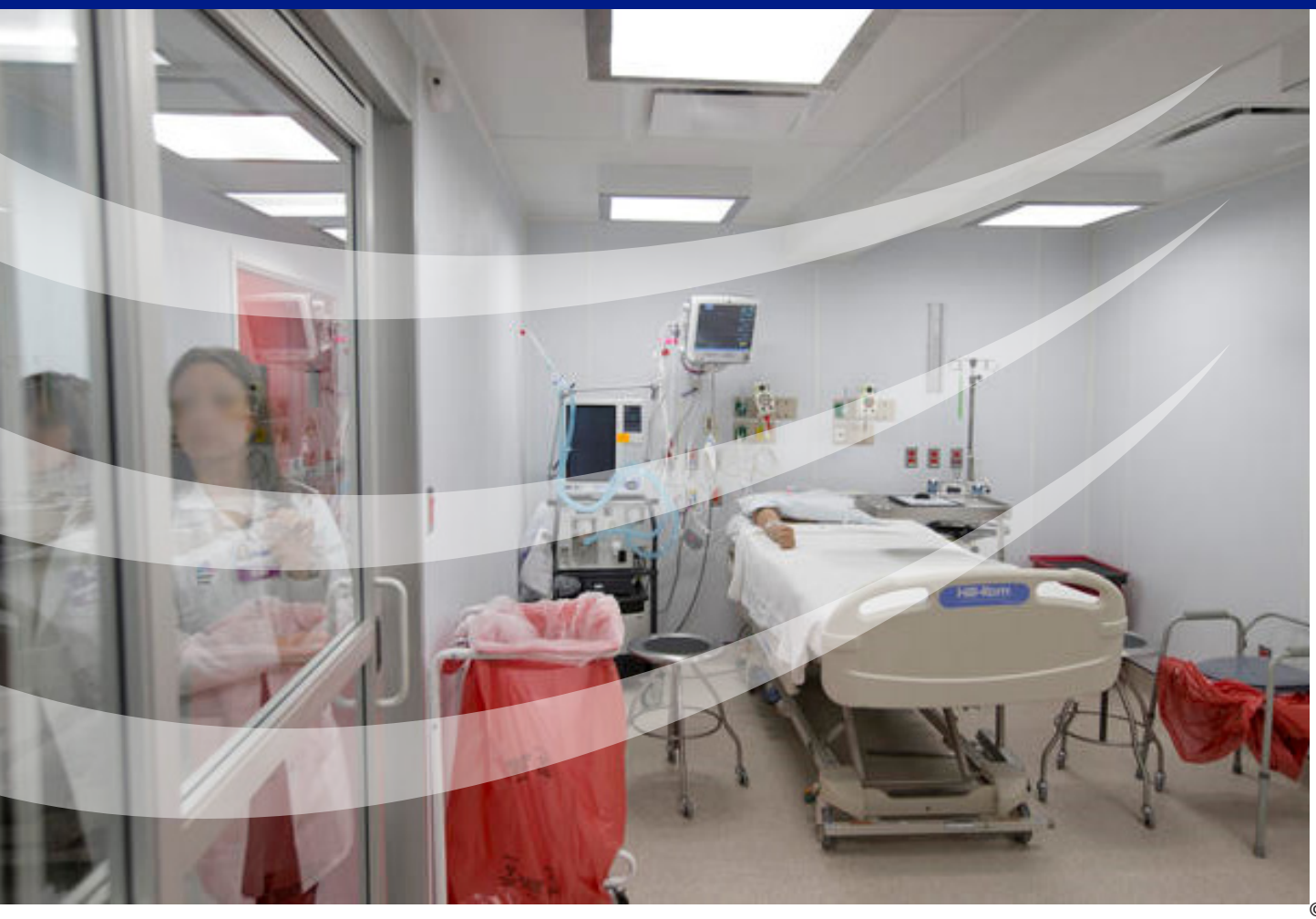
NAFA®
National Air
Filtration
Association

Guidelines

Recommended Practices for Filtration for Airborne Infections Containment Rooms in Health Care Facilities



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*, 5th Edition.

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Issues regarding health information may be superseded by new developments in the field of industrial hygiene.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.

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Filtration for Airborne Infections Containment Rooms in Health Care Facilities

Purpose

This best practice guideline establishes criteria for using air filtration in the removal of airborne infectious pathogens from hospital containment rooms for the purpose of protecting staff, patients and visitors from nosocomial infections.

Scope

This guideline will address air filter selection, hardware requirements, filter installation and service recommendations.

Background

The airborne spread of infectious diseases such as M. tuberculosis in health care facilities has been well documented. One of the primary control measures employed to reduce the risk for the spread of airborne infections is the use of negative pressure rooms and areas[1]. There are several areas within a hospital where this is applied. They include:

- Bronchoscopy rooms
- Sputum induction rooms
- Pentamidine administration areas
- Emergency room (ER) waiting areas
- Triage areas
- ER decontamination areas
- Radiology waiting rooms
- Airborne infection isolation rooms (AIIR)
- AIIR anterooms
- AIIR patient toilet rooms

Since these rooms all have very similar requirements, we will refer to them by group as Airborne Infection Containment Rooms (AICR). AICRs are maintained under negative pressure for the purpose of preventing potentially infectious airborne particles from leaving the space. Air removed from these spaces to create negative pressure is either exhausted directly to the outside or is filtered prior to exhaust so that airborne infectious contaminants are not spread to other areas of the facility.

Current construction guidelines call for AICRs to have from 10-12 air changes per hour (ACH) depending on the classification of the room. (Existing rooms constructed prior to 1994 may have 6 ACH).

Filtration of supply air is not covered by this document.

Recirculation air

Air may be recirculated within the AICR, within an isolation ward or back to the general use areas within the facility if proper high efficiency particulate respirator (HEPA) filters and test procedures are in place. The main benefits of recirculated air are lower energy costs and reduced installation costs. Recirculation of AICR air through a HEPA filter may be achieved with either a permanently mounted system or by using a portable self-contained unit.

[1] CDC 2005 TB guidelines

In-room recirculation
AICR rooms are required to have 10-12 air changes per hour (ACH) of which two ACH must be outdoor air. The remaining ACH may be achieved as equivalent air changes by using make-up air recirculated within the room through a HEPA filter.

Circulation within ward or to other areas within the facility
Air may be recirculated to other areas of the facility when exhaust to the outside is not feasible. When recirculating to other areas of the facility, all air must be passed through a HEPA filter that is properly installed, sealed and tested in place.

Note
HEPA filters should always be in-place tested using a cold poly-dispersed challenge, such as Emory Oil or other suitable challenge, and scanned using a light-scattering photometer. Both NAFA and the Controlled Environment Testing Association (CETA) have personnel trained and certified in this discipline and should be utilized for such testing.

Exhaust air
Dedicated exhaust air from an AICR must be exhausted 25 feet or more from a potential air intake. If this cannot be achieved, the exhaust air should be passed through a properly installed, certified and maintained HEPA filtration system.

Additional protection may be obtained for service personnel by using a Bag-in / Bag-out (BiBo) containment system.

All exhaust air from the AICR rooms, associated anterooms and associated toilet rooms shall not be combined with any other non-AICR exhaust system unless filtered through a properly installed, tested in place and maintained HEPA filtration system.

Bag-in / Bag-out (BiBo) containment systems
There is currently on-going debate regarding the validity of the continued practice of using BiBo containment systems for hospital isolation rooms.

BiBo systems have long been used to reduce the possibility of live microorganisms captured on high efficiency filters from becoming airborne during filter changes. The inherent risks associated with contaminated filters, mandates that service personnel who change filters in a BiBo system be properly gowned and safe-guarded with full-face respiratory protection (PPE). The process to change filters is a specific step-by-step procedure designed to ensure the proper installation of high efficiency filters and the protection of service personnel.

Protection for service personnel

Do microorganisms live on high efficiency filters?
It may be argued that microorganisms such as TB that were previously thought to live on filters for days, are quickly rendered inactive.

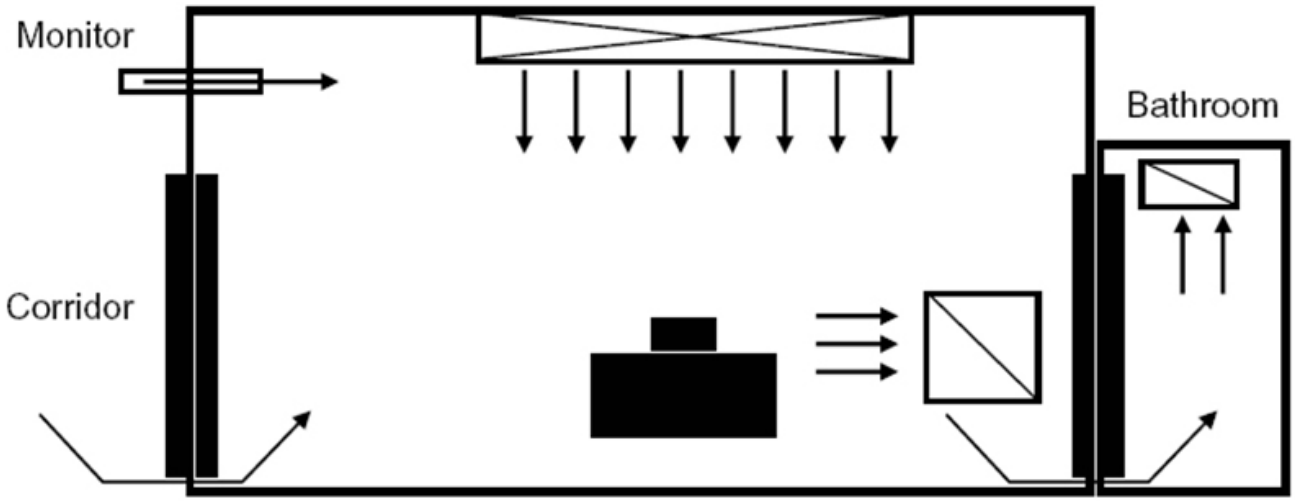
Should they no longer be considered hazardous?
While it has been stated by researchers that the risk of acquiring TB infection from the process of changing HEPA filters is minimal, the potential harm could be significant.

It is recommended that safety measures be taken to protect the technician when changing HEPA filters that service an AICR. One method is to remove HEPA filters from an air handler or air purifier directly into a bag while wearing appropriate PPE such as gloves and a respirator. Another method is to use BiBo filter housings which, when properly serviced, seal filters during the change-out procedure. If upstream and downstream isolation dampers are in place, a third method is to decontaminate or disinfect the filter in place using proven and accepted methods. To date, there is little evidence to support that one method provides a better health or safety outcome than the other in this setting.

When planning for new construction or renovations, a health care facility's Infection Control Risk Assessment (ICRA) committee should discuss and determine what safety measures they want to employ during the filter change-out process and plan their equipment purchases accordingly. For further guidance on employee health during the filter change-out process, contact your NAFA Certified Air Filter Specialist.

At the minimum, 95% dust masks should be worn when changing high efficiency filters. When changing HEPA filters, technicians should always wear full-face respiratory protection (PPE).

Standard AICR



Standard AIIR without ante-room: Stacked black boxes represent patient's bed. Long open box with cross-hatch represents supply air. Open boxes with single, diagonal slashes represent air exhaust registers. Arrows indicate direction of air flow. Illustration from Guidelines for Environmental Infection Control in Health-Care Facilities, Centers for Disease Control, 2003.

Negative pressure is achieved by exhausting more air from the room than is supplied. This creates a flow of air into the room that is from clean to dirty (or from low risk of contamination to high risk of contamination). This directional airflow helps prevent potentially pathogenic airborne particles from leaving the space in an unsafe manner.

An AICR may or may not include an anteroom and/or a patient bathroom. Please refer to Facility Guidelines Institute (FGI) 2014 construction guidelines for health care facilities for the correct pressure relationships between these and other spaces.

Filter efficiency and selection

Since the number of particles required to cause infection for pathogens such as M. tuberculosis may be as low as one[2], it is imperative that filtration solutions employed be capable of removing all potentially infectious particulates. Choosing the wrong filtration solution, the wrong hardware for filter installation or servicing the filters in an inappropriate manner may lead to dire consequences.

HEPA filters have a removal efficiency >99.97% on particles both greater than and less than the 0.3um challenge agent particle size (see most-penetrating particle size information in NAFA Guide to Air Filtration[3]), making them ideal for removing particles in the respirable particle size range. When filters are properly installed, and in-place performance tested, users can be assured that there is no air by-pass around the filters and that removal efficiency is maintained.

[2] Jacobs, A.L., Infective Dose in Pulmonary Tuberculosis, Tubercle 22(11):266-271, 1941.
[3] NAFA Guide to Air Filtration 5th edition, chapter 5, page 5.5

HEPA filters used for this application shall be individually certified to have an initial removal efficiency of 99.97% on particles 0.3 um in size, in accordance with industry standards (MIL Std 282, IEST-RP-CC1.4). See NAFA Guide to Air Filtration for a complete list of industry standards[4].

HEPA filters used in AICR applications shall not be constructed with materials that support microbial growth (i.e., wood or particle board frames).

In an effort to minimize the expense related to the use of HEPA filters, use of pre-filters upstream to remove larger particles will extend the life of the HEPA filter. When possible, adding a MERV 14 (>90% efficient) filter upstream of the HEPA filter may extend the life of the HEPA filter by as much as 900%[5].

Filter hardware

Every part of a HEPA filter system is equally important. Without an appropriate sealing mechanism and a properly contained housing which eliminates bypass, the integrity of the HEPA filter will be compromised. This means that:

- The filter-mounting system must be leak free, rigid and capable of supporting the HEPA filter(s).
- The sealing system that holds the HEPA filter in place must eliminate any possibility of leakage between the filter and the mounting system.

Sealing of HEPA filters

Typically, HEPA filter housings are made to accommodate one of two different types of HEPA sealing mechanisms, gasket seal or fluid seal.

Gasket seals

Gaskets are supplied on the HEPA filters, this provides the advantage of having a new gasket every time the filter is changed. The HEPA filter housing provides a mechanism that will compress the HEPA gasket so that it provides an air-tight seal.

Fluid seals

The fluid seal system is a filter with a channel in the face of the filter frame into which a non-Newtonian gel is loaded. When the filter is installed fully, the knife edge extends into the gel and provides a fluid seal. Fasteners are used to hold the filter in place inside the holding frame, but they do not require compression.

Please refer to the NAFA Guide to Air Filtration for more detailed information on both gasket and fluid seal HEPA filters.

A differential pressure monitoring device should be installed across each filter bank so that proper change out intervals can established.

[4] NAFA Guide to Air Filtration, 5th edition, chapter 8, page 8.5

[5] American Conference of Governmental Industrial Hygienists. Industrial ventilation: a manual of recommended practice. 24 ed. Cincinnati, OH: American Conference of Governmental Industrial Hygienists; 2001.

Filter location

Air that is exhausted from an AICR should be treated as contaminated air. HEPA filters should be installed as close to the point of exhaust as is possible.

When designing or installing filter housings, it is imperative to ensure that there are no barriers to service access doors (electrical conduit, piping, duct work, etc.) and that ample room for filter maintenance, preferably the largest filter dimension + 12", is available.

Installation and maintenance of AICR filtration systems

Proper installation, service and maintenance are imperative in order for these systems to perform at desired levels. HEPA filters may easily be damaged in shipment and when handled. To ensure proper performance of the filtration system the following points are considered best practices:

Personnel performing this work should be completely trained by a National Air Filtration Association member to be NCT level I certified.

All HEPA filters used in an AICR system shall be leak tested in place upon installation, and every 12 months thereafter (reference ISO 14644-1). We also recommend testing the HEPA filters when there is any change or variation in HEPA filtration system that could potentially cause an issue with the HEPA filters, seals or other hardware.

Additional consideration may be given to selecting HEPA filters with a perforated grille to protect the filter face from damage from shipping or handling.

Personal protection for filter installation and maintenance

NAFA recommends that you follow the CDC recommendations below when installing, testing or servicing any HEPA filter:

Laboratory studies indicate that re-aerosolization of viable mycobacterium from filter material (HEPA filters and N95 disposable respirator filter media) is not probable under normal conditions. Although these studies indicate that M. tuberculosis becoming an airborne hazard is not probable after it is removed by a HEPA filter (or other high efficiency filter material), the risks associated with handling loaded HEPA filters in ventilation systems under field-use conditions have not been evaluated. Therefore, persons performing maintenance and replacing filters on any ventilation system that is probably contaminated with M. tuberculosis should wear a respirator in addition to eye protection and gloves[6].

Filter disposal

Disposal of filters and other potentially contaminated items used in the filter change-out process should be done according to all local, state and federal regulations.

Summary

This best practice guideline is provided to give direction for using air filtration for the removal of airborne infectious pathogens in hospital AICRs. This is not meant to be an in-depth guideline on AICR applications. For more detailed information on additional aspects of these applications, please refer to the FGI Guidelines for Design and Construction of Health Care Facilities (2014 edition) or the CDC Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health-Care Settings (2005).

[6] CDC 2005 TB Guidelines

Glossary

Air change rate : Ratio of the airflow to the space volume per unit time, usually expressed in air changes per hour (ACH).

Air changes per hour (ACH): Air change rate expressed as the number of air exchange units per hour.

Airborne Infection Isolation (AII) precautions: The isolation of patients infected with organisms spread through airborne droplet nuclei 1–5 μm in diameter. This isolation area receives substantial ACH (>12 ACH for construction since 2001 and >6 ACH for construction before 2001) and is under negative pressure (i.e., the direction of the air flow is from the outside adjacent space [e.g., the corridor] into the room). The air in an AII room is preferably exhausted to the outside, but can be recirculated if the return air is filtered through a high efficiency particulate respirator (HEPA) filter.

Airborne infection isolation room (AIIR): The isolation of patients infected with organisms spread. A room designed to maintain airborne infection isolation. Formerly called negative pressure isolation room, an AIIR is a single-occupancy patient-care room used to isolate persons with suspected or confirmed infectious TB disease. Environmental factors are controlled in AIIR to minimize the transmission of infectious agents that are usually spread from person-to-person by droplet nuclei associated with coughing or aerosolization of contaminated fluids. AIIR should provide negative pressure in the room (so that air flows under the door gap into the room), an air flow rate of 6–12 ACH, and direct exhaust of air from the room to the outside of the building or recirculation of air through a HEPA filter.

Negative Pressure: This refers to the difference in air pressure between two areas. A room that is under negative pressure has a lower pressure than adjacent areas, which keeps air from flowing out of the room and into adjacent rooms or areas.

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.

Nosocomial: Acquired in a hospital.

Pathogen: A bacterium, virus, or other microorganism that can cause disease.

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American Conference of Governmental Industrial Hygienists. Industrial Ventilation: a manual of recommended practice. 24 ed., American Conference of Governmental Industrial Hygienists; Cincinnati, OH: 2001.

Infective Dose in Pulmonary Tuberculosis, Tubercle, Jacobs, A.L., 1941.

NAFA Guide to Air Filtration, 5th edition, 2014

TB guidelines, CDC 2005

The source for expertise, education and standards in air filtration.

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