



viledon[®]

AIR FILTRATION IN HOSPITAL APPLICATIONS

FREUDENBERG
FILTRATION TECHNOLOGIES

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INTRODUCTION: HOW TO USE THIS GUIDE

This guide is meant to be used as a reference tool. It contains a brief description of Viledon products and how they perform against common, environmental contaminants found in a hospital. The guide also summarizes key sections of pertinent building codes, their filtration requirements, and other factors which should be considered when choosing air filters for a hospital.



THE ROLE OF AIR FILTERS IN A HOSPITAL

Modern hygienic concerns have given air filters a new and expanded role in hospital applications. The purpose of today's hospital air filtration is to provide patients, staff, and visitors with a high degree of protection from airborne microorganisms that can cause infection, disease, and even death. Air filters perform this function by:

- Arresting non-pathogenic particulate from the air, thereby removing a transport mechanism for bacteria;
- Preventing microorganisms from entering the hospital;
- Protecting the occupants from recirculated air that has been contaminated by microorganisms which may have grown in the hospital or entered through unfiltered openings.

All possible precautions should be taken to prevent hospital acquired (nosocomial) infections. Aside from the dangerous consequences of nosocomial infections, there are enormous costs associated with treating this serious problem. In 2005, the Centers for Disease Control (CDC) estimated that nosocomial infections afflicted more than 2 million patients annually at a cost of over \$5 billion, and kill approximately **90,000 people** annually.¹ The United States has roughly 5 million people that work in over 7,000 hospitals. Hospitals with a high level of resources and a strong commitment to infection control can help eliminate more of these staggering statistics.

With the increase of anti-biotic resistant strains of bacteria like *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE), *Mycobacterium tuberculosis* (XTB), *Clostridium difficile* (C. diff.), and many others, it's imperative that today's health care institutions institute strong,

hygienic, housekeeping techniques. The lack of commitment of strong house keeping and staff education is eroding profitability of these institutions while putting more people at risk, whether hospital staff personnel, patients, or visitors. Hospital infections add more than \$30.5 billion annually to the nation's health tab in hospital costs alone.² The tab will only increase rapidly, as more infections become drug resistant.³

With the advent of anti-biotic strains of bacteria, avian flu, and bio-terrorism on the horizon, it's imperative that hospitals begin to implement strong, hygienic, housekeeping techniques, well coordinated and managed filtration and equipment maintenance programs, and use UVGI (Ultraviolet Germicidal Irradiation) to augment filtration and hygienic cleaning. UVGI is an effective tool for surface treatments in areas of the hospital when not in use by staff, patients, or visitors. Commitment by a hospital to inject a large level of resources, education for staff members, and a dedication to infection control, will significantly reduce the incidence of nosocomial infections in hospitals in hospital environments.

Thorough inspections and maintenance of operating suites and adjoining rooms should be monitored to insure that the system is working within specification. Infiltration of particles listed in (Figure 1) from adjoining rooms may cause additional nosocomial infections and cause the ventilation system to become unbalanced.

In this age of escalating health care costs and tightening budgets, the use of and maintenance of high quality filters should be actively pursued because of their potential for providing significant, long term cost reductions and improved health care not only to employees, but to patients and visitors alike.

¹ Centers for Disease Control and Prevention (CDC). Prevent antimicrobial resistance in healthcare settings: <http://www.cdc.gov/drugresistance/healthcare/problem.htm> , Accessed April 8, 2005

² Centers for Disease Control and Prevention. Four pediatric deaths from community-acquired methicillin-resistant *Staphylococcus aureus*: Minnesota and North Dakota, 1997-1999. *MMWR* 1999;48:707-710

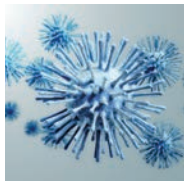
³ Layton MC, Hierholzer WJ, Patterson. The evolving epidemiology of methicillin-resistant *Staphylococcus aureus* at a university hospital. *Infect Control Hosp Epidemiol* 1995; 16:12-17.

WHAT ARE TYPICAL CONTAMINANTS IN A HOSPITAL?



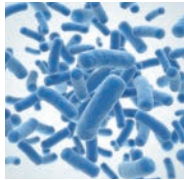
DUST 1-10,000 μm

Common atmospheric dust is comprised of soil particles, combustion soot, and organic debris. Normally, it is not pathogenic in the levels found in hospitals. However, dust particles can act as carriers and sources of nutrition for microorganisms.



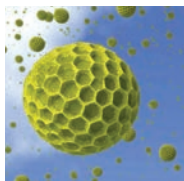
VIRUSES .002 TO .3 μm

Viruses are much too small ($<0.1\mu\text{m}$) to be effectively removed by existing air filter technology. Even H.E.P.A. filters are incapable of solving this persistent problem for hospitals.



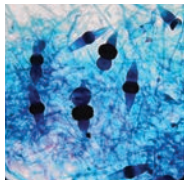
BACTERIA .5-20 μm

Although an operating room or laboratory may appear to be clean, the number of bacteria in the air depends on various factors. In general, the concentration of airborne bacteria in any room, hall or office is a balance between the rate of bacteria release by occupants and the rate of removal by the ventilation system. In recirculating systems, filters must remove these bacteria before they reenter the hospital. Table 1 contains a list of common bacteria and their sizes, the diseases or infections they can cause, and the initial efficiencies of selected Viledon® Filters.



POLLEN GRAIN 10-1,000 μm

Pollen grains are one of the reproductive cells of plants. Pollen grains are not pathogenic but can cause allergic rhinitis (allergic reactions such as sinus inflammation, eye irritation, etc.) and asthma. Pollen grains are relatively easy to remove as they are usually much larger than $15\mu\text{m}$ in diameter. High quality filtration media will immediately capture all pollen grains.



FUNGAL SPORES 10-30 μm

Fungi include many hundreds of different organisms that help plants decay, most of which can be allergens. A few can cause serious infection and death. Fungi are a serious concern as they produce classifications: yeasts & molds.

- Yeasts remain spherical during reproduction and form colonies of round cells.
- Molds reproduce into what is called mycelium. The mycelium is what people normally see when food goes bad, i.e., gray fuzzy clumps.

⁴ Lide, David R. "Characteristics of Particles and Particle Dispersoids." *Handbook of Chemistry and Physics, 75th Edition*. Florida: CRC Press, 1994.





COMMON BACTERIA AND FUNGI

**SIZES, SHAPES
& FILTRATION
EFFICIENCIES**



NAME	DISEASE / INFECTION CAUSED
<i>Klebsiella pneumoniae</i>	Accounts for 30% of all gram negative nosocomial pneumonias
<i>Legionella pneumophila</i>	Causes legionnaire's disease and Pontiac Fever
<i>Mycobacterium tuberculosis</i>	Cause of human tuberculosis
<i>Nocardia asteroides</i>	Grows in soil, causes serious lung infections especially in people with debilitating disorders
<i>Pseudomonas aeruginosa</i>	Most common cause of lower respiratory tract infections, can cause burn infections
<i>Staphylococcus aureus</i>	Carried by 30% of the population, causes wound infections, and abscesses
<i>Staphylococcus epidermidis</i>	Carried by most of the population, causes infections of the heart valves
<i>Streptococcus</i> genus	Carried by 5-60% of population depending on the season, causes bacterial pneumonia, ear infections and meningitis
<i>Aspergillus fumigatus</i>	Pulmonary infections and death in immunocompromised patients
<i>Candida albicans</i>	Causes thrush, moniliasis and pulmonary infections
<i>Penicillium</i>	Causes pulmonary infections and death
<i>Sporothrix schenckii</i>	Causes sporotrichosis, causes lesions, nodules and abscesses in the lungs

The values shown for the initial particle size efficiencies of different Viledon products on individual bacteria and fungal spores were calculated. The particle size used to determine the collection efficiencies was obtained directly for spherical or oval shapes by using the smaller of the diameter ranges shown. For rod shapes, the diameter of an equivalent volume sphere was calculated using the smallest dimensions shown.

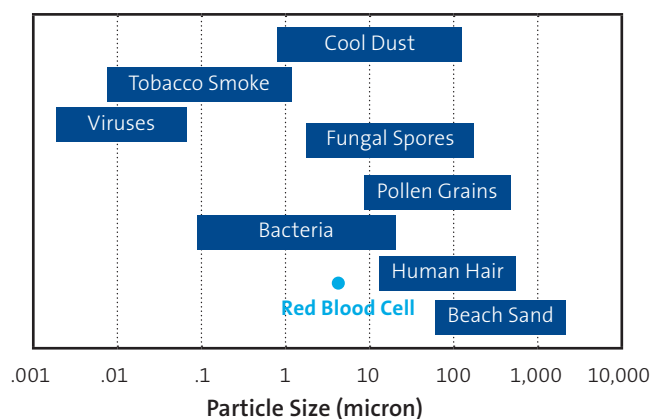
⁵ Bergey's Manual of Systematic Bacteriology, Volumes 1 - 4. Williams & Wilkins, Baltimore MD, 1984

SHAPE & SIZE ⁵ (μm)	INITIAL EFFICIENCY* (%)				
	MINI 75 2"	MF 70	MF 90	MF 95	MV 95
rod 0.3–1 x 0.6–6	>48	>75	>74	>96	>96
rod 0.3–0.9 x 2–20	>61	>80	>89	>98	>98
rod 0.3–0.6 x 1–4	>48	>76	>81	>97	>97
oval 0.5–1.2	>48	>76	>81	>97	>97
rod 0.5–1 x 1.5–5	>72	>83	>93	>99	>99
spherical 0.5–1	>48	>76	>81	>97	>97
spherical 0.5–1.5	>48	>76	>81	>97	>97
oval or spherical 0.5–1.25	>48	>76	>81	>97	>97
spherical 2–5	>92	>95	>98	>99	>99
spherical 3–5	>94	>97	>99	>99	>99
spherical 2–5	>92	>95	>98	>99	>99
spherical 2	>92	>95	>98	>99	>99

ENVIRONMENTAL AEROSOLS AT A GLANCE

This chart provides a comparison of the size ranges of some common environmental contaminants. As an example, fungal spores can range in size from two to two hundred μm . Most are smaller than the width of a human hair.

Initial pressure drop curves





CHOOSING THE CORRECT FILTERS FOR A HOSPITAL

WHAT DO THE BUILDING CODES SAY?

Any renovation, new construction, or maintenance project at a hospital requires adherence to prevailing state and local building codes. Except for states which either write their own or have no state-wide code (municipal jurisdiction only), the majority of building codes are modeled after one or more of the following:

- International Code Council (ICC) 500 New Jersey Avenue, NW, 6th Floor, Washington, DC 20001–2070
- The ICBO & IAPMO (International Conference of Building Officials & International Association of Plumbing and Mechanical Officials) Uniform Mechanical Code™
- ASHRAE/ASHE Standard 170, Ventilation of Health Care Facilities 2008

These documents are meant to be basic mechanical codes. As such, they contain information on many different subjects. However, all lack sufficient information on the filtration requirements for hospitals. To find additional requirements, federal and state regulations must be consulted, and usually, they refer to one of several documents:

- American Institute of Architects (A.I.A.) 1735 New York Ave., NW Washington, DC 20006-5292
- ASHRAE Handbook-Applications, Chapter 7, Health Facilities
- Guidelines for the Construction and Equipment of Hospitals and Medical Facilities 2006
- JCAHO, Joint Commission, One Renaissance Boulevard, Oakbrook Terrace, IL 60181 (<http://www.jcaho.org>) – Standards of Best Practice for health Industry

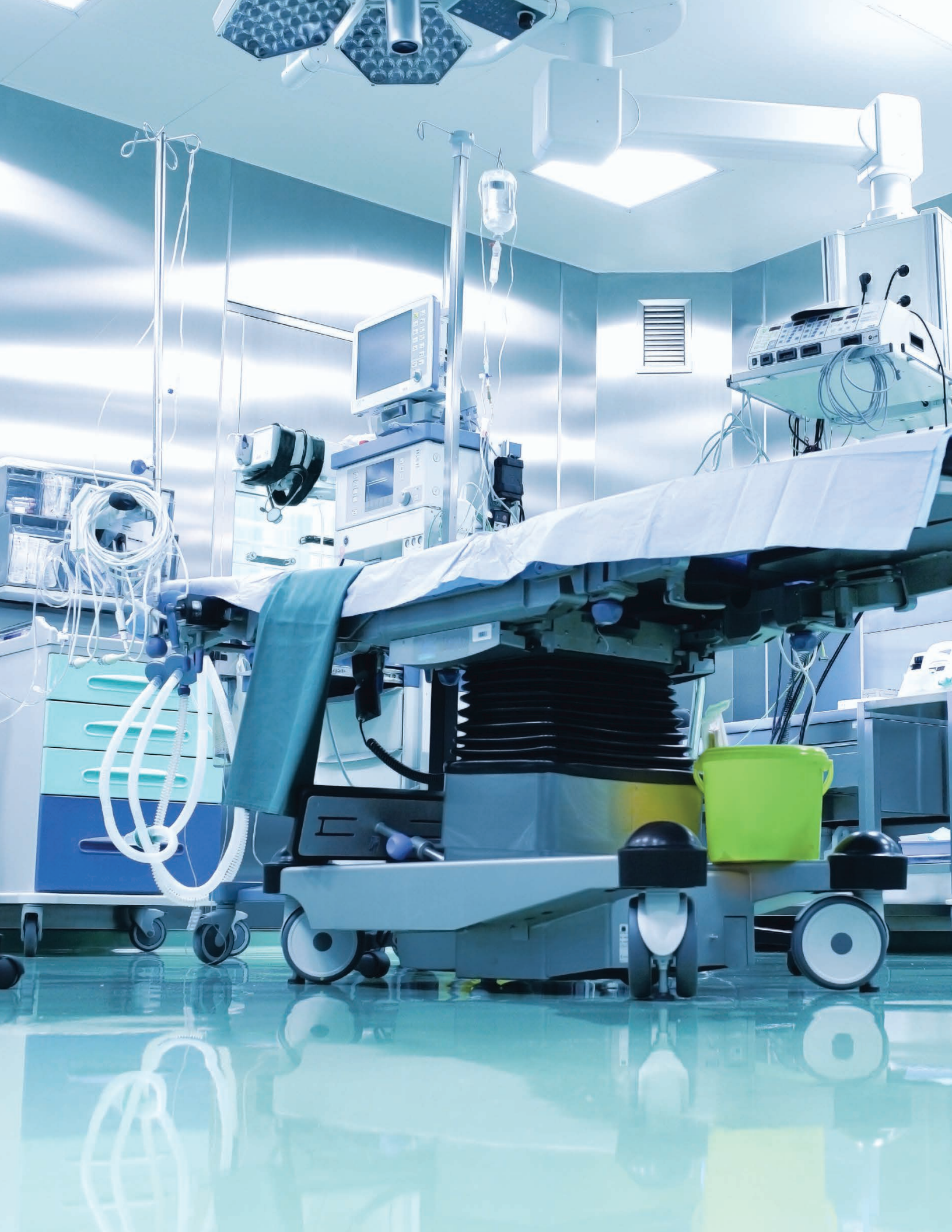
A summary of the filtration and ventilation requirements provided by these documents is provided in tables on the next several pages. While both publications provide more information than any of the mechanical codes, the information is still not sufficient. As you can see on the next several pages, the filtration requirements are based solely on the ASHRAE Standard 52.2, Minimum Efficiency Reporting Value (M.E.R.V.)

UNDERSTANDING THE A.S.H.R.A.E. 52.2-2012 RATINGS

A.S.H.R.A.E. Standard 52.2-2012 (“Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size”) has been updated and replaces ASHRAE Standard 52.1 to address some of the major deficiencies in the old standard, which didn’t provide a very good guide for selecting filters for particular size contaminants. The selection of filters should be based upon the following two things: one, selection of a filter to the particle contaminant you wish to arrest by particle size (microns); and two, defines the minimum particle collection efficiency value measured in microns (μm) before dust loading, which is called the MERV minimum efficiency reported value. For today’s hospital environment, ASHRAE 52.2 allows hospital engineers to choose products based on particle size efficiency.

PERFORMANCE TESTING PARAMETERS OF STANDARD 52.2-2012

1. Test the ability of a filter to remove particulate from the airstream measured in microns (μm)
2. The data provided reports the lowest capture efficiency
3. Resistance to airflow
4. Arrestance values for MERV rated filters 1 - 4 (Addendum B)
5. Dust holding capacity for MERV rated filters 5-16
6. Appendix J – voluntary filter conditioning step on electrostatic filters using 30 grams of KCl (potassiumchloride) to neutralize the charge. The test will indicate two (2) ratings, standard MERV rating and MERV-A test results after the treatment with KCl.





IMPORTANT CHARACTERISTICS FOR FILTERS IN HOSPITAL APPLICATIONS

AS EXPLAINED ON THE PREVIOUS PAGE, USING THE ASHRAE RATING ALONE WHEN CHOOSING A FILTER CAN HAVE UNDESIRE CONSEQUENCES. ASIDE FROM THE MINIMUM EFFICIENCY REQUIREMENTS DICTATED BY THE BUILDING CODES, FILTERS INSTALLED IN A HOSPITAL SHOULD HAVE THE FOLLOWING ADDITIONAL CHARACTERISTICS:

- 1. Filter Efficiency** — Pre-filters should capture and retain >90% of 8µm size particles and final filters should capture and retain a minimum of >95%⁶ of 1µm size particles immediately upon installation. JCAHO and AIA state that these are minimum efficiencies recommended for hospitals and more importantly that the most efficient filter the system can handle should be used when possible. (MERV 15&16)
- 2. Non-Shedding Media** — A filter should not add fibers or binders to the airstream. Respirable fibers can be dangerous and can transport bacteria.
- 3. High Particle Retention** — Once particulate is captured, it should not be released back into the airstream.
- 4. Moisture Resistant Materials** — Air filters are subject to constant wetting and drying cycles during their lifetimes. While low levels of moisture do not usually present many problems, high levels of moisture can have the following undesired effects on filters:
 - a. the pressure drop will increase and the efficiency will decrease
 - b. the fibers will mat with air/wet-laid microfiberglass
 - c. the weight of the filter media will increase
 - d. the binders may start to dissolve
 - e. the moisture will promote the growth of fungi
 - f. metal parts may start to corrode
- 5. High Degree of Structural Integrity** — A filter should not develop holes, rips, or blowouts of mini pleated extended surface filter (often due to moisture) that allow unfiltered air, bacteria laden particulate, fungal spores and other airborne pathogens to proceed downstream. This is especially critical in recirculating systems.
- 6. Retain Particulate During Change outs** — A filter that releases most of the captured particulate back into the supply plenum during change out is of little use. Such procedures can add unseen costs to the filters and can endanger maintenance personnel, other staff members, visitors, and patients.
- 7. Filter Media Should Be Safe to Handle** — No special handling or maintenance procedures should be required to install or service filters. Such procedures can add unseen costs to the filters and can endanger maintenance personnel, other hospital staff members, visitors and patients, file and read MSDS Sheets.
- 8. Microbial Resistant Media** — Media should be manufactured free from any media binder systems used to chemically bond or fuse the fibers together; binders typically promote microbial growth as they are a source for food.
- 9. GreenGuard® Certified** — All products used in air-handler systems should be certified by Greenguard to insure that harmful V.O.C.'s are not emitted from the product, eliminating any VOC's from traveling downstream of the filters.
- 10. Long Service Life** — Fewer changeouts and less frequent maintenance checks mean less chance of contamination and better use of manpower.
- 11. Low Energy Requirements** — Filters with high efficiencies and low pressure drops use less energy to operate, resulting in significant energy savings.
- 12. Exhausting Pathogens** — Filters should be used to eliminate the spread of pathogens from being exhausted to the outside, protecting the outside environment and workers that may be on the roof.

While any filter subjected to excess moisture will show some negative effects, care should be taken to choose filters that have been engineered to minimize these effects.

⁶ Joint Commission, A Guide to Managing Indoor Air Quality in Healthcare Organization, "Critical Quality Target", page 12

MINIMUM FILTRATION AND VENTILATION REQUIREMENTS

The following tables provide detailed information on the minimum filtration and ventilation requirements that selected areas of the hospital should meet. However, there may be areas in your particular hospital that do not appear in these tables. For these areas, a location with a similar function should be used as a guideline. It should be noted that the information contained in these tables are a summary of the requirements listed in the back of this guide, and individual requirements from city to city and state to state may vary. To simplify the tables that follow, the classification system to the right was developed to recommend particular Viledon products for those applications.

FILTER CATEGORY	VILEDON PRODUCTS	ASHRAE 52.2 MERV RATING
A	R-1/ES3 MINI-RF MP30	4–7
B	F45S F 50 GF55	8–9
C	T 60 GF 65 WinAir 75 MINI 75 MVP 75 MV 75 MF70	10–13
D	MF90 WinAir 95 MINI 95 MVP 95 DP 95 MX 95	14–15
E	MV95 MF 95 MX 98 MX100	>16

AREA DESIGNATION	MINIMUM CHANGES OF OUTDOOR AIR PER HOUR	MINIMUM TOTAL AIR CHANGES PER HOUR	ALL AIR EXHAUSTED TO OUTDOORS	RELATIVE HUMIDITY & TEMPERATURE (% AND °F)	MERV FILTRATION EFFICIENCY*** REQUIRED BY CODE		VILEDON PRODUCTS RECOMMENDED	
					PRE-FILTER	FINAL	PRE-FILTER	FINAL
SURGERY AND CRITICAL CARE AREAS								
Operating/Surgical (BC) Cytoscopic Rooms	4	20	NS	30-60 & 62-80	8	14	B	D or E
	4	20	NS	30-60 & 68-73	8	14	B	D or E
Delivery Room	4	20	NS	30-60 & 68-73	8	14	B	D or E
Recovery Room	2	6	NS	30-60 & 75±2	8	14	B	D or E
Critical and Intensive Care	2	6	NS	30-60 & 70-75	8	14	B	D or E
Treatment Room	NS	6	NS	30-60 & 70-75	8	14	B	D or E
Trauma Room	5	12	NS	30-60 & 70-75	8	14	B	D or E
Emergency Waiting Rooms	2	12	Yes	30-60 & 70-75	8	14	B	D or E
Surgical Areas for Immunocompromised Patients	3	15	Yes	50-60 & 70-75	8	17b*	B	D or E*
PATIENT CARE AND NURSING								
Patient Room	2	6	NS	30 (W), 50 (S)	8	14	B	D or E
Patient Corridor	2	2/4	NS	NS & NS	8	14	B	D or E
Toilet Room	Optional	10	Yes	NS & NS	8	14	B	D or E
Newborn Nursery Suite	2	6	NS	30-60 & 72-78	8	14	B	D or E
Protective Environment Room	2	12	NS	30-60 & 70-75	8	17b*	B	D or E*
Airborne Infectious Isolation	NS	12	Yes	30-60 & 70-75	8	14	B	D or E
Isolation Alcove or Anteroom	2	10	Yes	NS & NS	8	14	B	D or E
Labor, Delivery, and Postpartum	2	6	NS	30 (W), 50 (S)	8	14	B	D or E
DIAGNOSTIC AND TREATMENT								
Examination Room	2	6	NS	30 (W), 50 (S)	8	14	B	D or E
Medication Room	2	4	NS	NS & NS	8	14	B	D or E
Treatment Room	2	6	NS	NS & NS	8	14	B	D or E
Physical Therapy and Hydrotherapy	2	10	NS	30-60 & 72-78	8	14	B	D or E
Soiled Workroom or Soiled Holding	2	10	Yes	30-60 & 70-75	8	None	C	None
Clean Workroom or Clean Holding	2	4	NS	30-60 & 70-75	8	14	B	D or E

* Minimum 99.97 DOP HEPA filter required

** Hoods used to process infectious or radioactive materials shall have filters with a minimum 99.97 DOP rating in the exhaust stream.

*** Efficiency to be in accordance with ASHRAE 52.2-2007

NS Not specified; to be in accordance with ASHRAE Standard 170, Ventilation of Health Care Facilities, 2008

AREA DESIGNATION	MINIMUM CHANGES OF OUTDOOR AIR PER HOUR	MINIMUM TOTAL AIR CHANGES PER HOUR	ALL AIR EXHAUSTED TO OUTDOORS	RELATIVE HUMIDITY & TEMPERATURE (% AND °F)	MERV FILTRATION EFFICIENCY*** REQUIRED BY CODE		VILEDON PRODUCTS RECOMMENDED	
					PRE-FILTER	FINAL	PRE-FILTER	FINAL
SERVICE AND ADMINISTRATION								
Office Areas	NS	NS	NS	NS & NS	8	None	C	None
Food Preparation	2	10	Yes	NS & NS	8	None	C	None
Warewashing	Optional	10	Yes	NS & NS	8	None	C	None
Dietary Day Storage	NS	2	NS	NS & NS	8	None	C	None
Laundry, general	2	10	Yes	NS & NS	8	None	C	None
Soiled Linen & Sorting	Optional	10	Yes	NS & NS	8	None	C	None
Clean Linen Storage	2 (Optional)	2	NS	NS & NS	8	14	A or B	D
Linen & Trash Chute	Optional	10	Yes	NS & NS	8	None	C	None
Bedpan Room	Optional	10	Yes	NS & NS	8	None	C	None
Bathroom	Optional	10	NS	NS & 72-78 ^o	8	None	C	None
Janitor's Closet	Optional	10	Yes	NS & NS	8	None	C	None
Hazardous Material	2	10	Yes	NS & NS	8	None	C	None
LABORATORIES AND ANCILLARY AREAS								
General	2	6	Yes	30-60 & 70-75	13	None**	A or B	D, E
Biochemistry	2	6	NS	30-60 & 70-75	13	None**	A or B	D, E
Cytology	2	6	Yes	30-60 & 70-75	13	None**	A or B	D, E
Glass Washing	Optional	10	Yes	NS	13	None**	A or B	D, E
Histology	2	6	Yes	30-60 & 70-75	13	None**	A or B	D, E
Microbiology	NS	6	Yes	30-60 & 70-75	13	None**	A or B	D, E
Nuclear Medicine	2	6	Yes	30-60 & 70-75	13	None**	A or B	D, E
Pathology	2	6	Yes	30-60 & 70-75	13	None**	A or B	D, E
Serology	2	6	Yes	30-60 & 70-75	13	None**	A or B	D, E
Sterilizing	Optional	10	Yes	30-60 & 70-75	13	None**	A or B	D, E
X-ray (Surgical & Critical Care)	3	15	NS	30-60 & 70-75	13	None**	A or B	D, E
X-ray (Diagnostic & Treatment)	2	6	NS	40(W)50(S) 78-80	13	None**	A or B	D, E
X-ray Darkroom	2	10	Yes	30-60 & 70-75	13	None**	A or B	D, E
Autopsy Room	2	12	Yes	NS & NS	13	None**	A or B	D, E
Non-refrigerated Body-holding	Optional	10	Yes	NS & 70-75	13	None**	A or B	D, E
Pharmacy	2	4	NS	30-60 & 70-75	13	None**	A or B	D, E



WHAT IS B.F.E. — BACTERIA FILTER EFFICIENCY?

Bacteria Filter Efficiency is a test performed on media by an independent laboratory. The test measures the percentage of bacteria stopped and retained by the media. The tests are conducted by independent testing laboratories using *Staphylococcus aureus* as the challenge bacteria. The significance of the BFE test is that in the v2007 ASHRAE Handbook, HVAC Applications, Chapter 7 states, that Isoard et al. (1980) and Luciano ((1984) have shown that 99% of all bacteria present in a hospital are removed by 90-95% (MERV14) efficient filters, because bacteria are typically found in colony-forming units that are larger than 1µm. Based on an assumed 1µm size, the filtration efficiency would be as follows:

BACTERIA .50–20 µm				
MF 90 = 99%	MF 95 = 99%	WINAIR 95 = 99%	MV 95 = 99%	MX 95 = 99%

FILTER INSTALLATION & MAINTENANCE TIPS — HOW TO PROTECT YOUR INVESTMENT

Install filters correctly — Poorly fitting filters and pinched filter pockets create gaps that allow unfiltered air to pass through and decrease the filter’s efficiency. Four filter holding clips are recommended to hold the filters securely in place. To hold the filter without warping, the clips should be placed at 2 o’clock, 4 o’clock, 7 o’clock, and 10 o’clock.

Use proper gasketing — Install gasketing on the filters and not on the holding frames. With gaskets applied on the filter, new gaskets are automatically used each time the filter is replaced. Never again will the gasketing have to be checked or replaced before a change-out. Also, for side access systems always ensure that gasketing has been applied to one of the edges between the filters.

Seal all access openings — This is especially critical for negative pressure areas.

Filter change outs — Wear protective clothing during filter change outs while using a respiratory mask with a minimum >N95 rating. When filters are removed, use an H.E.P.A. vacuum to remove debris and wipe down with approved antimicrobial wipes.

Look for moisture — Perform regularly scheduled checks for condensed moisture, and prime the traps from condensate pans and floor drains. Standing water can become a breeding ground for microorganisms.

Install filler pieces to seal gaps — If the filters do not fit snugly, use pieces of metal, polystyrene or urethane foam to close gaps. Metal hardware spacers should be permanently attached as specified by Guidelines for Design & Construction of Hospital Care Facilities, 2006.

Replace missing hardware — Filter holding clips, screws and caulking on sheet metal sections and panels should be replaced as required.

Operating room air balance — Insure that operating suites are properly balanced, using smoke sticks or other techniques to insure compliance with specification to eliminate the spread of infection to adjoining rooms or other areas of the hospital as specified.

Validation analysis testing — A proactive Validation Analysis Testing Protocol should be developed for ongoing testing of air filters based on time, test parameters would include initial pressure drop, collection efficiency, dust loading, microscopic inspection of particle loading in the fiber structure, and microbial testing both upstream and downstream of the filter.

Secure a permanent record to the air handler — A record that specifies when the filters were changed and inspected should be adequate.

PREVENTING THE GROWTH OF MICROORGANISMS IN A HOSPITAL

Most microorganisms (bacteria, pollen, fungi) thrive in environments like hospitals which often provide the perfect conditions for growth. To grow, microorganisms need the following conditions:

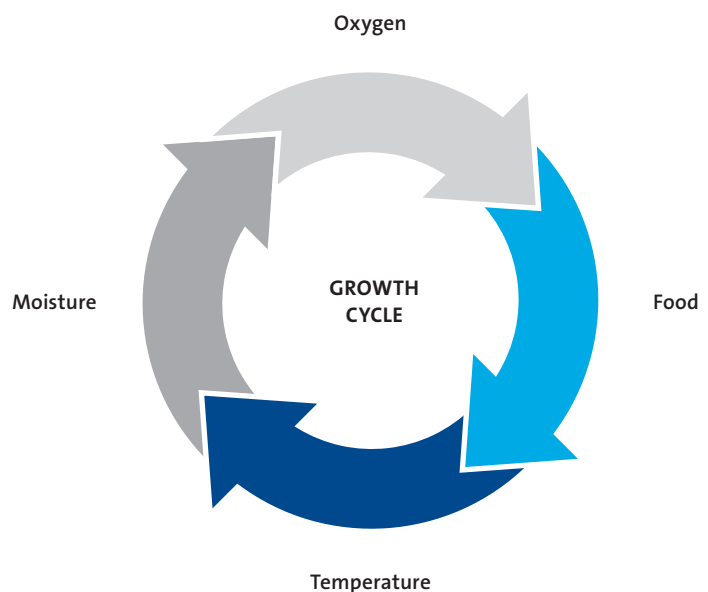
Oxygen — A necessary part of most chemical reactions, although some microorganisms are anaerobic.

Food — Usually traces of formed carbohydrate are required, although some microorganisms only require inorganic nitrogen sources like binders to grow. This may be why we see growth on fiberglass filters and not on synthetic filters.

Temperature — Most microorganisms grow best between 64°F and 90°F. Temperatures exceeding 160°F are generally lethal to microorganisms.

Moisture — When substrate moisture is limited, a relative humidity exceeding 65% is essential for microorganism growth.

To prevent the growth of microorganisms, one of these ingredients must be removed. As soon as the circle is broken, most microorganisms will not grow.







UVGI LIGHTING

Ultraviolet germicidal irradiation (UVGI) has been used since the early 1900's as a sterilization technique to irradiate micro-organisms for surface treatment, water, and ventilation air. UV air treatment uses a short wave length of UV radiation between 2000-3000 plus angstroms (radiation wave-lengths) that is quite effective in destroying microbial matter by destroying the DNA or genetic material of living cells and viruses, thus eliminating the possibility of replication. With the increase of immune, resistant, microbial infections causing H.A.I.'s (hospital associated infections) in hospitals, UVGI is a very effective tool in augmenting a hygienic, housekeeping protocol, filtration, and AHU PM strategies. UVGI should never be used to mask problems that may be occurring in air-handlers, but compliment a total system approach in irradiating microbials, whether in intake air-handler systems or return-air systems that might recirculate possible pathogens. UVGI would be an excellent tool for surface treatments of different areas within the hospital when these areas are not occupied by humans.

As with everything, research UVGI to insure that your vendor/s has adequate knowledge of UVGI installation techniques with regards to space you wish to treat, reflectivity, dwell time requirements, temperature, and air velocity. The hospital engineer should be careful when using UV in air handlers with certain synthetic polymers, because over time these polymers can breakdown to the point of turning into dust, ask your vendor about the capability of their polymer products for systems using UV radiation. The IUVA (International Ultraviolet Association) can also help you should you have any questions regarding an application of UVGI in your systems. ASHRAE (TC 2.9) has published a full chapter on UV-C in their 2008 Guide and Data Book, this will help alleviate some of the claims or misapplications of the product.

ANTI-MICROBIAL TREATMENT OF AIR FILTERS

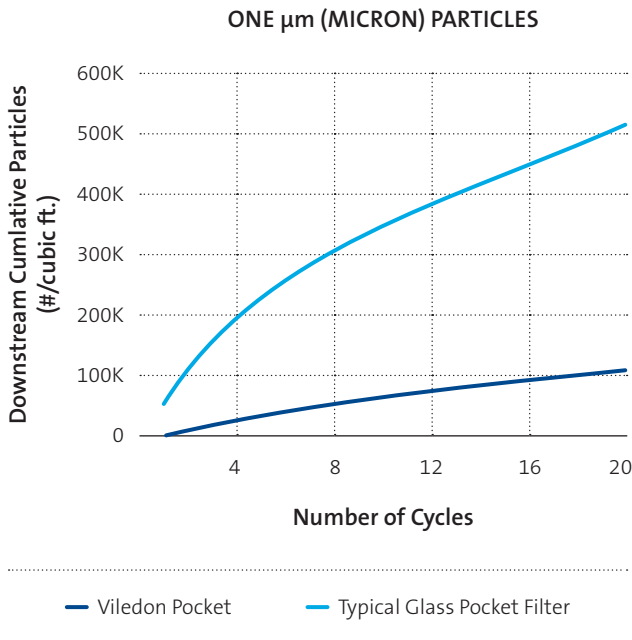
Although anti-microbial treatments are an interesting concept to eliminate microbial growth on filters, it should not be used to replace higher efficient filters that will capture the pathogen. The best long-term solution is a proactive PM (Planned Maintenance) program for AHU maintenance and filtration. ASHRAE has conducted studies of anti-microbial compounds applied to fibers and has found mixed results on the long-term effectiveness of the treatment of filters. Filtration efficiency and dust-loading drastically affect the performance of these treatments. As indicated earlier in this guide, to eliminate the growth cycle of microbial by-products on air filters, one of the ingredients of food, oxygen, temperature, and moisture must be removed or altered to eliminate the growth cycle.

Once the fibers are insulated with dust, the ability for the anti-microbial to work is gone. The selection of air filtration products should be based upon high initial MERV ratings; a filter that doesn't have high initial MERV rating leaves the hospital susceptible to increased infections due to the ability of some microbials to be reintroduced into the air stream by air handler systems.

CYCLE TESTING AND POCKET/BAG FILTERS:

CYCLE TESTING

95% Glass Pocket vs. 90% Viledon Electret



What amount of particulate will migrate downstream due to inflation and deflation of bag/pocket filter products in VAV/VFD drives? This test protocol would show the behavior of captured particulate in different air filter products at varying airflows.

The Viledon® Cycling Test illustrates one of the pitfalls of the current ASHRAE standards. The Viledon Cycle Test shows the retention behavior of different media in VAV/VFD air filter systems. Even in constant volume systems, air handlers are shut down during the weekend or for maintenance and turned back on early Monday morning. This could help explain some of the Monday morning blues or Sick Building Syndrome (SBS) often associated with office buildings. For hospitals, the implications of collected particulate migrating downstream of air filters is at best troubling.

The most interesting consideration when looking at the particulate that penetrated these filters is extrapolating the number of particles over a longer period of time. In many cases, these filters would have negative efficiencies.

The Cycling Test clearly illustrates the difference between “me-too” type products and well-engineered media formation techniques and final product design.

GAS PHASE FILTERS FOR DELIVERY AREA AIR INTAKES & HELIPADS

Some hospital designs have the majority of their fresh air intakes located closely to both delivery areas for trucks and helicopter landing pads and garbage bins are often located near these intakes aggravating the offensive smells. Ground level intakes, delivery areas, and even helicopter Life Flight landing pads have air intake ducts around them. As the collection mechanisms for particulate filtration and gas-phase air cleaning are different there are products available that can arrest both particulate and odors associated with articles of combustion from delivery trucks, helicopters, and even smells from garbage disposal bins that may be located near the intake. In the selection process you might consider a couple of sources to help select the correct gas-phase filtration product; this would include National Air Filtration Association’s (NAFA) Guide to Air Filtration NAFA 2007 and the ASHRAE Handbook and HVAC Systems and Equipment ASHRAE 2008.



A vertical strip on the left side of the page shows a close-up of hospital equipment, including various tubes and connectors, set against a light blue background.

VILEDON[®] PRODUCTS FOR HOSPITAL APPLICATIONS

THE RIGHT
PRODUCTS
FOR THE JOB



PRODUCT	TYPE OF PRODUCT	INITIAL EFFICIENCY AT 1 μm^*	ASHRAE 52.2-2007 MERV RATING	FILTER CATEGORY
R-1/ES3	Extended Surface	30%	8	A
SERIES A	Panel	30%	7	A
R-2/4	Panel	30%	7	A
WINAIR PLEAT	Pleated Panel	28%	7	A
MINI RF	Mini Pleated Panel	25%	7	A
F 455	Rigid Pocket	13%	8	B
F 50	Rigid Pocket	13%	9	B
T 60	Rigid Pocket	30%	10	C
WINAIR 75	Floppy Pocket	74%	12	C
MF 70	Rigid Pocket	75%	13	C
MINI 75	Mini Pleated Panel	75%	12	C
WINAIR 95	Bag Filter	92%	14	D
MF 90	Rigid Pocket	94%	14	D
MINI 95	Mini Pleated Panel	90%	14	D
MX 95	Rigid Box	92%	14	D
MVP 95	Rigid V Cell	95%	15	D
DP 95	Rigid V Cell	95%	15	D
MX 98	Rigid Box	98%	15	E
MF 95	Rigid Pocket	>99%	16	E
MV 95	Rigid V Cell	>99%	16	E
MX 100	Rigid Box	>99%	16	E

The above table illustrates the initial particle size efficiency of Viledon products on particles >1 μm micron and larger. The final filter should be able to remove and more importantly retain particles that are 1 μm and larger which are the sizes of most common bacteria. Removing 95% of 1 μm particles will not only eliminate most bacteria, but also eliminate pollen grains and fungal spores while meeting the filtration recommendations as outlined by the Joint Commission. The 1 μm size particle was chosen because it is within the respirable range (particle sizes that can enter the alveolar space) that can penetrate the lung.



R2/3 – R2/4

- Welded 10 gauge steel frame for Panels & Links
- Triple layer progressively structured media made from synthetic fibers
- High humidity environments
- SC: Scrim option available



WINAIR POCKET FILTERS

- MERV 12 & 14
- Dual Layer Synthetic Media
- Non-Shedding Synthetic Fibers
- Initial Pressure Drop (.26"w.g. – .39"w.g.)



R1/ES3

- MERV Rating 8
- General HVAC filtration
- Prefiltration for high efficiency filters
- 2 layer progressive media
- LEED Construction minimum filtration



F 45S

- MERV Rating 8
- Prefilter for second stage of high-efficiency filters
- Low pressure drop
- LEED Construction minimum filtration



MINI FILTERS

- MERV 12-15 (2" & 4" Depths)
- Polycarbonate Media
- Non-Shedding Synthetic Fibers
- Initial Pressure Drop (.16"w.g. – .45"w.g.)



F 50

- MERV Rating 9
- High humidity prefiltration
- Prefilter for second stage of high-efficiency filters
- Self-Supporting pocket filter



MV/MVP V-STYLED FILTERS

- MERV 12 -16
- UL Class 1 & Class 2
- Polypropelene/Spunbound
- Non-Shedding Synthetic Fibers
- Initial Pressure Drop (.28"w.g. – .46"w.g.)



MF 70

- MERV Rating 13
- General fine filtration for HVAC systems
- 3 layer progressively structured media
- Prefiltration in industrial paint spray booths
- LEED occupied building minimum filtration



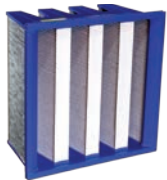
MX 98/MX 100

- MERV Rating 15-16
- Ultrafine filtration for HVAC systems: Hospitals, airports, office buildings
- Prefiltration for HEPA and ULPA filters
- Single header, Double header and Box Style



MF 90/T 90

- MERV Rating 14
- Ultrafine synthetic filtration for HVAC systems: Hospitals, airports, office buildings
- Prefilters for HEPA filters



GAS PHASE FILTERS/ MINI CP, CP/DP

- MERV Rating 7-15
- Ultrafine odor filtration for HVAC systems: Hospitals, airports, office buildings, pharmaceuticals and electronics
- Eliminate pollutant gases, unwanted odors
- Activated-carbon media



MF 95

- MERV Rating 16
- Ultrafine synthetic filtration for HVAC systems: Hospitals, airports, office buildings
- Final filters on air discharged to environment
- Prefilters for HEPA filters



PUBLICATIONS OF INTEREST FOR HEALTHCARE FACILITIES

THE FOLLOWING PUBLICATIONS WERE USED IN PUTTING TOGETHER THIS GUIDE.

ABIH

American Board of Industrial Hygiene
6015 West St. Joseph, Suite 102, Lansing, MI 48917-3980
www.abih.org
Hygiene Issues

A.I.A

Guidelines for Construction and Equipment of Hospital
and Medical Facilities
The American Institute of Architects Press
1735 New York Avenue N.W., Washington, DC 20006
www.aia.org

ASHE

The American Society for Healthcare Engineering
of the American Hospital Association
One North Franklin 28th Floor, Chicago, IL 60606
www.ashe.org
Healthcare Facility Management

ASHRAE

Handbook of Fundamentals,
American Society of Heating, Refrigerating,
and Air Conditioning Engineers
1741 Tullie Circle NE, Atlanta, GA 30329
www.ashrae.org
HVAC Air Filter Standards

ASHRAE

ASHRAE/ASHE Standard 170
Ventilation of Health Care Facilities 2008
Address ventilation in health care facilities

ASHRAE

ASHRAE Standard 62.1-2007
Ventilation for Acceptable Indoor Air Quality,
American Society of Heating, Refrigerating,
and Air Conditioning Engineers
1741 Tullie Circle NE, Atlanta, GA 30329
www.ashrae.org
Ventilation Standards

ASHRAE

ASHRAE Handbook
HVAC Systems and Equipment Air Cleaners for Particulate
Contaminants, 2004
American Society of Heating, Refrigerating, and Air
Conditioning Engineers
1741 Tullie Circle NE, Atlanta, GA 30329
www.ashrae.org

Association for Professionals in Infection
Control and Epidemiology, Inc.
1275 K St., NW, Suite 1000, Washington, DC, 20005-4006
www.apic.org
Infection Control Issues & Standards

American Industrial Hygiene Association
2700 Prosperity Ave., Suite 250, Fairfax, VA 22031
www.aiha.org
Industrial Hygiene Issues &
Certification of Testing Laboratories

CDC

Centers for Disease Control and Prevention
1600 Clifton Rd. Atlanta, GA 30333, USA
www.cdc.gov
SARS, Mold, Bio-terrorism, & Various Publications

The BOCA National Mechanical Code/1993
Building Officials & Code Administrators International, Inc.,
4051 West Flossmoor Road, Country Club Hills, IL 60477
www.iccsafe.org
Mechanical Codes

EPA

Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, N.W. Washington, DC 20460
www.epa.gov
Mold Remediation Guidelines &
Various Publications on Filtration.

GGHC

Green Guide to Health Care
first quantifiable sustainable design toolkit integrating
enhanced environmental and health principles and
practices into the planning, design, construction, operations
and maintenance of their facilities.
www.gghc.org

ICC

International Code Council (ICC)
500 New Jersey Ave NW, Washington, DC 20001
www.icc.org

International Association of Plumbing
and Mechanical Officials
5001 East Philadelphia Street, Ontario,
California, USA 91761-2816
www.iapmo.org

IUVA

International Ultraviolet Association Inc., PO Box 28154,
Scottsdale AZ 85255
www.iuva.org
UVGI Treatment

JCAHO

Joint Commission
One Renaissance Boulevard, Oakbrook Terrace, IL 60181
www.jcaho.org
Standards of Best Practice for Health Industry

NIBS

National Institute of Building Sciences: An Authoritative
Source of Innovative Solutions for the Building Environment
1090 Vermont Avenue, NW, Suite 700 | Washington, DC
20005-4905
Phone 202.289.7800
Web www.nibs.org

NADCA

National Air Duct Cleaners Association
1518 K St. N.W., Suite 503, Washington, DC 20005
www.nadca.com
Duct cleaning

NFPA

National Fire Protection Association,
NFPA, 1 Batterymarch Park
Quincy, Massachusetts 02169-7471
www.nfpa.org
Fire Codes & Filtration Standards

R.I.D

Reduce Infection Deaths
185 East 85th Street, Suite 35B, New York, NY 10028
www.hospitalinfection.org

SHEA

Society for Healthcare Epidemiology of America
1300 Wilson Boulevard, Suite 300, Arlington, VA 22209
www.shea-online.org
Preventing and controlling infections
in the Healthcare Industry

USP 797

59 West 19th St.: New York, NY 10011
www.usp797.org
Bio-aerosol Sampling & Standards

W.H.O.

World Health Organization
Health promoting hospitals project
WHO Regional Office for Europe
8 Scherfigsvej, 2100 Copenhagen,
DENMARK
www.euro.who.int
Quality Management of the Hospital & Technical

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