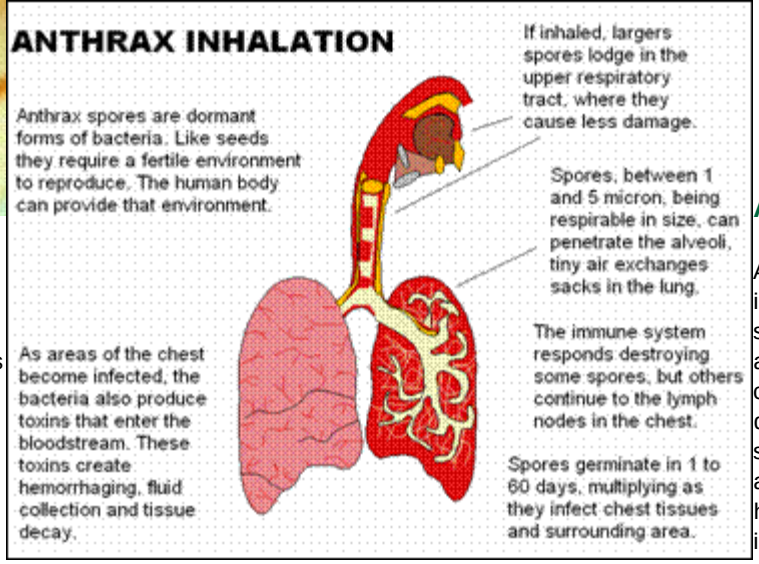


Anthrax

Anthrax is an acute infectious disease caused by the spore-forming bacterium bacillus anthracis. Anthrax most commonly occurs in wild and domestic animals including sheep, goats, camels, cattle, antelopes, and other herbivores, but it can also occur in humans when they are exposed to infected animals or tissue from infected animals.

Anthrax is most common in agricultural regions. These include South and Central America, Southern and Eastern Europe, Asia, Africa, the Caribbean, and the Middle East. When anthrax affects humans, it is usually due to an occupational exposure to infected animals or their products. It is rare to find infected animals in the United States.

As a biological weapon, anthrax may be inhaled by humans. It is also very cheap to produce, costing about $50 per kilogram. One test tube of feed stock (samples of anthrax) can produce a kilogram of anthrax in about 96 hours in a fermenter. Samples are relatively easy to find because it is a naturally occurring disease throughout the world. Anthrax is easy to deliver in the form of a weapon (crop dusting, air distribution systems, and enclosed spaces). Since HVAC air distribution systems may be a path of contamination, access to these areas should be secure.

Symptoms of disease vary depending on how the disease was contracted, but symptoms usually occur within 7 days. Once exposure to anthrax has been identified, timely medical treatment of the exposed individuals is recommended as the bacteria can be fatal.

There are three ways in which humans can be infected by Anthrax spores:

- Cutaneous (or through the skin): Most (about 95%) anthrax infections occur when the bacterium enters a cut or abrasion on the skin, such as when handling contaminated wool, hides, leather or hair products (especially goat hair) of infected animals. Skin infection begins as a raised itchy bump that resembles an insect bite but within 1-2 days develops into a vesicle and then a painless ulcer, usually 1-3 cm in diameter, with a characteristic black necrotic (dying) area in the center. Lymph glands in the adjacent area may swell. About 20% of untreated cases of cutaneous anthrax will result in death. Deaths are rare with appropriate antimicrobial therapy.
- Inhalation (or through the respiratory system): Initial symptoms may resemble the common cold. After several days, the symptoms may progress to severe breathing problems and shock. Inhalation anthrax can be fatal if treatment lags infection.
- Intestinal (or through eating contaminated products): The intestinal disease form of anthrax may follow the consumption of contaminated meat and is characterized by an acute inflammation of the intestinal tract. Initial signs of nausea, loss of appetite, vomiting, fever are followed by abdominal pain, vomiting of blood, and severe diarrhea. Intestinal anthrax may result in death in 25% to 60% of cases.

Direct person-to-person spread of anthrax is extremely unlikely to occur. Communicability is not a concern in managing or visiting with patients with anthrax. There is no evidence of person-to-person transmission of anthrax so quarantine of affected individuals is therefore not recommended. Anthrax spores may survive in the soil, water and on surfaces for many years. Spores can only be destroyed by steam sterilization or by burning. Disinfection of contaminated articles may be accomplished using a 0.05% hypochlorite solution (1 tablespoon of bleach per gallon of water).

Spore destruction requires steam sterilization." It has also been reported that boiling (100 degrees C) for 30 minutes kills the offending spores.

Given the current state of world affairs, anthrax bio-terrorism may include spores disseminated by the aerosol route, causing inhalation anthrax. Because atmospheric stability is important to its efficient spread, and because sunlight is highly toxic to biological agents, the most likely time of release will be at night. Particles from 1 to 5 microns in size (respirable size particles) are most efficient in causing infection. The considered infectious dose for man is upwards of 3000 particles. Some authorities quote the infectious range as 6000 to 8000 spores.

When questioned about anthrax the following points apply:

- There is extremely low risk of biological attack if the facility is outside of a major urban area. Hence, if you are tens of miles outside of a major city, you probably do not need to do much to be prepared other than have food, water, power, supplies, etc. stored up in case of long infrastructure outages due to biological attacks.
- The only true air filtration protection for anthrax is a HEPA filter. To be effective, this must be an air distribution system that takes outside air in through the filter and pushes this filtered air back out through the leak paths in the building - thus the HEPA system creates a slight positive overpressure in the facility. Such building positive pressure creates a balloon effect that helps keep contaminated air from entering the building. HEPA units that merely cleanse the recirculation air would provide little protection against anthrax laden air that is sucked into your facility, unless an area is provided with complete positive overpressure protection.
- A document already exists that may be used to combat airborne anthrax spores in a facility. The CDC Guidelines for the Control of Mycobacterium Tuberculosis has some excellent recommendations for control of this type of contaminant. Airborne tuberculosis in its respirable form is also 1-5 microns in size. When considering controls these guidelines provide sound mechanical system advice that may be applied to reduce the airborne level of infectious anthrax
- One additional point on filters bears mentioning. Although a HEPA filter is the only sure way of eliminating airborne spores, they may also be removed to a lesser degree by ASHRAE grade filters. MERV 14 and higher ASHRAE grade filters can remove more than 97%+ of the particles in the 1 to 5 micron range although they should not be considered a fail-safe alternative to HEPA filter application. A MERV 16 (commonly referred to as 95% DOP) filter is at least 99% efficient in this range.
- Additionally any filter in an HVAC system only performs when air is moved through the system. To decrease numbers of particles per cubic foot, increase the number of air changes to the space (thus moving more air through the filter, decreasing the number of particles per cubic foot with each pass). Given a particular particle size, and a filter efficiency approaching 100%, the following chart demonstrates the importance of increased air changes.

Air changes per hour	Minutes required for a removal efficiency of		
	90%	99%	99.9%
6	23	46	69
10	14	28	41
15	9	18	26
20	7	14	21
30	5	9	14
40	3	7	10
60	3	4	6

- The typical commercial building with a constant volume system offers 6-8 air changes per hour. VAV systems sometimes operate as low as 2-3 air changes per hour. During incidences of infectious control (flu season, etc.), increasing air changes can reduce the number of infectious airborne contaminant. If the system has a fan 'on' switch for constant flow volume, you can increase the number of air changes per hour, by moving this switch to 'on'. As an example, in the aforementioned chart increasing air changes from 6 to 15 will 'clean' the air to a 99% removal rate in 18 minutes as opposed to 46 minutes.

If anthrax exposure is suspected:

- Isolate any item suspected including mail or other items.
- Isolate individuals that may have been exposed.
- Call 911, or contact authorities, and state what has occurred.
- Notify building maintenance to turn off any ventilation systems.
- Ensure that all persons who may have been exposed wash their hands with soap and water.
- List all persons who may have been exposed and provide the list to public health authorities.
- Wait for the police and HAZMAT team to arrive. They will provide further directions.

The following web pages contain more information on the subject.

Centers for Disease Control and Prevention
Public Health Preparedness and Response

This information is available in portable document format (PDF) from your Camfil Farr Regional Manager. Additionally PDF copies of the CDC Guidelines are also available. The material contained herein is presented for informational purposes. In any suspected case of contamination the proper authorities should be notified. For updates and additional materials please check . For filtration guidance please contact your local Camfil Farr distributor or representative.

Clean Air Solutions
Air Filter Systems & Equipment

Cytotoxicity of Volatile Organic Compounds

Health effects of certain volatile organic compounds (VOCs) on animals and humans is well established in the toxicology literature. However, levels of airborne contaminants that are safe for adults and mature animals (a few micrograms per cubic meter) appear to be toxic at the cellular level. Below we present summaries of several investigations that have examined the relationship between airborne molecular contaminants in IVF laboratories, the viability of the cell cultures, and successful assisted reproduction efforts.

1) Cohen, J. et. al., “Opinion: Ambient Air and its potential effects on conception in-vitro”, Hum. Reprod., (12) 1742-1749, 1997.

This early discussion explored the potential impact of various indoor sources of VOCs in IVF laboratory air. The authors noted that traditional toxicological investigations focused on differentiated organisms, which are to some degree protected by their immune, digestive and epithelial systems. Few if any studies applied to oocytes or free-living embryos, where passive and active absorption mechanisms are ‘indiscriminate’. Sources of airborne molecular contaminants in IVF laboratory air cited included ‘trace’ contaminants in compressed air and bottled gases; outgassing from incubators, plastic Petri dishes, and labware; sorption, partitioning and desorption from ordinary fluids in the laboratory (e.g. water, mineral oil); outgassing from medical and electronic equipment; cleaning products, floor waxes and disinfectants; anesthetic gases; air conditioning refrigerants; building materials of construction, carpet and paint. Outdoor sources of

airborne pollutants include vehicular and industrial emissions, incineration and seasonal crop burning. A number of specific VOCs and airborne molecular compounds were assayed and identified in the laboratory air.

Note: The preceding article and other related information may be retrieved at:
www.ivfonline.com/User/Newsstand/research.aspx

2) Worrilow, K.C., Huynh, et. al., "A retrospective analysis: the examination of a potential relationship between particulate and volatile organic compound levels in a class 100 IVF laboratory cleanroom and specific parameters of embryogenesis and rates of implantation", Fertility and Sterility, (76) No. 3, Suppl. 1., p. S15-16, abstract #O-41, September 2001.

In this first of several papers, relationships were sought between particulate and organic vapor levels, and preimplantation embryogenesis and rates of implantation. The authors selected two independent, certified companies to collect and analyze air samples in clinical and laboratory areas. Independent observers evaluated all procedures performed in the facility, including fertilization rates, zygote and embryo morphology and rates of implantation. The authors then employed a retrospective experimental design to explore the role that measured ambient air constituents exerted on preimplantation toxicology over a twelve month study period.

The researchers found that all areas within the IVF laboratory and accompanying procedure rooms met NEBB requirements for a Class 100 clean room. However, implantation rates were significantly lower during the three-month 'testing quarter' (TQ3) corresponding to a detectable, ~2 ppb level of toluene in most of the facility. The following quarter, toluene levels declined below detectable limits (~0.1 ppb) and implantation rates returned to levels similar to the first two quarters.

3) Worrilow, K.C., Huynh, et. al., "A retrospective analysis: Seasonal decline in implantation rates and its correlation with increased levels of volatile organic compounds.", Fertility and Sterility, (78), Suppl. 1., p. S-39, abstract #O-101, September 2002.

The following year, the authors reported that their continued retrospective analysis of 26 months of operation had detected a potential seasonal relationship between periods of elevated outside temperature and high relative humidity, and elevated levels of the volatile organic compound toluene. They reported that a second quarterly period (TQ8) had exhibited slightly elevated toluene levels (inside and outside) along with a corresponding decrease in implantation rates. During the following quarter, outside temperature, humidity and toluene levels all declined, and corresponding implantation rates again returned to 'normal' levels. The authors hypothesized that the summertime seasonal elevation in outside temperature and humidity might have initiated desorption of trapped VOCs from the carbon filters installed in the laboratory air handling system, as well as reduced the adsorption efficiency level of the system.

4) A third research paper in this series, presented in Fall 2004, reports on improvements to IVF laboratory operation that resulted in a dramatic increase in clinical pregnancy rates. Please check back for a summary of this paper after it has been published later in 2005.

Note: The research in the studies cited above was conducted at the ultra-clean lab facility located at the Lehigh Valley Hospital & Health Network in Muhlenberg, Pennsylvania, USA. Clean, contaminant-free air in their lab is one of the key factors cited by the fertility experts at the facility for their higher success rates for pregnancies and healthy babies compared to traditional IVF facilities.

Ventilation Requirements for Areas Affecting Patient Care in Hospitals & Outpatient Facilities

Area Designation	Air movement relative to adjacent space[2]	Minimum air changes per hour OSA[3]	Minimum total air changers per hour[4, 5]	All air exhausted to outside[6]	Recirculate air by means of room units[7]	Relative humidity[8] %	Design temperature[9] F° C°
Surgery & Critical Care							
Operating/surgical cystoscopic rooms [10, 11]	Out	3	15	—	No	30-60	68-73 20-23
Delivery room [10]	Out	3	15	—	No	30-60	68-73 20-23 [12]
Recovery room [10]	—	2	6	—	No	30-60	70-75 21-24
Critical & intensive care	—	2	6	—	No	30-60	70-75 21-24
Newborn intensive care	—	2	6	—	No	30-60	72-78 22-26
Treatment room [13]	—	—	6	—	—		75 24
Trauma room [13]	Out	3	15	—	No	30-60	70-75 21-24
Anesthesia gas storage	In	—	8	Yes	—	—	—
Endoscopy	In	2	6	—	No	30-60	68-73 20-23
Bronchoscopy [11]	In	2	12	Yes	No	30-60	68-73 20-23
ER waiting room	In	2	12	Yes [14, 15]	—	—	70-75 21-24
Triage	In	2	12	Yes [14]	—	—	70-75 21-24
Radiology waiting rooms	In	2	12	Yes [14, 15]	—	—	70-75 21-24
Nursing							
Procedure room	Out	3	15	—	No	30-6-	70-75

							21-24
Patient room	—	2	6 [16]	—	—	—	70-75 21-24
Toilet room	In	—	10	Yes	—	—	—
Newborn nursery suite	—	2	6	—	No	30-60	72-78 22-26
Protective environment room [11, 17]	Out	2	12	—	No	—	75 24
Airborne infection isolation room [11, 18]	In	2	12	Yes [15]	No	—	75 24
Isolation alcove or anteroom [17, 18]	In / Out	—	10	Yes	No	—	—
Labor/delivery/recovery	—	2	6 [16]	—	—	—	70-75 21-24
Labor/delivery/recovery/postpartum	—	2	6 [16]	—	—	—	70-75 21-24
Patient corridor	—	—	2	—	—	—	—
Ancillary							
Radiology							
X-ray (surgical/critical care & catheterization)	Out	3	15	—	No	30-60	70-75 21-24
X-ray (diagnostic & treatment)	—	—	6	—	—	—	75 24
Darkroom	In	—	10	Yes	No	—	—
Laboratory							
General [19]	—	—	6	—	—	—	75 24
Biochemistry [19]	Out	—	6	—	No	—	75 24
Cytology	In	—	6	Yes	No	—	75 24

Glass washing	In	—	10	Yes	—	—	—
Histology	In	—	6	Yes	No	—	75 24
Microbiology [19]	In	—	6	Yes	No	—	75 24
Nuclear medicine	In	—	6	Yes	No	—	75 24
Pathology	In	—	6	Yes	No	—	75 24
Serology	Out	—	6	—	No	—	75 24
Sterilizing	In	—	10	Yes	—	—	—
Autopsy room [11]	In	In	—	12	Yes	No	—
Nonrefrigerated body-holding room	In	—	10	Yes	—	—	70 21
Diagnostic & Treatment							
Pharmacy	Out	—	4	—	—	—	—
Examination room	—	—	6	—	—	—	75 24
Medication room	Out	—	4	—	—	—	—
Treatment room	—	—	6	—	—	—	—

U.S.Department of Health & Human Services Health Care Facility Filtration Requirements

Area Designation	Number of Filter Beds	Filter Bed # 1 Efficiency	Filter Bed # 2 Efficiency
All areas for inpatient care, treatment, and diagnosis, and those areas providing direct service or clean supplies such as sterile and clean processing, etc.	2	MERV 8	MERV 14
Protective environment room	2	MERV 8	99.97 (MERV 15)

Laboratories	1	MERV 13	
Administrative, Bulk storage, Food preparation areas, Laundries, Soiled holding areas	1	MERV 8	

Notes: Additional roughing or prefilters should be considered to reduce maintenance for filter with higher efficiencies than 75 percent.
The filtration efficiency ratings are based on average dust spot efficiency per ASHRAE 52.1-1992.
Approximate conversion of ASHRAE 52.1 values to ASHRAE 52.2 values; 30% dust spot – MERV 7, 80% dust spot – MERV 13, 90% dust spot – MERV 14.

American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
Filter Efficiencies for Central Ventilation and Air Conditioning Systems
in General Hospitals

Area Designation	Number of Filter Beds	Filter Bed #1 Efficiency[a]	Filter Bed #2 Efficiency[a]
Orthopedic operating room Bone marrow transplant operating room Organ transplant operating room	2	MERV 8	17[b]
General procedure operating room Delivery rooms Nurseries Intensive care units Patient care rooms Treatment rooms Diagnostic & related areas	2	MERV 8	14
Laboratories Sterile storage	1	MERV 13	
Administrative Bulk storage Food preparation areas Laundries Soiled holding areas	1	MERV 8	

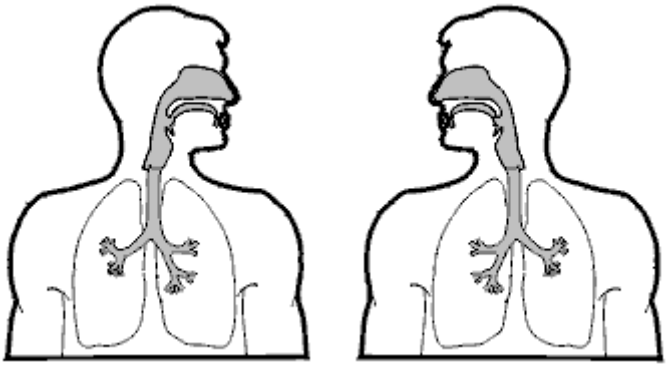
[a] Based upon ASHRAE Filter Testing Standard 52.2.
[b] HEPA filters at air outlets
Approximate conversion of ASHRAE 52.1 values to ASHRAE 52.2 values; 25% dust spot – MERV 6, 80% dust spot – MERV 13, 90% dust spot – MERV 14

Chart # 1 from: Guidelines for Design & Construction of Hospital & Health Care Facilities
The American Institute of Architects Academy of Architecture for Health
U.S. Department of Health & Human Services

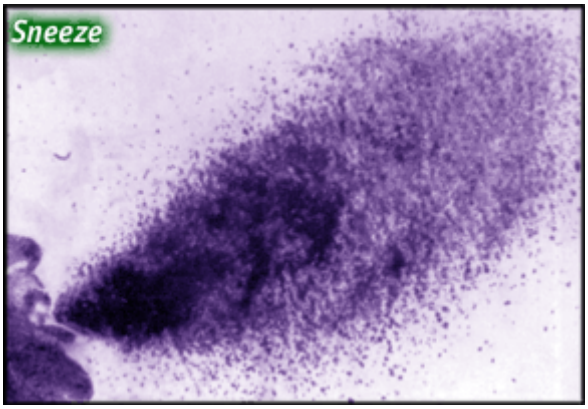
Chart # 2 from 2003 ASHRAE Applications Handbook

Infection Transfer - Airborne Droplet Nuclei

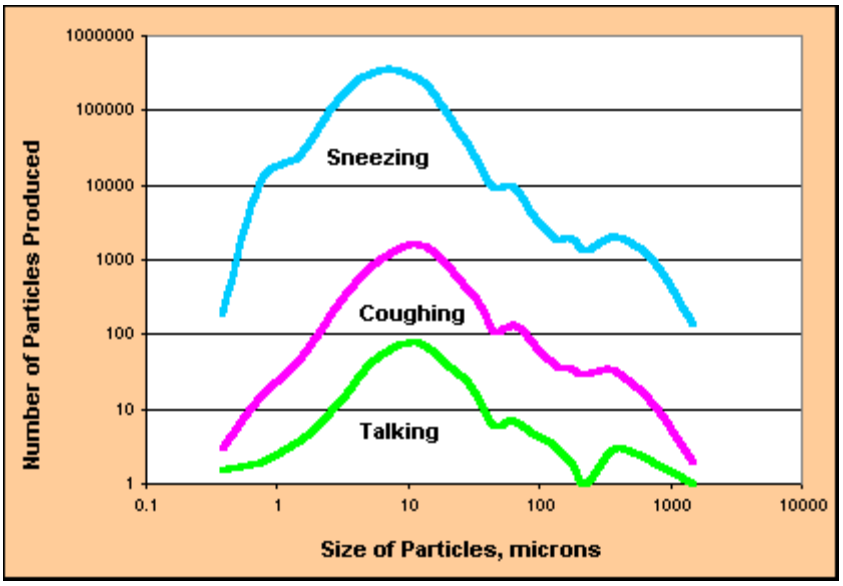
The most common form of transmission of bacterial of viral infection from one individual to another is through the respiratory system.



When an infected person coughs or sneezes, tiny particles containing droplet nuclei are expelled into the air.



These particles are about 1 to 5 microns in diameter. Droplet nuclei can remain suspended in the air for several hours, depending on the environment. The most effective droplet nuclei tend to have a diameter of 5 micron. Droplet nuclei are generated during talking, coughing and sneezing. One cough can generate 3000 droplet nuclei. Talking for 5 minutes can generate 3000 droplet nuclei and singing can generate 3000 droplet nuclei in one minute. Sneezing generates the most droplet nuclei by far (tens of thousands), which can spread to individuals up to 3 meters away.



Air filters commonly applied in health care air conditioning systems have a very high efficiency on removing airborne droplet nuclei. The minimum standard of care for areas of a facility wherein infected individuals are cared for would have MERV 7 prefiltration and MERV 14 final filtration. Some of these areas would also have an additional stage of HEPA filters.

The initial efficiency of a MERV 14 filter on 1-5 micron size particles is well over 95%.

Infectious Diseases

Bacterial Diseases

A bacterium is a certain type of single-celled organism without a nucleus. Bacteria are among the oldest and most numerous living beings and are found in the soil, the water and inside many multi-cellular organisms. They are small, typically in the range of a few micrometers.

Some typical bacterium include:

Bacillus anthracis Escherichia coli Helicobacter pylori Mycobacterium tuberculosis Neisseria gonorrhoeae Neisseria menigitidis Rickettsiae Salmonella typhimurium Staphylococcus aureus Streptococcus pyogenes Treponema pallidum Thiomargarita namibiensis Yersinia pestis

Bacterial infectious diseases include:

Anthrax -- Bacterial Meningitis -- Brucellosis -- Bubonic plague -- Campylobacteriosis -- Cholera -- Diphtheria -- Epidemic Typhus -- Gonorrhea -- Hansen's Disease -- Legionellosis -- Leprosy -- Leptospirosis -- Listeriosis -- Lyme Disease -- MRSA infection -- Nocardiosis -- Pertussis -- Pneumococcal pneumonia -- Psittacosis -- Q fever -- Rocky Mountain Spotted Fever or RMSF -- Salmonellosis -- Scarlet Fever -- Shigellosis -- Syphilis -- Tetanus -- Trachoma -- Tuberculosis -- Tularemia -- Typhoid Fever -- Typhus

Viral Diseases

Viruses are the smallest of parasites; they are completely dependent on cells (bacterial, plant, or animal) to reproduce. Viruses are composed of an outer cover of protein and sometimes lipid, and a

nucleic acid core of RNA or DNA. In many cases, this core penetrates susceptible cells and initiates the infection.

Viruses range from 0.02 to 0.3 micrn in size; too small for light microscopy but visible using electron microscopy.

Several hundred different viruses infect humans. Because many have been only recently recognized, their clinical effects are not fully understood. Many viruses infect hosts without producing symptoms; nevertheless, because of their wide and sometimes universal prevalence, they create important medical and public health problems.

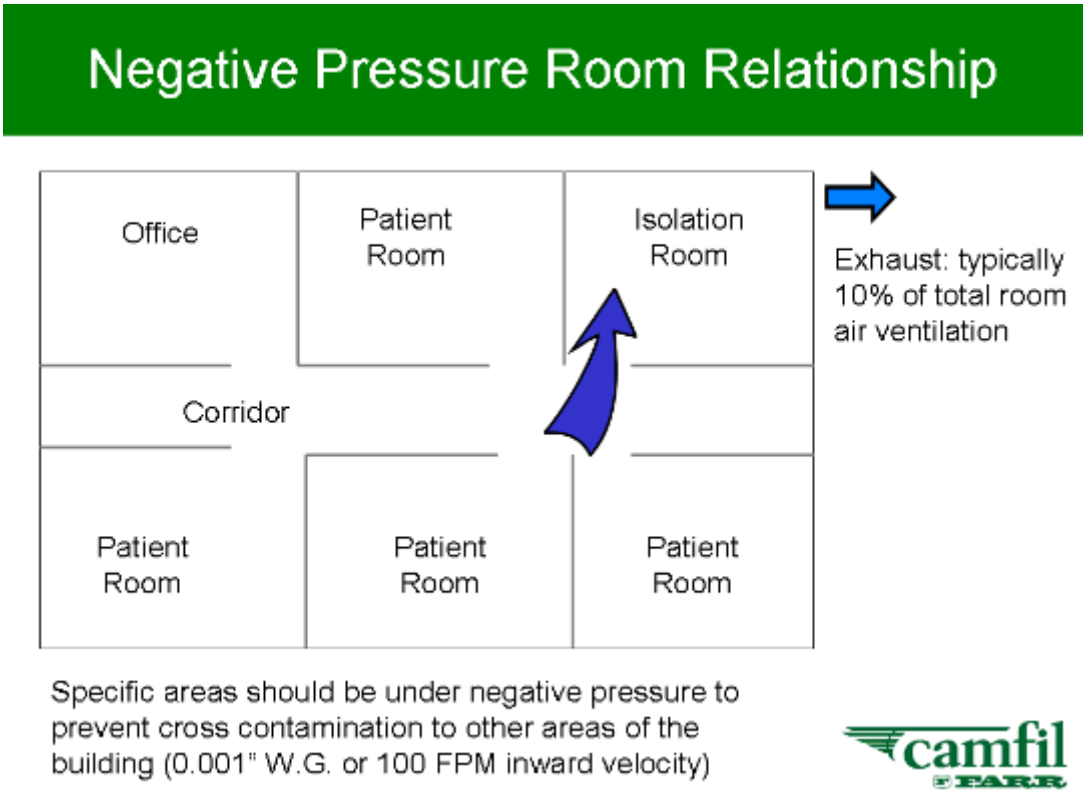
Viruses that primarily infect humans are spread mainly via respiratory and enteric excretions. These viruses are found worldwide, but their spread is limited by inborn resistance, prior immunizing infections or vaccines, sanitary and other public health control measures, and prophylactic antiviral drugs. Zoonotic viruses pursue their biologic cycles chiefly in animals; humans are secondary or accidental hosts. These viruses are limited to areas and environments able to support their nonhuman natural cycles of infection (vertebrates or arthropods or both).

Viral disease include:

AIDS -- AIDS Related Complex -- Chickenpox or Varicella -- Common cold -- Cytomegalovirus Infection -- Colorado tick fever -- Dengue fever -- Ebola haemorrhagic fever -- Epidemical parotitis -- Flu -- Hand, Foot and Mouth Disease -- Hepatitis -- Herpes zoster -- Influenza -- Lassa fever -- Measles -- Marburg haemorrhagic fever -- Mononucleosis -- Mumps -- Poliomyelitis -- Progressive multifocal leukencephalopathy -- Rabies -- Rubella -- SARS -- Smallpox or variola -- Viral meningitis -- West Nile disease -- Yellow fever

Negative Room Pressure to Prevent Cross-Contaminantion

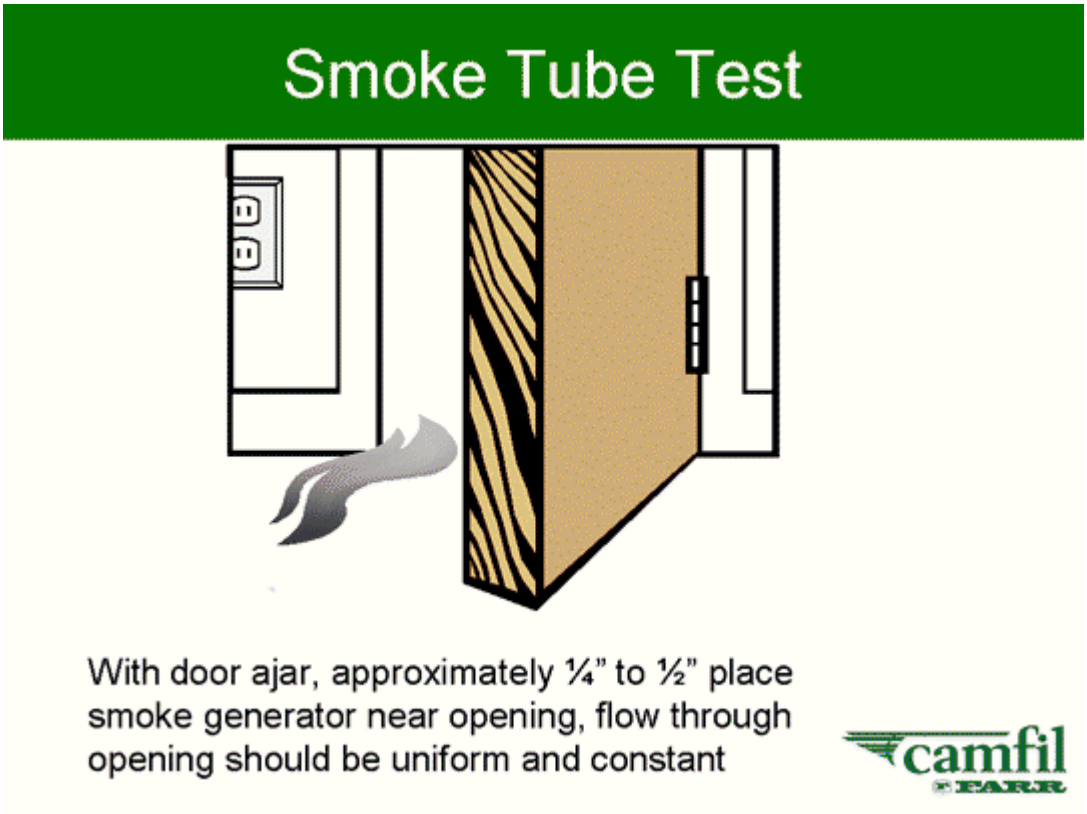
Negative Room Pressure to Prevent Cross-Contaminantion A negative pressure room includes a ventilation system designed so that air flows from the corridors, or any adjacent area, into the negative pressure room, ensuring that contaminated air cannot escape from the negative pressure room to other parts of the facility.



Air naturally moves from areas of higher pressure to areas of lower pressure. When negative pressure exists, a continuous air current enters the room under the door, which prevents airborne particles generated in the room from escaping into the corridor. A common example of negative pressure is a bathroom with an exhaust fan. When operating correctly, and with the door closed, the fan prevents unwanted odors and moisture from escaping.

Negative pressure is created by balancing the room's ventilation system so that more air is mechanically exhausted from a room than is mechanically supplied. This creates a ventilation imbalance, which the room ventilation makes up by continually drawing in air from outside the room. In a well-designed negative pressure room, this air is pulled in under the door through a gap (typically abot one half-inch high) for that purpose. Other than this gap, the room should be as airtight as possible to prevent air from being pulled in through cracks and gaps, such as those around windows, light fixtures, and electrical outlets. Leakage from these sources can compromise or eliminate room negative pressure, even if the system is balanced to achieve it.

A smoke test is a simple procedure to determine whether a room is under negative pressure. The smoke tube is held near the bottom of the negative pressure room door and approximately 2 inches in front of the door. The tester generates a small amount of smoke by gently squeezing the bulb. The smoke tube is held parallel to the door, and the smoke is exhausted from the tube slowly to ensure the velocity of the smoke from the tube does not overpower the air velocity. If the room is at negative pressure, the smoke will travel under the door and into the room. If the room is not a negative pressure, the smoke will be blown outward or will stay stationary.



This test must be performed while the door is closed. The windows in the room must be closed. If room air cleaners are being used (including fume hoods or biosafety cabinets), they should be running. If the room has an anteroom, test the pressure differential from the corridor to the anteroom, and from the anteroom to the room.

The minimum pressure difference necessary to achieve and maintain negative pressure that will result in airflow into the room is very small (0.001 inch of water gage). The actual level of negative pressure achieved will depend on the difference in the ventilation exhaust and supply flows and the physical configuration of the room, including the airflow path and flow openings. If the room is well sealed, negative pressures greater than the minimum of 0.001 inch of water may be readily achieved. However, if rooms are not well sealed, as may be the case in many facilities (especially older facilities), achieving higher negative pressures may require exhaust/supply flow differentials beyond the capability of the ventilation system.

To establish negative pressure in a room that has a normally functioning ventilation system, the room supply and exhaust airflows are first balanced to achieve an exhaust flow of either 10% or 50 cubic feet per minute (cfm) greater than the supply (whichever is the greater). In most situations, this specification should achieve a negative pressure of at least 0.001 inch of water. If the minimum 0.001 inch of water is not achieved and cannot be achieved by increasing the flow differential (within the limits of the ventilation system), the room should be inspected for leakage (e.g., through doors, windows, plumbing, and equipment wall penetrations), and corrective action should be taken to seal the leaks.

Negative pressure in a room can be altered by changing the ventilation system operation or by the opening and closing of the room's doors, corridor doors, or windows. When an operating configuration has been established, it is essential that all doors and windows remain properly closed in the negative pressure room and other areas (e.g., doors in corridors that affect air pressure) except when persons need to enter or leave the room or area.

(SARS) Severe Acute Respiratory Syndrome & Air Filter Recommendations

SARS and Air Filtration Application

Severe Acute Respiratory Syndrome (SARS) is thought to be spread through airborne droplets generated from coughing, sneezing or talking. It is also possible to contract the virus from contacting body secretions that would typically emanate from the eyes, nose or mouth. Droplet infection is most likely within 3 feet of infected patients. It is also important to note that unlike most viruses which cannot live outside of a host for long periods, SARS has been noted surviving up to 24 hours on uncleaned surfaces. Presently standard infection control practices are being recommended for the environmental area where suspected SARS patients, or probable infected individuals, are being cared for.

The environment should be controlled by using proven methodologies to reduce the probability of exposure. Some items of control include individual respiratory protection, direct source capture using local exhaust ventilation, controlling airflow direction to prevent cross-contamination, dilution and removal of contaminated air via general ventilation, and air cleaning through air filtration and ultraviolet germicidal irradiation.

The information presented includes recommendations from the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) and the United States Department of Health & Human Services (DHHS). It is important to note that some of these guidelines are also expressed in the Centers for Disease Control document, Guidelines for the Control of Mycobacterium Tuberculosis (TB), but that TB is a bacterium whose size is measured in microns. The coronavirus associated with SARS is viral and measured in nucleotides (magnitudes smaller than a micron).

These recommendations are consistent with World Health Organization (WHO) and CDC recommended precautions for environmental control for SARS at this time.

Critical areas for environmental control include; waiting/admittance areas, treatment areas, patient rooms, satellite treatment areas, and defined infectious isolation rooms. The following chart notes recommendations for specific areas of a medical facility.

HHS Medical Facility Requirements

Area	Filter Efficiency Bed #1	Bed #2	ACH	Temp F	Relative Humidity Min	Max	Relative Room Pressure
Operating Room	7	14	25	70-76	50	60	Positive
Delivery Room	7	14	12	70-76	50	60	Positive
Nursery	7	14	12	75	30	60	Positive
Recovery	7	14	6	75	50	60	Positive
Intensive Care	7	14	6	75-80	30	60	Positive
Patient	7	14	2	75	---	---	Equal
Isolation	7	14	12	75	---	---	Negative
Treatment	7	---	6	75	---	---	Equal
Food Prep	13	---	10	75	---	---	Equal
Laundry	13	---	10	75	---	---	Equal
Administration	7	---	---	75	---	---	Equal
Bulk Storage	7	---	10	75	---	---	Negative
Soiled Handling Area	7	---	10	75	---	---	Negative
Exhaust Hoods	99.97% DOP Test	---	---	---	---	---	Negative

Efficiencies are MERVs in accordance with ASHRAE 52.2 (except exhaust hoods).
Isolation room criteria is based upon 1994 CDC Guidelines. Changed from 6 ACH to 12 ACH and positive to negative room pressure.
Outdoor intakes should be located as high as possible above ground level (minimum 6' above ground, 3' minimum above roof).
Intakes should be not less than 25 feet from exhausts or any ventilating or combustion equipment.
Room supplies should be located at or near ceiling height.
Autopsy rooms require 12 ACH.

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The most important factor for infectious disease control is to isolate the patient. The isolation room should be under negative pressure to prevent droplet nuclei from transferring to other areas of the facility (negative pressure is defined as 0.001" W.G., or 100 feet per minute inward velocity). The area should also include a ventilation system that reduces droplet nuclei (virus carrier resultant from coughs or sneezes) generated by the patients within the space. Additionally, we should follow procedures as defined by cognizant authorities (local, state, CDC, ASHRAE), ventilation air should meet guidelines as established by the EPA defining 'clean air' and the absolute minimum air change rate of 6 air changes per hour should be used (although 12 is preferred).

It is important to note that negative pressure can only be maintained when access is controlled (door closed). Doors should only be opened for entrance and exiting of attending personnel, and closed immediately thereafter.

When exhausting air from an isolation room we should use exhaust criteria as defined by the ASHRAE Fundamentals Handbook Chapter 14 or the ACGIH Industrial Ventilation Manual (never less than within 30 feet of inhabitant areas). Air should not be exhausted in the vicinity of walkways or adjacent to windows or openings that may allow reentrance of contaminant.

When infectious isolation rooms can not be 100% exhausted, HEPA filters should be used in duct systems discharging into general ventilation (recirculated air), in ducts for individual room recirculation, in exhaust ducts from booths and enclosures, or in exhaust ducts to remove droplet nuclei from being discharged to other facility areas of habitation.

It is important to note that a HEPA filter is tested and certified to meet HEPA performance criteria (procedure as defined by the Institute of Environmental Sciences & Technology (IEST)). The term HEPA has been misused in the air filtration industry. In critical applications as defined herein you should request a letter of certification with each filter. This is a common practice in the air filtration industry when critical applications are involved. These documents are offered without charge as long as they are requested at the same time the filter is ordered. For your facility's protection these

letters should be maintained in a file to note conformance to the latest standards of care or recommended practices.

Air filtration serves an important function in the control of airborne droplet nuclei. A MERV 14 filter, as evaluated by ASHRAE Filter Testing Standard 52.2, will be more than 95% efficient on removing droplet nuclei as long as it is given the opportunity to clean the air by moving air through the filter.

In critical situations air changes should be increased to the maximum ability of the HVAC system serving the area. Variable air volume systems should be modified to operate at full capacity and the fan on all systems should be in the constant-on position rather than the typical mode of cycling based upon temperature. Please note, if an air filter can remove 90% of all 1 micron size particles within a space in 23 minutes the same filter only requires 9 minutes if the air change rate is increased to 15.

Air Changes Per Hour

Number of Air Changes per Hour	Minutes Required for a removal efficiency of		
	90%	99%	99.9%
6	23	46	69
10	14	28	41
15	9	18	28
20	7	14	21
30	5	9	14
40	3	7	10
50	3	6	8

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Exposure and the susceptibility of contracting a disease are tied with the volume of contaminant that the individual is exposed to. Reduce the volume of contaminant; reduce the individual's risk of contraction. Air filters and air changes are the critical factor in this equation.

Camfil Farr can provide a copy of the CDC Guidelines for the Control of Mycobacterium Tuberculosis (the document most often referred to in infectious disease situations) and some of the latest published materials specific to SARS. All documents are in PDF format and compressed into one zip file. Send your name, affiliation and email to: **literature@camfilfarr.com** for your electronic copy. Click here to send request.

Your local Camfil Farr Distributor is well versed in the intricacies of applying air filtration in medical or other critical care facilities. Your local Camfil Farr Representative can assist engineering and contracting firms in new system or room design. Contact **camfilfarr@camfilfarr.com** for the name of your local Camfil Farr agency.

Additional important SARS sites:

Hospital Infection Control Guidance for Severe Acute Respiratory Syndrome (SARS), World Health Organization,

Tuberculosis

Tuberculosis (TB) is the leading cause of death in the world from a single infectious disease. After a century of decline in the United States, incidences of tuberculosis are increasing, and multiple drug-resistant strains have emerged. This increase is attributable to changes in the social structure in cities, the HIV epidemic, and a failure of some cities to improve public treatment programs. Mycobacterium tuberculosis is the etiologic agent of tuberculosis (TB) in humans. Humans are a reservoir for the bacterium and can harbor the bacteria for many years.

Mycobacterium tuberculosis is a fairly large rod-shaped bacterium. The rods are 2-4 microns in length and 0.2-0.5 microns in width. TB is spread from person to person through the air. When a person with infectious TB coughs or sneezes, tiny particles containing Mycobacterium tuberculosis are expelled into the air. These particles, called droplet nuclei, are about 1 to 5 microns in diameter. Droplet nuclei can remain suspended in the air for several hours, depending on the environment. The most effective droplet nuclei tend to have a diameter of 5 micron.

Droplet nuclei are generated during talking, coughing and sneezing. One cough can generate 3000 droplet nuclei. Talking for 5 minutes can generate 3000 droplet nuclei and singing can generate 3000 droplet nuclei in one minute. Sneezing generates the most droplet nuclei by far (tens of thousands), which can spread to individuals up to 10 feet away. Direct sunlight quickly kills tubercle bacilli, but they can survive in the dark for several hours. The probability that TB will be transmitted depends on three factors: the infectiousness of the person with TB, the environment in which exposure occurred, and the duration of exposure.

The air filter efficiencies prescribed by the United States Department of Health & Human Services, as well as the recommendations published by the American Society of Heating, Refrigerating and Air Conditioning Engineers are sufficient to protect most areas of a medical facility (MERV 7 prefilter and MERV 14 final filter). In areas that directly serve TB patients HEPA filtration is required to protect medical facility employees and patient visitors.

Persons at the highest risk of becoming infected with TB are close contacts; persons who often spend time with someone who has infectious TB. These contacts include family members, roommates, friends, coworkers, or others. These persons are at risk for TB infection because they are more likely to be exposed to TB. Predisposing factors for TB infection include: Close contact with large populations of people (hospitals, schools, nursing homes, dormitories, prisons, etc.) IV drug use HIV infection is the #1 predisposing factor for TB infection. Ten percent of all HIV-positive individuals harbor TB. This is 400-times the rate associated with the general public Only 3-4% of infected individuals will develop active disease upon initial infection, 5-10% within one year. These percentages are much higher if the individual is HIV positive. TB infection progresses to disease

when tubercle bacilli overcome the defenses of the immune system and begin to multiply. Infection can progress to disease very quickly or many years after the actual infection. In the United States, of approximately 5% of the people who have been recently infected with TB, the disease will develop in the first year or two after infection. In another 5%, the disease will develop later in their lives. In other words, approximately 10% of persons infected with TB will develop active TB at some point. The remaining 90% will stay infected, but free of disease, for the rest of their lives.

Engineering controls are based primarily on the use of adequate ventilation systems; and may be supplemented with high-efficiency particulate air (HEPA) filtration and ultraviolet germicidal irradiation (UVGI) in high-risk areas. These strategies are designed to reduce the concentration of infectious droplet nuclei in the air, to prevent the dissemination of droplet nuclei throughout the facility, and to render droplet nuclei noninfectious by killing the tubercle bacilli they contain. In infectious patient isolation rooms, special ventilation system controls are necessary to maintain negative pressure within the room and to exhaust the air properly. Isolation rooms should be monitored daily when in use to ensure the negative pressure maintained. Isolation room doors should be kept closed, except when patients or personnel must enter or exit the room, in order to maintain negative pressure. Ventilation systems can also be designed to minimize the spread of TB to other areas of the health care facility.

HEPA filters can be used in ventilation systems to remove droplet nuclei from the air. These filters MUST be installed in ventilation ducts to filter air for recirculation into the same room or recirculation to other areas of a facility. The effectiveness of portable HEPA filtration units has not been adequately evaluated. All HEPA filters must be carefully installed and meticulously maintained to ensure adequate function.

The United States Centers for Disease Control publish a document titled *Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health Care Facilities*. The document includes recommendations for the use of engineering controls to prevent spread of the bacteria. Specifics include direct source capture using local exhaust ventilation, controlling airflow direction to prevent cross-contamination, dilution and removal of contaminated air via general ventilation and air cleaning through air filtration.

Some specifics include following DHHS recommendations for air changes and air filtration, supplying at least 12 air changes per hour to the infected patients room, using HEPA filters in an recirculation system (either within the room or returning air to other conditioned spaces) and ensuring that contaminated air is not exhausted in areas of human habitation.

For a full PDF copy of Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health Care Facilities, **click here**.