Healthcare Isolation Rooms

Architectural and Mechanical Design Considerations

Industry Guidelines and Preventing the Spread of Disease

**WARNING:**
The 2006 American Institute of Architects (AIA) Guidelines for Design and Construction of Hospital and Health Care Facilities do not permit the construction of variable pressure rooms (such as, rooms in which the ventilation can be switched from positive to negative pressure) in new facilities or in renovated areas of the facility. 2001 AIA guidelines first identified that the use variable pressure rooms was not acceptable for protective environments and All functions.

The 2006 AIA Guidelines state “…Rooms with reversible airflow provisions for the purpose of switching between protective environment and airborne infection isolation functions are not acceptable.” (AIA 2006 Guidelines, section 10.2.2.1(3), P 120) Also, variable pressure rooms in existing facilities are discouraged. The Centers for Disease Control (CDC) Guidelines for Environmental Infection Control in Health-Care Facilities state “Older healthcare facilities may have variable pressure rooms (i.e., rooms in which the ventilation can be manually switched between positive and negative pressure). These rooms are no longer permitted in the construction of new facilities or in renovated areas of the facility, and their use in existing facilities have been discouraged because of difficulties in assuring the proper pressure differential, especially for the negative pressure setting, and because of the potential for error associated with switching the pressure differentials for the room. Continued use of existing variable pressure rooms depends on a partnership between engineering and infection control. Both positive-pressure and negative-pressure rooms should be maintained according to specific engineering specifications.” (2003 CDC Guidelines, p. 19.)

Who Enforces the Guidelines?
The American Institute of Architects (AIA) and Centers for Disease Control (CDC) cannot write standards and codes; they write guidelines. However, once the authority having jurisdiction adopts their guidelines in whole or in part, they become law. Most states have adopted the infection control guidelines; check with your state department of health. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has also adopted the Guidelines as part of their standards, which means that hospitals seeking accreditation through JCAHO must meet the CDC and AIA Guidelines. The CDC Guidelines have become the standard of care in the healthcare industry.

When is this Effective?
Any newly constructed room or major modification of a room after December 2003 should not have variable pressure rooms. In states that adopt the AIA Guidelines, the effective date can be as early as January 2001. Again, check with your state department of health to identify the edition of the Guidelines that has been adopted.

Are Existing Rooms Grandfathered?
The CDC Guidelines state “…These (variable pressure) rooms are no longer permitted in the construction of new facilities or in renovated areas of the facility, and their use in existing facilities has been discourage because of difficulties in assuring the proper pressure differential, especially for the negative pressure setting, and because of the potential for error associated with switching the pressure differentials for the room. Continued use of existing variable pressure rooms depends on a partnership between engineering and infection control. Both positive-and negative-pressure rooms should be maintained according to specific engineering specifications.”
Preventing the Spread of Disease in Healthcare Facilities

In the years leading up to 1985, the annual number of new cases of Mycobacterium Tuberculosis (TB) in the United States was continuously decreasing and it was assumed, that for all practical purposes, this disease could be considered eradicated in the U.S. However, a reversal in this downward trend occurred in 1985, and in the years that followed, new infections were reported at an alarming rate.

In 1990, this resurgence in TB prompted the U.S. Centers for Disease Control and Prevention (CDC) to issue an initial set of guidelines intended to prevent the transmission of TB in healthcare facilities. In 1994, an enhanced set of guidelines superseded the 1990 version and called for increased room ventilation and additional engineering controls on ventilation systems serving TB isolation rooms. In 1996, the CDC also issued guidelines on isolation precautions in hospitals.

More recently, the outbreak of Severe Acute Respiratory Syndrome (SARS) in Asia and Canada, and the potential for biological terrorism has heightened the focus on ensuring that healthcare facilities incorporate state-of-the-art ventilation systems and associated engineering controls for protecting both patient populations and those responsible for providing medical treatment of those infected with an airborne transmitted disease.

This technology report summarizes the requirements and recommendations for the prevention of transmission of an airborne transmitted disease in healthcare facilities based on the current industry guidelines listed in the following section, as well as the experience of knowledgeable healthcare facility designers.

Current Industry Guidelines

In 2004, the CDC drafted an updated version of its 1996 Guideline on Isolation Precautions in Hospitals for public comment before official release. This draft is entitled: Preventing Transmission of Infectious Agents in Healthcare Settings.

In 2003, the CDC issued guidelines for reducing the propagation of diseases in healthcare facilities entitled: Guidelines for Environmental Infection Control in Health-Care Facilities.

In 2001, the Canadian Standards Association published CAN/CSA-Z317.2-01 entitled: Special Requirements for Heating, Ventilation, and Air Conditioning (HVAC) Systems in Health Care Facilities.

In 2006, the AIA published an updated version of its 2001 Edition: Guidelines for the Design and Construction of Hospital and Health Care Facilities. The requirements for Airborne Infection Isolation Rooms appear in section (3.2.2 and 10.2.2.1), Protective Environment Rooms are in section (10.2.2.2) and ventilation is in (Table 2.1-2).


Disease Transmission

Aerosols and Moisture Droplets, and Direct Contact are the two major avenues that transmit disease-carrying pathogens from an infection source to another person.

Aerosols and Moisture Droplets

Aerosols are 10 microns or smaller in size and are often between 1 and 5 microns. They’re not visible and can float indefinitely on room air currents. Moisture droplets are much larger than aerosols and are usually visible. Both aerosols and droplets containing infectious pathogens are generated when an infected person coughs or sneezes and even when the person speaks.

Although moisture droplets can transmit disease, they are a lesser concern than aerosols because the larger size of a droplet causes it to sink faster and mostly affect an area within about three feet from the patient. Aerosol transmission is the greatest concern because normal room air movement can cause aerosols containing infectious pathogens to travel appreciable distances. In fact, most airborne disease transmission is by aerosols containing bacterial agents (rather than viral agents). The most common diseases that are transmissible by aerosol and droplet transmission include TB, Influenza, Bacterial Pneumonia, SARS, Measles, and Smallpox.
Direct Contact

Direct contact transmission occurs when microorganisms are transferred directly from one person to another person. Examples of direct contact transmission in healthcare settings include:

- Blood from a patient directly enters a caregiver’s body through a cut in the skin.
- Scabies mites from a patient are transferred to the skin of a caregiver while he/she is lifting the patient.
- Herpetic whitlows that develop on a healthcare provider’s finger after contact with *Herpes simplex* virus when providing oral care to a patient without using gloves or transmitting HSV to a patient from a herpetic whitlow on an ungloved hand of a healthcare worker.

Direct contact transmission is more efficient than indirect contact transmission, but occurs less frequently in healthcare settings than does indirect contact transmission. Transmission by direct contact occurs more frequently between patients and healthcare personnel than between patients. Disease is more likely to develop following direct contact transmission when the pathogen is highly virulent or has a low infectious dose or the patient or healthcare worker is immunocompromised.

Infection Isolation Room Layout—An infection isolation patient room is to be designed for only one patient. Although designed as single patient rooms, facilities may also need to accommodate larger numbers of patients if a disease outbreak occurs (such as SARS) or subsequent to a biological terrorist attack. Cohorting is the practice of grouping patients with the same infection or colonization with the same multi drug resistant organism (MDRO) together to confine their care to one area and prevent contact with other patients. This is not a primary prevention strategy due to the logistical difficulties encountered and the frequent lack of microbiologic data to determine infection or colonization status, especially in Long Term Care Facilities. Cohorts are created based on clinical diagnosis, microbiologic confirmation when available, epidemiology, and mode of transmission of the infectious agent. Criteria for including a patient in a cohort include 1) the patient is not infected with other potentially transmissible microorganisms; 2) the likelihood of reinfection with the same organism is minimal; and 3) the patient is not severely immunocompromised.

Design Requirements for Healthcare Facilities

Airborne Infection Isolation

Airborne Infection Isolation (AII) is intended to protect healthcare workers and visitors from contracting a patient’s disease mainly via aerosol and moisture droplet transmission. Most notably this includes TB, but also includes other diseases that are susceptible to aerosol transmission.

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3. AIA Guidelines, 2006 Section 3.2.2.3, p. 43

Figure 1 shows a diagram of the room arrangement and HVAC design for an infection isolation room. The supply and exhaust air locations are chosen to promote maximize air mixing and to optimize airflow away from the healthcare worker towards the patient. Supply air enters the patient room through a Group A or Group E diffusers. The best location for the supply diffuser is located in the ceiling at the foot of the patient’s bed and the exhaust air on the wall near the floor at the head of the bed.

Room Exhaust—While the exhaust air from infection isolation rooms must be discharged outside of the building, the guidelines listed at the beginning of this document do not specifically require the exhaust to be High Efficiency Particulate Air (HEPA) filtered. However, HEPA filtering should be implemented if unfiltered exhaust air might pose a hazard to persons, other buildings or might be re-entrained into the building fresh air intakes. In most instances, one or more of these potential scenarios is likely; therefore, incorporating HEPA filters on the exhaust is usually warranted.

Infection Isolation Room Pressurization—The patient room must be maintained at a negative pressure with respect to the corridor. This is accomplished by exhausting a greater amount of airflow from the combination of patient room and toilet room than the amount of supply airflow provided. The greater negative pressurization created in the patient room ensures that airflow will move from the corridor into the patient room. The supply air diffuser location, the patient room exhaust location, and the negative room pressurization arrangement all combine to maintain a directional room airflow that minimizes the likelihood that infectious aerosols will travel from the patient to the healthcare personnel and visitors.

5. A HEPA filter will retain a minimum of 99.97% of aerosols above 0.3 microns in diameter (0.3 millionth of a meter). This will filter out all bacteria and most viruses. However it will not stop chemical fumes or infectious prions. More information on HEPA filters and their performance can be found on the following Web site: http://www.arche.psu.edu/iec/abe/wjffiltr.html
Newly constructed and renovated airborne infection isolation patient rooms should be 0.01 in. WC negative (-2.5 Pa) with respect to the corridor.\(^6\)

**Differential Pressure Monitoring**—To verify that the required level of pressure differential maintained between the infection isolation room and corridor, visual indication of the direction of airflow is required at the entry to the patient room\(^7\). This allows the negative pressurization to be constantly monitored and verified at the entry to the patient room. The differential pressure monitor provides visual indication of the direction of airflow to the healthcare workers. It lets them know that the required room pressurization is being maintained and also warns them of any loss of the required differential pressure. State building codes, may require room pressurization to be monitored at the nurses station by an auxiliary alarm panel to show individual room alarm indication.

When a door is opened, a momentary loss in differential pressure occurs as the door opens and then closes. Therefore, differential pressure alarms have an adjustable delay period to prevent nuisance alarms during the time needed for normal passage through the doorway and for the ventilation system to restore the required differential pressure. Even though a momentary loss of the differential pressure occurs while a door is open, proper directional airflow into the patient room is maintained and airborne pathogens are kept from drifting outward toward the doorway.

Differential pressure monitoring also provides remote monitoring and provides alarm indication to the building automation system (BAS), which allows historical isolation room operation data to be collected. If alarms are monitored by the BAS Remote Notification application these alarms can be monitored and assessed by infection control team. The alarm monitoring process should include alarm escalation procedures so corrective action can be implemented and documented.

Room pressurization must be confirmed before a patient is placed in an AII room, and checked daily while the room is occupied\(^8\). The Room differential pressure monitor documents room operation and reduces the need for manual confirmation of room pressurization by use of visible smoke test. However, smoke test verification of room airflow direction must still be completed as part of normal system maintenance. It is also important that HVAC controls for the patient room be located outside of the rooms so that access to the control devices will not require service personnel to enter the patient room.

**Ventilation Rate for Infection Isolation Rooms**—Newly constructed and renovated infection isolation patient rooms should receive a minimum of 12 air changes per hour (ACH) and existing rooms should have a minimum of 6 ACH\(^9\).

**Ventilation Rate Effectiveness**—Figure 2 shows a graph of the time required for various ACH rates to remove given percentages (90%, 99%, and 99.9%) of aerosols from a room. This data is taken from the CDC Guidelines for Preventing the Transmission of Tuberculosis in Healthcare Facilities.

![Figure 2. Time to Remove Various Percentages of Aerosols vs. Room ACH Rate.](image)

**Protective Environments**

A Protective Environment (PE) is intended to protect patients with immunocompromised systems from contracting infectious diseases by aerosol transmission. Immunocompromised is a condition in which the immune system is not functioning normally, leaving the patient in a permanent or temporary state of increased susceptibility to infection. In the broader term, immunosuppression refers to restricted states with iatrogenic causes, including causes that result from therapy for another condition. Susceptibility to various infections is determined by severity of immunosuppression and

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6. Centers for Disease Control (CDC), December 2003, *Guidelines for Environmental Infection Control in Health-Care Facilities*, Table 6, p. 19

7. Centers for Disease Control (CDC), December 2003, *Guidelines for Environmental Infection Control in Health-Care Facilities*, p. 34

8. Ibid.

9. Ibid, p. 36
the components of the immune system that are most severely affected. Conditions associated with immunocompromise may be congenital or acquired (for example, genetically determined primary immune deficiencies, human immunodeficiency virus infection). Immunocompromised states also make it more difficult to diagnose certain infections (for example, tuberculosis) and are associated with more severe clinical disease states than those seen in persons with a normal immune system. Most notably this includes patients who are suffering from extensive burns, leukemia, are recovering from bone marrow and organ transplant surgery.

Protective Environment Room Layout—Figure 3 shows a diagram of the preferred room arrangement and HVAC design for a protective isolation room. Supply air is required to be HEPA filtered to ensure that an uncontaminated environment is maintained in the area closest to the patient. All supply air HEPA filters should have a Minimum Efficiency Reporting Value (MERV) of 17 (ASHRAE Standard 52.2, 1999).

The supply air HEPA filter should be located after all air conditioning coils and humidification equipment to trap any biological agents that might be present due to duct moisture or dust. To extend the life of HEPA filters, a conventional pre-filter should always be used at the point of outside air entry into the air handling unit (AHU) to trap larger particulate in the supply air stream before such contaminants load the HEPA filter. In addition, HEPA filters can be located in the supply air terminal of the protective room.

Conventional filters may also be located immediately in front of the HEPA filter to trap additional particulate and further extend the life of the HEPA filter. All filter pressure drops (differential pressure) should be monitored from the building automation system (BAS) to ensure they are changed whenever warranted.

Figure 3 indicates that the HEPA filtered supply air enters the patient room through Group E, non-aspirating diffuser located above the patient's bed. As the supply air enters above the patient area, it gradually moves towards the doorways and is then removed by the room exhaust provisions (toilet and patient room exhaust registers located near the patient door). This directional airflow arrangement keeps airborne pathogens from migrating toward the patient.

Room Pressurization—The protective environment room is maintained at a positive pressure. This is accomplished by supplying a greater amount of air to the patient room than is exhausted from the patient room and toilet room. The positive pressurization created in the patient room ensures the airflow will always be from the patient area out to the corridor. The room supply air entry location, the room exhaust location and the room’s positive static pressurization all combine to provide a directional airflow pattern that minimizes the likelihood that infectious aerosols will travel to the patient.

The patient room should be at 0.01 to 0.03 in. WC (2.5 to 8.0 Pa) and ideally 0.03 in. WC (8.0 Pa) positive with respect to the corridor.

Differential Pressure Monitoring—As with the previous isolation room configurations, it is especially important to ensure that the required level of pressure difference is maintained between the protective environment room and corridor; visual indication of the direction of airflow is required at the entry to the patient room. The differential pressure monitor provides visual indication of the direction of airflow to the healthcare workers. It lets them know that the required room pressurization is being maintained.


11. Centers for Disease Control (CDC), December 2003, Guidelines for Environmental Infection Control in Health-Care Facilities, p. 35
maintained and also warns them of any loss of the required differential pressure. Differential pressure monitoring also allows remote monitoring and provides alarm indication to the building automation system (BAS), which allows historical protective environment room operational data to be collected. If alarms are monitored by the BAS Remote Notification application these alarms can be assessed by infection control team. The alarm monitoring process should include alarm escalation procedures so corrective action can be implemented and documented.

**Combined Protective Environment and Airborne Infection Isolation**

A patient with an immunocompromised system may also have a contagious disease. In this situation, the patient must be protected from additional infectious organisms, while at the same time facility personnel must also be protected from airborne agents emanating from the patient. To fulfill this requirement, the patient should be placed in a negatively pressurized airborne infection isolation room to contain the patient’s infectious airborne pathogens and, thus, protect the healthcare workers.

In addition, the ventilation control system in the anteroom may be adjustable to maintain the anteroom at either a higher positive or negative pressure than the patient room by increasing the anteroom supply or exhaust. Figure 4 illustrates this arrangement.

With the anteroom at a higher positive pressure, the patient room essentially becomes *negative* with respect to the anteroom. The resulting directional airflows help keep airborne organisms from migrating into the patient room from the corridor, while also retarding patient room airborne organisms from migrating out to the corridor. Staff members do not have to mask before entering the anteroom if the anteroom is positive to the patient room, and if air is directly exhausted to the outside and a minimum of 10 ACH.

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12. Centers for Disease Control (CDC), December 2003, *Guidelines for Environmental Infection Control in Health-Care Facilities*, p. 37 (middle figure)

13. Centers for Disease Control (CDC), December 2003, *Guidelines for Environmental Infection Control in Health-Care Facilities*, p. 38
Isolation Room HVAC Design Considerations

The 2006 edition of the AIA Guidelines for Design and Construction of Hospital and Health Care Facilities state that the number of airborne infection isolation rooms provided shall be based on the ICRA or by a multidisciplinary group designated for that purpose. This means that the Infection Control Risk Assessment (ICRA) and the facility location (urban versus rural) establish the appropriate isolation room ratio. The AIA Guidelines also require an airborne infection isolation room for ED, nurseries and critical care units.

Supply Air

An important component of being able to ensure a healthy environment is to have a source of good quality supply air. If outside air intakes are properly located and the areas in proximity to the intakes are properly maintained, outside air will be virtually free of bacteria and viruses in comparison to interior air. The following list describes important design factors that should be applied to all fresh air intakes to meet these criteria:

- The bottom of all HVAC supply air intakes should be a minimum of 6 feet above ground level and preferably as high as practical to reduce the intake of vehicular exhaust, surface dust, and mold spores that originate in damp or wet areas.
- Supply air intakes and the surrounding area should be designed to lessen the potential contamination by birds (no pigeon roosting ledges near the intakes).
- For roof locations, supply air intakes should be a minimum of 3 feet above the roof and as far as possible (at least 25 feet) from any exhaust outlet on the roof, including medical exhausts and emergency generator exhaust. All roof areas, and especially the area near a supply air intake, should have good drainage to prevent accumulation of standing water and prevent mold growth.
- Supply air intakes must be at least 10 feet, or more, from plumbing vents and medical vacuum exhaust, if these exhausts are discharged above the supply air intakes. Supply air intakes should be located as far as possible from cooling towers where microscopic water droplets could be entrained into the supply air.
• Supply air intakes should not face or be in close proximity to helicopter landing/takeoff sites, since the high air turbulence of flight operations could drive considerable dust, debris, and fumes into a supply air intake.
• All ventilation system ductwork should be equipped with access doors to allow inspection, service, and cleaning. Access panels should also be provided at all duct components, such as heating and cooling coils, dampers, turning vanes, air terminals, etc.

Exhaust Air—Care must be exercised in the system design and particularly in the location of the exhaust air inlets. The following list contains important design criteria for healthcare exhaust air systems:

• Infection isolation room exhaust ductwork must be labeled as Contaminated Air at 10-foot intervals within the facility and on the discharge housing in compliance with CDC Guidelines. Exhaust air ducts should also be provided with access panels to enable inspecting, cleaning, and servicing components.
• Exhaust air discharge outlets should be as high as practical and, therefore, most typically on the building roof.
• All potentially infectious exhaust should be discharged by means of a vertical stack or vertical fan discharge arrangement so that the exhaust air is released as high as possible. Mushroom type rooftop exhaust fans are not suitable for potentially infectious exhaust.
• The exhaust air discharge outlet must not have a rain cap or other elements that could disrupt the upward direction of the exhaust air stream.

Room Design Considerations
The following additional design considerations are recommended for implementation in new facilities and, where possible, in facilities undergoing extensive renovation:

• Appropriate permanent signs must clearly indicate the special nature of the rooms (infectious or protective isolation), as well as clearly indicate the type of protective clothing (gowns, masks, gloves, etc.) that must be worn and procedures to be followed. A changing room, with ample storage for protective items, should be available for those entering the isolation room area.
• Airborne infection isolation room perimeter walls, ceiling, and floors, including penetrations must be sealed tightly so that air does not infiltrate the room environment.16
• Isolation room and anteroom doors are required to have self-closing devices on all room exit doors17.
• Protective environment room walls should be smooth and impervious to the disinfectant solutions normally used to sanitize the room. Solid ceilings (such as drywall) are also required in these rooms. Ceiling height should be minimized (8 feet) to maximize the ventilation (ACH) rate effectiveness and to provide adequate space above the ceiling for ventilation system ductwork. No carpeting should be in the patient rooms or hallways, and furniture outer covering should be impervious to liquids.
• Humidity in isolation rooms should not exceed 60% rh, since higher values promote fungal growth. When additional moisture is required to maintain the desired humidity level, it is best to add the supply air via a steam type humidifier and potable water for steam generation (not chemically treated boiler water).
• All ventilation systems serving isolation rooms should be on the facility essential electrical power supply system.

Ultraviolet Germicidal Irradiation
In some climates or in certain high-risk areas of a facility, proper airborne infection isolation room ventilation may be supplemented by the application of Ultraviolet Germicidal Irradiation (UVGI). This may be particularly applicable for larger isolation rooms (wards), waiting rooms, or long-term patient common areas such as recreation rooms. Studies have shown that TB and other infectious organisms are killed when sufficiently exposed to UVGI. However, a major concern about UVGI is ensuring against personnel exposure and its continued effectiveness. UVGI systems must, therefore, be properly installed and maintained.

UVGI may be applied in several forms:

• In TB sputum collection booths, bare UV bulbs can be used to irradiate the entire booth when it is not occupied.
• UVGI bulbs in pre-configured units may also be incorporated to prevent the growth of microbes on HVAC system components, such as cooling coils and filter surfaces. Since the UVGI disinfecting process requires a finite exposure

16. AIA Guidelines 2006, section 3.2.2.4 p.43
17. Ibid.
time, UVGI is generally not effective for disinfecting a fast moving air stream due to the limited time that airborne microbes would be exposed to the UV rays.

- UVGI units must receive regular inspections and periodic bulb replacement. Good quality bulbs will have a service life of about seven to twelve months. After that time period, bulb effectiveness is rapidly reduced.

### General Healthcare Facility Ventilation Related Recommendations

- Monitor all ventilation system components in accordance with manufacturers’ recommendations to ensure optimal system performance for removal of particulates, and elimination of excess moisture.
- Ensure that filters are of proper type, properly installed, and maintained to prevent air leakage and dust overloads. Differential pressure sensors that are monitored from the BAS will detect filter loading.
- Monitor areas with special ventilation requirements for proper ACH rates and adequate room differential pressure.
- Provide automatic data recording and archiving of important room parameters, such as temperature, relative humidity, and especially ACH rates and pressure differentials.
- Monitor room relative humidity levels to ensure moisture levels are within the required range and do not rise above pre-set limits. Proper humidity controls and dehumidification are designed into the HVAC system. All patient rooms should have individual room temperature control.
- Locate duct humidifiers upstream from the final HEPA and pre-HEPA filters. Locate all duct takeoffs sufficiently downstream from a humidifier so that moisture is completely absorbed by the air stream.
- Develop an isolation room contingency plan in the event of a general power failure. Emphasize continuation of air quality and ventilation conditions in all isolation rooms as well as operating rooms, emergency departments, and intensive care units, etc.
- Coordinate HVAC system maintenance with infection-control procedures and arrange for relocation of immunocompromised patients if maintenance is necessary.
- Shut down HVAC systems serving offices and administrative areas during unoccupied periods for energy conservation. However, the shutdown must not alter or adversely affect pressure differentials maintained in critical-care areas with specific pressurization requirements.

### Construction and Renovation Procedures

Healthcare facilities are almost continually undergoing some construction, either for expansion or facility upgrades. Construction activities can pose a significant challenge to maintaining the proper level of infection control in existing, functioning parts of the facility. The following recommended measures minimize the adverse affects of construction activities:

- Establish a multidisciplinary team[^18] that includes architect, contractor, consultant(s) and infection control personnel to plan the necessary preventive measures during demolition, construction, or renovation activities. The Infection Control Risk Assessment (IRCA) will determine the location and construction of construction barriers to prevent dust from construction areas from entering any part of the facility. In addition, construction areas must be maintained at a negative pressure relative to the adjoining part of the facility.
- Educate the project design firms (architects and engineers) on the special needs of the ICRA to prevent airborne infection[^19] due to construction. These requirements must then be properly documented and added to or referred to by the project documents and contract documents (plans, specifications, instructions to bidders, etc.). This is necessary to ensure that contractors during the negotiation or bidding process can include these measures in their cost estimates and in establishing their construction schedule. In addition, including these requirements in the contract documents, or referring to them, will ensure that they can be enforced.
- During construction, it is important to monitor the integrity of the construction barriers and to

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[^18]: AIA Guidelines 2006, section 2.1.1 p. 26
[^19]: Immune suppressed patients are particularly susceptible to infections caused by airborne mold spores, particularly Aspergillus (which is often fatal) and tend to multiply rapidly in the high moisture situations as associated with new masonry and rainwater penetration in areas without finished roofs).
ensure proper directional airflow. Establish and maintain a surveillance program for airborne particulate. That particulate may include mold spores, bacteria, microbes, etc. within the active part of the facility during construction to ensure the health and safety of immunocompromised patients and continued maintenance of indoor air quality goals.

- During the entire construction period, ensure that signs and other provisions remain in place to direct persons away from the construction zone and minimize the dispersion of dust and contaminants. When construction personnel require access to the interior of the existing facility, entrances and elevators should be designated specifically for those workers. When the work mainly involves an area within the interior of an existing facility, separate washrooms and break areas should also be designated for the workers and, when practical, these areas should be separated from the other parts of the facility by adequate barriers.

**Commissioning**

Commissioning is a quality control process used to achieve, validate and document that facilities and HVAC mechanical systems, room environments are planned, constructed, installed, tested, and capable of being operated and maintained as required based upon design and performance requirements. The AIA 2006 guideline has includes commissioning to ensure that health care facilities are constructed to meet patient environment of care needs. This is of special importance for ventilation systems that are recognized as a means of infection control.

- The Commissioning agent should be an independent 3rd party, not associated with the installing contractor.
- Air balancing, pressure relationships, and exhaust criteria for mechanical systems should be clearly described and tested to create an environment of care that provides infection control. Ventilation deficiencies are not acceptable.\(^{20}\)
- Areas requiring emergency power should be specified and tested.

\(^{20}\) AIA Guidelines 2006, section 4.1.2, p.28