Technical Report 1

ASHRAE Standards 62.1, 170, and 90.1 Evaluation

Morton Hospital Expansion

Taunton, MA

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September 17, 2014

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Executive Summary

The purpose of this evaluation is to check the Morton Hopsital expansion project's compliance with ASHRAE Standard 62.1 – 2013 *Ventilation for Acceptable Indoor Air Quality* and ASHRAE 90.1 – 2013 *Energy Standard for Buildings except Low Rise Residential*. Being originally built in 1988, only the addition was evaluated by ASHRAE standards. Additionally, since the project is a health care facility, there are additional requirement that must be met. This evaluation also discusses its compliane with ASHRAE 170 – 2013 *Ventilation for Health Care Facilities*.

As demonstrated in this report, Morton's current mechanical design complies with all ASHRAE 62.1 - 2013 Section 5 requirements for acceptable indoor air quality. Systems will help to prevent adverse health effects by preventing mold growth, and minimizing contaminants through maintenance. Analysis of ASHRAE 170 replaces the ASHRAE 62.1 section 6 ventilation procedures.

After further assessment, The Morton Hospital Expansion project also satisfies the requirements stated in ASHRAE 170 – 2013. This is not surprising since this standard was the basis of design for the mechanical system ventilation rates. Being a healthcare facility, the indoor air quality of the building is exceedingly important to ensure the prevention in spreading diseases or putting patients at harm in any way.

Discussed below, Morton Expansion does not completely comply with ASHRAE 90.1 – 2013. As discussed in ASHRAE 90.1 section 6.5, a heat recovery system is required given the zone and percentage of outdoor air. In addition, although compliant, the use of a DX system could be improved as well as the air cooled chiller being replaces by a water cooled chiller could greatly increase energy performance. Redesigning the system based on these and other suggestions would be greatly beneficial to the energy consumption of the building.

Building Overview

Morton Hospital, originally built in 1988, is located in Taunton, MA serving the Greater Taunton Area. In 2010, Steward Healthcare acquired ownership of the hospital and soon after decided to expand its facility. It is currently a 100,000 SF 2-story hospital providing services including emergency and expressMed care, cardiology, orthopedics, maternity, and Outpatient surgery. The expansion will be split into two phases totaling 40,000 SF. Phase 1 being a new MRI, while the Phase 2 includes the Emergency Department, Psych Ward, imaging suite, various treatment and triage rooms, and decontamination and isolation rooms. *Figure 1* below shows the key plan with the Phase 1 expansion being the boxed out grey section directly in the middle, Phase 2 expansion in white, and the existing hospital in the remaining grey.

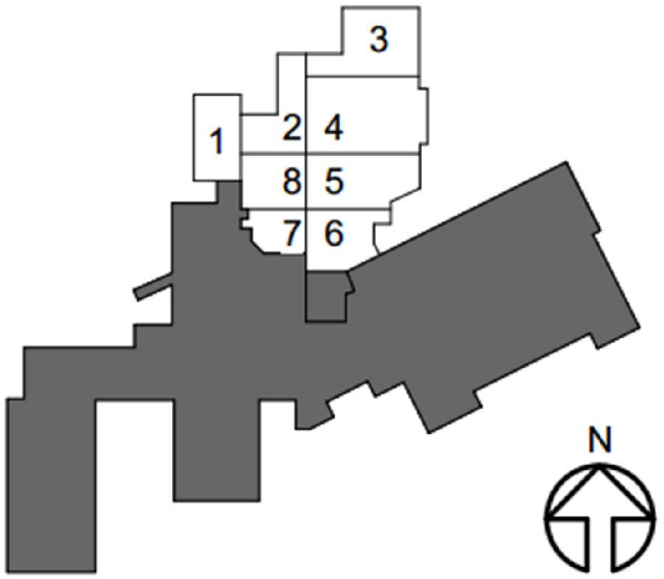

Figure 1: Key plan of existing versus expansion

This expansion will be built around an existing covered parking area that will be fit out for interior space. Both phases will begin construction at the same time, and phase 1 will be complete and opened while phase 2 remains under construction. The addition will be accessed from the existing building through an additional vestibule, and will also have multiple entryways from the exterior including an ambulance entry vestibule and emergency room vestibule. Roof slab construction is anticipated to house as a floor slab for possible future construction.

Mechanical Systems Overview

The primary source for the building addition heat and chilled water is provided by the existing hospital steam system and chiller plant. The low pressure steam system will employ heat exchangers to provide building reheat, preheat, perimeter heating, and domestic water heating. Chilled water will be provided by both the existing hospital distributed chiller plant as well as a new 155 ton air cooled chiller. Both steam and chilled water connections will originate from the existing basement below the proposed MRI space.

The central air handling system will be provided by two modular air handling units. Phase 1 will be provided by a rooftop packaged DX unit containing a steam preheat coil and direct expansion cooling coil, provided by existing steam plant and air cooled condensing unit respectfully. Phase 2 will employ a roof mounted chilled water air handling unit containing a hot water preheat coil and chilled water cooling coil, supplied by a steam-to-water heat exchanger and air cooled chiller respectfully. Both will be variable air volume, supply return type, controlled by minimum outside air monitoring and airside economizer control. Humidifiers are included within the units, and supply and return fans are driven by variable frequency drives.

Some spaces will require supplemental cooling provided by a chilled water fan coil unit, including the MRI equipment room, totaling 4 fan coil units within the addition. Chilled water will be provided for direct medical equipment cooling, and any equipment requiring a higher temperature, pressure, or filtration will require a system with an additional heat exchanger and pump.

Standard 62.1 Evaluation | Ventilation for Acceptable Indoor Air Quality

This section will discuss the current building addition's mechanical design compliance with ASHRAE 62.1-2013 Ventilation for Acceptable Indoor Air Quality. Sections 1 through 4 discuss the purpose, scope, and definitions of the standard, as well as outdoor air quality and therefore are not discussed. Note that because Morton is a health care facility, it must also comply with ASHRAE 170, Ventilation for Health Care Facilities. In lieu of the ventilation rate, IAQ, and natural ventilation procedures outlined in Standard 62.1 Section 6, Morton was designed using ventilation procedures outline in Standard 170. This evaluation can be found below.

Section 5.0: Systems and Equipment

Section 5.1: Ventilation Air Distribution

Section 5.1.1 requires the building ventilation system be provided with means to adjust to achieve the minimum airflow while maintaining a balancing of airflow at all times. Within the addition, each zone is controlled by either a constant or variable volume terminal box provided with supply/return air tracking control via supply return fan offset control.

Section 5.1.2 discusses using the plenum to recirculate and distribute air. All air within the hospital will be ducted, both supply and return, and therefore this section is not applicable.

Section 5.1.3 requires documentation for air balance testing. This can be found in the building specifications section 23 05 93 Part 3.1 *Air system Balancing and Testing Procedures*, which specifies its compliance with *The Associated Air Balance Council* (AABC).

Section 5.2: Exhaust Duct Location

This section requires that all exhaust ducts with potentially harmful contaminants be negatively pressurized to avoid exhaust leakage into adjacent spaces. Within the addition, spaces that do require negative pressure include the ER waiting room, triage rooms, patient restrooms, and airborne infection isolation rooms. Negative pressure is achieved by exhausting more air than is supplied within each of these spaces, and forcing airflow from adjacent spaces into these spaces. Additionally, specifications also indicate SMACNA Construction Stardards, *Figure 2* below, that designate seal and leakage classes required for all ductwork.

Minimum SMACNA Construction Standards						
Ductwork Location	Pressure Class Inches W.G.	Seal Class	Leakage Class	Material	Sound Lining	Table Notes
Supply from Air Handling Unit to terminal boxes	±4	A	4	G-90	No	
Supply from terminal boxes to outlets	±2	A	4	G-90	No	1
Return from inlets to return fan	-3	A	4	G-90	No	1
Isolation room exhaust.	-3	A	4	G-90	No	1, 2
Toilet exhaust	-3	A	4	G-90	No	1
General exhaust	-3	A	4	G-90	No	1
Plenums	±4	A	4	Same as Ducts	As In-dictated	1
Other	±3	A	4	G-90	No	1

Figure 1: Minimum SMACNA Construction Standards for Ductwork within the Project

Section 5.3 Ventilation System Controls

All systems' controls must maintain, at a minimum, the outdoor air intake flow at all times. The temperature control system (ATC) and overall building automation system (BAS) will employ a DDC with electric actuation connected to the existing Facilities Management System. Each zone will be provided with a terminal box controller to control temperature settings and zone airflow. The air handling unit and BAS work together to ensure that the minimum outdoor airflow is always achieved.

Section 5.4 Airstream Surfaces

Airstream surfaces are required to resist mold growth and erosion with a standardized test. Material standards of the addition are required to adhere to UL 181 – *Factory-Made Air Ducts and Connectors*, as stated in the building specifications.

Section 5.5 Outdoor Air Intakes

Considering that Morton Hospital is a health care facility, ASHRAE 170, *Ventilation for Health Care Facilities* Section 6.3, *Outdoor Air Intakes and Exhaust Discharge*, is analyzed below in lieu of ASHRAE 62.1 Section 5.5. The ASHRAE 170 standard is more stringent than the 62.1 standard, and therefore will also be compliant with 62.1.

Section 5.6 Local Capture of Contaminants

There is no equipment within the project that generates contaminants, and therefore this section is not applicable.

Section 5.7 Combustion Air

The main source of heat for the building is the existing steam plant, and therefore there is no fuel-burning appliances. This section is not applicable.

Section 5.8 Particulate Matter Removal

As stated in the filter section of the building specifications, Section 23 41 00, filters must have an average efficiency between 30-35%, an average arrestance between 90-92%, and have a MERV 8 rating in accordance with ASHRAE Standards 52-1 and 52.2. Thus, the filters comply with this section. ASHRAE Standard 170 discusses filters in more detail, see below.

Section 5.9 Dehumidification Systems

Humidification is provided by having air handling unit humidifiers in both AHUs. The baseline relative humidity is 30%, and therefore far exceeds that of the Section 5.9.1 requirement of no greater than 65%. As discussed in the standard, general exhaust, totaling 7400 CFM, does not exceed the minimum outside air intake, 9450 CFM, satisfying section 5.9.2.

Section 5.10 Drain Pans

Building specifications indicate that the drain pan slope is a minimum of 1/8”/foot, in compliance with section 5.10.1. Drain pans must extend 6 inches beyond each side of the pan to ensure sufficient collection of water droplets, in accordance with section 5.10.4. Drains are also piped to floor drains or utility sinks and are provided with a seal trap.

Section 5.11 Finned-Tube Coils and Heat Exchangers

The project heat exchangers and cooling coils are provided with a drain pan in accordance with 5.11.1. All heat exchangers are shell-and-tube type, thus section 5.11.2 does not apply.

Section 5.12 Humidifiers and Water-Spray Systems

Both AHU Humidifiers are steam humidifiers that receive steam at low pressure, or supply pressure, and exit at atmospheric pressure. Potable water standards are met, and obstructions must be at least 8 feet downstream of the humidifier, as specified by the manufacturer.

Section 5.13 Access for Inspection, Cleaning, and Maintenance

All equipment, including AHUs, terminal boxes, fan coil units, etc., will include access doors and sufficient working space for inspection purposes, in accordance with sections 5.13.1 and 5.13.2. As stated in section 26 05 20 of the building specification, all access panels shall be a minimum of 12" by 12", and located in closets, storage rooms, or other non-public areas when possible.

Section 5.14 Building Envelope and Interior Surfaces

Sheet membrane vapor barriers will be used below the concrete slab-on-grade to prevent water penetration through the slab. Also, a continuous bituminous sheet air barrier within the building enclosure will prevent vapor diffusion, and all penetrations due to joints or seams will be properly sealed. Ethylene propylele diene monomer (EDPM) single ply membrane roofing will be used to prevent water penetration through the roof. These key components all comply with ASHRAE 62.1 section 5.14.1.

Ductwork insulation will be faced flexible fiber glass insulation, with a thermal conductivity of 0.3 at 75° F. This satisfies section 5.14.2 in being sufficient to prevent the form of condensation.

Section 5.15 Building with Attached Parking Garages

Morton Hospital existing building and proposed addition will not be attached to a parking garage, thus this section is not applicable.

Section 5.16 Air Classification and Recirculation

Because Morton Hospital is a healthcare facility, and therefore many spaces are not designated an air class within ASHRAE 62.1. Rather spaces including, but not limited to, the ER waiting room, patient restrooms, isolation rooms, and decontamination rooms have different exhaust requirements which will be outlines in the ASHRAE 170, *Ventilation of Health Care Facilities* Evaluation below. Spaces such as corridors, offices, or reception areas are designated Air Class 1 or 2, and can be returned to the air handling unit to be treated by pre-filters, after filters, and final filters to be reused throughout the hospital.

Section 5.17 Requirements for Buildings Containing ETS Areas and ETS-Free Areas

Morton Hospital is a non-smoking facility and classified as an ETS-free space. This section does not apply to the project.

ASHRAE 62.1 Compliance Summary

Morton's current mechanical design complies with all ASHRAE 62.1 - 2013 Section 5 requirements for acceptable indoor air quality. Following these requirements will help the hospital maintain a healthy system, and therefore minimizes adverse health effects. This is the only section thouroughly evaluated within the standard because ASHRAE 170 has been evaluated in lieu of ASHRAE 62.1 section 6 ventilation procedures.

Standard 170 Evaluation | Ventilation for Health Care Facilities

This section will discuss the current building addition's mechanical design compliance with ASHRAE 170, Ventilation for Health Care Facilities. Because this standard is much more applicable to Morton Hospital's application, it is being evaluated as a replacement for ASHRAE Standard 62.1 Section 6 Procedures evaluation. Original analysis of the addition was done using ASHRAE 170. Note that sections 1 through 5 are related to the scope of the standard and are not discussed below.

Section 6: Systems and Equipment

Section 6.1 Utilities

Section 6.1.1 discusses the ventilation requirement upon loss of electrical power for limited types of spaces. The Morton addition does include airborne infection isolation (AII) rooms that must maintain ventilation and pressure relationships at all times. Drawings specify two isolation exhaust fans, one active and one standby for emergency situations. AII room exhaust also utilizes phoenix venture valves to ensure correct ventilation.

Section 6.2 Air-Handling Unit Design

The modular air handling units supplying air to the Morton Addition include casing that is a double wall galvanized steel construction. Panels shall provide a minimum R value of 12 and coated with 1.5 mil enamel finish, as stated in section 23 74 13 of the building specifications. This is in compliance with that of section 6.2 of ASHRAE 170.

Section 6.3 Outdoor Air Intakes and Exhaust Discharge

AHU outdoor air intakes are on the top of the roof mounted AHU, and therefore are well above the six feet above grade minimum and the 3 feet above roof level minimum. Intakes are also greater than 25 feet from all exhaust and vent discharges, in compliance with section 6.3.1. Isolation room exhaust and emergency department exhaust is discharged a minimum of 10 feet above the roof level and is more than 10 feet horizontally from air intakes or windows, also in compliance with section 6.3.2.

Section 6.4 Filtration

Filters must comply with Table 6.4, *Minimum Filter Efficiencies*, of ASHRAE 170. As seen from the table below, *Figure 3*, there are two required filter banks with listed minimum MERV ratings based on

space designations. The first filtration bank is placed upstream of the heating and cooling coils and filters all mixed air. The second bank is installed downstream of the coils.

TABLE 6.4 Minimum Filter Efficiencies

Space Designation (According to Function)	Filter Bank No. 1 (MERV)[a]	Filter Bank No. 2 (MERV)[a]
Operating rooms (Class B and C surgery); inpatient and ambulatory diagnostic and therapeutic radiology; inpatient delivery and recovery spaces	7	14
Inpatient care, treatment, and diagnosis, and those spaces providing direct service or clean supplies and clean processing (except as noted below); All (rooms)	7	14
Protective environment (PE) rooms	7	HEPA[c,d]
Laboratories; Procedure rooms (Class A surgery), and associated semirestricted spaces	13[b]	NR
Administrative; bulk storage; soiled holding spaces; food preparation spaces; and laundries	7	NR
All other outpatient spaces	7	NR
Nursing facilities	13	NR
Psychiatric hospitals	7	NR
Resident care, treatment, and support areas in inpatient hospice facilities	13	NR
Resident care, treatment, and support areas in assisted living facilities	7	NR

NR = not required

Notes:

a. The minimum efficiency reporting value (MERV) is based on the method of testing described in ANSI/ASHRAE Standard 52.2, *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size* ([ASHRAE 2012] in Informative Appendix B).

b. Additional prefilters may be used to reduce maintenance for filters with efficiencies higher than MERV 7.

c. As an alternative, MERV-14 rated filters may be used in Filter Bank No. 2 if a tertiary terminal HEPA filter is provided for these spaces.

d. High-Efficiency Particulate Air (HEPA) filters are those filters that remove at least 99.97% of 0.3 micron-sized particles at the rated flow in accordance with the testing methods of IEST RP-CC001.3 (IEST [2005] in Informative Appendix B).

Figure 2: ASHRAE 170 Minimum Filter Efficiencies

Modular AHU-1 services phase 1 of the project which includes the MRI. The pre-filter is located upstream of the coils and has a MERV rating of 8. The final filter is located downstream of all coils, the steam humidifier, and supply fan, and has a MERV rating of 14, both complying with Table 6.4. Modular AHU-2 services phase 2 which includes an array of spaces ranging from the ED, psych ward, and isolation rooms. Within AHU-2, there are three filter; the pre-filter with a MERV 8 rating and the after-filter with a MERV 11 rating are both downstream of the mixing plenum and upstream of the coils. The final filter is located downstream of the coils and supply fan and has a MERV rating of 14. With the additional filter, AHU-2 is well above the minimum standards listed in Table 6.4.

Section 6.5 Heating and Cooling Systems

Subsection 6.5.1 refers back to ASHRAE 62.1 Section 5.10 which has already been evaluated above, and does comply. Radiant cooling systems are not utilized in this project and therefore

subsection 6.5.2 does not apply. Radiant heating systems are used, but not in the specified spaces, and therefore subsection 6.5.3 also does not apply.

Section 6.6 Humidifiers

Steam humidifiers are located within the air handling units, and chemical additives used comply with FDA requirements, as stated in the building specifications Section 23 25 00, *Chemical Water Treatment*, in compliance with section 6.2.

Section 6.7 Air Distribution Systems

Pressure relationships are maintained at all times based on requirements listed in Table 7.1 of ASHRAE 170. Airstream surfaces comply with ASHRAE 62.1, evaluated above, and therefore comply with this section.

All diffusers are non-aspirating, or Group E Classification, in accordance with Table 6.7.2 *Supply Air Outlets* Classifications. Rooms designated as psychiatric treatment rooms include Type M diffusers, or supply grilles in security areas, specifically Tuttle and Bailey – SG500. This diffuser meets the requirements discussed in section 6.7.2.

Section 7: Space Ventilation

Section 7.1 General Requirements

Spaces must be ventilated in accordance with ASHRAE 170 Table 7.1. Each space must be designated a certain function of space, each requiring a pressure relationship to adjacent spaces, minimum outdoor air changes, minimum total air changes, exhaust requirements, relative humidity guidelines, and design temperature guidelines. This table can be found in Appendix A, Table 2.

Each space's requirements were found based on these minimums, and ventilation calculations can be found in Appendix A, Table 1. Only health care spaces were considered in this calculation. For instance, the few offices, electrical rooms, and conference rooms contained in the addition are not specified in ASHRAE 170 Table 7.1. These spaces were designed to assume an occupant ventilation requirement of 20 CFM per person, which assumes a higher requirement than ASHRAE Standard 62.1 Table 6.2.1, and were not analyzed further.

The number of air changes is defined as the number of times air is replaced within a space in one hour, with units of ach/hour. Defining airflow rates by air changes (ach) is done using the following equation:

Airflow rate (CFM) = Room Volume (ft^3) x #ach/60 min per hour

Specified pressurization relationships are met, ensuring that contaminants/diseases are not spread to adjacent spaces. Also, spaces that require all room air to be exhausted are grouped by "general exhaust", "ED room exhaust", and "Isolation Room exhaust" accordingly and are exhausted using centrifugal fans on the roof. All design parameters are met, satisfying section 7.1.

Section 7.2 Additional Room Specific Requirements

There are a number of additional space requirements found in this section. Section 7.2.1 *Airborne Infection Isolation (AII) Rooms* is the only applicable section for the Morton Addition. These spaces contain a pressure monitor that ensures that the correct pressure differential is met. All exhaust air is discharged to the outdoors and does not mix with general exhaust. Exhaust diffusers must also be located directly above the patient's bed. All requirements have been satisfied within the AII rooms.

ASHRAE 170 Compliance Summary

The Morton Hospital Expansion project satisfies the requirements stated in ASHRAE 170 – 2013. This is not surprising since this standard was the basis of design for the mechanical system ventilation rates. Being a healthcare facility, the indoor air quality of the building is exceedingly important to ensure the prevention in spreading diseases or other contaminants.

ASHRAE Standard 90.1 Evaluation | Energy Design Evaluation

Section 5.0: Building Envelope

Section 5.1.4: Climate

The climate region must be determined using Figure B1-1 in Appendix B of ASHRAE 90.1, shown below (*Figure 4*). According to this figure, Taunton, MA classifies as *Zone 5A*.

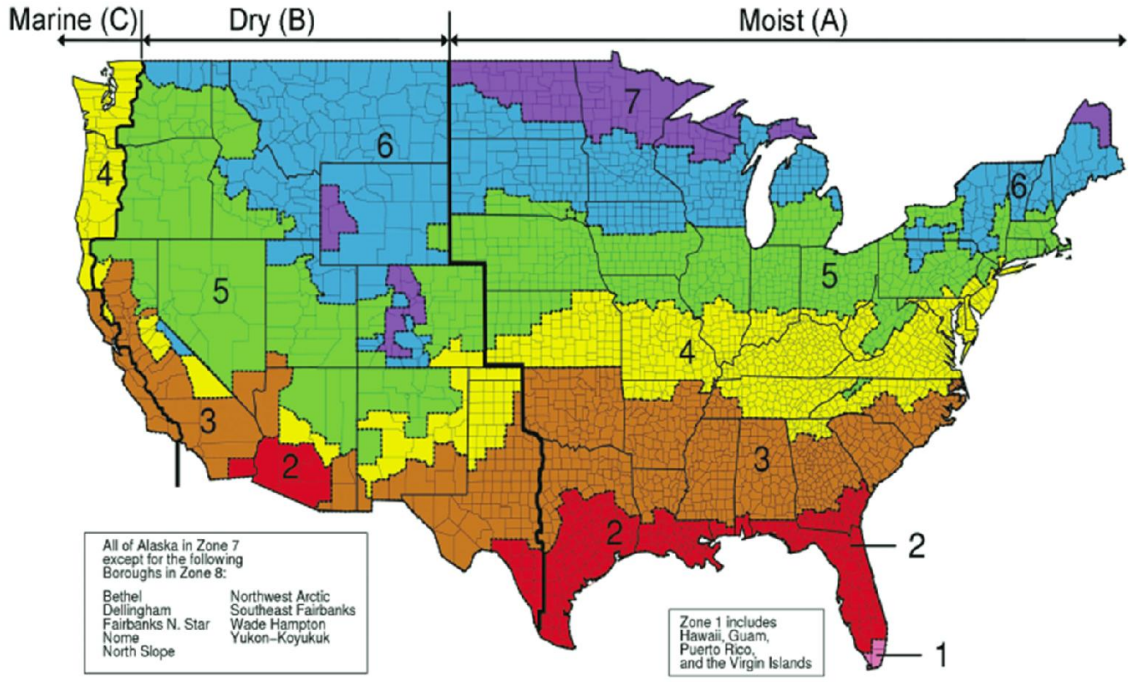

Figure 3: ASHRAE 90.1-2013 Figure B1-1 US Climate Zone Map

Section 5.2: Compliance Paths

Based on the fenestration requirements listed in section 5.5, it is allowable for Morton Hospital to use the "Prescriptive Building Envelope Option." These requirements state that a building's vertical fenestration cannot exceed 40% of the total wall area, and skylight fenestration cannot exceed 5% of the total roof area. Because Morton is well below these requirements, section 5.5, described below, is utilized.

Section 5.4: Mandatory Provisions

A continuous air barrier is utilized to ensure no air leakage through the envelope. Fenestration and doors are properly sealed to comply with section 5.4.3.2. All entrances to Morton Hospital have entrance vestibules in order to separate the exterior from the interior, in accordance with 5.4.3.4. This includes an ambulance vestibule that is conditioned with a fan coil unit, and air is supplied through linear diffusers along automated doors.

Section 5.5: Prescriptive Building Envelope Option

ASHRAE 90.1 Table 5.5-5 (Figure 5) can be used to meet building envelope requirements for climate zone 5A. All exterior walls, roofs, slab-on-grade floors, as well as fenestration meet the required building envelope U-values and R-values.

Table 5.5-5 Building Envelope Requirements for Climate Zone 5 (A,B,C)*

	Nonresidential		Residential		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation Entirely above Deck	U-0.032	R-30 c.i.	U-0.032	R-30 c.i.	U-0.063	R-15 c.i.
Metal Building[a]	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.082	R-19
Attic and Other	U-0.021	R-49	U-0.021	R-49	U-0.034	R-30
Walls, above Grade						
Mass	U-0.090	R-11.4 c.i.	U-0.080	R-13.3 c.i.	U-0.151[b]	R-5.7 c.i.[b]
Metal Building	U-0.050	R-0 + R-19 c.i.	U-0.050	R-0 + R-19 c.i.	U-0.094	R-0 + R-9.8 c.i.
Steel Framed	U-0.055	R-13 + R-10 c.i.	U-0.055	R-13 + R-10 c.i.	U-0.084	R-13+R-3.8 c.i.
Wood Framed and Other	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.089	R-13
Wall, below Grade						
Below Grade Wall	C-0.119	R-7.5 c.i.	C-0.092	R-10 c.i.	C-1.140	NR
Floors						
Mass	U-0.057	R-14.6 c.i.	U-0.051	R-16.7 c.i.	U-0.107	R-6.3 c.i.
Steel Joist	U-0.038	R-30	U-0.038	R-30	U-0.052	R-19
Wood Framed and Other	U-0.033	R-30	U-0.033	R-30	U-0.051	R-19
Slab-on-Grade Floors						
Unheated	F-0.520	R-15 for 24 in	F-0.510	R-20 for 24 in.	F-0.730	NR
Heated	F-0.688	R-20 for 48 in.	F-0.688	R-20 for 48 in.	F-0.900	R-10 for 24 in.
Opaque Doors						
Swinging	U-0.500		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	

Figure 4: ASHRAE 90.1 - 2013 Table 5.5-5

Section 6.0 Heating, Ventilating, and Air Conditioning

Section 6.4: Mandatory Provisions

Morton Hospital Expansion equipment must comply with the minimum performance rating listed in ASHRAE 90.1 Tables 6.8-1 through 6.8-4, 6.8-8, and 6.8-11 through 13. The other tables listed do not apply to the types of equipment within the project. As stated in the building specifications section 23 05 00, all of these requirements have been met.

Each zone has its own thermostatic controls located within each zone to control the supply of heating and cooling. However, psychiatric patient rooms within the hospital psych ward have temperature controls located in the corridor for safety purposes. This is an exception to the standard and therefore still complies. Furthermore, humidity and pressure sensors are provided for spaces that require a specific relative humidity and pressure relationship, defined by ASHRAE 170 above, in accordance with 6.4.3. Additionally, ductwork insulation complies with ASHRAE 90.1 Table 6.8.2-2, *Minimum Duct Insulation R-Values, Combined Heating and Cooling Supply Ducts and Return Ducts*.

Section 6.5: Prescriptive Path

As stated in the building specifications section 25 90 00, the air handling units shall be in economizer mode when the return dry bulb temperature is greater than the outside dry buld temperature. In accordance with ASHRAE 90.1 section 6.5.1.1, this air economizer modulates return and outdoor air to provide 100% of the load at all times. Below is Table 6.5.6.1-2 (Figure 6), *Exhaust Air Energy Recovery Requirements*, which requires an energy recovery system based on zone and percent

TABLE 6.5.6.1-2 Exhaust Air Energy Recovery Requirements for Ventilation Systems Operating Greater than or Equal to 8000 Hours per Year

Zone	% Outdoor Air at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and < 80%	≥80%
	Design Supply Fan Airflow Rate, cfm							
3C	NR	NR	NR	NR	NR	NR	NR	NR
1B, 2B, 3B, 4C, 5C	NR	≥19,500	≥9000	≥5000	≥4000	≥3000	≥1500	>0
1A, 2A, 3A, 4B, 5B	≥2500	≥2000	≥1000	≥500	>0	>0	>0	>0
4A, 5A, 6A, 6B, 7, 8	>0	>0	>0	>0	>0	>0	>0	>0

NR—Not required

Figure 5: ASHRAE 90.1-2013 Table 6.5.6.1-2

outdoor air. The average outdoor airflow percentage of the whole addition is 27% (9450 CFM OA/35000

CFM total), and the zone classification is 5A. Based on these conditions, an exhaust air recovery system is required for any design supply fan airflow rate.

However, heat recovery is not utilized within the design. This is because as of July 1, 2014, Massachusetts adopted ASHRAE 90.1 – 2010 as the statewide energy code requirement. In the 2013 predecessor, there are no outdoor air percentage requirements listed below 30%, and therefore the project satisfies the state code, but does not satisfy ASHRAE 90.1 Section 6.5 requirements.

Section 7.0 Service Water Heating

The primary source of heat for the addition is provided by the existing low pressure steam system and therefore does not need to comply with section 7. However this steam is used to supply new steam to hot water shell and tube heat exchangers, which must comply with the standard. Service hot-water piping insulation does comply with *Table 6.8.3-1 Minimum Piping Insulation Thickness Heating and Hot Water Systems.* Also, temperature controls are provided for each supply terminal box that control the amount of heat needed for each zone.

Section 8.0 Power

All feeders adhere to the maximum 2% voltage drop, and all branch circuits adhere to the maximum 3% voltage drop. Since most spaces are not classified as an office, conference rooms, or classrooms, the automatic receptacle control requirement does not apply to the critical spaces within Morton Hospital.

Section 9.0 Lighting

Based on the Compliance Path outlined in the standard, the *Building Area Method* can be used to determine compliance. According to Table 9.5.1 of ASHRAE 90.1, the average allowable lighting power density of a hospital is 1.05 W/ft^2. Most fixtures are fluorescent type and satisfy this requirement.

Section 10.4.1 Electric Motor

Motors used to power all fan coil units and cabinet and unit heaters are all under 1 hp, and do not have performance requirements in this section. Applicable motors powering fans and water pumps meet the efficiency requirements of Table 10.8-1, seen below in Figure 7. For example, water pump "HWP-1" uses a 60 Hz motor at 3 hp and 1800 rpm. Based on Table 10.8.1, the full-load efficiency should be 89.5%, which is satisfied by the motor.

TABLE 10.8-1 Minimum Nominal Full-Load Efficiency for General Purpose Electric Motors (Subtype I), Except Fire-Pump Electric Motors[a]

	Full-Load Efficiency, %					
	Open Drip-Proof Motors			Totally Enclosed Fan-Cooled Motors		
Number of Poles ⇒	2	4	6	2	4	6
Synchronous Speed (RPM) ⇒	3600	1800	1200	3600	1800	1200
Motor Horsepower						
1	77.0	85.5	82.5	77.0	85.5	82.5
1.5	84.0	86.5	86.5	84.0	86.5	87.5
2	85.5	86.5	87.5	85.5	86.5	88.5
3	85.5	89.5	88.5	86.5	89.5	89.5
5	86.5	89.5	89.5	88.5	89.5	89.5
7.5	88.5	91.0	90.2	89.5	91.7	91.0
10	89.5	91.7	91.7	90.2	91.7	91.0
15	90.2	93.0	91.7	91.0	92.4	91.7
20	91.0	93.0	92.4	91.0	93.0	91.7
25	91.7	93.6	93.0	91.7	93.6	93.0
30	91.7	94.1	93.6	91.7	93.6	93.0
40	92.4	94.1	94.1	92.4	94.1	94.1
50	93.0	94.5	94.1	93.0	94.5	94.1
60	93.6	95.0	94.5	93.6	95.0	94.5
75	93.6	95.0	94.5	93.6	95.4	94.5
100	93.6	95.4	95.0	94.1	95.4	95.0
125	94.1	95.4	95.0	95.0	95.4	95.0
150	94.1	95.8	95.4	95.0	95.8	95.8
200	95.0	95.8	95.4	95.4	96.2	95.8

a. Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.

Figure 6: ASHRAE 90.1 Table 10.8.1 Minimum Full-Load Efficiencies for Electric Motors

ASHRAE 90.1 Compliance Summary

The Morton Hospital Expansion project does not completely comply with ASHRAE 90.1 – 2013. As discussed in section 6.5, a heat recovery system is required given that Taunton is located in Zone 5A and the percentage of outdoor air is 27%. Also, l the use of a DX system, although compliable, has room for improvement. The air cooled chiller could also be updated to a water cooled chiller for added energy performance. Redesigning the system based on these and other suggestions would be greatly beneficial to the energy consumption of the building.

References

ANSI/AHSRAE Standard 62.1 – 2013, Ventilation for Acceptable Indoor Air Quality. Atlanta, GA: American Society of Heating refrigeration and Air Conditioning Engineers, Inc.

ANSI/ASHRAE/ASHE Standard – 2013, Ventilation of Health Care Facilities. Atlanta GA: American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.

ANSI/ASHRAE/IES Standard 90.1 – 2013, Energy Standard for Buildings Except Low-Rise Residential Buildings. Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

Appendix A

Ventilation Report																
Room Number	Room Name	Function of Space (defined by ASHRAE 170)	Pressure Relationship to Adjacent Spaces	Area (SF)	ASHRAE 170 Design Parameters						Actual Design Airflow Rates			ASHRAE 170 Design Parameters met?	Outdoor Air Percentage
					Ceiling Height	Minimum Outdoor ACH	Minimum Total ACH	Minimum OA Supply Airflow (CFM)	Minimum Total Supply Airflow (CFM)	Required Exhausted Air (CFM)	Outdoor Airflow (CFM)	Supply Airflow (CFM)	Exhausted Air (CFM)		
ED009	MEN'S RESTROOM	Inpatient Toilet Room	Negative	140	8.00	0	10	0	187	187	0	200	200	Yes	0%
ED008	WOMEN'S RESTROOM	Inpatient Toilet Room	Negative	185	8.00	0	10	0	247	247	0	250	250	Yes	0%
G000C01	CORR.	Patient Corridor	NR	080	8.00	0	2	0	21	0	0	25	0	Yes	0%
ED007	TRIAGE A	Triage	Negative	230	8.00	2	12	61	368	368	70	400	400	Yes	18%
ED000C01	WAITING	ER waiting room	Negative	1100	8.00	2	12	293	1,760	1,760	300	1,950	1,950	Yes	15%
ED006	TRIAGE B	Triage	Negative	240	8.00	2	12	64	384	384	70	400	400	Yes	18%
ED100C01	CORR.	Patient Corridor	NR	375	8.00	0	2	0	100	0	0	300	0	Yes	0%
ED100C02	CORR.	Patient Corridor	NR	225	8.00	0	2	0	60	0	0	150	0	Yes	0%
ED105	P TLT	Inpatient Toilet Room	Negative	050	8.00	0	10	0	67	67	0	100	100	Yes	0%
ED228	ANTE	All anteroom	Note 1	100	8.00	0	10	0	133	133	0	200	200	Yes	0%
ED227	ISOLATION TRTMNT-14	All room	Negative	175	8.00	2	12	47	280	280	50	300	300	Yes	17%
ED226	P. TLT	Inpatient Toilet Room	Negative	075	8.00	0	10	0	100	100	0	100	100	Yes	0%
ED109	TRTMNT-33	Treatment Room	NR	140	8.17	2	6	38	114	0	40	150	0	Yes	27%
ED110	TRTMNT-34	Treatment Room	NR	140	8.17	2	6	38	114	0	40	150	0	Yes	27%
ED111	TRTMNT-35	Treatment Room	NR	140	8.17	2	6	38	114	0	40	150	0	Yes	27%
ED112	WAITING	ER waiting room	Negative	125	8.00	2	12	33	200	200	40	200	200	Yes	20%
ED100C03	CORR.	Patient Corridor	NR	515	8.00	0	2	0	137	0	0	150	0	Yes	0%
ED108	P TLT	Inpatient Toilet Room	Negative	065	8.00	0	10	0	87	87	0	100	100	Yes	0%
ED114	TRTMNT-36	Treatment Room	NR	140	8.17	2	6	38	114	0	40	150	0	Yes	27%
ED100C05	CORR.	Patient Corridor	NR	300	8.00	0	2	0	80	0	0	100	0	Yes	0%
ED100C04	CORR.	Patient Corridor	NR	250	8.00	0	2	0	67	0	0	75	0	Yes	0%
ED115	TRTMNT-37	Treatment Room	NR	140	8.17	2	6	38	114	0	40	150	0	Yes	27%
ED118	TRTMNT-40	Treatment Room	NR	140	8.17	2	6	38	114	0	40	150	0	Yes	27%
ED117	TRTMNT-39	Treatment Room	NR	140	8.17	2	6	38	114	0	40	150	0	Yes	27%
ED116	GYN TRTMNT-38	Treatment Room	NR	160	8.00	2	6	43	128	0	50	175	0	Yes	29%
ED610	SOILED WORKROOM	Support Space Soiled Workroom	Negative	070	8.00	2	10	19	93	93	20	100	100	Yes	20%
ED500C05	CORR.	Patient Corridor	NR	640	8.00	0	2	0	171	0	0	175	0	Yes	0%
G600C03	CORR.	Patient Corridor	NR	200	8.00	0	2	0	53	0	0	75	0	Yes	0%
ED667	STAFF TOILET	Inpatient Toilet Room	Negative	050	8.00	0	10	0	67	67	0	75	75	Yes	0%
G600C04	CORR.	Patient Corridor	NR	080	8.00	0	2	0	21	0	0	25	0	Yes	0%
ED506	PATIENT DRESS	Patient Room	NR	060	8.00	2	4	16	32	0	20	75	0	Yes	27%
ED505	PATIENT DRESS	Patient Room	NR	060	8.00	2	4	16	32	0	20	75	0	Yes	27%
ED501	WAITING	ER waiting room	Negative	160	8.00	2	12	43	256	256	50	275	275	Yes	18%
ED503	P TLT	Inpatient Toilet Room	Negative	050	8.00	0	10	0	67	67	0	75	75	Yes	0%
ED504	PATIENT DRESS	Patient Room	NR	060	8.00	2	4	16	32	0	20	75	0	Yes	27%
ED500C02	CORR.	Patient Corridor	NR	100	8.00	0	2	0	27	0	0	50	0	Yes	0%
ED234	GYN TRTMNT-19	Treatment Room	NR	200	8.00	2	6	53	160	0	60	200	0	Yes	30%
ED200C06	CORRIDOR	Patient Corridor	NR	500	8.00	0	2	0	133	0	0	150	0	Yes	0%
ED235	PAT TOILET	Inpatient Toilet Room	Negative	075	8.00	0	10	0	100	100	0	100	100	Yes	0%
ED236	TRTMNT-20	Treatment Room	NR	150	8.17	2	6	41	122	0	50	175	0	Yes	29%
ED237	TRTMNT-21	Treatment Room	NR	140	8.17	2	6	38	114	0	40	150	0	Yes	27%
ED238	ISOLATION TRTMNT-22	All room	Negative	160	12.00	2	10	64	320	320	70	325	325	Yes	22%
ED239	P TLT	Inpatient Toilet Room	Negative	050	8.00	0	10	0	67	67	0	75	75	Yes	0%
ED224	MED PREP	Medication room	Positive	210	8.00	2	4	56	112	0	60	225	0	Yes	27%

Ventilation Report

Room Number	Room Name	Function of Space (defined by ASHRAE 170)	Pressure Relationship to Adjacent Spaces	Area (SF)	ASHRAE 170 Design Parameters						Actual Design Airflow Rates			ASHRAE 170 Design Parameters met?	Outdoor Air Percentage
					Ceiling Height	Minimum Outdoor ACH	Minimum Total ACH	Minimum OA Supply Airflow (CFM)	Minimum Total Supply Airflow (CFM)	Required Exhausted Air (CFM)	Outdoor Airflow (CFM)	Supply Airflow (CFM)	Exhausted Air (CFM)		
ED220	TRTMNT-13	Treatment Room	NR	130	8.17	2	6	35	106	0	40	150	0	Yes	27%
ED219	TRTMNT-12	Treatment Room	NR	130	8.17	2	6	35	106	0	40	150	0	Yes	27%
ED218	TRTMNT-11	Treatment Room	NR	130	8.17	2	6	35	106	0	40	150	0	Yes	27%
ED217	TRTMNT-10	Treatment Room	NR	130	8.17	2	6	35	106	0	40	150	0	Yes	27%
ED401	SOILED WORKROOM	Soiled workroom or soiled holding	Negative	130	8.00	2	10	35	173	173	40	175	175	Yes	23%
ED402	CLEAN SUPPLY	Clean workroom	Positive	450	8.00	2	4	120	240	0	120	450	0	Yes	27%
ED216	TRTMNT-9	Treatment Room	NR	150	8.17	2	6	41	122	0	50	175	0	Yes	29%
ED215	TRTMNT-8	Treatment Room	NR	150	8.17	2	6	41	122	0	50	175	0	Yes	29%
ED214	TRTMNT-7	Treatment Room	NR	150	8.17	2	6	41	122	0	50	175	0	Yes	29%
ED213	TRTMNT-6	Treatment Room	NR	150	8.17	2	6	41	122	0	50	175	0	Yes	29%
ED212	TRTMNT-5	Treatment Room	NR	150	8.17	2	6	41	122	0	50	175	0	Yes	29%
ED507	X-RAY	X-ray (diagnostic and treatment)	NR	350	9.00	2	6	105	315	0	110	700	0	Yes	16%
ED508	X-RAY	X-ray (diagnostic and treatment)	NR	350	9.00	2	6	105	315	0	110	750	0	Yes	15%
ED211	BARIATRIC TRTMNT-4	Treatment Room	NR	250	8.17	2	6	68	204	0	70	275	0	Yes	25%
ED241	SOILED WORKROOM	Soiled workroom or soiled holding	Negative	150	8.00	2	10	40	200	200	40	200	200	Yes	20%
ED242	TRTMNT-23	Treatment Room	NR	200	8.17	2	6	54	163	0	60	225	0	Yes	27%
ED301	PSYCH TRTMNT-24	Treatment Room	NR	160	9.00	2	6	48	144	0	50	200	0	Yes	25%
ED302	PSYCH TRTMNT-25	Treatment Room	NR	150	9.00	2	6	45	135	0	50	175	0	Yes	29%
ED303	PSYCH TRTMNT-26	Treatment Room	NR	150	9.00	2	6	45	135	0	50	175	0	Yes	29%
ED304	P TLT	Inpatient Toilet Room	Negative	050	8.00	0	10	0	67	67	0	75	75	Yes	0%
ED300C01	CORR.	Patient Corridor	NR	400	8.00	0	2	0	107	0	0	125	0	Yes	0%
ED305	PSYCH TRTMNT-27	Treatment Room	NR	150	9.00	2	6	45	135	0	50	175	0	Yes	29%
ED306	PSYCH TRTMNT-28	Treatment Room	NR	150	9.00	2	6	45	135	0	50	175	0	Yes	29%
ED300C03	CORR.	Patient Corridor	NR	300	8.00	0	2	0	80	0	0	100	0	Yes	0%
ED307	P TLT	Inpatient Toilet Room	Negative	070	8.00	0	10	0	93	93	0	100	100	Yes	0%
ED300C02	CORR.	Patient Corridor	NR	315	8.00	0	2	0	84	0	0	100	0	Yes	0%
ED313	MED PREP	Medication room	Positive	140	8.00	2	4	37	75	0	40	150	0	Yes	27%
ED309	SOILED WORKROOM	Soiled workroom or soiled holding	Negative	060	8.00	2	10	16	80	80	20	100	100	Yes	20%
ED310	PSYCH TRTMNT-30	Medication room	Positive	160	9.00	2	6	48	144	0	50	200	0	Yes	25%
ED311	PSYCH TRTMNT-29	Medication room	Positive	120	9.00	2	6	36	108	0	40	150	0	Yes	27%
ED245	TRTMNT-31	Treatment Room	NR	200	8.17	2	6	54	163	0	60	225	0	Yes	27%
ED246	TRTMNT-32	Treatment Room	NR	200	8.17	2	6	54	163	0	60	225	0	Yes	27%
ED200C04	LINEN STORAGE	Clean linen storage	Positive	200	8.00	0	2	0	53	0	0	75	0	Yes	0%
ED202A	TRAUMA 1 RESUSC. A	Trauma room	Positive	375	9.00	3	15	169	844	0	170	850	0	Yes	20%
ED202B	TRAUMA 1 RESUSC. B	Trauma room	Positive	375	9.00	3	15	169	844	0	170	850	0	Yes	20%
ED203	TRTMNT-1	Treatment Room	NR	175	8.17	2	6	48	143	0	50	200	0	Yes	25%
ED204	TRTMNT-2	Treatment Room	NR	175	8.17	2	6	48	143	0	50	200	0	Yes	25%
ED205	DECONTAM ROOM	ER decontamination	Negative	300	8.00	2	12	80	480	480	80	500	500	Yes	16%
ED209	P TLT	Inpatient Toilet Room	Negative	060	8.00	0	10	0	80	80	0	100	100	Yes	0%
ED206	P TLT	Inpatient Toilet Room	Negative	060	8.00	0	10	0	80	80	0	100	100	Yes	0%
ED210	TRTMNT-3	Treatment Room	NR	200	8.17	2	6	54	163	0	60	225	0	Yes	27%

TABLE 7.1 Design Parameters

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	Design Relative Humidity (k), %	Design Temperature (l), °F/°C
SURGERY AND CRITICAL CARE							
Operating room (Class B and C) (m), (n), (o)	Positive	4	20	NR	No	20–60	68–75/20–24
Operating/surgical cystoscopic rooms, (m), (n) (o)	Positive	4	20	NR	No	20–60	68–75/20–24
Delivery room (Caesarean) (m), (n), (o)	Positive	4	20	NR	No	20–60	68–75/20–24
Substerile service area	NR	2	6	NR	No	NR	NR
Recovery room	NR	2	6	NR	No	20–60	70–75/21–24
Critical and intensive care	NR	2	6	NR	No	30–60	70–75/21–24
Intermediate care (s)	NR	2	6	NR	NR	max 60	70–75/21–24
Wound intensive care (burn unit)	NR	2	6	NR	No	40–60	70–75/21–24
Newborn intensive care	Positive	2	6	NR	No	30–60	72–78/22–26
Treatment room (p)	NR	2	6	NR	NR	20–60	70–75/21–24
Trauma room (crisis or shock) (c)	Positive	3	15	NR	No	20–60	70–75/21–24
Medical/anesthesia gas storage (r)	Negative	NR	8	Yes	NR	NR	NR
Laser eye room	Positive	3	15	NR	No	20–60	70–75/21–24
ER waiting rooms	Negative	2	12	Yes (q)	NR	max 65	70–75/21–24
Triage	Negative	2	12	Yes (q)	NR	max 60	70–75/21–24
ER decontamination	Negative	2	12	Yes	No	NR	NR
Radiology waiting rooms	Negative	2	12	Yes (q), (w)	NR	max 60	70–75/21–24
Procedure room (Class A surgery) (o), (d)	Positive	3	15	NR	No	20–60	70–75/21–24
Emergency department exam/treatment room (p)	NR	2	6	NR	NR	max 60	70–75/21–24
INPATIENT NURSING							
Patient room	NR	2	4 (y)	NR	NR	max 60	70–75/21–24
Nourishment area or room	NR	NR	2	NR	NR	NR	NR
Toilet room	Negative	NR	10	Yes	No	NR	NR
Newborn nursery suite	NR	2	6	NR	No	30–60	72–78/22–26
Protective environment room (t)	Positive	2	12	NR	No	max 60	70–75/21–24
AII room (u)	Negative	2	12	Yes	No	max 60	70–75/21–24
Combination AII/PE room	Positive	2	12	Yes	No	Max 60	70-75/21-24
AII anteroom (u)	(e)	NR	10	Yes	No	NR	NR
PE anteroom (t)	(e)	NR	10	NR	No	NR	NR

Note: NR = no requirement

TABLE 7.1 Design Parameters *(Continued)*

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	Design Relative Humidity (k), %	Design Temperature (l), °F/°C
Combination AII/PE anteroom	(e)	NR	10	Yes	No	NR	NR
Labor/delivery/recovery/postpartum (LDRP) (s)	NR	2	6	NR	NR	max 60	70–75/21–24
Labor/delivery/recovery (LDR) (s)	NR	2	6	NR	NR	max 60	70–75/21–24
Patient Corridor	NR	NR	2	NR	NR	NR	NR
NURSING FACILITY							
Resident room	NR	2	2	NR	NR	NR	70–75/21–24
Resident gathering/activity/dining	NR	4	4	NR	NR	NR	70–75/21–24
Resident unit corridor	NR	NR	4	NR	NR	NR	NR
Physical therapy	Negative	2	6	NR	NR	NR	70–75/21–24
Occupational therapy	NR	2	6	NR	NR	NR	70–75/21–24
Bathing room	Negative	NR	10	Yes	No	NR	70–75/21–24
RADIOLOGY (v)							
X-ray (diagnostic and treatment)	NR	2	6	NR	NR	max 60	72–78/22–26
X-ray (surgery/critical care and catheterization)	Positive	3	15	NR	No	max 60	70–75/21–24
Darkroom (g)	Negative	2	10	Yes	No	NR	NR
DIAGNOSTIC AND TREATMENT							
Bronchoscopy, sputum collection, and pentamidine administration (n)	Negative	2	12	Yes	No	NR	68–73/20–23
Laboratory, general (v)	Negative	2	6	NR	NR	NR	70–75/21–24
Laboratory, bacteriology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, biochemistry (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, cytology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, glasswashing	Negative	2	10	Yes	NR	NR	NR
Laboratory, histology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, microbiology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, nuclear medicine (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, pathology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, serology (v)	Negative	2	6	Yes	NR	NR	70–75/21–24
Laboratory, sterilizing	Negative	2	10	Yes	NR	NR	70–75/21–24
Laboratory, media transfer (v)	Positive	2	4	NR	NR	NR	70–75/21–24
Nonrefrigerated body-holding room (h)	Negative	NR	10	Yes	No	NR	70–75/21–24

Note: NR = no requirement

TABLE 7.1 Design Parameters *(Continued)*

Function of Space	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	Design Relative Humidity (k), %	Design Temperature (l), °F/°C
Autopsy room (n)	Negative	2	12	Yes	No	NR	68–75/20–24
Pharmacy (b)	Positive	2	4	NR	NR	NR	NR
Examination room	NR	2	6	NR	NR	max 60	70–75/21–24
Medication room	NR	2	4	NR	NR	max 60	70–75/21–24
Gastrointestinal endoscopy procedure room (x)	NR	2	6	NR	No	20–60	68–73/20–23
Endoscope cleaning	Negative	2	10	Yes	No	NR	NR
Treatment room (x)	NR	2	6	NR	NR	max 60	70–75/21–24
Hydrotherapy	Negative	2	6	NR	NR	NR	72–80/22–27
Physical therapy	Negative	2	6	NR	NR	Max 65	72–80/22–27
STERILIZING							
Sterilizer equipment room	Negative	NR	10	Yes	No	NR	NR
CENTRAL MEDICAL AND SURGICAL SUPPLY							
Soiled or decontamination room	Negative	2	6	Yes	No	NR	72–78/22–26
Clean workroom	Positive	2	4	NR	No	max 60	72–78/22–26
Sterile storage	Positive	2	4	NR	NR	max 60	72–78/22–26
SERVICE							
Food preparation center (i)	NR	2	10	NR	No	NR	72–78/22–26
Warewashing	Negative	NR	10	Yes	No	NR	NR
Dietary storage	NR	NR	2	NR	No	NR	72–78/22–26
Laundry, general	Negative	2	10	Yes	No	NR	NR
Soiled linen sorting and storage	Negative	NR	10	Yes	No	NR	NR
Clean linen storage	Positive	NR	2	NR	NR	NR	72–78/22–26
Linen and trash chute room	Negative	NR	10	Yes	No	NR	NR
Bedpan room	Negative	NR	10	Yes	No	NR	NR
Bathroom	Negative	NR	10	Yes	No	NR	72–78/22–26
Janitor's closet	Negative	NR	10	Yes	No	NR	NR
SUPPORT SPACE							
Soiled workroom or soiled holding	Negative	2	10	Yes	No	NR	NR
Clean workroom or clean holding	Positive	2	4	NR	NR	NR	NR
Hazardous material storage	Negative	2	10	Yes	No	NR	NR

Note: NR = no requirement

Notes for Table 7.1:

a. Except where indicated by a "No" in this column, recirculating room HVAC units (with heating or cooling coils) are acceptable for providing that portion of the minimum total air changes per hour that is permitted by Section 7.1 (subparagraph [a][5]). Because of the cleaning difficulty and potential for buildup of contamination, recirculating room units shall not be used in areas marked "No." Recirculating devices with HEPA filters shall be permitted in existing facilities as interim, supplemental environmental controls to meet requirements for the control of airborne infectious agents. The design of either portable or fixed systems should prevent stagnation and short circuiting of airflow. The design of such systems shall also allow for easy access for scheduled preventative maintenance and cleaning.
b. Pharmacy compounding areas may have additional air change, differential pressure, and filtering requirements beyond the minimum of this table depending on the type of pharmacy, the regulatory requirements which may include adoption of USP 797), the associated level of risk of the work (see USP [2013] in Informative Appendix B), and the equipment utilized in the spaces.
c. The term *trauma room* as used herein is a first-aid room and/or emergency room used for general initial treatment of accident victims. The operating room within the trauma center that is routinely used for emergency surgery is considered to be an operating room by this standard.
d. Pressure relationships need not be maintained when the room is unoccupied.
e. See Section 7.2 and its subsections for pressure-relationship requirements.
f. This letter is not used in this table.
g. All air need not be exhausted if darkroom equipment has a scavenging exhaust duct attached and meets ventilation standards regarding NIOSH, OSHA, and local employee exposure limits.[2, 3]
h. A nonrefrigerated body-holding room is applicable only to facilities that do not perform autopsies on-site and use the space for short periods while waiting for the body to be transferred.
i. Minimum total air changes per hour (ach) shall be that required to provide proper makeup air to kitchen exhaust systems as specified in ANSI/ASHRAE Standard 154.[4] In some cases, excess exfiltration or infiltration to or from exit corridors compromises the exit corridor restrictions of NFPA 90A,[5] the pressure requirements of NFPA 96,[6] or the maximum defined in the table. During operation, a reduction to the number of air changes to any extent required for odor control shall be permitted when the space is not in use. (See FGI [2010] in Informative Appendix B.)
j. In some areas with potential contamination and/or odor problems, exhaust air shall be discharged directly to the outdoors and not recirculated to other areas. Individual circumstances may require special consideration for air exhausted to the outdoors. To satisfy exhaust needs, constant replacement air from the outdoors is necessary when the system is in operation.
k. The RH ranges listed are the minimum and/or maximum allowable at any point within the design temperature range required for that space.
l. Systems shall be capable of maintaining the rooms within the range during normal operation. Lower or higher temperature shall be permitted when patients' comfort and/or medical conditions require those conditions.
m. National Institute for Occupational Safety and Health (NIOSH) criteria documents regarding occupational exposure to waste anesthetic gases and vapors, and control of occupational exposure to nitrous oxide[7] indicate a need for both local exhaust (scavenging) systems and general ventilation of the areas in which the respective gases are utilized. Refer to NFPA 99 for other requirements.[8]
n. If pressure-monitoring device alarms are installed, allowances shall be made to prevent nuisance alarms. Short-term excursions from required pressure relationships shall be allowed while doors are moving or temporarily open. Simple visual methods such as smoke trail, ball-in-tube, or flutterstrip shall be permitted for verification of airflow direction.
o. Surgeons or surgical procedures may require room temperatures, ventilation rates, humidity ranges, and/or air distribution methods that exceed the minimum indicated ranges.
p. Treatment rooms used for bronchoscopy shall be treated as bronchoscopy rooms. Treatment rooms used for procedures with nitrous oxide shall contain provisions for exhausting anesthetic waste gases.
q. In a recirculating ventilation system, HEPA filters shall be permitted instead of exhausting the air from these spaces to the outdoors provided that the return air passes through the HEPA filters before it is introduced into any other spaces. The entire minimum total air changes per hour of recirculating airflow shall pass through HEPA filters. When these areas are open to larger, nonwaiting spaces, the exhaust air volume shall be calculated based on the seating area of the waiting area. (***Note:*** The intent here is to not require the volume calculation to include a very large space [e.g., an atrium] just because a waiting area opens onto it.)
r. See NFPA 99 for further requirements.[8]
s. For intermediate care, labor/delivery/recovery rooms, and labor/delivery/recovery/postpartum rooms, four total ach shall be permitted when supplemental heating and/or cooling systems (radiant heating and cooling, baseboard heating, etc.) are used.
t. The protective environment airflow design specifications protect the patient from common environmental airborne infectious microbes (i.e., *Aspergillus* spores). Recirculation HEPA filters shall be permitted to increase the equivalent room air exchanges; however, the outdoor air changes are still required. Constant-volume airflow is required for consistent ventilation for the protected environment. The pressure relationship to adjacent areas shall remain unchanged if the PE room is utilized as a normal patient room. Rooms with reversible airflow provisions for the purpose of switching between protective environment and AII functions shall not be permitted.
u. The AII room described in this standard shall be used for isolating the airborne spread of infectious diseases, such as measles, varicella, or tuberculosis. Supplemental recirculating devices using HEPA filters shall be permitted in the AII room to increase the equivalent room air exchanges; however, the minimum outdoor air changes of Table 7.1 are still required. AII rooms that are retrofitted from standard patient rooms from which it is impractical to exhaust directly outdoors may be recirculated with air from the AII room, provided that air first passes through a HEPA filter. When the AII room is not utilized for airborne infection isolation, the pressure relationship to adjacent areas, when measured with the door closed, shall remain unchanged and the minimum total air change rate shall be 6 ach. Switching controls for reversible airflow provisions shall not be permitted.
v. When required, appropriate hoods and exhaust devices for the removal of noxious gases or chemical vapors shall be provided in accordance with NFPA 99.[8]
w. The requirement that all room air is exhausted directly to outdoors applies only to radiology waiting rooms programmed to hold patients who are waiting for chest x-rays for diagnosis of respiratory disease.
x. If the planned space is designated in the organization's operational plan to be utilized for both bronchoscopy and gastrointestinal endoscopy, the design parameters for "bronchoscopy, sputum collection, and pentamidine administration" shall be used.
y. For single-bed patient rooms using Group D diffusers, a minimum of six total ach shall be provided and calculated based on the volume from finished floor to 6 ft (1.83 m) above the floor.