AIR EQUIPMENT COMPANY

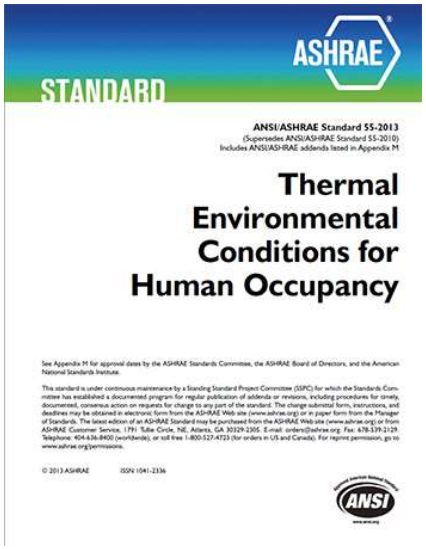
EXPERTS HELPING EXPERTS

Providing Quality Equipment and Services
for Specialized Mechanical Air Systems

Serving Kentucky and Southern Indiana over 70 years

ASHRAE Standard 55

ASHRAE 55 (Thermal Comfort)



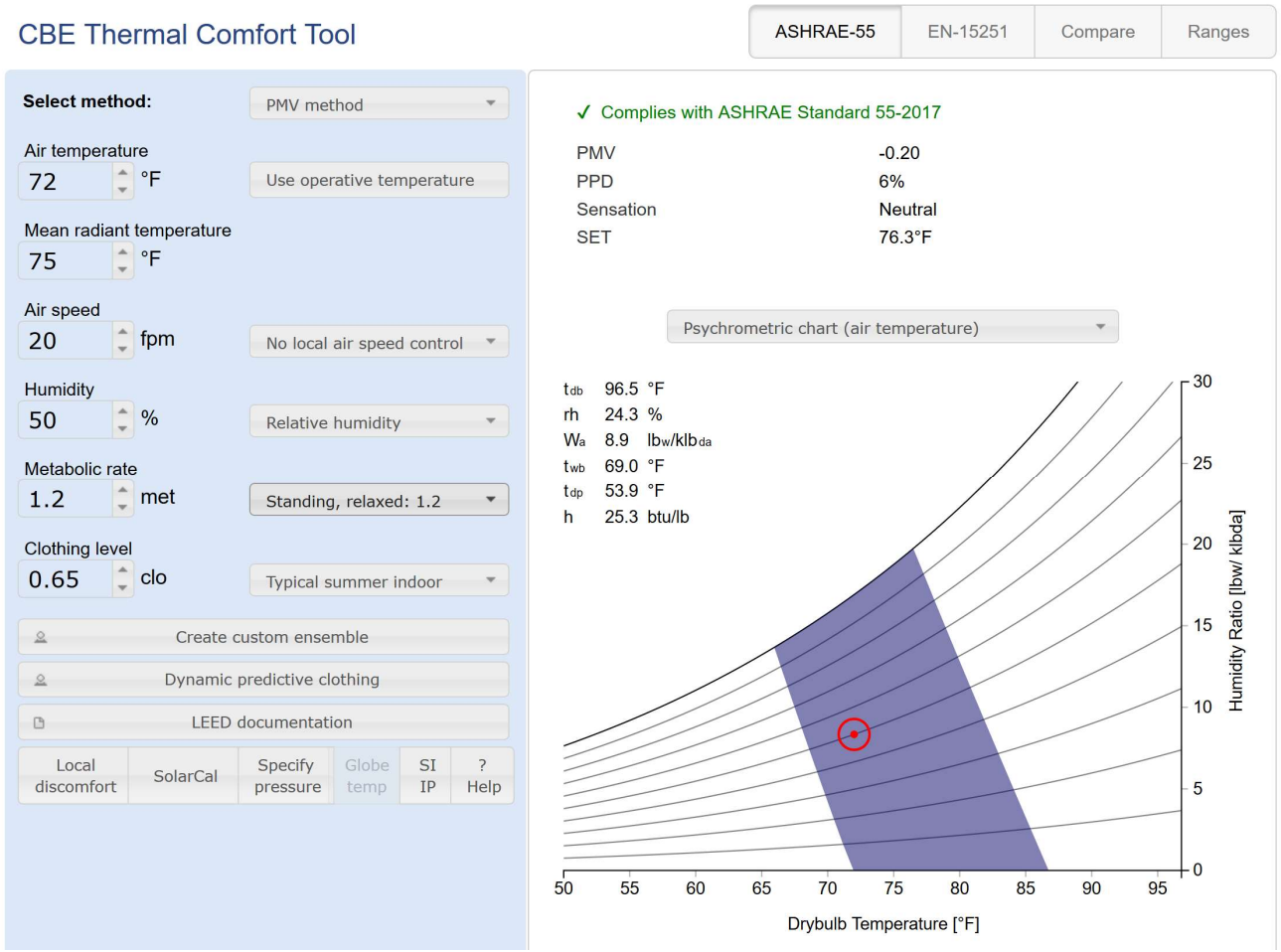
- First published in 1966
- Since 2004 has been updated every 3-6 years
- Most recent published in 2017
- The standard addresses the four primary environmental factors (temperature, thermal radiation, humidity, and air speed) and two personal factors (activity and clothing) that affect thermal comfort.

ASHRAE Standard 55

Three compliance methods for Evaluating Thermal Comfort

- Graphical
- Analytical
- Elevated Air Speed

ASHRAE Standard 55



For humidity ratios & metabolic rates out of normal, the **analytical model** must be used.

Software programs exist that will calculate the ideal thermal comfort zone.

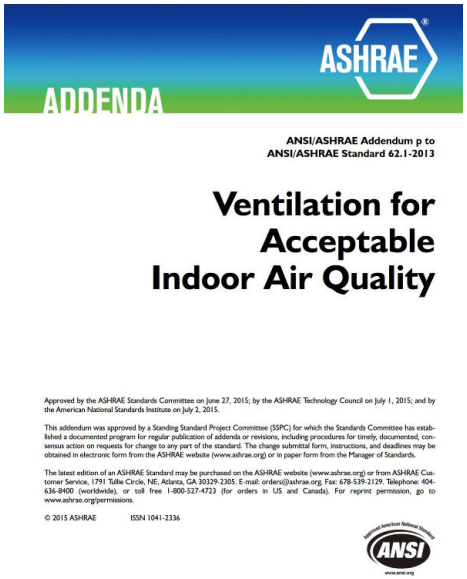
ASHRAE Standard 62.1

ASHRAE 62.1 (Ventilation)

- First published in 1973

- 2001 and earlier as "62", 2004 and beyond as "62.1" & "62.2"
- Most recent published in 2016

- The intent is to provide a comprehensive enforceable method of establishing ventilation rates centered around indoor air quality (IAQ) and applies to all spaces intended for human occupancy.


ASHRAE

ADDENDA

ANSI/ASHRAE Addendum p to
ANSI/ASHRAE Standard 62.1-2013

Ventilation for Acceptable Indoor Air Quality

Approved by the ASHRAE Standards Committee on June 27, 2015; by the ASHRAE Technology Council on July 1, 2015; and by the American National Standards Institute on July 2, 2015.

This addendum was approved by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Manager of Standards.

The latest edition of an ASHRAE Standard may be purchased on the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

 ISSN 1041-2336

ANSI

ASHRAE Standard 62.1

Section 6: Procedures for calculating minimum outdoor airflow rates as well as the requirements for exhaust ventilation.

- Three options
  - The Ventilation Rate Procedure **(VRP)** is the most commonly used procedure. It is a prescriptive design procedure in which outdoor-air rates are dependent on space type, occupancy, and floor area.
  - The Indoor Air Quality Procedure **(IAQP)** is a performance procedure in which minimum outdoor-air requirements are based on analysis of contaminant sources, contaminant concentration limits, and the level of perceived indoor-air acceptability
  - The third option is the **natural ventilation procedure**, which is a prescriptive procedure where outdoor air is provided through outdoor openings.

ASHRAE Standard 62.1

VRP is the most commonly used procedure.

You must verify if outdoor-air treatment is required (applies to ventilation systems that provide outdoor air through a supply fan).

Breathing Zone Outdoor Airflow CFM

$$V_{bz} = R_p$$

Minimum CFM/Person

Zone Population

VRP + Demand-Controlled Ventilation (DCV)

- Based on CO_2 concentrations as a surrogate for human occupancy

$$V_{bz} = R_p P_z + R_a A_z$$

Minimum CFM/Person

Actual Zone Population

Zone Floor Area Constant

Minimum CFM/ft²

$$V_{oz} = V_{bz} / E_z$$

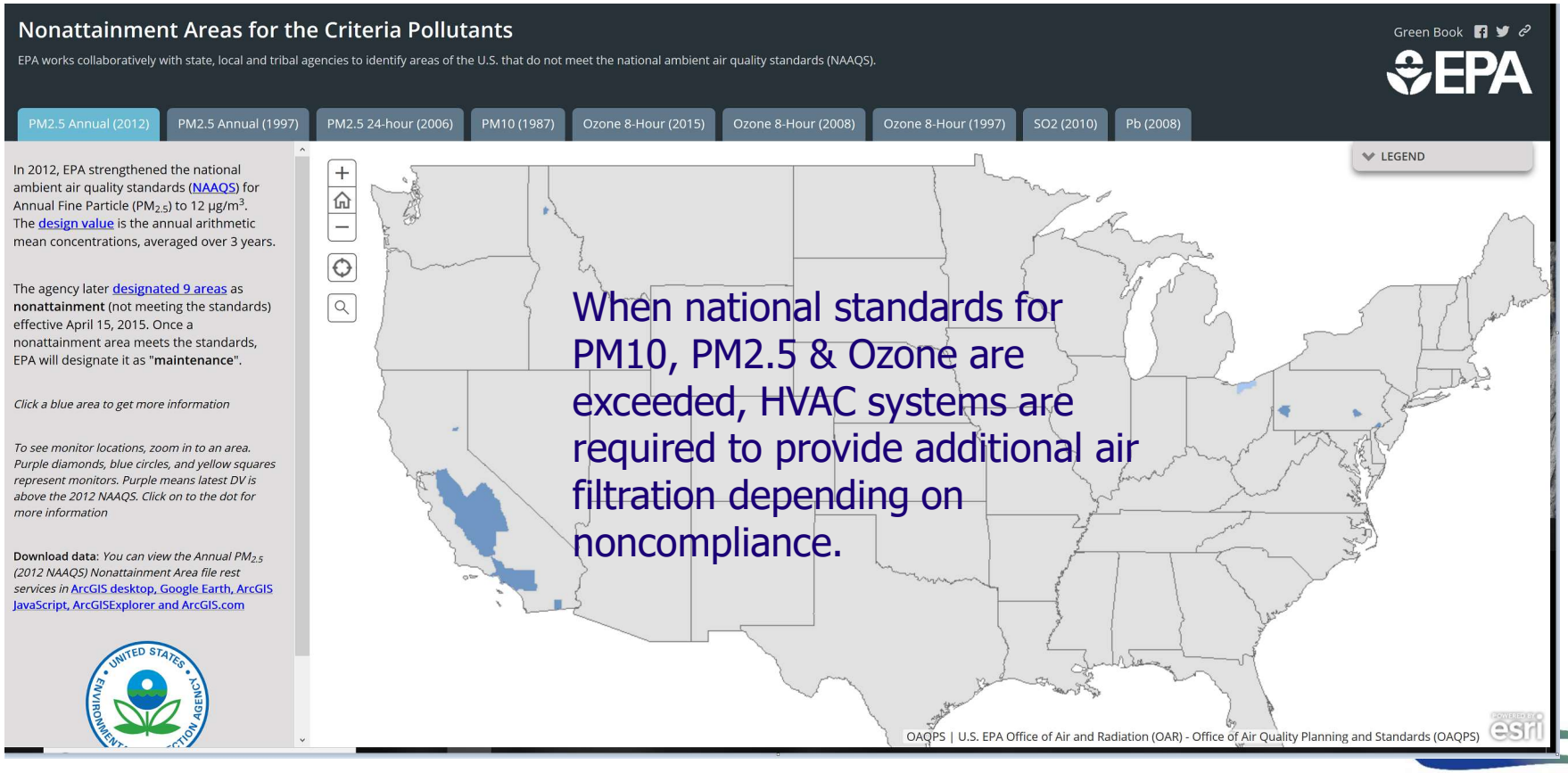
Zone Outdoor Airflow

Breathing Zone Outdoor Airflow

Zone Distribution Effectiveness

Occupancy Category	People Outdoor Air Rate R_P		Area Outdoor Air Rate R_A	
	cfm/person	L/s•person	cfm/ft²	L/s•m²
Correctional Facilities				
Cell	5	2.5	0.12	0.6
	5	2.5	0.06	0.3
	5	2.5	0.06	0.3
	7.5	3.8	0.06	0.3
	10	5	0.18	0.9
	10	5	0.12	0.6
	10	5	0.12	0.6
	7.5	3.8	0.06	0.3
	7.5	3.8	0.06	0.3
	10	5.0	0.18	0.9
Science laboratories	10	5.0	0.18	0.9
Wood/metal shop	10	5	0.18	0.9

ASHRAE Standard 62.1



ASHRAE Standard 62.1

IAQ procedure

Performance-based approach that accounts for contaminant sources, concentrations and occupant satisfaction.

Zone and system outdoor airflow rates are based on emission rates, concentration limits and other relevant design parameters (e.g., air cleaning efficiencies and supply airflow rates).

ASHRAE Standard 62.1

IAQP Steps

1. Identify contaminants of concern (COC) and emission rates

2. Determine acceptable concentrations of these contaminants

3. Specify the perceived indoor air quality criteria

4. Apply mass balance analysis and subjective evaluation to achieve performance criteria.

ASHRAE Standard 62.1

Mass Balance Analysis

Determine the minimum OA rates required to achieve the contaminant concentration limits specified

Appendix D includes steady-state mass-balance equations that describe the impact of air cleaning on outdoor air and recirculation rates for ventilation systems serving a single zone

In the completed building, measurement of the concentration of contaminants or mixtures of concern may be useful as a means of checking the accuracy of the design mass-balance analysis, but such measurement is not required for compliance.

ASHRAE Standard 62.1

Subjective Evaluation

Panels have been used to perform subjective evaluation of indoor air quality in buildings.

Generally the air can be considered acceptably free of annoying contaminants if 80% of a panel consisting of a group of untrained subjects exposed to known concentrations of contaminants under representative controlled conditions of use and occupancy deems the air not to be objectionable.

Occupant must render a judgment of acceptability within 15 seconds.

Some harmful contaminants will not be detected by such tests. (CO & Radon) are examples of odorless contaminants that pose health risks.

ASHRAE Standard 62.1

Bi-Polar Ionization

Using the mass-balance equation in the IAQP, you can reduce the resulting contaminant levels to less than or equal to those realized using the prescriptive Ventilation Rate (VRP) Method.

In buildings like schools, churches, office buildings and arenas, the predominant pollutant load is from the occupants (smoke, dust pollen, VOC, odors, as well as bacteria and viruses). The bi-polar ionization systems reduce these pollutants through a gas phase molecule splitting process.

Manufacturer's have software or spreadsheets that calculate both the VRP outside air requirements and the IAQP requirements simultaneously for comparison. They claim a reduction in OA by up to 75% in some cases.

ASHRAE Standard 62.1

Natural Ventilation Procedure

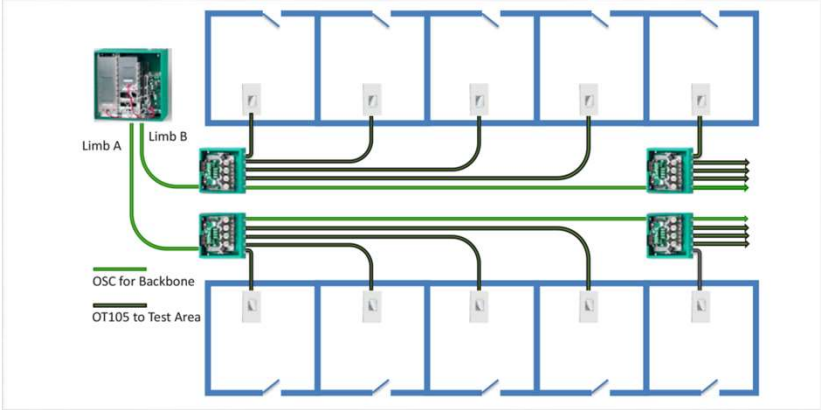
Mechanical ventilation systems are not required when:

- Natural ventilation openings are permanently open or have controls that prevent the openings from being closed during periods of expected occupancy
- The zone is not served by heating or cooling equipment.

ASHRAE Standard 62.1

Other variables to consider:

- Ventilation System Controls to maintain minimum OA
- Exhaust air capture location
- Humidification
- Filters / Bird Screens
- Inspection, cleaning & maintenance
- Air balancing / dampers
- Condensate Drains
- Demand Control Ventilation or Occupant Diversity
  - The breathing zone outdoor airflow shall be reset in response to current occupancy and shall be no less than the building component (OA rate/ft2 x Area) of the DCV zone. Examples of reset methods or devices include population counters, carbon dioxide (CO2) sensors, timers, occupancy schedules or occupancy sensors.



ASHRAE Standard 62.1

Recent Debate of IAQP

In June 2019 Summer Meetings, the ASHRAE Standards Committee rejected the proposed 62.1 addendum "AA" sending it back to the committee to be reworked over the next three years. If adopted, addendum "AA" would have significantly changed the requirements of ASHRAE's IAQ Procedure (IAQP) and made its application considerably more time-consuming and cumbersome, if not impossible.

Addendum "AA" proposed to:

- Lowered the CO2 threshold level (from 5000 ppm to 1100 ppm)
- Added a post-occupancy testing requirement

2016 Harvard study – Research showed "statistically significant and meaningful reductions in decision-making performance" in test subjects as CO2 levels rose from a baseline of 600 parts per million (ppm) to 1000 ppm and 2500 ppm.

ASHRAE Standard 62.1

Saving Energy While Complying

With IAQP, a local purification device can be used to obtain equivalent air quality by removal of contaminants.

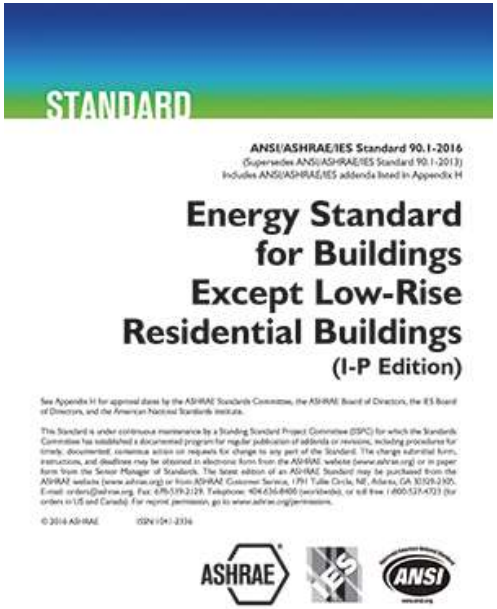
If VRP is used, an air-to-air heat exchanger can be used to recover conditioning energy.

Some of the configuration issues are the equipment sizing and the associated first cost. Operating energy is also considered in a life-cycle approach, as is the reduction in demand charges that some configurations make possible.

In comparing configurations for energy savings, metrics are needed for life-cycle cost, comfort, indoor air quality, and ventilation effectiveness.

ASHRAE Standard 90.1

ASHRAE 90.1 (Energy Standard)



- First published in 1975
- Placed on "continuous maintenance" in 1999
- Renamed ASHRAE 90.1 in 2001 and has been updated every 3 years since then.
- Provides minimum requirements for energy efficient designs for buildings except for low-rise residential buildings (i.e. single-family homes, multi-family buildings, etc.).

ASHRAE Standard 90.1

Two means, or paths for building designers to comply with ASHRAE 90.1:

- **Prescriptive path:** All components of the building meet the minimum standards specified by ASHRAE 90.1.
- **Performance path:** A proposed building design is demonstrated (through building performance simulation) to use less energy than a baseline building built to ASHRAE 90.1 specifications.

ASHRAE Standard 90.1

Prescriptive Path

- **Building Envelope** (Section 5): minimum wall insulation, minimum roof insulation, roof reflectance, minimum glazing performance
- **HVAC** (Section 6): minimum equipment efficiency, minimum system features, limitation on reheat, limitation on fan power
- **Domestic Hot Water** (Section 7): minimum equipment efficiency, minimum system features
- **Power** (Section 8): transformer efficiency, automatic receptacle controls, energy monitoring
- **Lighting** (Section 9): maximum indoor lighting power density (LPD, expressed in Watts/Sq.Ft.), minimum lighting controls, exterior lighting, parking garage lighting
- **Other Equipment** (Section 10): electric motors, potable water booster pumps, elevators, and escalators

ASHRAE Standard 90.1

HVAC

- Economizers (Section 6.5.1)
- Simultaneous Heating and Cooling Limitation (Section 6.5.2)
- Air System Design and Control (Section 6.5.3)
- Hydronic System Design and Control (Section 6.5.4)
- Heat Rejection Equipment (Section 6.5.5)
- Energy Recovery (Section 6.5.6)
- Exhaust Systems (Section 6.5.7)
- Radiant Heating Systems (Section 6.5.8)
- Hot Gas Bypass Limitation (Section 6.5.9)
- Door Switches (Section 6.5.10)
- Refrigeration Systems (Section 6.5.11)

ASHRAE Standard 90.1

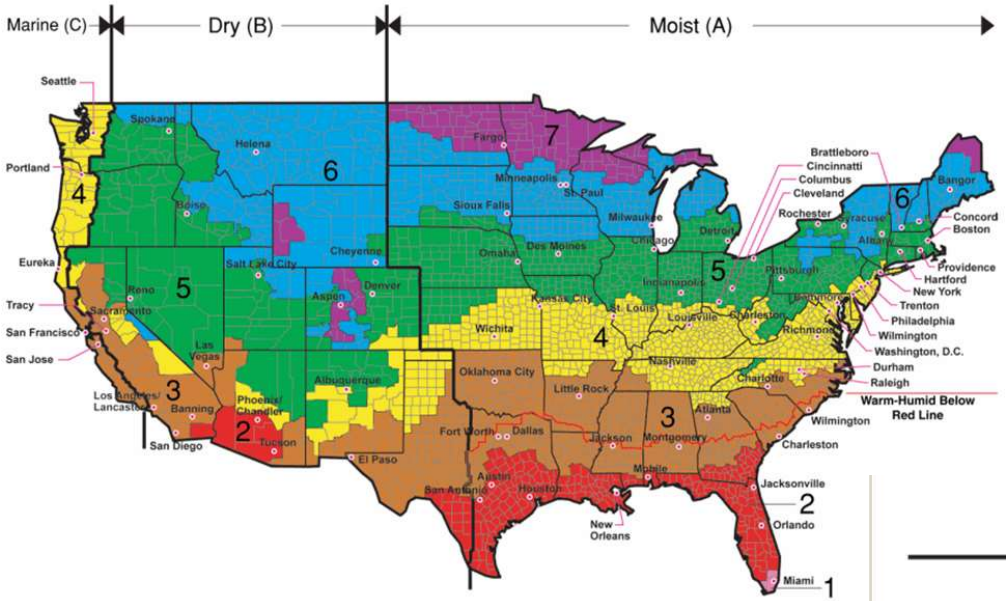
HVAC

Replacement equipment now needs to meet many of the requirements formerly for new equipment only (controls, economizer, fan efficiency, boiler turndown, etc.)

Exceptions that are allowed:

- Equipment being modified or repaired (not replaced) - provided such modifications will not result in an increase in the annual energy consumption
- Equipment being replaced or altered which requires extensive revisions to other systems and such replaced or altered equipment is a like-for-like replacement
- Refrigerant change of existing equipment
- Relocation of existing equipment
- Ducts and pipes where there is insufficient space or access to meet these requirements

ASHRAE Standard 90.1



All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dellingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairb Yukon-Koyukuk

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands

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

	% *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%
Climate Zone	**Design Supply Fan Airflow Rate, cfm**							
3C	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B, 3B, 4C, 5C	NR	≥19,500	≥9000	≥5000	≥4000	≥3000	≥1500	≥120
0A, 1A, 2A, 3A, 4B, 5B	≥2500	≥2000	≥1000	≥500	≥140	≥120	≥100	≥80
4A, 5A, 6A, 6B, 7, 8	≥200	≥130	≥100	≥80	≥70	≥60	≥50	≥40

NR—Not required

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

	% Outdoor Air at Full Design Airflow Rate							
Zone	≥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

ASHRAE Standard 90.1

Lighting

Lighting alterations (retrofits) section revised in 2016 to add interior and exterior controls.

Automatic time control and occupancy based (occupancy sensors) are methods that can be used to comply.

New equipment installed as a direct replacement of existing equipment must comply with Lighting Power Density (LPD) limits and basic after-hours automatic shutoff requirements.

ASHRAE Standard 90.1

TABLE 9.6.1 Lighting Power Density Allowances Using the Space-by-Space Method and Minimum Control Requirements Using Either Method

Informative Note: This table is divided into two sections; this first section covers space types that can be commonly found in multiple building types. The second part of this table covers space types that are typically found in a single building type.

The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1. For each space type:
(1) All REQs shall be implemented.
(2) At least one ADD1 (when present) shall be implemented.
(3) At least one ADD2 (when present) shall be implemented.

Common Space Types[1]	LPD, W/ft^2	RCR Threshold	a Local Control (See Section 9.4.1.1[a])	b Restricted to Manual ON (See Section 9.4.1.1[b])	c Restricted to Partial Automatic ON (See Section 9.4.1.1[c])	d Bilevel Lighting Control (See Section 9.4.1.1[d])	e Automatic Daylight Responsive Controls for Sidelighting (See Section 9.4.1.1[e][6])	f Automatic Daylight Responsive Controls for Toplighting (See Section 9.4.1.1[f][6])	g Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complies])	h Automatic Full OFF (See Section 9.4.1.1[h])	i Scheduled Shutoff (See Section 9.4.1.1[i])
Atrium											
... that is <20 ft in height	0.03/ft total height	NA	REQ	ADD1	ADD1	—	REQ	REQ	—	ADD2	ADD2
... that is ≥20 ft and ≤40 ft in height	0.03/ft total height	NA	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
... that is >40 ft in height	0.40 + 0.02/ft total height	NA	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
Audience Seating Area											
... in an auditorium	0.63	6	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
... in a convention center	0.82	4	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
... in a gymnasium	0.65	6	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
... in a motion picture theater	1.14	4	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
... in a penitentiary	0.28	4	REQ	ADD1	ADD1	—	REQ	REQ	—	ADD2	ADD2
... in a performing arts theater	2.43	8	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
... in a religious building	1.53	4	REQ	ADD1	ADD1	REQ	REQ	REQ	—	ADD2	ADD2
... in a sports arena	0.43	4	REQ	ADD1	ADD1	—	REQ	REQ	—	ADD2	ADD2
... all other audience seating areas	0.43	4	REQ	ADD1	ADD1	—	REQ	REQ	—	ADD2	ADD2

ASHRAE Standard 90.1

Performance Path

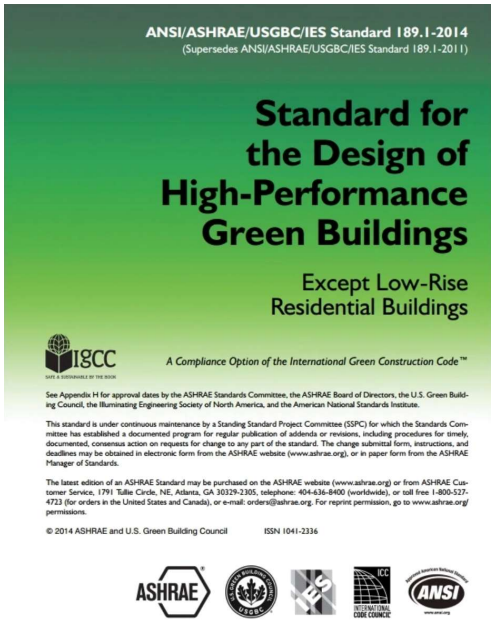
- An energy model may be used to see what energy-conservation measures (ECMs) need to be incorporated into the project to comply.
- Some energy-modeling software can generate an energy-cost budget (ECB) report for submittal.
- The best way to confirm compliance is to use the ECB compliance forms in the ASHRAE 90.1 User's Manual or their online tool (https://901ecb.ashrae.org/).

ASHRAE Standard 189.1

ASHRAE 189.1 (High-Performance Bldg)

- First published in 2009 in partnership with the IgCC & USGBC

- Most recent published in 2017



- A model code that contains minimum requirements for increasing the environmental and health performance of buildings' sites and structures.

ASHRAE Standard 189.1

Provides minimum requirements for siting, design, construction, and operation of high-performance green buildings

This standard provides minimum criteria that apply to new buildings and their systems, new portions of buildings and their systems, and new systems and equipment in existing buildings.

Takes other ASHRAE Standards to the next level.

Ways to benefit from designing around ASHRAE 189.1

- Find innovative concepts that go above and beyond standard "green" practice.
- Find the design approach that differentiates your firm form the competition.

ASHRAE Standards

Other Standards:

- **ASHRAE Standard 15 – Safety Standard for Refrigeration Systems**
- **ASHRAE Standard 34 – Designation and Safety Classification of Refrigerants**
- **ASHRAE Standard 52 – Testing Air-Cleaning Devices**
- **ASHRAE Standard 100 – Energy Efficiency in Existing Buildings**
- **ASHRAE Standard 170 – Ventilation of Health Care Facilities**
- **ASHARE Standard 188 – Legionellosis: Risk Management for Building Water Systems**

ASHRAE Standards

Other Resources:

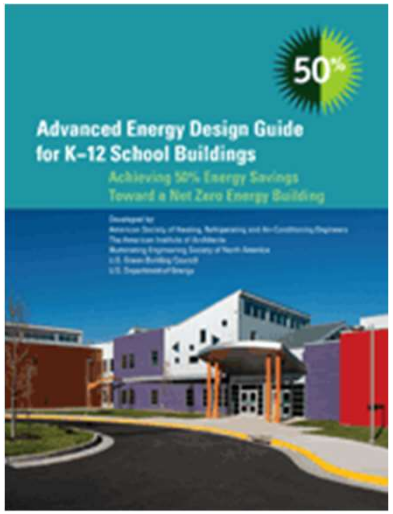
www.ashrae.org

https://www.energycodes.gov/adoption/states/

https://www.usgbc.org/resources/

ASHRAE Advanced Energy Design Guides

How these apply to LEED and WELL



ASHRAE Standards

ASHRAE Standard Jeopardy


LENNOX
Phoenix Controls
PRECISION AIR PRODUCTS CO.
LG
IEC International Environmental
ABB
condair
Bry-Air EST. 1964
CLIMATEMASTER
ClimateCraft
AAON
Strobic Air Technologies
A CECO Environmental Brand
AIR MONITOR AIRFLOW MEASUREMENT SOLUTIONS
VTS
DESERT AIRE
PLASMA AIR INTERNATIONAL
systemair
SEMCO
MULTISTACK
ISCO INDUSTRIES
FRIEDRICH
Honeywell
Systecon Inc.
SCHOOL AIR
AIRCUITY
ONICON FLOW AND ENERGY MEASUREMENT
DRY-O-TRON Dectron