Targeted Performance: Thermal Energy Demand Intensity (TEDI)

Relative Performance: ASHRAE 90.1 Appendix G Performance Rating Method

mass save

2023 Massachusetts Commercial Stretch Code

Maria Karpman LEED AP, BEMP, CEM

Christina LaPerle PE, BEMP, CEM, CBCP

www.karpmanconsulting.net

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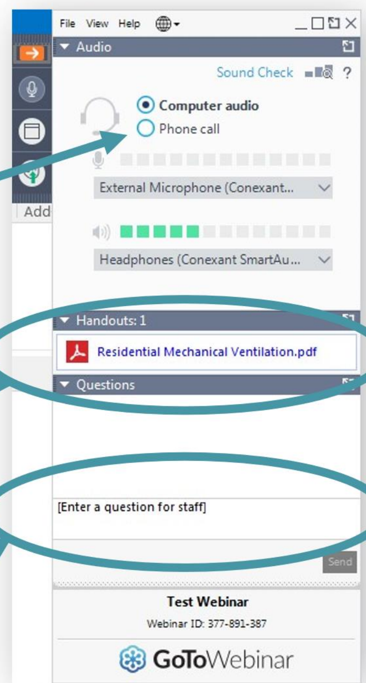

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- 2-hour CSL CEU
- 2 AIA LU | HSW
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- 2 BPI CEU

Everyone will receive a certificate of attendance via email.

Another 2 continuing education credits (CEUs) will be available to participants that also attend the second half of the webinar on Thursday, August 1st from 1pm to 3 pm.

Learning Objectives

- Understand MA Commercial Stretch Energy Code compliance options and their applicability to different building occupancy types
- Articulate energy modeling requirements of the Relative Performance Path, and where they deviate from the ASHRAE 90.1 Performance Rating Method
- Articulate the energy modeling requirements of the Targeted Performance Path (TEDI) and understand sample envelope designs that were shown to comply with TEDI
- Understand how to use energy modeling results to demonstrate compliance with the Relative and Targeted Performance Paths
- Understand the applicability of the performance-based compliance options to retrofits, core-and-shell projects and additions
- Describe energy code requirements that projects following the performance paths of compliance must meet in addition to energy modeling
- List the documentation that must be submitted to code officials for projects following performance paths of compliance

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Agenda

2023 Massachusetts Energy Code Compliance Options Overview

Requirements Other Than Energy Modeling Applicable to the Relative and Targeted Performance Paths

Relative Performance Path

- General concept
- Modifications compared to 90.1 2019 Appendix G
- Mixed use, retrofit and core and shell projects

Targeted Performance Path

- General concept
- Overview of the modeling requirements
- Mixed use, retrofit and core-and-shell projects

Overview of Available Trainings

Title	Target Audience	Topics covered
MA Stretch Energy Code 2023 for Commercial Buildings: Targeted Performance (TEDI) and Relative Performance (90.1 Appendix G) Compliance Paths	Code Officials & Modelers	• Applicability • Overview of the modeling requirements • Special rules for additions, core-and-shell and retrofits • Requirements other than energy modeling
Modeling for MA Stretch TEDI and Appendix G (8 hours)	Modelers	Detailed modeling requirements
Compliance documentation for MA Stretch TEDI and Appendix G (2 hours)	Code Officials & Modelers	• Reporting templates • Other materials that must be submitted

2023 Massachusetts Stretch Energy Code Compliance Options Overview

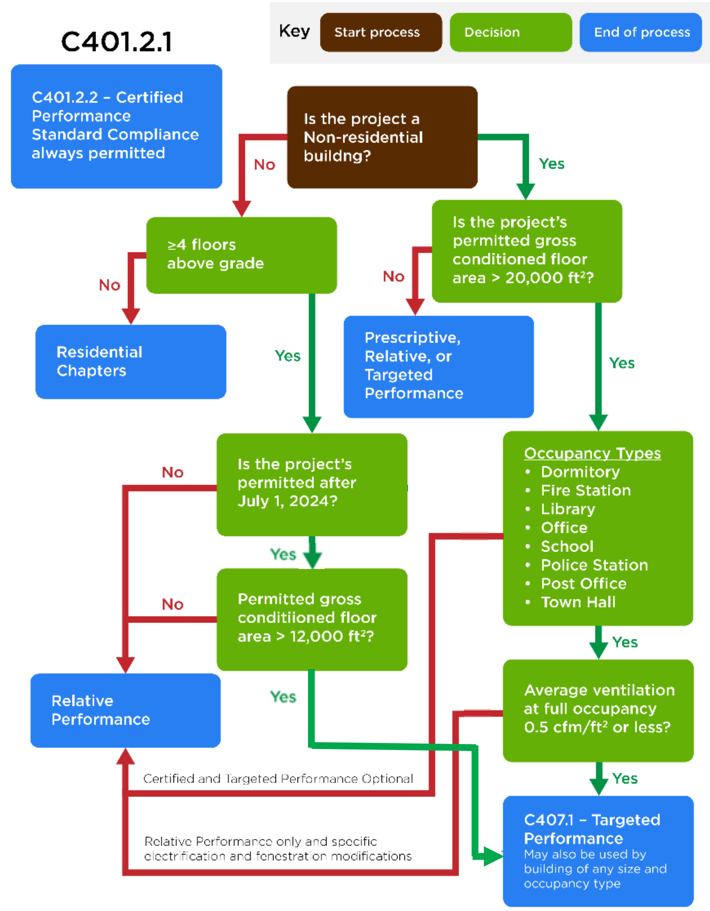
Overview of Compliance Options

- **Prescriptive Path:** 2021 IECC with strengthening amendments
- **Targeted Performance Path:** Requires developing an energy model following the 2023 Stretch Code Targeted Performance Simulation Guidelines to demonstrate that project's heating and cooling Thermal Energy Demand Intensities (TEDIs) do not exceed the set limits. In addition, projects must meet selected requirements of the prescriptive path.
- **Relative Performance Path:** Requires energy modeling following 2019 ASHRAE 90.1 Appendix G and as described in 2023 Stretch Code ASHRAE Appendix G Simulation Guidelines using site energy metric with strengthening amendments. In addition, projects must meet selected requirements of the prescriptive path.
- **Passive House:** (Certification through either PHI or Phius), optional for any building type
- **HERS Rating:** Home Energy Rating System (HERS) index certification, optional for multi-family buildings

SCOPE OF THIS TRAINING

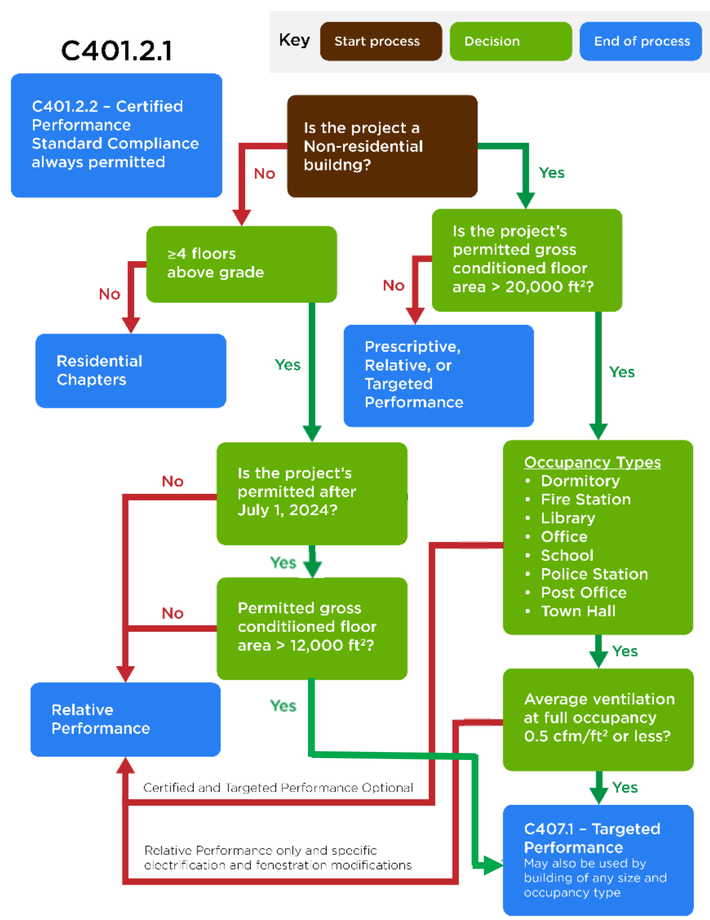
Compliance Options

- **Prescriptive path** is allowed only for alterations of any size and new buildings and additions under 20,000 ft^2.
- **Certified Performance: Passive House** path can be used for any building of any size
- **Certified Performance: HERS Path** can be used for any multifamily building.
- Core and shell projects and the first-time tenant space construction must follow the same path as new construction projects
- Residential compliance options are limited after a phase-out date of July 1st, 2024.



Compliance Options

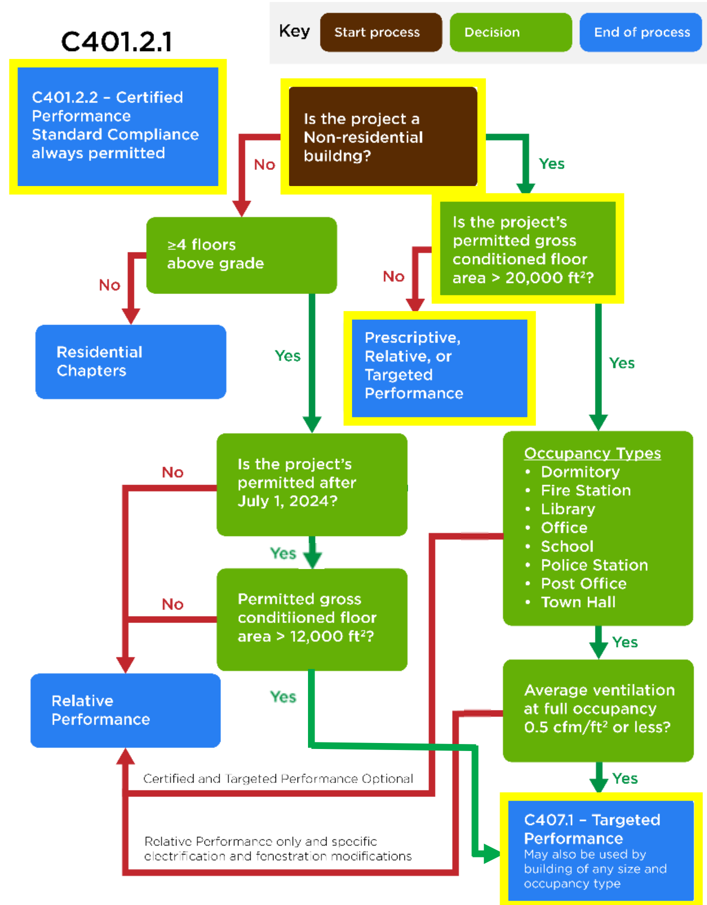
- **Targeted Performance (TEDI), Passive House** or **HERS** paths are required in the following cases:
  - When all the following conditions are met:
    - Total floor area over 20,000 ft^2
    - Average ventilation at full occupancy no greater than 0.5 cfm/ft^2
    - One of the following occupancy types:
      - Dormitories
      - Fire Stations
      - Libraries
      - Offices*
      - K-12 Schools
      - Police Stations
      - Post Offices
      - Town Halls
    - *Office use should be broadly interpreted. For example, an office on a college campus may include some class and conference rooms.
  - After 1 July 2024, for multifamily buildings over 12,000 ft^2, or portions of buildings which have residential use over 12,000 ft^2
- All other types of projects may use the **Relative Performance** (amended 90.1 2019 Appendix G).



Compliance Options: Example 1

A new 18,000 ft^2 retail store may use the following compliance options:

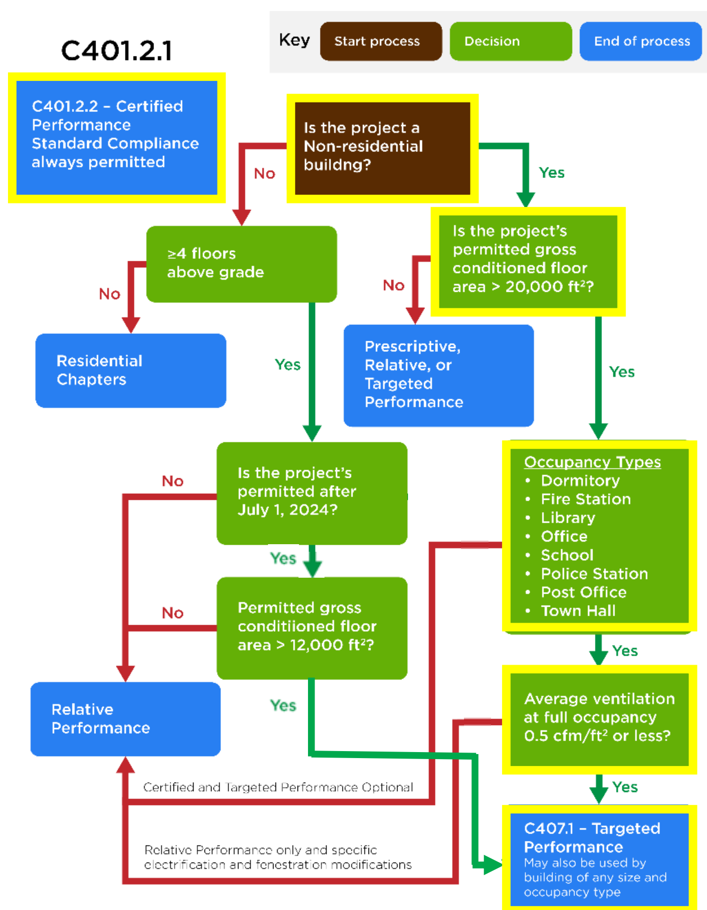
- Prescriptive
- Certified Performance: Passive House
- Relative Performance
- Targeted Performance

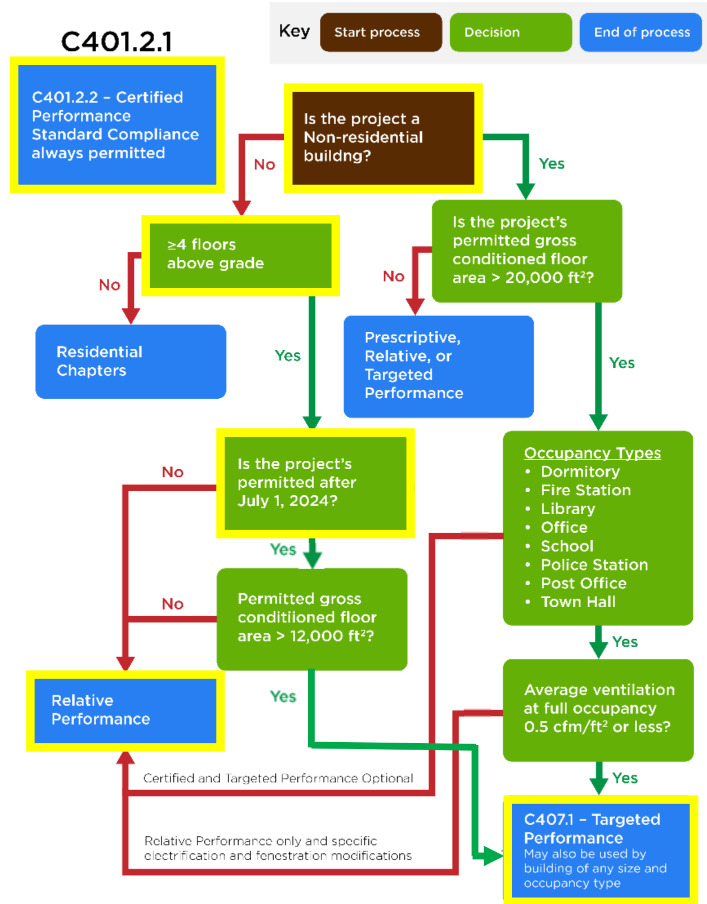


Compliance Options: Example 2

A new 75,000 ft^2 school may use the following compliance options:

- Certified Performance: Passive House
- Targeted Performance

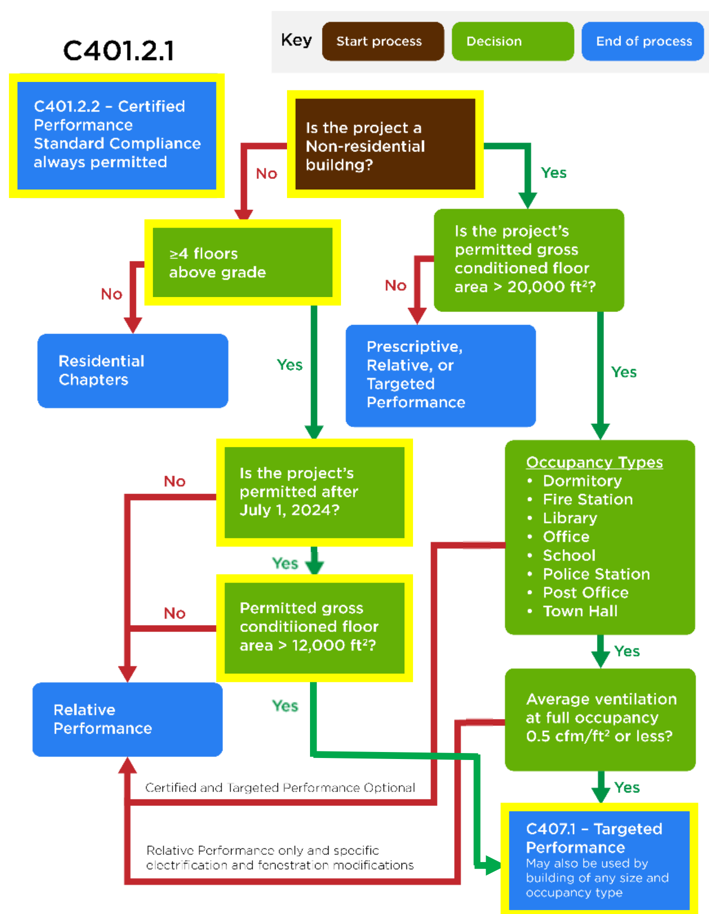




Compliance Options: Example 3

A new 5 story 18,000 ft² multifamily building permitted in May 2024 may use the following compliance options:

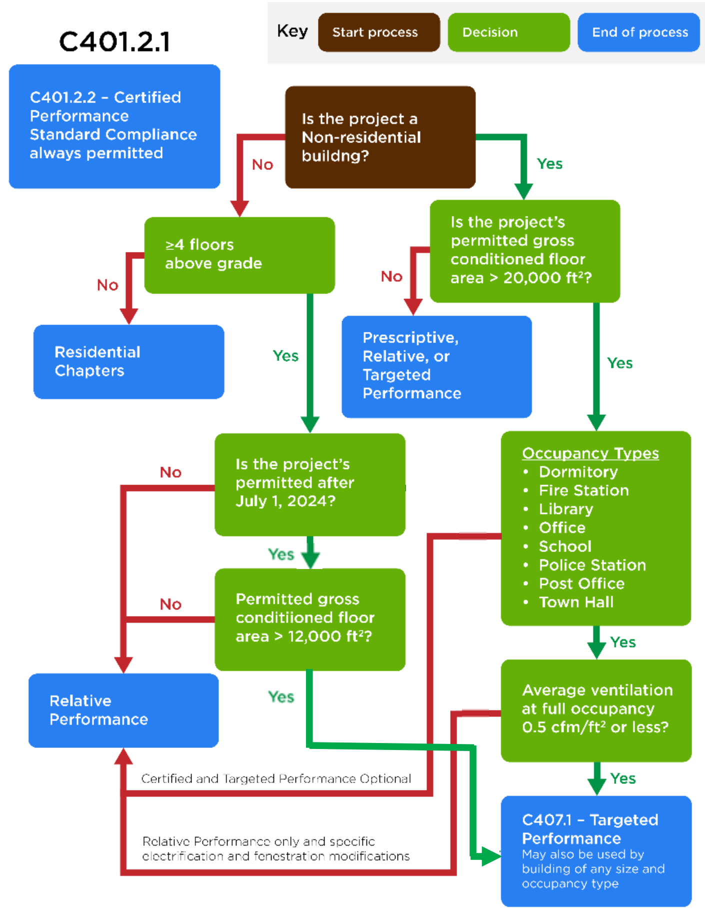
- Certified Performance: Passive House
- Certified Performance: HERS
- Targeted Performance
- Relative Performance



Compliance Options: Example 4

A new 5 story 18,000 ft² multifamily building permitted in August 2024 may use the following compliance options:

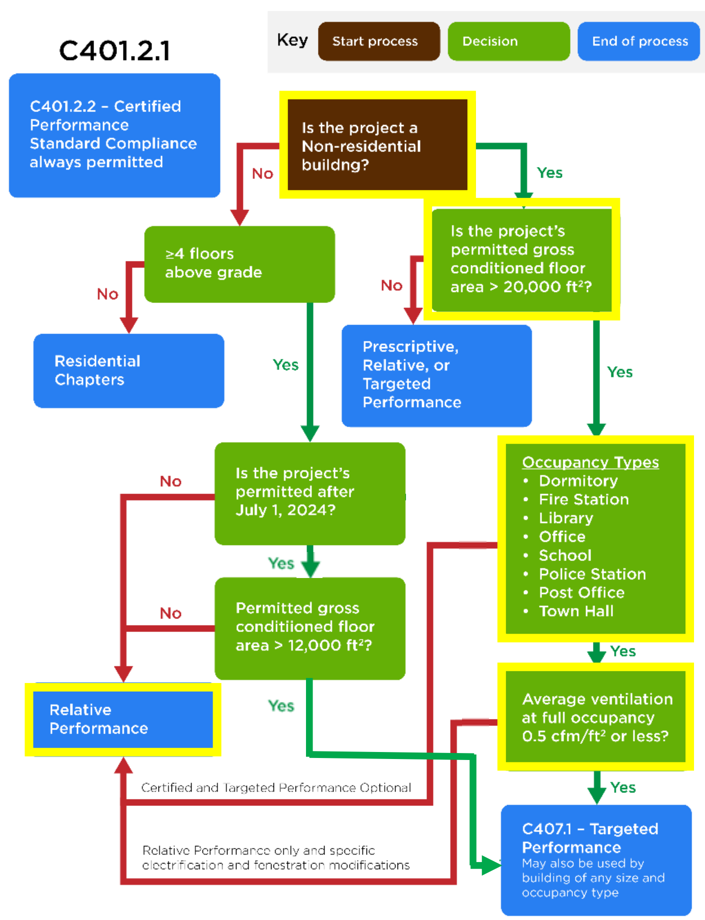
- Certified Performance: Passive House
- Certified Performance: HERS
- Targeted Performance



Quiz 1

A new 100,000 ft² pharmaceutical company office building has an average ventilation rate of 0.69 cfm/ft² at full occupancy. What compliance option can be used?

a. Prescriptive
b. Relative Performance
c. Certified Performance: HERs
d. Residential Chapters of IECC 2021



Quiz 1 Answer

A new 100,000 ft² pharmaceutical company office building has an average ventilation rate of 0.69 cfm/ft² at full occupancy. What compliance option can be used?

a. Prescriptive
b. Relative Performance
c. Certified Performance: HERs
d. Residential Chapters of IECC 2021

High Ventilation Rate Exception

-Buildings using the Relative Performance pathway due to average ventilation at full occupancy exceeding 0.5 cfm/ft^2 as allowed in C401.2.1 #2 must submit the supporting information below with the building permit as required in C103.2 (16).

-Projects do not have to provide a reason for the high ventilation

- Mechanical schedules showing the total design outdoor airflow for each new and existing air handler designed to supply any quantity of outdoor air to spaces
- An airflow riser diagram encompassing the complete project boundary, including all supply, exhaust, and return air systems serving the spaces
- Calculations showing the total outdoor air supplied by each unit, the project conditioned and semi-heated floor area, and the overall flow rate per area in cfm/ft^2

$$Average\ Ventilation\ Rate\ [\frac{CFM}{ft^2}] = \frac{\sum Design\ Outdoor\ Air\ Flow\ [CFM]}{Conditioned\ Floor\ Area\ [ft^2]}$$

High Ventilation Rate Exception

- If the building does not have a complete ventilation design at the time of permitting, the Targeted Performance path must be used
- Ventilation requirements of ASHRAE Standard 62.1 or applicable mechanical code may be used early in the design process to help understand whether the relative performance path may be available to the project

High Ventilation Rate Example

Based on mechanical equipment schedules and air-flow riser diagram included in the submittal, a veterinary office has average ventilation at full occupancy over 0.5 cfm/ft^2. The associated calculations are included in the submittal package. The project may document compliance using the Relative Performance pathway in lieu of Targeted Performance.

Occupancy Category	Floor Area	Outdoor Air	Ventilation Rate
Units	FT^2	CFM	CFM/FT^2
Source of Information	From Construction Documents		Calculated
Animal exam rooms	16,000	10000	0.625
Animal procedure rooms	20,000	11000	0.55
Administrative offices	5,000	700	0.14
Waiting rooms	1,000	700	0.7
Corridors	500	50	0.1
Total	42,500	22,450	0.53

Mixed Use Building (C407.1.1.6)

- For mixed-use buildings, the allowable path must be determined for each use type separately.
- Each use type accounting for more than 10% of the total space conditioned area and subject to Targeted Performance (TEDI) must individually comply with TEDI requirements (Section C407.1.1.5) for that respective use type.
- Use types that are supported by the Targeted Performance Path and that account for 10% or less of the total space conditioned area may be incorporated into and treated as the majority use type that is supported by TEDI.

Mixed Use Buildings Example 1

A new construction project includes an office use on the first floor (15,000 ft^2) and residential multi-family use on floors 2-5 (60,000 ft^2).

Compliance Path	15,000 ft^2 office on 1st floor	60,000 ft^2 multifamily on floors 2-5	
		Up through 7/1/2024	After 7/1/2024
Prescriptive Path	Yes (area <20,000 ft^2)	No (area >20,000 ft^2)	No (area >20,000 ft^2)
Targeted Performance (TEDI)	Yes, separate from MF	Yes	Yes
Relative Performance	Yes	Yes	No
Passive House	Yes	Yes	Yes
HERS	No	Yes	Yes

If the office was > 20,000 ft^2, Prescriptive Compliance would no longer be an option. Assuming the average ventilation rate at full occupancy is under 0.5 cfm/ft^2, the office would be limited to Targeted Performance or Passive House.

Mixed Use Buildings Example 2

Q: A new construction project is permitted after July 1st 2024 and includes an office occupancy on the first floor (**15,000 ft^2**) and multi-family residential occupancy on the upper floors (**160,000 ft^2**). Which compliance options are permitted?

A: The following considerations are used to determine the available compliance pathways:

- Both the office and multifamily occupancies are subject to the Targeted Performance
- The office occupancy accounts for <10% of the total project conditioned floor area subject to Targeted Performance, which is below the threshold in C407.1.1.6.

Compliance Path	15,000 ft^2 office	160,000 ft^2 multifamily
Prescriptive Path	Yes (area <20,000 ft^2)	No (>20,000 ft^2)
Targeted Performance (TEDI)	Yes, combined with MF or separate; if separate, use “Residential Multifamily and Dormitory” in Table C407.1.1.5	Yes
Relative Performance	Yes	No
Passive House	Yes	Yes
HERS	No	Yes

Mixed Use Building Example 3

Q: A new construction project includes 15,000 ft^2 restaurant and 160,000 ft^2 office occupancy on the upper floors. Which compliance options are permitted?

A: Restaurant portion is less than 20,000 ft^2, so it can follow Prescriptive Path, Targeted Performance, Relative Performance, or Passive House.

Office portion may follow Targeted Performance or Passive House.

Even though the restaurant is less than 10% of area of the building, the 10% accommodation in Section C407.1.1.6 does not extend to the restaurant because "restaurant" is not a use type subject to Targeted Performance. The restaurant and office portions require showing separate compliance pathways for each of these uses within an individual building permit.

Quiz 2

A new construction project includes 50,000 ft^2 school and 60,000 ft^2 office occupancy on the upper floors both with average ventilation rates at full occupancy less than 0.5 cfm/ft^2. Which compliance option is allowed for both occupancies?

a. Prescriptive

b. Relative Performance

c. Certified Performance: HERs

d. Targeted Performance Compliance

Quiz 2 Answer

A new construction project includes 50,000 ft^2 school and 60,000 ft^2 office occupancy on the upper floors both with average ventilation rates at full occupancy less than 0.5 cfm/ft^2. Which compliance option is allowed for both occupancies?

a. Prescriptive

b. Relative Performance

c. Certified Performance: HERs

d. Targeted Performance Compliance

Compliance Path	50,000 ft^2 school	60,000 ft^2 office
Prescriptive Path	No (>20,000 ft^2)	No (>20,000 ft^2)
Targeted Performance (TEDI)	Yes	Yes
Relative Performance	No	No
Passive House	Yes	Yes
HERS	No	No

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Requirements Other Than Energy Modeling Applicable to the Relative and Targeted Performance Paths

General Concept

Projects following the Targeted Performance and Relative Performance paths must meet a majority of the requirements applicable to the prescriptive path in addition to performing energy modeling.

Unlike IECC and ASHRAE 90.1 performance-based compliance options, the Targeted and Relative Performance paths offer limited design flexibility compared to the prescriptive path while imposing additional performance requirements.

Code Requirements and Performance

Code Requirement for Building Envelope	Targeted Performance	Relative Performance
C401.3 Thermal envelope certification (Unchanged from IECC) Must post thermal envelope certificate with the key performance characteristics of the opaque envelope and fenestration and air leakage testing results.	Yes	Yes
C402.1.5 Component Performance Alternative • Allows performance trade-offs within vertical assemblies by prescribing limits on the area-weighted U-factor for above grade wall assemblies and whole assembly U-factors for vision glass glazed wall systems. The maximum allowed U-factors in either Section C402.1.5.1 or C402.1.5.2 depends on the percentage of the exterior wall taken up by glazed wall systems; • Fenestration shall meet the applicable SHGC requirements of Section C402.4.3.	Yes, as an option to comply with C402.1.1. Required to comply with C402.	Yes
C402.2.8 Requirement for combustion fireplaces	Yes	Yes
C402.3 Rooftop solar readiness	Yes	Yes
C402.4.6 Fenestration Documentation Allowed methods for determining fenestration performance.	Yes	Yes
C402.5 Air Leakage Air barrier design and testing requirements; maximum allowed air leakage rates.	Yes	Yes
C402.7 Derating and Thermal Bridges Methodology that must be used to account for thermal bridging in exterior walls	Yes	Yes

Component Performance Alternative (C402.1.5)

A Different overall (area-weighted) U-factor allowances for buildings with glazed wall systems accounting for ≤ 50% of the total building thermal envelope above-grade wall area, versus buildings where such systems account for > 50%

B No longer allows trade offs between horizontal envelope (roof and floors) and vertical envelope (walls and windows). Only “intra-vertical” trade offs are allowed.

C Wall U-factors must be derated for thermal bridging when determining compliance.

D Proposed envelope must comply with the following requirements:

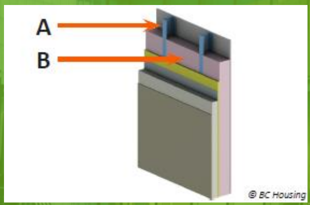
- Vision glass wall assembly no greater than U-0.25 (see “Mass Stretch Energy Codes Attachment A- Envelope Performance and Thermal Bridging” exceptions)
- Area-weighted U-factor (including glazed wall assemblies and opaque exterior walls) ≤ 0.1285 for buildings with “low glazed wall systems” (C402.1.5.1) and ≤ 0.1600 for high glazed wall system buildings (C402.1.5.2)
- Prescribes maximum U-factors for roofs, below grade walls, floors, slab-on-grade floors, and opaque doors (shall comply with C402.1.4).

E High glazed wall system buildings must comply with Section C401.4.2 (full space heating efficient electrification)

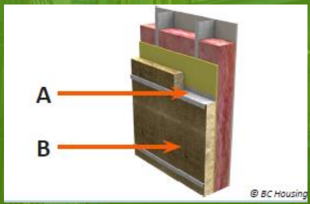
Exception: Buildings using the Relative Performance path because average ventilation at full occupancy is greater than 0.5 cfm/ft2 must comply with C401.4.1

Thermal Bridging Derating

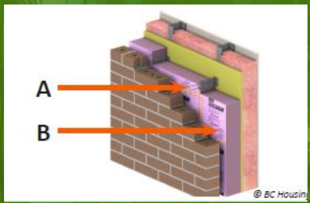
1. <u>Cavity Insulation between wall framing</u>
   Wall framing (A), which can be wood or metal, interrupts the cavity insulation on the inboard side of the assembly (B).



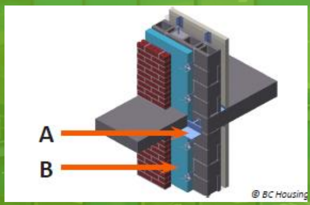
2. <u>Fasteners which hold exterior cladding (wall paneling/rain screen) to the framing</u>
   Fasteners (A) which are used to connect the exterior paneling/rain screen (not shown) and/or support exterior insulation interrupt the exterior insulation (B).



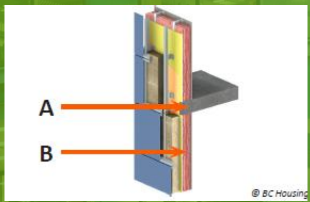
3. <u>Brick ties which hold brick panel sections to the framing</u>
   Brick ties (A) which are used to connect the exterior brick to the building framing interrupt the exterior insulation (B)



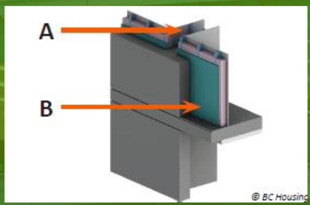
4. <u>Balcony to exterior vertical wall intersection</u>
   Structural connections (A) which are used to connect the balcony to the building framing typically bypass all insulation.



5. <u>Interior horizontal floor to exterior vertical wall intersection</u>
   Horizontal floor (A) interrupt vertical wall insulation (B).

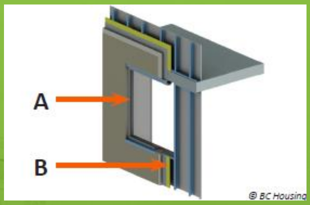


6. <u>Interior vertical wall to exterior vertical wall intersection</u>
   Interior vertical wall (A) interrupts vertical wall insulation (B).

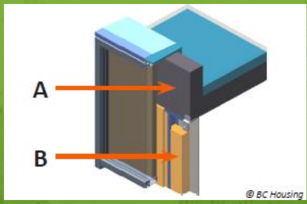


Thermal Bridging Derating (Continued)

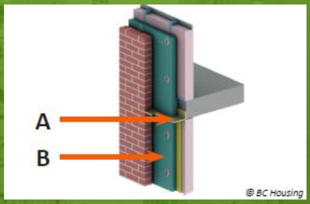
7. <u>Fenestration to exterior vertical wall intersection</u>
   Window framing (A) interrupts vertical wall insulation (B).



8. <u>Exterior vertical wall to roof intersection (e.g. parapet)</u>
   Uninsulated portion of cladding covering parapet connects to roof edge (A) beyond insulation (B).

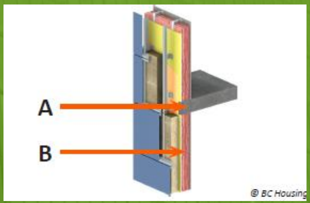


9. <u>Brick shelfs</u>
   Straight shelf (A) interrupts continuous insulation (B) at slab edge.



10. <u>Exterior vertical wall to grade intersection</u>
    Footing (A) bypasses under-slab and wall insulation (B).

11. <u>Exterior vertical wall plane transition, such as building corners and other changes in the plane of the vertical wall face</u>
    Additional framing (A) at intersections interrupts insulation (B).



Thermal Bridging Derating (Continued)

- 90.1 2019 Appendix G required derating for thermal bridging scenarios #1, 4, 5, 6, 8, 10 and 11 but it was often overlooked in the models.
- Whole building energy modeling developed for compliance with both the Relative and Targeted Performance Paths must account for thermal bridging using methods described in Section C402.7 accounting for scenarios 1-11.

Code Requirements Other Than Envelope	Targeted Performance	Relative Performance
C401.4.1 Partial Space Heating Electrification	No	Yes, if highly ventilated
C401.4.2 Full Space Heating Electrification	Yes, for high glazed wall system buildings (C402.1.5.2)	Yes, for high glazed wall system buildings (C402.1.5.2) only if not highly ventilated
C403 Building Mechanical Systems	Yes	No except must meet C403.5 (Economizer) and C403.7 (Ventilation and exhaust systems)
C404 Service Water Heating The minimum equipment efficiency and controls; piping insulation.	Yes	No
C405 Electric Power and Lighting Systems Interior and exterior lighting power and controls; electric metering; transformers; motors; vertical and horizontal transportation systems and equipment; voltage drop; automatic receptacle controls; energy monitoring; provisions for the electric vehicles ready parking spaces.	Yes	Yes
C406 Additional Efficiency Requirements Must implement efficiency measures to achieve at least 15 credits.	Yes	Yes, some measures may contribute to achieving the required modeled performance; others (e.g., heavy timber, fault detection and diagnostics, etc.).
C408 Maintenance Information and System Commissioning Unchanged from IECC; requires systems commissioning, functional testing and maintenance information.	Yes	Yes

Additional Requirements for Relative Performance Path

- Projects must meet mandatory requirements of 90.1 2019 Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4.
- In most cases these requirements are aligned with provisions in IECC and MA Stretch listed on the previous slides, but there are some exceptions.

Additional Requirements for Relative Performance Path

Example: Automatic receptacle controls must be specified for the following applications (Section 8.4.2)

- At least 50% of all 125 V, 15, and 20 amp receptacles in private offices, conference rooms, rooms used primarily for printing and/or copying, break rooms, classrooms, and individual workstations.
- At least 25% of branch circuit feeders installed for modular furniture not shown on the construction documents.

Quiz 3

True or False: Projects following the Targeted Performance path are not required to meet lighting power limits in Section C405 if they demonstrate that improvements in other systems make up for energy penalty for inefficient lighting.

Quiz 3 Answer

True or False: Projects following the Targeted Performance path are not required to meet lighting power limits in Section C405 if they demonstrate that improvements in other systems make up for energy penalty for inefficient lighting.

False

Quiz 4

True or False: Projects following the Relative Performance path are required to meet lighting power limits in Section C405.

Quiz 4 Answer

True or False: Projects following the Relative Performance path are required to meet lighting power limits in Section C405.

True

Quiz 5

True or False: Projects following the Targeted Performance path are not required to demonstrate compliance with Section C406, Additional Efficiency Requirements.

Quiz 5 Answer

True or False: Projects following the Targeted Performance path are not required to demonstrate compliance with Section C406, Additional Efficiency Requirements.

False

Quiz 6

True or False: Projects following the Relative Performance path are not required to demonstrate compliance with Section C406, Additional Efficiency Requirements.

Quiz 6 Answer

True or False: Projects following the Relative Performance path are not required to demonstrate compliance with Section C406, Additional Efficiency Requirements.

False

Quiz 7

True or False: For projects following the Targeted Performance path, reducing envelope air leakage to the levels required in Section C406.9 (reduced air leakage energy credit) contributes to both demonstrating compliance with the TEDI limits and Section C406.

Quiz 7 Answer

True or False: For projects following the Targeted Performance path, reducing envelope air leakage to the levels required in C406.9 (reduced air leakage energy credit) contributes to both demonstrating compliance with the TEDI limits and Section C406.

True

Quiz 8

True or False: For projects following the Relative Performance path, reducing envelope air leakage to the levels required in C406.9 (reduced air leakage energy credit) contributes to both demonstrating compliance with the PCI target and Section C406.

Quiz 8 Answer

True or False: For projects following the Relative Performance path, reducing envelope air leakage to the levels required in C406.9 (reduced air leakage energy credit) contributes to both demonstrating compliance with the PCI target and Section C406.

True

Modeler Qualification Requirements

Energy models must be created by persons qualified by education and training to perform such work.

The submittal package must include signatures of the licensed professional(s) as required for other compliance options.

In addition, the modeling documentation submitted to AHJ shall be signed by a professional meeting qualification requirements outlined in Modeler_Quals_FINAL.pdf (energycodes.gov) and summarized below.

EXPERIENCE: The minimum of 3 years of full-time equivalent modeling experience OR successfully completion of at least 5 modeling projects; requirement is waived for professionals with ASHRAE BEMP certification.

TRAINING: A minimum of 8 hours of training completed in the last three years, including the following:

- **Performance Based Compliance Documentation for ASHRAE 90.1 Section 11 and Appendix G (required)**
- **2 hours minimum on ASHRAE 90.1 Section 11 or Appendix G**
- **Energy modeling training**

CERTIFICATIONs: One of the following:

- **ASHRAE Building Energy Modeling Professional (BEMP); High-Performance Building Design Professional (HBDP); Building Energy Assessment Professional (BEAP); Commissioning Professional (BCxP)**
- **Association of Energy Engineers Certifications Building Energy Simulation Analyst (BESA); Certified Energy Auditor (CEA) Certified Energy Manager (CEM); Existing Building Commissioning Professional (EBCP); Certified Building Commissioning Professional (CBCP)**

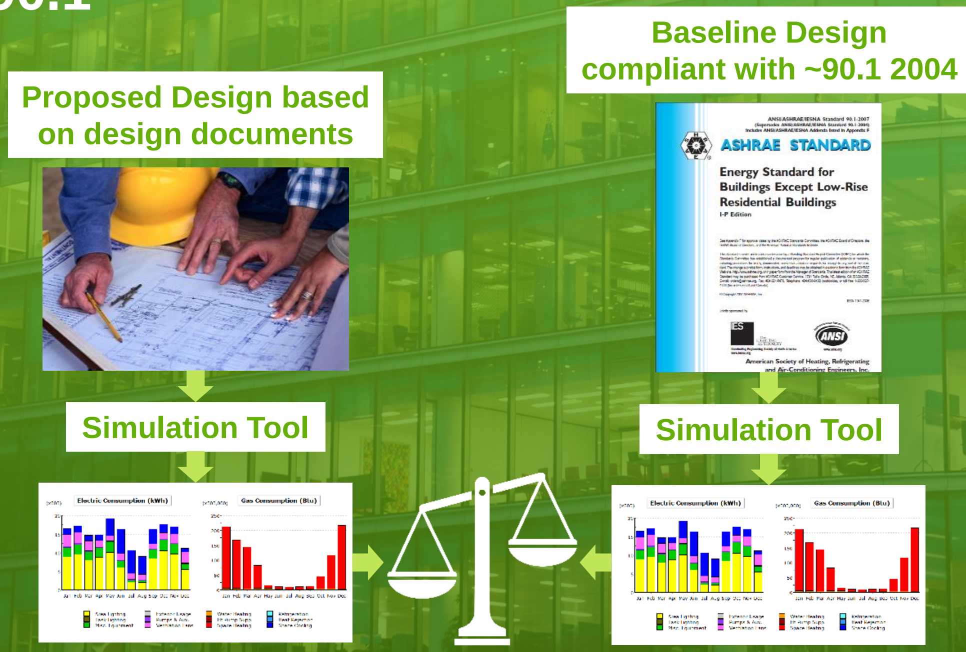
Relative Performance Path

Overview

- Based on 90.1 2019 Appendix G Performance Rating Method with Massachusetts amendments
- Establishes compliance based on the relative energy use of two models - the proposed design model and the baseline design model
  - The proposed design model must reflect design documents.
  - Baseline model reflects efficiency levels that are approximately aligned with requirements in 90.1 2004
- Requirements are detailed in 2023 Technical Guidance Massachusetts Stretch Energy Codes Attachment B

General Concept of Performance-Based Compliance with 90.1

- Allow projects to not meet some of the prescriptive requirements and make up for the associated energy penalty by exceeding minimum requirements in other areas
- Configuration of both models is prescribed in ASHRAE Standard 90.1
- Energy use of both models is calculated using the same simulation tool and weather file

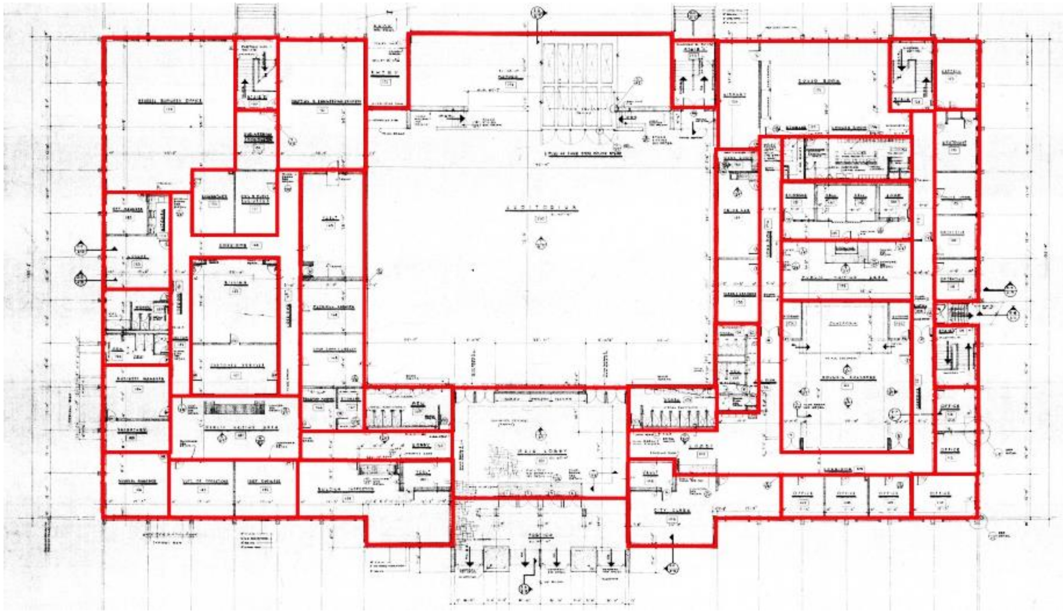


Proposed Design Model

- Must reflect buildings systems, components and controls specified in the construction documents
- The modeled operating conditions and schedules must reflect the expected operation of the building or typical for the given building use type
- The following systems must be excluded from the proposed design model (MA Stretch amendments to 90.1 G2.4.1):
  - Energy used to recharge vehicles that are used for on-road and off-site transportation purposes, or energy losses from use of behind-the-meter energy storage
  - On-site renewable energy systems

Floor Plan Details that Must Be Captured

HVAC zones must be modeled individually or combined into a thermal block when they have similar orientation and space use classification and are served by the same HVAC system type.



Baseline Design Model

The same building use type, programming, envelope shape, HVAC zoning and operating schedules (with some exceptions) as the proposed design model.

Most systems and components regulated by energy code (envelope constructions, fenestration area, HVAC system type and controls, SWH system type and lighting power and controls) are prescribed in 90.1 Appendix G, are independent from the specified systems and are modeled at efficiency levels approximately aligned with 90.1 2004.

Parameters that are not explicitly defined in 90.1 PRM must be modeled the same as in the proposed design.

The end uses that are not included in the proposed design must not be modeled in the baseline. For example, if the project includes a parking lot for which no exterior lighting is specified, the parking lot lighting power allowance cannot be modeled in the baseline.

Baseline energy use is calculated as an average of four alternative orientations of the baseline design model except when exposure is dictated by building site or when fenestration area on different exposures differ by less than 5%.

Approved Simulation Tools

- eQUEST, EnergyPlus, IESVE and OpenStudio are preapproved
- Other software tools may be approved by Massachusetts Department of Energy Resources (DOER) on a case-by-case basis, provided that the tool meets requirements of ASHRAE 90.1 2022 Section G2.2.
- If an approved simulation tool used on a project does not have the capability to model a specified system or component specified for the proposed design, supplemental calculations may be used. Such calculations must be documented as required in Section G2.5 and are subject to AHJ approval.

District Energy Systems

MA Stretch modeling requirements for district energy systems are aligned with ASHRAE 90.1 2022 Addendum A:

- The HVAC systems in the baseline design for projects served by the district systems shall be modeled the same as for projects with on-site systems.
- The proposed design is modeled with steam, chilled water or hot water supplied by an on-site virtual chiller, boiler plant and/or water heater that complies with but does not exceed the applicable mandatory and prescriptive requirements in 90.1 2022 Section 6.

Electricity Generation Systems

- Contribution of renewable electricity generation systems toward compliance with Section C407.2 is not allowed following MA Stretch amendments to 90.1 Section G2.4.1. Such systems should not be modeled in either the proposed design or baseline design.
- Combined Heat and Power systems must be modeled the same in the baseline and proposed design, except the baseline design must be modeled without waste heat recovery (90.1 G2.4.2).

Example: Modeling Combined Heat and Power Systems

Q: A hospital project includes a combined heat and power (CHP) system that uses natural gas to generate electricity. The waste heat from the CHP is recovered and used for service water heating. How should the CHP be modeled in the baseline and proposed design?

A: In the proposed design, CHP must be modeled as specified, reflecting the specified system electric and thermal efficiency and controls.

In the baseline design, CHP must be modeled based on the specified electricity generation efficiency but without accounting for the recovered heat. Service hot water would be supplied by the gas storage water heater (90.1 Table G3.1.1-2).

Operating and Other Schedules

- Operating schedules used in the energy simulation determine how the building is used throughout the year
  - Occupancy schedules determine the number of occupants in each space every hour of the year
  - Lighting schedules determine the fraction of lighting fixtures that are on during each hour of the year
  - Thermostat setpoint schedules determine heating and cooling temperature setpoints that HVAC systems are operating to meet.
  - Periods when HVAC systems are operating in the occupied mode (e.g., running continuously to provide heating, cooling and ventilation) versus unoccupied mode when ventilation is off and HVAC systems are cycling with load to maintain setback temperatures.
- The simulated values must reflect expected building operation provided by building owner and design team. The AHJ may ask modelers to justify schedules if they deviate significantly from typical. Examples of acceptable documentation include a statement from the owner with anticipated project's operating hours, or operating hours of a similar franchise.
- Where the details of building operation are unknown, typical schedules for the building use type must be used based on provided resources.
- Schedules must be modeled identically in the baseline and proposed design models except when explicitly permitted otherwise in 90.1 Appendix G Table G3.1 #4.

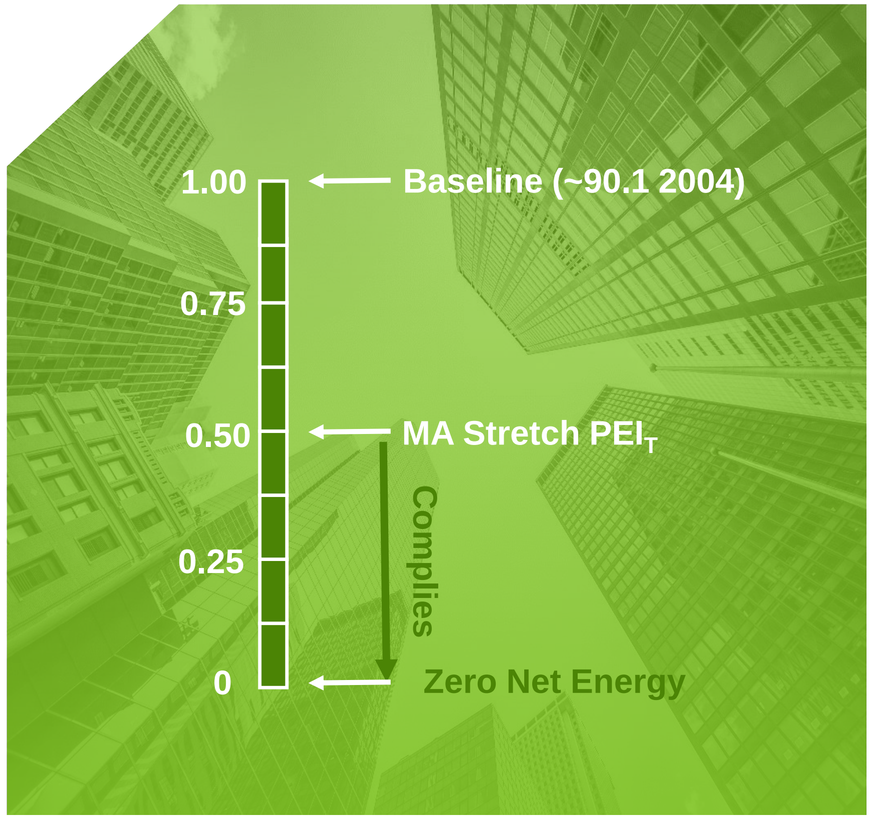
Performance Energy Index

- Performance of the proposed design relative to the baseline is expressed as Performance Energy Index (PEI)

$$PEI = \frac{\textit{Proposed Building Site Energy}}{\textit{Baseline Building Site Energy}}$$

- Project meets code if the PEI is less than or equal to the Performance Energy Index Target (PEI_T)

$$\mathbf{PEI \leq PEI_T}$$



Performance Energy Index Target

$$PEI_T = \frac{(BBUE + (BPF \times BBRE))}{BBP}$$

BBUE = Baseline Building Unregulated Site Energy

BBRE = Baseline Building Regulated Site Energy

BBP = Baseline Building Performance; BBP = BBUEC + BBREC

BPF = Building Performance Factor

$$\textit{\% Improvement beyond code} = 100 \times \frac{PEI_T - PEI}{PEI_T}$$

Unregulated Energy

$$PEI_T = \frac{(BBUE + (BPF \times BBRE))}{BBP}$$

- Energy use of systems and components that have no requirements in 90.1 Sections 5-10 are considered **UNREGULATED**.
- As a general rule, **unregulated components must be modeled the same in the baseline and proposed design.**

Regulated Energy

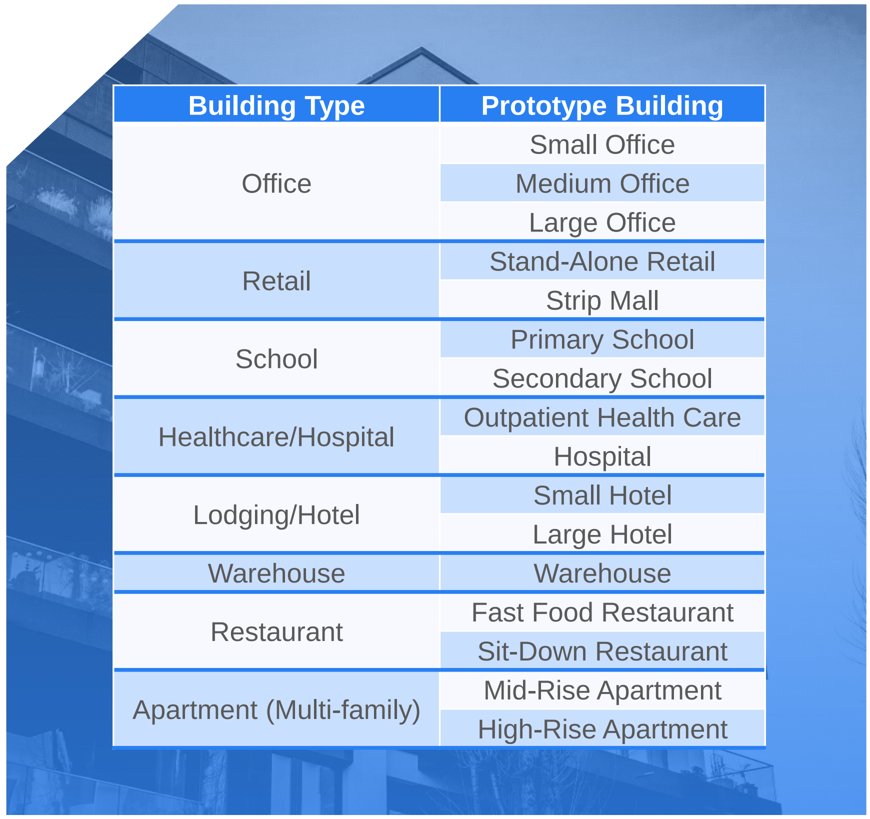
$$PEI_T = \frac{(BBUE + (BPF \times BBRE))}{BBP}$$

- Energy use of systems and components with requirements prescribed in 90.1 Sections 5-10 are considered regulated. Envelope of conditioned spaces, lighting, HVAC are examples of **REGULATED** systems.
- In the **baseline** model, the regulated systems are modeled at the **efficiency levels prescribed in Appendix G** that are generally consistent with the requirements of 90.1 2004.
- In the proposed model, regulated loads must match the design documents.

Building Performance Factor

$$PEI_T = \frac{(BBUE + (BPF \times BBRE))}{BBP}$$

- Quantifies stringency of MA Stretch Code relative to 90.1 2004 which is used as the basis for the baseline model
- Determined using DOE/PNNL Prototype Models
  - Representative of the US building stock
  - Versions of these models are created for each edition of Standard 90.1 starting with 2004
  - BPF for each building type and climate zone is calculated as the ratio of the regulated energy cost of the prototype model configured to minimally comply with 90.1 2019 versus the prototype configured to minimally comply with 90.1 2004
  - The results for similar building types (e.g., different size of office buildings) are averaged



Building Type	Prototype Building
Office	Small Office
	Medium Office
	Large Office
Retail	Stand-Alone Retail
	Strip Mall
School	Primary School
	Secondary School
Healthcare/Hospital	Outpatient Health Care
	Hospital
Lodging/Hotel	Small Hotel
	Large Hotel
Warehouse	Warehouse
Restaurant	Fast Food Restaurant
	Sit-Down Restaurant
Apartment (Multi-family)	Mid-Rise Apartment
	High-Rise Apartment

Quiz 9

What can be said about a design subject to MA Stretch 2023 following the relative performance path that has a PEI less than PEI target?

a. Design complies with the modeling performance requirement of the relative performance path

b. This is a net zero design.

c. Design is minimally compliant with ~ 90.1 2004.

d. Something is wrong PCI should never be less than the PCI target.

Quiz 9 Answer

What can be said about a design subject to MA Stretch 2023 following the relative performance path that has a PEI less than PEI target?

a. Design complies with the modeling performance requirement of the relative performance path.

b. This is a net zero design.

c. Design is minimally compliant with ~ 90.1 2004.

d. Something is wrong PCI should never be less than the PCI target.

Quiz 10

What can be said about a design subject to MA Stretch 2023 following the relative performance path that has a PEI equal to 1?

a. Design complies with the modeling performance requirement of the relative performance path

b. This is a net zero design.

c. Design is minimally compliant with ~ 90.1 2004.

d. Something is wrong PCI should never be equal to 1.

Quiz 10 Answer

What can be said about a design subject to MA Stretch 2023 following the relative performance path that has a PEI equal to 1?

a. Design complies with the modeling performance requirement of the relative performance path

b. This is a net zero design.

c. Design is minimally compliant with ~ 90.1 2004.

d. Something is wrong PCI should never be equal to 1.

MA Stretch Building Performance Factor

- The MA Stretch Building Performance Factors are based on ASHRAE 90.1-2022 Informative Appendix I, Table 13-1, which provides the BPFs for jurisdictions adopting ASHRAE 90.1 2022 Appendix G using site energy metric.
- The 90.1 Appendix I BPFs have been further reduced by 10%, resulting in 10% increase in stringency relative to 2022 requirements
- Building occupancies for which TEDI path is required are excluded from the BPF table

Table 4.2.1.1 Building Performance Factor (BPF)

Building Area Type	Climate Zone 5A
Health Care/Hospital	0.59
Hotel/Motel	0.57
Restaurant	0.62
Retail	0.47
Warehouse	0.41
All Others	0.51

Example: Interpreting Modeling Results

Q. A project was modeled following the Relative Performance path. The modeling results are shown below:

Site energy use intensity of the baseline building design is 50 kBtu/ft^2
Site energy use intensity of the proposed design is 25 kBtu/ft^2
Performance Energy Index Target is 0.55
Performance Energy Index is 25 ÷ 50 = 0.5

The proposed design has a 50% lower site EUI than the baseline. Does this mean that the project is 25 ÷ 50 x 100 = 50% improved over code?

No! The baseline design represents a building that is approximately as efficient as was necessary to comply with 90.1 2004 and the proposed design is 50% better than this inefficient baseline building.

Example: Interpreting Modeling Results

Q. Continuing the previous example, is there a way to estimate improvement of the proposed design beyond MA Stretch code without developing an additional model of a minimally code compliant design?

Reminder:
Site energy use intensity of the baseline building design is 50 kBtu/ft^2
Site energy use intensity of the proposed design is 25 kBtu/ft^2
Performance Energy Index Target is 0.55
Performance Energy Index is 25 ÷ 50 = 0.5

A. Yes. Improvement over code may be calculated using Equation 1:

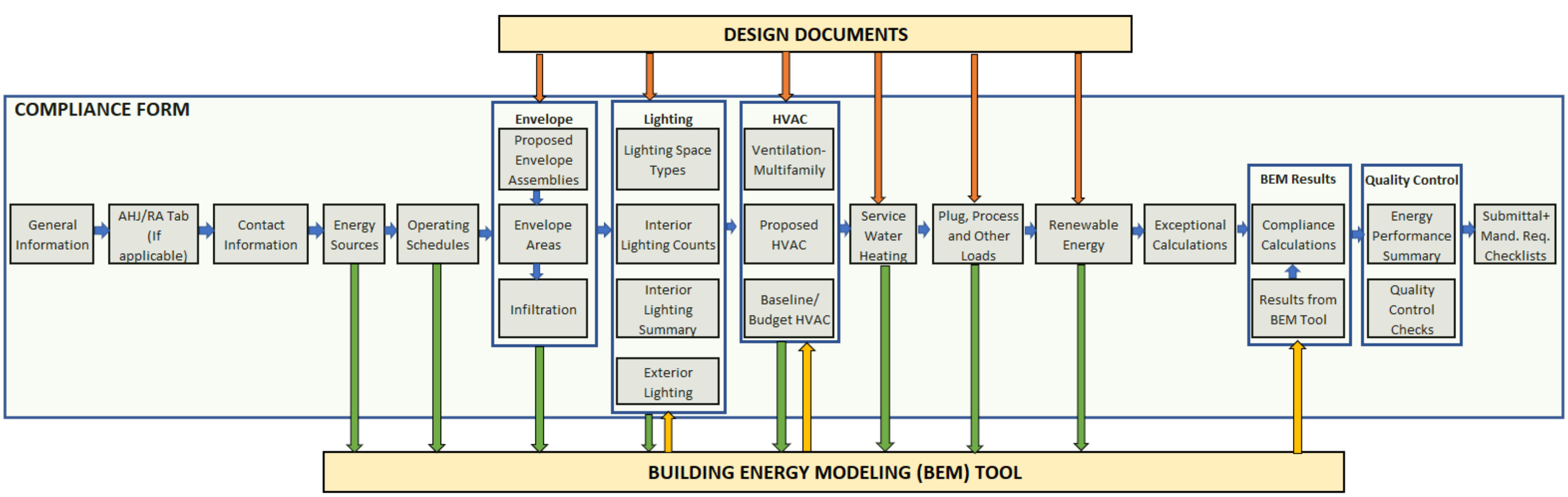
$$\textit{Improvement beyond code} = \frac{(0.55 - 0.5)}{0.55} = 9.1\%$$

Key Differences Between
90.1 2019 Appendix G and MA Stretch Code

	90.1 2019 Appendix G	C407.2 Relative Performance
Compliance Metric	energy cost	site energy
Contribution of renewable energy toward compliance allowed?	Yes, up to 5% of baseline energy cost	No
Additional Efficiency Requirements (Section C406) apply?	No	Yes, but improvement in performance due to C406 measures can also contribute toward improving Performance Energy Index.
Additional envelope requirements	90.1 mandatory provisions	90.1 mandatory provisions; Must meet C402.1.5 (component performance alternative) Modeled vertical envelope must be derated to account for thermal bridging
Additional lighting requirements	90.1 mandatory provisions; must not be worse than baseline lighting power (90.1 2004)	90.1 mandatory provisions, MA Stretch C405 electrical power and lighting system requirements.
Additional HVAC requirements	90.1 mandatory provisions	90.1 mandatory provisions, prescriptive requirements for economizer and ventilation and exhaust systems (including exhaust air energy recovery)
Additional SWH requirements	90.1 mandatory provisions	90.1 mandatory provisions
Stringency	As prescribed in 90.1 2019	10% more stringent than 90.1 2022 on site energy bases; achieved by reducing the BPFs by 10%

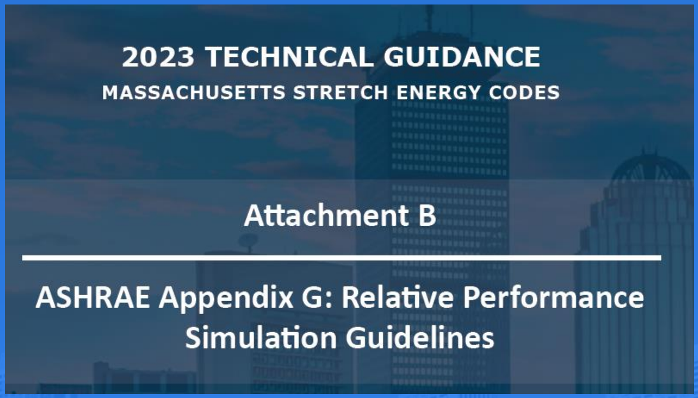
Reporting Requirements

- Filled out DOE/PNNL ASHRAE Standard 90.1 Performance Based Compliance Form. A version of the Compliance Form package customized for MA Stretch Code is under development.



Relative Performance Simulation Guidelines

- Clarify areas where the Relative Performance Path deviates from ANSI/ASHRAE/IESNA Standard 90.1 2019 (90.1) Appendix G Performance Rating Method (PRM) due to MA Stretch Code amendments.
- Provides requirements for areas that are either not directly addressed by the PRM or are ambiguous. In most cases, such requirements are based on addenda to 90.1 2019, which are directly referenced.
- Explains PRM rules that are often misapplied or misinterpreted.
- Provide examples to illustrate the above.
- The Simulation Guidelines are not a standalone document and must be used in conjunction with the modeling requirements in ASHRAE 90.1 2019 Appendix G and MA Stretch Code 2023 Section C407.2.



2023 TECHNICAL GUIDANCE

MASSACHUSETTS STRETCH ENERGY CODES

Attachment B

ASHRAE Appendix G: Relative Performance Simulation Guidelines

Additional Reference Materials

- ASHRAE 90.1 2019 Users' Manual
- ASHRAE 90.1 Section 11 and Appendix G Submittal Review Manual is a comprehensive reference for reviewing modeling-based submittals. The Manual is a companion to the DOE/PNNL 90.1 Section 11 and Appendix G Compliance Form and supports 2016 and 2019 editions of ANSI/ASHRAE Standard 90.1. The document was developed to help code officials review modeling-based submittals and should also be used energy modelers to self-check the models before submitting compliance documentation to code official.
- ASHRAE Standard 90.1 Performance Based Compliance Form is spreadsheet-based and meets the documentation requirements of Standards 90.1-2016 and 2019 Section 11 Energy Cost Budget Method and Appendix G Performance Rating Method. It helps the modeler establish simulation inputs for the baseline/budget and proposed design models and includes a submittal checklist to ensure that all necessary supporting documentation is included in the submittal. It standardizes compliance documentations and simplifies submittal reviews by code officials and administrators of above code program implementers.
- Massachusetts Stretch Relative Performance Path Companion Tool is spreadsheet-based tool that imports data from the ASHRAE Standard 90.1 Performance Based Compliance Form to calculate MA Stretch 2023 compliance using MA Stretch BPFs and the site energy compliance metric.

Targeted Performance Path

- New compliance path
- Targets building envelope performance due to long useful life.
- Requires a whole building energy simulation
- Must follow modeling requirements in the Targeted Performance Simulation Guidelines.
- Designs must demonstrate heating and cooling Thermal Energy Demand Intensities (TEDIs) no greater than the individual limits in Table C407.1.1.5 for the appropriate building type and size.
- Heating TEDIs are rounded to a single decimal point; cooling TEDI are rounded to the nearest whole number.
- Projects must also comply with additional requirements in Section C401.2.1.

Overview

Table C407.1.1.5 Thermal Energy Demand Intensity (TEDI Limits)

Use Type	Heating TEDI (kBtu/ft^2-yr)	Cooling TEDI (kBtu/ft^2-yr)
Office, fire station, library, police station, post office, town hall ≥ 125,000 ft^2	1.5	23
Office, fire station, library, police station, post office, town hall between 75,000 and 125,000 ft^2	4 – 0.00002* Area (ft^2)	18 + 0.00004* Area (ft^2)
Office, fire station, library, police station, post office, town hall ≤ 75,000 ft^2	2.5	21
K-12 School ≥ 125,000 ft^2	2.2	12
K-12 School between 75,000 and 125,000 ft^2	2.7 – 0.000004* Area (ft^2)	32 – 0.00016* Area (ft^2)
K-12 School ≤ 75,000 ft^2	2.4	20
Residential multifamily and dormitory ≥ 125,000 ft^2	2.8	22
Residential multifamily and dormitory between 75,000 and 125,000 ft^2	3.8 – 0.000008* Area (ft^2)	4.5 + 0.00014* Area (ft^2)
Residential multifamily and dormitory ≤ 75,000 ft^2	3.2	15
All other ≥ 125,000 ft^2	1.5	23
All other between 75,000 and 125,000 ft^2	4 – 0.00002* Area (ft^2)	18 + 0.00004* Area (ft^2)
All other ≤ 75,000 ft^2	2.5	21

Quiz 11

How many models need to be created to demonstrate TEDI compliance for a project with a single building occupancy type?

a. 1
b. 2
c. It depends.
d. 0

Quiz 11 Answer

How many models need to be created to demonstrate TEDI compliance for a project with a single building occupancy type?

a. 1
b. 2
c. It depends.
d. 0

TEDI Calculations: General Approach

- **Emphasizes reducing heating and cooling loads by improvements to the building envelope and ventilation system design regardless of system type or efficiency.**
- **The heating TEDI is the annual heating energy delivered to the spaces and ventilation within the building to maintain heating thermostat setpoints normalized by the floor area**

$$\textit{Heating TEDI}\left[\frac{kBtu}{ft^2}\right] = \frac{\Sigma \textit{ Space and Ventilation Heating Output } [kBtu]}{\textit{Modeled Floor Area } [ft^2]}$$

- **The <u>cooling TEDI</u> is the annual energy extracted from the spaces and ventilation to maintain cooling thermostat setpoint normalized by the floor area.**

$$\textit{Cooling TEDI}\left[\frac{kBtu}{ft^2}\right] = \frac{\Sigma \textit{ Space and Ventilation Cooling Output } [kBtu]}{\textit{Modeled Floor Area } [ft^2]}$$

TEDI Calculations: Modeled Floor Area

Modeled floor area: the total enclosed floor area of the building, as reported by the simulation program, including conditioned and excluding unconditioned spaces.

Conditioned space (from IECC 2021): an area, room or space that is enclosed within the building thermal envelope that is directly or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors, or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.

Unconditioned space (from 90.1 2019): an enclosed space within a building that is not a conditioned space.

Modeled Floor Area: Special Cases and Rules 1

What if my project has a lot of heated only space?

If modeling as-designed HVAC systems per Sections 13.3 and 13.4 and heated only thermal zone floor area accounts for more than 10% of the modeled floor area, then the heated only floor area shall be subtracted from the Modeled Floor Area for the purposes of determining the Cooling TEDI.

Modeled Floor Area: Special Cases and Rules 2

What types of spaces would typically be <u>included</u> in the Modeled Floor Area?

- **All spaces that are considered conditioned spaces including those that are directly and indirectly conditioned.**

  Based on the definition of conditioned space the following spaces are <u>typically</u> included because they include either include direct heating or cooling, uninsulated heating or cooling system ductwork an /or piping and/or are <u>not</u> isolated from adjacent conditioned spaces with insulation.

  - **storage rooms,**
  - **stairs and**
  - **mechanical rooms that are not thermally isolated from the adjacent conditioned spaces.**

Modeled Floor Area: Special Cases and Rules 3

What types of spaces would typically be excluded from the Modeled Floor Area?

- Based on the definition of conditioned space the following spaces are typically excluded because they are not directly heated or cooled, exclude uninsulated heating or cooling system ductwork and/or piping, and are thermally isolated from adjacent conditioned spaces with insulation:
  - elevator shafts,
  - crawl spaces,
  - parking garages,
  - insulated HVAC shafts with insulated ductwork and or piping

Modeled Floor Area: Special Cases and Rules 4

Can unconditioned spaces be included in the energy model but be modeled as unconditioned and excluded from the Modeled Floor Area when determining TEDI?

- Yes

How should atriums and other double heighted spaces be accounted for in the Modeled Floor Area?

- The Modeled Floor Area must include only the floor area of the atrium and/or double heighted space. In other words, the footprint of the space is only counted once in the Modeled Floor Area.

Quiz 12

True or False: A building includes an unheated and uncooled storage room that has insulation thermally isolating it from adjacent conditioned rooms. The square footage of this room shall be excluded from the Modeled Floor Area.

Quiz 12 Answer

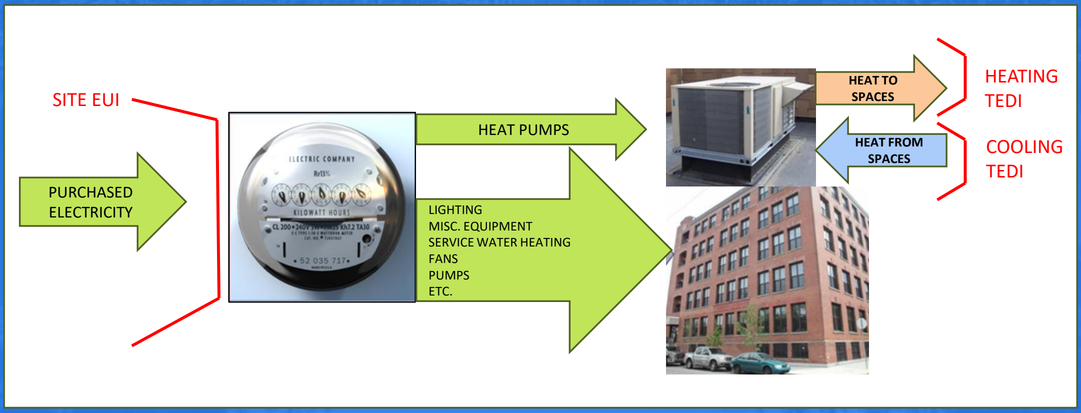
True or False: A building includes an unheated and uncooled storage room that has insulation thermally isolating it from adjacent conditioned rooms. The square footage of this room shall be excluded from the Modeled Floor Area.

True

TEDI Calculations: Heating and Cooling Output

Σ Space and Ventilation Heating Output = the annual heating output of all systems in the building that maintain space temperature setpoints and heat ventilation air including the heating coils of the central air systems (e.g., make-up air units and air handling units) and terminal equipment (e.g., fan coils, heat pumps and unit heaters).

Σ Space and Ventilation Cooling Output = the annual cooling output of all HVAC systems that maintain space temperature setpoints and cool ventilation air, including but not limited to the cooling coils of the central air systems (e.g., make-up air units and air handling units) and terminal equipment (e.g., fan coils, heat pumps).



Simulation Guidelines Annex 1 includes steps for extracting the simulation outputs necessary to calculate cooling and heating TEDI from the simulation reports generated by the approved energy modeling tools.

How is TEDI Different from Energy Use Intensity (EUI)?

Although TEDI and EUI have the same units (kBtu/ft^2-yr), they are not the same.

- TEDI represents the annual heating (or cooling) load on the HVAC systems (e.g., it represents the heating (or cooling) “need”).
- EUI represents the annual amount of energy used to operate equipment that heats (or cools) the spaces and ventilation air.

Example

- If a heat pump delivers 4.8 kBtu/ft^2 heating energy to spaces annually and has annual average COP = 3.2, the site heating EUI is 1.5 kBtu/ft^2 while the Heating TEDI is 4.8 kBtu/ft^2.
- Improved heat pump efficiency reduces site heating EUI but does not impact heating TEDI.

How do as-designed parameter impact TEDI?

	Impacts TEDI?
Envelope Insulation	Yes
Thermal bridging	Yes
Window U-factor and SHGC	Yes
Ventilation air energy recovery	Yes
Lighting	No
Plug loads	No
Heating system efficiency	No
Cooling system efficiency	No

Quiz 13

Which of the following design parameters can be adjusted to impact modeled heating and cooling TEDIs?

a. Lighting power

b. HVAC heating and cooling efficiency

c. Plugload power

d. Fenestration thermal properties

Quiz 13 Answer

Which of the following design parameters can be adjusted to impact modeled heating and cooling TEDIs?

a. Lighting power

b. HVAC heating and cooling efficiency

c. Plugload power

d. Fenestration thermal properties

Is Heating TEDI the same as Heating Demand?

Although the word “demand” is used in multiple contexts in the industry, the common use of the term “heating demand” differs from heating TEDI.

1. Energy per unit of time context. “Heating TEDI” represents the annual heating load on the HVAC systems. In contrast, “heating demand” in this context represents a monthly or annual peak rate of energy consumption associated with heating.

    The units reflect this difference: “heating TEDI” has units of kBtu/ft^2-yr, while “heating demand” is expressed in units of MBtu/hr (often abbreviated to MBH) or kW.

2. TEDI vs EUI context. “Heating TEDI” is the annual energy demand on the HVAC system while the “heating demand” in this context is the energy consumption associated with heating.

Approved Simulation Tools

- **eQUEST version 3.65 or higher using the DOE2.3 engine**
  <u>Exception:</u> DOE2.2 can be used for projects that do not include HVAC systems and designs that require workarounds in DOE2.2 but are explicitly supported in DOE2.3, such as variable refrigerant flow heat pumps and dedicated outdoor air systems.
- **Energy Plus version 9.3.0 or higher**
- **IES Virtual Environment version 2021.4.0.0 or higher**
- **When the approved simulation program does not model a specified design, material or device, an external calculation shall be used as approved by the AHJ. The documentation submitted in support of the external calculations shall include a narrative explaining the methods, theoretical or empirical information supporting its accuracy, and documentation required in ASHRAE 90.1 2019 Section G2.5 (a) – (e).**

What Does it Take to Meet TEDI?

- DOER maintains a library of models which reflect sample designs that were modeled following the TEDI guidelines and were demonstrated to comply with TEDI limits.
- The models were developed using Energy Plus version 22.1.0.

SMALL MULTIFAMILY
33,700 ft^2
4-Story

MULTIFAMILY TOWER
168,700 ft^2
20-Story

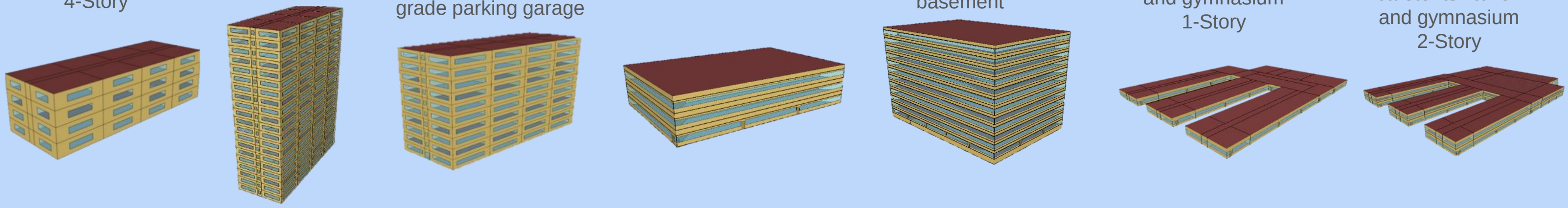
MULTIFAMILY PODIUM
75,900 ft^2
9-Story plus below grade parking garage

LOW-RISE OFFICE
53,600 ft^2
3-Story

HIGH-RISE OFFICE
498,600 ft^2
12-story plus basement

SMALL SCHOOL
73,960 ft^2 with cafeteria/kitchen and gymnasium
1-Story

LARGE SCHOOL
210,900 ft^2 with auditorium, cafeteria/kitchen and gymnasium
2-Story



What Does it Take to Meet TEDI?

<table>
<tr><th></th><th>Small Multifamily</th><th>Multifamily Podium</th><th>Multifamily Tower</th><th>Low-Rise Office</th><th>High-Rise Office</th><th>Small School</th><th>Large School</th></tr>
<tr><td>Square Ft. (ft^2)</td><td>33,700</td><td>75,900</td><td>168,700</td><td>53,600</td><td>498,600</td><td>73,960</td><td>210,900</td></tr>
<tr><td>Exterior Walls</td><td>U-0.051</td><td>U-0.055</td><td>U-0.053</td><td colspan="4">U-0.055</td></tr>
<tr><td>Roof</td><td colspan="3">U-0.032</td><td colspan="4">U-0.025</td></tr>
<tr><td>Exposed Floors</td><td>N/A</td><td>U-0.051</td><td colspan="5">N/A</td></tr>
<tr><td>Below Grade Walls</td><td colspan="4">N/A</td><td>C-0.119</td><td colspan="2">N/A</td></tr>
<tr><td>Slab-on-Grade</td><td>F-0.46</td><td>N/A</td><td>F-0.51</td><td>F-0.52</td><td>N/A</td><td colspan="2">F-0.52</td></tr>
<tr><td>WWR</td><td>18%</td><td>16%</td><td>25%</td><td>40%</td><td>40%</td><td>22%</td><td>22%</td></tr>
<tr><td>Fenestration (U/SHGC)</td><td colspan="3">0.30/0.33</td><td>0.3/0.3</td><td>0.29/0.3</td><td colspan="2">0.3/0.3</td></tr>
<tr><td>Infiltration</td><td colspan="3">0.25 CFM/ft^2</td><td colspan="4">0.35 CFM/ft^2 of total building envelope area at 75 Pa</td></tr>
<tr><td>Exhaust Air Energy Recovery Effectiveness</td><td colspan="2">75% sensible and latent</td><td>77% sensible and latent</td><td colspan="4">75% sensible and latent</td></tr>
</table>

Notes: 1. All opaque assembly U-values shown in the table have been derated for thermal bridging.
2. Fenestration thermal properties are assembly properties.
3. WWR = window to wall ratio.

Systems that Must Be Modeled as Specified

A. Opaque envelope insulation accounting for thermal bridges and thermal mass effects
B. Fenestration area and orientation
C. Thermal and solar properties of windows and skylights
D. Shape of exterior envelope
E. Envelope air leakage
F. Building orientation
G. Fixed exterior shading (e.g., fenestration set back in envelope plane, side fins, and overhangs) and site shading (e.g., from surrounding buildings).
H. Mechanical ventilation rate when it exceeds the prescribed value determined in 13.4.1.
I. Exhaust air energy recovery effectiveness.

Systems Excluded from the Simulation

Systems that do not interact with heating and cooling loads of the building or that are not permanent must be excluded from the simulations.

A. Exterior lighting system power and controls

B. Heating loads unrelated to maintaining indoor air related occupant comfort such as swimming pool water heaters, outdoor comfort heating (e.g., patio heaters and exterior fireplaces), gas-fired appliances (stoves and dryers), heat tracing.

C. Renewable energy systems including but not limited to PV and solar thermal hot water collectors

D. Other electricity generation systems such as combined heat and power.

E. Service water heating systems.

Quiz 14

Which of the following systems/components should not be excluded from the TEDI model?

a. Exterior lighting

b. Heat trace on hot water piping running through a parking garage

c. Exhaust air energy recovery system

d. Swimming pool heater

Quiz 14 Answer

Which of the following systems/components should not be excluded from the TEDI model?

a. Exterior lighting

b. Heat trace on hot water piping running through a parking garage

c. Exhaust air energy recovery system

d. Swimming pool heater

Prescribed Simulation Inputs

Prescribed inputs correspond to the design elements and operating conditions that are not meant to impact compliance. Examples of prescribed inputs:

A. Weather file

B. Minimum mechanical ventilation rates, except when the specified ventilation rate exceeds the prescribed value determined in 13.4.1

C. Interior lighting system power and controls

D. Miscellaneous plug and process loads and schedules

E. Operating and occupancy schedules such as building operating hours, lighting runtime, thermostat setpoints, etc.

HVAC Modeling Requirements

HVAC Option 1: Model default HVAC system prescribed in the TEDI Technical Guidelines

- Required for buildings and areas within the building for which HVAC systems are not designed and are not shown on the construction documents.
- Allowed for all other buildings.

HVAC Option 2: Model as-designed HVAC Systems and Controls

- Allowed for projects where an HVAC system has been designed and submitted with design documents
- The modeled HVAC systems must be consistent with design documents with the following exceptions:
  - Airflows and heating and cooling capacities must be auto-sized using a prescribed methodology.
  - Modeled ventilation rates must be determined as follows:
    - as specified if the specified rate (1) exceeds the prescribed ventilation rate AND (2) exceeds the minimum code requirements by more than 135%,
    - prescribed ventilation rate for the building use type in all other cases

Note: Minimum required outdoor air and specified ventilation rates shall be documented as described in Section C103.2 #16.

Quiz 15

True or False: Projects are required to model as-designed HVAC systems if they are included in the construction documents?

Quiz 15 Answer

True or False: Projects are required to model as-designed HVAC systems if they are included in the construction documents?

False

Floor Plan Modeling

Floor Plan Option 1: Thermal block based on the specified HVAC zoning simplified as allowed by ASHRAE 90.1 Appendix G

Required for projects modeling as-designed HVAC systems.

Floor Plan Modeling

Floor Plan Option 2: Projects modeled with default HVAC system (HVAC Option 1) may use default perimeter/core thermal blocks based on building use type.

The building geometry simplifications are similar to those appropriate for early design modeling cycles, such as the Load Reduction cycle, described in the ASHRAE Standard 209 Computer Simulation Aided Design. They allow evaluating compliance with Section C407.1 early in the design process before the building programming and HVAC zoning schemes are finalized.

Quiz 16

True or False: Projects modeling default HVAC systems are also required to use the default approach in Sections 8.2 and 8.3 for establishing thermal blocks (i.e., perimeter/core zoning)?

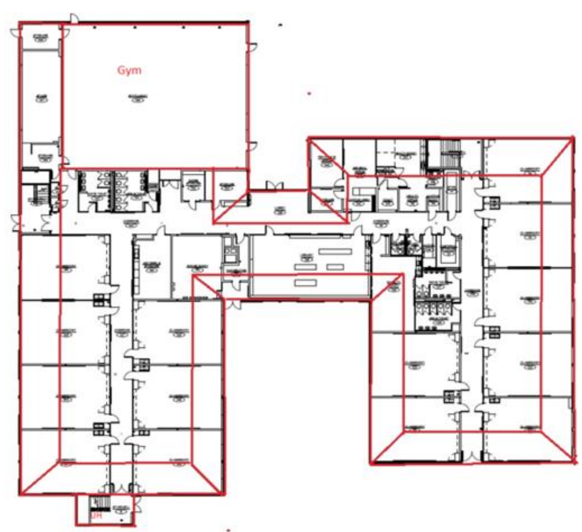
Quiz 16 Answer

True or False: Projects modeling default HVAC systems are also required to use the default approach in Sections 8.2 and 8.3 for establishing thermal blocks (i.e., perimeter/core zoning)?

False

Default Thermal Blocks

Building Use Type	Types of Thermal Blocks
Residential	• Residential areas (dwelling units and dormitory rooms; perimeter/core not required) • Supporting areas (corridors, stairs, trash rooms, lobbies, mechanical rooms; perimeter/core not required) • Nonresidential areas (lounges, laundry, leasing office, fitness rooms, common bathrooms, community rooms, etc.)
K-12 Schools	• Cafeteria; Gymnasium; Auditorium (perimeter/core not required) • School (classrooms, corridors, restrooms, offices)
Offices, fire stations, libraries, police stations, post offices, town halls	• Office thermal blocks representing spaces typical for office buildings



Required Alignment in Envelope and Floor Areas

- The total *modeled floor area* of *conditioned spaces* shall be within 5% of the *gross floor area* shown on the architectural drawings unless justification is provided to *AHJ*.
  - Common reasons for the deviation between the *modeled floor area* and the floor area reported on the construction documents include differences in accounting for area taken by interior partitions, mechanical chutes and stairwells and thickness of exterior walls.
- The *modeled floor area* of *residential* and *nonresidential thermal blocks* in residential buildings and cafeteria, gymnasium and auditorium thermal blocks in K-12 schools shall be within 5% of the actual design shown on construction documents.
- The modeled exterior envelope geometry must be consistent with construction documents, including proper accounting of *fenestration* and *opaque* building envelope types and areas.
- Each modeled *thermal block* must reflect the total area, type and orientation of *opaque* surfaces (i.e., *above and below-grade exterior walls, roof, above and below grade floors*) and *fenestration* associated with the spaces included in the block.

Building Envelope Properties

- All components of the building envelope must be modeled as shown on architectural drawings
- Simulation must account for thermal mass of the exterior surfaces.
- Exterior walls must be modeled with the U-factors derated to account for thermal bridging as required in Section C402.7.
- Fenestration must be modeled based on NFRC rating or using default (inefficient) properties (90.1 Table A8.1 for skylights & Table A8.2 for vertical fenestration).
- Manual shading devices, such as blinds or shades, may only be modeled in the residential spaces.
- Automatically controlled shades or blinds must not be modeled.
- Permanent shading such as from fins, overhangs, light shelves and fenestration setbacks must be modeled.
- Automatically or manually controlled dynamic glazing may be modeled.

Infiltration

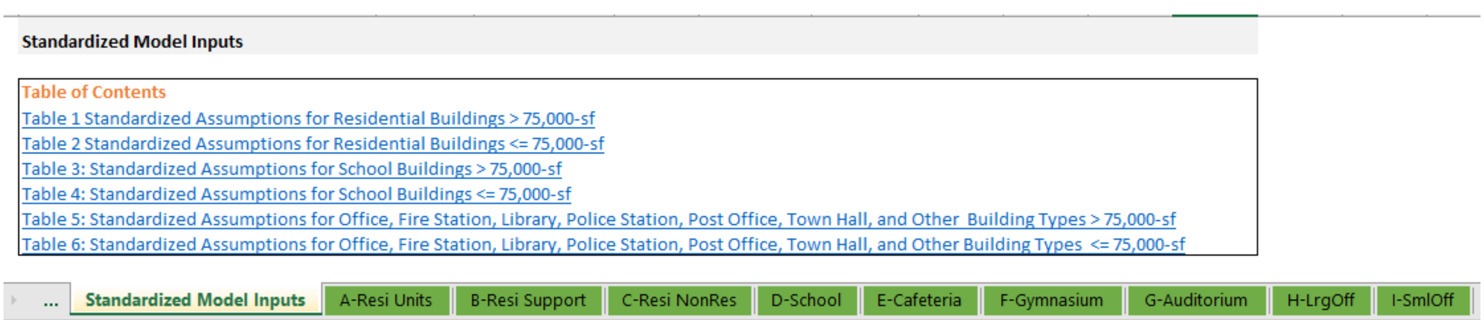
- The modeled air leakage rate of the building envelope shall be based on air leakage testing completed following Section C402.5.2.
- Since model will ultimately be updated to reflect the test results, avoid using overly optimistic air leakage assumptions to ensure that TEDI compliance is not jeopardized. For example, 0.35 cfm/ft^2 at 75Pa, the maximum allowed in Section C402.5.2, may be used as an early air leakage estimate.

Standardized Assumptions

A. Included in Tables 1-6 in the Schedules and Loads Guideline Supplement. Parameters shall be modeled based on building use type and square footage, and thermal block use type. Parameters with standardized assumptions:
   1. Interior lighting power and schedules.
   2. Miscellaneous loads and schedules.
   3. OA CFM ventilation rates and schedules.
   4. Occupant densities and schedules.
   5. Occupant heat gains

B. Daylighting shall not be modeled in residential thermal blocks. In all other thermal blocks daylighting shall be modeled as prescribed.

C. Default HVAC assumptions are in Sections 13.2.2-13.2.9



Standardized Model Inputs

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Table 1 Standardized Assumptions for Residential Buildings > 75,000-sf
Table 2 Standardized Assumptions for Residential Buildings <= 75,000-sf
Table 3: Standardized Assumptions for School Buildings > 75,000-sf
Table 4: Standardized Assumptions for School Buildings <= 75,000-sf
Table 5: Standardized Assumptions for Office, Fire Station, Library, Police Station, Post Office, Town Hall, and Other Building Types > 75,000-sf
Table 6: Standardized Assumptions for Office, Fire Station, Library, Police Station, Post Office, Town Hall, and Other Building Types <= 75,000-sf

... | Standardized Model Inputs | A-Resi Units | B-Resi Support | C-Resi NonRes | D-School | E-Cafeteria | F-Gymnasium | G-Auditorium | H-LrgOff | I-SmlOff

Standardized Model Inputs

Table of Contents

Table 1 Standardized Assumptions for Residential Buildings > 75,000-sf

Thermal Block Type	Schedule Index (Note 1)	Misc. Loads*	Lighting Power	Ventilation Rate	Occupant Density	Occupant Heat Gain	
						Btu/h-person	
		W/sf	W/sf	CFM/sf	sf/Person	Sensible	Latent
Residential	A	1.74	0.41	0.096	245	257	166
Supporting Spaces (heated and cooled)	B	0.2	0.46	0.08	1000	257	166
Non-residential Thermal Blocks	C	1.15	0.66	0.11	200	257	166

* Use a sensible fraction of 1.0 and a latent fraction of 0.0 for all thermal blocks with the exception that Residential should be modeled with a latent fraction of 0.14.

Table 2 Standardized Assumptions for Residential Buildings <= 75,000-sf

Thermal Block Type	Schedule Index (Note 1)	Misc. Loads*	Lighting Power	Ventilation Rate	Occupant Density	Occupant Heat Gain	
						Btu/h-person	
		W/sf	W/sf	CFM/sf	sf/Person	Sensible	Latent
Residential	A	1.74	0.41	0.096	245	257	166
Supporting Spaces (heated and cooled)	B	0.2	0.46	0.08	1000	257	166
Non-residential Thermal Blocks	C	1.15	0.66	0.11	200	257	166

* Use a sensible fraction of 1.0 and a latent fraction of 0.0 for all thermal blocks with the exception that Residential should be

... | Standardized Model Inputs | A-Resi Units | B-Resi Support | C-Resi NonRes | D-School | E-Cafeteria | F-Gymnasium | G-Auditorium | H-LrgOff | I-SmlOff

A-Resi Units

Schedule	Type	Through	Day of Week	1 am	2 am	3 am	4 am	5 am	6 am	7 am	8 am	9 am	10 am	11 am	Noon	1 pm	2 pm	3 pm	4
RESI_UNIT_OCC_SCH	Fraction	1/1 - 12/31	Weekday	1	1	1	1	1	1	1	0.9	0.4	0.2	0.2	0.2	0.2	0.2	0.2	
			Saturday	1	1	1	1	1	1	1	0.9	0.4	0.2	0.2	0.2	0.2	0.2	0.2	
			Sunday/Holiday	1	1	1	1	1	1	1	0.9	0.4	0.2	0.2	0.2	0.2	0.2	0.2	
			WinterDesign	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			SummerDesign	1	1	1	1	1	1	1	0.9	0.4	0.2	0.2	0.2	0.2	0.2	0.2	
RESI_UNIT_EQUIP_SCH	Fraction	1/1 - 12/31	Weekday	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.5	0.5	0.5	0.3	0.5	0.5	
			Saturday	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.5	0.5	0.5	0.3	0.5	0.5	
			Sunday/Holiday	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.5	0.5	0.5	0.3	0.5	0.5	
			WinterDesign	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			SummerDesign	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.5	0.5	0.5	0.5	0.3	0.5	0.5	
RESI_UNIT_LIGHT_SCH	Fraction	1/1 - 12/31	Weekday	0.015	0.015	0.015	0.015	0.015	0.015	0.077	0.139	0.139	0.108	0.108	0.108	0.077	0.077	0.077	0.
			Saturday	0.015	0.015	0.015	0.015	0.015	0.015	0.077	0.139	0.139	0.108	0.108	0.108	0.077	0.077	0.077	0.
			Sunday/Holiday	0.015	0.015	0.015	0.015	0.015	0.015	0.077	0.139	0.139	0.108	0.108	0.108	0.077	0.077	0.077	0.
			WinterDesign	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
			SummerDesign	0.015	0.015	0.015	0.015	0.015	0.015	0.077	0.139	0.139	0.108	0.108	0.108	0.077	0.077	0.077	0.
RESI_UNIT_HTGSETP_SCH	Temperature (°F)	1/1 - 12/31	Weekday	70	70	70	70	70	70	70	72	72	72	72	72	72	72	72	
			Saturday	70	70	70	70	70	70	70	72	72	72	72	72	72	72	72	
			Sunday/Holiday	70	70	70	70	70	70	70	72	72	72	72	72	72	72	72	
			WinterDesign	70	70	70	70	70	70	70	72	72	72	72	72	72	72	72	
			SummerDesign	70	70	70	70	70	70	70	72	72	72	72	72	72	72	72	
RESI_UNIT_CLGSETP_SCH	Temperature (°F)	1/1 - 12/31	Weekday	78	78	78	78	78	78	78	78	78	80	80	80	80	80	80	
			Saturday	78	78	78	78	78	78	78	78	78	80	80	80	80	80	80	
			Sunday/Holiday	78	78	78	78	78	78	78	78	78	80	80	80	80	80	80	
			WinterDesign	78	78	78	78	78	78	78	78	78	80	80	80	80	80	80	
			SummerDesign	78	78	78	78	78	78	78	78	78	80	80	80	80	80	80	
RESI_FAN_SCH*	Fraction	1/1 - 12/31	Weekday	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
			Saturday	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
			Sunday/Holiday	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
			WinterDesign	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
			SummerDesign	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
RESI_UNIT_MINOA_SCH	Fraction	1/1 - 12/31	Weekday	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
			Saturday	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
			Sunday/Holiday	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
			WinterDesign	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
			SummerDesign	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
RESI_UNIT_INFILTRATION	Fraction	1/1 - 12/31	Weekday	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
			Saturday	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
			Sunday/Holiday	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Quiz 17

True or False: If available, project teams complying with TEDI are allowed to use project specific model inputs for lighting and equipment power and schedules given backup documentation is project to the AHJ.

Quiz 17 Answer

True or False: If available, project teams complying with TEDI are allowed to use project specific model inputs for lighting and equipment power and schedules given backup documentation is project to the AHJ.

False

Special Cases: Core-and-Shell and Tenant Fit-Out

- For projects in which systems and components that must be modeled as designed have not yet been designed, those yet-to-be-designed features must be modeled as minimally compliant with the MA Stretch Energy Code.
- Core-and-shell buildings where the details of the building occupancy is not known shall be categorized as an office building.
- For initial tenant fit-out projects, existing unmodified systems and components must be modeled as-built. The Targeted Performance does not apply to subsequent tenant fit-outs. Such projects must be treated as alterations or change of use, as appropriate.

Special Cases: Additions

- For additions which are either more than 100% of the size of the existing building or equal to or greater than 20,000 ft^2 must determine allowed compliance path following the same rules as new construction projects (C502.1).
- If the addition use type is dormitory, fire station, library, office, school, police station, post office, and town hall the addition must show compliance with the Targeted Performance Compliance (C401.2 Part 2).
- In this scenario, the existing building should be excluded from the model and only the addition should be modeled. Surfaces separating the addition from existing building should be modeled as adiabatic.

Quiz 18

Which compliance paths would a 21,000 ft^2 office addition with an average ventilation rate of 0.18 cfm/ft^2 at full occupancy be eligible to follow?

a. Prescriptive
b. Relative Performance
c. Certified Performance: HERs
d. Targeted Performance Compliance

Quiz 18 Answer

Which compliance paths would a 21,000 ft^2 office addition with an average ventilation rate of 0.18 cfm/ft^2 at full occupancy be eligible to follow?

a. Prescriptive
b. Relative Performance
c. Certified Performance: HERs
d. Targeted Performance Compliance

Documentation Requirements (C407.1.2)

A. Completed COMcheck™ Envelope, Lighting and Mechanical Compliance Certificates, and a Plan Review Inspection Checklist (C103.2.2).

B. Simulation reports:
   - eQUEST: <project name>.SIM file with the complete set of simulation reports.
   - Energy Plus / Open Studio: Complete set of simulation reports in the HTML format. See Annex A for the report generation instructions.
   - IESVE: Room Loads Report, Zone Loads Report, Space Loads & Ventilation Report, System Loads Report, Energy Model Output Report, Unmet Hours Report, Detailed Simulation Report

C. Calculation of the average ventilation rate similar to what is required by Section C103.2 #16

D. The items described in ANSI/ASHRAE/IESNA 90.1-2019 Appendix G Section G1.3.2 Parts b, g, h, i, j, k, l, n, o, and q, and Section G1.3.3.

E. TEDI Compliance Tool – spreadsheet-based tool with checklist from guidelines, automated QC checks, and compliance outcome calculation.

How to Achieve Low Heating & Cooling TEDI?

- Achieving low heating and cooling TEDIs requires careful attention to envelope performance (including thermal bridging), solar gains, tightness, and ventilation system design.
- Solar gains can be addressed with attention to fenestration area and location, solar heat gain coefficient, and external shading.
- Lighting, occupancy, and miscellaneous equipment modeling inputs are prescribed (fixed) and are independent of design. These impact internal heat gains, which affect heating and cooling TEDI. However, these cannot be adjusted as a strategy to meet TEDI requirements.

Conclusion

Targeted and Relative Performance Summary

	Targeted Performance (C407.1)	Relative Performance (C407.2)
Modeling Rules	1 model developed following MA Stretch modeling guidelines	2 models developed following 90.1 2019 Appendix G with MA amendments
Approved simulation software	eQUEST, EnergyPlus, IESVE	Any BEM tool compliant with 90.1 Appendix G
Modeler Qualifications	Modelers must meet Modeler_Quals_FINAL.pdf (energycodes.gov)	
Applicable Building Types	Allowed for all, required for multifamily (after 7/1/2024), dormitory, fire station, library, office, K-12 school, police station, post office and town halls except if high ventilation	Allowed only for projects that are not required to follow the Targeted Performance path
Compliance Criteria	Modeled heating and cooling TEDIs must not exceed the set targets	Modeled PEI of the proposed design must not exceed PEItarget
Systems that Affect Modeled Compliance Outcome	Envelope shape and performance, exhaust air energy recovery effectiveness.	Envelope, lighting, HVAC, SWH, other loads regulated by code
Trade-off limits	Must meet all prescriptive requirements.	Must meet 90.1 2019 mandatory requirements and certain prescriptive requirements of MA Stretch.

Modeled vs. Measured Energy Use

Post-occupancy utility bills will likely differ from the modeled performance due to the following

- Variations in schedule of operation and occupancy
- Building operation and maintenance
- Weather (10-year historical weather average ≠ 2023 weather)
- Use of prescribed simulation assumptions
- Tenant equipment
- Precision of the simulation tool and modeler mistakes

Other Relevant Trainings

Title	Target Audience	Topics covered
MA Stretch Energy Code 2023 for Commercial Buildings: Targeted Performance (TEDI) and Relative Performance (90.1 Appendix G) Compliance Paths	Code Officials & Modelers	• Applicability • Overview of the modeling requirements • Special rules for additions, core-and-shell and retrofits • Requirements other than energy modeling
Modeling for MA Stretch TEDI and Appendix G (8 hours)	Modelers	• Detailed modeling requirements
Compliance documentation for MA Stretch TEDI and Appendix G (2 hours)	Code Officials & Modelers	• Reporting templates • Other materials that must be submitted

Commercial New Construction or Major Renovation Program

Choose Your Path to Generate Energy Savings and Reduce Carbon

A Pathway for Every Project

Mass Save Sponsors offer the highest incentives for projects with the lowest EUIs and greatest levels of decarbonization.

Path 1, Net Zero and Low EUI Buildings (10,000 sqft or greater)	Path 2, Whole Building Energy Use Intensity (EUI) Reduction Approach (50,000 sqft or greater)	Path 2, High Performance Buildings
Receive expert net zero building technical assistance and the highest new construction/major renovation project incentives available. Set an ultra-low EUI and save. We provide support through a post occupancy period to help you make sure the building performs at the level you expect.	In this path for larger, complex building projects, your incentives will be greater with the lowest design EUIs. We offer technical support and energy modeling services to help you succeed.	For whole building projects of any size where customers do not wish to set and pursue an EUI target, projects that are not whole buildings (e.g., tenant fit outs, open air parking garages), projects that are process-load heavy buildings (e.g., cannabis, industrial), and projects where customers are only interested in one-off measures.

Energy Code Support

Questions about the energy code?

Energy Code Support Hotline:

855-757-9717

Energy Code Support Email:

energycodesma@psdconsulting.com

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