Targeted Performance: Thermal Energy Demand Intensity (TEDI)

Relative Performance: ASHRAE 90.1 Appendix G Performance Rating Method

# 2023 Massachusetts Commercial Stretch Code

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## Logistics

Audio Settings

- **If you can't hear anything right now or you're having trouble with your audio**, you may select "Phone call" in the Audio portion of the control panel. Dial the number and enter the access code.
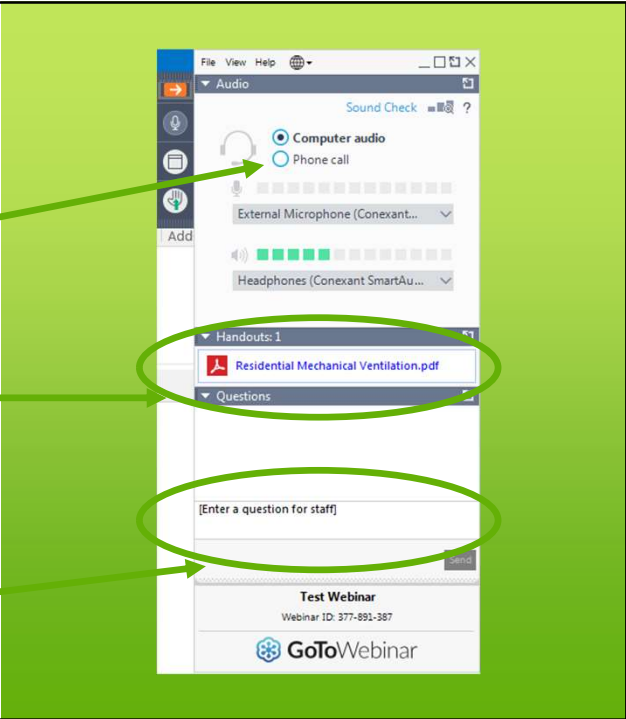
Handouts

Recordings

- This webinar is being recorded.

Polls

- You may have to exit "Full Screen Mode" for Polls

Questions



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# We Are Mass Save®

**Together, we make good happen for Massachusetts.**

Your local electric and natural gas utilities and energy efficiency service provider are taking strides in energy efficiency: Berkshire Gas, Cape Light Compact, Eversource, Liberty, National Grid and Unitil.

As one, we form Mass Save®, with the common goal of helping residents and businesses across Massachusetts save money and energy, leading our state to a clean and energy efficient future.

**WE ARE MASS SAVE®:**

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# Presented by:

PSD

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## Moving Energy Efficiency Forward

We combine building science with technology to help utility companies, program implementers, and building performance professionals achieve energy savings.
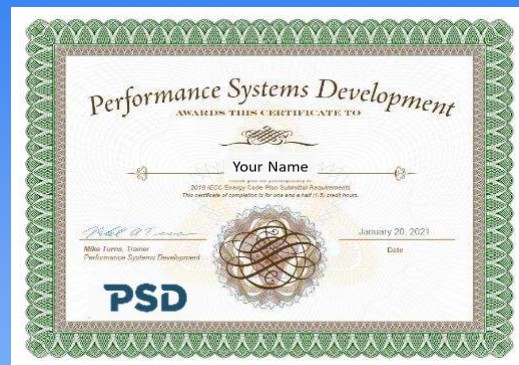
5

## Continuing Education

**This webinar is approved for:**

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

Everyone will receive a certificate of attendance via email.

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# Learning Objectives

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List the documentation that must be submitted to code officials for projects following performance paths of compliance.

Understand how to fill out the TEDI Compliance Tool for Targeted Performance Projects

Understand how to fill out the Compliance Form and Companion Tool for Relative Performance Projects

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# Learning Objectives [Not Included]

Understand MA Commercial Stretch Energy Code compliance options and their applicability to different building occupancy types.

Understand sample envelope designs that were shown to comply with TEDI.

Detailed understanding of Massachusetts Stretch 2023 mandatory requirements.

Understand in detail the modeling requirements associated with the Targeted Performance Path and the Relative Performance Path for MA Commercial Stretch Energy Code compliance.

**These objectives are covered in the 4-hour training titled "MA Stretch Energy Code 2023 for Commercial Buildings: Targeted Performance (TEDI) and Relative Performance (90.1 Appendix G) Compliance Paths" and/or the 8-hour training titled "Modeling for MA Stretch TEDI and Appendix G"**

**This 2-hour training is focused on documentation requirements.**

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# Agenda

**Documentation Requirements Applicable to the Relative and Targeted Performance Paths**

**Targeted Performance Path**
- General concept
- Documentation Requirements
- Filling out the TEDI Compliance Tool

**Relative Performance Path**
- General concept
- Documentation Requirements
- Filling out the Compliance Form
- Filling out the Comparison Tool

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# Documentation Requirements Applicable to the Relative and Targeted Performance Paths

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## Documentation Requirements Applicable to Both Parts

- Average ventilation rate calculations (C103.2 #16)
  - Relative Performance: required for projects using the Relative Performance Pathway due to ventilation at full occupancy being greater than 0.5 CFM/sf.
  - Targeted Performance: required for all projects to show that minimum ventilation rates are modeled according to the Simulation Guidelines

- Modeler qualifications

- Design documents

- Derating calculations (C402.7)

- Documentation for fenestration performance (C402.4.6)

- Air leakage testing results (C402.5.2)

- Maintenance and commissioning plan (C408)

- 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

**Checklists for confirming compliance with mandatory requirements are under development**

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## Poll Question #1

True or False: Projects following either pathway (Relative or Targeted Performance) must submit ventilation rate calculations.

A. True
B. False

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# Targeted Performance Path

**C407.1**

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## Topics Covered

- Pathway Overview
- Targeted Performance Path-Specific Documentation Requirements
- General TEDI Compliance Tool features and layout
- TEDI Compliance Tool
  - Instructions
  - Project Information
  - Guidelines Checklist
  - Compliance Calculations
  - Quality Control Checks
  - Submittal Checklist
- Productivity Tips

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## Targeted Performance Pathway Overview

| Use Type | Heating TEDI (kBtu/ft²-yr) | Cooling TEDI (kBtu/ft²-yr) |
|---|---|---|
| Office, fire station, library, police station, post office, town hall ≥ 125,000 ft² | 1.5 | 23 |
| Office, fire station, library, police station, post office, town hall between 75,000 and 125,000 ft² | $4 - 0.00002 \times$ Area (ft²) | $18 + 0.00004 \times$ Area (ft²) |
| Office, fire station, library, police station, post office, town hall ≤ 75,000 ft² | 2.5 | 21 |
| K-12 School ≥ 125,000 ft² | 2.2 | 12 |
| K-12 School between 75,000 and 125,000 ft² | $2.7 - 0.000004 \times$ Area (ft²) | $32 - 0.00016 \times$ Area (ft²) |
| K-12 School ≤ 75,000 ft² | 2.4 | 20 |
| Residential multifamily and dormitory ≥ 125,000 ft² | 2.8 | 22 |
| Residential multifamily and dormitory between 75,000 and 125,000 ft² | $3.8 - 0.000008 \times$ Area (ft²) | $4.5 + 0.00014 \times$ Area (ft²) |
| Residential multifamily and dormitory ≤ 75,000 ft² | 3.2 | 15 |
| All other ≥ 125,000 ft² | 1.5 | 23 |
| All other between 75,000 and 125,000 ft² | $4 - 0.00002 \times$ Area (ft²) | $18 + 0.00004 \times$ Area (ft²) |
| All other ≤ 75,000 ft² | 2.5 | 21 |

- 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

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## Poll Question #2

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

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## Documentation Requirements

- The documentation items applicable to both paths (see a prior slide)

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

- 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

**G1.3.2 Application Documentation**

Simulated performance shall be documented, and documentation shall be submitted to the *rating authority*. The information shall be submitted in a report and shall include the following:

  b. An overview of the project that includes the number of stories (above and below *grade*), the typical *floor* size, the uses in the *building* (e.g., office, cafeteria, retail, parking, etc.), the gross area of each use, and whether each use is *conditioned space*.

  g. A site plan showing all adjacent *buildings* and topography that may shade the proposed *building* (with estimated height or number of stories).

  h. *Building* elevations and *floor* plans (schematic is acceptable).

  i. A diagram showing the *thermal blocks* used in the computer simulation.

  j. An explanation of any significant modeling assumptions.

  k. Backup calculations and material to support data inputs (e.g., *U-factors* for *building envelope* assemblies, NFRC ratings for *fenestration*, end-uses identified in Table G3.1, "1. Design Model," paragraph [a]).

  l. Input and output reports from the *simulation program* or compliance software, including a breakdown of *energy* use by at least the following components: lights, internal *equipment* loads, *service water-heating equipment*, *space*-heating *equipment*, *space*-cooling and heat rejection *equipment*, fans, and other HVAC *equipment* (such as pumps). The output reports shall also show the amount of *unmet load hours* for both the *proposed design* and *baseline building design*.

  n. An explanation of any error messages noted in the *simulation program* output.

  o. For any exceptional calculation methods employed, document the predicted *energy* savings by *energy* type, the *energy* cost savings, a narrative explaining the exceptional calculation method performed, and theoretical or empirical information supporting the accuracy of the method.

  q. The version of the software and the link to the website that contains the ASHRAE Standard 140 results for the version used in accordance with Section G2.2.4.

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# TEDI Compliance Tool Overview

- MS **Excel** format
- Helps establish modeling inputs using built-in look-ups
- Includes a **guidelines checklist** to make sure the model is created correctly
- Helps establish the **heating and cooling TEDIs** and the **TEDI limits**
- Integrated **quality control checks**
- Submittal checklist
- PDF report generation
- Posted on the Mass Save technical support website

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# TEDI Compliance Tool Overview



Worksheets (aka "Tabs")

- Instructions
- Project Information
- Guidelines Checklist
- Results from <BEM Tool>
- Compliance Calculations
- Quality Controls Checks
- Submittal Checklist

Tabs should be filled out sequentially, according to the Instructions tab

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## Instructions

How to use the TEDI Compliance Tool

1. Enable macros
2. Complete the Project Information tab
3. Review the Guidelines Checklist tab
4. Transfer simulation outputs into the Compliance Calculations tab
5. Review Quality Control Checks tab
6. Fill out Submittal Checklist tab
7. Generate Summary TEDI Compliance Report

**The Instructions tab also has productivity tips, color legends, acronyms/abbreviations, and links to reference documents**
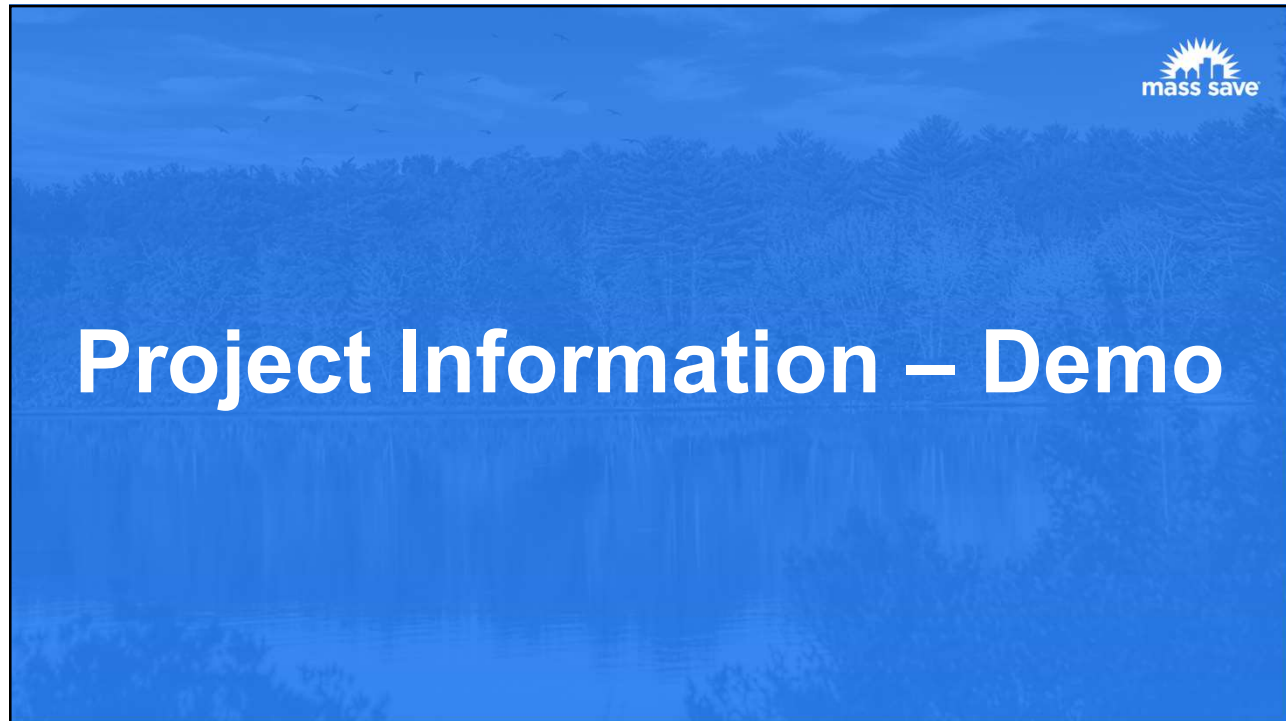
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# Instructions – Demo

mass save

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## Instructions

How to use the TEDI Compliance Tool

1. Enable macros
2. **Complete the Project Information tab**
3. Review the Guidelines Checklist tab
4. Transfer simulation outputs into the Compliance Calculations tab
5. Review Quality Control Checks tab
6. Fill out Submittal Checklist tab
7. Generate Summary TEDI Compliance Report

**The Instructions tab also has productivity tips, color legends, acronyms/abbreviations, and links to reference documents**

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## Project Information Tab

**Purpose:**

- Report **basic project information** such as simulation program, weather file used in the energy model, building types and areas, thermal block types and areas, and HVAC modeling method
- **Automatically generate model inputs** such as lighting power densities, miscellaneous equipment loads, ventilation rates, occupant densities, schedules, and default HVAC system configurations (if applicable)

**Process:**

- Use this tab **before energy modeling** and **before filling out any other tabs** since downstream selections depend on the information reported here

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# Project Information – Demo

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## Poll Question #3

Which of the following model inputs are displayed once the Project Information tab is filled out in the TEDI Compliance Tool?

A. Lighting power density by thermal block type

B. Miscellaneous equipment power density by thermal block type

C. Occupant densities and occupant heat gain by thermal block type

D. Default HVAC configurations (if following default HVAC modeling method)

E. All of the above

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## Instructions

How to use the TEDI Compliance Tool

1. Enable macros
2. Complete the Project Information tab
3. **Review the Guidelines Checklist tab**
4. Transfer simulation outputs into the Compliance Calculations tab
5. Review Quality Control Checks tab
6. Fill out Submittal Checklist tab
7. Generate Summary TEDI Compliance Report

**The Instructions tab also has productivity tips, color legends, acronyms/abbreviations, and links to reference documents**

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## Guidelines Checklist Tab

**Purpose:**

• Adapts the Targeted Performance **Simulation Guidelines** (Attachment C) into a **checklist** format to assist the energy modeler

**Process:**

• Use this tab **before and during energy modeling** to ensure the Simulation Guidelines are followed

**Simulation Guidelines**        **Guidelines Checklist**

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# Guidelines Checklist – Demo

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## Instructions

How to use the TEDI Compliance Tool

1. Enable macros
2. Complete the Project Information tab
3. Review the Guidelines Checklist tab
4. **Transfer simulation outputs into the Compliance Calculations tab**
5. Review Quality Control Checks tab
6. Fill out Submittal Checklist tab
7. Generate Summary TEDI Compliance Report

**The Instructions tab also has productivity tips, color legends, acronyms/abbreviations, and links to reference documents**

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## Compliance Calculations Tab

**Purpose:**

- Establish heating and cooling **TEDI targets**
- Report heating and cooling space and ventilation outputs based on model results
- Report modeled energy by end-use (for QC purposes)
- Report **unmet load hours**
- Determine **heating and cooling TEDI outcomes**

**Process:**

- Use this tab **after initial energy modeling** or **after making changes** to the energy model

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# Compliance Calculations – Demo

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## Poll Question #4

What annual space and ventilation heating and cooling loads should be reported in Table 1 and Table 2 on the Compliance Calculations tab of the TEDI Compliance Tool?

A. Whatever annual heating and cooling loads result in passing heating and cooling TEDIs

B. Annual heating and cooling loads from the energy model's simulation reports, as described for the pre-approved simulation tools in the TEDI Simulation Guidelines

C. Annual heating and cooling load estimates based on the building size and equipment selections

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## Instructions

How to use the TEDI Compliance Tool

1. Enable macros
2. Complete the Project Information tab
3. Review the Guidelines Checklist tab
4. Transfer simulation outputs into the Compliance Calculations tab
5. **Review Quality Control Checks tab**
6. Fill out Submittal Checklist tab
7. Generate Summary TEDI Compliance Report

**The Instructions tab also has productivity tips, color legends, acronyms/abbreviations, and links to reference documents**

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## Quality Control Checks Tab

**Purpose:**

- **Automatic quality control checks** based on the information reported on the Project Information and Compliance Calculations tabs
  - Checks if the unmet load hours are below the prescribed limit
  - Checks if the modeled lighting and miscellaneous energy consumption is reasonable
- Shows modeled energy use intensity by end-use compared to **benchmark models**

**Process:**

- Use this tab **after energy model results are reported** in the TEDI Compliance Tool
- **Revisit this tab as model changes are made** to address all flagged issues

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# Quality Control Checks – Demo
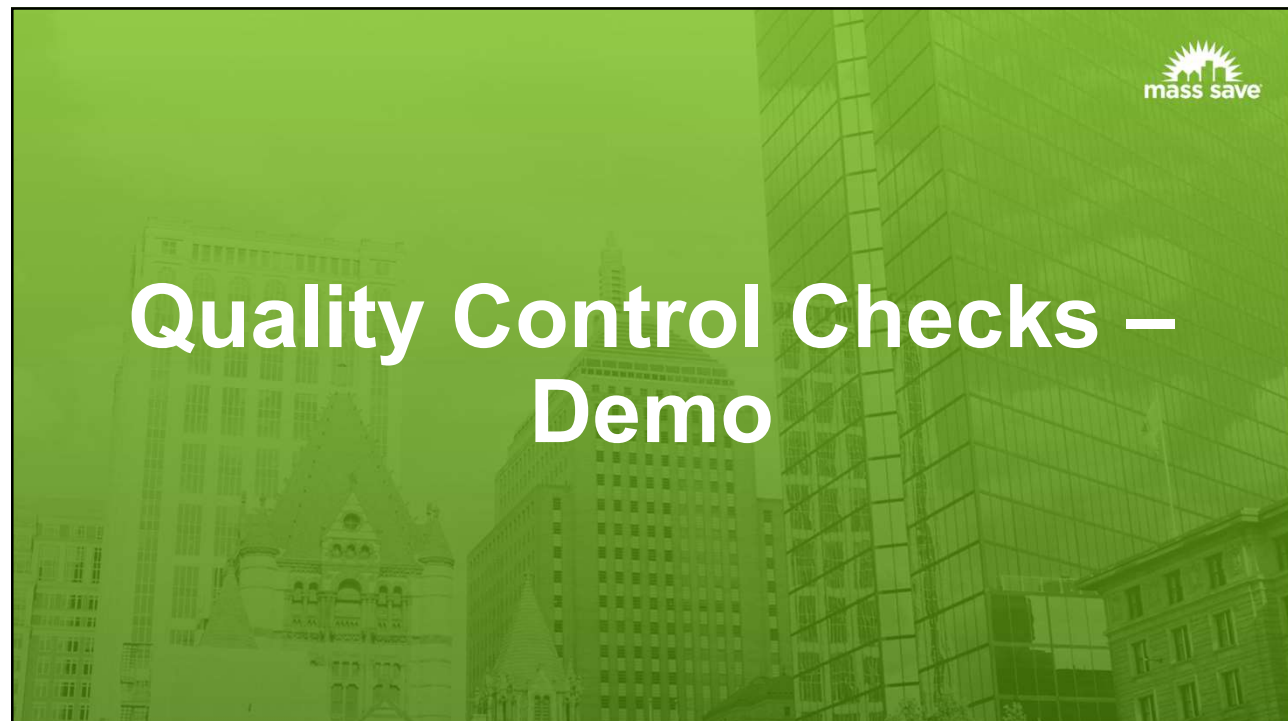
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## Instructions

How to use the TEDI Compliance Tool

1. Enable macros
2. Complete the Project Information tab
3. Review the Guidelines Checklist tab
4. Transfer simulation outputs into the Compliance Calculations tab
5. Review Quality Control Checks tab
6. **Fill out Submittal Checklist tab**
7. Generate Summary TEDI Compliance Report

**The Instructions tab also has productivity tips, color legends, acronyms/abbreviations, and links to reference documents**

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## Submittal Checklist Tab

**Purpose:**

- Checklist format of the **documentation** that must be submitted to the Authority Having Jurisdiction (AHJ)
  - The list of **documentation requirements dynamically updates** based on selections in the TEDI Compliance Tool

**Process:**

- Use this tab **after energy modeling** and once all flagged issues on the Quality Control Checks tab are resolved, and **before submitting to the AHJ**

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# Submittal Checklist – Demo
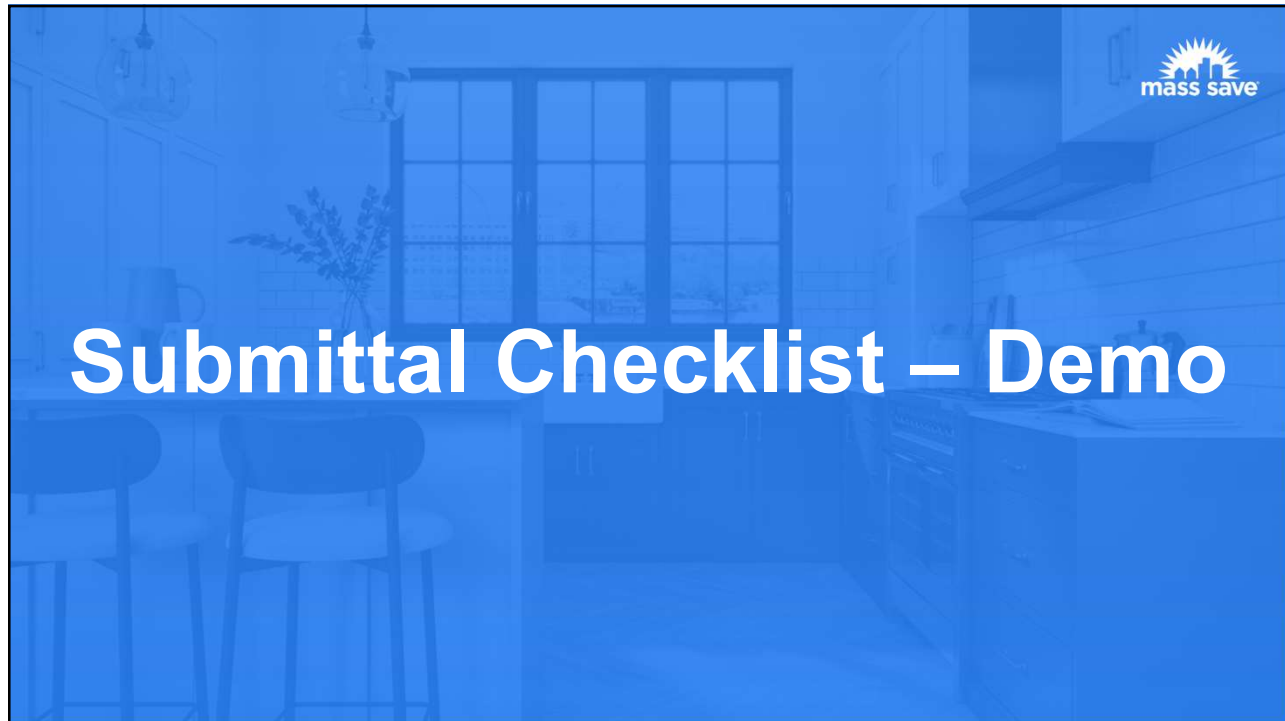
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## Instructions

How to use the TEDI Compliance Tool

1. Enable macros
2. Complete the Project Information tab
3. Review the Guidelines Checklist tab
4. Transfer simulation outputs into the Compliance Calculations tab
5. Review Quality Control Checks tab
6. Fill out Submittal Checklist tab
7. **Generate Summary TEDI Compliance Report**

**The Instructions tab also has productivity tips, color legends, acronyms/abbreviations, and links to reference documents**

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## TEDI Compliance Report

**Purpose:**

- **Quick PDF generation** of the completed TEDI Compliance Tool **for submittal to the AHJ**

**Process:**

- Generate the TEDI Tool Compliance Report **after the TEDI Compliance Tool is filled out**

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# TEDI Compliance Report – Demo

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# TEDI Compliance Tool Productivity Tips

## Quality Control Checks

**Table of Contents**
Table 1: Modeled vs Standardized Inputs Energy Consumption
Table 2: Schedules and Loads Guideline Supplement Checks
Table 3: Modeled vs Benchmark Energy Use Intensity (EUI) by End-Use

This tab performs automatic quality control checks for modeled unmet loads, lighting, and miscellaneous equipment based on the information reported in Table 3 and Table 4 on the *Compliance Calculations* tab and the thermal blocks reported in Table 2 on the *Project Information* tab. Table 3 on this tab also performs quality control checks on the modeled energy use intensity (EUI) by end use compared to the models used to establish the TEDI targets.

**Table 1: Modeled vs Standardized Inputs Energy Consumption**

| - | Annual Lighting Use [kWh] | Annual Miscellaneous Use [kWh] |
|---|---|---|
| Modeled | 0 | 0 |
| Standardized Inputs | 0 | 0 |

**Table 2: Schedules and Loads Guideline Supplement Checks**
**Instructions**
1. Review flagged QC checks. Update the model and/or inputs in this tool as appropriate to address the "Fail" outcomes before submitting the package for review to the AHJ.

| # | Review Check | Review Outcome | Required Action |
|---|---|---|---|
| 1 | Unmet load hours do not exceed 300 of the 8760 hours simulated. | In Progress | Report the unmet load hours in Table 4 on the Compliance Calculations tab. |
| 2 | Modeled interior lighting energy consumption aligns with the Schedules and Loads Guideline Supplement. | In Progress | Report the modeled interior lighting consumption on the Compliance Calculations tab and report the thermal block types and areas on the Project Information tab. |
| 3 | Modeled miscellaneous equipment energy consumption aligns with the Schedules and Loads Guideline Supplement. | In Progress | Report the modeled miscellaneous equipment energy consumption on the Compliance Calculations tab and report the thermal block types and areas on the Project Information tab. |

**Notes**
Please include applicable notes as needed.

There are **Notes** sections throughout the tool

These can be used to communicate special circumstances to the reviewer

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# Relative Performance Path
## C407.2

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## Topics Covered

- Pathway Overview
- Relative Performance Path-Specific Documentation Requirements
- Compliance Form and Companion Tool Overview
- Compliance Form and Companion Tool Demonstrations:
  - Basic Information and Informative tabs of Compliance Form
  - Selected Component Tab in the Compliance Form: Lighting
  - Selected Simulation Results
    - Simulation Outputs in Compliance Form
    - Data Exchange with Companion Tool
    - Project Performance in Companion Tool
    - Submittal Checklist in Compliance Form

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## Relative Performance Pathway 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
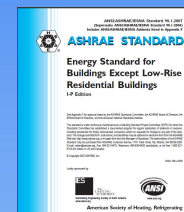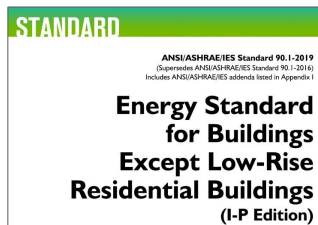
**Proposed Design**    **Baseline Design**

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## Documentation Requirements

- The documentation items applicable to both paths (see a prior slide)

- All items described in ANSI/ASHRAE/IESNA 90.1-2019 Appendix G Section G1.3.2

**STANDARD**

ANSI/ASHRAE/IES Standard 90.1-2019
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2016)
Includes ANSI/ASHRAE/IES addenda listed in Appendix I

**Energy Standard for Buildings Except Low-Rise Residential Buildings**
**(I-P Edition)**

**Appendix G**
**G1.3.2 Application Documentation**

Simulated performance shall be documented, and documentation shall be submitted to the *rating authority*. The information shall be submitted in a report and shall include the following:

a. A brief description of the project, the key *energy efficiency* improvements compared with the requirements in Sections 5 through 10, the *simulation program* used, the version of the *simulation program*, and the results of the *energy* analysis. This summary shall contain the calculated values for the *baseline building performance*, the *proposed building performance*, and the percentage improvement.

b. An overview of the project that includes the number of stories (above and below *grade*), the typical *floor* size, the uses in the *building* (e.g., office, cafeteria, retail, parking, etc.), the gross area of each use, and whether each use is *conditioned space*.

c. A list of the *energy*-related features that are included in the design and on which the performance rating is based. This list shall document all *energy* features that differ between the models used in the *baseline building performance* and *proposed building performance* calculations.

d. A list showing compliance for the *proposed design* with all the requirements of Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4 (mandatory provisions).

e. A list identifying those aspects of the *proposed design* that less stringent than the requirements of Sections 5.5, 6.5, 7.5, 9.5, and 9.6 (prescriptive provisions).

f. A table with a summary by end use of the *energy* cost savings in the *proposed building performance*.

g. A site plan showing all adjacent *buildings* and topography that may shade the proposed *building* (with estimated height or number of stories).

h. *Building* elevations and *floor* plans (schematic is acceptable).

i. A diagram showing the *thermal blocks* used in the computer simulation.

j. An explanation of any significant modeling assumptions.

k. Backup calculations and material to support data inputs (e.g., *U-factors* for *building envelope* assemblies, NFRC ratings for *fenestration*, end-uses identified in Table G3.1, "1. Design Model," paragraph [a]).

l. Input and output reports from the *simulation program* or compliance software, including a breakdown of *energy* use by at least the following components: lights, internal *equipment* loads, *service water-heating equipment*, space-heating *equipment*, space-cooling and heat rejection *equipment*, fans, and other HVAC *equipment* (such as pumps). The output reports shall also show the amount of *unmet load hours* for both the *proposed design* and *baseline building design*.

m. *Purchased energy rates* used in the simulations.

n. An explanation of any error messages noted in the *simulation program* output.

o. For any exceptional calculation methods employed, document the predicted *energy* savings by *energy* type, the *energy* cost savings, a narrative explaining the exceptional calculation method performed, and theoretical or empirical information supporting the accuracy of the method.

p. The reduction in *proposed building performance* associated with *on-site renewable energy*.

q. The version of the software and the link to the website that contains the ASHRAE Standard 140 results for the version used in accordance with Section G2.2.4.

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## Key Reporting Requirements of 90.1 Appendix G

- Features that differ between the baseline and proposed design models

- Aspects of the proposed design that improve over or are less efficient than 90.1 **prescriptive requirements**

- A list showing compliance of the proposed design with **90.1 mandatory provisions**

- A summary by end use of the energy cost savings of the proposed design relative to the baseline

- Input and output reports from the simulation program showing a breakdown of energy by end use and the amount of unmet load hours for the baseline and proposed design

- **Backup calculations** and material to support data inputs

**\*Information not used in the energy simulation**

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## Reporting Template: DOE/PNNL Compliance Form

- Meets the reporting requirements of 90.1-2019 **Section G1.3.2**
- Is required documentation for the Relative Performance Pathway, per Section 6 of the Relative Performance Simulation Guidelines (Attachment B)
- Posted at DOE Building Energy Codes Program website
- Summary of features
  - **MS Excel** format
  - Helps establish the necessary **modeling inputs** using built-in code look-ups and calculators
  - Allows **copying and pasting simulation results** from BEM tools including EnergyPlus, eQUEST, and OpenStudio
  - Integrated **quality control checks**
  - **Data export** to streamline transferring information to databases and other tools

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## Reporting Template: MA Stretch Companion Tool

- Accounts for MA Stretch amendments to 90.1-2019 Appendix G related to performance calculations:
  - Site energy metric
  - BPFs (10% more stringent than 90.1-2022)
  - Excludes renewable energy contributions to performance
- Posted on the Mass Save technical support website
- Summary of features
  - **MS Excel** format
  - **Data import** of relevant project and simulation outputs from the Compliance Form
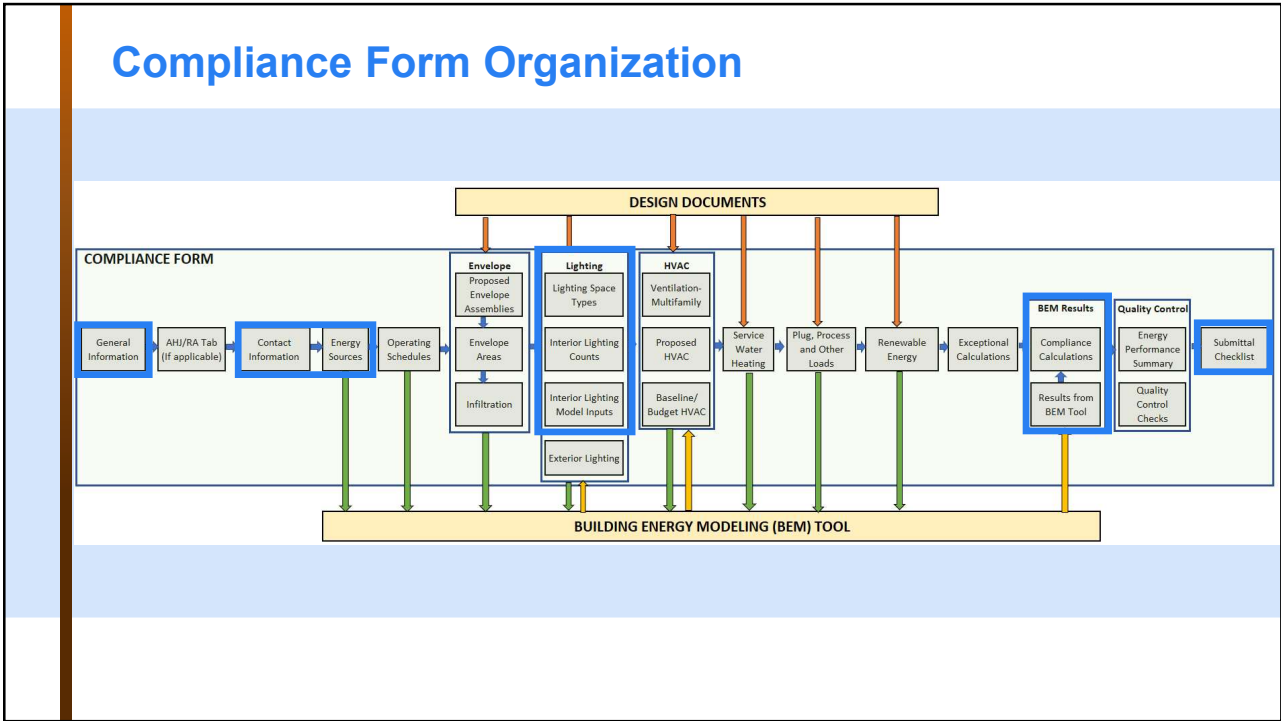
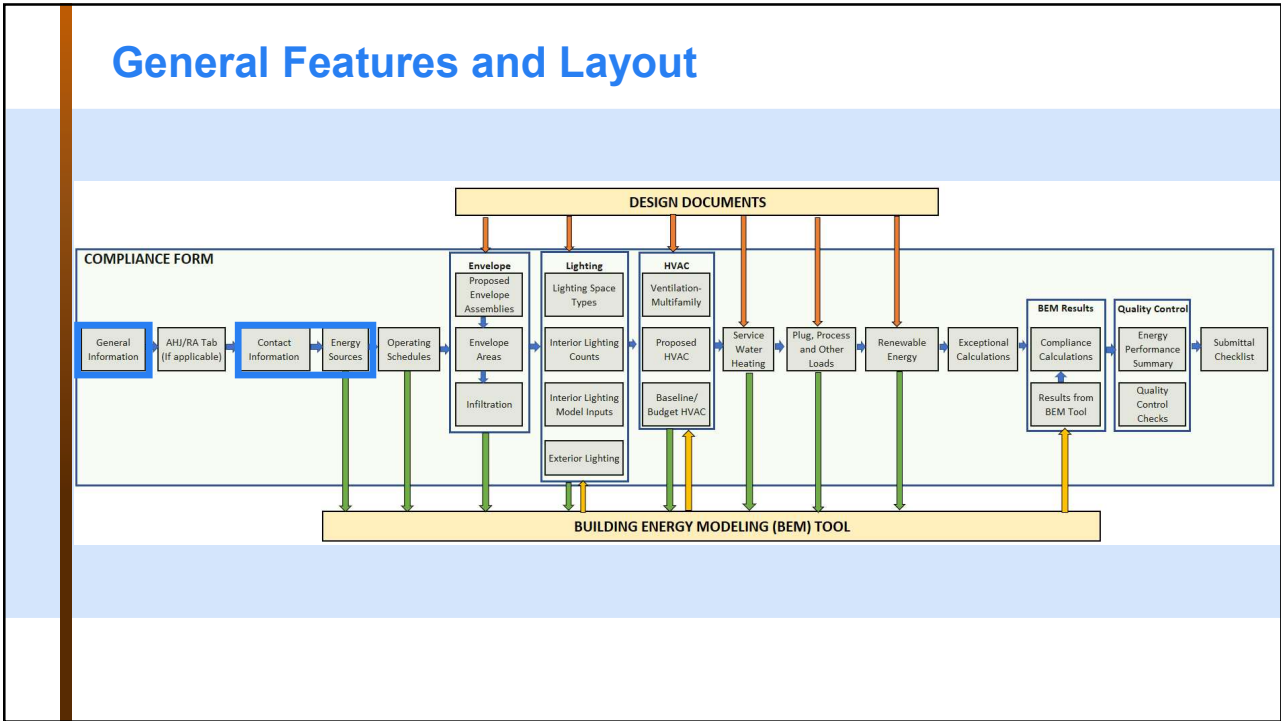DOE/PNNL Compliance Form

*Meets reporting requirements of 90.1-2019*

→

MA Stretch 2023 Companion Tool

*Accounts for MA Stretch amendments to 90.1-2019*

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# Compliance Form Organization



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# General Features and Layout



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## Dashboard

**Compliance Summary**

| Compliance Path | ASHRAE Standard 90.1 2016 Appendix G, Above Code Performance |
|---|---|
| Energy Modeling Outcome | Pass |
| Design Professional Sign-off | Yes |
| Modeler Sign-off | Yes |

| Tabs Navigator | Design Professional Sign-off | | | Modeler Sign-off | | |
|---|---|---|---|---|---|---|
| | Status | Name | Date | Status | Name | Date |
| Instructions | N/A | - | - | N/A | - | - |
| Documentation Process Overview | N/A | - | - | N/A | - | - |
| General Information | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 3/21/2020 |
| Contact Information | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 3/30/2020 |
| Energy Sources | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 3/30/220 |
| Operating Schedules | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 4/20/2020 |
| Proposed Envelope Assemblies | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 4/20/2020 |
| Envelope Areas | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 4/20/2020 |
| Infiltration | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/2/2020 |
| Lighting Space Types | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/2/2020 |
| Interior Lighting Counts | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/2/2020 |
| Interior Lighting Model Inputs | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/2/2020 |
| Exterior Lighting | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/8/2020 |
| Ventilation - Multifamily | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/8/2020 |
| Proposed HVAC | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/8/2020 |
| Baseline HVAC App G | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/8/2020 |
| Budget HVAC Section 11 | N/A | - | - | N/A | - | - |
| Service Water Heating | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/2/2020 |
| Plug, Process and Other Loads | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/2/2020 |
| Renewable Energy | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/2/2020 |
| Exceptional Calculations | N/A | - | - | N/A | - | - |
| Results from eQuest | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/8/2020 |
| Compliance Calculations | N/A | - | - | Complete | Jackson Jordan | 5/8/2020 |
| Energy Performance Summary | N/A | - | - | Complete | Jackson Jordan | 5/8/2020 |
| Quality Control Checks | N/A | - | - | Complete | Jackson Jordan | 5/8/2020 |
| Submittal Checklist | Complete | Smith Sam | 3/9/2021 | Complete | Jackson Jordan | 5/8/2021 |
| Revision Log | N/A | - | - | N/A | - | - |

| Instructions | Documentation Process Overview | General Information | Contact Information | Dashboard | Energy Sources |

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# Basic Structure – Demo

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## Poll Question #5

Which of the following accurately characterizes the flow of information between design documents, the simulation tool, and the Compliance Form?

1. Design Documents → Simulation Tool → Compliance Form

2. Compliance Form → Design Documents → Simulation Tool

3. Design Documents → Compliance Form ↔ Simulation Tool

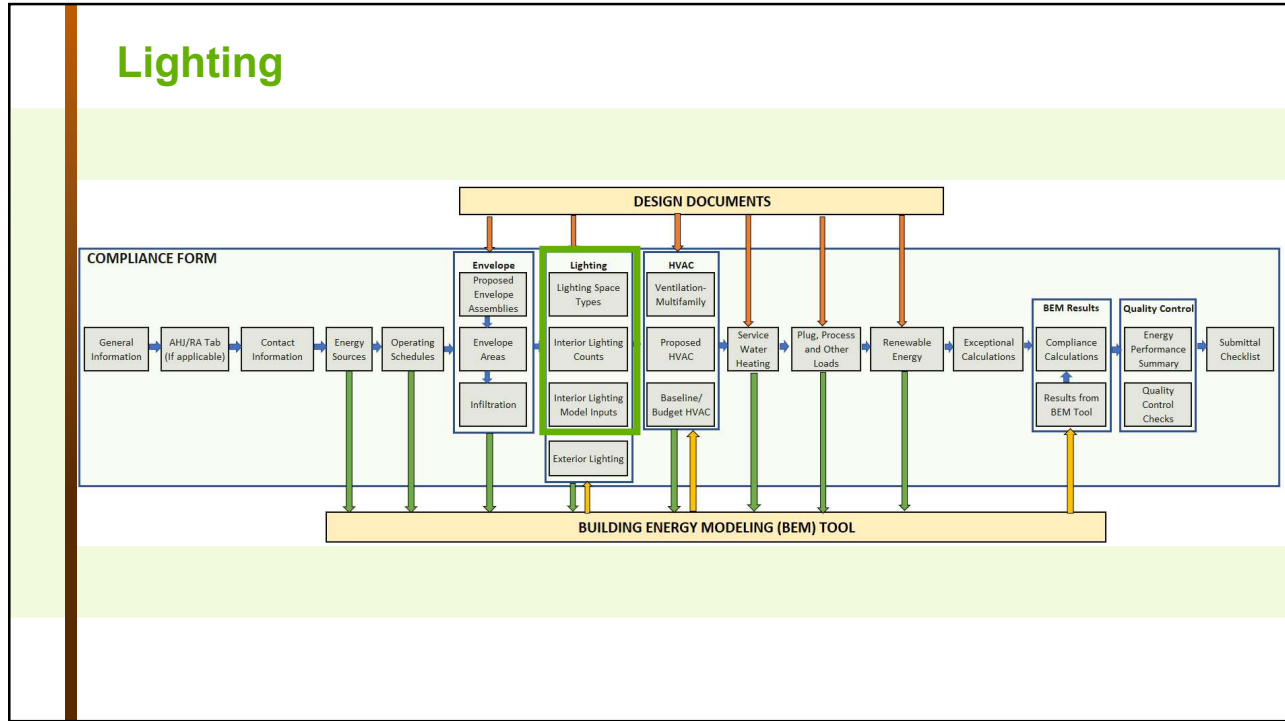4. None of the above

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## Building Component Tabs

Several tabs in the Compliance Form are for reporting the **proposed building components**:

1. Envelope
2. Lighting
3. HVAC
4. Service Water Heating
5. Plug, Process, and Other Loads
6. Renewable Energy (not applicable for MA Stretch)

These tabs also determine the **baseline model inputs** using code look ups and calculators, and the **proposed model inputs**

We will look at the lighting tabs in this training, but similar logic applies to other building components

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# Lighting



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# Design Documents → BEM Tool Inputs

**DESIGN DOCUMENTS**



**BEM TOOL INPUTS**



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## Design Documents → BEM Tool Inputs

**DESIGN DOCUMENTS**

- Lighting schedules with wattages for each lighting fixture based on the <u>specified</u> bulb + ballast.
- Lighting plans showing lighting fixtures and lighting controls in each <u>space</u>
- Specifications with lighting control sequences

**BEM TOOL INPUTS**

**Proposed Design Model**

- Lighting wattage and schedule adjustment credits for each HVAC zone based on the <u>maximum</u> rated wattage of specified lighting fixtures

**Baseline Design Model**

- Lighting wattage and schedule for each <u>HVAC zone</u> based on the 90.1 lighting power and control allowances and floor area of different types of spaces within this zone

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## Reporting Requirements

**90.1 G1.3 DOCUMENTATION REQUIREMENTS**

**a. …**the key *energy efficiency* improvements compared with the requirements in Sections 5 through 10….
**c.** … all *energy* features that differ between the models used in the *baseline building performance* and *proposed building performance* calculations.
**e.** A list identifying those aspects of the *proposed design* that are less stringent than the requirements of 5.5, 6.5, 7.5,9.5, and 9.6 (prescriptive provisions).

**k.** Backup calculations and material to support data inputs…

**d.** A list showing compliance for the *proposed design* with all the requirements of Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4 (mandatory provisions).

**COMPLIANCE FORM**

**Proposed design** lighting power
**Baseline design** lighting power
**Prescriptive 90.1 lighting allowances**

**Proposed design**: fixture counts, wattages and controls in each HVAC zone to document modeled LPDs and schedule credits
**Baseline design**: floor area by space type within each modeled HVAC zone to document modeled LPDs

Lighting controls specified in the proposed design alongside the **mandatory lighting control requirements**

***Not a simulation input**

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## Lighting Example – HVAC Zones

Prior to entering lighting information in the Compliance Form the building geometry and thermal zoning needs to be created in the BEM tool so that the modeled names of the HVAC zones associated with each space are known
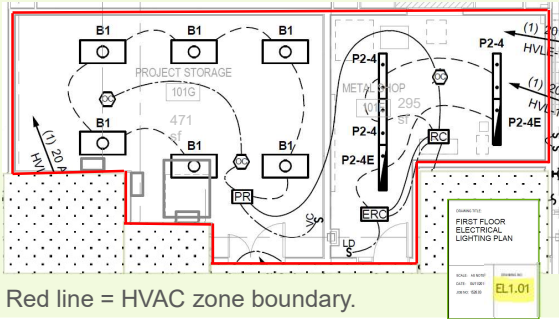


Red line = HVAC zone boundary.
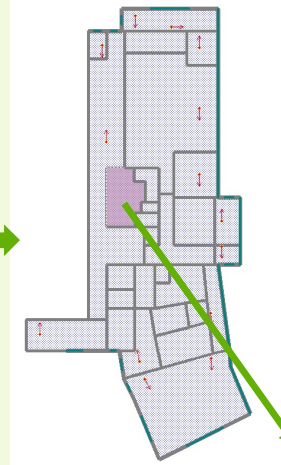
In this example, there are two different spaces and space types that make up this HVAC zone.

Project Storage 101G
Metal Shop 101F

In the model these two spaces comprise thermal zone called "IC1 Core Spc (G.C4)"

**IC1 Core Spc (G.C4)**

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## Lighting Example – Lighting Power Density, 101G

| Lighting Schedules | B1 | PHILIPS LIGHTING OR ACCEPTABLE EQUIVALENT BY: | 2TG48L - 835 - 4 - RA -02F - UNV - DIM SERIES | 43.2W LED 4800 DELIVERED LUMENS 3500K 80CRI |
|---|---|---|---|---|

**Fixture Specifications**

2x4 T-Grid LED troffer, 4800 nominal delivered lumens

| | | Candlepower | |
|---|---|---|---|
| | | Angle | End |
| Test No. | 33531 | 0 | 1950 |
| S/MH | 1.2 | 5 | 1942 |
| | | 15 | 1868 |
| Lamp Type | LED | 25 | 1707 |
| | | 35 | 1443 |
| Lumens | 4633 | 45 | 1098 |
| Input Watts | 43.2 | 55 | 734 |
| | | 65 | 434 |
| Comparative yearly lighting energy cost per 1000 lumens – $2.24 based on 3000 hrs. and $.08 pwr | | 75 | 238 |
| | | 85 | 88 |

Maximum Fixture B1 Wattage Confirmed = 43.2

**Lighting Plans**



Qty B1 = 6          Space ft$^2$ = 471

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## Lighting Example – Lighting Controls

**Lighting Plans**



PROJECT STORAGE
101G
471 sf

B1 B1 B1
B1
B1 B1
PR
K1
(7) MDP ELR   ELEV. CTRL RM
(1) 20 A-1P HVL-1

**Lighting Symbols**

VC
S    VACANCY SENSOR CONTROL SWITCH

OC / OC   OCCUPANCY SENSOR W / POWER PACK (CEILING / WALL)

**Project Specifications**

Space 101G is controlled with a vacancy sensor control switch.

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## Lighting Example – Lighting Controls

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

| | | | 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. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *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. | | | Local *Control* (See Section 9.4.1.1[a]) | Restricted to *Manual ON* (See Section 9.4.1.1[b]) | Restricted to Partial *Automatic ON* (See Section 9.4.1.1[c]) | Bilevel Lighting *Control* (See Section 9.4.1.1[d]) | *Automatic Daylight Responsive Controls* for Sidelighting (See Section 9.4.1.1[e][6]) | *Automatic Daylight Responsive Controls* for *Toplighting* (See Section 9.4.1.1[f][6]) | *Automatic Partial OFF* (See Section 9.4.1.1[g] [Full Off complies]) | *Automatic Full OFF* (See Section 9.4.1.1[h]) | Scheduled Shutoff (See Section 9.4.1.1[i]) |
| Storage Room | | | | | | | | | | | |
| <50 ft$^2$ | 0.97 | 6 | REQ | | | | | | | ADD2 | ADD2 |
| ≥50 ft$^2$ and ≤1000 ft$^2$ | 0.46 | 6 | ✓ | ✓ | N/A | | N/A | N/A | | ✓ | |
| All other storage rooms | 0.46 | 6 | REQ | ADD1 | ADD1 | | REQ | REQ | REQ | ADD2 | ADD2 |

Space G 101G mandatory requirements as defined in 9.4.1.1:
* Local Control (one or more manual lighting controls in the space that controls all of the lighting in the space)
* Restricted to Manual ON or Restricted to Partial Automatic ON
* Side and Toplighting Automatic Daylight Responsive Controls (Not applicable because no fenestration)
* Automatic Full OFF (automatically shut off within 20 minutes of occupants leaving the space)

**Which of these control functions are included in the design for the space?**

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# Lighting Example – Compliance Form Demo

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## Poll Question #6

Baseline lighting power density for each HVAC zone for Appendix G models is determined based upon the following

1.  The predominant space type in the HVAC zone and the LPDs in Table G3.7

2.  The predominant space type in the HVAC zone and the prescriptive LPDs in Table 9.6.1

3.  The weighted average LPDs by space square footage and type per Table G3.7

4.  None of the above

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## Poll Question #7

Which model inputs related to lighting are calculated in the Compliance Form (Select all that Apply)?

1. Proposed model lighting power densities by space type and HVAC zone.
2. Baseline model lighting power densities by space type and HVAC zone.
3. None, all lighting model inputs require side calculations outside of the Compliance Form.
4. Proposed model lighting schedule adjustment factors by space type and HVAC zone.

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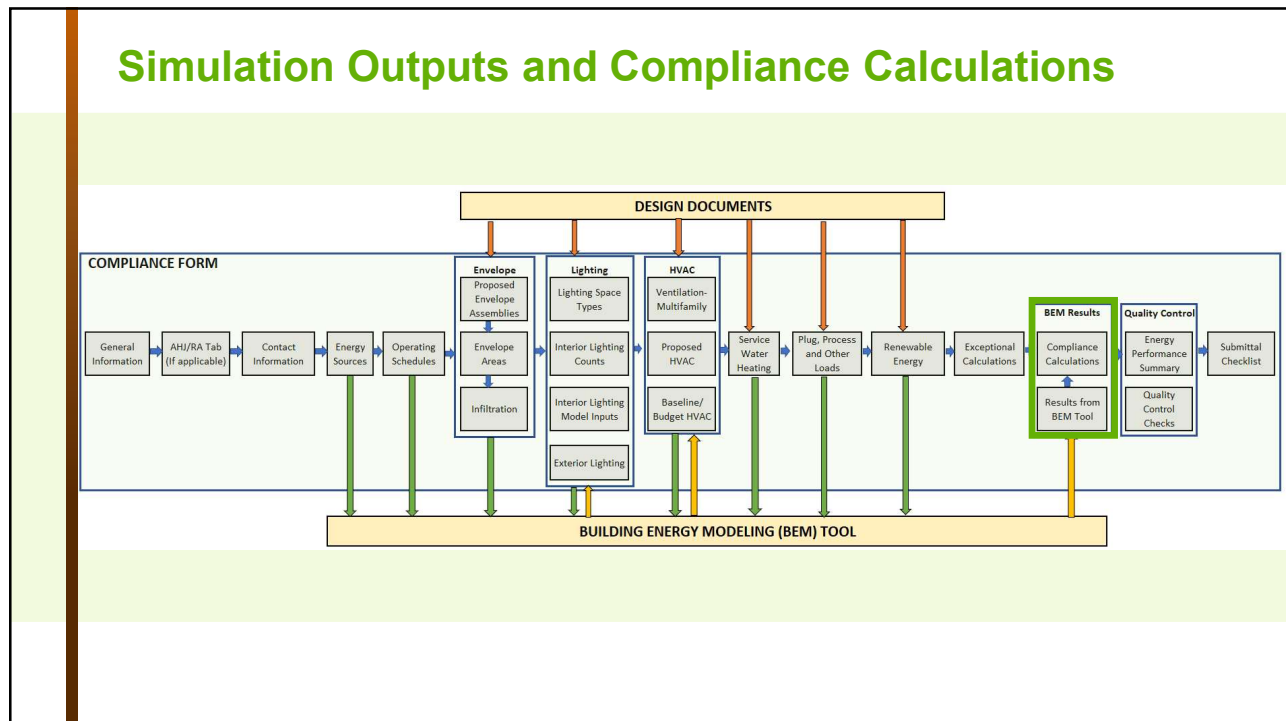
# Simulation Outputs and Compliance Calculations



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## Reporting Requirements

**90.1 G1.3 DOCUMENTATION REQUIREMENTS**

**COMPLIANCE FORM**

**f.** A table with a summary by end use of the *energy cost savings* in the *proposed building performance*.

→ Annual baseline and proposed design heating, cooling, lighting, miscellaneous equipment, SWH pumping, heat rejection, and ventilation costs.

**l.** Input and output reports from the simulation program or compliance software, including a breakdown of energy use by at least the following components: lights, internal equipment loads, service water-heating equipment, space-heating equipment, space-cooling and heat rejection equipment, fans, and other HVAC equipment (such as pumps). The output reports shall also show the amount of unmet load hours for both the proposed design and baseline building design.

→ Modelers can paste the standard output reports generated by the supported simulation tools into the software specific tabs to import simulation results for the baseline and proposed models.

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## Results from <BEM Tool>

Pre-approved supported BEM Tools:
  EnergyPlus
  eQuest
  Openstudio

IESVE results are manually entered

...anually over-written. For example, if the "Fans - interior ventilation" and "Fan - parking garage" end-us...
...d to be split into two separate categories. Or, for example, an end-use contains both regulated and unr...
...stems and components, enter the regulated vs unregulated energy use in separate rows. See "?" for "U...

...ergy | Results from EnergyPlus | Results from Openstudio | Results from eQuest | Complianc...

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## Compliance Calculations Tab

Project performance is <u>not</u> displayed in the Compliance Form due to **MA Stretch amendments**:

**Table 7: Compliance Calculations**

| Parameter | Symbol | Cost $ | Site Energy MMBtu | Source Energy MMBtu | GHG Emissions Mt CO$_2$e |
|---|---|---|---|---|---|
| Proposed building performance before site-generated renewable energy and exceptional calculations | PBP$_{nre\_nec}$ | $51,536 | 3,940 | | |
| Proposed design on-site renewable savings | - | | | | |
| Exceptional calculations savings excluding on-site renewable energy | - | | | | |
| Proposed building performance including on-site renewable energy and exceptional calculations | PBP | $51,536 | 3,940 | 0 | 0 |
| Proposed building performance including exceptional calculations and excluding on-site renewables | PBP$_{nre}$ | $51,536 | 3,940 | 0 | 0 |
| Baseline building unregulated energy, GHG emissions, and/or energy cost | BBUEC | $27,531 | 717 | | |
| Baseline building regulated energy, GHG emissions, and/or energy cost | BBREC | $124,461 | 5,410 | | |
| Baseline building performance | BBP | $151,992 | 6,126 | | |
| Building Performance Factor | BPF | | | | |
| Performance Index Target | PCI$_t$ | 0.40 | 0.44 | | |
| Performance index without on-site renewable energy and exceptional calculations | PCI$_{nre\_nec}$ | 0.42 | 0.61 | | |
| Performance index including exceptional calculations | PCI$_{ec}$ | 0.42 | 0.61 | | |
| Performance Index including exceptional calculations and on-site renewable energy | PCI | 0.42 | 0.61 | | |
| Performance Index adjusted based upon ASHRAE 90.1-2019 Section 4.2.1.1 | PCI$_{adjusted}$ | | | | |
| % improvement beyond ASHRAE 90.1-2019, excluding proposed design on-site renewable energy and exceptional calculations | - | n/a | n/a | n/a | n/a |
| % improvement beyond ASHRAE 90.1-2019, including proposed design on-site renewable energy and exceptional calculations | - | n/a | n/a | n/a | n/a |

**Please use the Companion Tool to determine project compliance/performance.**

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# Results from <BEM Tool> and Compliance Calculations – Compliance Form Demo

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9/27/2024

## Companion Tool

Reminder:

- Accounts for MA Stretch amendments to 90.1-2019 Appendix G related to performance calculations:
    - Site energy metric
    - BPFs (10% more stringent than 90.1-2022)
    - Excludes renewable energy contributions to performance
- Import data from the completed Compliance Form

| DOE/PNNL Compliance Form | → | MA Stretch 2023 Companion Tool |
|---|---|---|
| *Meets reporting requirements of 90.1-2019* | | *Accounts for MA Stretch amendments to 90.1-2019* |

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## Companion Tool Tabs and Workflow

Instructions for Submitter tab

- **Special instructions** for filling out the Compliance Form
- Helpful modeling reminders and color legends

Instructions for CF Import tab

- Instructions for **importing data** from the Compliance Form

Project Performance

- Displays project BPFs (based on MA Stretch 2023 amended BPFs)
- Displays renewable energy cap (0% = no contribution), and energy content for fuel sources in the models
- Determines compliance using **site energy** with **MA Stretch BPFs** and **excluding renewable energy**
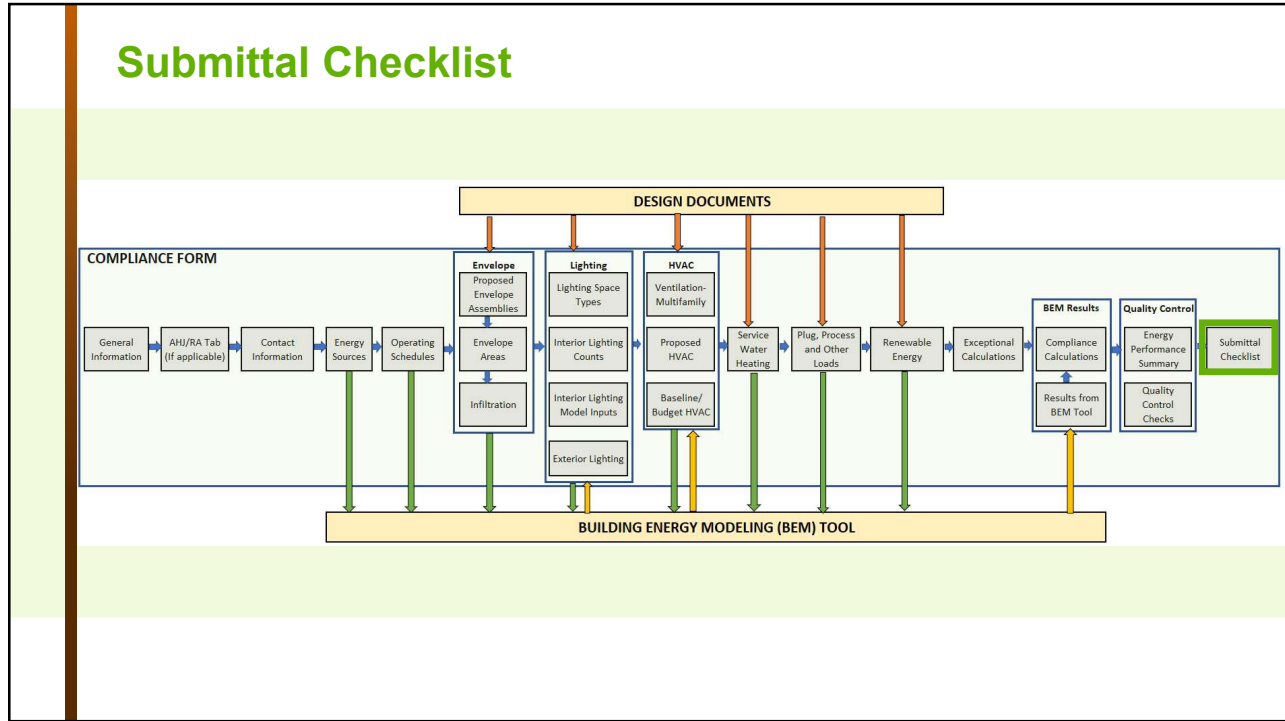
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# Companion Tool Demo

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## Poll Question #8

What documentation tool, tab, and table show the performance outcome for <u>Relative Performance Pathway</u> projects?

A. Compliance Form: Compliance Calculations tab, Table 7

B. TEDI Compliance Tool: Compliance Calculations tab, Tables 1 and 2

C. Companion Tool: Project Performance tab, Table 4

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## Submittal Checklist



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## Submittal Checklist

### 90.1 G1.3 DOCUMENTATION REQUIREMENTS

a. A brief description of the project, the key *energy efficiency* improvements compared with the requirements in Sections 5 through 10, the *simulation program* used, the version of the *simulation program*, and the results of the *energy* analysis. This summary shall contain the calculated values for the *baseline building performance*, the *proposed building performance*, and the percentage improvement.
b. An overview of the project that includes the number of stories (above and below grade), the typical *floor* size, the uses in the *building* (e.g., office, cafeteria, retail, parking, etc.), the gross area of each use, and whether each use is *conditioned space*.
c. A list of the *energy*-related features that are included in the design and on which the performance rating is based. This list shall document all *energy* features that differ between the models used in the *baseline building performance* and *proposed building performance* calculations.
d. A list showing compliance for the *proposed design* with all the requirements of Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4 (mandatory provisions).
e. A list identifying those aspects of the *proposed design* that are less stringent than the requirements of 5.5, 6.5, 7.5, 9.5, and 9.6 (prescriptive provisions).
f. A table with a summary by end use of the *energy* cost savings in the *proposed building performance*.
g. A site plan showing all adjacent *buildings* and topography that may shade the proposed *building* (with estimated height or number of stories).
h. *Building* elevations and *floor* plans (schematic is acceptable).
i. A diagram showing the *thermal blocks* used in the computer simulation.
j. An explanation of any significant modeling assumptions.
k. Backup calculations and material to support data inputs (e.g., *U-factors* for *building envelope* assemblies, NFRC ratings for *fenestration*, end-uses identified in Table G3.1, "1. Design Model," paragraph [a]).
l. Input and output reports from the *simulation program* or compliance software, including a breakdown of *energy* use by at least the following components: lights, internal *equipment* loads, *service water-heating equipment*, *space-heating equipment*, *space*-cooling and heat rejection *equipment*, fans, and other HVAC *equipment* (such as pumps). The output reports shall also show the amount of unmet load hours for both the *proposed design* and *baseline building design*.
m. *Purchased energy rates* used in the simulations.
n. An explanation of any error messages noted in the *simulation program* output.
o. For any exceptional calculation methods employed, document the predicted *energy* savings by *energy* type, the *energy* cost savings, a narrative explaining the exceptional calculation method performed, and theoretical or empirical information supporting the accuracy of the method.
p. The reduction in *proposed building performance* associated with *on-site renewable energy*.

### COMPLIANCE FORM

The Submittal Checklist is designed to ensure that submitters provide all documentation as required by 90.1.

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# Submittal Checklist – Compliance Form Demo

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## Productivity Tips

**Help Buttons**

**Table of Contents**

**Notes**

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## Targeted and Relative Performance
### Reporting 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 |
| **Documentation Requirements** | Average ventilation rate calculations (C103.2 #16)<br>Modeler qualifications<br>Design documents<br>Derating calculations (C402.7)<br>Documentation for fenestration performance (C402.4.6)<br>Air leakage testing results (C402.5.2)<br>Maintenance and commissioning plan (C408)<br>Simulation reports | |
| | Completed COMcheck™ Envelope, Lighting and Mechanical Compliance Certificates, and a Plan Review Inspection Checklist (C103.2.2)<br><br>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 | All items described in ANSI/ASHRAE/IESNA 90.1-2019 Appendix G Section G1.3.2 |
| **Compliance Criteria** | Modeled heating and cooling TEDIs must not exceed the set targets | Modeled PEI of the proposed design must not exceed PEItarget |
| **Documentation Tool** | TEDI Compliance Tool | DOE/PNNL Compliance Form & MA Stretch 2023 Companion Tool |

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## 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<br>• Overview of the modeling requirements<br>• Special rules for additions, core-and-shell and retrofits<br>• 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<br>• Other materials that must be submitted |

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# Commercial New Construction or Major Renovation Program

**Choose Your Path to Generate Energy Savings and Reduce Carbon**

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## 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 ft² 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. |

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**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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# Thank you.
**Massachusetts Energy Code Technical Support Program**

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