

ASHRAE 90.1 Energy Cost Budget and Performance Rating Method Submittal Review Manual

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Summary

The 90.1 Energy Cost Budget and Performance Rating Method Submittal Review Manual (the Manual) is a comprehensive reference for reviewing modeling-based submittals. The Manual is a companion to the DOE/PNNL 90.1 Performance-based Compliance Form (Compliance Form) and supports 2016, 2019, and 2022 editions of ANSI/ASHRAE Standard 90.1. The forms can be downloaded [here](#). The Manual includes the following:

- a. The review checks to verify that the proposed design reported in the Compliance Form reflects design documents; that the configuration of the baseline/budget model is established correctly, that the baseline/budget and proposed design is modeled as reported, that the simulation is error-free, and that the compliance outcome is established correctly;
- b. The review checks to verify compliance with the mandatory requirements of 90.1 relevant to the simulation inputs;
- c. Examples and common mistakes;
- d. Methodologies for prioritizing the review;
- e. Simulation reports for common BEM tools annotated with tips on performing specific checks.

Jurisdiction and rating authorities' administrators charged with establishing a submittal review framework for their organization should refer to the [DOE Energy Codes website](#) for recommendations for organizing an effective and efficient submittal review process including adoption of the DOE/PNNL 90.1 Performance-based Compliance Form, establishing the minimum qualification requirements for energy modelers and submittal reviewers, and third party reviewer Scope of Work template.

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Authors

Maria Karpman, Karpman Consulting

Christina LaPerle, Karpman Consulting

Abbreviations and Acronyms

AFUE - annual fuel utilization efficiency

AHJ – authority having jurisdiction

AHRI – American Heating and Refrigeration Institute

AHVAC – air-side HVAC

ANSI – American National Standards Institute

ASHP – air-source heat pump

ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers

BBREC – baseline building regulated energy cost

BBUEC – baseline building unregulated energy cost

BHP – brake horsepower

CF – compliance form

CFM – cubic feet per minute

CHP – combined heat and power

CV – constant volume

DCV – demand control ventilation

Ec - combustion efficiency

ECB – Energy Cost Budget Method described in ASHRAE Standard 90.1 Section 11 in 90.1 2016 and 2019 and Section 12 in 90.1 2022

EFLH – effective full load hours

Et - thermal efficiency

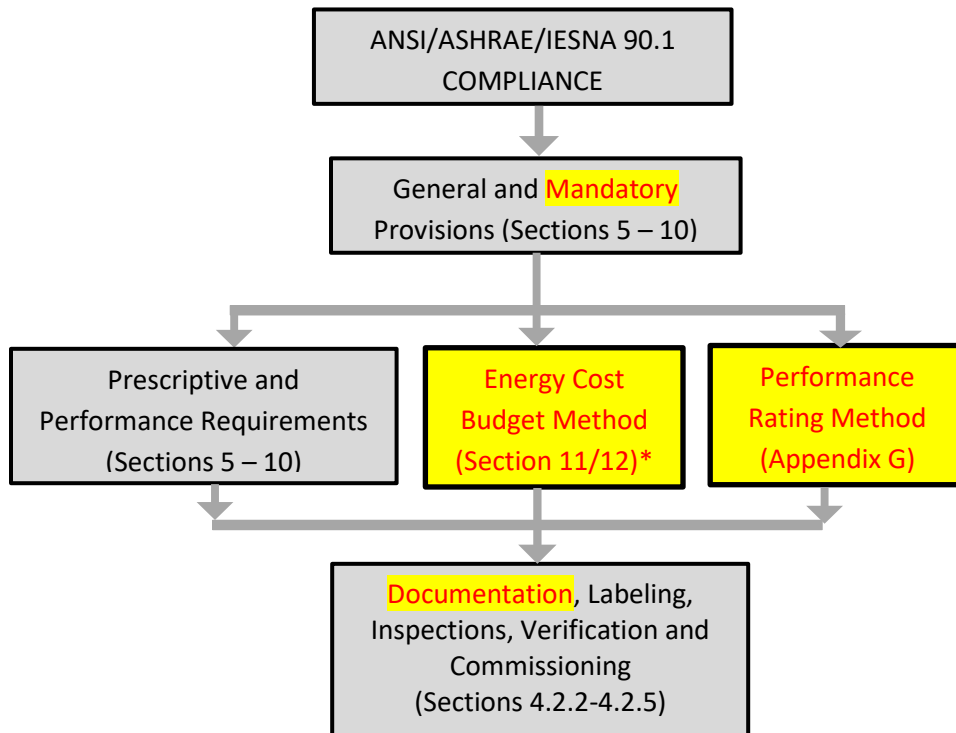
ERV – energy recovery ventilator

DOAS – dedicated outdoor air system

HVAC – Heating, Ventilation and Air Conditioning
IECC – International Energy Conservation Code
IESNA – Illuminating Engineering Society of North America
LE – lighting, exterior
LI – lighting, interior
ML – miscellaneous loads
OA – outdoor air
PA – permit applicant
PCI – performance cost index
PCIt – performance cost index target
PRM – Performance Rating Method described in ASHRAE Standard 90.1 Appendix G
PRM RM – Performance Rating Method Reference Manual
PV – photovoltaic panels
SG – Simulation, General
SWH – service water heating
UMLH – unmet load hour
VAV – variable air volume
WBP – whole building performance
WHVAC – water-side HVAC
WWR – window to wall ratio

1. Background

The 90.1 Energy Cost Budget and Performance Rating Method Submittal Review Manual (the Manual) is a comprehensive reference for reviewing modeling-based submittals. The Manual supports 2016, 2019, and 2022 editions of ANSI/ASHRAE Standard 90.1 focusing on the aspects unique to whole building performance-based compliance, as illustrated in Figure 1 with the red text and yellow highlighting. Some of the enforcement steps that are the same for prescriptive and performance projects, such as site inspections and commissioning, are not addressed.



*The Energy Cost Budget Method is Section 11 in ASHRAE 90.1 2016 and 2019 and Section 12 in ASHRAE 90.1 2022.

Figure 1: Scope of the Manual

The Manual is a companion to the DOE/PNNL 90.1 Energy Cost Budget and Performance Rating Method Compliance Form (the Compliance Form) which meets 90.1 Energy Cost Budget and Performance Rating Method documentation requirements. The Compliance Form is a spreadsheet-based tool that is filled out by the energy modeler and design team and submitted, along with the required supporting documentation, to the Authority Having Jurisdiction (AHJ) or the Rating Authority (RA) for review. The review checks described in this Manual are incorporated into the Quality Control Checks tab (QC Tab) of the Compliance Form. The compliance documentation process is illustrated in Figure 2.

The QC tab allows the reviewer to identify the checks to be performed for the project based on the established high impact areas and the available review budget and record a pass/fail outcome and comments for each completed check. This Manual includes a description of each check listed in the QC tab including references to the applicable 90.1 requirements, simulation reports, and common mistakes.

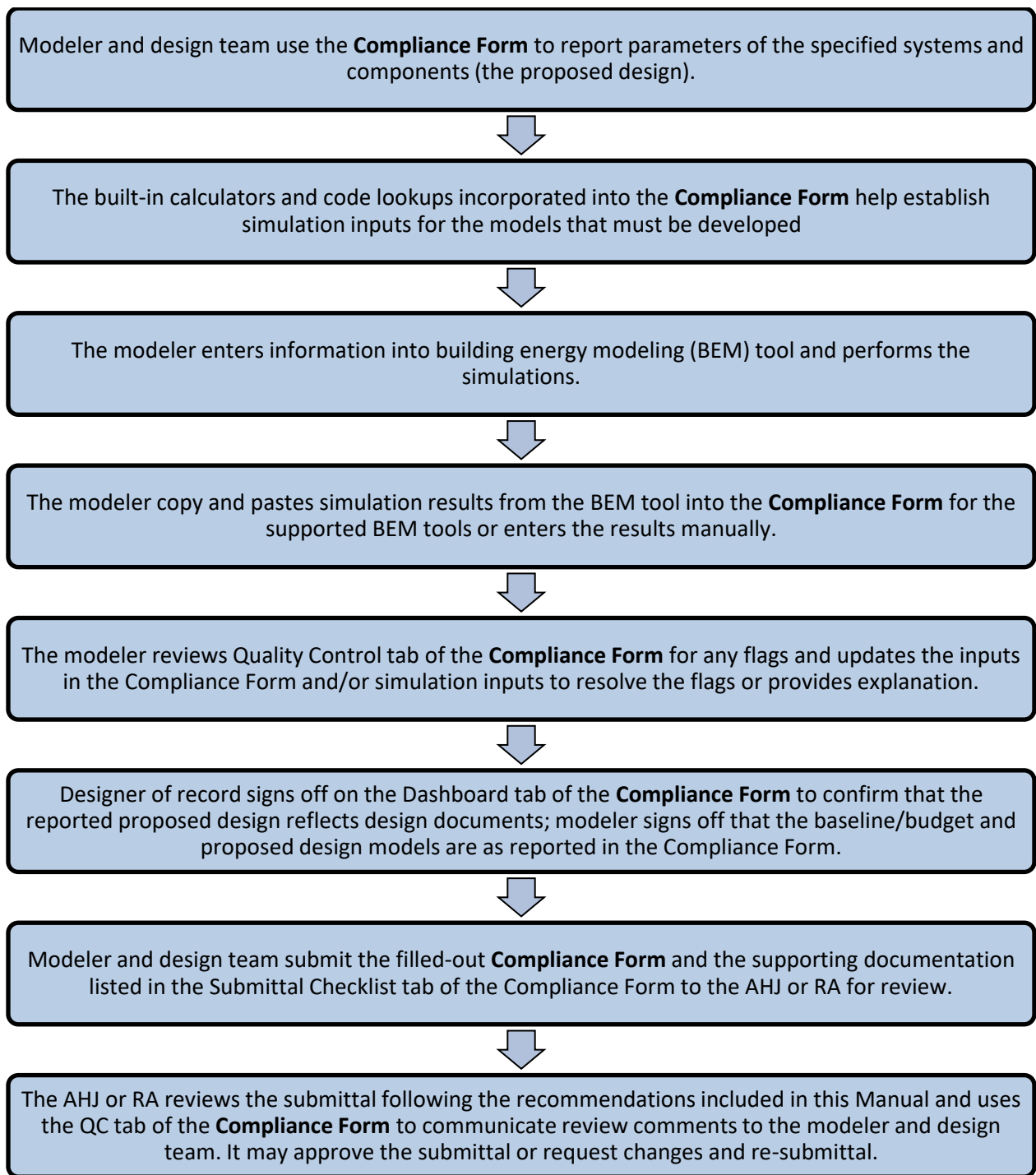


Figure 2: Compliance Documentation Process

This Manual includes the following:

- a) The review checks to verify that the proposed design reported in the Compliance Form reflects design documents; that the configuration of the baseline/budget model is established correctly, that the baseline/budget and proposed design is modeled as reported, that the simulation is error-free, and that the compliance outcome is established correctly;

- b) Examples and common mistakes;
- c) Methodologies dependent on AHJ resources for prioritizing the review to focus on the most impactful areas;
- d) Simulation reports for common BEM tools annotated with tips on performing specific checks.
- e) Checks to verify compliance with the mandatory requirements of 90.1 relevant to the simulation inputs.

For jurisdiction and rating authorities' administrators charged with establishing a submittal review framework for their organization, see the [DOE Energy Codes website](#) for recommendations for organizing an effective and efficient submittal review process including but not limited to the following:

- adoption of the DOE/PNNL90.1 Performance-based Compliance Form,
- establishing the minimum qualification requirements for energy modelers and submittal reviewers,
- and third-party reviewer scope of work template.

2. Organization of the Manual

The [Submittal Review Quick Start](#) (Section 3) describes how this Manual may be used by different user groups including the following:

- building code officials and other professionals tasked with reviews of modeling-based submittals.
- energy modelers who may use procedures outlined in the Manual for internal quality control before submitting to AHJ/RA.

The [Review Process](#) (Section 4) of this Manual provides a step-by-step overview of the submittal review process including references to the tabs of the Compliance Form and sections of the Manual relevant to each step.

The [Submittal Review Methodology](#) (Section 5) of this Manual summarizes the general concept of Standard 90.1 Energy Cost Budget and Performance Rating Method compliance, describes the types of review checks included in the Manual, and includes approaches for identifying impactful aspect of the submittal to help prioritize review effort based on different levels of resources available to conduct submittal reviews. The section also discusses how to use the QC Checks tab of the Compliance Form to establish scope of the review.

The [Review Checks](#) (Section 6) of this Manual is a comprehensive library of checks that may be performed. The checks are organized in subsections based on the type of building systems and components, such as interior lighting, building envelope, etc. Description of each check includes references to the relevant sections of 90.1, review tips including where the relevant information may be found in the Compliance Form, common mistakes, and references to the applicable simulation reports for the supported tools.

[Simulation Reports](#) (Section 7) of this Manual contains the annotated BEM tool reports that are referenced in the review checks, to help locate the necessary information.

The following additional Standard 90.1 resources are available and may include requirements applicable to special situations and exceptions that are beyond the scope of this Manual.

1. ANSI/ASHRAE/IES Standard 90.1-2016, 90.1-2019, and 90.1-2022 available from ASHRAE Bookstore¹. Read-only version may also be available from the ASHRAE website.²
2. 90.1-2016 and 90.1-2019 User's Manuals (available from ASHRAE Bookstore). The User's Manual provides examples and explains requirements of the standard, including the Energy Cost Budget and Performance Rating Methods.
3. ANSI/ASHRAE/IES Performance Rating Method Reference Manual³. The document expands on requirements of 90.1-2016, 2019, and 2022 Appendix G and can be used as the source for the simulation assumptions and methodologies that are not addressed in 90.1.
4. ASHRAE Interpretation Requests
5. Questions on applying code requirements to the specific projects may be sent to ASHRAE as an official or unofficial interpretation request⁴. The official interpretations are posted on ASHRAE website for 90.1-2013⁵, 90.1-2016⁶, 90.1-2019⁷, and 90.1-2022⁸, and are useful resources.
6. DOE Help Desk⁹
7. Additional software-specific resources are included in the Simulation Reports section.

Standard 90.1 Section G3.2 (New Construction/Major Alterations) and G3.3 (Minor Alterations)

New buildings, additions, and alterations (i.e., New Construction/Major Alterations) meeting 90.1 2022 G3.1.4a follow the modeling requirements in Standard 90.1-2022 Section G3.2. All other alterations (i.e., Minor Alterations) follow the modeling requirements in Standard 90.1-2022 Section G3.3. In each section of this document where 90.1 requirements differ across 90.1 Sections G3.2 and G3.3 separate headings are presented for G3.2 and G3.3 with a description of the requirements associated with each under the applicable heading. Refer to section [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) in the [Review Checks](#) (Section 6) for a more detailed explanation and review tips specific to alterations subject to 90.1 Section G3.3.

¹ <https://www.ashrae.org/technical-resources/standards-and-guidelines>

² <https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards>

³ https://www.energycodes.gov/performance_based_compliance

⁴ <https://www.ashrae.org/technical-resources/standards-and-guidelines/pcs-toolkit/standards-forms-procedures#interpretationrequest>

⁵ <https://www.ashrae.org/standards-research--technology/standards-interpretations/interpretations-for-standard-90-1-2013>

⁶ <https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-interpretations/interpretations-for-standard-90-1-2016>

⁷ <https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-interpretations/interpretations-for-standard-90-1-2019>

⁸ <https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-interpretations/interpretations-for-standard-90-1-2022>

⁹ <https://www.energycodes.gov/HelpDesk>

Example of the format for distinguishing between 90.1 G3.2 and G3.3 requirements.

G3.2 New Construction/Major Alterations

Requirements for 90.1 G3.2 specifically will be included under this heading.

G3.3 Minor Alterations

Requirements for 90.1 G3.3 specifically will be included under this heading.

3. Submittal Review Quick Start

For AHJ and RA Administrators

See the [DOE Energy Code website](#) for recommendations for organizing an effective and efficient submittal review process including but not limited to the following:

- adoption of the 90.1 Performance-based Compliance Form,
- establishing the minimum qualification requirements for energy modelers and submittal reviewers,
- and third-party reviewer scope of work template.

For Submittal Reviewers

1. Before performing the first review:
 - a. Review the submittal review policy documents published by AHJ/RA to understand the documentation requirements, review scope, target turnaround time and budget.
 - b. Read the [Review Process](#) section to understand the review steps.
 - c. Read [Review Methodology](#) section to learn about the different types of checks included in the Manual and understand methodology for identifying impactful aspect of the submittal, and the tools available in the Compliance Form to help facilitate the reviews.
 - d. View the Department of Energy ["Performance-based Compliance for Submittal Reviewers" training](#).
2. Follow the steps outlined in the [Review Process](#) section of this Manual to perform a review.

For Energy Modelers

Modelers and design teams should use the same process as described above for the Submittal Reviewers to perform quality control before submitting the package for review. This helps minimize review iterations and ensures a speedy approval. The following is recommended:

- a. At minimum, review the QC Checks tab of the Compliance Form to verify that no automated checks result in "Fail" outcome. Investigate all failed checks and correct the inputs in the appropriate tabs of the Compliance Form and/or in the simulation to resolve the check. If a check is not resolved, provide an explanation for the reviewer.
- b. To improve submittal quality, consider completing all checks for which "Include in Review" is automatically set to "Yes" on the QC Checks tab of the Compliance Form. Some jurisdictions and rating authorities may require this step.

- c. When replying to review comments, refer to the [Review Checks](#) section of this manual to understand the 90.1 requirements and common mistakes relevant to the checks.

4. Review Process

The section describes the submittal review process utilizing the [Quality Control Checks](#) tab of the Compliance Form.

Review Tiers

AHJs and RAs may select different review scopes based on their enforcement philosophy and resource availability. The review tiers are designed to align quality assurance efforts with AHJ and RA goals, available budgets, and resource constraints. While all tiers emphasize impactful elements, Tiers 3 and 4 provide a greater level of targeted scrutiny, focusing on many of the key compliance drivers. Only Tier 5 is intended to offer a fully comprehensive evaluation. As such, while earlier tiers can identify critical issues, some items may go undetected without the full-scope analysis provided by Tier 5.

This document includes five review tiers, ranging from Tier 1 (least rigorous) to Tier 5 (most rigorous).

- Tier 5 provides the most comprehensive assessment, covering all applicable review checks.
- Lower tiers offer reduced review scopes, often chosen due to technical or time constraints.
- Estimated review times apply to the **first review only** (not subsequent iterations) and can vary significantly based on reviewer experience, project complexity, and the quality of submitted materials. These estimates serve as planning guidelines rather than fixed guarantees.

Tier 1 – High-Level Review (~1–2 hours)

A high-level completeness check that focuses on automated flags in the Quality Control Checks tab within the Compliance Form.

Tier 2 – Limited Targeted Review (~3–7 hours)

Includes Tier 1 checks, plus a sample of review checks focused on higher impact building features.

- If **≥20% of checks fail**, consider a Tier 4 review for a deeper assessment.

Tier 3 – Moderate Targeted Review (~8–15 hours)

Includes Tier 1 checks, with an expanded review of higher impact building features compared to Tier 2.

- If **≥20% of checks fail**, a Tier 4 review is recommended.

Tier 4 – Comprehensive Targeted Review (~16–21 hours)

Includes Tier 1 checks, plus all checks that target specific systems and components affecting major end uses.

Tier 5 – Full Review (21+ hours)

A complete analysis, covering all applicable review checks to ensure thorough compliance.

Review Steps

Refer to Figure 4 below for a flow chart depiction of the review steps.

Step 1: Check submittal for completeness

Applicability: All review tiers

- Use the [Submittal + Mand. Req. Checklists](#) tab of the Compliance Form to verify that all required materials are provided. Request additional information if submittal is incomplete.
- Review the [Dashboard](#) tab of the Compliance Form to verify compliance outcome and confirm that modeler and design professional signed off on the submittal as required

Step 2: Get a general understanding of the project

Applicability: All review tiers with tier-specific guidance noted below in parentheses

- Review the [General Information](#) tab of the Compliance Form to understand building type, size, location, whether it's a new construction or renovation and the compliance path followed (All tiers)
- Review the [Energy Performance Summary](#) tab of the Compliance Form to understand which end uses have significant impact on the modeled energy use. (See [Identifying Impactful Aspects of the Submittal](#) section) (All tiers except tier 1)

Step 3: Establish review scope

Applicability: All review tiers

- Open [Quality Control Checks](#) tab of the Compliance Form (Figure 3) and begin by selecting which review tier will be used.
- The tab contains all review checks outlined in the manual. The Compliance Form utilizes automated logic to select a sample of checks based on the chosen review tier, automatically setting the "Include in Review" column to "Yes" for the selected checks. This process follows the guidelines described in the [Identifying Impactful Aspects of the Submittal](#) and [Establishing Review Scope](#) sections of the Manual. The number of checks included will vary based on the selected review tier.

CheckID	Review Check	Include in Review? <i>Reviewer Only</i>	Review Outcome <i>Reviewer Only</i>	Affects an Impactful End-use, Yes/No/N/A	Ranking	Review Time Category (1 = fastest, 4 = longest)	Rev 0 Compliance Form Generated Review <i>Reviewer Only</i>
Ref SG01	The same approved simulation program is used for the baseline and proposed design models.	Yes	Pass	N/A	0	1	
Ref SG02	Project climate zone reported in the Compliance Form is established correctly.		n/a	N/A	1	1	
Ref SG03	The same approved weather file was used in the baseline and proposed design simulations		n/a	N/A	1	1	
Ref	The reported project floor area is consistent with the						

Figure 3: Quality Control Checks tab of the Compliance Form

- For some of the pre-selected checks, the review outcome is automatically set to “Pass” or “Fail” based on the information provided on other tabs of the Compliance Form. For checks with “Fail” outcome, a default review comment is displayed and may be edited by the reviewer.

Step 4: Perform the review

Applicability: All review tiers

- Perform the selected review checks in the order listed in the QC Checks tab of the Compliance Form. Record “Pass” or “Fail” outcome for each check and provide actionable review comments for each check with the “Fail” outcome.
 - A “Pass” outcome means that no changes are required in the given area and any provided comments can be treated as informative.
 - A “Fail” outcome means that changes must be made to the submittal before it is approved. In this case, the issues and required changes should be described in the review comment.
- Confirm the outcome on the checks that are automatically set to “Pass” and update the outcome if necessary.
- Use CheckID provided in the QC Checks Tab to locate the 90.1 references and tips for performing the check in the [Review Checks](#) section of the Manual as necessary.
- For checks that involve verifying simulation reports, use the names of the reports listed for each check to locate the annotated reports in the [Simulation Reports](#) section of the Manual.

Step 5: Communicate the review outcome to the permit applicant

Applicability: All review tiers

Provide written comments to the applicant if corrective actions are required or approve the submittal. The comments may be communicated by returning the Compliance Form with the filled-out [Quality Control Checks](#) tab to the applicant.

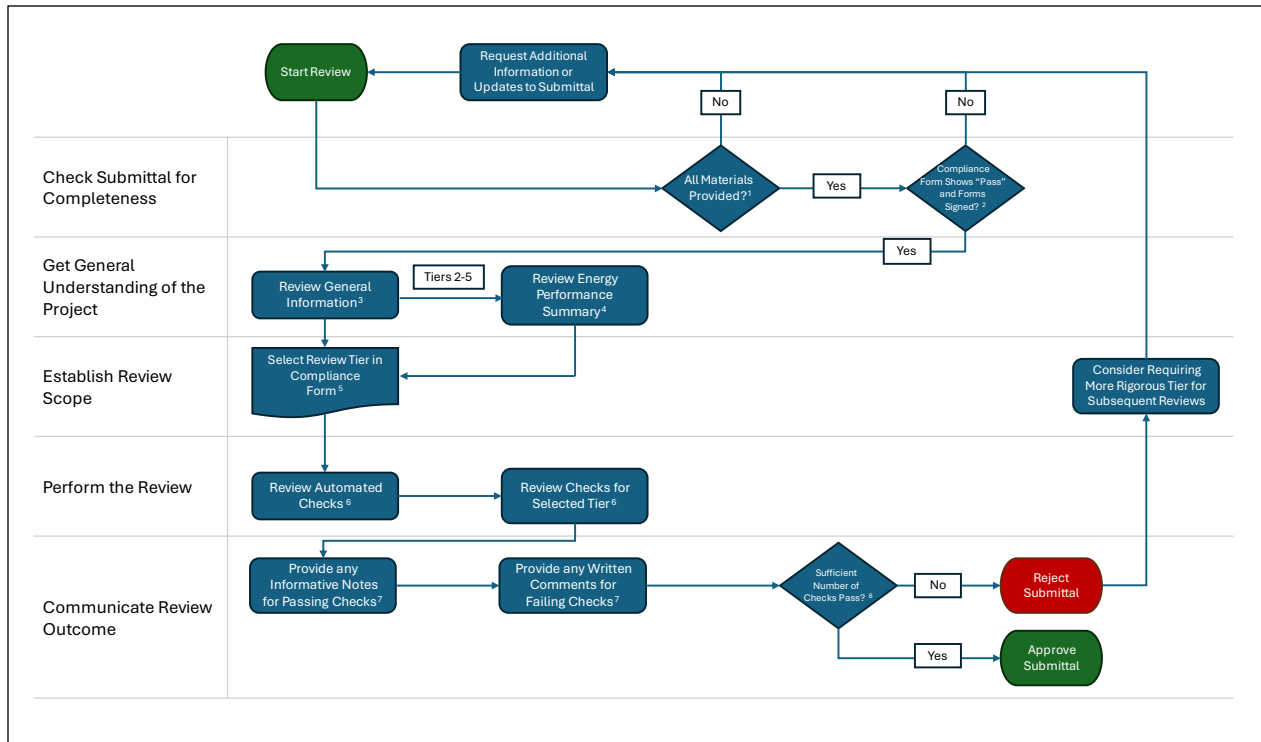


Figure 4: Flow Chart of Review Process

1. Use the Submittal Checklist tab of the Compliance Form to verify that all required materials are provided.
2. Review the Dashboard tab of the Compliance Form to verify the compliance outcome and confirm that the modeler and design professional have signed the submittal.
3. Review the General Information tab of the Compliance Form to understand building type, size, location, whether it's a new construction or renovation and the compliance path followed.
4. Review the Energy Performance Summary tab of the Compliance Form to understand which end uses have significant impact on the modeled energy use.
5. Use Quality Control Checks tab of the Compliance Form to select the desired review tier.
6. Review the Quality Control Checks tab of the Compliance Form to evaluate the status of the automated checks, and to determine which checks are relevant to the selected review tier.
7. Informative notes and comments with required corrective actions can be provided in the Quality Control Checks tab of the Compliance Form.
8. The Submittal Review Manual recommends that if more than 20% of checks fail, then a more rigorous review tier should be used for subsequent reviews. Reviewers may choose a different threshold if desired. If fewer checks fail, revisions may still be requested from the submitter.

5. Review Methodology

General Concept of Standard 90.1 ECB and PRM Compliance

The performance path allows projects to not meet some of the prescriptive requirements and make up for the associated energy penalty by improving over mandatory and prescriptive provisions in other areas. For example, projects with high window to wall ratio may demonstrate compliance by showing that the energy penalty associated with the high thermal loads is offset by savings from an efficient HVAC system and daylighting. The required analysis involves developing two whole building energy simulation models. The first model establishes the point of reference and is referred to as budget (90.1 Energy Cost Budget Method which is also known as Section 11 in 90.1 2016 and 2019 and Section 12 in 90.1 2022) or baseline (90.1 Performance Rating Method which is also known as Appendix G) building design. The second model represents the building design based on the design documents. The compliance outcome is established by comparing the simulated annual energy cost of the two models. This general concept is illustrated in Figure 4.

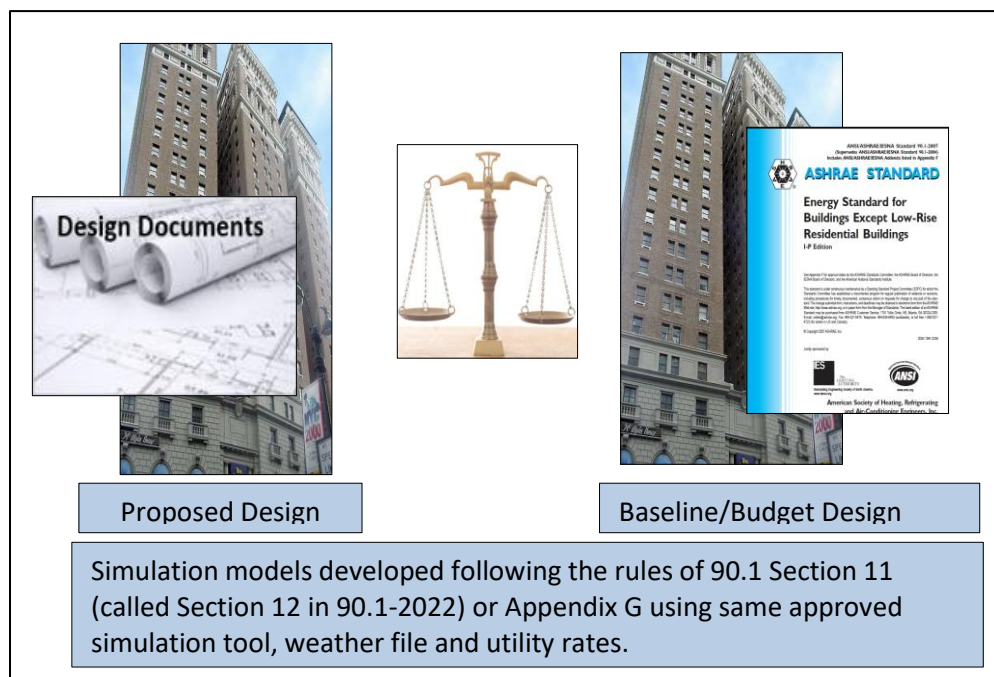


Figure 5: General Concept of 90.1 Energy Cost Budget and Performance Rating Method

Types of the Review Checks

The review checks described in this manual have the following focus areas:

- 1. General requirements of 90.1 Energy Cost Budget and Performance Rating Method**
 - Examples include verifying that an approved simulation tool and weather file was used.
- 2. Specified systems and components reported in the Compliance Form reflect design documents**

- Examples include verifying that the rated wattage of lighting fixture and the number of lighting fixtures specified in various spaces reported in the Compliance Form are consistent with the lighting plans and schedules; that the reported HVAC system types, capacities and efficiencies reflects design documents, etc.
- 3. Specified systems and components meet the mandatory requirements in 90.1 Sections 5 - 10.**
- Examples include verifying that the specified lighting controls meet mandatory requirements in Section 9; that efficiency of the specified HVAC systems meet or exceed minimums provided in Section 6, etc.
 - The applicable mandatory requirements for many systems and components are listed in the Compliance Form. Compliance with these requirements is automatically verified by these QC checks
- 4. Budget/baseline systems and components reported in the Compliance Form reflect requirements of the 90.1 Energy Cost Budget Method or Performance Rating Method**
- Examples include verifying that the lighting power density, HVAC system types, thermal and solar properties of the envelope reported in the Compliance Form for the budget/baseline design are established correctly.
 - In many cases, the relevant parameters are automatically populated in the Compliance Form by applying the rules of the ECB or PRM to the reported “triggers”. For example, project climate zone is one of the triggers that determine the auto populated U-values of the baseline exterior walls. The key triggers are typically listed in the check description.
 - The auto-populated budget/baseline parameters may be accepted without further review once the triggers are verified and if the auto-populated values are not over-written.
 - Some defaults may be over-written, for example when 90.1 rules have exceptions that are not automated in the Compliance Form. The over-written defaults are shown in brown font in the Compliance Form and may require additional verification.
- 5. Simulation inputs reflect systems and components reported in the Compliance Form**
- Examples include verifying that lighting power density or mechanical system type, capacity and efficiency is modeled as reported in the Compliance Form. E.g., if the Compliance Form indicates that the baseline exterior lighting power is 1,700 W, the check would confirm that it matches the exterior lighting input in the simulation tool.
 - Such checks apply to both the baseline/budget and proposed design models.
- 6. Simulation outputs are consistent with systems and components reported in the Compliance Form**
- Baseline/budget and proposed design models include numerous inputs in addition to those reported in the Compliance Form. These undisclosed inputs, as well as modeling mistakes, may have a significant impact on the compliance outcome. Confirming a reasonable correlation between inputs and outputs is an effective way of identifying potential issues. For example, if air leakage through the envelope is reported to be the same in the baseline and proposed design, an output report may be used to verify that infiltration heating and cooling loads are the same in the baseline (budget) and proposed models.
 - Some of these checks are automated in the Compliance Form. For example, since both non-coincident interior lighting peak demand and the rated lighting fixture wattage are reported, projects with non-coincident peak demand exceeding the rated lighting wattage are clearly

erroneous. Similarly, projects with no electric space heating systems reported in the Compliance Form but with electricity used for space heating based on the simulation reports are automatically flagged.

7. Simulation outputs are consistent with the selected benchmarks

- The check may be applied at the whole building level, for example to confirm that the modeled energy use intensity (EUI) of the budget design is similar to a typical EUI for buildings of similar type in the same climate zone minimally compliant with the given edition of 90.1. A similar approach may be used to verify EUI of individual end uses such as lighting or space heating.
- The benchmarks for the budget/baseline and proposed designs are selected in Table 4 of the Energy Performance Summary tab of the Compliance Form. The default benchmarks are set based on DOE/PNNL prototype models¹⁰ (the prototype models) as described below.
 - a. Proposed design documenting minimum code compliance: the prototype model of the appropriate building type and climate zone, compliant with the same edition of 90.1.
 - b. Proposed design documenting performance above code: the prototype model of the appropriate building type and climate zone, compliant with 90.1 2019.
 - c. ECB budget design: the prototype model of the appropriate building type and climate zone, compliant with the same edition of 90.1.
 - d. PRM baseline: the prototype model of the appropriate building type and climate zone, compliant with 90.1 2004.
 - e. For mixed use buildings, the benchmark energy use is calculated as an area-weighted average.

The configuration and key operating assumptions of the prototype models are summarized in the scorecards which can be downloaded at the DOE Building Energy Codes Program website¹⁰.

Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution for alterations subject to Section G3.3 (i.e., Minor Alterations).

- The default limits by which the modeled EUIs can deviate from the benchmark EUIs before a flag is triggered for the corresponding review check on the Quality Control Checks tab are included in Table 6 of the Performance Summary tab from the proposed design, and in Table 7 for the baseline/budget design and may be customized.

Identifying the Impactful Aspects of the Submittal

This section provides tips for identifying systems and components, and the related modeling inputs, that have a significant impact on the compliance outcomes and that should be targeted in the reviews. The impactful building systems and components may be established using a three-step process described below.

Impactful end-uses are identified automatically in the Compliance Form using the methodology described in this section. In addition, the review checks affected by impactful end-uses (i.e., the review check deals with systems and components that affect the impactful end-use) are also automatically

¹⁰ <https://www.energycodes.gov/prototype-building-models#Commercial>

determined in the Compliance Form. See Figure 6 and Figure 7 below for excerpts from the Compliance Form.

Impactful End-Uses
Instructions (Reviewer Only)
 1. Select the performance metric on which to base the determination.
 2. Override the impactful end-uses, if desired, or add additional end-uses.

Impactful End-use Metric (Select):
 Energy Cost

Impactful End-Uses
Misc equipment
Space cooling
Space heating
Interior lighting
Fans - interior ventilation

Note: End-uses are not displayed in order of impact.

Figure 6: Impactful End-Uses on the Quality Control Checks tab in the Compliance Form

CheckID	Review Check	Include in Review? Reviewer Only	Review Outcome Reviewer Only	Affects an Impactful End-use, Yes/No/N/A
Ref BE01-P	Thermal properties of the above-grade walls in the proposed design are established correctly.		n/a	Yes
Ref BE01-B	Thermal properties of the above-grade walls in the baseline design are established correctly.		n/a	Yes
Ref BE02-P	Thermal properties of below-grade walls in the proposed design are established correctly.		n/a	Yes
Ref BE02-B	Thermal properties of below-grade walls in the baseline design are established correctly.		n/a	Yes
Ref BE03-P	Thermal properties of the roof in the proposed design are established correctly.		n/a	Yes

Figure 7: Example on the Quality Control Checks tab of “Affects an Impactful End-use” for a Selection of Review Checks

Step 1: Identify the impactful end uses

End uses that fall into the top tier based on any of the following criteria should be considered impactful.

- a. Contribution toward the difference in energy use between the baseline/budget and proposed design.

For example, lighting end use should be considered impactful for both the baseline and proposed design if reduction in lighting energy use of the proposed design relative to the baseline is one of the top three contributors toward the total reported savings. (In this example, the top tier is defined as top three end uses.)

- b. Contribution toward the total energy use of the proposed design, except when the trade-offs for the end use are not allowed.
- c. The relative contribution toward the total energy use of the budget/baseline design, except when the trade-offs for the end use are not allowed.

Criteria (b) and (c) are important because there are typically multiple differences between the systems and components of the budget/baseline versus proposed design that affect a given end use. Some of the difference may result in energy savings while others in energy penalty. For example, proposed design may have less efficient envelope, but more efficient heating system compared to the budget/baseline, resulting in a similar heating energy use in the budget/baseline and proposed design. In such scenarios, criteria (a) may not be triggered by criteria (b) and (c) would apply if heating end use is a significant contributor toward energy use of the budget/baseline or proposed design. This will ensure that the trade-offs between envelope and heating are evaluated as part of the review.

Criteria (b) and (c) are not applicable to end uses for which no trade-offs are allowed, such as miscellaneous equipment for projects following 90.1 Section 11 (called Section 12 in 90.1-2022) or documenting the minimum compliance following 90.1 Appendix G, or exterior lighting for projects following Section 11 (called Section 12 in 90.1-2022).

Tables 2-4 of the Energy Performance Summary tab of the Compliance Form rank the end uses based on these criteria using simulation results reported in the Compliance Calculations tab (Figure 8). The ranking may be different depending on units used to express simulation results. Since 90.1 Energy Cost Budget and Performance Rating Method compliance is based on energy cost, the impactful end uses should also be determined on the cost basis. Alternative units may be used when required by AHJ or rating authority. It is important to note that for projects with utility rate structures that include demand charges, the cost impact of these charges on each end-use is not accounted for when automatically determining impactful end-uses in the Compliance Form for the energy cost metric. This is because the cost calculation relies on average or virtual rates and the kWh consumption of each end-use.

Table 2: Enduses with the Highest Contribution Towards the Total Energy Use of the Proposed Design

Rank	Site Energy	Source Energy	Energy Cost	GHG Emissions
#1	Space heating (42%)	Misc equipment (27%)	Misc equipment (29%)	Space heating (34%)
#2	Service water heating (17%)	Space heating (25%)	Space heating (22%)	Misc equipment (22%)
#3	Misc equipment (17%)	Space cooling (12%)	Space cooling (13%)	Service water heating (14%)
#4	Space cooling (7%)	Fans - interior ventilation (11%)	Fans - interior ventilation (12%)	Space cooling (10%)
#5	Fans - interior ventilation (7%)	Interior lighting (11%)	Interior lighting (12%)	Fans - interior ventilation (9%)

Table 3: Enduses with the Highest Contribution Towards the Total Energy Use of the Baseline Design

Rank	Site Energy	Source Energy	Energy Cost	GHG Emissions
#1	Space heating (36%)	Interior lighting (21%)	Interior lighting (24%)	Space heating (29%)
#2	Service water heating (17%)	Space heating (20%)	Misc equipment (20%)	Interior lighting (18%)
#3	Interior lighting (14%)	Misc equipment (18%)	Space cooling (17%)	Misc equipment (15%)
#4	Misc equipment (12%)	Space cooling (16%)	Fans - interior ventilation (16%)	Service water heating (13%)
#5	Space cooling (10%)	Fans - interior ventilation (14%)	Space heating (15%)	Space cooling (13%)

Table 4: Enduses with the Highest Contribution Towards Savings of the Proposed Design vs. Baseline Design

Rank	Site Energy	Source Energy	Energy Cost	GHG Emissions
#1	Interior lighting (30%)	Interior lighting (40%)	Interior lighting (38%)	Interior lighting (35%)
#2	Space heating (25%)	Space cooling (22%)	Space cooling (23%)	Space cooling (19%)
#3	Space cooling (17%)	Fans - interior ventilation (20%)	Fans - interior ventilation (20%)	Space heating (18%)
#4	Service water heating (15%)	Space heating (12%)	Misc equipment (9%)	Fans - interior ventilation (17%)
#5	Fans - interior ventilation (15%)	Service water heating (8%)	Space heating (7%)	Service water heating (11%)

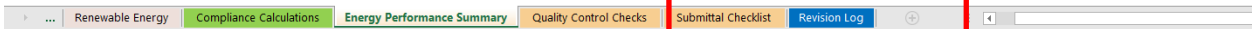


Figure 8: Ranking of the Impactful End Uses in the Energy Performance Summary tab of the Compliance Form.

Step 2: Identify the impactful systems and components

Systems and components associated with the impactful end uses are shown in Table 1 and should be considered impactful. Impactful end-uses are identified automatically in the Compliance Form. The impactful end-uses used to determine impactful review checks are shown in the Impactful End-uses section on the Quality Control Checks tab in the Compliance Form. These can be overwritten by the reviewer as desired.

Step 3: Identify the performance characteristics and operating conditions that drive the modeled energy use of the impactful systems and components.

The performance characteristics and operating conditions that drive the modeled energy use of the impactful systems and components are shown in Table 1. The review checks affected by impactful end-uses (i.e., the review check deals with systems and components that affect the impactful end-use) are also automatically determined in the Compliance Form. See Figure 7 for an excerpt of a sample of checks from the Compliance Form showing this concept.

Table 1: Impactful Systems and Components to be Reviewed

Lighting End Use	
Performance Characteristics	Operating Conditions
<ul style="list-style-type: none"> i. Wattage of the lighting fixtures which account for at least 10% of the lighting power based on the fixture wattage and quantity. ii. Lighting controls in a representative sample of spaces. 	<ul style="list-style-type: none"> i. Lighting runtime hours in a representative sample of spaces.
Service Water-heating End Use	
Performance Characteristics	Operating Conditions
<ul style="list-style-type: none"> i. Type, capacity and efficiency at full and part load of the service water heaters that account for 25% or more of the total specified or installed capacity. 	<ul style="list-style-type: none"> i. Volume of hot water consumed. ii. Supply hot water temperature.
Space Heating End Use	
Performance Characteristics	Operating Conditions
<ul style="list-style-type: none"> i. Type, capacity and efficiency at full and part load of the space heating systems accounting for 25% or more of the total specified or installed capacity. Where there are multiple systems of the same type, the combined capacity of all systems of that type shall be compared to the 25% threshold. ii. In envelope-dominated building types including multifamily, hotels/motels, dormitories and schools: <ul style="list-style-type: none"> - For each opaque surface type¹¹: U-factors and area of assemblies accounting for 25% or more of the total opaque surface area of this type - For fenestration: window to wall ratio; U-factor and area of assemblies accounting for 25% or more of the total fenestration area - Infiltration rate iii. Mechanical ventilation rate iv. Exhaust air energy recovery including recovery effectiveness and bypass control v. HVAC system controls 	<ul style="list-style-type: none"> i. Hourly heating thermostat setpoints ii. HVAC control setting iii. Mechanical ventilation schedule
Space Cooling and Heat Rejection End Use	
Performance Characteristics	Operating Conditions
<ul style="list-style-type: none"> i. Type, capacity and efficiency at full and part load of the space cooling systems accounting for 25% or more of the total specified or installed capacity. Where there are multiple systems of the same type, the combined capacity of all systems of that type shall be compared to the 25% threshold. ii. Fenestration SHGC. iii. Infiltration rate in the envelope-dominated occupancies including multifamily, hotels/motels, dormitories and schools. iv. Mechanical ventilation rates. 	<ul style="list-style-type: none"> i. Hourly cooling thermostat setpoints ii. HVAC control setting iii. Mechanical ventilation schedule

¹¹ Exterior wall, roof, exposed floor, interior surfaces adjacent to unconditioned spaces, etc.

v. Exhaust air energy recovery including recovery effectiveness and bypass control	
vi. Economizer operation.	
vii. HVAC system control.	
Fan End Use	
Performance Characteristics	Operating Conditions
i. Type, rated flow CFM, BHP, flow control method, minimum specified flow fraction, fan and motor efficiency at full and part load for fans serving air-side systems identified as impactful.	i. Fan full load hours
ii. Mechanical ventilation rate and schedule relevant to the identified fans.	ii. The hourly ratio of actual flow to design flow
iii. HVAC system controls relevant to the identified fans.	
Other HVAC Equipment (e.g. Pumps) End Use	
Performance Characteristics	Operating Conditions
i. Type, rated flow GPM, BHP, flow control method, minimum specified flow fraction, pump and motor efficiency at full and part load for pumps serving heating or cooling loops associated with the systems identified as impactful.	i. Pump full load hours
ii. HVAC system controls relevant to the identified pumps	ii. The hourly ratio of actual flow to design flow
Other End Uses	
Performance Characteristics	Operating Conditions
i. Peak and daily average kW load for systems and equipment that combined account for at least 75% of the rated design kW of all equipment associated with this end use. Examples include but not limited to refrigeration equipment and elevators.	i. Equipment full load hours

Establishing Review Scope

The goal of the review is to identify whether any specified systems or components must be changed in order for the design to comply with the ASHRAE Standard 90.1 Energy Cost Budget Method or Performance Rating Method. Both compliance options require designs to meet the applicable mandatory provisions of the Standard; thus, any identified issues with the mandatory requirements will necessitate changes to the design.

Since the 90.1 Energy Cost Budget and Performance Rating Methods allow performance trade-offs between systems and components (with the exception of not meeting mandatory provisions), identifying issues pertaining to the impactful systems are likely to affect the compliance outcome and necessitate changes to the design. On the other hand, uncovering issues with systems that have relatively low impact on the modeled energy cost of baseline/budget and proposed design may result in updates to the models and/or information reported in the Compliance Form without any changes to the design documents. Incidentally, it is important to stress that some of the systems and components that fall into low impact category for the purpose of 90.1 compliance modeling may have high impact on

building lifecycle cost and occupant comfort. Table 2 illustrates the recommended review prioritization logic based on these considerations.

Table 2: Review Check Prioritization Strategies

Type of Review Checks (see Types of Review Checks section)	PROPOSED DESIGN	BASELINE/BUDGET DESIGN
1. General requirements of the 90.1 Energy Cost Budget Method or Performance Rating Method	Always	
2. Specified systems reported in the Compliance Form reflect design document	Only for impactful systems based on sampling	NA
3. Specified systems meet mandatory requirements	Only for impactful systems	NA
4. Budget/baseline systems reported in the Compliance Form meet 90.1 Energy Cost Budget Method or Performance Rating Method requirements	NA	Only for impactful systems, based on sampling
5. Simulation inputs reflect systems and components reported in the Compliance Form	Only for impactful systems based on sampling	Only for impactful systems based on sampling
6. Simulation outputs are consistent with systems and components reported in the Compliance Form	Only for impactful systems, based on sampling	Only for impactful systems, based on sampling
7. Modeled end uses are consistent with benchmark	Always (Note 1)	Always (Note 1)

Note 1: Consistency with the benchmark is always checked for the total site energy use intensity (EUI) and the following end uses: interior lighting, miscellaneous and process equipment, space heating, space cooling, ventilation fans, heat rejections, service water heating and elevators.

Review Check Classifications

Each review check automatically receives the classifications as described below on the Quality Control Checks tab in the Compliance Form based on the specifics of the projects. These classifications, with the exception of Review Time Ranking, which is for informational purposes only, are then used to automatically select the review checks to include in the review following the logic in the Review Check Selection Logic section. See [Appendix B: Logic for Automatic Prioritization of Review Checks](#) for the logic applied to each check to determine the ranking on a project-by-project basis.

- **Review Time Classification**— Each check is assigned a number from 1 to 5 to represent the estimated level of effort required. These values are preset in the Compliance Form and are for reference only. The time estimates below provide a general guideline, though actual duration may vary based on factors such as project size, complexity, reviewer experience, and the quality and completeness of submitted materials. Effort estimates:
 - 1: Automated check
 - 2: 1-2 Minutes
 - 3: 3-7 Minutes

- 4: 8-10 Minutes
 - 5: 11+ Minutes
- **Identifying Review Checks Connected to Impactful End-Uses** – Each check is dynamically assigned a "Yes" or "No" based on whether it involves systems and components that influence an end-use identified as impactful. If the review check is associated with any of the end-uses identified as impactful following the method described in the [Identifying Impactful Aspects of the Submittal](#) section then it will be marked as "Yes".
 - **Ranking**—For each check, a ranking is determined. The following are the assigned rankings and their meaning.
 - 0: Automated checks - always conducted for all tiers.
 - 1: Always conducted for Tiers 2-5. These include EUI checks and general requirements of the PRM or ECB, such as verifying that unmet load hours do not exceed allowable limits.
 - 2: Checks that have a significant impact on energy consumption AND where the systems and components associated with the check affect end-use(s) determined to be impactful for the project (i.e., the check was assigned a "Yes" according to the bullet above). Project attributes like number of stories, building type, and climate zone (CZ) will be considered when dynamically assigning a ranking of either a 2 or 3 to a check. For example, slab on grade construction related to checks for a single-story school in climate zone 6A will receive a ranking of 2, whereas those checks for a 15-story office in CZ 2A will receive a ranking of 3.
 - 3: Checks that have a less significant impact on energy consumption AND where the systems and components associated with the check affect end-use(s) determined to be impactful for the project. Project attributes like number of stories, building type, and climate zone will be considered when dynamically assigning a ranking of either a 2 or 3 to a check.
 - 4: These are the checks that either always have a less significant impact on energy consumption OR are checks that were found to not affect any of the impactful end uses determined for the project.

Review Check Selection Logic

The following logic and process is used for determining whether "Include in Review" will be set equal to "Yes" or "No" dynamically for each review check on the Quality Control Checks tab in the Compliance Form. Steps 2-4 are automated in the Compliance Form.

- **Step 1: Selection of review tier.** For each project review, the reviewer must determine the appropriate review tier, considering both the available review time and the desired level of rigor. The review tier is selected on the Quality Control Checks tab in the Compliance Form.

When aligning the selected tier with the allocated review time, several factors should be taken into account:

- Reviewer Experience – Less experienced reviewers may require additional time to complete reviews.

- Project Complexity – More complex projects generally demand longer review times, even at lower tiers.
- Quality of Submitted Materials – Projects submitted with well-prepared, high-quality documentation often require significantly less review time compared to those with incomplete or inconsistent materials.

By carefully assessing these elements, reviewers can select a tier that balances efficiency and thoroughness while ensuring a comprehensive evaluation of the project.

- **Step 2: Identify impactful end-uses and checks that pertain to these end-uses.** Impactful end uses will be determined automatically in the Compliance Form based on model results using the logic in [Identifying Impactful Aspects of the Submittal](#) section. Each check will be marked as Yes/No as to whether it affects any impactful end uses.
- **Step 3: Rank checks.** Rankings of 0 and 1 are not dynamic and are therefore not project specific. These are pre-assigned and remain stable across projects. The checks that received a “Yes” in step 2 will be ranked as either 2 or 3 based on its level of influence on energy consumption. A ranking of 2, 3, or 4 will be automatically determined in the Compliance Form based upon attributes of the project including but not limited to impactful end uses, climate zone, building type, number of stories, etc. See the Review Check Classifications section for more information regarding ranking. See Appendix B: Logic for Automatic Prioritization of Review Checks for the logic applied to each check to determine the ranking on a project-by-project basis.
- **Step 4: Selection of checks to be performed.** Checks will be selected automatically following the default logic shown below depending on the tier selected. “Include in Review” will be set equal to “Yes” or “No” dynamically following the logic below. In certain cases, the reviewer may choose to override the default percentages shown below. For example, if a submitter consistently provides high-quality work, the reviewer may adjust the percentage of rank 4 checks conducted from 20% to 5% for a Tier 3 review. Conversely, if a submitter frequently submits lower-quality work, the reviewer may opt to increase the percentage to 40% for a more thorough assessment. The percentage of checks conducted can be manually adjusted on the Quality Control Checks tab in the Compliance Form in the Review Tier section.
 - Tier 1: 1
 - Verify all automated checks Pass
 - No additional checks are selected for review; however, if any automated checks fail, then the reviewer should investigate, or ask the submitter to explain.
 - Tier 2:
 - Verify all automated checks Pass
 - 100% of checks with a ranking of 1
 - 50% of checks with a ranking of 2
 - 25% of checks with a ranking of 3
 - 10% of checks with a ranking of 4
 - Tier 3:
 - Verify all automated checks Pass

- 100% of checks with a ranking of 1
 - 75% of checks with a ranking of 2
 - 50% of checks with a ranking of 3
 - 20% of checks with a ranking of 4
- Tier 4:
 - All checks ranked 0 through 3
 - 20% of checks with a ranking of 4
- Tier 5:
 - All checks (ranking 0 through 4)

The [Review Checks](#) section of the Manual includes sub-sections dedicated to the key building systems (e.g., interior lighting, building envelope, etc.). Each subsection starts with an introduction that includes a table listing the available checks based on their type, as defined in the first column of Table 2, and component being addressed (e.g., lighting wattage, lighting controls, etc.) These introductory sections also include the sampling recommendations. For example, verification that the specified lighting fixture wattage reported in the compliance form reflects design document should focus on fixtures that account for the largest share of the specified wattage and spot-checking other fixtures.

6. Review Checks

Nomenclature

The review checks included in this section are organized into the following groups:

[Simulation General \(SG\)](#) checks verify compliance with the general simulation requirements such as that an approved simulation program was used to model baseline/budget and proposed design, that project's climate zone was established correctly, that simulation results used to establish compliance outcome reflect submitted simulation reports, and that the number of unmet load hours does not exceed the specified limit. In addition, SG checks verify that the total simulated energy use intensity and energy intensities of individual end uses including lighting, miscellaneous loads, heating, cooling, fans, pumps, heat rejection and service water heating are consistent with the selected benchmarks.

[Utility Rates \(UR\)](#) checks verify that energy cost is established using utility rates from an approved source and are properly modeled.

[Building Envelope \(BE\)](#) checks verify that the envelope geometry, thermal and solar properties are established and modeled correctly.

[Lighting, Interior \(LI\)](#) and [Lighting, Exterior \(LE\)](#) checks verify that the interior and exterior lighting power and controls are properly established and modeled.

[Plug, Process and Other Loads \(PPO\)](#) checks verify that the miscellaneous unregulated loads, industrial process, elevators, regulated refrigeration, motors and combined heat and power systems are properly established and modeled.

[Service Water Heating \(SWH\)](#) checks verify that service water heating equipment type, efficiency and controls, that the related auxiliary equipment and hot water demand were established and modeled correctly.

[Air-side HVAC Systems \(AHVAC\)](#) and [Water-side HVAC Systems \(WHVAC\)](#) checks verify heating, cooling and ventilation system type, capacity, efficiency and controls, and parameters of the related auxiliary components such as fans, pumps and heat rejection equipment were established correctly and properly modeled.

[Renewable Energy \(RE\)](#) checks cover renewable electricity and thermal energy generation systems such as photovoltaic (PV) systems. [Exceptional Calculations \(EC\)](#) checks address calculations that were completed outside of the simulation tool. The checks are only relevant to projects involving renewable systems or exceptional calculations, respectively.

In addition, checks are designated as applying to the Baseline/Budget Design or Proposed Design.

Budget/Baseline Design (B) checks confirm that the baseline (budget) design described in the submittal reflects the requirements of the selected compliance path and is modeled as reported.

Proposed Design (P) checks that verify that the parameters of the proposed design reported in the Compliance Form match design documents, comply with applicable 90.1 mandatory requirements, and are appropriately modeled.

[90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) includes a detailed explanation of the requirements associated with 90.1 Section G3.3 (Minor Alterations) and review tips specific to alterations subject to 90.1 Section G3.3 (i.e., Minor Alterations).

Example of the format for distinguishing between 90.1 G3.2 and G3.3 requirements through the Review Checks Section

G3.2 New Construction/Major Alterations

Requirements for 90.1 G3.2 specifically will be included under this heading.

G3.3 Minor Alterations

Requirements for 90.1 G3.3 specifically will be included under this heading.

Each check has CheckID expressed using this nomenclature. For example, BE08-P is check #8 related to building envelope (BE) for the proposed design (P).

Sections below list the checks included in each check group. The following information is provided for each check:

- Summary of the relevant 90.1 requirements
- Review tips including location of the relevant information in the Compliance Form, steps for completing the check, sampling recommendations for checks that apply to multiple similar systems and components (e.g. HVAC systems), and common mistakes.
- For review checks that involve verifying simulation inputs or outputs, list of the relevant simulation reports of commonly used BEM. The annotated reports are included in the

Simulation Reports section of this Manual. Note that the majority of the annotated reports provided for eQuest also pertain to projects using other tools that rely on the DOE-2 engine.

Compliance Form tab Name Changes

The DOE/PNNL 90.1 Performance-based Compliance Form (the Compliance Form) undergoes continuous maintenance where updates are made based upon user feedback and when there are changes to 90.1 that impact the Compliance Form (i.e., the Compliance Form was updated to support 90.1 2022 in addition to 90.1 2016 and 2019 at the end of 2023). A few tab names have changed since previous versions of the Compliance Form. These changes are summarized below so that if an older version of the Compliance Form is being reviewed the reviewer can follow along with the review tips in the sections below.

- Interior Lighting Summary tab (formerly called the Interior Lighting Model Inputs tab)
- HVAC PRM tab (formerly called the Baseline HVAC App G tab)
- Budget HVAC ECB tab (formerly called the Budget HVAC Section 11 tab)
- Submittal+Mand. Req. Checklists (formerly called the Submittal Checklist tab)

Simulation General (SG)

Overview of Simulation General Checks

Simulation General checks help gauge the general quality of the submittal, such as whether an approved simulation tool and weather file were used, modeled floor area reflects design documents, and simulation results reported in the Compliance Form reflect simulation output reports.

In addition, there are checks that compare modeled energy use of the baseline/budget and proposed design to the selected benchmarks to verify that the simulation results are reasonable. The relevant information is shown on the Energy Performance Summary tab of the Compliance Form in both the tabular and graphical format (Figure 9). Significant deviations between the modeled energy use intensities of the baseline/budget and proposed design and the benchmark should be flagged, as discussed in the specific checks described below.

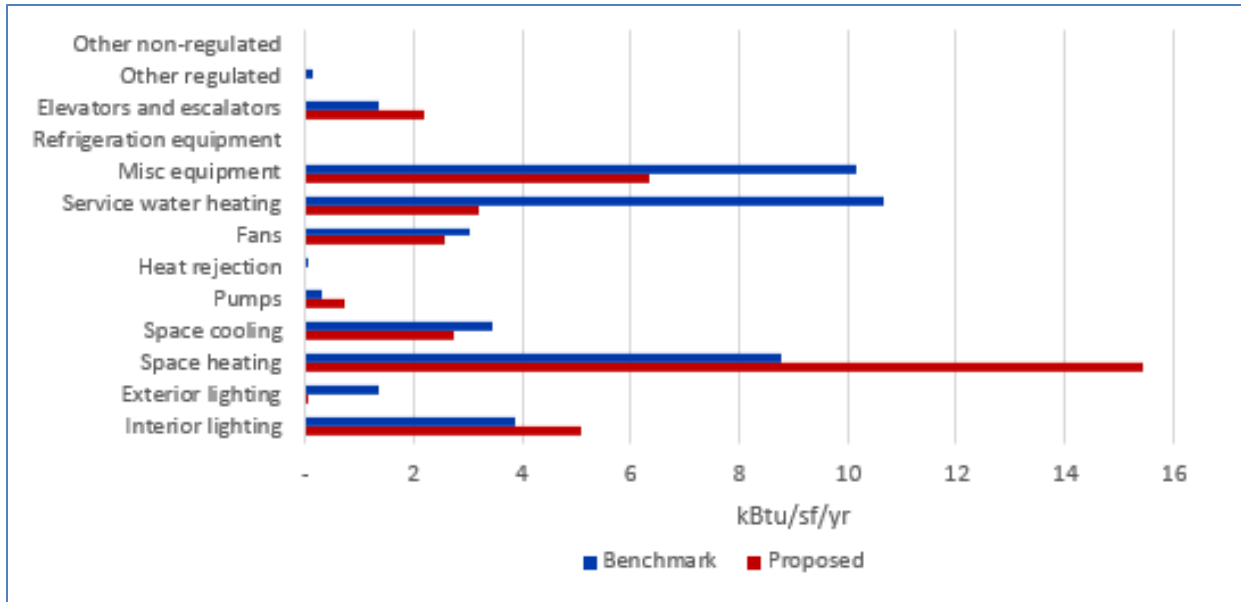


Figure 9: Energy Performance Summary tab of the Compliance Form, Benchmark Comparison

Of especial concern are the instances when the baseline/budget EUI is significantly higher than the benchmark or proposed EUI is significantly lower than the benchmark as it may result in overly optimistic compliance outcome.

However, the differences may be justified by different operating conditions (e.g., longer daily operating hours) between the project and the benchmark and the building use (e.g., school project that has a swimming pool versus school benchmark with no swimming pool). The configurations of the benchmarks are summarized in the scorecards which can be downloaded at the [DOE Building Energy Codes Program website](#)¹⁰. In addition, a large difference may be acceptable for end uses that account for a small percentage of energy use in both benchmark and completed models, such as heating energy use in Miami or cooling energy use in Alaska.

Table 3 summarizes the checks included in the Simulation General section.

Table 3: Simulation General (SG) Checks Overview

Focus of the Check	Type of Check	Proposed Design	Baseline/Budget Design
Simulation Tools	General requirements of ECB/PRM	SG01	SG01
Climate Zone	General requirements of ECB/PRM	SG02	SG02
Weather File	General requirements of ECB/PRM	SG03	SG03
Floor area	CF inputs reflect design documents	SG04	NA
	Simulation inputs consistent with CF	SG05	SG05
Number of hours per year explicitly modeled	Simulation inputs consistent with CF	SG06	SG06
Unmet load hours	CF inputs reflect requirements of ECB/PRM	SG07	SG07

	Simulation outputs consistent with CF	SG08	SG08
Energy Use	Simulation outputs consistent with CF	SG09-P	SG09-B
Total EUI	Simulation outputs consistent with benchmark	SG10-P	SG10-B
Interior Lighting EUI	Simulation outputs consistent with benchmark	SG11-P	SG11-B
Miscellaneous and Process EUI	Simulation outputs consistent with benchmark	SG12-P	SG12-B
Space Heating EUI	Simulation outputs consistent with benchmark	SG13-P	SG13-B
Space Cooling EUI	Simulation outputs consistent with benchmark	SG14-P	SG14-B
Ventilation Fans EUI	Simulation outputs consistent with benchmark	SG15-P	SG15-B
HVAC Pumps EUI	Simulation outputs consistent with benchmark	SG16-P	SG16-B
Heat Rejection EUI	Simulation outputs consistent with benchmark	SG17-P	SG17-B
Service Water Heating EUI	Simulation outputs consistent with benchmark	SG18-P	SG18-B
Elevator EUI	Simulation outputs consistent with benchmark	SG19-P	SG19-B
Compliance Calculations	CF inputs reflect requirements of ECB/PRM	SG20	SG20
LEGEND			
PASS/FAIL/NA outcome is determined automatically in the Quality Control Checks tab of the Compliance Form			

SG01 The same approved simulation program used for the baseline/budget and proposed design models

90.1 2016 and 2019 ECB

Section 11.4.1 The *simulation program* must be approved by the *adopting authority* and have the following capabilities:

- explicitly support simulation method, systems and components listed in Section 11.4.1.1, such as hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat set points, and HVAC system operation, defined separately for each day of the week and holidays; thermal mass effects; ten or more thermal zones; part-load performance curves for mechanical equipment; capacity and efficiency correction curves for mechanical heating and mechanical cooling equipment.; air-side economizer and fluid economizer with integrated control; and the budget building design characteristics specified in Section 11.4.5.
- either directly determine the design energy cost and energy cost budget or produce hourly reports of energy use by energy source suitable for determining the design energy cost and energy cost budget using a separate calculation engine (11.4.1.2)
- perform design load calculations to determine required HVAC equipment capacities and air and water flow rates in accordance with Section 6.4.2 for both the proposed design and the budget building design.

In addition, the simulation program must be tested according to ASHRAE Standard 140, except for Sections 7 and 8, and the results must be furnished by the software provider (Section 11.4.1.4). In 90.1 2019, the relevant reporting requirements were expanded and clarified as follows:

- The test results and modeler reports must be posted on a publicly available website and include the test results of the simulation program along with the results of the other simulation programs included in ASHRAE Standard 140, Annexes B8 and B16.

- The modeler report in Standard 140, Annex A2, Attachment A2.7 must be completed for results exceeding the maximum or falling below the minimum of the reference values or for missing results.

90.1 2022 ECB

Section 12.4.1 has requirements similar to 90.1 2016 and 2019 ECB Section 11.4.1 summarized above with the following additions:

- The required ASHRAE Standard 140 tests are specified in Section 12.4.1.4 and include building thermal envelope and fabric load tests (Sections 5.2.1, 5.2.2, and 5.2.3), ground coupled slab-on-grade analytical verification tests (Section 5.2.4), space-cooling equipment performance tests (Section 5.3), space-heating equipment performance tests (Section 5.4), and air-side HVAC equipment analytical verification tests (Section 5.5), along with the associated reporting (Section 6).
- Section 12.4.1.4.3 specifies that the testing shall be performed for the version of the simulation program used to calculate the design energy cost and energy cost budget.

90.1 2016 and 2019 PRM

Section G2.2.1 has the same requirements as 90.1 2016 and 2019 ECB Section 11.4.1 summarized above.

90.1 2022 PRM

Section G2.2.1 has the same requirements as 90.1 2022 ECB Section 12.4.1 summarized above.

Review Tips

1. Simulation tool name and version is reported in the Energy Model Information section on the General Information tab of the Compliance Form.

Instructions

1. Complete the "General Information" tab before completing any other tabs because some of the inputs on this tab determine the selections available within other tabs.

Energy Model Information		ASHRAE 90.1-2016: Appendix G		Above Code Performance	
Compliance path					
Energy model based on	100% Construction Documents	Document date	2/21/2020		
Simulation program	eQuest	7175	ASHRAE Std 140 Tests	http://www.doe2.com/download/IRScode179D_eQUEST-DOE22/	

2. If AHJ/RA has the list of simulation programs, verify that the simulation program used for the project is on the list.
3. If AHJ/RA does not have the list of simulation programs, verify that the simulation program meets the relevant requirements of 90.1 summarized above. The footnote below includes tools listed on the IRS website approved for 179d modeling analysis¹². An individual AHJ/RA may allow only some of these tools, a subset of versions for each program, or simulation tools not listed on the IRS website.

¹² Software tools approved by the IRS for 179D modeling as of January 2024 includes: DesignBuilder, DeST, DOE-2.2, EnergyGuage, EnergyPlus, eQuest, Hourly Analysis Program (HAP), IES Virtual Environment, OpenStudio® with EnergyPlus, TAS, TRACE 3D Plus, TRACE 700, and TRNSYS. Other software tools may also be allowed if they have published 140 results. IRS website: <https://www.energy.gov/eere/buildings/qualified-software-calculating-commercial-building-tax-deductions>

- If it is determined that the simulation program used on the project is not approved, it is recommended that the issue is resolved before proceeding with other checks described in the manual. Alternatively, only the checks that do not involve verifying simulation inputs or outputs should be completed.

SG02 Project climate zone reported in the Compliance Form is established correctly

90.1 2016, 2019, and 2022 Energy Cost Budget and Performance Rating Methods

Section 5.1.4 (5.1.5 in 90.1 2022): Use ASHRAE Standard 169, Table B-1, “U.S. Climate Zones by State and County,” Table A-5, “Canada Stations and Climate Zones,” and Table A-6, “International Stations and Climate Zones,” to determine the assigned climate zone and, where required, the assigned climate zone letter. If there are recorded historical climatic data available for a construction site, they may be used to determine compliance if approved by the building official. The information is also included in 90.1 Annex 1, which contains the relevant abstracts from ASHRAE Standard 169.

Review Tips

- Project address is listed in the Project Information section of the Contact Information tab of the Compliance Form. Use the reported zip code to determine the county.

Project Information			
Project # or ID	123456	Submission date	6/12/2020
Project name	The Woods on Main Street		
Project address	123 Main Street		
Project City	Bedford Falls	State	New York
Zip code	12345		

- Refer to 90.1 Annex 1 to confirm that the climate zone listed on the General Information tab, Energy Model Information section is established correctly based on the state and county where project is located.

Energy Model Information			
Compliance path	ASHRAE 90.1-2016: Appendix G		
Energy model based on	100% Construction Documents	Document date	2/21/2020
Simulation program	eQuest	7175	
Simulation weather station	Central Park		
Type of weather data	TMY3		
Name of simulation weather file	NY_New_York_Central_Prk_O.bin		
Climate zone	4A		

SG03 The same approved weather file used in the baseline/budget and proposed simulation

90.1 2016 and 2019/2022 ECB

Section 11.4.2/12.4.2: The simulation must be performed using hourly values of climatic data, such as temperature and humidity from representative climatic data, for the city in which the proposed design is to be located. For cities or urban regions with several climatic data entries, and for locations where weather data are not available, the designer must select available weather data that best represents the climate at the construction site.

Section 11.4.4/12.4.4: The same weather file must be used for the budget (baseline) and proposed design simulations.

90.1 2016, 2019, and 2022 PRM

G2.3: The simulation must be performed using hourly values of climatic data, such as temperature and humidity from representative climatic data, for the city in which the proposed design is to be located. For cities or urban regions with several climatic data entries, and for locations where weather data are not available, the designer must select available weather data that best represents the climate at the construction site.

G2.1: The same weather file must be used for the budget (baseline) and proposed design simulations.

Review Tips

1. Weather file used in the simulation is reported in the General Information tab of the compliance Form.

Energy Model Information			
Compliance path	ASHRAE 90.1-2016: Appendix G		
Energy model based on	100% Construction Documents	Document date	2/21/2020
Simulation program	eQuest	7175	
Simulation weather station	Central Park		
Type of weather data	TMY3		
Name of simulation weather file	NY_New_York_Central_Prk_O.bin		
Climate zone	4A		

2. If AHJ/RA has pre-approved weather files that must be used for specific project locations, confirm that the weather file listed in the Compliance Form and in the model is approved.
3. If AHJ/RA does not have pre-approved weather files, as a general rule projects should use a weather file for the Typical Meteorological Year (TMY) station closest to the project site. In areas with large elevation changes or microclimates, the closest station may be at a significantly different elevation and therefore have different weather or psychrometric characteristics or may be in a different microclimate. In such cases, a weather station at similar elevation and latitude or similar microclimate may be a better fit.
4. Once the weather station is determined, TMY2¹³, TMY3¹⁴, or TMYx¹⁵ data files for the selected station should be used (for projects located in the United States). TMYx data reflects more recent weather patterns compared to TMY3 and TMY2 data. Alternative weather data sources, such as those accounting for expected climate change, may be allowed with sufficient supporting documentation.
5. The same weather file must be used for the budget/baseline and proposed design simulations.

eQUEST	BEPS and at the top of other reports
Trane TRACE 700	Title Page report (the same weather file will always be used for both alternatives)
Trane TRACE 3D Plus	Climatic Summary report

¹³ http://rredc.nrel.gov/solar/old_data/nsrdb/1961-1990/tmy2/State.html

¹⁴ http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/by_state_and_city.html

¹⁵ <https://climate.onebuilding.org/>

IESVE SOFTWARE	PRM Compliance Report, ECB Compliance Report, BPRM Report, IECC Compliance Report, Detailed Simulation Report, Energy Model Output Report
EnergyPlus	eplustbl.html 'Top' section EnergyPlus HTML output file > Input Verification and Results Summary report > General table > "Weather File"
OpenStudio	eplustbl.html 'Top' section; EnergyPlus HTML output file > Input Verification and Results Summary report > General table > "Weather File"
Carrier HAP v5	Simulation Weather Summary Report <i>(The same simulation weather file will always be used for both Proposed and Baseline in the same project. It is not possible to use different simulation weather data for Proposed and Baseline in a single project)</i>
Design Builder	EnergyPlus Output Summary Document

SG04 The reported project floor area is consistent with the design documents.

90.1 2016 and 2019/2022 ECB

Table 11.5.1/12.5.1 Column A, #1a: The simulation model of the proposed design must be consistent with the design documents thus the modeled project area is expected to be as designed.

90.1 2016, 2019 and 2022 PRM

Table G3.1 Proposed Building Performance column #1a: The simulation model of the proposed design must be consistent with the design documents thus the modeled project area is expected to be as designed.

Review Tips

1. Check that the project floor area reported in Table 1 of the General Information tab aligns with the design documents. In addition, check that the classification of the project floor areas reported in Table 1 on the General Information tab align with the design in terms of the floor area described as "new construction", "alteration" and "modeled existing to remain – no alteration" and "conditioned", "semi-heated and unconditioned", and "space not enclosed" (click the help text for definitions).

Building Area Type(s)	Conditioned Floor Area, ft ²				Semi-Heated and Unconditioned Floor Area, ft ²				Spaces not Enclosed, ft ²			Total, ft ²
	New Construction	Alteration	Does Alteration Area Meet G3.1.4a/11.1.4.1?	Modeled Existing to Remain - No Alteration	New Construction	Alteration	Does Alteration Area Meet G3.1.4a/11.1.4.1?	Modeled Existing to Remain - No Alteration	New Construction	Alteration	Modeled Existing to Remain - No Alteration	
Multifamily	84,365											84,365
Retail	24,750											24,750
Sub-total	109,115											109,115
Total			109,115									109,115

Add Row Delete Row

Plans/Spec Reference(s) for Verifying the Building Areas and # of Floors: A-001

2. For 90.1 2022 projects, verify that the selection in the "Does Alteration Area Meet G3.1.4a/11.1.4.1?" column aligns with design documents (click the help text for explanation of these sections). This selection is important in that it impacts the compliance calculation for PRM projects and, if the answer is "No", PRM projects must follow 90.1 Section G3.3 instead of Section G3.2.
3. Small deviations between the modeled area and the area specified in the design documents are common and may be acceptable. Below are some common reasons for the mismatch.

- a. Gross floor area reported in the design documents is based on the definition in the 2015 IBC¹⁶, which differs from the 90.1 – 2016 definition (both are quoted below). ECB and PRM do not specify how building area should be inputted into the model, e.g. whether it should be based on the inside perimeter of the exterior walls (based on the IBC definition), or the outside perimeter of the exterior walls (90.1 definition), so it may be modeled either way.

Floor Area, Gross (IBC). The floor area within the inside perimeter of the exterior walls of the building under consideration; exclusive of vent shafts and courts, without deductions for corridors, stairways, ramps, closets, the thickness of interior walls, columns or other features. The floor area of a building, or portion thereof, not provided with surrounding exterior walls shall be the usable area under the horizontal projection of the roof of floor above. The gross floor area shall not include shafts with no openings or interior courts.

Floor Area, Gross (90.1): the sum of the floor areas of the spaces within the building, including basements, mezzanine and intermediate-floored tiers and penthouses with a headroom height of 7.5 ft or greater. It is measured from the exterior faces of walls or from the centerline of walls separating buildings, but excludes covered walkways, open roofed-over areas, porches and similar spaces, pipe trenches, exterior terraces or steps, chimneys, roof overhangs, and similar features.

- b. 90.1 distinguishes between the enclosed spaces, which include directly or indirectly conditioned, semi-heated, or unconditioned spaces and un-enclosed spaces, such as crawlspaces, attics and parking garages with natural or mechanical ventilation (see 90.1 definition of unconditioned space). Un-enclosed spaces may be modeled with ambient conditions, thus not contributing to the modeled floor area.
- c. Multilevel spaces such as stairwells may be modeled as an open shaft (i.e. modeled area = area of the footprint), or as multiple floors (modeled area = area of the footprint times the number of floors the space spans).
- d. To ensure a fair comparison between the floor areas shown in the simulation reports and the design documents, it's important to understand how the floor area is reported by the simulation tool. For example, certain simulation reports may show conditioned floor area, others the gross floor area including unconditioned spaces and plenums, etc.

+/- 5% difference between the modeled floor area of heated and cooled spaces and the area of the corresponding spaces listed in the design documents may be acceptable. Higher deviations may be permitted with an appropriate explanation.

¹⁶ <https://codes.iccsafe.org/content/IBC2015>

SG05 The modeled floor area is as reported in the Compliance Form and the same between budget/baseline and proposed design

90.1 2016 and 2019/2022 ECB

Table 11.5.1/12.5.1 Column B, #1a: The baseline building design shall be modeled with the same number of floors and floor area as the proposed design.

90.1 2016, 2019, and 2022 PRM

Table G3.1 Baseline Building Performance column #1: The baseline building design shall be modeled with the same number of floors and floor area as the proposed design.

Review Tips

1. Use simulation reports listed below to confirm that the modeled project floor area is as reported in the Compliance Form and the same in the baseline/budget and proposed design. Project floor area is reported in Table 1 of the General Information tab.

eQUEST Reports	Conditioned area: LS-C, CSV Space Loads Report
Trane TRACE 700	LEED Summary Section 1.2
Trane TRACE 3D Plus	LEED Summary Section 1.2
IESVE SOFTWARE	Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report
EnergyPlus	eplustbl.html 'Annual Building Utility Performance Summary' report
OpenStudio	eplustbl.html 'Annual Building Utility Performance Summary' report
Carrier HAP v5	"LEED Summary" report, Section 1 "Report and Project Information", table titled "Space Summary"
Design Builder	LEED Summary Reports in EnergyPlus output summary document

SG06 The correct number of hours per year was explicitly modeled

90.1 2016 ECB

11.4.1.1 At least 1,400 hours per year representing the full range of conditions must be explicitly simulated; the same number of hours must be explicitly simulated for the budget and proposed design.

90.1 2019/2022 ECB

11.4.1.1/12.4.1.1 8,760 hours (full year) must be explicitly simulated.

90.1 2016, 2019 and 2022 PRM

G2.2.1: 8,760 hours (full year) must be explicitly simulated.

Review Tips

1. Refer to the simulation reports listed below to confirm that the simulation timestep was as required and the same for both the baseline/budget and proposed design models.

eQUEST Reports	8,760 simulated by default; CSV Hourly Results, LS-F and other monthly reports
Trane TRACE 700	Project Information entered values report
Trane TRACE 3D Plus	The program always models 8,760 hours

IESVE SOFTWARE	PRM Compliance Report, ECB Compliance Report, IECC Compliance Report, Energy Model Output Report, BPRM Report
EnergyPlus	eplustbl.html 'Annual Building Utility Performance Summary' report; EnergyPlus HTML output file > Input Verification and Results Summary report > General table > "Hours Simulated"
OpenStudio	eplustbl.html 'Annual Building Utility Performance Summary' report; EnergyPlus HTML output file > Input Verification and Results Summary report > General table > "Hours Simulated"
Carrier HAP v5	8760 hours simulated by default. There is no way to simulate fewer hours. To provide proof you can graph simulation results or export hourly simulation results to CSV and demonstrate in Excel.
Design Builder	Output Summary Document

SG07 The number of unmet load hours reported in the Compliance Form does not exceed the prescribed limits.

90.1 2016 and 2019/2022 ECB

Section 3: Unmet load hour is an hour in which one or more zones is outside of the thermostat set point plus or minus one half of the temperature control throttling range. Any hour with one or more zones with an unmet cooling load or unmet heating load is defined as an unmet load hour.

11.5.2 i/12.5.2 i: Unmet load hours for the proposed design or baseline designs shall not exceed 300 hours. In addition, the UMLHs for the proposed design shall not exceed the unmet load hours for the budget building design. Unmet load hours exceeding these limits may be accepted if sufficient justification is given that the accuracy of the simulation is not significantly compromised by these unmet loads. See Section 3 above for the definition of unmet load hour.

90.1 2016 and 2019/2022 PRM

G3.1.2.3/G3.2.2.3: Unmet load hours for the proposed design or baseline building design shall not exceed 300 out of the 8,760 hours simulated. Unmet load hours exceeding these limits may be accepted if sufficient justification is given that the accuracy of the simulation is not significantly compromised by these unmet loads. See Section 3 above for the definition of unmet load hour.

Review Tips

1. Unmet load hours (UMLH) are reported in Table 1 on the Compliance Calculations tab of the Compliance Form

Unmet Loads	Proposed Design	Baseline Design
Number of hours heating loads are not met	15	6
Number of hours cooling loads are not met	6	2
Total	21	8
Compliance	Yes	

2. The prescribed limits should be enforced for most projects, because high UMLHs is often due to simulation errors that may have a high impact on the compliance outcome. The higher the UMLHs in

the proposed design compared to the baseline (budget) model effectively means that even though the two models have the same thermostat setpoints, the actual space temperatures in the proposed design were lower during the heating season and/or higher during the cooling season. This will reduce energy use of the proposed design, which is not an allowed trade-off. Below are several common reasons for a high UMLH³.

- a) The thermostat schedules do not align with the schedules associated with HVAC system operation, occupant schedules, miscellaneous equipment schedules, outside air ventilation schedules and other schedules of operation that could affect the HVAC system's ability to meet loads in the thermal block.
- b) The inputs for internal gains, occupants and outside air ventilation are unreasonable and inconsistent with the intended operation of the building.
- c) The simulated operation of the controls associated with primary or secondary heating or cooling equipment (pumps, coils, boilers, etc.) is out of alignment with the heating and cooling requirements of the building.
- d) Inadequate equipment capacity in the proposed design.
Example: The specified equipment may be intentionally under-sized to achieve higher part load performance, resulting in unmet loads during extreme conditions. In this case, the modeled thermostat setpoints should be adjusted to ensure that the UMLH in the proposed design are within the required limits. Once such the thermostat schedule is established, it must be modeled the same in the baseline/budget and proposed designs.

3. Example of extenuating circumstances that may be considered include the following:

- a) Number of UMLHs beyond the allowed limit
Reviewer may judge a submittal with 350 UMLHs (that exceed the 300 limit by 50 hours) to be acceptable, but reject a submittal with 800 UMLHs (that exceed the 300 limit by 500 hours).
- b) Floor area of the thermal blocks where the UMLHs occur
Reviewer may choose to accept a submittal with high UMLHs in a 100 ft² thermal block (e.g. a stairwell) but reject a submittal with high UMLHs in the zones that account for a notable fraction (e.g. over 5%) of the overall conditioned floor area.
- c) How far the indoor temperatures drop or rises outside of the acceptable range.
For example, the AHJ may accept a submittal if the actual zone temperatures during an UMLH is one or two degrees outside of the throttling range, but reject submittals with larger discrepancies, for example if during the UMLH the temperature in the thermal block is 60F compared to a 70F heating setpoint.

Reviewer may request additional simulation reports to substantiate the explanations provided by the modeler.

SG08 The number of unmet load hours reported in the Compliance Form reflects simulation results.

Review Tips

1. Review simulation reports listed below to confirm that the number of unmet load hours reported in the compliance form is aligned with the simulation reports.

eQUEST	BEPS, SS-R, SS-O, LS-C, CSV Space Loads Report
Trane TRACE 700	Energy Cost Budget/PRM Summary, LEED Summary Section 1.3
Trane TRACE 3D Plus	LEED Summary report Section 1.3
IESVE SOFTWARE	PRM Compliance Report, ECB Compliance Report, BPRM Report, IECC Compliance Report, Unmet Hours Report
EnergyPlus	eplustbl.html 'LEED Summary' report, section EAp2-2 Advisory Messages
OpenStudio	eplustbl.html 'LEED Summary' report, section EAp2-2 Advisory Messages
Carrier HAP v5	"LEED Summary" report, Section 2 "Minimum Energy Performance Calculator", table titled "Unmet Loads")
Design Builder	LEED Minimum Energy Performance Calculator, LEED Summary report

SG09-B, SG09-P Energy use reported in the Compliance Form matches simulation reports

Review Tips

PRM and ECB compliance is established based on the simulation outputs for the baseline (budget) and proposed design. The Compliance Form allows modelers to copy results from the standard simulation output reports generated by the supported modeling tools into the designated areas to auto-populate the template with the simulation results, to avoid mistakes from manual data transfer. Performing this check should involve the following:

- a) Confirm that electricity (kWh) and natural gas (Therm) use for the baseline/budget design reported in the Compliance Calculations tab of the compliance form matches the submitted simulation reports.
- b) Confirm that the total baseline/budget design energy cost reported in the Compliance Calculations tab matches the submitted simulation reports.
- c) Confirm that electricity (kWh) and natural gas (Therm) use for the proposed design reported in the Compliance Calculations tab matches the submitted simulation reports.
- d) Confirm that the total proposed energy cost reported in the Compliance Calculations tab matches the submitted simulation reports.
- e) Spot-check electricity and gas use for individual end uses reported in the compliance form versus simulation reports.

eQUEST Reports	ES-D, BEPS
Trane TRACE 700	LEED Summary Section 1.4
Trane TRACE 3D Plus	LEED Summary report

IESVE SOFTWARE	PRM Compliance Report, ECB Compliance Report, BPRM Report, IECC Compliance Report, Energy Model Output Report
EnergyPlus	eplustbl.html 'LEED Summary' report, section EAp2-7 Energy Cost Summary
OpenStudio	eplustbl.html 'LEED Summary' report, section EAp2-7 Energy Cost Summary
Carrier HAP v5	"LEED Summary" report, Section 2, "Energy Performance Calculator", table titled "Performance Rating Energy Consumption and Cost by Fuel Type – Performance Rating Method Compliance".
Design Builder	LEED Summary Reports in EnergyPlus Output Summary Document

SG10-P Site Energy Use Intensity (EUI) of the proposed design is generally consistent with the selected benchmark

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. The benchmarks are selected in Table 4 of the Energy Performance Summary tab in the Compliance Form. See #6 in the [Types of Review Checks](#) section for additional information. Table 6 of the Energy Performance Summary tab shows the modeled EUI versus the EUI of the selected benchmark.
3. Verify the following
 - a. If the default benchmark in Table 4 of the Energy Performance Summary tab is overwritten, verify that an appropriate option is selected. (The over-written defaults are shown in brown font.)
 - b. If the default values in columns Table 6 of the Energy Performance Summary tab, the "Acceptable Difference Before QC Flag" columns, the "Total" row are overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.)
 - c. Question results if the difference between the modeled EUI and the benchmark EUI is outside the acceptable limits. Proposed EUI that is below the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly optimistic modeled energy use of the proposed design.
 - d. Higher deviations may be justified by project-specific circumstances, for example if project aims to significantly exceed code and participates in a utility incentive program or pursues LEED or passive house certification or have significantly longer operating hours than the benchmark.

SG10-B Site Energy Use Intensity (EUI) of the budget/baseline design is generally consistent with the selected benchmark

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. The benchmarks are selected in Table 4 of the Energy Performance Summary tab in the Compliance Form. See #6 in the [Types of Review Checks](#) section for additional information. Table 7 of the Energy Performance Summary tab shows the modeled EUI versus the EUI of the selected benchmark.
3. Verify the following:

- a. If the default benchmark in Table 4 of the Energy Performance Summary tab is overwritten, verify that an appropriate option is selected. (The over-written defaults are shown in brown font.)
- b. If the default values in columns Table 7 of the Energy Performance Summary tab, the “Acceptable Difference Before QC Flag” columns, the “Total” row are overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.)
- c. Question results if the difference between the modeled EUI and the benchmark EUI is outside of the acceptable limits. Baseline/budget EUI that is above the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly inefficient/lenient baseline/budget energy use.
- d. Higher deviations may be justified by project-specific conditions – for example, if project involves a school building that is occupied year-round compared to a benchmark school occupied only during the school year.

SG11-P Modeled interior lighting energy use of the proposed design is generally consistent with the selected benchmark, with the difference less than set threshold.

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. If the default values in Table 5 of the Energy Performance Summary tab, the “Acceptable Difference Before QC Flag” columns, the “Interior Lighting” row are overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.)
3. Question results if the difference between the modeled interior lighting EUI and the benchmark EUI is outside the limits set in the last two columns of Table 6. See #6 in the [Types of Review Checks](#) section for the default values. A proposed EUI that is significantly below the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in optimistic lighting energy use in the proposed design.
4. Common reasons and possible mistakes:
 - a. Lighting wattage too high/low
 - b. Lighting runtime hours are too high/low
 - c. Savings from occupancy sensors and daylighting are too high/low

SG11-B Modeled interior lighting energy use in the baseline/budget design is generally consistent with the selected benchmark, with difference less than set threshold

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. If the default values in columns Table 6 of the Energy Performance Summary tab, the “Acceptable Difference Before QC Flag” columns, the “Interior Lighting” row are overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.)
3. Question results if the difference between the modeled interior lighting EUI and the benchmark EUI is outside the limits set in the last two columns of Table 6. See #6 in the [Types of Review Checks](#)

section for the default values. Baseline/budget EUI that is significantly higher than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly inefficient/lenient baseline/budget design.

4. Common reasons and possible mistakes:
 - a. Lighting wattage too high/low
 - b. Lighting runtime hours are too high/low
 - c. Savings from occupancy sensors and daylighting are too high/low

SG12-P, SG12-B Modeled energy use intensity of the miscellaneous and process loads in the baseline/budget design is generally consistent with the selected benchmark, with the difference less than the set threshold.

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. If the default values in columns Table 6 of the Energy Performance Summary tab, the “Acceptable Difference Before QC Flag” columns, the “Interior Lighting” row are overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.) See #6 in the [Types of Review Checks](#) section for the default values.
3. Question results if the difference between the modeled interior lighting EUI and the benchmark EUI is outside the limits set in the last two columns of Table 6. Baseline/budget EUI that is significantly higher than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly inefficient/lenient baseline/budget design. However, it may be justified by a difference in operating conditions (e.g. longer than typical operating hours), or differences in building use. For example, hotels with dining facilities will have higher miscellaneous equipment EUI than hotels without restaurants.
4. Common reasons and possible mistakes:
 - a. Unrealistic miscellaneous equipment loads impact HVAC end uses. For example, unrealistically low loads reduce internal heat gains, over-estimating heating energy use and magnifying the impact of any heating-related trade-offs (e.g., savings from high performance heating system in the proposed design). On the other hand, cooling energy use is lower than expected minimizing penalty from cooling-related deficiencies in the proposed design, such as when economizer is not specified.

SG13-P, SG13-B Modeled heating energy use in the proposed and baseline/budget design is generally consistent with the selected benchmark, with the difference less than the set threshold

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. If the default values in Table 6 of the Energy Performance Summary tab (Table 5 for the baseline/budget), the “Acceptable Difference Before QC Flag” columns, the “Space Heating” row are

overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.) See #6 in the [Types of Review Checks](#) section for the default values.

3. Question results if the difference between the modeled heating EUI and the benchmark EUI is outside the limits set on the Energy Performance Summary tab, except when heating energy use is low in both the benchmark and the model, such as for projects in the climate zones with the minimal heating. Focus on the following:
 - a. Proposed EUI that significantly lower than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly optimistic heating energy use in the proposed design.
 - b. Baseline/budget EUI that is significantly higher than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly inefficient/lenient heating in the baseline/budget design.
4. Common reasons or mistakes that may result in unrealistically high/low heating energy use intensity include the following:
 - a. Thermal properties of the envelope are not established or modeled correctly
 - b. Infiltration rate is too high/low
 - c. Window to wall ratio (WWR) is higher (lower) than typical for the building type
 - d. Internal heat gains from lighting, appliances, or plug loads are too low/high
 - e. Excessive simultaneous heating/cooling (simulation outputs show high heating use during summer months, leading to high heating EUI)
 - f. Modeled ventilation rate is too high/low
 - g. Heating efficiency is too low/high
 - h. Heating thermostat setpoints are too high/low

SG14-P, SG14-B Modeled cooling energy use in the proposed and baseline/budget design is generally consistent with the selected benchmark, with the difference less than the set threshold

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. If the default values in Table 6 of the Energy Performance Summary tab (Table 5 for the baseline/budget), the “Acceptable Difference Before QC Flag” columns, the “Space Cooling” row are overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.) See #6 in the [Types of Review Checks](#) section for the default values.
5. Question results if the difference between the modeled cooling EUI and the benchmark EUI is outside the limits set on the Energy Performance Summary tab, except when the end use is low in both the benchmark and the model, such as for projects in the climate zones with the minimal heating. Focus on the following:
 - a. Proposed EUI that significantly lower than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly optimistic cooling energy use in the proposed design.

- b. Baseline/budget EUI that is significantly higher than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly inefficient/lenient cooling energy use in the baseline/budget design.
- 3. Common reasons or mistakes that may result in unrealistically high/low cooling energy use intensity:
 - a. Fenestration SHGC is too high/low
 - b. WWR significantly higher (lower) than typical
 - c. Internal heat gains from lighting, appliances, or plug loads are too high/low
 - d. Excessive simultaneous heating/cooling (simulation outputs show high cooling use during winter months, leading to high cooling EUI)
 - e. Modeled ventilation rate is too high/low
 - f. Baseline cooling efficiency is too low/high
 - g. Modeled heating thermostat setpoints are too low/high
 - h. Economizer not modeled or modeled incorrectly

SG15-P, SG15-B Modeled HVAC fans energy use in the in the proposed and baseline/budget design is generally consistent with the selected benchmark, with the difference less than the set threshold

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. If the default values in Table 6 of the Energy Performance Summary tab (Table 5 for the baseline/budget), the “Acceptable Difference Before QC Flag” columns, the “Fans” row are overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.) See #6 in the [Types of Review Checks](#) section for the default values.
3. Question results if the difference between the modeled fan EUI and the benchmark EUI is outside the limits set on the Energy Performance Summary tab. Focus on the following:
 - a. Proposed EUI that significantly lower than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly optimistic fan energy use in the proposed design.
 - b. Baseline/budget EUI that is significantly higher than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly inefficient/lenient fan energy use in the baseline/budget design.
4. Common reasons or mistakes that may result in unrealistically high/low fan energy use intensity:
 - a. Fans are not modeled explicitly (low EUI)
 - b. Fans modeled and reported as process or miscellaneous load (low EUI)
 - c. Exhaust or DOAS fans are modeled in addition to the baseline allowance (high baseline EUI)
 - d. Project includes parking garage with exhaust fans
 - e. Flow controls are not properly modeled (e.g. high EUI if Constant Volume (CV) instead of Variable Air Volume (VAV) control was modeled)
 - f. Minimum flow rates on VAV systems are set too high/low

SG16-P, SG16-B Modeled HVAC pumps energy use in the proposed and baseline/budget design is generally consistent with the selected benchmark, with the difference less than the set threshold

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. If the default values in Table 6 of the Energy Performance Summary tab (Table 5 for the baseline/budget), the “Acceptable Difference Before QC Flag” columns, the “Pumps” row are overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.) See #6 in the [Types of Review Checks](#) section for the default values.
2. Question results if the difference between the modeled pump EUI and the benchmark EUI exceeds the limits. Focus on the following:
 - a. Proposed EUI that significantly lower than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly optimistic pump energy use in the proposed design.
 - b. Baseline/budget EUI that is significantly higher than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly inefficient/lenient pump energy use in the baseline/budget design.
3. This check is optional because the difference in pump energy use between the model and the benchmark is often due to difference in the HVAC system type. For example, the model may include geothermal or water-source heat pump or chilled/hot water system while the benchmark may have heating/cooling provided by DX systems with gas furnaces.
4. Common reasons or mistakes that may result in unrealistically high/low pump energy use intensity:
 - a. Hot or chilled water loops are modeled with constant flow (three-way valves) instead of variable flow (two-way valves).
 - b. Hot water loop is modeled as operating year-round instead of only during heating season, which is often the case for buildings such as multifamily.

SG17-P, SG17-B Modeled heat rejection energy use in the proposed and baseline/budget design is generally consistent with the selected benchmark, with the difference less than the set threshold

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. If the default values in Table 6 of the Energy Performance Summary tab (Table 5 for the baseline/budget), the “Acceptable Difference Before QC Flag” columns, the “Heat rejection” row are overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.) See #6 in the [Types of Review Checks](#) section for the default values.
3. Question results if the difference between the modeled heat rejection EUI and the benchmark EUI exceeds the set limits. Focus on the following:

- a. Proposed EUI that significantly lower than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly optimistic heat rejection energy use in the proposed design.
 - b. Baseline/budget EUI that is significantly higher than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly inefficient/lenient heat rejection in the baseline/budget design.
4. This check is optional because the difference in heat rejection energy use between the model and the benchmark is often due to difference in the HVAC system type. For example, the model may include cooling towers while the benchmark may have heating/cooling provided by DX systems with energy associated with heat rejection reported under cooling end use.

SG18-B, SG18-P Modeled service water heating energy use in the baseline/budget and proposed design is generally consistent with the selected benchmark, with the difference less than the set threshold

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. If the default values in Table 6 of the Energy Performance Summary tab (Table 5 for the baseline/budget), the “Acceptable Difference Before QC Flag” columns, the “Service water heating” row are overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.) See #6 in the [Types of Review Checks](#) section for the default values.
3. Question results if the difference between the modeled service water heating EUI and the benchmark exceeds the set limits. Focus on the following:
 - a. Proposed EUI that significantly lower than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly optimistic service water heating energy use in the proposed design.
 - b. Baseline/budget EUI that is significantly higher than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly inefficient/lenient service water heating energy use in the baseline/budget design.
4. Common reasons and mistakes that may result in unrealistically high/low service water heating energy use:
 - a. Hot water demand too high/low
 - b. Water heater efficiency too low/high

SG19-P, SG19-B Modeled elevator energy use in the baseline/budget and proposed design is generally consistent with the selected benchmark, with the difference less than the set threshold.

Review Tips

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for notes of caution and tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. If the default values in Table 6 of the Energy Performance Summary tab (Table 5 for the baseline/budget), the “Acceptable Difference Before QC Flag” columns, the “Elevators and

Escalators” row are overwritten, confirm that the entered values are justified. (The over-written defaults are shown in brown font.) See #6 in the [Types of Review Checks](#) section for the default values.

3. Question results if the difference between the modeled elevator EUI and the benchmark EUI is outside the set limits. Focus on the following
 - a. Proposed EUI that significantly lower than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly optimistic elevator energy use in the proposed design.
 - b. Baseline/budget EUI that is significantly higher than the benchmark is of especial concern as it may indicate inappropriate simulation assumptions or modeling mistakes that result in overly inefficient/lenient elevator energy use in the baseline/budget design.

Projects that have more stories or longer operating hours than the selected benchmark may justifiably have higher elevator energy use.

4. Common mistakes that may result in unrealistically high/low elevator energy use:
 - a) Unrealistically high/low modeled elevator runtime hours

SG20 Compliance outcome is established correctly

90.1 2016/2019 ECB

Section 11.2: The energy cost of the proposed design (design energy cost) must not exceed the energy cost budget. Both the design energy cost and the energy cost budget must be based on the completed simulations and may include adjustments based on exceptional calculation methods.

90.1 2022 ECB

Section 12.2: The energy cost of the proposed design (design energy cost) must not exceed the energy cost budget adjusted for the energy credits required (ECreq) for the building in accordance with Section 11.5.1 and adjusted for if the project includes additions or alterations. See the equation shown below for clarity. Both the design energy cost and the energy cost budget must be based on the completed simulations and may include adjustments based on exceptional calculation methods.

Design Energy Cost \leq Energy Cost Budget x [1 - ECreq/1000 x Aadj]

Aadj = where the project includes additions or alterations use an adjustment factor as follows; otherwise use 1.0: (Addition Gross Floor Area + Alteration Gross Floor Area)/ Modeled gross floor area

90.1 2016 and 2019 PRM

Section 4.2.1.1 c: The section includes the methodology for calculating the Performance Cost Index Target (PCIt). To demonstrate compliance, the project’s Performance Cost Index (PCI) calculated as a ratio of the proposed energy cost to the baseline energy cost, must not exceed the PCIt. The PCIt calculation requires separating the baseline energy cost into the baseline building regulated energy cost (BBREC) and the baseline building unregulated energy cost (BBUEC) components. Regulated energy cost is calculated by multiplying the total baseline energy cost by the ratio of the regulated energy use to the

total energy use for each fuel type. Unregulated energy cost is calculated by subtracting regulated energy cost from total energy cost.

Section 3: regulated energy use is defined as energy used by building systems and components with requirements prescribed in Sections 5 through 10. This includes energy used for HVAC, lighting, service water heating, motors, transformers, vertical transportation, refrigeration equipment, computer-room cooling equipment, and other building systems, components, and processes with requirements prescribed in Sections 5 through 10.

90.1 2022 PRM

Section 4.2.1.1 c has requirements similar to Section 4.2.1.1 c summarized above with some new additions including that the PCIt calculation requires accounting for the prescriptive on-site renewable energy requirements in Section 10.5.1.1; alterations that meet the criteria in Section G3.1.4(a) apply a multiplier of 1.05 to the building performance factors (BPFs) in 90.1 Table 4.2.1.1 when determining PCIt; and all other alterations (i.e., Minor alterations) subject to 90.1 Section G3.3 use BPF = 1 instead of the BPFs in 90.1 Table 4.2.1.1 when determining PCIt.

Review Tips

Energy Cost Budget Method

90.1 2016 and 2019

1. The calculation is automated in the Compliance Calculations tab of the Compliance Form based on the simulation results for the budget and proposed design.

90.1 2022

1. The compliance calculation is automated on the Compliance Calculations tab in the Compliance Form based on the simulation results for the budget and proposed design. However, submitters need to populate the project’s energy credit requirements per Section 11.5.1. Table 6 on the Compliance Calculations tab in the Compliance Form is designed to facilitate this process and for submitters to report the required energy credits. Many values in Table 6 auto populate, manual overrides are shown in bold orange, review the explanation in the “Reason(s) for Overridden Energy Credit Requirements/Adjustments” for validity if manual overrides have been made.

Table 6: Energy Credit Requirements for Prescriptive Compliance

Instructions:
 1. Enter the horizontal projection of available roof area (R_A) to determine the PV Availability Adjustment Factor used in ASHRAE 90.1 Equation 11.5.1.
 2. Verify that all energy credit requirements and adjustments have populated correctly in columns R.V. Override autopopulated values in the table below as needed and provide an explanation for overrides in the notes column.

Horizontal Projection of Available Roof Area (R_A) 1,000
 PV Availability Adjustment Factor 0.542

Building Area Type(s)	Conditioned Floor Area, ft ²		Semi-Heated and Unconditioned Floor Area, ft ²						Total Conditioned Core and Shell Floor Area, ft ²	Total Conditioned Addition+ New Construction Floor Area, ft ²	Total Conditioned Alteration that Meets 90.11.1.4.1 Floor Area, ft ²	Is the Conditioned Alteration Area an Initial Build-Out?	Base Energy Credit Requirement for Conditioned Floor Area	Energy Credit Requirement for Unconditioned and Semiheated Areas per 11.5.1d	Energy Credit Adjustments to Conditioned Floor Area Credits			Energy Credit Requirement	Reason(s) for Overridden Energy Credit Requirements/Adjustments
	New Construction, Excluding Additions	Addition	Alteration that Meets 90.11.1.4.1	Alteration that Does Not Meet 90.11.1.4.1	New Construction, Excluding Additions	Addition	Alteration that Meets 90.11.1.4.1	Alteration that Does Not Meet 90.11.1.4.1							11.5.1b Credit Req.	11.5.1c Credit Req.	11.5.1e Credit Adjustment		
Multifamily	74,365	0	10,000	0	0	0	0	0	74,365	10,000	No	48	14	100%	94%	7	38		
Retail	0	24,750	0	0	0	0	0	0	24,750	0	No	50	14	100%	100%	4	46		
Area - Weighted Average Credit Requirement															40				
Section 12.2 A ₉₉															0.995				
Energy Credit Requirement w/ Section 12.2 A ₉₉															40				

Performance Rating Method

90.1 2016, 2019 and 2022

1. The PCI and PCI_t calculations are automated in the Compliance Calculations tab of the Compliance form based on the simulation results for the baseline and proposed design. However, the compliance outcome is strongly influenced by whether the baseline energy cost is properly separated into regulated (BBREC) and unregulated (BBUEC) components, thus the review should focus on verifying that the regulated versus unregulated loads are identified correctly on the Compliance Calculations tab.
2. Reporting regulated load as unregulated makes Appendix G less stringent. Review Table 2 of the Compliance Tab to verify that regulated loads are not erroneously listed as unregulated. The table has default regulated/unregulated assignments for common end uses. Review any over-written defaults (these will be shown in brown font in the “Unregulated?” column of the table). Below are examples of loads unregulated loads.
 - Transformers except low-voltage dry-type transformers included in Section 8.4.4.
 - Plug-in equipment including but not limited to residential kitchen appliances, consumer and office electronic systems.
 - Industrial process equipment with no requirements in 90.1.
 - Lighting subject to the exceptions 90.1 Section 9.1.1 including the emergency lighting that is automatically off during normal building operation, lighting that is specifically designated as required by a health or life safety statute, ordinance, or regulation and decorative gas lighting systems.
3. Common mistakes involving reporting regulated loads as unregulated include the following:
 - a. Elevator energy is included in the unregulated “Misc. Equipment” category instead of being separately reported as a regulated load under “Elevators and escalators” end use.
 - b. Parking garage fans are not reported as regulated load in the “Fans - parking garage” end use. (Such fans have requirements in Section 6.4.3.4.5 and must thus be treated as regulated.)
 - c. Energy use of miscellaneous motors covered in 90.1 Section 10 is included under unregulated “Misc. Equipment” category instead of being treated as regulated. (Projects can get credit for exceeding the required efficiency in accordance with Table G3.1 #12.)

Utility Rate (UR)

Overview of the Utility Rate Checks

Utility Rate checks verify that utility rates from the approved source were used for all applicable fuels, that the required supporting information is included in the submittal, and that modeling inputs and outputs reflect the reported rate structure. Table 4 summarizes the checks included in the Utility Rates section. This group of checks may be skipped if project documents compliance using unit other than energy cost, such as site or source energy or emissions, which may be allowed by some rating authorities and jurisdictions.

Table 4: Utility Rates Checks Overview

	Type of Check	Proposed Design	Baseline/ Budget Design
Utility Rates	CF inputs reflect design documents	UR01	NA
	Simulation outputs consistent with CF	UR02	UR02
	Simulation inputs consistent with CF	UR03	UR03
LEGEND			
PASS/FAIL/NA outcome is determined automatically in the Quality Control Checks tab of the Compliance Form			

UR01 The utility rate for electricity, natural gas and other applicable energy sources are based on the approved source

90.1 2016 and 2019/2022 ECB

11.4.3.2/12.4.3.2: The rates for purchased energy (such as electricity, gas, oil, propane, steam and chilled water) must be approved by the AHJ.

90.1 2016 and 2019/2022 PRM

Section G2.4.2: Either the actual rates for purchased energy or state average energy prices published by U.S. Energy Information Administration (EIA) for commercial building customers may be used, but rates from different sources may not be mixed in the same project.

Review Tips

1. All fuels applicable to the baseline/budget or proposed design must be listed on the Energy Sources tab of the Compliance Form. Table 1 includes the list of fuels and description of utility rates for each.

Energy Type	Energy Consumption Units	Demand Units	Utility Rate Type
Electricity	kWh	kW	Fixed Rates per unit of consumption
Natural Gas	therm	kBtu/hr	Fixed Rates per unit of consumption

The fee structures for each fuel is further described in Tables 2-4 of the Energy Sources tab. Table 2 is used for reporting rates that have uniform charges, Table 3 for time of user charges, Table 4 for block charges. These tables also list Source of Data for each rate which may include Actual Rates, EIA Rates or Other.

Energy Type	Energy Consumption Units	Demand Units	Season 1					Source of Data
			Start Date	End Date	Monthly Meter Charge [\$/Month]	\$/Unit Demand	\$/Unit Energy	
Electricity	kWh	kW	Jan-01	Dec-31	\$25.0	n/a	\$0.138	Actual Rates
Natural Gas	therm	kBtu/hr	Jan-01	Dec-31	\$32.0	n/a	\$1.131	Actual Rates

2. With the EIA option, the most recent annual average rates for electricity and natural gas published at the EIA website should be used. These rates are readily available and are simple usage charges such as \$/kWh.
3. The actual rates may be more challenging to establish for a new construction project, as several different rate classes and choice of electricity suppliers may apply. The actual rates may also be harder to model as they often include block charges, time of use charges, demand charges, ratchet clauses, etc. However, using the actual rates makes models more representative of the post-occupancy energy costs and allows capturing impact of electricity demand and time of use on compliance. If actual utility rates are used on the project, the supporting information should be included in the submittal (Submittal Checklist #7), such as rate description from the utility company.

The United Illuminating Company			
General Service Time-of- Day Rate GST			
<i>Applies throughout the Company's Service Area.</i>			
Availability:			
Service under this rate is optional for all requirements on a Customer's Premises, subject to the availability of metering equipment.			
Transmission Charge (Non Demand)			
		On- Peak	Off-Peak
Winter:	Jan. – May	6.0172¢/kWhr	0.0000¢/kWhr
	Oct. – Dec.	6.0172¢/kWhr	0.0000¢/kWhr
Summer:	June – Sept.	7.5215¢/kWhr	0.0000¢/kWhr
Transmission Charge (Demand)			
		On-Peak	Off-Peak
Winter:	Jan. – May	\$ 6.97/kW	\$0.00/kW
	Oct. – Dec.	\$ 6.97/kW	\$0.00/kW
Summer:	June – Sept.	\$ 8.71/kW	\$0.00/kW
Distribution Charges:			

UR02 The difference between the average (virtual) modeled budget/baseline and proposed utility rates for electricity, natural gas and other applicable energy sources are as expected.

Review Tips

1. Background

The average annual rate, often referred to as the virtual rate, is calculated for each fuel as the ratio of the annual fuel consumption to the annual fuel cost. For example, if the simulation output reports show that the baseline annual electricity use was 509,150 kWh and the annual electricity cost was \$76,370, the virtual electricity rate is $\$76,370 / 509,150\text{kWh} = 0.15 \text{ \$/kWh}$.

For projects that used EIA rates or the actual rates with fixed usage charges (e.g. \$/kWh, \$/Therm) and no demand, time of use, or block charges, the virtual rate is expected to be the same for the budget/baseline and the proposed design and match the rate reported on the Energy Sources tab of the Compliance Form. For projects that use more complex utility rate structures, virtual rates may differ between the budget/baseline and proposed design. For example, the virtual electricity rate for

the proposed design may be lower than for the budget (baseline) design if the proposed design reduces the peak demand and the modeled electricity rates include demand charges.

2. Virtual utility rates for the budget/baseline and proposed design that are not equal for projects with simple utility rate structures or differ by more than 5% for projects with complex utility rate structures, should be flagged.

UR03 The modeled utility rates for electricity, natural gas and other fuels applicable to the project are as reported in the Compliance Form and are the same in the baseline/budget and proposed design model.

Review Tips

1. Review simulation input and output reports to confirm that the utility rate structure described in the submittal was properly modeled. This QC check should be performed if UR02 check fails or instead of UR02.

eQUEST Reports	ES-D, ES-E, ES-F
Trane TRACE 700	Library Members entered values report Utility rates section for utility rate input, Monthly Energy Consumption and Monthly Utility Cost reports for consumption and cost output
Trane TRACE 3D Plus	Site Consumption Summary report for energy consumption for each fuel and Economic and Life Cycle Costs Summary report for consumption costs for each fuel
IESVE SOFTWARE	Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report, ASHRAE 90.1-2016 PCI Report
EnergyPlus	eplustbl.html 'Tariff Report' report
OpenStudio	
Carrier HAP v5	"Electric Rate Inputs", "Fuel Rate Inputs" reports. Virtual rate found on "Billing Details" report, generated by energy or fuel source.
Design Builder	Utility:Tariffs sections in Input Data file (.idf)

Building Envelope (BE)

Overview of the Building Envelope Checks

Building Envelope group of checks addresses above and below grade walls and floors, roof, fenestration, infiltration, building orientation and exterior and interior shading. Table 5 summarizes the checks included in this group.

For 90.1 2022 PRM alterations subject to G3.3 (i.e., Minor alterations), the summary tables on the Quality Control Checks tab in the Compliance Form may not reflect correct values for the baseline since projects, for the most part, only enter proposed design information and provide notes as to what was modeled in the baseline in the notes fields associated with the proposed design related tables. Refer to the [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) section for more information regarding 90.1 2022 G3.3.

Table 5: Building Envelope Checks Overview

	Check Type	Proposed Design	Baseline/Budget Design
Above-grade wall	CF inputs reflect design documents	BE01-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	BE01-B
	Simulation inputs consistent with CF	BE06-P	BE06-B
	Simulation outputs consistent with CF	BE19	BE19
Below-grade Walls	CF inputs reflect design documents	BE02-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	BE02-B
	Simulation inputs consistent with CF	BE07-P	BE07-B
	Simulation outputs consistent with CF	BE19	BE19
Roof	CF inputs reflect design documents	BE03-P, BE11-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	BE03-B, BE11-B
	Simulation inputs consistent with CF	BE08-P, BE12-P	BE08-B, BE12-B
	Simulation outputs consistent with CF	BE19	BE19
Exterior Floor	CF inputs reflect design documents	BE04-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	BE04-B
	Simulation inputs consistent with CF	BE09-P	BE09-B
	Simulation outputs consistent with CF	BE19	BE19
Slab-on Grade	CF inputs reflect design documents	BE05-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	BE05-B
	Simulation inputs consistent with CF	BE10-P	BE10-B
	Simulation outputs consistent with CF	BE19-P	BE19
Fenestration	CF inputs reflect design documents	BE13-B, BE15-B	NA
	CF inputs reflect requirements of ECB/PRM	NA	BE13-P, BE15-P
	Simulation inputs consistent with CF	BE14-P, BE16-P	BE14-B, BE16-B
	Simulation outputs consistent with CF	BE19	BE19
Infiltration	CF inputs reflect design documents	BE17-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	BE17-B
	Simulation inputs consistent with CF	BE18-P	BE18-B
	Simulation outputs consistent with CF	BE19	BE19
Orientation	CF inputs reflect design documents	BE20-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	BE20-B
	Simulation inputs consistent with CF	BE21-P	BE21-B
Interior/Exterior Shading	CF inputs reflect design documents	BE22-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	BE22-B
	Simulation inputs consistent with CF	BE23-P	BE23-B
All Components	CF inputs reflect requirements of ECB/PRM	BE24-P	NA
LEGEND			
PASS/FAIL/NA outcome is determined automatically in the Quality Control Checks tab of the Compliance Form			

The following strategies may be used to prioritize the review:

1. Checks related to slab on grade floors and below grade walls are more important for low-rise buildings (e.g., 5 floors or less) where HVAC energy use is envelope-dominated such as in multifamily, hotels, motels, dormitories and schools. For other types of projects, it may be spot-checked or skipped.
2. Focus on verifying constructions that account for the largest surface area and spot-check the rest. For these selected constructions, perform all types of checks listed in Table 5. To facilitate prioritization based on surface area, the Quality Control Checks tab of the Compliance Form includes a table showing the three constructions accounting for the largest area within each surface type (exterior wall, roof, floor, etc.)
3. The review of fenestration should similarly focus on window products accounting for the largest area. Refer to the table on the Quality Control Checks tab, Building Envelope section for the fenestration types sorted by area.
4. Roof and exterior wall reflectance has a higher impact in cooling-dominated climates such as Climate Zones 0-4 and may be spot-checked or skipped for projects in other climate zones.
5. Interior and exterior shading has a higher impact in cooling-dominated climates such as Climate Zones 0-4 and may be spot-checked or skipped for projects in other climate zones.

BE01-B Thermal properties of the baseline/budget above-grade walls are established correctly.

See BE05-B for section references and review tips as they are analogous for all opaque assemblies.

BE02-B Thermal properties of the baseline/budget below-grade walls are established correctly.

See BE05-B for section references and review tips as they are analogous for all opaque assemblies.

BE03-B Thermal properties of the baseline/budget roof are established correctly.

See BE05-B for section references and review tips as they are analogous for all opaque assemblies.

BE04-B Thermal properties of the baseline/budget exterior floors are established correctly.

See BE05-B for section references and review tips as they are analogous for all opaque assemblies.

BE05-B Thermal properties of the baseline/budget slab-on-grade floor are established correctly.

90.1 2016 and 2019 ECB

Table 11.5.1#5a, Column B: The opaque assemblies, such as roof, floors, doors and walls must be modeled with the same heat capacity (the same construction) as the proposed building design and the U-factors in 90.1 Section 5.5 for new buildings or additions and 90.1 Section 5.1.3 (5.1.4 in 90.1 2022) for alterations. When trade-offs are made between an addition and an existing building as described in the exception to Section 4.2.1.2, the envelope in the budget building design must reflect existing conditions

prior to any retrofits that are part of the permit. Unconditioned envelope components must be modeled with the same properties as specified in the proposed design.

90.1 2022 ECB

12.5.1 #5a, Column B has similar requirements to Table 11.5.1#5a, Column B described above. However, 90.1 2022 specifically includes requirements for adjusting above grade wall U-factors in the budget model to account for linear thermal bridges and point thermal bridges. **12.5.1 #5b, Column B:** Where linear thermal bridges and point thermal bridges, as identified in Sections 5.5.5.1 through 5.5.5.5, are included in the proposed design, they must be modeled by adjusting the U-factor of the parent assembly in accordance with the default values in Section A10. If the proposed design does not have linear thermal bridges and point thermal bridges, as identified in Sections 5.5.5.1 through 5.5.5.5, they do not have to be modeled in the budget building design. If the balcony length in the proposed design exceeds the maximum allowed by Sections 5.5.5.2.2, the area must be reduced proportionally for each balcony until the limit set in Sections 5.5.5.2.2 is met.

90.1 2016 and 2019 PRM

Table G3.1 #5, Baseline Building Performance column: Opaque assemblies of new buildings, existing buildings, or additions shall conform with assemblies detailed in 90.1 Appendix A and match the appropriate assembly maximum U-factors in 90.1 Tables G3.4-1 through G3.4-8:

- Roofs—Insulation entirely above deck (90.1 Section A2.2).
- Above-grade walls—Steel-framed (90.1 Section A3.3).
- Below-grade walls—Concrete block (90.1 Section A4).
- Floors—Steel-joist (90.1 Section A5.3).
- Slab-on-grade floors shall match the F-factor for unheated slabs from the same tables (90.1 Section A6).

Unconditioned envelope components must be modeled in the baseline with the same properties as specified in the proposed design.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Requirements are similar to 90.1 2016 and 2019 PRM requirements described above. An addition is that the process of establishing the space conditioning category was clarified in 90.1 2022. **Table G3.1 #5b, Baseline Building Performance column:** Space conditioning categories used to determine applicability of the envelope requirements in Tables G3.4-1 through G3.4-8 shall be the same as in the proposed design.

Exception: Envelope components of the HVAC zones that are semiheated in the proposed design must meet conditioned envelope requirements in Tables G3.4-1 through G3.4-8 if, based on the sizing runs, these zones are served by a baseline system with sensible cooling output capacity ≥ 5 Btu/h·ft² of floor area, or with heating output capacity greater than or equal to the criteria in Table G3.4-9, or that are indirectly conditioned spaces.

G3.3 Minor Alterations

The opaque assemblies included in the scope of retrofit for alterations subject to 90.1 2022 G3.3 (i.e., minor alterations not meeting G3.1.4a) shall be modeled with U-factors meeting the requirements in Section 5.1.4 (see [errata sheet for ANSI/ASHRAE/IES STANDARD 90.1-2022](#) for correction from 5.1.3 to 5.1.4) as prescribed in 90.1 Section G3.3.2.3.

Review Tips

1. Baseline/budget assembly U/F/C factors are auto populated in Table 1 of the Envelope Areas tab of the Compliance Form based on the space conditioning categories specified by the user. Thus, the review should focus on verifying that the building envelope conditioning categories are established correctly, with the focus on the above-grade exterior walls that account for the greatest area. (The ranking of exterior walls by area is shown in the Quality Controls Checks tab, Building Envelope (BE) area. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

Modeled Construction Name	New, Existing to Remain, or Retrofitted	Building Area Type (for Appendix G Projects Only, 90.1 Section G3.1.1-1)	Orientation	Building Envelope Conditioning Category	Proposed Design			Assembly U/F/C Factor	Baseline Design		ASHRAE 90.1 Prescriptive Requirement	
					Net Area, ft ²	Plans / Specs	Software Reports		Solar Reflectance/ Thermal Emittance	Solar Reflectance/ Thermal Emittance	Assembly U/F/C Factor per 90.1 Tables 5.5-1 through 5.5-8	Solar Reflectance/ Thermal Emittance
SOGFL		Other	Horizontal	Residential	8,436	A-301		F-0.73			F-0.52	
AGW1		Other	North	Residential	3,606	A-301		U-0.064		0.25/0.9	U-0.064	n/a
AGW1		Other	East	Residential	9,881	A-301		U-0.064		0.25/0.9	U-0.064	n/a
AGW1		Other	South	Residential	3,606	A-301		U-0.064		0.25/0.9	U-0.064	n/a
AGW1		Other	West	Residential	9,881	A-301		U-0.064		0.25/0.9	U-0.064	n/a
AGW2		Retail (stand alone)	North	Nonresidential	2,498	A-302		U-0.124		0.25/0.9	U-0.064	n/a
AGW2		Retail (stand alone)	East	Nonresidential	2,736	A-302		U-0.124		0.25/0.9	U-0.064	n/a

The selection should be based on the following criteria:

- Residential surface bounds residential space and must be classified as exterior building envelope
- Nonresidential surface bounds nonresidential space and is classified as exterior building envelope
- Semiheated surface is classified as semiexterior building envelope
- All other surfaces are classified as unconditioned.

90.1 Section 3: Residential vs non-residential spaces

- Residential spaces are “spaces in buildings used primarily for living and sleeping. Residential spaces include, but are not limited to, dwelling units, hotel/motel guest rooms, dormitories, nursing homes, patient rooms in hospitals, lodging houses, fraternity/sorority houses, hostels, prisons, and fire stations.”
- All other enclosed spaces are classified as non-residential.
- Unenclosed spaces include crawlspaces, attics, and parking garages with natural or mechanical ventilation and are treated as exterior when determining applicable envelope requirements.

90.1 Section 3 and Figure 5.5.2: Exterior vs semi-exterior building envelope

- Exterior Building Envelope: the elements of a building that separate conditioned spaces from the exterior

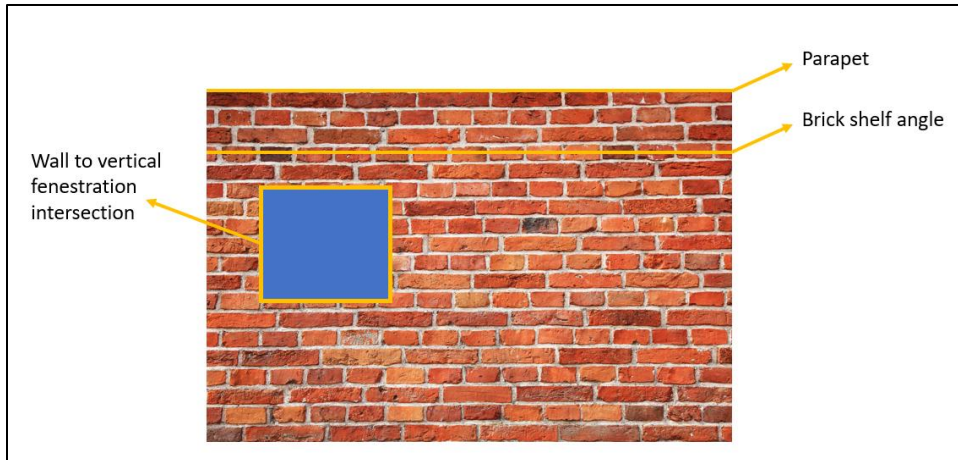
- Semiexterior Building Envelope: the elements of a building that separate conditioned space from unconditioned space or that enclose semiheated spaces through which thermal energy may be transferred to or from the exterior, to or from unconditioned spaces, or to or from conditioned spaces.
 - Spaces may be classified as conditioned (cooled, heating or indirectly conditioned), semiheated, unconditioned or unenclosed. See definition of the space in 90.1 Section 3 for more details.
 - Common examples of conditioned spaces include offices, classrooms, hotel guestrooms, etc. Common examples of semiheated spaces include storage areas.
2. For 90.1 2022 ECB projects, budget assembly U factors accounting for linear and point thermal bridging are manually entered in Table 1 of the Envelope Areas tab of the Compliance Form in the column labeled Utot. The Submittal Checklist on the Submittal+Mand Req. Checklists tab in the Compliance Form requests that the submitter provide supporting documentation/calculations in accordance with the default values in 90.1 2022 Section A10 for establishing the Utot values modeled in the budget design model. Confirm that the supporting documentation/calculations Utot values align with the values entered in Table 1 and that values were established in accordance with the default values in Section A10. Note that alterations other than additions are exempt from thermal bridging requirements according to Standard 90.1-2022 Section 5.5.5 exception #6.

Modeled Construction Name	New, Existing to Remain, or Retrofitted	Building Area Type (for Appendix G Projects Only, 90.1 Section G3.1.1-1)	Orientation	Building Envelope Conditioning Category	Proposed Design			Budget Design			ASHRAE 90.1 Prescriptive Requirement	
					Net Area, ft ²	Plans / Specs	Software Reports	Assembly U/F/C-Factor (Populates Uclearfield for AGWs)	Utot	Solar Reflectance/Thermal Emittance	Assembly U/F/C-Factor per 90.1 Tables 5.5-1 through 5.5-8	Solar Reflectance/Thermal Emittance
SOGFL	New	Other	Horizontal	Residential	8,436	A-301		F-0.52	n/a	n/a	F-0.52	n/a
AGW1	New	Other	North	Residential	3,606	A-301		U-0.064	0.100	0.3/0.9	U-0.064	n/a
AGW1	New	Other	East	Residential	9,881	A-301		U-0.064	0.100	0.3/0.9	U-0.064	n/a
AGW1	New	Other	South	Residential	3,606	A-301		U-0.064	0.100	0.3/0.9	U-0.064	n/a
AGW1	New	Other	West	Residential	9,881	A-301		U-0.064	0.100	0.3/0.9	U-0.064	n/a
AGW2	New	Retail (stand alone)	North	Nonresidential	2,498	A-302		U-0.064	0.100	0.3/0.9	U-0.064	n/a
AGW2	New	Retail (stand alone)	East	Nonresidential	2,736	A-302		U-0.064	0.100	0.3/0.9	U-0.064	n/a

Example BE05-B

(This specific example applies to 90.1 2022 ECB budget designs only)

A 33,000 square foot, 4-story multifamily building includes thermal bridging due to brick shelf angle cladding support, a parapet that follows the entire perimeter of the roof, and wall to vertical fenestration intersections. Below is a high-level graphical depiction showing the location of these thermal bridges. The length of the parapet would equal the perimeter of the building since it runs along the edge of the roof, the brick shelf angles run continuously along the perimeter once per floor so the total linear length would be the perimeter of the building multiplied by 4-stories, and the length of the wall to vertical fenestration would be the sum of the perimeter of each window as depicted with the yellow lines around the perimeter of the window shown in the graphic below.



The design team needs to quantify the length of each linear thermal bridge as measured on the outside surface of the building envelope (L_i) and the number of occurrences of each type of point thermal bridge (n_i). Below, outlined in red, is an example of the minimum information needed to determine the budget U-factor to model for example assembly EW-1. This process would need to be completed for all above grade wall assemblies. Project teams can use the built-in functionality in Comcheck for 90.1 2022 to complete and document these calculations.

Assembly ID	Class of Construction	Uo Proposed Design	Uo Prescriptive	Atotal
EW-1	Steel framed and metal buildings	0.055	0.064	13,294
	Thermal Bridge Type	L_i	n_i	Meets Prescriptive Requirements?
	Cladding support	1,162.0	0	Yes
	Parapet	415.0	0	No
	Wall to vertical fenestration intersection	1,387.2	0	Yes

The budget U_{tot} is calculated using equation 90.1 2022 A10.2 which is shown directly below.

$$U_{tot} = \{[(\sum \psi_i \times L_i) + (\sum \chi_j \times n_j)] / A_{total}\} + U_o$$

Where

U_{tot} = overall thermal transmittance, including the effect of linear thermal bridges and point thermal bridges not included in the construction assembly U_o -factor, $Btu/(h \cdot ft^2 \cdot ^\circ F)$

U_o = clear-field thermal transmittance of the construction assembly as determined from 90.1 2022 Tables 5.5, 0-8 based on the proposed design assembly type, $Btu/(h \cdot ft^2 \cdot ^\circ F)$

A_{total} = total opaque projected surface area of the construction assembly, ft^2

ψ_i = psi-factor, thermal transmittance for each type of linear thermal bridge from 90.1 2022 Table A10.1 "Default" column, $Btu/(h \cdot ft \cdot ^\circ F)$

- Li = length of a particular linear thermal bridge as measured on the outside surface of the building envelope, ft
- χ_i = chi-factor, thermal transmittance for each detail type of point thermal bridge from 90.1 2022 Table A10.1 “Default” column, Btu/(h·°F)
- ni = number of occurrences a particular type of point thermal bridge

Below, outlined in red, shows the Psi-factor from both the Unmitigated column and the Default column from 90.1 2022 Table A10.1 (left value is unmitigated and right is default). The chi-factors are not shown because they are not applicable to the thermal bridging types shown in the table.

Assembly ID	Class of Construction	Uo Proposed Design	Uo Prescriptive	Atotal	
EW-1	Steel framed and metal buildings	0.055	0.064	13,294	
	Thermal Bridge Type	Li	ni	Meets Prescriptive Requirements?	Unmitigated/ Default Psi-Factor, Btu/(h·ft·°F) per Table A10.1
	Cladding support	1,162.0	0	Yes	0.314/0.217
	Parapet	415.0	0	No	0.289/0.151
	Wall to vertical fenestration intersection	1,387.2	0	Yes	0.262/0.112

Using equation A10.2 the Utot required to be modeled in the budget design model is calculated as follows:

$$U_{tot} \text{ budget for EW-1} = 0.064 + [(1,162 \text{ ft} * 0.217 \text{ Btu}/(\text{h}\cdot\text{ft}\cdot^\circ\text{F})) + (415 \text{ ft} * 0.151 \text{ Btu}/(\text{h}\cdot\text{ft}\cdot^\circ\text{F})) + (1,387.2 \text{ ft} * 0.112 \text{ Btu}/(\text{h}\cdot\text{ft}\cdot^\circ\text{F}))]/13,294 \text{ ft}^2 = 0.064 + 0.0353 = 0.099 \text{ Btu}/(\text{h}\cdot\text{ft}^2\cdot^\circ\text{F})$$

Below is an example format for complete documentation/supporting calculations. These calculations would need to be submitted for each above grade wall assembly. The chi-factors are not shown because they are not applicable to the thermal bridging types shown in the table. For this review check the proposed design related columns can be ignored. Project teams can use the built-in functionality in Comcheck for 90.1 2022 to complete and document these calculations.

						Calculated per Equation 90.1 2022 A10.2	
Assembly ID	Class of Construction	Uo Proposed Design	Uo Prescriptive	Atotal	Utot Proposed Using Actual Default or Unmitigated Psi and Chi Factors	Utot Budget using Default Values Only and Uo Prescriptive	
EW-1	Steel framed and metal buildings	0.055	0.064	13,294	0.095	0.099	
	Thermal Bridge Type	Li	ni	Meets Prescriptive Requirements?	Proposed Design Psi-Factor, Btu/(h-ft ² ·°F) per Table A10.1	Unmitigated/ Default Psi-Factor, Btu/(h-ft ² ·°F) per Table A10.1	
	Cladding support	1,162.0	0	Yes	0.217	0.314/0.217	
	Parapet	415.0	0	No	0.289	0.289/0.151	
	Wall to vertical fenestration intersection	1,387.2	0	Yes	0.112	0.262/0.112	

For this review check spot check the calculations for alignment with 90.1 2022 equation A10.2 and compare Li and ni inputs to design documents to ensure they have been captured correctly in the calculations.

Common Mistakes

- Floors of conditioned spaces adjacent to garages must be treated as exterior surfaces when establishing the baseline floor U-value, as garages are considered un-enclosed spaces.
- Treating the envelope of residential spaces in non-residential buildings as non-residential envelope. For example, even though hospitals are considered non-residential building type, patient rooms are used primarily for living and sleeping, and are thus residential spaces.

BE01-P Thermal properties of the exterior walls in the proposed design are established correctly.

90.1 2016 and 2019 ECB

Table 11.5.1 #5 Column A

All components of the building envelope in the proposed design must be modeled as shown on architectural drawings or as installed for existing building envelopes. Any building envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) need not be separately described. If not separately described, the area of a building envelope assembly must be added to the area of the adjacent assembly of that same type.

90.1 2022 ECB

Requirements of Table 12.5.1 #5 Column A are similar to Table 11.5.1 #5 Column A above except for the addition of the following.

All linear thermal bridge and point thermal bridge as identified in Section 5.5.5 must be modeled using either of the following techniques:

- Separate model of each of these assemblies within the energy simulation model.
- Adjustment of the clear-field U-factor in accordance with Section A10.2.

All uninsulated assemblies (e.g., projecting balconies, perimeter edges of intermediate floor slabs, concrete floor beams over parking garages, roof parapet) must be separately modeled using either of the following techniques:

- Separate model of each of these assemblies within the energy simulation model.
- Separate calculation of the U-factor for each of these assemblies. The U-factors of these assemblies are then averaged with larger adjacent surfaces using an area-weighted average method. This average U-factor is modeled within the energy simulation model.

90.1 2016 and 2019 PRM

Table G3.1 #5 (a), Proposed Building Performance column

All components of the building envelope in the proposed design must be modeled as shown on architectural drawings or as built for existing building envelopes.

All uninsulated assemblies (e.g., projecting balconies, perimeter edges of intermediate floor slabs, concrete floor beams over parking garages, roof parapet) must be separately modeled using either of the following techniques:

- Separate model of each of these assemblies within the energy simulation model.
- Separate calculation of the U-factor for each of these assemblies. The U-factors of these assemblies are then averaged with larger adjacent surfaces using an area-weighted average method. This average U-factor is modeled within the energy simulation model.

Any other building envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) need not be separately described, provided that it is similar to an assembly being modeled. If not separately described, the area of a building envelope assembly must be added to the area of an assembly of that same type with the same orientation and thermal properties.

90.1 2022 PRM

Requirements are similar to 90.1 2016 and 2019 PRM Table G3.1 #5 (a), Proposed Building Performance column requirements above except for the addition of the following.

All linear thermal bridge and point thermal bridge as identified in Section 5.5.5 must be modeled using either of the following techniques:

- Separate model of each of these assemblies within the energy simulation model.
- Adjustment of the clear-field U-factor in accordance with Section A10.2.

Review Tips

1. Locate constructions selected for the review in the design documents based on the reference provided for that construction in the Plans/Specs column of Table 1 in the Proposed Envelope Assemblies tab of the Compliance form (note that some columns may be hatched out and table headings may vary depending on the applicable version of 90.1 since requirements differ across vintages). Focus the review on constructions that account for the highest wall area, as shown in the table in the Building Envelope (BE) section of the Quality Control Check tab.

Modeled Construction Name	Surface Type	Construction Type Legend: AGW = Above Grade Wall	Detailed Description	Rated R-Value of Cavity Insulation	Rated R-Value of Continuous Insulation	Effective U/F/C-Factor of Insulation Based on 90.1 App A	Total R-value of Materials in Addition to Cont. and Cav. Insulation (If Any)	Uclearfield Applies to Above Grade Walls Only	Techn
SOGFL	Slab-On-Grade Floor	Unheated	Unheated - Fully insulated slab	0	15	F-0.300, Table A6.3.1-1	n/a	n/a	
Roof1	Roof	Insulation Entirely above Deck	Insulation Entirely above Deck	0	39	U-0.026, Table A2.2.3	n/a	n/a	
AGW1	Above-Grade Exterior Wall	Steel-Framed	16 Inch on Center with a 6.0 Inch Depth (Steel-Frame)	19	8.5	U-0.057, Table A3.3.3.1	n/a	0.057	Ad

- Verify that the description of the construction provided in the table reflects design documents. The location in the design documents where construction is described is included in the last column of Table 1 in the Proposed Envelope Assemblies tab of the Compliance Form shown above.
- Verify that the value reported in “Modeled U/C/F-factor Including Int. and Ext. Air Film” is established correctly. (See Common Mistakes section.)

For 90.1 2022 PRM and ECB projects, the proposed assembly U factors are required to account for linear and point thermal bridging, so Uclearfield needs to be derated and the resultant derated U-factor entered in the “Modeled U/C/F-factor Including Int. and Ext. Air Film” column. Uclearfield is entered in the “Uclearfield” column. Clear-field thermal bridges (90.1 Section 3) are elements of a building envelope assembly that are distributed over the area of the assembly and addressed in determining the thermal performance of the assembly in accordance with Normative Appendix A (i.e., U-factors determined from Appendix A tables are considered Uclearfield and need to be adjusted for linear and point thermal bridging).

The Submittal Checklist on the Submittal+Mand.Req. Checklists tab in the Compliance Form requests that the submitter provide supporting documentation/calculations for the modeled U-factors that account for linear and point thermal bridging. Confirm that the supporting documentation/calculations align with the U-factor values entered in Table 1. If “Adjustment of the clear-field U-factor in accordance with Section A10.2” was selected in the “Technique to Capture Linear and Point Thermal Bridging” column, verify that values were established in accordance with Section A10.2. If “A separate model of the assembly within the energy simulation model” was selected in the “Technique to Capture Linear and Point Thermal Bridging” column, refer to Envelope Areas tab Table 1 to confirm that the reported Net Area for such assemblies is appropriate.

Example BE01-P: Project that is adjusting the clear-field U-factor in accordance with Section A10.2

See Example BE05-B for description of example project, assembly, and assembly thermal bridges. The same assembly and set of thermal bridges are used for this example.

Like in Example BE05-B, the design team needs to quantify the length of each linear thermal bridge as measured on the outside surface of the building envelope (Li) and the number of occurrences of each type of point thermal bridge (ni). Below is an example of the minimum information needed to determine the proposed U-factor to model (Utot) for example assembly EW-1. This process would need to be completed for all above grade wall assemblies. Project teams can use the built-in functionality in Comcheck for 90.1 2022 to complete and document these calculations.

Assembly ID	Class of Construction	Uo Proposed Design		Atotal
EW-1	Steel framed and metal buildings	0.055		13,294
	Thermal Bridge Type	Li	ni	Meets 90.1 5.5.5 Prescriptive Requirements?
	Cladding support	1,162.0	0	Yes
	Parapet	415.0	0	No
	Wall to vertical fenestration intersection	1,387.2	0	Yes

The proposed Utot is calculated using equation 90.1 2022 A10.2 which is shown directly below.

$$U_{tot} = \{[(\sum \psi_i \times L_i) + (\sum \chi_j \times n_j)]/A_{total}\} + U_o$$

Where

U_{tot} = overall thermal transmittance, including the effect of linear thermal bridges and point thermal bridges not included in the construction assembly U_o-factor, Btu/(h·ft²·°F)

U_o = clear-field thermal transmittance of the construction assembly as determined in accordance with Section 5, Btu/(h·ft²·°F)

A_{total} = total opaque projected surface area of the construction assembly, ft²

ψ_i = psi-factor, thermal transmittance for each type of linear thermal bridge from 90.1 2022 Table A10.1. The default column shall be used where the thermal bridge meets 90.1 Section 5.5.5 prescriptive requirements. The unmitigated column shall be used where the thermal bridge does not meet the prescriptive requirements., Btu/(h·ft·°F)

L_i = length of a particular linear thermal bridge as measured on the outside surface of the building envelope, ft

χ_i = chi-factor, thermal transmittance for each detail type of point thermal bridge from 90.1 2022 Table A10.1. The default column shall be used where the thermal bridge meets 90.1 Section 5.5.5 prescriptive requirements. The unmitigated column shall be used where the thermal bridge does not meet the prescriptive requirements., Btu/(h·°F)

n_i = number of occurrences a particular type of point thermal bridge

The “Proposed Design Psi-Factor, Btu/(h·ft·°F) per Table A10.1” column in the graphic below shows the Psi-factor used in the calculation of U_{tot} for the proposed design for this example assembly. This is determined based on whether the specified thermal bridging mitigation techniques (if any are specified) meet the prescriptive requirements in 90.1 Section 5.5.5. If the specified thermal bridging mitigation techniques do not meet prescriptive requirements, then the unmitigated column in Table A10.1 must be used. For reference only, the “Unmitigated/Default Psi-Factor, Btu/(h·ft·°F) per Table A10.1” column below shows both the Unmitigated and Default columns from 90.1 2022 Table A10.1 (left value is unmitigated and right is default). The chi-factors are not shown because they are not applicable to the thermal bridging types shown in the table.

Assembly ID	Class of Construction	Uo Proposed Design		Atotal		
EW-1	Steel framed and metal buildings	0.055		13,294		
	Thermal Bridge Type	Li	ni	Meets 90.1 5.5.5 Prescriptive Requirements?	Proposed Design Psi-Factor, Btu/(h·ft·°F) per Table A10.1	Unmitigated/ Default Psi-Factor, Btu/(h·ft·°F) per Table A10.1
	Cladding support	1,162.0	0	Yes	0.217	0.314/0.217
	Parapet	415.0	0	No	0.289	0.289/0.151
	Wall to vertical fenestration intersection	1,387.2	0	Yes	0.112	0.262/0.112

Using equation A10.2 the proposed Utot required to be modeled in the proposed design model for this example assembly is calculated as follows:

$$U_{tot} \text{ proposed for EW-1} = 0.055 + [(1,162 \text{ ft} \cdot 0.217 \text{ Btu}/(\text{h}\cdot\text{ft}\cdot^\circ\text{F})) + (415 \text{ ft} \cdot 0.289 \text{ Btu}/(\text{h}\cdot\text{ft}\cdot^\circ\text{F})) + (1,387.2 \text{ ft} \cdot 0.112 \text{ Btu}/(\text{h}\cdot\text{ft}\cdot^\circ\text{F}))]/13,294 \text{ ft}^2 = 0.055 + 0.0353 = 0.095 \text{ Btu}/(\text{h}\cdot\text{ft}^2\cdot^\circ\text{F})$$

Below is an example format for complete documentation/supporting calculations. These calculations would need to be submitted for each above grade wall assembly. The chi-factors are not shown because they are not applicable to the thermal bridging types shown in the table. Project teams can use the built-in functionality in Comcheck for 90.1 2022 to complete and document these calculations.

Assembly ID	Class of Construction	Uo Proposed Design		Atotal	90.1 2022 A10.2 Utot Proposed Using Actual Default or Unmitigated Psi and Chi Factors	
EW-1	Steel framed and metal buildings	0.055		13,294	0.095	
	Thermal Bridge Type	Li	ni	Meets 90.1 5.5.5 Prescriptive Requirements?	Proposed Design Psi-Factor, Btu/(h·ft·°F) per Table A10.1	Unmitigated/ Default Psi-Factor, Btu/(h·ft·°F) per Table A10.1
	Cladding support	1,162.0	0	Yes	0.217	0.314/0.217
	Parapet	415.0	0	No	0.289	0.289/0.151
	Wall to vertical fenestration intersection	1,387.2	0	Yes	0.112	0.262/0.112

Spot check the calculations for alignment with 90.1 2022 equation A10.2, compare Li and ni inputs to design documents, and verify that the project complies with prescriptive thermal bridging mitigation requirements in Section 5.5.5 where default psi and chi factors are used.

- Review architectural details drawing to identify if project includes any uninsulated assemblies such as projecting balconies, perimeter edges of intermediate floor slabs, concrete floor beams over parking garages and roof parapets (for 90.1 2022 projects many of these may already be captured as linear and/or point thermal bridges). If present, check “Modeled U/C/F-Factor Includes Uninsulated Assemblies?” column to confirm that such elements were included with the adjacent constructions with the appropriate adjustment to overall U-factor (based on area-weighted average) or reported as separate construction. If separately reported, refer to Envelope Areas tab Table 1 to confirm that the reported Net Area for such assemblies is appropriate.

5. Common Mistakes

- a. The overall assembly U-value is established without accounting for clear-field thermal bridging, as required by 90.1 Section 5.5.3. For example, a steel framed wall assembly with R-13 insulation in the 16” on center steel framing cavity and R-3 continuous insulation must be reported as U-0.091.

TABLE A3.3.3.1 Assembly U-Factors for Steel-Frame Walls

Framing Type and Spacing Width (Actual Depth)	Cavity Insulation R-Value: Rated (Effective Installed [see Table A9.2B])	Overall U-Factor for Entire Base Wall Assembly	Overall U-Factor for Assembly of Base Wall Plus Continuous Insulation (Uninterrupted by Framing)													
			Rated R-Value of Continuous Insulation													
			R-1.00	R-2.00	R-3.00	R-4.00	R-5.00	R-6.00	R-7.00	R-8.00	R-9.00	R-10.00	R-11.00	R-12.00	R-13.00	R-14.00
Steel Framing at 16 in. on Center																
3.5 in. depth	None (0.0)	0.352	0.260	0.207	0.171	0.146	0.128	0.113	0.102	0.092	0.084	0.078	0.072	0.067	0.063	0.060
	R-11 (5.5)	0.132	0.117	0.105	0.095	0.087	0.080	0.074	0.069	0.064	0.060	0.057	0.054	0.051	0.049	0.047
	R-13 (6.0)	0.124	0.111	0.100	0.091	0.083	0.077	0.071	0.066	0.062	0.059	0.055	0.052	0.050	0.048	0.046
	R-15 (6.4)	0.118	0.106	0.096	0.087	0.080	0.074	0.069	0.065	0.061	0.057	0.054	0.051	0.049	0.047	0.045

- b. For tapered roof insulation, the U-value should be based on the area-weighted average R-Value for the varying insulation thickness (see Standard 90.1 2016 User’s Manual Example FY1, Area Weighted Averages).
- c. For 90.1 2022 projects, failure to account for linear and point thermal bridging following the requirements for the ECB and PRM.

BE02-P Thermal properties of the proposed below-grade walls are established correctly.

Review Tips

- 1. The QC check may be skipped for projects with small below-grade wall area.
- 2. See BE01-P for additional tips.

BE03-P Thermal properties of the proposed roof are established correctly.

Review Tips

See BE01-P for additional tips.

BE04-P Thermal properties of the proposed exterior floors are established correctly.

Review Tips

- 1. Majority of projects that include garage on lower floors are expected to have this surface type as garages are typically classified as un-enclosed spaces (which is equivalent to ambient conditions for envelope compliance purposes) and the floor separating garage from conditions spaces above should be insulated appropriately.
- 2. See BE01-P for additional tips.

BE05-P Thermal properties of the proposed slab-on-grade floor are established correctly.

Review Tips

- 1. Unless a project includes a portion of the building over conditioned spaces (e.g., floors 3-10 of a building that has conditioned 2nd floor), it is expected to have exposed floors, slab-on-grade, or

below-grade walls. (Slab below grade does not have to be reported). If neither of these surfaces are included in the Compliance Form, a comment should be made to request that missing surfaces are reported in the Compliance Form and modeled.

2. See BE01-P for additional tips.

BE06-B, BE06-P Modeled U-factors and areas of the baseline/budget and proposed above-grade walls are as reported in the Compliance Form.

Review Tips

1. Use simulation reports to verify that modeled U-factors and areas of the exterior walls reflect the values reported in the Compliance Form. The reported values are located in the following tables within the Compliance Form:
 - a. Baseline/budget design: Table 1 in the Envelope Areas tab.
 - b. Proposed Design: Table 1 in the Proposed Envelope Assemblies tab.
2. Focus on constructions that account for the largest above grade wall area based on the table in the Building Envelope section of the Quality Control Checks tab.
3. Small deviations (e.g. up to 3%) between the value reported in the Compliance Form and simulation output reports may be accepted as it is often due to the contribution of the exterior air film. The prescriptive U-factors included in 90.1 Section 5 are based on the exterior air film R-values listed in 90.1 Appendix A (e.g., R-0.17 for roof constructions), while simulation tools may determine it dynamically based on the hourly weather conditions.

eQUEST Reports	LV-D
Trane TRACE 700	Building U-Values, Building Areas
Trane TRACE 3D Plus	Envelope Summary report
IESVE SOFTWARE	Room Loads Report, Zone Loads Report, System Loads Report, ModelIT Model Report, BPRM Report
EnergyPlus	eplustbl.html 'Envelope Summary' report
OpenStudio	eplustbl.html 'Envelope Summary' report
Carrier HAP v5	Surface Areas: "LEED Summary Report", Section 2 "Minimum Energy Performance Calculator", table titled "Above Grade Wall & Vertical Glazing Areas" Wall Assembly U-Value: "Wall Constructions" report.
Design Builder	Opaque Exterior Table in Output Summary Document

BE07-B, BE07-P Modeled C-factors and areas of the baseline/budget and proposed below-grade walls are as reported in the Compliance Form.

1. Use simulation reports to verify that modeled C-factors and areas of the below-grade walls reflect the values reported in the Compliance For. The reported values are located in the following tables within the Compliance Form:
 - a. Baseline/budget design: Table 1 in the Envelope Areas tab.
 - b. Proposed Design: Table 1 in the Proposed Envelope Assemblies tab.

2. Focus on constructions that account for the largest below grade wall area based on the table in the Building Envelope section of the Quality Control Checks tab.
3. The QC check may be skipped for projects with relatively small area of below-grade walls.

eQUEST Reports	LV-D
Trane TRACE 700	Building U-Values, Building Areas
Trane TRACE 3D Plus	Envelope Summary report
IESVE SOFTWARE	Room Loads Report, Zone Loads Report, System Loads Report, ModelIT Model Report, BPRM Report
EnergyPlus	eplustbl.html 'Envelope Summary' report
OpenStudio	eplustbl.html 'Envelope Summary' report
Carrier HAP v5	Wall and Roof Surface Areas: "LEED Summary Report", Section 2 "Minimum Energy Performance Calculator", table titled "Above Grade Wall & Vertical Glazing Areas" Wall Assembly U-Value: "Wall Constructions" report.
Design Builder	Opaque Exterior Table in Output Summary Document

BE08-B, BE08-P Modeled U-factors and areas of the baseline/budget and proposed roof are as reported in the Compliance Form.

1. Use simulation reports to verify that modeled U-factors and areas of the roof reflect the values reported in the Compliance For. The reported values are located in the following tables within the Compliance Form:
 - a. Baseline/budget design: Table 1 in the Envelope Areas tab.
 - b. Proposed Design: Table 1 in the Proposed Envelope Assemblies tab.
2. Focus on constructions that account for the largest roof area based on the table in the Building Envelope section of the Quality Control Checks tab.

eQUEST Reports	LV-D
Trane TRACE 700	Building U-Values, Building Areas
Trane TRACE 3D Plus	Envelope Summary report
IESVE SOFTWARE	Room Loads Report, Zone Loads Report, System Loads Report, ModelIT Model Report, BPRM Report
EnergyPlus	eplustbl.html 'Envelope Summary' report
OpenStudio	eplustbl.html 'Envelope Summary' report
Carrier HAP v5	Wall and Roof Surface Areas: "LEED Summary Report", Section 2 "Minimum Energy Performance Calculator", table titled "Above Grade Wall & Vertical Glazing Areas" Roof Assembly U-Value: "Roof Constructions" report.
Design Builder	Opaque Exterior Table in Output Summary Document

BE09-B, BE09-P Modeled U-factors and areas of the baseline/budget floor is as reported in the Compliance Form.

1. Use simulation reports to verify that modeled U-factors and areas of the floor reflect the values reported in the Compliance For. The reported values are located in the following tables within the Compliance Form:
 - a. Baseline/budget design: Table 1 in the Envelope Areas tab.
 - b. Proposed Design: Table 1 in the Proposed Envelope Assemblies tab.
2. Focus on constructions that account for the largest floor area based on the table in the Building Envelope section of the Quality Control Checks tab.

eQUEST Reports	LV-D
Trane TRACE 700	Building U-Values, Building Areas
Trane TRACE 3D Plus	Envelope Summary report
IESVE SOFTWARE	Room Loads Report, Zone Loads Report, System Loads Report, ModelIT Model Report, BPRM Report
EnergyPlus	eplustbl.html 'Envelope Summary' report
OpenStudio	eplustbl.html 'Envelope Summary' report
Carrier HAP v5	Exposed Floor Area and U-Value: "Space Input Data" report.
Design Builder	Opaque Exterior Table in Output Summary Document

BE10-B, BE10-B P Modeled F-factors and areas of the baseline/budget slab-on-grade are as reported in the Compliance Form.

1. Use simulation reports to verify that modeled U-factors and areas of the floor reflect the values reported in the Compliance For. The reported values are located in the following tables within the Compliance Form:
 - a. Baseline/budget design: Table 1 in the Envelope Areas tab.
 - b. Proposed Design: Table 1 in the Proposed Envelope Assemblies tab.
2. Focus on constructions that account for the largest floor area based on the table in the Building Envelope section of the Quality Control Checks tab.
3. The QC check may be skipped for projects involving buildings over 5 floors.

eQUEST Reports	LV-D
Trane TRACE 700	Building U-Values, Building Areas
Trane TRACE 3D Plus	Envelope Summary report
IESVE SOFTWARE	Room Loads Report, Zone Loads Report, System Loads Report, ModelIT Model Report, BPRM Report
EnergyPlus	eplustbl.html 'Envelope Summary' report
OpenStudio	eplustbl.html 'Envelope Summary' report
Carrier HAP v5	Slab on Grade, Below Grade Area and U-value: "Space Input Data" report
Design Builder	Opaque Exterior Table in Output Summary Document

BE11-B Baseline/Budget roof and above grade wall reflectance and thermal emittance are established correctly in the Compliance Form

90.1 2016 and 2019 ECB

Table 11.5.1 Column A No 5 (b).

The exterior roof surfaces shall be modeled with a solar reflectance and thermal emittance as required in Section 5.5.3.1.1(a). All other roofs, including roofs exempted from the requirements in Section 5.5.3.1.1, shall be modeled the same as the proposed design.

There is no baseline requirement for above grade walls so the solar reflectance and thermal emittance should be modeled identically in the budget and proposed design models.

90.1 2022 ECB

Table 12.5.1 Column A No 5 (b).

- The exterior roof surfaces shall be modeled with a solar reflectance and thermal emittance as required in Section 5.5.3.1.4(a). All other roofs, including roofs exempted from the requirements in Section 5.5.3.1.4, shall be modeled the same as the proposed design.
- The above-grade wall surfaces of buildings shall be modeled with a solar reflectance and thermal emittance as required in Section 5.5.3.2.2 and 5.5.3.2.2(a). All other above-grade walls, including those exempt from the requirements in Section 5.5.3.2.2, shall be modeled the same as the proposed design.

90.1 2016 and 2019 PRM

Table G3.1 #5 Baseline Building Performance (f) and (g)

- The exterior roof surfaces shall be modeled using a solar reflectance of 0.30 and a thermal emittance of 0.90.
- All roof surfaces shall be modeled with a reflectivity of 0.30.

There is no baseline requirement for above grade walls so the solar reflectance and thermal emittance should be modeled identically in the baseline and proposed design models.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Table G3.1 #5 Baseline Building Performance (h) and (i)

- The exterior roof surfaces shall be modeled using a solar reflectance of 0.30 and a thermal emittance of 0.90.
- Above-grade wall surfaces shall be modeled with a solar reflectance of 0.25 and a thermal emittance of 0.90.

G3.3 Minor Alterations

For alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations) roof and above grade wall reflectance and thermal emittance shall be modeled identically in the baseline and proposed design models since there are no applicable prescriptive or mandatory requirements in Section 5 for alterations.

Review tips

1. The related properties of the roof and above grade wall surfaces in the baseline/budget design are reported on the Envelope Areas tab Table 1. Over-written values are shown in bold brown.
2. This QC check is important for projects located in cooling-dominated climates such as Climate Zones 0-4.

BE11-P Proposed design roof and above grade wall reflectance and thermal emittance reported in the Compliance Form reflect design documents

90.1 2016 and 2019 ECB

Table 11.5.1 Column A No 5 Exception 3.

The exterior roof surface shall be modeled using the aged solar reflectance and thermal emittance determined in accordance with Section 5.5.3.1.1(a). Where aged test data are unavailable, the roof surface shall be modeled with a solar reflectance of 0.30 and a thermal emittance of 0.90.

90.1 2022 ECB

Table 12.5.1 Column A No 5 Exception 5.

- The exterior roof surface shall be modeled using the aged solar reflectance and thermal emittance determined in accordance with Section 5.5.3.1.4(a). Where aged test data are unavailable, the roof surface shall be modeled with a solar reflectance of 0.30 and a thermal emittance of 0.90.
- The above-grade wall surfaces of buildings shall be modeled with an initial solar reflectance and thermal emittance determined in accordance with the test methods identified in Section 5.5.3.2.2(a). Where initial test data are unavailable, the above-grade wall surfaces shall be modeled with a solar reflectance of 0.25 and a thermal emittance of 0.90.

90.1 2016 and 2019 PRM

Table G3.1 #5 Proposed Building Performance (a)3

The exterior roof surface shall be modeled using the aged solar reflectance and thermal emittance determined in accordance with Section 5.5.3.1.1(a). Where aged test data are unavailable, the roof surface may be modeled with a reflectance of 0.30 and a thermal emittance of 0.90.

90.1 2022 PRM

Table G3.1 #5 Proposed Building Performance (a)5 and 8

- The exterior roof surface shall be modeled using the aged solar reflectance and thermal emittance determined in accordance with Section 5.5.3.1.1(a). Where aged test data are unavailable, the roof surface may be modeled with a reflectance of 0.30 and a thermal emittance of 0.90.
- The above-grade wall surface shall be modeled using the initial solar reflectance and thermal emittance determined in accordance with the test methods identified in Section 5.5.3.2.2(a). Where initial test data are unavailable, the wall surface may be modeled with a solar reflectance of 0.25 and a thermal emittance of 0.90.

Review tips

1. Reflectance and emittance of the roof and above grade wall surfaces in the proposed design are reported in the Proposed Envelope Assemblies tab, Table 1.
2. If reported reflectance/emittance differ from the default values above, refer to design documents to confirm the entered values or ask modeler for supporting documentation.
3. This QC check is important for projects located in cooling-dominated climates such as Climate Zones 0-4.

BE12-B, BE12-P Baseline/Budget and proposed roof and above grade wall reflectance and thermal emittance are modeled as reported in the Compliance Form

Review Tip

Review simulation reports to verify that roof and above grade wall reflectance and thermal emittance values were modeled as reported in the Compliance Form.

BE13-B Fenestration area in the baseline/budget design is established correctly

90.1 2016 and 2019/2022 ECB

90.1 Table 11.5.1 #5 c/Table 12.5.1 #5 d: The budget building design must have identical exterior dimensions as the proposed design, except when the fenestration area of the new buildings or additions exceeds 40% of the gross exterior wall area, the budget fenestration area is reduced proportionally along each exposure until the total fenestration area is equal to 40%. Fenestration must be distributed on each face of the building in the same proportion as in the proposed design.

Exception: When trade-offs are made between an addition and an existing building, as described in Section 4.2.1.2.1, the budget building design shall reflect existing conditions, such as fenestration area, prior to any revisions that are part of the permit.

90.1 2016 and 2019 PRM

Table G3.1 #5 Baseline Building Performance column (c) and Table G3.1.1-1: The baseline fenestration area depends on the Building Area Type in Table G3.1.1-1. For example, a 40,000 ft² office building is modeled with the baseline vertical fenestration area equal to 31% of the gross above grade wall area. For building types not specified in Table G3.1.1-1, such as multifamily, the baseline fenestration area shall be equal to that in the proposed design or 40% of the gross above-grade wall area, whichever is smaller. Fenestration must be distributed on each face of the building in the same proportion as in the proposed design.

Exception: The fenestration area for an existing building shall equal the existing fenestration area prior to the proposed work and shall be distributed on each face of the building in the same proportions as the existing building.

90.1 2022 PRM

Table G3.1 #5 Baseline Building Performance column (e) and Table G3.1.1-1 requirements are similar to *Table G3.1 #5 Baseline Building Performance column (c) and Table G3.1.1-1* above except a clarification was added for the scenario in which distributing the vertical fenestration on each face of the building in the same proportion as in the proposed design would cause the combined vertical

fenestration and opaque door area on a given face to exceed the gross above-grade wall area on that face. In this case, then the vertical fenestration area on other faces shall be increased in proportion to the gross above-grade wall area of these faces such that the total baseline building vertical fenestration area is equal to that calculated following Table G3.1.1-1.

Review Tips

1. Baseline/budget fenestration area by exposure and building type is shown in the Envelope Areas tab Tables 3-5. The areas are automatically calculated by the Compliance Form by applying the appropriate rules of 90.1 to the project, but may be over-written by the modeler. If the default value was over-written, the input in the Fenestration Area, ft² column is shown in light brown font. Over-ride may be justified for projects involving existing buildings where the baseline/budget fenestration must reflect area prior to retrofit or where distributing the fenestration on each face of the building in the same proportion as in the proposed design would cause the combined vertical fenestration and opaque door area on a given face to exceed the gross above-grade wall area on that face. The over-written values should be commented on, to request an explanation if one has not already been provided in the notes section.
2. Based on the 90.1 Definition section, all areas (including frame) that let in lighting, such as windows, translucent plastic panels, doors that are more than one half glass and glass block walls are considered fenestration.

Example: A multifamily project with 58,000ft² gross wall area including 8,000 ft² of operable windows, 5,000 ft² of transparent glass block walls and 7,000 ft² of spandrel, has fenestration area of 8,000 ft² + 5,000 ft² = 13,000 ft² or 13,000 ft²/58,000 ft²=22% of gross exterior wall

BE13-P Fenestration area in the proposed design reported in the Compliance Form reflects design documents

90.1 2016 and 2019/2022 ECB

Table 11.5.1 No5, Column A/Table 12.5.1 No5, Column A: Fenestration area must be as shown on architectural drawings, or as installed for existing building envelopes.

90.1 2016, 2019, and 2022 PRM

Table G3.1 #5, Proposed Building Performance column: Fenestration area must be as shown on architectural drawings, or as installed for existing building envelopes.

Review Tips

1. The proposed fenestration area and the design documents where it can be found is reported in Table 2 of the Envelope Areas tab. Cross-check fenestration areas reported in the Compliance Form for representative orientations to confirm the alignment with the design documents.

Modeled Fenestration Name	New, Existing to Remain, or Retrofitted	Building Area Type (for Appendix G Projects Only, 90.1 Section G3.1.1-1)	Orientation	Building Envelope Conditioning Category	Proposed Design	
					Fenestration Area, ft ²	Plans / Specs
W1	New	Other	North	Residential	1,943	A-301
W1	New	Other	East	Residential	5,319	A-302
W1	New	Other	South	Residential	1,943	A-303
W1	New	Other	West	Residential	5,319	A-304
W2	New	Retail (stand alone)	East	Nonresidential	4,104	A-301

BE14-B, BE14-P Modeled fenestration areas for the baseline/budget and proposed design are as reported in the Compliance Form

Review Tips

1. Use simulation reports to confirm that the modeled fenestration area is as reported in the Compliance Form. The reported values are found as follows:
 Baseline/budget design: Envelope Areas tab Tables 3-5
 Proposed Design: Envelope Areas tab Table 2

eQUEST	LV-D
Trane TRACE 700	Building U-Values, Building Areas, Walls by Direction Entered Values report, Walls by Cardinal Direction entered values report
Trane TRACE 3D Plus	
IESVE SOFTWARE	Room Loads Report, Zone Loads Report, ModelIT Model Report, BPRM Report
EnergyPlus	
OpenStudio	
Carrier HAP v5	“LEED Summary” report, Section 2, “Minimum Energy Performance Calculator”, table titled “Above Grade Wall and Vertical Glazing Areas”
Design Builder	

BE15-B Baseline/budget fenestration U-factor, SHGC and VT reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.1 #5, Column B/ Table 12.5.1 #5, Column B: Fenestration U-factor and SHGC must be based on the code requirements for the appropriate climate (90.1 Tables 5.5-1 to 5.5-8). The fenestration for envelope alterations must reflect the limitations on area, U-factor and SHGC as described in 90.1 Section 5.1.3. When trade-offs are made between an addition and an existing building based on 90.1 Section 4.2.1.2.1, properties of the existing envelope in the budget building design must reflect existing conditions prior to any revisions that are part of the permit. Fenestration in unconditioned spaces must be modeled as specified for the proposed design.

90.1 2016 and 2019 PRM

Table G3.1 #5, Baseline Building Performance column (c): Vertical Fenestration Assemblies for new buildings, existing buildings and additions must have U-factors and SHGC matching the requirements for the appropriate climate zone in 90.1 Tables G3.4-1 to 3.4-8. All vertical fenestration shall be assumed to

be flush with the exterior wall and no shading projections shall be modeled. Manual window shading devices such as blinds or shades are not required to be modeled. Fenestration in unconditioned spaces must be modeled in the baseline as specified for the proposed design.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Table G3.1 #5, Baseline Building Performance column (f) requirements are the same as Table G3.1 #5, Baseline Building Performance column (c) above for the 90.1 2016 and 2019 PRM.

G3.3 Minor Alterations

Section G3.3.2.4, which applies only to alterations that do not meet the criteria in G3.1.4a (i.e., Minor alterations), prescribes that for fenestration included in the scope of the retrofit requirements are that the U-factor, SHGC, and VT shall be modeled as meeting the requirements in Section 5.1.4 (see [errata sheet for ANSI/ASHRAE/IES STANDARD 90.1-2022](#) for correction from 5.1.3 to 5.1.3).

Review Tips

1. Baseline/budget fenestration U-factor, SHGC and VT are determined automatically in the Compliance Form based on project climate zone and space conditioning category and are shown in the Envelope Areas tab Table 2. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

BE15-P Proposed fenestration properties are established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.1#5 Column A/Table 12.5.1#5 Column A: All components of the building envelope in the proposed building design must be modeled as shown on architectural drawings or as installed for existing building envelopes, except any building envelope assembly that covers less than 5% of the total area of that assembly type (e.g. vertical fenestration) need not be separately described. If not separately described, the area of that assembly must be added to the area of the adjacent assembly of that same type and the thermal and solar properties of the aggregated surface must reflect the area-weighted average.

90.1 2016, 2019, and 2022 PRM

Table G3.1 #5 Proposed Design Column (a): All components of the building envelope in the proposed building design must be modeled as shown on architectural drawings or as installed for existing building envelopes, except any building envelope assembly that covers less than 5% of the total area of that assembly type (e.g., vertical fenestration) need not be separately described. If not separately described, the area of that assembly must be added to the area of the adjacent assembly of that same type and the thermal and solar properties of the aggregated surface must reflect the area-weighted average.

Review Tips

1. Cross-check vertical fenestration products listed in Table 2 of the Proposed Envelope Assemblies tab with the design documents to confirm alignment. (The location of window schedules should be apparent from Plans/Specs reference included in this table.) Focus the review on fenestration products that account for the largest area.

2. Refer to design document referenced in Plans / Specs column for the fenestration units being reviewed to confirm that specified U-factor, SHGC and VT align with the values reported in Table 2 of the Proposed Envelope Assemblies tab.
3. Verify that the required supporting information specified to the right of Table 2 of the Proposed Envelope Assemblies tab is included in the submittal package.
4. Review supporting documentation to verify that U-factor, SHGC and VLT are established correctly using the approved method, as described below.
 - 90.1 Section 5.8.2.1 requires that the performance of the windows and other fenestration products including U-factor, SHGC, VT and air leakage rate be determined by a laboratory accredited by the National Fenestration Rating Council (NFRC) or another nationally recognized rating authority. Fenestration U-Factor must be determined in accordance with NFRC 100; SHGC and VT must be determined in accordance with NFRC 200. Other approaches, such as AMCA, are not allowed.
 - Default values from 90.1 Appendix A (e.g. 90.1 Table A8.2 for the vertical fenestration) must be used for the fenestration products for which NFRC 100 and NFRC 200 test results are not available.
 - 90.1 Section 5.8.2.2 requires that all manufactured and site-built fenestration and door products state the rated performance factors either on a label or a signed and dated manufacturer’s certificate provided with the product. If such information is not available, projects must use the defaults from 90.1 Table A8.1-1.
 - The NFRC standards referenced in 90.1 Section 5.8.2.3 require that the rated U-value takes into account properties of the entire fenestration assembly including heat loss through center of glass, edge of glass, sash and frame elements. This requirement is often overlooked for custom fenestration, with center of glass properties used in lieu of the properties of the entire assembly, which typically under-estimates fenestration U-value.
5. Confirm that Visible Light Transmittance (VLT) is provided. VLT affects savings from daylighting controls. Fenestration with lower SHGC reduces space solar heat gains (with positive impact on cooling), but often have lower VLT which reduces daylighting.

BE16-B, BE16-P Modeled U-factor, SHGC and VLT of the baseline/budget and proposed fenestration are as reported in the Compliance Form

Review Tips

1. Use simulation reports to verify that the modeled U-factor, SHGC and VLT are as reported in the Compliance Form. The reported values are found at the following locations:
 Baseline/budget design: Table 1 in the Envelope Areas tab.
 Proposed Design: Table 2 in the Proposed Envelope Assemblies tab
2. Focus on fenestration types that account for the largest area.

eQUEST Reports	LV-D
Trane TRACE 700	Building U-Values, Building Areas, Walls by Direction entered values report, Walls by Cardinal Direction entered values report

Trane TRACE 3D Plus	Envelope Summary report
IESVE SOFTWARE	BPRM Report, Room Loads Report, Zone Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report
EnergyPlus	eplustbl.html 'Envelope Summary' report
OpenStudio	eplustbl.html 'Envelope Summary' report
Carrier HAP v5	"Window Constructions" Report
Design Builder	Exterior Fenestration Table in Output Summary Document

BE17-B Baseline/budget infiltration rate reported in the Compliance Form is established correctly

90.1 2016 and 2019 ECB

Air-leakage is not prescribed. Thus, it must be modeled the same in the budget and proposed design Based on Table 11.5.1 No1.

90.1 2022 ECB

Table 12.5.1 No 5 Column B (f): The air leakage rate of the building envelope (I75Pa) at a pressure differential of 75 Pa (0.30 of water) shall be 0.35 cfm/ft² of building envelope area and shall be converted to appropriate units for the simulation software using the same method as the proposed design.

90.1 2016 PRM

Table G3.1 Proposed Building Performance No 5 (b): The air leakage rate of the building envelope (I75Pa) at a fixed building pressure differential of 0.3 in. of water shall be 0.4 cfm/ft². Infiltration must be modeled using the same methodology, air leakage rate and adjustments for weather and building operation in both the proposed design and the baseline building design. The air leakage rate of the building envelope must be converted to appropriate units for the simulation program using one of the methods in 90.1 Section G3.1.1.4.

90.1 2019 PRM

Table G3.1 Baseline Building Performance No 5(h): The air leakage rate of the building envelope (I75Pa) at a fixed building pressure differential of 0.3 in. of water shall be 1.0 cfm/ft².The air leakage rate of the building envelope shall be converted to appropriate units for the simulation program using one of the methods in Section G3.1.1.4.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Table G3.1 Baseline Building Performance No 5(i): same as Table G3.1 Baseline Building Performance No 5(h) described above for the 90.1 2019 PRM.

G3.3 Minor Alterations

Section G3.3.2.5, which is applicable to alterations that do not meet the criteria in 90.1 G3.1.4a, requires that when Section 5.4.3.1.3 applies, the air leakage rate of the building envelope(I75Pa) shall be equal to 0.35 cfm/ft² of building envelope area at a pressure differential of 75 Pa (0.30 in. of water). The

air leakage rate shall be converted to appropriate units for the simulation software using the same method as the proposed design.

Review Tips – ECB

1. 90.1 2016 and 2019: Infiltration rate is not prescribed thus any reasonable rate may be modeled. Modeling unrealistically high air leakage will exaggerate contribution of heating energy use toward budget building performance and may skew the compliance outcome. Assumptions that are substantially different from the default values shown in Table 1 of the Infiltration tab may be questioned if heating is one of the impactful end uses.
2. 90.1 2022: The required infiltration rate at 75Pa pressure differential is automatically calculated in Table 1 of the Infiltration tab shows the applicable budget infiltration rate.

Review Tips – PRM

1. The required infiltration rate at 75Pa pressure differential is automatically calculated in Table 1 of the Infiltration tab shows the applicable baseline infiltration rate. Overrides may be required for alterations subject to 90.1 2022 Section G3.3 which will be shown in bold brown.

	Pressure Differential	Air Leakage Rate of the Building Envelope @ Specified Pressure Differential	Air Leakage Measurement Type	Total Building Envelope Area	Total Air Leakage at the Specified Pressure Differential
	-	l	-	S	Q
	Pa	cfm/ft ²	-	ft ²	cfm
Proposed Design:	75	0.45	None	68,610	30,875
Baseline Design:	75	1.00	n/a		68,610

BE17-P Proposed infiltration rate reported in the Compliance Form is established correctly.

90.1 2016 and 2019 ECB

Air-leakage is not prescribed and thus must be modeled with the same rate as in the budget design.

90.1 2016 PRM

Table G3.1 No 5: The infiltration rate in the proposed design must be the same as in the baseline, except when whole-building air leakage testing in accordance with ASTM E779 is specified during design and completed after construction, the measured air leakage rate must be modeled in the proposed design.

90.1 2019 PRM

Table G3.1 Proposed Building Performance column No 5b: The air leakage rate of the building envelope (175Pa) at a fixed building pressure differential of 0.3 in. of water shall be 0.6 cfm/ft² for buildings providing verification in accordance with Section 5.9.1.2. The air leakage rate of the building envelope shall be converted to appropriate units for the simulation program using one of the methods in Section G3.1.1.4., except when whole-building air leakage testing in accordance with ASTM E779 is specified during design and completed after construction, the measured air leakage rate must be modeled in the proposed design.

90.1 2022 ECB/PRM

Table 12.5.1 No 5 Column A (b)/Table G3.1 Proposed Building Performance column No 5b: The air leakage rate of the building envelope shall be in accordance with one of the following:

- When whole-building pressurization testing is required or specified during design, and completed in accordance with Section 5.4.3.1.4, the measured air leakage rate of the building envelope (175Pa) at a fixed building pressure differential of 75 Pa (0.30 in. of water) shall be modeled for purposes of demonstrating compliance with this standard.
- For buildings providing verification in accordance with Section 5.9.1.2, the air leakage rate of the building envelope (175Pa) at a fixed building pressure differential of 75 Pa (0.30 in. of water) shall be 0.45 cfm/ft². The air leakage rate of the building envelope shall be converted to appropriate units for the simulation program using one of the methods in Section 12.5.3.

Review Tips

1. Table 1 of the Infiltration tab shows the applicable infiltration rate at 75Pa pressure differential for the proposed design assuming no air leakage testing was performed. If the air leakage rate for the proposed design is over-written by modeler, the entered values show in light brown font.
2. If the value is over-written, verify the following:
 - a) Confirm that infiltration testing report is submitted.
 - b) Confirm that test results are based on the approved testing method (e.g., ASTM E3158 for 90.1 2022 (see 90.1 Section 5.4.3.1.4 for other approved methods), E779 or E1827 for 90.1 2019, or E779 for 90.1 2016).
 - c) Confirm that test results at 75Pa shown in the testing documentation are correctly transferred to Table 1 for the proposed design on the Infiltration tab in the Compliance Form.

BE18-B, BE18-P Baseline/budget and proposed modeled infiltration rate reflects the values reported in the Compliance Form

Review Tips

1. Use the simulation reports to verify that the modeled baseline/budget infiltration rate is as reported in Table 2 of the Infiltration tab. Ensure that both the units (e.g., CFM/SF, ACH) and the value is correct.
2. Common Mistakes
 - a. An infiltration rate from Table 1 of the Infiltration tab is entered into simulation tool without converting to normal wind conditions. This exaggerates infiltration related loads by about factor of ten, significantly increasing the heating load and any savings from air leakage reduction in the proposed design.

eQUEST Reports	LV-B
Trane TRACE 700	Room Information entered values report
Trane TRACE 3D Plus	System Cooling Checksums report and System Heating Checksums report

IESVE SOFTWARE	Room Loads Report, Zone Loads Report, Thermal Template Report, System Loads Report, BPRM Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html 'InitializationSummary' report, 'ZoneInfiltration Airflow Stats Nominal' section
OpenStudio	eplustbl.html 'InitializationSummary' report, 'ZoneInfiltration Airflow Stats Nominal' section
Carrier HAP v5	"Space Input Data" report.
Design Builder	Zone Infiltration Airflow Stats Nominal Table in EnergyPlus Output Summary Document

BE19 Change in the proposed versus baseline/budget total annual and design loads from envelope components is reasonable given the difference in the proposed versus baseline/budget envelope parameters reported in the Compliance Form

Review Tips

1. This check verifies that the simulation outputs are generally consistent with the baseline/budget and proposed envelope parameters. The check does not consider factors such as thermal mass, exposure and shading, so look for a general correlation and not an exact match.
 - a. If a given envelope component has the same or very similar thermal properties in the baseline (budget) and proposed design, heating and cooling losses and gains from this component should be the same or very similar based on the simulation outputs. For example, all 90.1 2016/2019 Energy Cost Budget projects and most 90.1 2016/2019 Performance Rating Method projects (except for those that performed air leakage testing) must model the same infiltration rate in the baseline/budget and proposed design, thus the heating and cooling losses and gains from infiltration are expected to be the same or very close in the baseline/budget and proposed simulations.
 - b. Conductive heat losses through surfaces (windows, exterior walls, roofs) should correlate to the surface U-value and area.

Example 1: Based on the submittal, the proposed roof is U-0.032, compared to U-0.063 in the PRM baseline. The annual heat losses through the roof in the simulation output reports should be substantially lower in the proposed design. Assuming the skylight area is the same in the proposed and baseline building, the heat loss through the baseline roof should be about twice that of the proposed building roof (0.063/0.032=2).

Example 2: Based on the submittal, the proposed design has 40,000 SF of vertical fenestration with U-0.5; the baseline has 30,000 SF of fenestration with U-0.5. The heat loss through windows due to conduction should go up. $(U_{prop} \times A_{prop}) / (U_{base} \times A_{base}) = (40,000 \times 0.5) / (30,000 \times 0.5) \sim 1.3$
 - c. Solar heat gains through windows should be approximately proportional to the product of the window area and SHGC.

The scope of this check depends on the reporting capabilities of the simulation tool.

eQUEST Reports	LS-C, LS-F
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Trane TRACE 700	Building Envelope Cooling Loads at Coil Peak and Building Envelope Heating Loads at Coil Peak
Trane TRACE 3D Plus	Room and Zone Cooling and Heating Loads by Component Reports (keep in mind if the room/zones are peaking at the same time or not)
IESVE SOFTWARE	Room Loads Report, Zone Loads Report, Space Loads & Ventilation Report, Plant Loops and Equipment Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report
EnergyPlus	eplustbl.html 'Sensible Heat Gain Summary' report
OpenStudio	eplustbl.html 'Sensible Heat Gain Summary' report
Carrier HAP v5	"Air System Design Load Summary" report, generated for HVAC air side system, for same design cooling day hour for Baseline and Proposed.
Design Builder	simulated output result file (.eso)

BE20-B The baseline/budget building performance is an average of four orientations, if required

90.1 2016, and 2019/2022 ECB

Table 11.5.1 Column B #5 (c)/Table 12.5.1 Column B #5 (d): If the vertical fenestration area facing west or east of the proposed building exceeds the area limit set in 90.1 Section 5.5.4.5, then the energy cost budget shall be generated by simulating the budget building design with its actual orientation and again after rotating the entire budget building design 90, 180 and 270 degrees and then averaging the results.

90.1 2016, 2019, and 2022 PRM

Table G3.1 Baseline Building Design column #5 (a): The baseline building performance must be calculated by simulating the building with its actual orientation and again after rotating the entire building 90, 180 and 270 degrees, then averaging the results. The baseline building performance may be based on the actual building orientation (without averaging) if (a) the building vertical fenestration area on each orientation varies by less than 5%, or if (b) it is demonstrated to the satisfaction of the AHJ that the building orientation is dictated by site considerations, such as for major renovation projects, or building sharing party walls with the adjacent buildings on a city block.

Review Tips

1. The Envelope Areas tab, "Baseline Orientation and Rotation" indicates whether the baseline/budget design was "rotated". The default is auto-populated based on applying the appropriate 90.1 rules described above to the project. The modeler can over-write this default. If the default is over-written, confirm that an explanation is provided in the Note field and that it is acceptable. For example, the modeler may indicate that the project was not rotated because it is a major renovation.
2. If it is established that the baseline must be rotated, verify that simulation results are reported for the four baseline orientations in the Compliance Calculations tab Table 2 (Baseline 0 Rotation, Baseline 90 Rotation, Baseline 180 Rotation, Baseline 270 Rotation).

BE20-P Proposed building orientation reflected in the Compliance Form is as specified

Review Tips

1. Proposed building orientation must reflect the actual building exposure. Compare surface areas by orientation in Table 5 of the Envelope Areas tab to architectural drawings to ensure alignment in exposure.

BE21-B, BE21-P Baseline/budget and proposed building orientation is modeled as reported in the Compliance Form.

Review Tips

1. Use the simulation reports listed below to verify that the modeled exposure is as reported in the Compliance Form.

eQUEST Reports	LV-D, results for the four baseline orientations must be averaged externally
Trane TRACE 700	LEED Summary Section 1.6
Trane TRACE 3D Plus	Envelope Summary report Azimuth/Cardinal Direction columns
IESVE SOFTWARE	Model Orientation and Rotation Check Report, BPRM Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report
EnergyPlus	eplustbl.html 'Input Verification and Results Summary' report
OpenStudio	eplustbl.html 'Input Verification and Results Summary' report
Carrier HAP v5	"LEED Summary" report, Section 2, "Minimum Energy Performance Calculator", table titled "Above Grade Wall and Vertical Glazing Areas".
Design Builder	Output_Performance_1 sheet in LEED Minimum Energy Performance Calculator

BE22-P Proposed interior and exterior shading is established correctly in the Compliance Form

90.1 2016 and 2019/2022 ECB

Table 11.5.1 #5, Proposed Building Design column Exception 4/ Table 12.5.1 #5, Proposed Building Design column Exception 6

Manually operated fenestration shading devices, such as blinds or shades, must not be modeled. Permanent shading devices, such as fins, overhangs, and light shelves, must be modeled.

90.1 2016 and 2019/ 2022 PRM

Table G3.1 Proposed Building Performance Column No 5 (a #4,5)/Table G3.1 Proposed Building Performance Column No 5 (a #6,7)

- Manual fenestration shading devices, such as blinds or shades, must be modeled or not modeled the same as in the baseline building design.
- Automatically controlled fenestration shades or blinds must be modeled.
- Permanent shading devices, such as fins, overhangs, and light shelves must be modeled.
- Automatically controlled dynamic glazing may be modeled. Manually controlled dynamic glazing must use the average of the minimum and maximum SHGC and VT.

Table G3.1 Proposed Building Performance column #14 (a)/ Table G3.1 Proposed Building Performance column #14 (a)

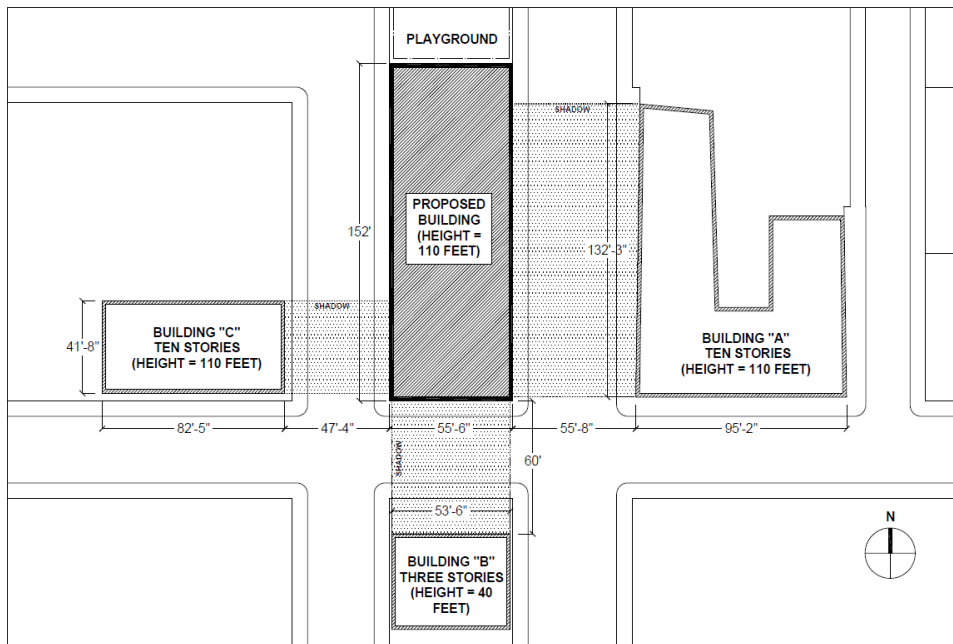
- All elements whose effective height is greater than their distance from a proposed building and whose width facing the proposed building is greater than one-third that of the proposed building shall be accounted for in the analysis.

G1.3 (g)/G1.3(h)

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

Review Tips

1. For PRM projects, review the site plan showing all adjacent *buildings* and topography that may shade the proposed building with the estimated height or number of stories. An example of site shading documentation is provided below.



2. Exterior and interior shading of the proposed design is described in the Envelope Areas tab Table 8. The applicable 90.1 modeling rules are shown in the table and may be over-written by the modeler. The over-written values are shown in brown font. If any of the values are overwritten, the changes must be described in the notes below the table. Confirm that modeling approach aligns with 90.1 rules stated above.
3. The check should be performed on projects located in Climate Zones 0-5.

BE22-B Baseline/Budget interior and exterior shading is established correctly in the Compliance Form

90.1 2016 and 2019/2022 ECB

Table 11.5.1 Column B #5 (c)/Table 12.5.1 Column B #5 (d)

No shading projections are to be modeled; fenestration is assumed to be flush with the wall or roof.

90.1 2016 and 2019/2022 PRM

G3.2 New Construction/Major Alterations

Table G3.1 Baseline Building Performance column #5 (d)/Table G3.1 Baseline Building Performance column #5 (f)

- All vertical fenestration shall be assumed to be flush with the exterior wall, and no shading projections shall be modeled.
- Manual window shading devices such as blinds or shades are not required to be modeled.

Table G3.1 Proposed Building Performance column #14/Table G3.1 Proposed Building Performance column #14

Shading by adjacent structures and terrain must be the same as in the proposed design.

G3.3 Minor Alterations

Alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) should model interior and exterior shading identically in the baseline and proposed models since there are no relevant requirements in Section 5 applicable to alterations.

Review Tips

1. Exterior and interior shading of the proposed design is described in the Envelope Areas tab Table 8. The applicable 90.1 modeling rules are shown in the table and may be over-written by the modeler. The over-written values are shown in brown font. If any of the values are overwritten, the changes must be described in the notes below the table. Confirm that modeling approach aligns with 90.1 rules stated above.
2. Shading is especially important in climate zones where cooling is significant, such as Climate Zones 0-5, and where fenestration area is relatively large.

BE23-B, BE23-P Baseline/Budget and proposed interior shading is modeled as reported in the Compliance Form

Review Tips

1. Review simulation reports to confirm that interior and exterior shading is modeled as reported in the Compliance Form.
2. The check should be performed on projects located in Climate Zones 0-5.

BE24-P, Proposed envelope complies with minimum mandatory envelope requirements 90.1 2016 and 2019 ECB and PRM

No minimum mandatory envelope requirements other than those included in 90.1 Section 5.4.

90.1 2022 ECB/PRM

12.2d/G1.2.1d

For new buildings, one of the following must be met:

1. The building envelope complies with Section 5.5, “Prescriptive Building Envelope Compliance Path.”
2. Using Section 5.6, “Building Envelope Trade-Off Compliance Option,” the proposed envelope performance factor shall not exceed the base envelope performance factor by more than 15% in multi-family residential, hotel/motel, and dormitory building area types. For all other building area types, the limit shall be 7%. For buildings with both residential and nonresidential occupancies, the limit shall be based on the area-weighted average of the gross conditioned floor area.

Review Tips

1. This review check applies to 90.1 2022 projects only, inputs for documenting compliance with Sections 12.2d/G1.2.1d are included in the “Envelope Backstop Verification” section on the Envelope Areas tab in the Compliance Form (a screenshot from the section is shown below for reference).

Review the section to check that one of the compliance options is selected. If compliance with Section 5.5, “Prescriptive Building Envelope Compliance Path” is selected then ensure that “Yes” is selected for each row in the “Complies?” column in the table shown below. Some of the rows autopopulate with manual overrides shown in bold orange. If “Exception Applies” is selected review the explanation for validity. For peach cells that require a user input, manual overrides, or scenarios in which exceptions apply ensure that the inputs and explanations align with the documentation noted in the “Plans/Spec Reference” column.

Envelope Backstop Verification

Background
Projects demonstrating compliance following the Energy Cost Budget Method or the Performance Rating Method must meet minimum envelope performance requirements (envelope backstop) as described in Sections 12.2.d and G1.2.1 (d).

Instructions
1. Select compliance option:

Project meets prescriptive envelope requirements in Section 5.5

a. After the Proposed Envelope Assemblies and Envelope Areas tabs have been filled out completely, please mark them as Complete on the Dashboard tab in both the design professional and modeler sign-off columns. This will allow the “Complies?” column to autopopulate in the table below..

b. The “Complies?” column will autopopulate based upon the entries on the Proposed Envelope Assemblies and Envelope Areas tabs. If the “Complies?” column in the table below is overwritten due to an applicable exception, please provide an explanation in the notes section below.

Prescriptive Criteria	90.1 Section	Complies?	Reference Table	Explanation of Exception	Plans/Spec Reference
Opaque envelope components meet the requirements in Tables 5.5-0 through 5.5-8 for the appropriate climate zone	5.5.1 - 5.5.2	No	Envelope Areas tab Table 1		Include in Reference Table
Opaque envelope components meet the requirements in Section 5.5.3	5.5.3	Yes	Envelope Areas tab Table 6		Include in Reference Table
Area of vertical fenestration in the proposed design does not exceed 40% of the gross wall area	5.5.4.2.1	Yes	Envelope Areas tab Table 6		Include in Reference Table
Area of skylights in the proposed design does not exceed 3% of the roof area	5.5.4.2.2	Yes	Envelope Areas tab Table 6		Include in Reference Table
Area of skylights in the proposed design meets minimum skylight fenestration area requirements	5.5.4.2.3	Yes	Envelope Areas tab Table 2		Include in Reference Table
Fenestration envelope components meet the requirements in Tables 5.5-0 through 5.5-8 for the appropriate climate zone	5.5.4.3 - 5.5.4.4	Yes	Envelope Areas tab Table 2		Include in Reference Table
Vertical fenestration complies with fenestration orientation requirements in Section 5.5.4.5	5.5.4.5	No	Envelope Areas tab Table 9		Include in Reference Table
Visible transmittance/SHGC ratio complies with 5.5.4.6	5.5.4.6	Yes	Envelope Areas tab Table 2		Include in Reference Table
Linear and point thermal bridging complies with Section 5.5.5	5.5.5				

Project used the Section 5.6, “Building Envelope Trade-Off Compliance Option”

a. Fill out the table below.

Envelope Backstop (results from ComCheck)

Building Area Type	Area (ft ²)	Margin
Residential	84,365	-15%
Nonresidential	24,750	-7%
Allowance margin (area-weighted average margin of residential and nonresidential)		-13.2%
The margin by which the proposed envelope performance factor exceeds the base envelope performance factor (Note 1)		-2.0%

Note 1: Enter the value shown in the lower left corner of the ENVELOPE tab of COMcheck, including the sign. If the value is negative, it must be entered as such.

Compliance
Project passes the envelope backstop? Pass

Dashboard | Energy Sources | Operating Schedules | Proposed Envelope Assemblies | **Envelope Areas** | Infiltration | Lighting Space Types | Interior Lighting Counts | Interior Lighting Summary | Exterior Lighting

For projects following the Section 5.6, “Building Envelope Trade-Off Compliance Option” the 90.1 Sections 12.2d/G1.2.1d allowances are such that the proposed envelope performance factor cannot exceed the base envelope performance factor by more than 15% for multifamily/residential, hotel/motel, and dormitory building area types and for all other building area types, the limit is set at 7%. For buildings with both residential and nonresidential occupancies, the limit is determined based on the area-weighted average of the gross conditioned floor area. The allowance margin is automatically calculated in the Compliance Form on the Envelope Areas tab, as shown below outlined in pink, based on 90.1 Sections 12.2d/G1.2.1d allowances and the building area types entered on the General Information tab in Table 1.

If the Section 5.6, “Building Envelope Trade-Off Compliance Option” option is selected, then compare the margin by which the proposed envelope performance factor exceeds the base envelope performance factor entry with the provided Comcheck report requested in Submittal Checklist #36 to ensure they match. Confirm that the field shown below reports a “Pass” outcome. See fields outlined in red in the graphic below from the Envelope Areas tab in the Compliance Form.

Envelope Backstop Verification

Background
 Projects demonstrating compliance following the Energy Cost Budget Method or the Performance Rating Method must meet minimum envelope performance requirements (envelope backstop) as described in Sections 12.2.d and G1.2.1 (d).

Instructions

1. Select compliance option:

Project meets prescriptive envelope requirements in Section 5.5

a. After the Proposed Envelope Assemblies and Envelope Areas tabs have been filled out completely, please mark them as Complete on the Dashboard tab in both the design professional and modeler sign-off columns. This will allow the "Complies?" column to autopopulate in the table below.

b. The "Complies?" column will autopopulate based upon the entries on the Proposed Envelope Assemblies and Envelope Areas tabs. If the "Complies?" column in the table below is overwritten due to an applicable exception, please provide an explanation in the notes section below.

Prescriptive Criteria	90.1 Section	Complies?	Reference Table	Explanation of Exception	Plans/Spec Reference
Opaque envelope components meet the requirements in Tables 5.5-0 through 5.5-8 for the appropriate climate zone	5.5.1 - 5.5.2	No	Envelope Areas tab Table 1		Include in Reference Table
Opaque envelope components meet the requirements in Section 5.5.3	5.5.3				
Area of vertical fenestration in the proposed design does not exceed 40% of the gross wall area	5.5.4.2.1	Yes	Envelope Areas tab Table 6		Include in Reference Table
Area of skylights in the proposed design does not exceed 3% of the roof area	5.5.4.2.2	Yes	Envelope Areas tab Table 6		Include in Reference Table
Area of skylights in the proposed design meets minimum skylight fenestration area requirements	5.5.4.2.3				
Fenestration envelope components meet the requirements in Tables 5.5-0 through 5.5-8 for the appropriate climate zone	5.5.4.3 - 5.5.4.4	Yes	Envelope Areas tab Table 2		Include in Reference Table
Vertical fenestration complies with fenestration orientation requirements in Section 5.5.4.5	5.5.4.5	No	Envelope Areas tab Table 9		Include in Reference Table
Visible transmittance/SHGC ratio complies with 5.5.4.6	5.5.4.6	Yes	Envelope Areas tab Table 2		Include in Reference Table
Linear and point thermal bridging complies with Section 5.5.5	5.5.5				

Project used the Section 5.6, "Building Envelope Trade-Off Compliance Option"

a. Fill out the table below.

Envelope Backstop (results from ComCheck)

Building Area Type	Area (ft ²)	Margin
Residential	84,365	-15%
Nonresidential	24,750	-7%
Allowance margin (area-weighted average margin of residential and nonresidential)		-13.2%
The margin by which the proposed envelope performance factor exceeds the base envelope performance factor (Note 1)		-2.0%

Note 1: Enter the value shown in the lower left corner of the ENVELOPE tab of COMcheck, including the sign. If the value is negative, it must be entered as such.

Compliance

Project passes the envelope backstop?

Dashboard | Energy Sources | Operating Schedules | Proposed Envelope Assemblies | Envelope Areas | Infiltration | Lighting Space Types | Interior Lighting Counts | Interior Lighting Summary | Exterior Lighting

Lighting, Interior (LI)

Overview

Lighting Interior check group addresses interior lighting power and controls. Table 7 summarizes the checks included in this group.

Table 7: Lighting Interior Quality Control Checks Overview

	Type of Check	Proposed Design	Baseline/Budget Design
General	CF inputs reflect design documents	LI01	NA
	Simulation outputs consistent with CF	LI11	NA
Lighting Power	CF inputs reflect design documents	LI02-P	NA
	CF inputs reflect requirements of ECB/PRM	LI03	LI03
	Meet mandatory requirements	NA	NA
	Simulation inputs consistent with CF	LI07	LI07
	Simulation outputs consistent with CF	LI06	LI06
Lighting Controls	CF inputs reflect design documents	LI04-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	NA
	Meet mandatory requirements	LI05	NA
	Simulation inputs consistent with CF	LI08, LI09	LI08, LI09
	Simulation outputs consistent with CF	LI10	LI10
LEGEND			
PASS/FAIL/NA outcome is determined automatically in the Quality Control Checks tab of the Compliance Form			

The following strategies should be used to prioritize the review:

1. For checks that verify the specified fixture wattages, focus on fixtures that account for the largest total wattage on the project and spot-check the rest.
2. For checks that verify the specified fixture counts, focus on space types that account for the largest total wattage and spot-check the rest.
3. For checks that verify that the lighting wattage is modeled as reported, check the thermal blocks that account for the highest wattage.
4. 90.1 Section 9 requires occupancy sensors and daylighting controls in many types of spaces. These requirements are mandatory and must be met where applicable. Perform the checks to verify that mandatory requirements are met for a representative sample of spaces selected as described in #2 above.

Refer to the table included in the Quality Control Checks, Lighting Interior section that ranks lighting fixtures, space types and thermal blocks based on their total wattage to facilitate the prioritization described above.

Space Type, Thermal Block, and Fixture Type Rank by Total Wattage

Rank based Upon Total Wattage Associated with Each	Space Types	Thermal Blocks	Fixture Types
	Name, Total Wattage	Name, Total Wattage	Name, Total Wattage
1	Dwelling Unit, 45,600	Retfl1Sales, 5,904	E, 17,712
2	Sales Area, 17,712	Retfl2Sales, 5,904	D, 3,840
3	Corridor/All Other, 2,610	Retfl3Sales, 5,904	A, 2,610
4	Storage Room/≥50 ft ² , 2,400	MF1ESE Perim Spc (M.ESE15), 4,620	C, 1,426
5	Stairwell, 1,196	MF1WSW Perim Spc (M.WSW22), 4,620	
6	Lounge/Breakroom/All Other, 768	MF1ENE Perim Spc (M.ENE18), 4,578	
7	Office/Enclosed, 480	MF1WNW Perim Spc (M.WNW19), 4,578	
8	Storage Room/<50 ft ² , 230	MF1East Perim Spc (M.E17), 4,524	
9	Restroom/ All Other, 192	MF1West Perim Spc (M.W20), 4,524	
10		MF1East Perim Spc (M.E16), 4,518	

For 90.1 2022 PRM alterations subject to G3.3 (i.e., Minor Alterations), the summary tables on the Quality Control Checks tab in the Compliance Form may not reflect correct values for the baseline since projects, for the most part, only enter proposed design information and provide notes as to what was modeled in the baseline in the notes fields associated with the proposed design related tables. Refer to the [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) section for more information regarding 90.1 2022 G3.3.

LI01 The floor area used in the lighting calculations is consistent with the reported project floor area.

Review Tips

1. In order to establish the baseline/budget lighting power allowance, the floor area of individual spaces (for projects using space-by-space method) or building area types (for Energy Cost Budget Method projects using building area method) are reported in Table 1 of the Interior Lighting Counts tab. The baseline/budget lighting power allowance will not be determined correctly if the total floor area reported on the Interior Lighting Counts tab does not match the actual floor area in Table 1 of the General Information tab. Misalignment should be flagged. This check is performed automatically in the Quality Control Checks tab with discrepancies over 3% flagged. See also SG05.

LI02-P Proposed lighting power reported in the Compliance Form reflects design documents for spaces where lighting is fully specified.

90.12016 and 2019/2022 ECB; 90.1 2016, 2019, and 2022 PRM

90.1 Table 11.5.1 #6/90.1 Table 12.5.1 #6; Table G3.1 #6

- Where a complete lighting system exists (e.g., in a renovation project where lighting is left as is), the actual lighting power must be modeled for each thermal block.
- Where a lighting system has been designed, lighting power must be determined in accordance with 90.1 Sections 9.1.3 and 9.1.4. Based on these sections, the wattage must include all power used by the fixtures including lamps, ballasts, transformers and control devices and be based on the

manufacturers' labeled maximum wattage of the luminaire. Some exceptions may apply (90.1 Sections 9.1.1, 9.1.3, 9.1.4, 9.2.2.3, 9.4.2).

- Lighting system power shall include all lighting system components shown or provided for on plans (including lamps, ballasts, task fixtures and furniture mounted fixtures).

Review Tips

1. Refer to the table in the Interior Lighting section on the Quality Control Tab to identify lighting fixtures with the highest total wattage. Focus the review on these fixtures and spot-check others. data.

Space Type, Thermal Block, and Fixture Type Rank by Total Wattage

Rank based Upon Total Wattage Associated with Each	Space Types	Thermal Blocks	Fixture Types
	Name, Total Wattage	Name, Total Wattage	Name, Total Wattage
1	Dwelling Unit, 45,600	Retfl1Sales, 5,904	E, 17,712
2	Sales Area, 17,712	Retfl2Sales, 5,904	D, 3,840
3	Corridor/All Other, 2,610	Retfl3Sales, 5,904	A, 2,610
4	Storage Room/≥50 ft ² , 2,400	MF1ESE Perim Spc (M.ESE15), 4,620	C, 1,426
5	Stairwell, 1,196	MF1WSW Perim Spc (M.WSW22), 4,620	
6	Lounge/Breakroom/All Other, 768	MF1ENE Perim Spc (M.ENE18), 4,578	
7	Office/Enclosed, 480	MF1WNW Perim Spc (M.WNW19), 4,578	
8	Storage Room/<50 ft ² , 230	MF1East Perim Spc (M.E17), 4,524	
9	Restroom/ All Other, 192	MF1West Perim Spc (M.W20), 4,524	
10		MF1East Perim Spc (M.E16), 4,518	

For these selected fixtures, locate fixture make and model on the lighting schedule drawings and verify that the manufacturer maximum rated wattage reported for the fixtures in Table of the Interior Lighting Counts tab is aligned with the manufacturer’s maximum rated fixture wattage shown on the cutsheets. Request cutsheets for selected fixtures if necessary.

How were Automatic Daylighting Controls Modeled?							
Lighting Schedule Dwg #	E-105						
Fixture Label from Lighting Schedules	A	B	C	D	E		
Maximum Rated Fixture Wattage	26.1	30.1	23.0	32.0	48.0		
Exempt Lighting Application?	No	No	No	No	No	N	
Decorative Lighting	No	No	No	No	No	N	
Sales Area Merchandise Highlighting	No	No	No	No	No	N	
109,661	Total Fixture Counts:		100	-	62	120	369
?							

Example: Wall sconces installed in the corridors of a multifamily building are specified with two 18W CFL bulbs but have the manufacturers’ rated wattage of 120 W based on incandescent bulbs. The 120W per fixture must be used in the LPD calculations for the proposed design, unless the installed fixtures are re-labeled by the manufacturer based on the CFL lamps. Thus, unless all of the specified fixtures reflect the maximum rated wattage, or the fixtures are re-labeled by the manufacturer, the total fixture wattages specified on the lighting drawings will typically be lower than the wattages that must be used in the lighting compliance calculations.

2. Refer to the table in the Interior Lighting section on the Quality Control Tab to identify space types that account for the greatest total lighting wattage.

Space Type, Thermal Block, and Fixture Type Rank by Total Wattage

Rank based Upon Total Wattage Associated with Each	Space Types	Thermal Blocks	Fixture Types
	Name, Total Wattage	Name, Total Wattage	Name, Total Wattage
1	Dwelling Unit, 45,600	Retfl1Sales, 5,904	E, 17,712
2	Sales Area, 17,712	Retfl2Sales, 5,904	D, 3,840
3	Corridor/All Other, 2,610	Retfl3Sales, 5,904	A, 2,610
4	Storage Room/≥50 ft ² , 2,400	MF1ESE Perim Spc (M.ESE15), 4,620	C, 1,426
5	Stairwell, 1,196	MF1WSW Perim Spc (M.WSW22), 4,620	
6	Lounge/Breakroom/All Other, 768	MF1ENE Perim Spc (M.ENE18), 4,578	
7	Office/Enclosed, 480	MF1WNW Perim Spc (M.WNW19), 4,578	
8	Storage Room/<50 ft ² , 230	MF1East Perim Spc (M.E17), 4,524	
9	Restroom/ All Other, 192	MF1West Perim Spc (M.W20), 4,524	
10		MF1East Perim Spc (M.E16), 4,518	

Locate several spaces of that type on the Interior Lighting Counts tab. Refer to the lighting plans to confirm that fixture types and counts for these spaces reported in the Compliance Form match design documents.

Table 1: Lighting Fixture Counts							Lighting Schedule Dwg # E-105	
Space Name Reference (e.g. space name(s) from drawings)	Thermal Block Name from Model	Lighting Plans Dwg#	Multiplier	Space/Building Area Type (90.1-Section 9)	Area (ft ²)	RCR LPD Adjustment per Section 9.6.4?	Fixture Label from Lighting Schedules	Count
Corr 101	Corr1	E-101	1	Corridor/All Other	604	No	A	10
Total for Area (ft ²):					109,661		Total Fixture Counts: 100 -	

3. Common Mistakes

- a. Fixture wattage is not based on a complete fixture including lamp and ballast and does not reflect manufacturer rated fixture wattage.
- b. Track lighting is not calculated according to the allowed methods as described in 90.1 Section 9.1.4.
- c. Proposed LPDs are based on partially specified or temporary lighting. For example, in hotel guest rooms the hardwired fixtures shown on drawings are typically supplemented by plug-in floor and table lamps. See LI03-P for the relevant rules.

LI03-P Proposed LPD to be modeled for spaces where lighting is not specified or partially specified is established correctly in the Compliance Form

90.1 2016 and 2019/2022 ECB

Table 11.5.1 #6, Column A, #c/ Table 21.5.1 #6, Column A, #c: Where no lighting exists or is specified, lighting power must be determined in accordance with the Building Area Method for the appropriate building type, based on the allowances in 90.1 Section 9.

90.1 2016 and 2019 PRM

Table G3.1 #6, proposed Column, #c: Where lighting neither exists nor is submitted with the design documents, lighting power must be modeled as minimally complying with the prescriptive requirements of 90.1 Section 9, Building Area Method.

90.1 2022 PRM

Table G3.1 #6, proposed Column, #c: Where lighting neither exists nor is submitted with design documents, lighting shall comply with but not exceed the requirements of Section 9. Where space types are known, lighting power shall be determined in accordance with the Space-by-Space Method. Where space types are not known, lighting power shall be determined in accordance with the Building Area Method.

Review Tips

1. This check should be performed for projects involving hotels, models, dormitories and multifamily occupancy types, or if the Table 1 on the Lighting Space Types indicate a design status as “Core and Shell”, or if lighting is listed on the General Information tab, “Alterations and Yet to be Designed Systems and Components” section. This logic is used to select this check on the Quality Control Checks tab.
2. The Interior Lighting Counts tab Table 1 includes a column for entering floor area for which lighting is not specified in the proposed design. This may include spaces where lighting is not specified (e.g., in core and shell projects) or where lighting is partially specified. Partially specified lighting is common in residential occupancies. For example, in hotel guestrooms, hard-wired fixtures may be specified in bathrooms and hallways, to be supplemented by plug-in table or floor lamps. These plug-in fixtures are often not shown on the lighting drawings, or the lighting plans may refer to the power and furniture plans for supplemental and task lighting.

Space/Building Area Type (90.1-Section 9)	Area (ft ²)	RCR LPD Adjustment per Section 9.6.4?	FIXTURE COUNTS Enter fixture counts for each thermal block. If Rated Input Wattage is entered as W/ft ² , enter fixture length in linear feet (LnFt).										Area Where Proposed Lighting is Not Specified [ft ²]			
Corridor/All Other	604	No	10													
Storage Room/<50 ft^2	49	No				1										
Stairwell	92	No				2										
Stairwell	92	No				2										
Dwelling Unit	963	No														963
Dwelling Unit	941	No														941
Dwelling Unit	943	No														943
Dwelling Unit	954	No														954

3. On projects that include residential occupancies (hotels, motels, dormitories, multifamily) but have no inputs in the “Area where proposed lighting is not specified”, spot-check lighting plans for a sample of residential spaces to confirm that hard-wired lighting is specified in spaces such as guest rooms and is sufficient to meet IESNA-recommended lighting levels. If it is determined that lighting is not fully specified, request that the floor area with no lighting is reported in the Compliance Form as shown above.

LI03-B Baseline/budget Lighting Power Density (LPD) is established correctly in the Compliance Form

90.1 2016 and 2019/2022 ECB

Table 11.5.1 No 6 Column B/Table 12.5.1 No 6 Column B

The budget LPD must be determined using the same categorization procedure (building area or space-by-space method) and categories as the proposed design, with lighting power set equal to the maximum allowed for the corresponding method and category in 90.1 Section 9.2. Lighting in the proposed design that is specifically exempted in 90.1 Section 9.1.1, 9.2.2.3 in 90.1 2016, Table 9.2.3.1 in 90.1 2019, Table 9.2.2.1 in 90.1 2022, 90.1 Section 9.4.2 in 90.1 2016 and 2019, or Table 9.2.2.2 in 90.1 2022 must be modeled in the baseline the same as in the proposed design. Exempt lighting, decorative and retail display lighting allowance can only be claimed if it is specified in addition to general lighting and is separately controlled.

90.1 2016 and 2019 PRM

Table G3.1 #6, Baseline Building Performance column

The baseline LPD must be established using the space-by-space method based on 90.1 Table G3.7. Lighting in the proposed design that is specifically exempted in 90.1 Section 9.1.1, 9.2.2.3 in 90.1 2016, Table 9.2.3.1 in 90.1 2019, or 90.1 Section 9.4.2 in 90.1 2016 and 2019 must be modeled in the baseline the same as in the proposed design.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Table G3.1 #6, Baseline Building Performance column

Interior lighting power in the baseline building design shall be determined using the values in Tables G3.7-1 and G3.7-2. However, where lighting neither exists nor is submitted with design documents, and the proposed design lighting power is determined in accordance with the Building Area Method, the baseline building design lighting power shall be determined in accordance with Table G3.8. Where retail display lighting is included in the proposed building design in accordance with Section 9.5.2.2(b), the baseline building design retail display lighting additional power shall be equal to the limits established by Section 9.5.2.2(b) or same as proposed, whichever is less. Lighting in the proposed design that is specifically exempted in 90.1 Section 9.1.1, Table 9.2.2.1, or Table 9.2.2.2 must be modeled in the baseline the same as in the proposed design.

G3.3 Minor Alterations

G3.3.2.6 Interior Lighting applies to alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) and requires interior lighting power density included in the scope of the alteration to be

modeled as meeting the minimum requirements of 90.1 Section 9.1.1.3.1 using applicable allowances in 90.1 Section 9.5.2.1. Lighting not included in the scope of the alteration should be modeled identically in the baseline and proposed.

Review Tips

1. Baseline/budget interior lighting is found in the following tables of the Compliance Form:
 - a. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
 - b. Table 1 on the Lighting Space Types tab shows whether the project used space-by-space or building area method. (Only space-by-space method is allowed for PRM projects except in some narrow circumstances for alterations following 90.1 2022 Section G3.3.)
 - c. Space-by-space LPDs are shown in Table 1 of the Interior Lighting Counts tab, Baseline/Budget group of columns. These values are set automatically by the Compliance Form based on user-provided description of the building area types and space types.
2. Spot-check the baseline/budget LPDs in spaces where proposed LPD is substantially lower than the baseline/budget LPD (based on Table 1 of the Interior Lighting Counts tab). The exaggerated savings may be due to the mistakes described below. LPD difference over 30% on Energy Cost Budget models and over 50% on Performance Rating Method model should be flagged.
4. Common Mistakes
 - a. Baseline LPD increased to include decorative lighting allowance
 - 90.1 Performance Rating Method (does not apply to 90.1 2022 alterations subject to Section G3.3): the baseline LPD is always based on the values in 90.1 Table G3.7. There are no provisions for any additional allowances except for 90.1 2022 projects where if retail display lighting is included in the proposed building design in accordance with Section 9.5.2.2(b), the baseline building design retail display lighting additional power shall be modeled as equal to the limits established by Section 9.5.2.2(b) or same as proposed, whichever is less.
 - 90.1 Energy Cost Budget : the baseline may be increased to include additional wattage up to the decorative lighting allowance specified in 90.1 Section 9.6.2 only if it meets the requirement of that section (e.g., is installed in addition to the general lighting, is automatically controlled separately from the general lighting and turned off during nonbusiness hours).

Example: The proposed design includes decorative wall sconces in the corridors of a multifamily building. The sconces are controlled separately from the general ceiling lighting and have 0.7 W/ft² LPD calculated as described in 90.1 Section 9.1.3 and 90.1 Section 9.1.4.

Energy Cost Budget : If the project used the space-by-space method, 0.7 W/ft² can be added to the budget corridor LPD allowance. If the project uses the building area method, lighting in the budget design cannot be increased to include the decorative allowance. The proposed design must be modeled as specified and include both the general and decorative lighting.

Performance Rating Method (example does not apply to 90.1 2022 alterations subject to Section G3.3): the decorative lighting allowance cannot be added to the baseline. The

proposed design must be modeled as specified and include both the general and decorative lighting.

- b. LPD is based on an incorrect space type.

Using the incorrect space type in 90.1 Table G3.7 (Performance Rating Method path) or 90.1 Section 9.6.1 (Energy Cost Budget path) may lead to an exaggerated baseline/budget LPD allowance.

Example: A project includes a large space that houses some mechanical equipment but is mostly used as storage. Establishing the baseline LPD by applying the allowance for the Electrical/Mechanical space type (1.5W/SF based on Table G3.7 with PRM; 0.97 W/SF based on 90.1 Table 9.6.1 with Note 7 for ECB) to the entire space is incorrect. Instead, the baseline/budget allowance must be established by breaking the space into sub-spaces, as described in 90.1 Section 9.6.1 (a), with the storage room lighting allowance (0.63 W/SF ECB, 0.80 W/SF PRM) used for a portion of the space.

LI04-P Proposed lighting controls reported in the Compliance Form reflect design documents

90.1 2016 ECB

Table 11.5.1 #6 e,f:

- The lighting schedules in the proposed design shall reflect the mandatory automatic lighting control requirements in Section 9.4.1 (e.g., programmable controls or occupancy sensors).
- Design documents must include lighting controls required in 90.1 Section 9.4.1, since these requirements are mandatory.
- Automatic lighting controls included in the proposed design but not required by Section 9.4.1 may be modeled directly in the building simulation or be modeled in the building simulation through schedule adjustments determined by a separate analysis approved by the authority having jurisdiction. As an alternative to modeling such lighting controls, the proposed design lighting power may be reduced for each luminaire under control by dividing the rated lighting power of the luminaire per Section 9.6.3 and Table 9.6.3.

90.1 2019/2022 ECB

Table 11.5.1 #6 e,f,g/ Table 12.5.1 #6 e,f,g:

- The lighting schedules in the proposed design shall reflect the mandatory automatic lighting control requirements in Section 9.4.1 (e.g., programmable controls or occupancy sensors).
- Design documents must include lighting controls required in 90.1 Section 9.4.1, since these requirements are mandatory.
- The specified daylighting controls must be modeled explicitly in the simulation tool, or through an adjustment determined by a separate approved analysis. Modeling and schedule adjustments shall separately account for primary sidelighted areas, secondary sidelighted areas, and toplighted areas.
- Automatic lighting controls included in the proposed design but not required by Section 9.4.1 may be modeled using the following methods for each luminaire under control:

- Manual-ON or partial-auto-ON occupancy sensors shall be modeled by reducing the lighting schedule each hour by the occupancy sensor reduction factors in Table G3.7 for the applicable space type multiplied by 1.25.
- Automatic lighting controls listed in Table 9.6.3/9.5.2.3 shall be modeled using the sum of the applicable control factors (CF). Apply control factors (CF) to only the portion of wattage of the fixtures in the space controlled by said lighting control. Divide each hour of the lighting schedule by $(1 + \sum CF)$, where $\sum CF$ indicates the sum of all applicable control factors for that space per Section 9.6.3/9.5.2.3 and Table 9.6.3/9.5.2.3.

90.1 2016, 2019, and 2022 PRM

G3.2 New Construction/Major Alterations

90.1 Table G3.1 #6: The specified daylighting controls must be modeled explicitly in the simulation tool, or through an adjustment determined by a separate approved analysis. Other specified automatic lighting controls included in the proposed design must be modeled by reducing the lighting schedule each hour by the Occupancy Sensor Reduction factors in 90.1 Table G3.7, including Notes b and c below the table. Credit for other programmable lighting control in buildings less than 5000 ft² can be taken by reducing the lighting schedule each hour by 10%.

G3.3 Minor Alterations

For alterations subject to Section G3.3 (i.e., Minor Alterations), credit for lighting controls that exceed the minimum requirements of 90.1 Section 9.1.1.3.1 can be modeled following the method described in 90.1 Table G3.1 #6.

Review Tips

1. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. Lighting controls specified for each space are reported in Table 1 of the Interior Lighting Counts tab. Spot-check large or representative space types (e.g., offices, corridors and conference rooms in an office building) to confirm that the specified lighting controls reported for these spaces in the Compliance Form reflect design documents.

Table 1: Lighting Fixture Counts			Automatic Daylighting Controls				Automatic Occupancy Sensor								
Space Name Reference (e.g. space name(s) from drawings)	Thermal Block Name from Model	Lighting Plans Dwg#	Controlled Lighting [Watt]	Daylight Sidelighting 90.1 9.4.1.1 (e)	Daylight Toplighting 90.1 9.4.1.1 (f)	Exceed Mandatory Requirements?	Total Controlled Lighting [Watt]	Manual ON 90.1 9.4.1.1 (b)	Partial/Automatic ON 90.1 9.4.1.1 (c)	Bilevel 90.1 9.4.1.1 (d)	Automatic Partial OFF 90.1 9.4.1.1 (g)	Automatic Full OFF 90.1 9.4.1.1 (h)	Scheduled Shutoff 90.1 9.4.1.1 (i)	Exceed Mandatory Requirements?	Workstation Lighting Controlled by Individual OS [Watt]
Corr 101	Corr1	E-101	0	n/a	n/a	No	261	No	No	No	Yes	No	Yes	No	0
Trash 102	Corr1	E-101	0	No	No	No	23	No	No	No	No	Yes	No	No	0
Stair 103	N Stair1	E-101	0	n/a	n/a	No	46	No	No	Yes	Yes	No	Yes	No	0
Stair 104	S Stair1	E-101	0	n/a	n/a	No	46	No	No	Yes	Yes	No	Yes	No	0
Apt 101A	MF1ESE Perim Spc (G.ESE4)	E-101	0	No	No	No									
Apt 101B	MF1East Perim Spc (G.E5)	E-101	0	No	No	No									
Apt 102A	MF1East Perim Spc (G.E6)	E-101	0	No	No	No									
Apt 102B	MF1ENE Perim Spc (G.ENE7)	E-101	0	No	No	No									

3. Credit for daylighting and OS controls must only be applied to the portion of lighting in each thermal block that is being controlled and not to all lighting in the thermal block. The controlled wattage withing each space must be listed in the Compliance Form. Verify that it matches the design documents.

Table 1: Lighting Fixture Counts

Space Name Reference (e.g. space name(s) from drawings)	Thermal Block Name from Model	Lighting Plans Dwg#	Total	Automatic Daylighting Controls				Automatic Occupancy Sensor						
				Controlled Lighting [Watt]	Daylight Side-lighting 90.1 9.4.1.1 (e)	Daylight Top-lighting 90.1 9.4.1.1 (f)	Exceed Mandatory Requirements?	Total Controlled Lighting [Watt]	Manual ON 90.1 9.4.1.1 (b)	Partial Automatic ON 90.1 9.4.1.1 (c)	Bi-level 90.1 9.4.1.1 (d)	Automatic Partial OFF 90.1 9.4.1.1 (g)	Automatic Full OFF 90.1 9.4.1.1 (h)	Scheduled Shutoff 90.1 9.4.1.1 (i)
Sales 106	Retfl1Sales	E-103	1.22	0	n/a	n/a	No	1,488	Yes	No	Yes	No	Yes	No
Sales 107	Retfl1Sales	E-103	1.22	696	Yes	n/a	Yes	1,392	Yes	No	Yes	No	Yes	No
Sales 108	Retfl1Sales	E-103	1.22	816	Yes	n/a	Yes	1,632	Yes	No	Yes	No	Yes	No
Stair R101	Strfl1N	E-102	0.58	0	n/a	n/a	No	46	No	No	Yes	Yes	No	Yes
Stair R102	Strfl1S	E-102	0.58	0	n/a	n/a	No	46	No	No	Yes	Yes	No	Yes
Stor R201	Retfl2Other	E-103	0.46	0	n/a	n/a	No	800	Yes	No	No	No	Yes	No
Breakroom R202	Retfl2Other	E-103	0.62	0	n/a	n/a	No	256	Yes	No	Yes	No	Yes	No
Office R203	Retfl2Other	E-103	0.93	0	n/a	n/a	No	160	Yes	No	Yes	No	Yes	No

4. Tips for Energy Cost Budget projects

- Only the lighting controls in the proposed design that exceed the minimum requirements of 90.1 Section 9.4.1 may be modeled differently in the proposed design compared to the baseline. Examples of controls that exceed the minimum requirements include but are not limited to the occupancy sensors and daylighting controls where they are not required in 90.1 Section 9.4.1, Manual on control where it is not required, automatic full off where only partial off is required, continuous dimming where not required and lumen maintenance controls.
- In 90.1 2016, the standard does not specify the schedule adjustments to be used for capturing occupancy sensor savings, thus the values from 90.1 Table G3.7 Occupancy Sensor Reduction column should be used.

LI05-P Specified lighting controls meet mandatory requirements in 90.1 Section 9

Review tips

1. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. Table 1 of the Interior Lighting Counts tab lists the mandatory lighting control requirements for each space depending on the space type. The lighting control requirements in 90.1 2016 and beyond are significantly more comprehensive compared to 90.1 2010 - for example, many spaces with windows must have daylighting controls. Spot-check lighting controls specified in the design document for a sample of typical spaces to ensure that they meet the mandatory lighting requirements shown in the Compliance Form.

Insert Rows Filter On/Off Import Lighting Data

Table 1: Lighting Fixture Counts

Total for Area (ft²):

Space Name Reference (e.g. space name(s) from drawings)	Thermal Block Name from Model	Lighting Plans Dwg#	Multiplier	Space/Building Area Type (90.1-Section 9)	90.1 Mandatory Lighting Control Requirements (For Reference)									
					Local Controls, 90.1 9.4.1.1(a)	Manual ON 90.1 9.4.1.1 (b)	Partial Automatic ON 90.1 9.4.1.1 (c)	Multilevel lighting control 90.1 9.4.1.1 (d)	Daylight Sidelighting 90.1 9.4.1.1 (e)	Daylight Toplighting 90.1 9.4.1.1 (f)	Automatic reduction control 90.1 9.4.1.1 (g)	Automatic Full OFF 90.1 9.4.1.1 (h)	Scheduled Shutoff 90.1 9.4.1.1 (i)	Dwelling Unit Lighting Controls (9.4.3.2)
Corr 101	Corr1	E-101	1	Corridor	REQ	-	-	-	REQ	REQ	REQ	ADD2	ADD2	-
Trash 102	Corr1	E-101	1	Storage Room/<50 ft^2	REQ	REQ	-	-	-	-	-	REQ	-	-
Stair 103	N Stair1	E-101	1	Stairwell	-	-	-	-	REQ	REQ	REQ	ADD2	ADD2	-
Stair 104	S Stair1	E-101	1	Stairwell	-	-	-	-	REQ	REQ	REQ	ADD2	ADD2	-
Apt 101A	ESE Perim Spc (G.E)	E-101	1	Dwelling Unit										REQ
Apt 101B	E East Perim Spc (G)	E-101	1	Dwelling Unit										REQ
Apt 102A	E East Perim Spc (G)	E-101	1	Dwelling Unit										REQ
Apt 102B	E NE Perim Spc (G.E)	E-101	1	Dwelling Unit										REQ
Apt 103A	NW Perim Spc (G.V)	E-101	1	Dwelling Unit										REQ
Apt 103B	West Perim Spc (G)	E-101	1	Dwelling Unit										REQ
Apt 104A	West Perim Spc (G)	E-101	1	Dwelling Unit										REQ
Apt 104B	SW Perim Spc (G.V)	E-101	1	Dwelling Unit										REQ
Corr 201-901	Corr2	E-101	8	Corridor	REQ	-	-	-	REQ	REQ	REQ	ADD2	ADD2	-
Trash 202-902	Corr2	E-101	8	Storage Room/<50 ft^2	REQ	REQ	-	-	-	-	-	REQ	-	-
Stair 203-903	N Stair2	E-101	8	Stairwell	-	-	-	-	REQ	REQ	REQ	ADD2	ADD2	-
Stair 204-904	S Stair2	E-101	8	Stairwell	-	-	-	-	REQ	REQ	REQ	ADD2	ADD2	-
Apt 201A-901A	ESE Perim Spc (M.E)	E-101	8	Dwelling Unit										REQ

> ... Operating Schedules Proposed Envelope Assemblies Envelope Areas Infiltration Lighting Space Types Interior Lighting Controls Interior Lighting Summary

3. This check is performed automatically in the Compliance Form.

LI05-B Baseline/budget lighting controls are established correctly in the Compliance Form 90.1 2016/2019/2022 ECB

Table 11.5.1 #6 c/ Table 11.5.1 #6 e /Table 12.5.1 #6 e: Mandatory automatic lighting controls required by Section 9.4.1 must be modeled the same as the proposed design.

90.1 2016 and 2019 PRM

Table G3.1 #6: No occupancy or daylighting controls should be modeled, except the lighting schedules for the employee lunch and break rooms, conference/meeting rooms and classrooms (not including shop classrooms, laboratory classrooms and preschool through 12th-grade classrooms) must reflect the reduced runtime hours due to occupancy sensors.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

The requirements are the same as described in Table G3.1 #6 for the 90.1 2016 and 2019 PRM above.

G3.3 Minor Alterations

Lighting controls shall be modeled as meeting the minimum requirements of 90.1 Section 9.1.1.3.1 in the baseline design model.

Review Tips

1. Baseline/budget lighting controls for each space are determined automatically and are shown in Table 1 of the Interior Lighting Counts tab of the Compliance form. This check is automatically completed in the Quality Control Checks tab of the Compliance Form.

2. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

LI06-B, LI06-P Modeled interior lighting peak demand is consistent with the baseline interior lighting wattage reported in the Compliance Form

Review Tips

1. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations).
2. Table 2 of the Compliance Calculations tab shows non-coincident peak demand for interior lighting. The value is taken from the simulation reports and reflects the maximum modeled interior lighting load (kW). Peak lighting demand depends on the modeled lighting wattage, the hourly lighting schedule, adjustments to the hourly schedule to reflect reduced runtime due to occupancy sensors (if applicable) and modeled daylighting controls. The modeled interior lighting peak demand may be compared to the interior lighting wattage reported on the Interior Lighting Summary tab Table 1 to verify the following for Performance Rating Method (except for 90.1 2022 alterations subject to G3.3) projects:

$MLD_{base} > TLW_{base}$ indicates an error in the baseline model because the modeled non-coincident peak demand cannot exceed the maximum wattage reported in the Compliance Form. When this check fails, the model inputs or the baseline lighting wattage reported in the Compliance Form must be corrected.

MLD = modeled noncoincident lighting peak demand from simulation reports[kW]
 TLW = total lighting wattage from Table 1 of the Interior Lighting Summary tab [kW]

Optionally, a similar check may be completed for Performance Rating Method proposed design and Energy Cost Budget budget and proposed design. However, for these models the coincident peak demand is expected to be lower than the total lighting wattage reported in the compliance form due to occupancy sensor and daylighting controls. A multiplier of 0.7 may be used to roughly approximate the impact of such controls on coincident demand, as follows:

$MLD_{prop} < 0.7 * TLW_{prop}$
 $MLD_{budget} > 0.7 * TLW_{budget}$

As part of this check, it is also helpful to verify that the non-coincident lighting peak demand reported in the Compliance Calculations tab Table 2 matches simulation reports.

eQUEST Reports	PS-E
Trane TRACE 700	LEED Summary Section 1.6
Trane TRACE 3D Plus	LEED Summary Section 1.6
IESVE SOFTWARE	Room Loads Report, Zone Loads Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report
EnergyPlus	eplustbl.html 'Demand End Use Components Summary' report, 'End Uses' section

OpenStudio	eplustbl.html 'Demand End Use Components Summary' report, 'End Uses' section
Carrier HAP v5	"LEED Summary" report, Section 2, "Minimum Energy Performance Calculator", table titled "Proposed Energy Summary by End Use".
Design Builder	LEED Summary Reports in Output Summary Document

LI07-B, LI07-P Baseline/budget and proposed wattage entered into simulation tool reflects values reported in the Compliance Form.

Review Tips

Proposed and baseline (budget) LPDs and floor areas may be correctly reported in the submittal, but not match the modeling inputs. For example, there may be a difference in the areas of different space types reported in the submittal compared to what was modeled due to incorrect assignment of the space types to the modeled thermal blocks. Depending on the reporting capabilities of the simulation tool, the following steps should be followed to verify the inputs.

- a. Review simulation reports to confirm that the total modeled baseline (budget) and proposed wattage reported in the Compliance Form matches the modeled values.
- b. Spot-check simulation reports showing inputs for individual thermal blocks, to confirm that the entered baseline (budget) and proposed LPDs reflect the values reported in Table 2 of the Interior Lighting Summary tab. Focus on the larger thermal blocks with high lighting wattage, as input discrepancies for these thermal blocks may be impactful and spot-check the rest. Refer to the table in the Interior Lighting section on the Quality Control Tab to identify thermal blocks that account for the greatest total lighting wattage.

Space Type, Thermal Block, and Fixture Type Rank by Total Wattage

Rank based Upon Total Wattage Associated with Each	Space Types	Thermal Blocks	Fixture Types
	Name, Total Wattage	Name, Total Wattage	Name, Total Wattage
1	Dwelling Unit, 45,600	Retfl1Sales, 5,904	E, 17,712
2	Sales Area, 17,712	Retfl2Sales, 5,904	D, 3,840
3	Corridor/All Other, 2,610	Retfl3Sales, 5,904	A, 2,610
4	Storage Room/≥50 ft ² , 2,400	MF1ESE Perim Spc (M.ESE15), 4,620	C, 1,426
5	Stairwell, 1,196	MF1WSW Perim Spc (M.WSW22), 4,620	
6	Lounge/Breakroom/All Other, 768	MF1ENE Perim Spc (M.ENE18), 4,578	
7	Office/Enclosed, 480	MF1WNW Perim Spc (M.WNW19), 4,578	
8	Storage Room/<50 ft ² , 230	MF1East Perim Spc (M.E17), 4,524	
9	Restroom/ All Other, 192	MF1West Perim Spc (M.W20), 4,524	
10		MF1East Perim Spc (M.E16), 4,518	

Some of the modeled thermal blocks include spaces of different types, thus the modeled baseline (budget) LPD for some thermal blocks may represent area-weighted average of the LPDs prescribed by the standard for individual space types. For example, if 75% of the floor area in a thermal block is an office occupancy (1.1 W/SF PRM baseline LPD) and the remaining 25% is a restroom occupancy (0.9 W/SF PRM baseline LPD), the baseline LPD of

1.1*0.75+0.9*0.25=1.05 W/SF should be modeled. These calculations are automated in the compliance form with the results included on the Interior Lighting Summary tab in Table 2.

eQUEST Reports	LV-B, CSV Space Loads Report (as information in available)
Trane TRACE 700	Room Information entered values report
Trane TRACE 3D Plus	Lighting and Daylighting Summary report
IESVE SOFTWARE	Thermal Template Report, BPRM Report, Room Loads Report, Zone Loads Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report
EnergyPlus	eplustbl.html 'Lighting Summary' report, 'Interior Lighting' section
OpenStudio	eplustbl.html 'Lighting Summary' report, 'Interior Lighting' section
Carrier HAP v5	"Space Input Data" report.
Design Builder	Lighting sheet in LEED Minimum Energy Performance Calculator (.xlsm)

LI08-B, LI08-P Occupancy sensor controls in the baseline/budget and proposed design are modeled as reported in the Compliance Form

Since occupancy sensors are modeled by reducing hourly values in the lighting schedule, the review should focus on verifying that modified schedule reflect the occupancy sensors reported in the Compliance Form including the following:

- a. Reduction in hourly lighting schedule fractions does not exceed the allowed limit.
- b. Reduction in hourly lighting schedule fractions is only applied to modeled lighting power for which occupancy sensors are specified and not all lighting.

For additional verification, if available in model output reports, check that modeled schedules reflect building occupancy types including appropriate seasonal and weekly variation. For example, if the building occupancy type is a school that closes during the summer months, then the lighting schedules should be reflective of this seasonal occupancy pattern. Refer to the Operating Schedule tab in the Compliance Form for anticipated building occupancy patterns.

Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

eQUEST Reports	TBD
Trane TRACE 700	
Trane TRACE 3D Plus	
IESVE SOFTWARE	
EnergyPlus	
OpenStudio	
Carrier HAP v5	
Design Builder	

LI09-B, LI09-P Daylighting controls in the baseline/budget and proposed design are modeled as reported in the Compliance Form

Verify simulation reports to confirm that daylighting controls are modeled as reported in the Compliance Form. Focus on the following:

- a. Daylighting controls are applied only to the lighting fixtures that have such controls based on the information provided in the Compliance Form
- b. Modeled daylighting control settings are as specified including but not limited to the target illuminance levels and continuous versus stepped dimming.

eQUEST Reports	TBD
Trane TRACE 700	
Trane TRACE 3D Plus	
IESVE SOFTWARE	
EnergyPlus	
OpenStudio	
Carrier HAP v5	
Design Builder	

LI10 Modeled interior lighting runtime hours are realistic

Review Tips

1. The check is automatically performed in the Quality Control Checks tab of the Compliance Form (for alterations subject to 90.1 2022 G3.3 (i.e., Minor Alterations) the baseline design runtime hours will not auto populate accurately since the project is not inputting baseline model inputs into the Compliance Form).
2. Modeled lighting schedules describe how lights are used throughout the day and during different days of the week (e.g., weekdays vs weekends). The lighting schedules are comprised of 8760 values that represent percentage of the design wattage that is lit during each hour of the year. Hourly values of 1 indicates that 100% of the specified lighting is on during that hour. Hourly values of 0.05 indicates that 5% of the specified lighting is on during that hour. Effective Full Load Hours (EFLH) are equal to the sum of the hourly schedule fractions over the year. EFLH represent the number of hours lights must be fully on in order to consume the equivalent amount of energy.

$$EFLH = LEU / TLW$$

LEU = simulated annual lighting energy use [kWh]

TLW = total lighting wattage from Table 1 of the Interior Lighting Summary tab tab [kW]

90.1 Section 9.4.1.1 requires turning off most non-emergency lights during unoccupied periods. Furthermore, during the hours when the building is occupied, not all lights are on at all times due to occupancy sensors, daylighting controls and the use of manual lighting controls. Typical lighting

EFLH for common building types without accounting for controls are included in Appendix A to this Manual.

3. EFLH may be used to perform the following checks:
 - a) EFLH in the Performance Rating Method baseline do not exceed typical provided in Appendix A. While EFLHs significantly higher (e.g. by more than 20%) than those provided in Appendix A may be justified by non-standard building operation (e.g. an office building occupied 16 hours a day), unrealistic values should be flagged by reviewers because it exaggerates the lighting-related performance penalty/credit. Too low EFLH underestimates the lighting penalty/credit.
 - b) EFLH for the ECB budget and proposed design models are the same unless proposed design has improved lighting controls reported in Table 1 of the Interior Lighting Counts tab (this tip also applies to alterations subject to 90.1 2022 Section G3.3).

Table 1: Lighting Fixture Counts				Total for Area (ft ²):	Automatic Daylighting Controls				Automatic Occupancy Sensor							
Space Name Reference (e.g. space name(s) from drawings)	Thermal Block Name from Model	Lighting Plans Dwg#	Multiplier	Space/Building Area Type (90.1-Section 9)	Controlled Lighting [Watt]	Daylight Sidelighting 90.1.9.4.1.1 (e)	Daylight Toplighting 90.1.9.4.1.1 (f)	Exceed Mandatory Requirements?	Total Controlled Lighting [Watt]	Manual ON 90.1.9.4.1.1 (b)	Partial Automatic ON 90.1.9.4.1.1 (c)	Ellevel 90.1.9.4.1.1 (d)	Automatic Partial OFF 90.1.9.4.1.1 (g)	Automatic Full OFF 90.1.9.4.1.1 (h)	Scheduled Shutoff 90.1.9.4.1.1 (i)	Exceed Mandatory Requirements?
Corr 101	Corr1	E-101	1	Corridor/All Other	0	n/a	n/a	No	261	No	No	No	Yes	No	Yes	No
Trash 102	Corr1	E-101	1	Storage Room/<50 ft^2	0	No	No	No	23	No	No	No	No	Yes	No	No
Stair 103	N Stair1	E-101	1	Stairwell	0	n/a	n/a	No	46	No	No	Yes	Yes	No	Yes	No
Stair 104	S Stair1	E-101	1	Stairwell	0	n/a	n/a	No	46	No	No	Yes	Yes	No	Yes	No

eQUEST Reports	BEPU
Trane TRACE 700	LEED Summary Section 1.6
Trane TRACE 3D Plus	Lighting and Daylighting Summary report
IESVE SOFTWARE	BPRM Report, Room Loads Report, Zone Loads Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report
EnergyPlus	eplustbl.html 'Lighting Summary' report, 'Interior Lighting' section
OpenStudio	eplustbl.html 'Lighting Summary' report, 'Interior Lighting' section
Carrier HAP v5	"LEED Summary" report, Section 2, "Minimum Energy Performance Calculator", table titled "Proposed Energy Summary by End Use".
Design Builder	LEED Summary Reports in Output Summary Document

LI11 The difference in the interior lighting annual energy use of the baseline(budget) and proposed design is reasonable

Review Tips

1. The difference between the baseline (budget) and proposed annual lighting energy use (kWh) is driven by the difference in the lighting wattages and controls of the two models. The expected patterns are described below.

$$TLW_{prop} * LCC / LTW_{budget} \sim LEU_{prop} / LEU_{budget}$$

LCC = proposed design lighting controls credit.

- For Performance Rating Method, LCC=0.7 may be assumed (i.e. ~30% reduction in lighting energy due to 90.1 mandatory lighting controls and any additional controls that are specified).

- For Energy Cost Budget and alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations), LCC=1 if the proposed design does not have any lighting controls in addition to those required by 90.1, or ~ 0.9 if additional lighting controls are specified.

Difference in the lighting energy use between baseline/budget and proposed design that does not follow this expected pattern may indicate that lighting was not simulated correctly and should be flagged in the review. However, the expected change in lighting energy use may be different on projects using space-by-space method, as shown in examples below.

Example 1: 60,000 ft² dormitory building includes 30,000 ft² of dorm rooms (dormitory living quarters space type) with 0.3 W/ ft² specified lighting and 30,000 ft² corridors (corridor space type) with 0.8 W/ ft² specified lighting. Corridor lighting has bilevel occupancy sensor controls meeting the minimum requirements in 90.1 Table 9.6.1. The project follows ECB and uses the building area method for the lighting calculations.

Based on 90.1 Table 9.5.1, the building area allowance is 0.61W/ ft² (90.1 Table 9.5.1). This LPD must be modeled for all spaces in the budget model. The proposed LPD is $(30,000 \times 0.3 + 30,000 \times 0.8) / 60,000 = 0.55$ and must be modeled in all spaces. The annual lighting energy use in the proposed design is expected to be $0.55 / 0.61 \sim 90\%$ of the budget lighting energy use.

Example 2: Same project as in Example 1, but the space-by-space method is used. 90.1 Table 9.6.1 has an allowance of 0.54 W/ ft² for dormitory living quarters and 0.66 W/ ft² for corridors. Lights are typically on 3-4 hours per day in the living quarters and 24 hours per day in corridors. Based on 90.1 Table G3.7, bi-level lighting controls in corridors result in 25% runtime reduction that will be applied to both the budget and proposed lighting. Based on the above assumptions, the proposed lighting energy use is expected to be $(0.3 \times 30,000 \times 4 + 0.8 \times 30,000 \times 24 \times (1 - 0.25)) / (0.54 \times 30,000 \times 4 + 0.66 \times 30,000 \times 24 \times (1 - 0.25)) \sim 110\%$ of the budget lighting energy use.

eQUEST Reports	BEPU
Trane TRACE 700	LEED Summary Section 1.6
Trane TRACE 3D Plus	Lighting and Daylighting Summary report
IESVE SOFTWARE	BPRM Report, Room Loads Report, Zone Loads Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report
EnergyPlus	eplustbl.html 'Lighting Summary' report, 'Interior Lighting' section
OpenStudio	eplustbl.html 'Lighting Summary' report, 'Interior Lighting' section
Carrier HAP v5	"LEED Summary" report, Section 2, "Minimum Energy Performance Calculator", table titled "Proposed Energy Summary by End Use".
Design Builder	LEED Summary Reports in Output Summary Document

Lighting, Exterior (LE)

Overview

Lighting Exterior check group addresses exterior lighting and controls. Table 8 summarizes the checks included in this group.

Table 8: Lighting, Exterior Checks Overview

	Type of Check	Proposed Design	Baseline/Budget Design
Lighting Power	CF inputs reflect design documents	LE01-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	LE01-B
	Meet mandatory requirements	LE02-P	NA
	Simulation inputs consistent with CF	LE03-P	LE03-B
	Simulation outputs consistent with CF	NA	NA
Lighting Controls	CF inputs reflect design documents	LE04-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	LE04-B
	Meet mandatory requirements	LE05-P	NA
	Simulation inputs consistent with CF	NA	NA
	Simulation outputs consistent with CF	LE06-P, LE07	LE06-B, LE07
LEGEND			
PASS/FAIL/NA outcome is determined automatically in the Quality Control Checks tab of the Compliance Form			

The following strategies may be used to prioritize the review:

1. For checks that verify the specified fixture wattages, focus on fixtures that account for the largest total exterior wattage on the project and spot-check the rest.
2. For checks that verify the specified fixture counts, focus on exterior application types that account for the largest total wattage and spot-check the rest.
3. Exterior lighting allowances and controls prescribed in 90.1 Section 9 are mandatory and must be met where applicable. Perform the checks to verify that mandatory requirements are met using the prioritization techniques described in #1 and 2 above.
4. For ECB projects, exterior lighting trade-offs are not allowed (i.e., the exterior lighting is not an impactful end use), thus review is limited to verifying that the reported exterior lighting wattage and controls are as specified and meet the mandatory requirements.

For 90.1 2022 PRM alterations subject to G3.3 (i.e., Minor Alterations), the summary tables on the Quality Control Checks tab in the Compliance Form may not reflect correct values for the baseline since projects, for the most part, only enter proposed design information and provide notes as to what was modeled in the baseline in the notes fields associated with the proposed design related tables. Refer to the [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) section for more information regarding 90.1 2022 G3.3.

LE01-B Baseline/Budget exterior lighting Power is established correctly in the Compliance Form

90.1 2016 and 2019/2022 ECB

Table 11.5.1 No 1 Column B/ Table 12.5.1 No 1 Column B

Except as specifically instructed in this table, all building systems and equipment must be modeled identically in the budget building design and proposed design. Exterior lighting is not explicitly listed in Table 11.5.1/12.5.1, this is not a trade-off opportunity and must be modeled the same in the Budget building as specified in the proposed design.

90.1 2016 and 2019 PRM

Table G3.1 No 6, Baseline Building Performance column

Exterior lighting in areas identified as “Tradable Surfaces” in Table G3.6 must be modeled with the baseline lighting power shown in Table G3.6. Other exterior lighting must be modeled the same in the baseline building design as in the proposed design.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Same as the Table G3.1 No 6, Baseline Building Performance column requirements described above for the 90.1 2016 and 2019 PRM.

G3.3 Minor Alterations

Alterations subject to Section G3.3.2.7 (i.e., Minor Alterations) are required to model tradable exterior lighting as minimally compliant with 90.1 Section 9.1.1.3.2 in the baseline design model.

Review Tips

1. Baseline/budget exterior lighting wattage is shown in Table 1 of the Exterior Lighting tab. It is established automatically based on the following user inputs (refer to the 90.1 2022 Section G3.3 Performance Calculations for Other Alterations section for the location of the baseline lighting wattage for alterations subject to 90.1 2022 Section G3.3):
 - a. Project’s exterior lighting zone based on 90.1 Table 9.4.2-1
 - b. Exterior lighting applications for which lighting is specified in the proposed design.
 - c. The surface area or length of the exterior lighting application (e.g., area of the parking that or length of entrance door) that has exterior lighting specified in the proposed design.

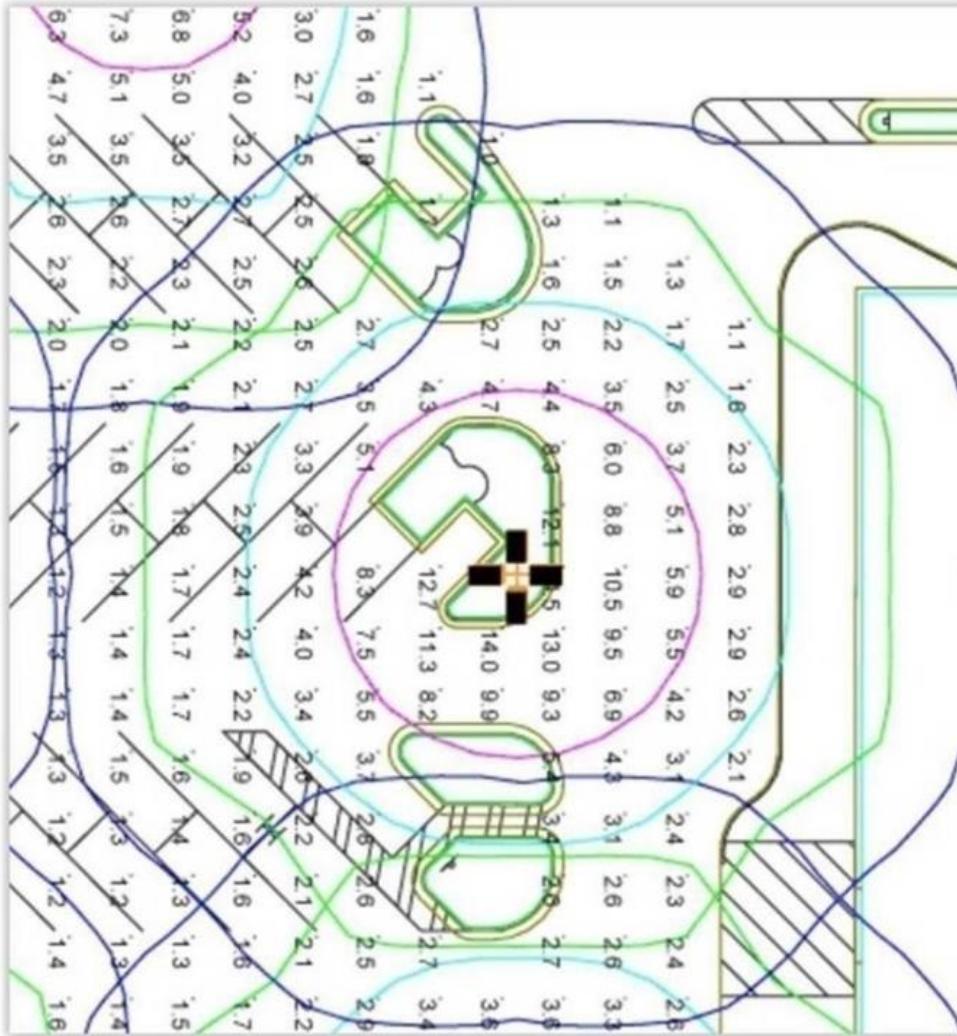
Exterior Area Name Reference (Optional)	Exterior Lighting Application	Allowance Type (Tradable or Nontradable)	Required Input (Area or Length)	Total Area (ft²) or Length (ft) or Other	Multiplier	Plans/Spec	FIXTURE COUNTS Enter fixture counts for each exterior area. If Rated Input Wattage is	Proposed Design Exterior Lighting Power [Watt]			Baseline Design Exterior Lighting Power [Watt]	
								Lighting Power Excluding Exempt Lighting	Exempt Exterior Lighting Power	Total Exterior Lighting Power including Exempt Lighting	Lighting Power Excluding Exempt Lighting	Total Exterior Lighting Power including Exempt Lighting
	Walkways less than 10 ft wide	Tradable	Length	40	1		2	18	-	18	40	40
	Main entries	Tradable	Length	15	1		3	225	-	225	450	450

2. Confirm that an appropriate exterior lighting zone is selected for the project based on the definitions below from Table 9.4.3-1:

- a. Zone 0: Undeveloped areas within national parks, state parks, forest land, rural areas, and other undeveloped areas as defined by the authority having jurisdiction
- b. Zone 1: Developed areas of national parks, state parks, forest land, and rural areas
- c. Zone 2: Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas
- d. Zone 3: All other areas
- e. Zone 4: High-activity commercial districts in major metropolitan areas as designated by the local jurisdiction

Some AHJ and RAs may specify the exterior lighting zones that must be used based on the project address.

3. Use Table 1 of the Exterior Lighting tab to identify exterior lighting applications with the greatest difference in wattage between the baseline and proposed design. Refer to the exterior lighting plans drawings to confirm that entered surface area or length are not exaggerated. The input must reflect the area or length of the surface in the proposed building that is illuminated to some industry standard, such as the IESNA Handbook. It is the responsibility of the design team to identify the illumination design standard and the area actually illuminated, as illustrated in the following figure.



- a. Only the areas that are illuminated without obstruction may be included.
- b. Each portion of the illuminated area must only be assigned one lighting application consistent with the actual use of the area. Any overlapping area of another lighting application, such as a pathway crossing the parking lot, must be subtracted from the area of the other lighting application.
- c. The allowed area of a site roadway, driveway, sidewalk, walkway or bikeway should be determined as either the actual paved area plus 5 feet on either side of the centerline path of travel; or a 25-foot-wide area running along the axis of the path of travel and including as much of the paved area of the site roadway, driveway, sidewalk, walkway or bikeway as possible.¹⁷

3. Common Mistakes

- a. Modeling different exterior lighting between the budget and proposed design with the ECB path.
- b. Including areas of the proposed design that are not illuminated, or incorrectly accounting for partially illuminated areas, when calculating the baseline exterior lighting power. For example, if

¹⁷ California Title 24

the proposed design has an uncovered parking lot that has no lighting specified, the exterior lighting allowance for the uncovered parking areas in 90.1 Table G3.6 cannot be included in the baseline.

- c. Double-counting areas when calculating the baseline exterior lighting power allowance. For example, the baseline lighting allowance for the walkway that crosses an illuminated parking lot can be determined based on the parking lot allowance, or walkway allowance in 90.1 Table G3.6, but not both. If walkway allowance is used, the walkway area calculated as described in #3 above must be subtracted from the parking lot area used to calculate the parking lot baseline lighting allowance.
- d. Modeling baseline lighting for non-tradeable surfaces based on the full allowance in 90.1 Table 3.6. The baseline non-tradeable lighting must be modeled as specified in 90.1 Table G3.6 or based on the proposed lighting for each non-tradeable application, whichever is lower.

LE01-P Proposed exterior lighting power reported in the Compliance Form reflects design documents.

90.1 2016 and 2019/2022 ECB

Table 11.5.1 #6 Column A (a) and (b)/Table 12.5.1 #6 Column A (a) and (b)

Where a complete lighting system exists, the actual lighting power should be used in the model. Where a complete lighting system has been designed, lighting power must be determined in accordance with Sections 9.1.3 and 9.1.4.

90.1 2016, 2019 and 2022 PRM

Table G3.1 No.6 (a), (b), (d)

- a. Where a complete lighting system exists (e.g., in a renovation project where lighting is left as is), the actual lighting power must be modeled.
- b. Where a lighting system has been designed, lighting power must be determined in accordance with 90.1 Sections 9.1.3 and 9.1.4.
- c. The input wattage of specified fixtures must include all power used by the fixture including lamps, ballasts, transformers and control devices and be based on the manufacturers' labeled maximum wattage of the luminaire. The lamp and ballast combination shown on drawings may result in lower input wattage than the maximum rated and thus cannot be used for compliance calculations.

Review Tips

1. The exterior lighting wattage is reported in Table 1 of the Exterior Lighting tab and include the following:
 - a. Lighting fixtures used for exterior lighting applications and the maximum fixture rated wattage for each.
 - b. Number of fixtures of each type specified for each exterior lighting application.

Exterior Lighting Zone (90.1 Table 9.4.2-1)		Zone 2		Lighting Schedules Dwg #			E-103		
Freeze Panes					Fixture Label:			E1	A5
					Maximum Fixture Wattage:			9.0	75.0
					Exempt Lighting Application?			No	No
					Total Fixture Counts:			2	3
Exterior Area Name Reference (Optional)	Exterior Lighting Application	Allowance Type (Tradable or Nontradable)	Required Input (Area or Length)	Total Area (ft ² or Length (ft) or Other)	Multiplier	Plans/Spec	FIXTURE COUNTS Enter fixture counts for each exterior area. If Rated Input Wattage is		
	Walkways less than 10 ft wide	Tradable	Length	40	1		2		
	Main entries	Tradable	Length	15	1			3	

- Use Table 1 of the Exterior Lighting tab to identify lighting fixtures that contribute the most toward the total specified lighting wattage based on the product of the Maximum Rated Fixture Wattage and Total Fixture Counts. Refer to the Lighting Schedule drawings to establish the manufacture and model number for the fixtures. Check the manufacturer information to confirm that the maximum rated fixture wattage reported in the compliance form reflects manufacturer’s data.
- Use Table 1 of the Exterior Lighting tab to identify exterior lighting applications with the greatest difference in wattage between the baseline and proposed design. (The top contributors are also shown on the QC tab.) Refer to the exterior lighting plans drawings to confirm that fixture types and counts for these spaces reported in the Compliance Form match design documents.

4.2-1)		Zone 2		Lighting Schedules Dwg #			E-103			Insert Column			
					Fixture Label:			E1	A5				
					Maximum Fixture Wattage:			9.0	75.0				
					Exempt Lighting Application?			No	No	No			
					Total Fixture Counts:			2	3				
Exterior Lighting Application	Allowance Type (Tradable or Nontradable)	Required Input (Area or Length)	Total Area (ft ² or Length (ft) or Other)	Multiplier	Plans/Spec	FIXTURE COUNTS Enter fixture counts for each exterior area. If Rated Input Wattage is			Proposed Design Exterior Lighting Power (Watt)		Baseline Design Exterior Lighting Power (Watt)		
Walkways less than 10 ft wide	Tradable	Length	40	1	E23	2			Lighting Power Excluding Exempt Lighting	Exempt Exterior Lighting Power	Total Exterior Lighting Power including Exempt Lighting	Lighting Power Excluding Exempt Lighting	Total Exterior Lighting Power including Exempt Lighting
Main entries	Tradable	Length	15	1	E24	3			18	-	18	40	40
									225	-	225	450	450

- Common Mistakes
 - Proposed fixture wattage is based on the specified lamps and not the manufacturer’s labeled maximum wattage of the luminaire.
 - Exterior lighting wattage is excluded for compliance calculations. Submittals with no exterior lighting should be flagged.

LE02-P Specified exterior lighting meets 90.1 mandatory requirements.

Review Tips

- Table 2 of the Exterior Lighting tab shows the total specified exterior lighting wattage alongside the total exterior lighting power allowance in Table 9.4.2.2. Since the exterior lighting requirements are mandatory, projects where the total specified exterior lighting exceeds the exterior lighting power

allowance should be flagged as not complying with 90.1. Refer to the 90.1 2022 Section G3.3 Performance Calculations for Other Alterations section for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations).

Table 2: Exterior Lighting to Be Modeled

Instructions
 1. The table shows the modeling inputs for exterior lighting.
 2. The same schedules reflecting the mandatory exterior lighting controls are to be modeled in the baseline/budget and proposed design models.

Type	Proposed Design Lighting Power including Exempt Lighting [Watt]	Baseline Design [Watt] including Exempt Lighting	?	% Savings of Proposed Design Relative to Allowance
Total Tradeable	243	490	230	-5.7%
Total Non-tradeable	-	-	-	-
Base Site Allowance	-	-	400	-
Total	243	490	630	61.4%

... Interior Lighting Model Inputs Exterior Lighting Ventilation - Mult

- Table 1 of the Exterior Lighting tab shows the total wattage of exterior lighting specified for the individual non-tradeable exterior lighting applications alongside their corresponding lighting power allowances from Table 9.4.2.2-2. Projects where specified lighting for at least one non-tradeable exterior lighting application exceeds the corresponding allowance should be flagged as not complying with 90.1. Refer to the 90.1 2022 Section G3.3 Performance Calculations for Other Alterations section for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations).

Exterior Lighting Application	Allowance Type (Tradable or Nontradable)	Required Input (Area or Length)	Total Area (ft ²) or Length (ft) or Other	Multi-plier	Plans/ Spec	Fixture Label: E1 A5 A10	Maximum Fixture Wattage: 9.0 75.0 34.5	Exempt Lighting Application? No No No	Total Fixture Counts: 2 3 5	Proposed Design Exterior Lighting Power [Watt]			Baseline Design Exterior Lighting Power [Watt]		Individual Lighting Power Allowance [Watt]	
										Lighting Power Excluding Exempt Lighting	Exempt Exterior Lighting Power	Total Exterior Lighting Power including Exempt Lighting	Lighting Power Excluding Exempt Lighting	Total Exterior Lighting Power including Exempt Lighting	Lighting Power Excluding Exempt Lighting	Individual Lighting Power Allowance Including Exempt
Walkways less than 10 ft wide	Tradable	Length	40	1	E23	2				18	-	18	40	40	20	20
Main entries	Tradable	Length	15	1	E24		3			225	-	225	450	450	210	210
Building Facades, Area	Nontradable	Area	2000	1	E35		5			173	-	173	173	173	173W (up to 200W)	173W (up to 200W)

Interior Lighting Model Inputs Exterior Lighting Ventilation - Mu ...

LE03-B, LE03-P Modeled baseline/budget and proposed exterior lighting power reflects the wattages reported in the Compliance Form.

Review Tips

- The modeled baseline/budget exterior lighting wattage must reflect the values reported in Table 2 of the Exterior Lighting tab (refer to the 90.1 2022 Section G3.3 Performance Calculations for Other Alterations section for the location of the baseline lighting wattage for alterations subject to 90.1 2022 Section G3.3).

Table 2: Exterior Lighting to Be Modeled

Instructions

1. The table shows the modeling inputs for exterior lighting.
2. The same schedules reflecting the mandatory exterior lighting controls are to be modeled in the baseline/budget and proposed design models.

Type	Proposed Design Lighting Power including Exempt Lighting [Watt]	Baseline Design [Watt] including Exempt Lighting	Total Exterior Lighting Power Allowance, per 90.1 Table 9.4.2-2 + Exempt [Watt]	% Savings of Proposed Design Relative to Allowance
Total Tradeable	243	490	230	-5.7%
Total Non-tradeable	173	173	173	-
Base Site Allowance	-	-	400	-
Total	416	663	803	48.2%

Interior Lighting Model Inputs **Exterior Lighting** Ventilation - M

2. Depending on the reporting capabilities of the simulation tool used on the project, the inputs can be verified in the input or output reports, as follows:

- Use simulation input reports to verify that the exterior lighting wattage entered into the simulation tool matches the wattage reported in the submittal.
- Use simulation output reports to verify that the modeled lighting peak demand does not exceed the exterior lighting wattage reported in the submittal. The exterior lighting peak demand occurs at night and thus does not coincide with the building overall electricity peak which occurs in the late afternoon for most building types.

PLD <= LTW

PLD [kW] = peak exterior lighting demand based on the simulation output reports

LTW [kW] = design exterior lighting wattage reported in the submittal

eQUEST Reports	PS-E
Trane TRACE 700	LEED Summary Section 1.4, Plant Information entered values report
Trane TRACE 3D Plus	Utility Peak Demand Summary
IESVE SOFTWARE	BPRM Report, Room Loads Report, Zone Loads Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report
EnergyPlus	eplustbl.html 'Lighting Summary' report, 'Exterior Lighting' section
OpenStudio	eplustbl.html 'Lighting Summary' report, 'Exterior Lighting' section
Carrier HAP v5	Input Data: "Building Input Data" report. Output Data: "LEED Summary" Report, Section 2 "Minimum Energy Performance Calculator", table titled "Proposed Energy Summary by End Use".
Design Builder	Exterior Lighting Table in Output Summary Document

LE04-P Exterior lighting controls reported in the Compliance Form reflect design documents

Refer to the Exterior Lighting tab of the Compliance Form to confirm that the exterior lighting controls are reported as specified. Focus on exterior lighting applications that account for the largest reported exterior lighting wattage.

LE04-B Exterior lighting controls reported in the Compliance Form for the baseline/budget design are established correctly

Exterior lighting controls must be the same in the baseline/budget as in the proposed design. No trade-offs in this area are allowed by either the Energy Cost Budget Method or the Performance Rating Method.

LE05-P Specified exterior lighting controls meet 90.1 mandatory requirements

90.1 2016, 2019 and 2022 The Energy Cost Budget and Performance Rating Methods

Section 9.4.1.4 includes exterior lighting control requirements. This section is mandatory, and thus must be met by project documenting compliance following Energy Cost Budget Method or Performance Rating Method.

Review Tip

Review design documents to confirm that exterior lighting controls required in Section 9.4.1.4 are met.

LE06-P Modeled exterior lighting runtime hours in the proposed design are reasonable

Review Tips

1. Following Section 9.4.1.4, in 90.1 2016 and 2019 the exterior lighting must be controlled to turn off when sufficient lighting is available and turned off or operate at a wattage reduced by at least 50%, during non-business hours (applies to most exterior lighting applications 90.1 2022). These controls are mandatory and thus must be specified on all projects. Thus, the modeled exterior lighting runtime may be up to 12 hours / day (4,380 hours per year) for facilities opened 24/7, such as hospitals. Lower runtime (e.g., 6 hours per day) is expected for other building types due to lighting control requirements in 90.1 Section 9.4.1.4.

$EFLH = LEU / LTW$

EFLH [hrs/yr] = exterior lighting effective full load hours

LEU [kWh] = annual exterior lighting energy use, based on the simulation output reports

The review check should be performed only for Performance Rating Method projects.

- EFLH > 4380 should be flagged as a likely error
- EFLH < 2190 (less than 6 hours per day) are reasonable for non-24/7 facilities and should be accepted.
- EFLH between 2190 and 4380 should be investigated on Performance Rating Method projects that have proposed exterior lighting energy use significantly lower than the baseline.

eQUEST Reports	BEPU
Trane TRACE 700	LEED Summary Section 1.6
Trane TRACE 3D Plus	LEED Summary Section 1.6
IESVE SOFTWARE	BPRM Report, Room Loads Report, Zone Loads Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report
EnergyPlus	eplustbl.html 'Lighting Summary' report, 'Exterior Lighting' section
OpenStudio	eplustbl.html 'Lighting Summary' report, 'Exterior Lighting' section
Carrier HAP v5	"LEED Summary" report, Section 2 "Minimum Energy Performance Calculator", table titled "Proposed Energy Summary by End Use".
Design Builder	Lighting sheet in LEED Minimum Energy Performance Calculator (.xlsm)

LE07 Difference between the baseline/budget and proposed exterior lighting energy is as expected

Review Tips

1. 90.1 2016/2019/2022 Energy Cost Budget Method : Since exterior lighting is not a trade-off opportunity, the annual exterior lighting kWh must be the same in the budget and proposed design. Energy Cost Budget Method projects with different exterior lighting energy use in budget vs proposed design should be flagged.
2. 90.1 Performance Rating Method : Since the exterior lighting controls (i.e., lighting runtime) must be the same between the baseline and proposed design, the difference in the annual baseline versus proposed exterior lighting use is expected to be directly proportional to the difference in the exterior lighting wattage reported in the Table 2 of the Exterior Lighting tab of the Compliance Form. For example, if the proposed exterior lighting wattage reported in the submittal is 20% lower than the baseline, the proposed exterior lighting kWh are expected to be also 20% lower than the baseline exterior lighting kWh. Projects where this relationship does not hold should be flagged.

$$\begin{aligned} \text{Performance Rating Method :} & \quad LTW_{prop} / LTW_{base} = LEU_{prop} / LEU_{base} \\ \text{Energy Cost Budget Method :} & \quad LEU_{prop} = LEU_{budget} \end{aligned}$$

eQUEST Reports	BEPU
Trane TRACE 700	LEED Summary Section 1.6
Trane TRACE 3D Plus	LEED Summary Section 1.6
IESVE SOFTWARE	BPRM Report, Room Loads Report, Zone Loads Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report
EnergyPlus	eplustbl.html 'Lighting Summary' report, 'Exterior Lighting' section
OpenStudio	eplustbl.html 'Lighting Summary' report, 'Exterior Lighting' section
Carrier HAP v5	"LEED Summary" report, Section 2 "Minimum Energy Performance Calculator", table titled "Proposed Energy Summary by End Use".
Design Builder	Lighting sheet in LEED Minimum Energy Performance Calculator (.xlsm)

Plug, Process and Other Loads (PPO)

Overview

This category includes receptacle loads, non-HVAC motors, process loads, refrigeration equipment, elevators and other systems and components reported on Plug, Process and Other Loads tab of the Compliance Form. Some of these systems, such as certain refrigeration equipment and elevators, are regulated by 90.1, while others are not. Table 9 summarizes the checks included in this group.

Table 9: Plug, Process and Other Loads Checks Overview

	Type of Check	Proposed Design	Baseline/Budget Design
Miscellaneous and Process Equipment	CF inputs reflect design documents		
	CF inputs reflect requirements of ECB/PRM	PPO02-P	PPO02-B, PPO03
	Simulation inputs consistent with CF	PPO04-P	PPO04-B
	Simulation outputs consistent with CF	PPO01	PPO01
Commercial Refrigerators and Freezers	CF inputs reflect design documents	PPO05-P	
	CF inputs reflect requirements of ECB/PRM		PPO05-B
	Meet mandatory requirements		
	Simulation inputs/outputs consistent with CF	PPO06	PPO06
Regulated Motors	CF inputs reflect design documents	PPO07-P	
	CF inputs reflect requirements of ECB/PRM		PPO07-B
	Meet mandatory requirements		
	Simulation inputs/output consistent with CF	PPO08	PPO08
Elevators	CF inputs reflect design documents	PPO09-P	
	CF inputs reflect requirements of ECB/PRM		PPO09-B
	Simulation inputs/outputs consistent with CF	PPO10	PPO10
Combined Heat and Power	CF inputs reflect design documents	PPO11-P	PPO11-B
	CF inputs reflect requirements of ECB/PRM		
	Simulation inputs/outputs consistent with CF	PPO12	PPO12
LEGEND			
PASS/FAIL/NA outcome is determined automatically in the Quality Control Checks tab of the Compliance Form			

Table 10 illustrates whether trade-offs are allowed for systems and components included in the PPO category by the Energy Cost Budget and Performance Rating Methods. If trade-offs are not allowed, the review should be limited to verifying that the energy use of the associated systems and equipment is the same in the baseline/budget and proposed designs. No other checks are necessary.

Table 10: 90.1 Trade-off Limits for Plug, Process and Other Loads

	2016 ECB	2019/2022 ECB	2016 and 2019 PRM and 2022 G3.2 PRM		2022 PRM G3.3	
			Min. compliance	Above code	Min. compliance	Above code
Miscellaneous plug and process equipment	No	No	No	Yes	No	Yes
Commercial refrigerators and freezers	No	Yes	Yes	Yes	Yes	Yes
Regulated Motors	Yes	Yes	Yes	Yes	Yes	Yes
Elevators	No	No	Yes	Yes	Yes	Yes
Combined Heat and Power	Recovered Heat Only					

In addition, skip review checks for the following systems and components if they are not reported in the Compliance Form and are not expected to be specified:

- a. Elevators in buildings two stories or less
- b. Commercial refrigerators and freezers in building types other than convention center, retail, school/university, dining, health care clinic, hospital or warehouse
- c. Regulated motors in buildings 10 stories or less
- d. Combined heat and power in any project

Within the given type of equipment, focus on verifying units with the highest contribution to the total energy use of that category or that are representative and spot-check the rest. For example, if a project includes 10 passenger elevators of the same type and two service elevators, the review should focus on the passenger elevator.

For 90.1 2022 PRM alterations subject to G3.3 (i.e., Minor Alterations), the summary tables on the Quality Control Checks tab in the Compliance Form may not reflect correct values for the baseline since projects, for the most part, only enter proposed design information and provide notes as to what was modeled in the baseline in the notes fields associated with the proposed design related tables. Refer to the [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) section for more information regarding 90.1 2022 G3.3.

PPO01 The difference between the modeled baseline/budget and proposed misc. equipment and process energy use is as expected

Review Tips

1. Modeled energy use from miscellaneous equipment and industrial is reported in Table 2 of the Compliance Calculations tab

a) 90.1 2016/2019/2022 Energy Cost Budget Method or 90.1 2016/2019/2022 Performance Rating Method minimum code compliance:

Modeled energy use of miscellaneous loads must be the same for the baseline/budget and proposed design. Differences in reported energy use should be flagged as an error.

Exception: 90.1 2019 and 2022 PRM projects can model credit when receptacle controls are included in the proposed design in spaces not required by Section 8.4.2. The credit and corresponding savings shall not exceed 10% per Table G3.1 #12 Proposed Building Performance column.

b) 90.1 2016/2019/2022 Performance Rating Method when documenting above code performance:

Energy use of the baseline may differ from proposed design as specifically approved by the rating authority. Complete checks PPO02 and PPO03 to confirm that the difference is justified.

End Use	Unregulated?	Energy Type	Energy Use Units	
Interior lighting		Electricity	kWh	
Interior lighting (unregulated)	X	Electricity	kWh	
Exterior lighting		Electricity	kWh	
Space heating		Natural Gas	therm	
Space heating		Electricity	kWh	
Heat pump supplemental heater		Electricity	kWh	
Space cooling		Natural Gas	therm	
Space cooling		Electricity	kWh	
Pumps		Electricity	kWh	
Heat rejection		Electricity	kWh	
Fans - interior ventilation		Electricity	kWh	
Fans - parking garage		Electricity	kWh	
Service water heating		Natural Gas	therm	
Service water heating		Electricity	kWh	
Misc equipment	X	Natural Gas	therm	
Misc equipment	X	Electricity	kWh	
Industrial process	X	Electricity	kWh	
Refrigeration equipment (regulated)		Electricity	kWh	
Refrigeration equipment (unregulated)	X	Electricity	kWh	
Elevators and escalators		Electricity	kWh	

PPO02–P Proposed design miscellaneous unregulated plug and process loads reported in the Compliance Form are as expected.

90.1 2016 ECB

Table 11.5.1 #12

- Unregulated receptacle and process loads must be estimated based on the building area type or space type category and included in the simulations and when calculating the energy cost budget and design energy cost.

- All end-use load components within and associated with the building must be modeled including but not limited to exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators and escalators, refrigeration equipment, and cooking equipment.

Table 11.5.1 Sections 13 allow excluding components if their energy use does not affect the energy use of systems and components that are being considered for trade-off and the prescriptive requirements applicable to the excluded component are met.

Table 11.5.1 Section 14 allows excluding components that cannot be explicitly modeled by the simulation program if their energy impact on the trade-offs is not significant.

90.1 2019/2022 ECB

Table 11.5.1 #12/ Table 12.5.1 #12

The requirements for modeling unregulated loads are aligned with 90.1 2016 quoted above. The references to Table 11.5.1 Section 13 and 14 were removed, however the exceptions still apply because they are covered in the updated Table 11.5.1/12.5.1 Section 14 that addresses all systems and components in the proposed design.

90.1 2016, 2019, and 2022 PRM:

Table G3.1 #12:

Unregulated receptacle and process loads, such as those for office and other equipment, must be estimated based on the building area type or space type category and must always be included in simulations of the building.

Review Tips

1. Miscellaneous unregulated plug loads are reported in Tables 1 of the Plug, Process and Other Loads tab of the Compliance Form. The table includes the default values established as described in Appendix A of this manual based on the building area types applicable to the project. Proposed EPD significantly deviating from the provided default values without sufficient justifications included in the Notes field below the table should be flagged in the review.

Table 1: Miscellaneous Equipment Loads

Instructions
1. Document the modeling inputs and methodology used to model miscellaneous equipment loads in the proposed and baseline/budget design.

Building Area Type	Default Miscellaneous Equipment Load, Building Area Method (for Reference)				Modeled Misc. Equipment Loads				
	Building Area [ft ²]	Default Misc. Equipment Power Density [W/ft ²] EPD	Total Equipment Power [kW] A x EPD	Equivalent Full Load Hours	Modeling Method	Basis of Assumed Equipment Power Density	Proposed EPD [W/ft ²]	Baseline EPD [W/ft ²]	Same Schedules Used in Proposed and Baseline design?
Multifamily, common spaces	8,365	0.20	1.7	3,285	Space Type Category	Other (please explain in the notes field below)	0.2	0.2	Yes
Retail	24,750	0.30	7.4	4,526	Building Area Type	Other (please explain in the notes field below)	0.3	0.3	Yes

2. Process equipment is reported in Table 4 of the Plug, Process and Other Loads tab in the Compliance Form. Ensure that the project captured all unique end-use load components within and associated with the building including but not limited to swimming pool heaters and pumps, fireplaces, firepits, BBQs, water features, etc.

PPO02–B Miscellaneous unregulated baseline/budget plug and process loads reported in the Compliance Form are the same as proposed unless allowed to differ.

90.1 2016 and 2019/ 2022 ECB

Table 11.5.1 #12/Table 12.5.1 #12

Miscellaneous receptacle and process loads in the budget design must be identical to the proposed design.

90.1 2016, 2019, and 2022 PRM

Table G3.1 #12

Energy used for cooking equipment, receptacle loads, computers, medical or laboratory equipment, and manufacturing and industrial process equipment not specifically identified in the standard, power and energy rating or capacity of the equipment must be identical between the proposed building performance and the baseline building performance.

Exceptions: When quantifying performance that exceeds the requirements of Standard 90.1 (but not when using the PRM as an alternative path for minimum standard compliance per Section 4.2.1.1) variations of the power requirements, schedules, or control sequences of the equipment modeled in the baseline building design from those in the proposed design shall be approved by the rating authority based on documentation that the equipment installed in the proposed design represents a significant verifiable departure from documented current conventional practice. The burden of this documentation is to demonstrate that accepted conventional practice would result in baseline building equipment different from that installed in the proposed design. Occupancy and occupancy schedules shall not be changed.

Review Tips

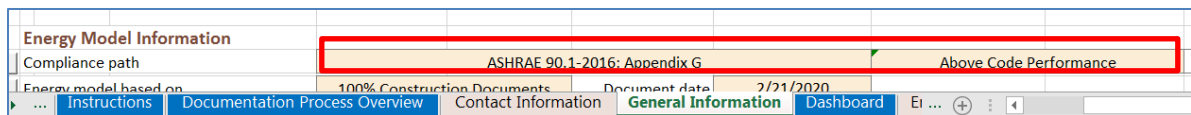
1. Miscellaneous unregulated plug and process loads assumed for the baseline/budget design are reported in Table 1 of the Plug, Process and Other Loads tab of the Compliance Form. The baseline/budget equipment power density (EPD) must be equal to proposed except when the

Table 1: Miscellaneous Equipment Loads

Instructions
1. Document the modeling inputs and methodology used to model miscellaneous equipment loads in the proposed and baseline/budget design.

Building Area Type	Default Miscellaneous Equipment Load, Building Area Method (for Reference)				Modeled Misc. Equipment Loads				
	Building Area [ft ²]	Default Misc. Equipment Power Density [W/ft ²] EPD	Total Equipment Power [kW] A x EPD	Equivalent Full Load Hours	Modeling Method	Basis of Assumed Equipment Power Density	Proposed EPD [W/ft ²]	Baseline EPD [W/ft ²]	Same Schedules Used in Proposed and Baseline design?
Multifamily, common spaces	8,365	0.20	1.7	3,285	Space Type Category	Other (please explain in the notes field below)	0.2	0.2	Yes
Retail	24,750	0.30	7.4	4,526	Building Area Type	Other (please explain in the notes field below)	0.2	0.2	Yes

project is documenting above-code performance following 90.1 PRM, as indicated in the General Model Information section of the General Information tab. In this case, supporting documentation must be included in the submittal to justify the modeled difference.



- Review supporting documentation to verify that the methodology and assumptions used to establish the baseline and proposed EPDs are substantiated as required in Table G3.1 #12 Exception quoted above.

PPO03 Miscellaneous unregulated plug and process load schedules reported in the Compliance Form for the baseline/budget design are the same as for the proposed design unless allowed to differ.

90.1 2016, 2019 and 2022 ECB

Table 11.5.1 #4/Table 12.5.1 #4

The schedules must be typical of the proposed design as determined by the designer and approved by the authority having jurisdiction, and the same for the proposed design and budget building design.

90.1 2016 PRM

Table G3.1 #4

The schedules must be typical of the proposed building type as determined by the designer and approved by the rating authority.

Table G3.1 #12

Occupancy and occupancy schedules must not be changed when documenting savings as allowed in Table G3.1 #12 exception.

90.1 2019 and 2022 PRM

Table G3.1 #4

The schedules must be typical of the proposed building type as determined by the designer and approved by the rating authority.

Table G3.1 #12

- Receptacle schedules must be the same as the proposed design before the receptacle power credit is applied.
- Occupancy and occupancy schedules must not be changed when documenting savings as allowed in Table G3.1 #12 exception.

Review Tips

- Confirm that the same schedules are used in the baseline/budget and proposed design based on Table 1 of the Plug, Process and Other Loads tab. Schedules are only allowed to differ for 90.1 2019 and 2022 PRM projects due to office receptacle controls.

Table 1: Miscellaneous Equipment Loads

Instructions
1. Document the modeling inputs and methodology used to model miscellaneous equipment loads in the proposed and baseline/budget design.

Building Area Type	Default Miscellaneous Equipment Load, Building Area Method (for Reference)				Modeled Misc. Equipment Loads				
	Building Area [ft ²]	Default Misc. Equipment Power Density [W/ft ²] EPD	Total Equipment Power [kW] A x EPD	Equivalent Full Load Hours	Modeling Method	Basis of Assumed Equipment Power Density	Proposed EPD [W/ft ²]	Baseline EPD [W/ft ²]	Same Schedules Used in Proposed and Baseline design?
Multifamily, common spaces	8,365	0.20	1.7	3,285	Space Type Category	Other (please explain in the notes field below)	0.2	0.2	Yes
Retail	24,750	0.30	7.4	4,526	Building Area Type	Other (please explain in the notes field below)	0.3	0.3	Yes

- The allowed office receptacle control credit is reflected in Table 10 of the Plug, Process and Other Loads tab of the Compliance Form.

PPO04 Miscellaneous plug and process loads are modeled as reported in the Compliance Form.

Review simulation reports shown in the table below to verify that the plug and process loads are modeled as reported. Energy use from miscellaneous equipment and industrial is reported in Table 2 of the Compliance Calculations tab.

For additional verification, if available in model output reports, check that modeled schedules reflect building occupancy types including appropriate seasonal and weekly variation. For example, if the building occupancy type is a school that closes during the summer months, then the miscellaneous plug and process load schedules should be reflective of this seasonal occupancy pattern. Refer to the Operating Schedule tab in the Compliance Form for anticipated building occupancy patterns.

eQUEST Reports	BEPU
Trane TRACE 700	Energy Cost Budget report
Trane TRACE 3D Plus	LEED Summary Section 1.6
IESVE SOFTWARE	PRM Compliance Report, ECB Compliance Report, Room Loads Report, Zone Loads Report, System Loads Report, Energy Model Output Report, BPRM Report
EnergyPlus	eplustbl.html 'LEED Summary' report
OpenStudio	eplustbl.html 'LEED Summary' report
Carrier HAP v5	"LEED Summary" report, Section 2 "Minimum Energy Performance Calculator", table titled "Proposed Energy Summary by End Use".
Design Builder	Output_Performance_1 sheet in LEED Minimum Energy Performance Calculator (.xlsm)

PPO05-P Regulated commercial refrigerators & freezers reported in the Compliance Form for the proposed design reflect design documents

90.1 2016 ECB

Table 11.5.1 #12 Column A: All end use load components within and associated with the building must be modeled including, but not limited to refrigeration equipment.

Table 6.8.1-13 Commercial Refrigeration—Minimum Efficiency Requirements

Minimum efficiency requirements specified in the table are mandatory and must be met by the specified units.

90.1 2019/2022 ECB

Table 11.5.1 #13 Column A/Table 12.5.1 #13 Column A: Where refrigeration equipment in the proposed design is rated in accordance with AHRI 1200, the rated energy use shall be modeled. Otherwise, the proposed design shall be modeled using the actual equipment capacities and efficiencies.

Table 6.8.1-11 Commercial Refrigerators, Commercial Freezers, and Refrigeration—Minimum Efficiency Requirements

Minimum efficiency requirements specified in the table are mandatory and must be met by the specified units.

90.1 2016 PRM

Table G3.1 #17 Proposed Building Performance Column: The proposed design shall be modeled using the actual equipment capacities and efficiencies.

Table 6.8.1-13 Commercial Refrigeration—Minimum Efficiency Requirements Minimum efficiency requirements specified in the table are mandatory and must be met by the specified units.

90.1 2019 and 2022 PRM

Table G3.1 #17 Proposed Building Performance Column: Where refrigeration equipment in the proposed design is rated in accordance with AHRI 1200, the rated energy use shall be modeled. Otherwise, the proposed design shall be modeled using the actual equipment capacities and efficiencies.

Table 6.8.1-11 Commercial Refrigerators, Commercial Freezers, and Refrigeration—Minimum Efficiency Requirements: Minimum efficiency requirements specified in the table are mandatory and must be met by the specified units.

Review Tips

1. Specified regulated refrigerators and freezers are reported in Table 3 of the Plug, Process and Other Loads tab. Cross-check information provided in the Compliance Form to design documents for a sample of units focusing on the units that account for largest difference between baseline and proposed design accounting for unit quantity. Reference to appropriate design documents where each unit is described must be provided in the last column of Table 3. If the details that must be captured in Table 3 are not available in the design documents, request equipment cutsheets or manufacturer literature.

Table 3: Regulated Commercial Refrigerators & Freezers
Instructions

1. Fill in the table below for refrigeration equipment regulated in 90.1 Table 6.8.1-12 and 6.8.1-13.

Equipment Category	Equipment Family	Condensing Unit Configuration	Rating Temperature	Equipment Tag from Design Documents (if Available)	Equipment Classification	V, ft ³ or TDA, ft ²	Enter V, ft ³ or TDA, ft ²	Qty of Units	Proposed kWh/Day per Unit	Baseline Design kWh/Day per Unit	ASHRAE 90.1 - 2016 Prescriptive Requirement kWh/Day/Unit
Self-Contained Commercial Refrigerators and Commercial Freezers With and Without Doors	Horizontal Open (HZO)	Self-Contained (SC)	38F (Medium)	REF12	HZO.SC.M	TDA	250	3	175.0	290.55	198.05

2. Verify that proposed kWh/day does not exceed corresponding 90.1 requirements shown in the table. Since these requirements are mandatory, all specified units must have lower rated kWh/Day consumption.

PP005-B Baseline/budget design for the regulated commercial refrigerators & freezers reported in the Compliance Form is established correctly

90.1 2016 ECB

Table 11.5.1 #12 Column B

Receptacle, motor, and process loads shall be modeled and estimated based on the building area type or space type category and shall be assumed to be identical in the proposed and budget building designs.

90.1 2019/2022 ECB

Table 11.5.1 #13 Column B/Table 12.5.1 #13 Column B

Where refrigeration equipment is specified in the proposed design and listed in Table 6.8.1-11, the budget building design shall be modeled as specified in Table 6.8.1-11 using the actual equipment capacities. If the refrigeration equipment is not listed in Table 6.8.1-11, the budget building design shall be modeled the same as the proposed design.

90.1 2016 and 2019 PRM

Table G3.1 #13/#17 Baseline Building Performance Column

- Where refrigeration equipment is specified in the proposed design and listed in Tables G3.10.1 and G3.10.2, the baseline building design shall be modeled as specified in Tables G3.10.1 and G3.10.2 using the actual equipment capacities.
- If the refrigeration equipment is not listed in Tables G3.10.1 and G3.10.2, the baseline building design shall be modeled the same as the proposed design.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Requirements are the same as described for the 90.1 2016 and 2019 PRM above.

G3.3 Minor Alterations

Based on 90.1 Section G3.3.2.1, commercial refrigerators & freezers included in the scope of retrofit shall be modeled at efficiency levels meeting the mandatory and prescriptive requirements in 90.1 Section 6.1.4.

90.1 Section 6.1.4.1, which applies to direct replacements, includes requirements for walk-in coolers and walk-in freezers (90.1 Section 6.4.5) and equipment efficiency (90.1 Section 6.4.1). When the scope of the alteration includes new cooling systems installed to serve previously uncooled spaces the refrigerated display cases (90.1 Section 6.4.6), and refrigeration system (90.1 Section 6.5.11) are also applicable to the baseline.

Review Tips

1. Energy use of the regulated refrigerators and freezers in the baseline/budget design is established automatically in Table 3 on the Plug, Process and Other Loads tab. However, the calculations are based on the characteristic of the corresponding proposed unit reported in Table 3 below, thus the related inputs should be verified. Cross-check information provided in the Compliance Form to design documents for a sample of units focusing on the units that account for largest difference between baseline and proposed design accounting for unit quantity. Reference to appropriate design documents where each unit is described must be provided in the last column of Table 3. If details that must be captured in Table 3 are not available in the design documents, request equipment cutsheets or manufacturer literature.

For 90.1 2019 and 2022 projects, Table 9 on the Plug, Process and Other Loads tab includes information about walk-in cooler and freezer equipment. Similar to above, cross-check information provided in the Compliance Form to design documents for a sample of units.

Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

Table 3: Regulated Commercial Refrigerators & Freezers
Instructions

1. Fill in the table below for refrigeration equipment regulated in 90.1 Table 6.8.1-13 and 6.8.1-11.

Equipment Category	Equipment Family	Condensing Unit Configuration	Rating Temperature	Equipment Tag from Design Documents (if Available)	Equipment Classification	V, ft ³ or TDA, ft ³	Enter V, ft ³ or TDA, ft ³	Qty of Units	Proposed kWh/Day per Unit	Baseline Design kWh/Day per Unit	ASHRAE 90.1 - 2016 Prescriptive Requirement kWh/Day/Unit
Self-Contained Commercial Refrigerators and Commercial Freezers With and Without Doors	Horizontal Open (HZO)	Self-Contained (SC)	38F (Medium)	REF12	HZO.SC.M	TDA	250	3	175.0	290.55	198.05

- The check may be skipped if the modeled difference between the baseline/budget and proposed design is small.

PPO06 Regulated refrigerators and freezers are modeled as reported in the Compliance Form for the baseline/budget and proposed design.

Review Tips

- Since regulated refrigerators and freezers are rated in kWh/day, annual energy use reported in Table 2 of the Compliance Calculations tab, “Refrigeration Equipment, regulated” row should be equal to the total value shown in Table 8 of the Plug, Process and Other Loads tab. Discrepancies should be flagged. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
- Common Mistakes
 - 90.1 2016 ECB:
 - Claiming credit for better than code regulated refrigeration systems on projects following. (Budget and proposed design must be modeled the same.)
 - 90.1 2016/2019/2022 PRM:
 - Reporting all refrigeration systems as unregulated loads on the Compliance Calculations tab. Energy used by units included in 90.1 2016/2019 and 2022 Table 6.8.1-13/6.8.1-11 must be reported under “Refrigerated Equipment, regulated”.
 - Refrigeration equipment is not reported or modeled for projects involving building types that likely have it such as supermarkets, large office buildings, hospitals, schools that have cafeteria, etc.
 - Modeled energy use deviates from annual energy use inferred in kWh/Day efficiency ratings.
 - Internal gains/losses to space where refrigeration systems are located are not modeled correctly. Refer to PNNL Performance Rating Method Reference Manual¹⁸ Section G3.3.6 for methodology for determining internal gains/losses for packaged refrigeration units versus units with remote condensers.

PPO07-P Regulated Motors reported in the Compliance Form for the proposed design reflect design documents

90.1 2016/2019 ECB

Table 11.5.1 #12, Column A

¹⁸ https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

Receptacle, motor, and process loads shall be modeled and estimated based on the building area type or space type category and shall be assumed to be identical in the proposed and budget building designs. All end-use load components within and associated with the building shall be modeled, ... including but not limited to parking garage ventilation fans and escalators.

90.1 2022 ECB

Table 12.5.1 #12, Column A

Same requirements as Table 11.5.1 #12, Column A described above with the addition of:

- a. Where power and other systems covered by Sections 8 and 10 have been designed and submitted with design documents, those systems shall be determined in accordance with Sections 8 and 10.
- b. Where power and other systems covered by Sections 8 and 10 have not been submitted with design documents, those systems shall comply with but not exceed the requirements of those sections.

90.1 2016, 2019, and 2022 PRM

Table G3.1#12, Proposed Building Performance column

- a. Where power and other systems covered by Sections 8 and 10 have been designed and submitted with design documents, those systems shall be determined in accordance with Sections 8 and 10.
- b. Where power and other systems covered by Sections 8 and 10 have not been submitted with design documents, those systems shall comply with but not exceed the requirements of those sections.

Review Tips

1. All motors that have efficiency requirements prescribed in 90.1 Section 10 are considered regulated. Regulated motors are reported in Table 5 on the Plug, Process and other Loads tab of the Compliance Form. Typically, only larger motors including but not limited to water booster pumps and garage exhaust fans should be individually reported.
2. Cross-check larger motors included in Table 5 with the design documents referenced in the Plans/Specs row of the table to confirm alignment in the reported motor HP, type, quantity and efficiency.
3. Confirm that specified efficiency is not below the minimum required in 90.1 Section 10. For most types of motors, the requirements are included in the Minimum Efficiency column of Table 5 on the Plug, Process and other Loads tab.

PPO07-B Regulated Motors reported in the Compliance Form for the baseline/budget design are established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.1 #12, Column B/ Table 12.5.1 #12, Column B: Same as proposed

90.1 2016 and 2019 PRM

Table G3.1#12, Baseline Building Performance column

Motors shall be modeled as having the efficiency ratings found in Table G3.9.1 Other systems covered by Section 10 shall be modeled as identical to those in the proposed design, including schedules of operation and control of the equipment.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Same requirements as Table G3.1#12, Baseline Building Performance column described above for the 90.1 2016 and 2019 PRM.

G3.3 Minor Alterations

Based on Section G3.3.2.1, motors included in the scope of retrofit shall be modeled at efficiency levels meeting the mandatory and prescriptive requirements in Sections 10.1.4. All other motors should be modeled identically in the baseline and proposed.

Review Tips

1. Parameters of the baseline/budget motors are auto populated in the Table 5 of the Plug, Process and other Loads tab (examine the “Minimum Efficiency” column for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) for the baseline value and the Notes field under the table for clarifications regarding what was modeled and why).
2. Equivalent Full Load Hours must be the same for the baseline/budget and proposed design.

PPO08 Regulated Motors are modeled as reported in the Compliance Form for the baseline/budget and proposed design.

Review Tips

Review simulation reports to verify alignment with the values reported in the Compliance Form.

eQUEST Reports	TBD
Trane TRACE 700	
Trane TRACE 3D Plus	
IESVE SOFTWARE	
EnergyPlus	
OpenStudio	
Carrier HAP v5	
Design Builder	

PPO09-P Elevators reported in the Compliance Form for the proposed design reflect design documents

90.1 2016 and 2019/2022 ECB

Table 11.5.1/12.5.1 #12, Column A

All end-use load components within and associated with the building shall be modeled, ... including but not limited to ... elevators and escalators.

90.1 2016, 2019, and 2022 PRM

Table G3.1#16, Proposed Building Performance column

Where the proposed design includes elevators, the elevator motor, ventilation fan, and light load shall be included in the model. The cab ventilation fan and lights shall be modeled with the same schedule as the elevator motor.

Review Tips

1. Specified elevators are described in Table 6a of Plug, Process and Other Loads tab. Cross-check information provided in the table with the design documents that must be referenced in the last column of the table for each elevator. Focus on elevators that account for the greatest annual motor energy use based on Table 6b.

PPO09-B Elevators reported in the Compliance Form for the baseline/budget design are established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.1/12.5.1 #12, Column B: Same as proposed.

90.1 2016 and 2019 PRM

Table G3.1#16, Baseline Building Performance column

Where the proposed design includes elevators, the baseline building design shall be modeled to include the elevator cab motor, ventilation fans, and lighting power. Calculations are provided to determine baseline elevator peak motor power. The elevator motor use shall be modeled with the same schedule as the proposed design. When included in the proposed design, the baseline elevator cab ventilation fan shall be 0.33 W/cfm and the lighting power density shall be 3.14 W/ft²; both operate continuously.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Same requirements as Table G3.1#16, Baseline Building Performance column described above for the 90.1 2016 and 2019 PRM.

G3.3 Minor Alterations

Based on Section G3.3.2.1, elevators included in the scope of retrofit shall be modeled at efficiency levels meeting the mandatory and prescriptive requirements in Sections 10.1.4. All other elevators should be modeled identically in the baseline and proposed.

Review Tips

1. Energy use of the baseline elevators is established automatically based on the details provided for the proposed elevators and is shown in Table 6b of Plug, Process and Other Loads tab (examine the Notes field under the table for clarifications regarding what was modeled and why for alterations subject to 90.1 2022 Section G3.3).

PPO10 Elevators are modeled as reported in the Compliance Form for the baseline/budget and proposed design.

Review Tips

1. The total elevator energy use for the baseline/budget and proposed design should be as shown in the Totals row of Table 6b (examine the Notes field under the table for clarifications regarding what was modeled and why for alterations subject to 90.1 2022 Section G3.3).

PPO11-P Combined Heat and Power (CHP) systems reported in the Compliance Form for the proposed design reflect design documents and electricity generation and recovered energy reported in submittal is reasonable.

90.1 2016 and 2019/2022 ECB, 90.1 2016, 2019 and 2022 PRM

Table 11.5.1/12.5.1, Table G3.1: The proposed design must be consistent with the design documents.

Review Tips

1. The specified CHP systems are reported in Table 7 of the Plug, Process and other Loads tab. The provided information must at minimum include the generator ownership, type, quantity, total generation capacity (kW) at design conditions, thermal and electrical efficiency at design conditions, controls, schedule of operation, fuel used, where the recovered heat is used (e.g. absorption chillers, space heating loop, service water heating loop, etc.), specified back-up systems when recovered heat is not available and parasitic losses (e.g. air handling unit to cool the intake air).
2. Verify that the required information is provided and reflects design documents.

PPO11-B CHP systems reported in the Compliance Form for the baseline/budget design are established correctly

90.1 2016 ECB:

Based on Table 11.5.1 #1 Column B, all building systems and equipment must be modeled identically in the budget and proposed design except as specifically instructed. Since Table 11.5.1 does not cover CHP systems, the budget building design and the proposed design must be modeled with the same CHP system that is specified for the proposed design. Following Section 11.4.3.2, where CHP waste heat is recovered in the proposed design, the budget building design must be based on the energy source used as the backup energy source, or electricity if no backup energy source has been specified. In the proposed design, the recovered waste heat must not be considered purchased energy and must be subtracted from the proposed design energy consumption, thus contributing to the performance credit. The requirement was further clarified by adding the explicit language to that section in the 2019 edition of the standard.

90.1 2019/2022 ECB

11.4.3.2/12.4.3.2: Where the proposed design includes on-site electricity generation systems other than on-site renewable energy systems, the baseline design shall include the same generation systems excluding its site recovered energy.

90.1 2016 PRM

Based on Table G3.1 #1 Baseline Building column, all building systems and equipment must be modeled identically in the baseline and proposed design except as specifically instructed. Since 90.1 Appendix G

does not cover CHP systems, the baseline must be modeled with the same CHP system that is specified for the proposed design. The recovered waste heat of the specified CHP system must not be considered purchased energy and must be subtracted from the proposed design energy consumption following Section G2.4.1, thus contributing to the performance credit.

90.1 2019 and 2022 PRM

G3.2 New Construction/Major Alterations

G2.4.2: Where the proposed design includes on-site electricity generation systems other than on-site renewable energy systems, the baseline design shall include the same generation systems excluding its site-recovered energy.

G3.3 Minor Alterations

90.1 Section G3.3.1 states that systems and equipment excluded from the scope of retrofit shall reflect the existing conditions. Consequently, the requirement for CHP is the same as for G3.2 with the exception that if existing building systems use recovered heat from an existing on-site CHP, then this existing recovered heat should be subtracted from the baseline (i.e., modeled the same in the baseline and proposed).

Review Tips

1. Confirm that the baseline CHP system is established correctly. It must be the same as the proposed system in all respects except without energy recovery.
2. Common mistake includes not modeling CHP in the baseline and instead assuming that all electricity is purchased from grid.

PP012 CHP systems are modeled as reported in the Compliance Form for the baseline/budget and proposed design.

Review Tips

1. Review simulation reports to verify that CHP systems are modeled as reported in the Compliance Form.
2. If the CHP system is modeled using exceptional calculation methods, perform checks EC01-EC03
3. Irrespective of whether the CHP is modeled in the simulation tool or through exceptional calculations method, the amount of electricity generated by CHP is expected to be the same in the baseline (budget) and proposed design. The value of the recovered heat should be subtracted from the proposed design energy cost but not from the baseline. Similar patterns should be verified in the simulation output reports if CHP is incorporated in the simulation.

Service Water Heating (SWH)

Overview

The service water heating category covers parameters related to the service water heating equipment and demand. Table 11 summarizes the checks included in this group.

Table 11: Service Water Heating Quality Control Checks Overview

	Type of Check	Proposed Design	Baseline/Budget Design
SWH System Components	CF inputs reflect design documents	SWH01-P, SWH03-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	SWH01-B, SWH03-B
	Meet mandatory requirements	SWH02-P	NA
	Simulation inputs consistent with CF	SWH05-P	SWH05-B
	Simulation outputs consistent with CF	NA	NA
Hot Water Demand	CF inputs reflect design documents	SWH04-P	NA
	CF inputs reflect requirements of ECB/PRM	NA	SWH04-B
	Meet mandatory requirements	NA	NA
	Simulation inputs consistent with CF	NA	NA
	Simulation outputs consistent with CF	SWH06, SWH07	SWH06, SWH07
LEGEND			
PASS/FAIL/NA outcome is determined automatically in the Quality Control Checks tab of the Compliance Form			

The following strategies may be used to prioritize the review:

1. If there are multiple water heater types, the review should focus on water heaters with the largest capacity or a representative smaller unit.
2. Hot water demand checks should only be performed for Appendix G projects where different hot water demand is reported in the Compliance Form for the baseline versus proposed design.

For 90.1 2022 PRM alterations subject to G3.3 (i.e., Minor Alterations), the summary tables on the Quality Control Checks tab in the Compliance Form may not reflect correct values for the baseline since projects, for the most part, only enter proposed design information and provide notes as to what was modeled in the baseline in the notes fields associated with the proposed design related tables. Refer to the [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) section for more information regarding 90.1 2022 G3.3.

SWH01-P Proposed SWH system type, efficiency and capacity reported in the Compliance Form reflects design documents

90.1 2016 and 2019/2022 ECB

Table 11.5.1 Column A #11/Table 12.5.1 Column A #11

The service water-heating system type and all related performance parameters, such as equipment capacities and efficiencies, in the proposed design are determined as follows:

- Where a complete service water-heating system exists, the model must reflect the actual system type using actual component capacities and efficiencies.
- Where a service water-heating system has been designed and submitted with design documents, the service water-heating model must be consistent with design documents.
- Where no service water-heating system exists or has been submitted with the design documents, no service water heating must be modeled.
- Piping losses must not be modeled.

90.1 2016, 2019, and 2022 PRM

Table G3.1 #11, Proposed Building Performance

The service water-heating system type and all related performance parameters, such as equipment capacities and efficiencies, in the proposed design must be determined as follows:

1. Where a complete service water-heating system exists, the proposed design must reflect the actual system type using actual component capacities and efficiencies.
2. Where a service water-heating system has been designed and submitted with design documents, the service water heating model must be consistent with design documents.
3. Where no service water-heating system exists or has been designed and submitted with design documents, but the building will have service water-heating loads, a service water-heating system must be modeled that matches the system type in the baseline building design, serves the same water-heating loads, and comply with but not exceed the requirements of Section 7. Exception: For alterations subject to 90.1 Section G3.3, because the same system types are modeled in the baseline and proposed, if no service water heating system exists in the proposed then none will be modeled in the proposed or baseline.
4. For buildings that will have no service water-heating loads, no service water-heating system is modeled.
5. Piping losses must not be modeled.

Review Tips

1. Proposed SWHs are listed in Table 1 of the Service Water Heating tab. If projects include multiple water heaters, identify SWH types with the highest total nameplate input rate calculated as the product of the number of heaters and nameplate input rate per heater, and focus the review on these units only.
2. Cross-check information provided for the SHWs in the design documents with the inputs in Table 1. The reference to drawings/specs where information for each heater is available should be included in Table 1 for each heater. Request cutsheets if any of the parameters are missing.

Modeled Water Heater Name	Design Drawing Water Heater Name	Drawing #	Building Area Served	Number of Identical Water Heaters	Energy Source	Equipment Type	Nameplate Input Rate per Heater [C, Btu/h]	Subcategory or Rating Condition	Rated Heater Volume [gal]	Eff. Units	Rated Eff.	Minimum Eff.	Rated Stand-by Loss [L, Btu/hr]	Maximum Stand-by Loss	Volume of Unfired Storage Tanks [gal]
SWH_1	SWH-1	P-104	Multifamily	3	Natural Gas	Gas storage water heaters	399,000	<4000 (Btu/h)/gal	100	Et	96%	90%	1,000		0
SWH_2	SWH-2	P-104	Retail	1	Electricity	Electric water heaters	37,532	Resistance ≥20 gal, ≤12 kW	80	EF	0.96	0.68	n/a	n/a	0

SWH02 -P Proposed SWH system efficiency reported in the Compliance Form meets the mandatory requirements of 90.1 Section 8.

Review Tips

1. Confirm that the rated efficiency exceeds the minimum required efficiency and that the rated standby loss is below the maximum listed in Table 1. These reference values are based on 90.1 Table 7.8 and are mandatory. Failure to meet these requirements should be flagged. For most SWHs, the reference values will be determined automatically. If the auto-populated default is over-written, the value is shown in bold brown font and should be confirmed.

SWH02-B Baseline/budget SWH system type, efficiency and capacity reported in the Compliance Form is established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.1 Column B #11/Table 12.5.1 Column B #11

The SWH system type and fuel must be the same as in the proposed design, except a dedicated SWH system must be modeled if the proposed design has a combination space/service water heating system. Storage tank volume in the budget design must be the same as in the proposed design. Piping losses must not be modeled.

90.1 2016 and 2019 PRM

Table G3.1 Baseline Building Performance column #11

The SWH system type and fuel must be as prescribed in 90.1 Table G3.1.1-2 based on the building type, irrespective of system type and fuel source in the proposed design. For example, all multifamily occupancies have a central gas storage water heater; all office occupancies have a central electric resistance storage water heater. In mixed use buildings, e.g. in a building with multifamily occupancy on the top 10 floors and office occupancy on the lower 3 floors, a separate baseline SWH system type must be modeled for each occupancy. Storage tank volume in the budget design must be the same as in the proposed design.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Requirements are the same as Table G3.1 Baseline Building Performance column #11 for the 90.1 2016 and 2019 PRM described above.

G3.3 Minor Alterations

Service water heating systems included in the scope of the alteration are required to be modeled with the minimum requirements in 90.1 Section 7.1.4 with the same system type modeled as specified in proposed design. All unmodified service water heating systems and equipment shall be modeled the same as in the proposed design.

Review Tips

1. Baseline/budget SWHs are listed in Table 2 of the Service Water Heating tab. All values are set automatically by applying the appropriate 90.1 rules to the project. Default values over-written by the modeler are shown in brown bold font in the table and should be verified by reviewer. Refer to

[90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

Modeled Baseline Water Heater Name	Building Area Served	Number of Identical Water Heaters	Energy Source	Equipment Type	Nameplate Input Rate per Heater [Q, Btu/h]	Rated Heater Volume [gal]	Eff. Units	Rated Eff.	Stand-by Loss [SL, Btu/hr]	Vol. of Unfired Storage Tanks [Gal]
SWH_1	Multifamily	Single central water heater	Natural Gas	Gas storage water heater	1,197,000	300	Et	80%	3,402	0

- Common mistakes (these are not applicable to alterations subject to 90.1 2022 PRM Section G3.3):
 - Assuming distributed water heaters in the PRM baseline when there are distributed water heaters in the proposed design. Baseline always has a central water heater for each building occupancy type. Multiple service water heaters may only be included in mixed-use buildings.
 - Where proposed design has distributed water heaters, assuming that the capacity of the central baseline water heater is equal to the sum of capacities of the specified water heaters. Instead, baseline systems must be sized according to the provisions of 90.1 Section 7.4.1 to avoid excessive oversizing and low operating efficiency.
 - Where proposed design has combination space/service water heating boiler, assuming that the capacity of the central baseline water heater is equal to the capacity of the specified space/service water heating boiler. Instead, baseline systems must be sized according to the provisions of 90.1 Section 7.4.1 to avoid excessive oversizing and low operating efficiency.

SHW03-P The ancillary components of the proposed SWH system reported in the Compliance Form reflect design documents

90.1 2016 and 2019/2022 ECB, 90.1 2016/2019/2022 PRM

Based on Tables 11.5.1 #11/12.5.1 #11 and G3.1 #11, ancillary components include recirculation pumps, service hot water preheat and condenser heat recovery.

Review Tips

- Table 1 includes fields for specifying recirculation pumps and hot water reheat strategies, if applicable. The review check should be completed for projects with entries in either of these fields or if service water heating is identified as one of the impactful end uses.
- Cross-check information provided in the table with the design documents to verify alignment.

SHW03-B Ancillary components of the baseline/budget SWH system reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.1 Column B #11 Exception 3/Table 12.5.1 Column B #11 Exception 3

For 24-hour facilities that meet the prescriptive criteria for use of condenser heat recovery systems described in Section 6.5.6.2, a system meeting the requirements of that section must be included in the baseline building design, regardless of the exceptions to Section 6.5.6.2. If a condenser heat recovery system meeting the requirements described in Section 6.5.6.2 cannot be modeled, the requirement for

including such a system in the actual building must be met as a prescriptive requirement in accordance with Section 6.5.6.2 and no heat recovery system must be included in the proposed design or budget building design.

90.1 2016 and 2019 PRM

Table G3.1 #11, Baseline Building Performance column, (e) & (f)

- For large, 24-hour-per-day facilities that meet the prescriptive criteria for use of condenser heat recovery systems described in Section 6.5.6.2, a system meeting the requirements of that section shall be included in the baseline building design regardless of the exceptions to Section 6.5.6.2. If a condenser heat recovery system meeting the requirements described in Section 6.5.6.2 cannot be modeled, the requirement for including such a system in the actual building must be met as a prescriptive requirement in accordance with Section 6.5.6.2, and no heat recovery system would be included in the proposed design or baseline building design.
- Where recirculation pumps are used to ensure prompt availability of service water-heating at the end use, the energy consumption of such pumps must be calculated explicitly.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Requirements are the same as Table G3.1 #11, Baseline Building Performance column, (e) & (f) for the 90.1 2016 and 2019 PRM described above.

G3.3 Minor Alterations

Alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) are only required to model condenser heat recovery systems if the requirements are applicable based on the scope of the alteration and based on the language in 90.1 Section 6.1.4. This means, based on the language in 90.1 Section 6.1.4, that only alterations in which new cooling systems are installed to serve previously uncooled spaces would need to minimally comply with 90.1 Section 6.5.6.2 in the baseline.

Review Tips

1. The ancillary components of service hot water systems are reported in Table 2 of the Service Water Heating tab. The values are auto populated but may be over-written. The overwritten defaults should be verified to confirm that they are justified (for alterations following 90.1 2022 Section G3.3 see Table 1 for baseline and proposed design model inputs and examine the Notes section under Table 1 for clarifying notes regarding modeled values).

SHW04-P Proposed service hot water demand reported in the Compliance Form is reasonable.

90.1 2016 and 2019/2022 ECB and PRM

Table 11.5.1 Column B #11/ Table 12.5.1 Column B #11, Table G3.1 #11 Baseline Building Performance column: Service water-heating energy consumption shall be calculated explicitly based on the volume of service water heating required, the entering makeup water, and the leaving service water heating temperatures. Entering water temperatures shall be estimated based on the location. Leaving temperatures shall be based on the end-use requirements.

Review Tips

1. The check should only be performed for PRM projects if hot water demand reported in the Compliance Form is different between the baseline/budget and proposed.
2. SHW demand assumptions are provided in Tables 4 - 6 of the Service Water Heating tab.
 - a. Table 4 calculates SHW demand for multifamily projects based on the entered flow rates for the specified fixtures in showers and sinks, average supply SHW temperature, entering cold water temperature and temperature at the fixture point of use. The calculations are based on requirements of the EPA ENERGY STAR Multifamily New Construction Program Simulation Guidelines¹⁹. Verify that entered flow rates match design documents.
 - b. Table 5 shows default service hot water use for non-residential building types. The default values are based on typical hot water use in buildings of similar type provided in ASHRAE 90.1 2013 User's Manual. If default is overwritten, the input is shown in brown font and should be verified.

SWH04-B Difference between the baseline/budget and proposed hot water demand reported in the Compliance Form is as allowed

90.1 2016 ECB

Change in service water heating load is not listed as a trade-off opportunity in the section, thus must be modeled the same in the budget and proposed design. This is further clarified in the updates to this section incorporated into 2019 edition of 90.1 shown below.

90.1 2019/2022 ECB

Table 11.5.1 Column B #11/Table 12.5.1 Column B #11: Service water loads and use shall be the same for both the proposed design and baseline building design and typical of the proposed building type.

90.1 2016 and 2019/2022 PRM

Table G3.1 #11 Baseline Building Performance column: Exception to (g) states that service water-heating use can be reduced due to the following:

- water conservation measures that reduce the physical volume of service water required. Examples include low-flow shower heads.
- reducing the required temperature of service mixed water, by increasing the temperature, or by increasing the temperature of the entering makeup water. Examples include alternative sanitizing technologies for dishwashing and heat recovery to entering makeup water.
- reducing the hot fraction of mixed water to achieve required operational temperature. Examples include shower or laundry heat recovery to incoming cold-water supply, reducing the hot-water fraction required to meet required mixed-water temperature.

Such reductions must be demonstrated by calculations.

2019 and 2022 editions include the following clarification in Table G3.1 #1, Baseline Building column: Where the baseline building systems and equipment are permitted to be different from the proposed

¹⁹ [ENERGY STAR Multifamily Highrise Program Simulation Guidelines – Appendix G 90.1 2016 Version 1.0](#)

design but are not prescribed in this appendix, the baseline must be determined based on the following, in the order of priority:

- Requirements in Sections 5 through 10
- Requirements of other efficiency or equipment codes or standards applicable to the design of the building systems and equipment

Review Tips

1. Hot water demand is reported in Table 4 of the Service Water Heating tab for the residential occupancies and in Table 5 for all others.
2. ECB: the amount of service hot water consumed in the building is not a trade-off opportunity and must be modeled the same in the budget building and the proposed design.
3. PRM:
 - a) Projects may document a reduction in demand provided the methodology is approved by the building official. For example, on projects with low-flow fixtures, hot water demand in the Proposed Design may be reduced to reflect the lower flow rates of the installed fixtures compared to the maximum flow allowed by the applicable code or standard.
 - b) Table 4 of the Service Water Heating tab automatically calculates savings from common water-savings technologies found on residential projects such as low flow plumbing fixtures and ENERGY STAR appliances. Baseline values are set by defaults and should be verified if overwritten.
4. Common Mistakes
 - a) Modeling hot water demand reduction on projects following ECB.
 - b) Using baseline flow rate based on requirements of the outdated standard such as Energy Policy Act 1992 (EPACT 1992). The baseline must be based on the maximum allowed flow rates of the applicable codes such as state International Plumbing Code.

SWH05-B, SWH05-P Modeled baseline/budget and proposed SWH system type, efficiency, capacity and ancillary features reflect parameters reported in the Compliance Form

Review Tips

1. Review the simulation reports to confirm that the modeled SWH system parameters are as reported in the Compliance Form.

eQUEST	PV-A, PS-H
Trane TRACE 700	Plant Information entered values report
Trane TRACE 3D Plus	System Component Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, Florida Energy Code Compliance Report, Room Loads Report, Zone Loads Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report
EnergyPlus	eplustbl.html 'Equipment Summary' report, 'Service Water Heating' section
OpenStudio	eplustbl.html 'Equipment Summary' report, 'Service Water Heating' section
Carrier HAP v5	"Plant Input Data" report, "Boiler Input Data" report.

Design Builder	Service Water Heating sheet in LEED Minimum Energy Performance Calculator (.xslm)
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SWH06 Difference in the baseline/budget and proposed hot water use is reasonable based on the system parameters reported in the Compliance Form

Review Tips

1. **ECB:** Since the budget SWH system must be of the same type and use the same fuel as the proposed system and the reduction in the hot water demand is not a trade-off opportunity, the difference in SWH energy use between the budget and proposed design depends only on the difference in efficiencies of the budget and proposed systems.

$$SWH_Use_{prop} * SWH_Eff_{prop} = SWH_Use_{budget} * SWH_Eff_{budget}$$

SWH_Use [MMBtu] = the annual SWH use from simulation output reports
 SWH_Eff = SWH efficiency reported in the submittal

Projects that do not show this pattern should be flagged and explanation and supporting documentation should be requested. Higher savings may be demonstrated by projects that have solar hot water preheat as allowed by 90.1 Section 11.4.3.1/12.4.3.1, or other means of service hot water preheat, such as use of condenser heat recovery, that differs between the budget and proposed design.

2. **90.1 PRM:** The baseline SWH system may be of a different type and use a different fuel than the proposed SWH system and there may be a difference in hot water demand between the baseline and proposed design, thus this check cannot be effectively performed. For alterations following 90.1 2022 Section G3.3 (i.e., Minor Alterations) that are not modeling a reduction in hot water demand the check described in review tip #1 can be performed using the baseline and proposed efficiency values reported in Table 1 on the Service Water Heating tab in the Compliance Form.

eQUEST Reports	BEPU
Trane TRACE 700	Equipment Energy Consumption report
Trane TRACE 3D Plus	LEED Summary Section 1.6
IESVE SOFTWARE	Detailed Simulation Report, Plant Loops & Equipment Report, Room Loads Report, Zone Loads Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report
EnergyPlus	
OpenStudio	
Carrier HAP v5	“Monthly Simulation Results” report for an SHW plant.
Design Builder	Service Water Heating sheet in LEED Minimum Energy Performance Calculator (.xslm)

SWH07- P Modeled proposed SWH effective full load hours are reasonable

Review Tips

1. SWH effective full load hours are equal to the ratio of the annual service water heating energy use from the simulation outputs to the reported service water heater capacity. Effective full load hours which are higher than typical included in Appendix A may indicate that modeled service water heating demand exceeds the values anticipated by the design team and that the modeled service water heater energy use is exaggerated. EFLH exceeding typical by more than 25%, or exceeding 8760 hours per year, should be flagged.

eQUEST Reports	BEPU
Trane TRACE 700	Equipment Energy Consumption report
Trane TRACE 3D Plus	LEED Summary Section 1.6
IESVE SOFTWARE	Room Loads Report, Zone Loads Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report, Plant Loops & Equipment Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html 'LEED Summary' report, 'EAp2-4/5. Performance Rating Method Compliance' section
OpenStudio	eplustbl.html 'LEED Summary' report, 'EAp2-4/5. Performance Rating Method Compliance' section
Carrier HAP v5	"Monthly Simulation Results" report for an SHW plant.
Design Builder	Service Water Heating sheet in LEED Minimum Energy Performance Calculator (.xls)
Energy Gauge	

Airside HVAC (AHVAC)

Overview

This group of checks covers air-side systems including type, heating and cooling efficiency and controls. In addition, it covers fan systems and controls, mechanical ventilation including ventilation rate, controls and exhaust air energy recovery, and economizer. Table 12 summarizes the checks included in this group.

Table 12: Air-side HVAC Quality Control Checks Overview

	Type of Check	Proposed Design	Baseline/Budget Design
Thermal Blocks	CF inputs reflect design documents	AHVAC01-P	NA
	CF inputs reflect requirements of ECB/PRM	AHVAC01-P	NA
	Simulation inputs consistent with CF	AHVAC02-P	AHVAC02-B
AHVAC System Type,	CF inputs reflect design documents	AHVAC03-P(system type) AHVAC05-P(capacity) AHVAC07-P (efficiency)	NA

Heating & Cooling	CF inputs reflect requirements of ECB/PRM	AHVAC08-P(efficiency) AHVAC09-P(eff. w/o fan pwr) AHVAC10-P(p. curves)	AHVAC03-B(system type) AHVAC05-B (capacity) AHVAC08-B (efficiency) AHVAC09-B eff. w/o fan pwr) AHVAC10-B(p. curves)
	Meet mandatory requirements	AHVAC08-P (efficiency)	NA
	Simulation inputs consistent with CF	AHVAC04-P(system type) AHVAC06-P(capacity) AHVAC11-P(efficiency)	AHVAC04-B (system type) AHVAC06-B (capacity) AHVAC11-B (efficiency)
	Simulation outputs consistent with CF	AHVAC13-P(h. efficiency), AHVAC12-P(c. efficiency) AHVAC31-P(monthly c. h. pattern)	AHVAC13-B (h. efficiency), AHVAC12-B (c. efficiency), AHVAC31-B (monthly c. h. pattern)
Fans	CF inputs reflect design documents	AHVAC14-P(flow), AHVAC15-P(power), AHVAC16-P(flow, T)	NA
	CF inputs reflect requirements of ECB/PRM	AHVAC17-P(fan curves)	AHVAC14-B(flow), AHVAC15-B(power), AHVAC16-B(flow, T), AHVAC17-B(fan curves)
	Simulation inputs consistent with CF	AHVAC18-P(power, flow, control)	AHVAC18-B(power, flow, control)
	Simulation outputs consistent with CF	AHVAC19-P, AHVAC20-P	AHVAC19-B, AHVAC20-B
Ancillary	CF inputs reflect design documents	AHVAC21-P (economizer), AHVAC23-P (ventilation), AHVAC24-P (DCV), AHVAC27-P (energy recovery), AHVAC29-P(other)	NA
	CF inputs reflect requirements of ECB/PRM		AHVAC21-B (economizer), AHVAC23-B (ventilation), AHVAC24-B (DCV) AHVAC27-B (energy recovery)
	Meet mandatory requirements	AHVAC25-P (DCV)	NA

	Simulation inputs consistent with CF	AHVAC22-P (economizer) AHVAC26-P (ventilation and DCV), AHVAC28-P(energy recovery), AHVAC31-P(other)	AHVAC22-B(economizer) AHVAC26-B (ventilation and DCV), AHVAC28-B(energy recovery)
LEGEND			
PASS/FAIL/NA outcome is determined automatically in the Quality Control Checks tab of the Compliance Form			

90.1 Section 6 has mandatory minimums for heating and cooling system efficiencies and ventilation controls. Checks verifying mandatory requirements should be completed where applicable.

In addition, checks should focus on air-side systems with the highest heating or cooling capacity, design and ventilation flow rates and spot-checking the rest. A table in the Air-side HVAC section of the Quality Control Checks tab ranks air-side systems based on these criteria and should be used to identify systems to be reviewed. For example, if a multifamily project includes a rooftop unit serving common corridors and a water-source heat pumps serving each apartment, the rooftop unit and several representative heat pump systems should be reviewed.

For 90.1 2022 PRM alterations subject to G3.3 (i.e., Minor Alterations), the summary tables on the Quality Control Checks tab in the Compliance Form may not reflect correct values for the baseline since projects, for the most part, only enter proposed design information and provide notes as to what was modeled in the baseline in the notes fields associated with the proposed design related tables. Refer to the [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) section for more information regarding 90.1 2022 G3.3.

AHVAC01–P Thermal blocks are established correctly

90.1 2019/2022 ECB, 90.1 2016 and 2019/2022 PRM

11.7.2 g/12.7.2 g, G1.3.2 i/ G1.3.2 j: A diagram showing the *thermal blocks* used in the computer simulation must be submitted.

90.1 2016 and 2019/2022 ECB, 90.1 2016, 2019, and 2022 PRM

90.1 Table 11.5.1 #7/12.5.1 #7, 90.1 G3.1 #7

Thermal blocks must be based on the HVAC zones specified in the proposed design. Where HVAC zones are defined on drawings, each HVAC zone must be modeled as a separate thermal block. Different HVAC zones may be combined into a single thermal block if all of the following applies:

- zones have similar occupancy types (e.g., include primarily office spaces)
- have windows facing the same orientation, or their orientations vary by less than 45 degrees
- are served by the same kind of HVAC system

Thermal blocks in the baseline (budget) design must be the same as in the proposed design.

90.1 Table 11.5.1 #8/12.5.1 #8 and Table G3.1 #8 Special rules apply to projects with no HVAC zones designed. Thermal blocks in the baseline (budget) design must be the same as in the proposed design.

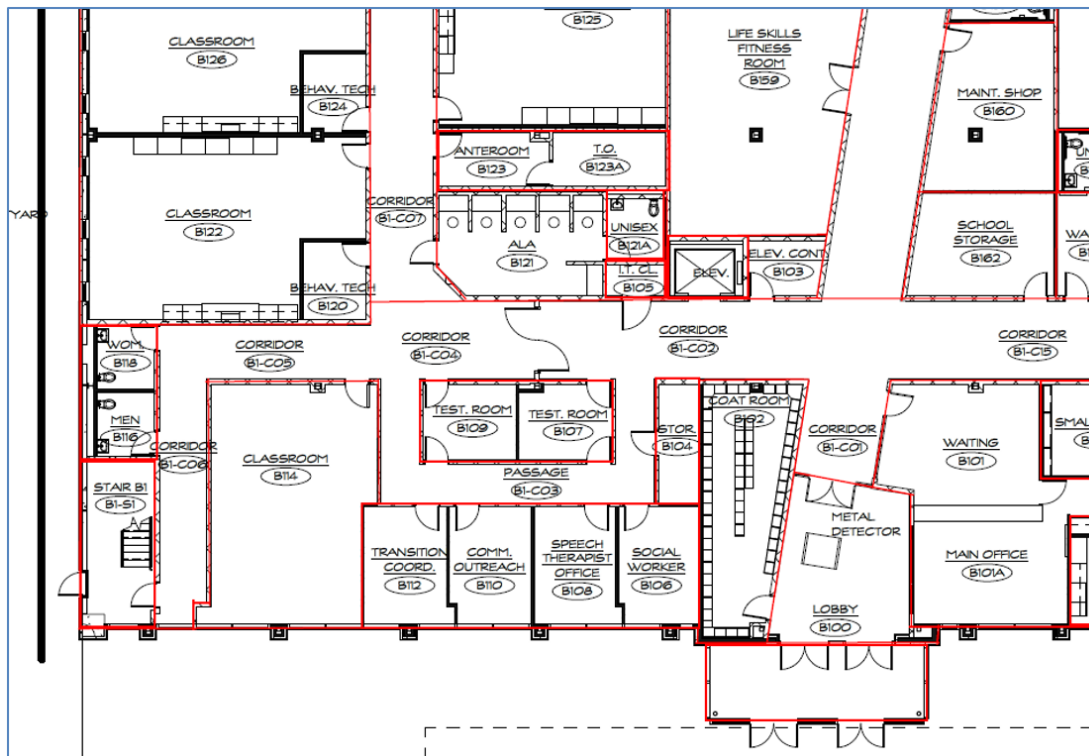
90.1 Table 11.5.1 #9/12.5.1 #9 and Table G3.1 #9

Residential occupancies such as multifamily must be modeled using at least one thermal block per dwelling unit, except units facing the same orientations may be combined into one thermal block. Corner units and units with roof or floor loads may only be combined with units sharing the same features. Thermal blocks in the baseline (budget) design must be the same as in the proposed design.

Review Tips

1. The submittal package for projects following the PRM or 2019 and 2022 ECB must include a diagram showing the thermal blocks used in the computer simulation. Refer to the Review Checklist tab #15 to identify the name of the file or document with the necessary information. The diagram should include the labels corresponding to the block names used in the simulation, or a description of the thermal block naming convention used. For example, the names of the thermal blocks may be based on the space names shown on architectural drawings. Request thermal block diagram if it is not included in the submittal package or lacks the necessary details. Even though it is not required for projects following 90.1 2016 ECB, a reviewer may still choose to request it to help verify that the relevant requirements of 90.1 are met.

Figure 7: Sample Thermal Blocks Used in the Computer Simulation



2. The thermal blocks are summarized in Table 2 of the Interior Lighting Summary tab. Spot-check the table to confirm alignment with the submitted diagram.

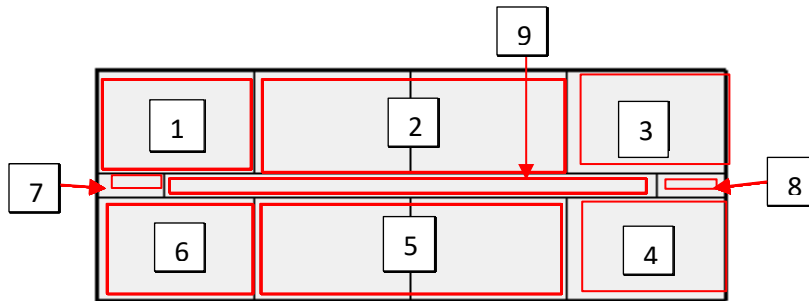
- The relevant 90.1 rules set the minimum level of details to which the project's floor plans must be captured in the model. HVAC zone may include one or more spaces where indoor conditions (e.g., temperature) are maintained by a single sensor (e.g., thermostat). Refer to Table 1 of the Interior Lighting Counts tab where detailed information for thermal blocks is provided. Spot check a sample of larger or typical thermal blocks with the submitted block diagram and mechanical plans drawings to confirm that the rules were correctly applied to the project.

Table 1: Lighting Fixture Counts

Space Name Reference (e.g. space name(s) from drawings)	Thermal Block Name from Model	Lighting Plans Dwg#	Multiplier	Space/Building Area Type (90.1-Section 9)	Area (ft ²)	RCR LP per Sq Ft
Corr 101	Corr1	E-101	1	Corridor/All Other	604	
Trash 102	Corr1	E-101	1	Storage Room/<50 ft^2	49	
Stair 103	N Stair1	E-101	1	Stairwell	92	
Stair 104	S Stair1	E-101	1	Stairwell	92	
Apt 101A	MF1ESE Perim Spc (G.ESE4)	E-101	1	Dwelling Unit	963	
Apt 101B	MF1ESE Perim Spc (G.ESE4)	E-101	1	Dwelling Unit	963	

Total for Area (ft²): 109,661

Example: A ten story multifamily building with eight apartments, corridor and stairwells on each floor would be modeled with 27 thermal blocks (highlighted in red in the figure below), including nine thermal blocks on the top and bottom floors and another 9 thermal blocks on a typical middle floor to which a multiplier of 8 is applied to indicate that there are eight such floors in the building.



AHVAC02-B,P Thermal blocks are modeled as reported in the Compliance Form

Review Tips

1. Spot-check simulation reports to verify that the modeled thermal blocks for the baseline/budget and proposed design reflect thermal blocks reported in Table 2 of the Interior Lighting Summary tab.

eQUEST Reports	SV-A
Trane TRACE 700	Room Information entered values report
Trane TRACE 3D Plus	NA
IESVE SOFTWARE	Plant Loops & Equipment Report, Space Loads & Ventilation Report, Room Loads Report, Zone Loads Report, System Loads Report, Detailed Simulation Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report
EnergyPlus	eplustbl.html 'Input Verification and Results Summary' report, 'Zone Summary' section, and 'Initialization Summary' report, 'Zone Information' section
OpenStudio	eplustbl.html 'Input Verification and Results Summary' report, 'Zone Summary' section, and 'Initialization Summary' report, 'Zone Information' section
Carrier HAP v5	"Air System Input Data" reports.
Design Builder	Zone Sensible Heating/Cooling Tables in Output Summary Document

AHVAC03-P All specified air-side HVAC systems are reported in the Compliance Form

Review Tips

1. Each HVAC system shown on mechanical schedules must be included in the Compliance Form. Cross-check information provided in Table 1a of the Proposed HVAC with the Mechanical Schedules to confirm that all specified air-side systems are reported.
2. Common Mistakes

- a) Supplemental systems such as electric resistance unit heaters and baseboards that are often specified for mechanical rooms, stairwells and bathrooms not reported in the Compliance Form.

AHVAC03–B Baseline/budget system types reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

Each HVAC system specified in the proposed design must have a corresponding baseline system established following 90.1 Figure 11.5.2/Figure 12.5.2, Table 11.5.2-1/Table 12.5.2-1 and accompanying notes.

90.1 2016 and 2019 PRM

Baseline HVAC system type and description must be based on 90.1 Section G3.1.1. Mixed use buildings that include both residential and non-residential building types with non-predominant conditions accounting for more than 20,000 ft² of conditioned floor area must have a separate baseline system type established for each set of conditions. The following baseline systems apply to climate zones 3B, 3C, and 4 to 8:

- All residential occupancies (dormitory, hotel, motel and multifamily):
System 1 – PTAC
- All public assembly occupancies (houses of worship, auditoriums, movie theaters, performance theaters, concert halls, arenas, enclosed stadiums, ice rinks, gymnasiums, convention centers, exhibition centers and natatoriums):
System 3—PSZ-AC if <120,000 ft²
System 12—SZ-CV-HW if $\geq 120,000$ ft²
- Heated-only storage (e.g. warehouse) meeting the definition of non-predominant conditions, or certain heated-only spaces such as storage rooms, stairwells, electrical/mechanical rooms (90.1 Section G3.1.1 e):
System 9—Heating and ventilation
- All other non-residential:
System 3—PSZ-AC if 3 floors or fewer and <25,000 ft²
System 5—Packaged VAV with reheat if 4 or 5 floors and <25,000 ft² or 5 floors or fewer and 25,000 ft² to 150,000 ft²
System 7—VAV with reheat if more than 5 floors or >150,000 ft²

The following baseline systems apply to climate zones 0 to 3A:

- All residential occupancies (dormitory, hotel, motel and multifamily):
System 1 – PTHP
- All public assembly occupancies (houses of worship, auditoriums, movie theaters, performance theaters, concert halls, arenas, enclosed stadiums, ice rinks, gymnasiums, convention centers, exhibition centers and natatoriums):
System 4—PSZ-HP if <120,000 ft²
System 13—SZ-CV-ER if $\geq 120,000$ ft²

- Heated-only storage (e.g. warehouse) meeting the definition of non-predominant conditions, or certain heated-only spaces such as storage rooms, stairwells, electrical/mechanical rooms (90.1 Section G3.1.1 e):
 - System 10—Heating and ventilation
- All other non-residential:
 - System 4—PSZ-HP if 3 floors or fewer and <25,000 ft²
 - System 6—Packaged VAV with PFP boxes if 4 or 5 floors and <25,000 ft² or 5 floors or fewer and 25,000 ft² to 150,000 ft²
 - System 8—VAV with PFP boxes if more than 5 floors or >150,000 ft²

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Baseline HVAC system type and description for projects following Section G3.2 must be based on 90.1 Section G3.2.1. Below is a summary of the process for determining the baseline HVAC system(s):

1. Determine the combined gross conditioned and semi-heated floor area for each of the following building area types in the proposed design:

- residential and residential-associated zones
residential associated HVAC zone (90.1 Section 3): any HVAC zone that primarily includes nonresidential spaces designed to serve occupants of residential spaces, including but not limited to corridors, stairwells, elevator lobbies, and common restrooms, on a floor where over 75% of the gross conditioned floor area are residential spaces. This definition does not apply to HVAC zones within hospitals.
- public assembly
- heating-only storage
- retail
- hospitals
- other nonresidential

2. Classify the nonresidential building area type with the largest combined area as the predominant nonresidential building area type. Add the combined area of any remaining nonresidential building area types with less than 20,000 ft² to the combined area of the predominant nonresidential building area type.

3. Select a baseline HVAC system type from Table G3.1.1-3 for each of the following building area types included in the proposed design:

- a. Residential based on Section G3.2.1.1(a)
- b. Predominant nonresidential based on Section G3.2.1.1(b)
- c. Each additional nonresidential building area type with more than 20,000 ft² of combined area based on Section G3.2.1.1(a)

G3.3 Minor Alterations

The systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) must be modeled following the requirements of G3.3.2.8(a) which specify that the baseline HVAC system type is the same as the proposed design. **Exception:** if the proposed

design includes variable refrigerant flow heat pumps or single-zone systems with electric resistance heat, then air source heat pumps shall be modeled in the baseline design.

Review Tips – 90.1 ECB

1. Budget HVAC system types are reported in Table 1a of the Budget HVAC ECB tab. Since ECB requires that each system in the proposed design has a corresponding budget system, the default budget system types are set in the table by applying the appropriate rules of ECB to each proposed system. The over-written defaults are shown in brown bold font and should be verified.

Modeled Budget Sys Name	Corresponding Proposed System	Areas Served	System Type (Figure 11.5.2)	Qty
Cor_Sys	Cor_Sys	Corridors	System 10 - Packaged terminal air conditioner	1
UH_HW	UH_HW	Stairs	System 11 - Packaged rooftop air conditioner	26
Retail_Sys	Retail_Sys	Retail	System 11 - Packaged rooftop air conditioner	6
Apt_Sys	Apt_Sys	Apartments	System 10 - Packaged terminal air conditioner	80
DOAS_Sys	DOAS_Sys	Apartments	System 10 - Packaged terminal air conditioner	1

Review Tips – 90.1 PRM

1. Baseline HVAC system types are reported in Table 1a of the Baseline HVAC PRM tab. Spot-check to confirm that the baseline systems were established correctly based on the applicable 90.1 rules. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

Modeled Sys Name	System Type	Applicable Exception, if Any	Zoning	Areas Served	Qty
UH_Stairs	System 9 - Heating and ventilation	G3.1.1 (e)	System per Block	Stairs	26
PSZ_Retail	System 3 - PSZ-AC	G3.1.1 (b)	System per Block	Retail	6
PTAC_Apts	System 1 - PTAC		System per Block	Apartments and Corridors	90

2. Common Mistakes (not applicable to alterations subject to 90.1 2022 Section G3.3)
 - a. Baseline HVAC heating fuel source based on the heating source used in the proposed design instead of based on the project’s climate zone. For example, a project in climate zone 4A that has electric heating in the proposed design should not have electric heating modeled in the baseline design.
 - b. Modeling dedicated outdoor air system (DOAS) in the baseline on projects with DOAS in the proposed design. Instead, heating, cooling and ventilation in the baseline design is provided by systems determined following 90.1 Section G3.1.1/G3.2.1.
 - c. System 5 - 8 are not modeled as System per floor; instead, multiple systems per floor are modeled to maintain the same arrangement as in the proposed design. This impacts a baseline system’s individual OA to supply ratio which determines baseline energy recovery requirements and may also affect the baseline system efficiency.

AHVAC04–B,P All baseline/budget and proposed air-side HVAC systems reported in the Compliance Form are modeled.

Review Tips

1. Spot-check simulation reports to confirm that all proposed air-side systems reported on Table 1a of the Proposed HVAC tab are modeled and reflect the reported system type and fuel.
2. Spot-check simulation reports to confirm that all budget/baseline air-side HVAC systems reported in Table 1a of the Budget HVAC ECB/ Baseline HVAC PRM tabs are modeled and reflect the reported system type and fuel. For alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) review Table 1a on the Proposed HVAC tab for baseline systems since there should be a one-to-one relationship between the baseline and proposed.
3. Confirm alignment between heating/cooling fuel sources reported in the Compliance Form for baseline/budget and proposed design with modeling results. For example, if some systems reported in the Compliance Form use electric resistance heat, simulation output reports must show electricity consumption under space heating end use.
4. Common Mistakes
 - a) Using incorrect “template” within the simulation tool to model specified system type, such as a constant volume system template to model a variable volume system.
 - b) Omitting electric resistance space heaters and radiators from the model

eQUEST Reports	SV-A (includes all air-side systems), SS-P, DOE-2 Help (established modeled system type based on SV-A and enter it into DOE-2 Help “search” box to see typical applications), BEPU (check that electricity is reported under heating end use if electric resistance heaters are specified) The following system types are commonly used to model PRM Baseline systems: System 1 – PTAC, PSZ-AC, PVVT-AC System 3 – PSZ – AC, PVVT-AC System 5 – PVAVS, PIU System 7 – VAVS, PIU System 9 – UHT
Trane TRACE 700	System Information entered values report for system type and Energy Cost Budget report for space heating end use
Trane TRACE 3D Plus	System Component Summary report
IESVE SOFTWARE	BPRM Report, Plant Loops & Equipment Report, Space Loads & Ventilation Report, Room Loads Report, Zone Loads Report, System Loads Report, Detailed Simulation Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report
EnergyPlus	eplustbl.html ‘Component Sizing Summary’ report, ‘AirLoopHVAC’ section
OpenStudio	eplustbl.html ‘Component Sizing Summary’ report, ‘AirLoopHVAC’ section
Carrier HAP v5	Input Data: “Air System Input Data” report. Output Data: “Monthly Simulation Results” report for an Air System
Design Builder	Air-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

AHVAC05–P Heating and cooling types and capacities of the proposed air-side HVAC systems reported in the Compliance Form reflect Design Documents.

Review Tips

1. Heating and cooling types and capacities of the air-side HVAC systems are reported in Table 1a of the Proposed HVAC tab. Cross-check the provided information with the design documents for a sample of systems to confirm alignment.

Modeled System Name	Drawing System Name(s)	Drawing Plans/ Spec	Areas Served	Quantity	Single-zone or Multi-zone?	Heating System Type and Capacity							
						Equipment Type	Heat Pump Type	Fuel Type / Heating Source	Total Capacity for Qty Listed	Cap. Units	Preheat Coil Heating Source	Reheat Type	Perimeter Radiati
Cor_Sys	RTU_1	M-101	Corridors	1	Single Zone Non-Residential	Unit Heater	n/a	Electric Resistance	78	kBtu/h	No preheat coil	None	No
UHLHw	UHL_1	M-102	Stairs	26	Single Zone Non-Residential	Unit Heater	n/a	Electric Resistance	35	kBtu/h	No preheat coil	None	No
Retail_Sys	AHL_1	M-101	Retail	6	Single Zone Non-Residential	Central Furnace	n/a	Natural Gas	900	kBtu/h	No preheat coil	None	No
Apt_Sys	FCUL_1-80	M-103	Apartments	80	Single Zone Residential	Heat Pump	VRF w/Heat Recovery Air Source	n/a	2,240	kBtu/h	No preheat coil	None	No
DOAS_Sys	DOAS_1	M-103	Apartments	1	Single Zone Residential	Central Furnace	n/a	Natural Gas	1,260	kBtu/h	No preheat coil	None	No

AHVAC05–B Heating and cooling types and capacities of the baseline/budget air-side HVAC systems reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

The equipment capacities for the budget building design must be sized proportionally to the capacities in the proposed design based on sizing runs, i.e., the ratio between the capacities used in the annual simulations and the capacities determined by the sizing runs must be the same for both the proposed design and budget building design (90.1 Section 11.5.2 i/90.1 Section 12.5.2 i). The capacity of each system in the budget building should have a reasonable correlation to the corresponding system in the proposed design. For example, if the proposed design has a less efficient envelope compared to the budget design, budget system capacities are expected to be lower compared to the corresponding proposed system.

90.1 2016 PRM

G3.1.2.2 Equipment Capacities: The coil capacities for the baseline systems must be based on sizing runs for each orientation (90.1 Table G3.1, No. 5 a) and oversized by 15% for cooling and 25% for heating; i.e., the ratio between the cooling/heating capacities used in the annual simulations and the capacities determined by the sizing runs must be 1.15/1.25. Weather conditions used in sizing runs must be based either on hourly historical weather files with typical peak conditions, or 99.6% heating design temperatures and 1% dry-bulb and 1% wet-bulb cooling design temperatures from 90.1 Appendix D, as illustrated below.

Figure 41: Example Design Conditions from 90.1 Appendix D

State/City	Latitude	Longitude	Elev., ft	HDD65	CDD50	Cooling Design Temperature		Number of Hours 8 a.m.–4 p.m. 55 < T _{db} < 69	
						Heating Design Temperature 99.6%	Dry-Bulb 1.0%		Wet-Bulb 1.0%
(New York cont.)									
Cortland	42.60 N	76.18 W	1129	7168	2225	NA	NA	NA	NA
Elmira/Chemung Co	42.17 N	76.90 W	951	6845	2420	-2	87	71	NA
Geneva Research Farm	42.88 N	77.03 W	718	6939	2364	NA	NA	NA	NA
Glens Falls FAA AP	43.35 N	73.62 W	321	7635	2182	-10	85	71	NA

90.1 2019 PRM

G3.1.2.2 Equipment Capacities: The coil capacities for the baseline systems must be based on sizing runs for each orientation (90.1 Table G3.1, No. 5 a) and oversized by 15% for cooling and 25% for heating; i.e., the ratio between the cooling/heating capacities used in the annual simulations and the capacities determined by the sizing runs must be 1.15/1.25.

Weather conditions used in sizing runs to determine baseline equipment capacities is required to be based on design days developed using heating design temperatures, cooling design temperature, and cooling design wet-bulb temperature. For cooling sizing runs, schedules for internal loads, including those used for infiltration, occupants, lighting, gas and electricity using equipment, are required to be equal to the highest hourly value used in the annual simulation runs and applied to the entire design day. For heating sizing runs, schedules for internal loads, including those used for occupants, lighting, gas and electricity using equipment, are required to be equal to the lowest hourly value used in the annual simulation runs, and schedules for infiltration are required to be equal to the highest hourly value used in the annual simulation runs and applied to the entire design day. An exception is that for cooling sizing runs in residential dwelling units, the infiltration, occupants, lighting, gas and electricity using equipment hourly schedule are required to be the same as the most used hourly weekday schedule from the annual simulation.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

G3.2.2.2 Equipment Capacities: Requirements are the same as described for the 90.1 2019 PRM above.

G3.3 Minor Alterations

For the systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 capacities for the baseline design are required to be sized proportionally to the capacities in the proposed design based on sizing runs—i.e., the ratio between the capacities used in the annual simulations and the capacities determined by the sizing runs shall be the same for both the proposed design and baseline building design based on 90.1 G3.3.2.8e.

Review Tips – ECB

1. Heating and cooling types and capacities of the baseline air-side HVAC systems are reported in Table 1a of the Budget HVAC ECB tab of the Compliance Form.
2. The capacity of each system in the budget building should have a reasonable correlation to the corresponding system in the proposed design. For example, if the proposed design has a less efficient envelope compared to the budget design, the budget system capacities are expected to be lower compared to the corresponding proposed system.

Review Tips – PRM

1. Heating and cooling types and capacities of the baseline air-side HVAC systems are reported in Table 1a of the Baseline HVAC PRM tab of the Compliance Form. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

Modeled Sys Name	System Type	Areas Served	Qty	Heating			Cooling			
				Equipment Type	Fuel Type / Heating Source	Total Capacity	Cap. Units	Equipment Type	Total Capacity	Cap. Units
UH_Stairs	System 9 - Heating and ventilation	Stairs	26	Fossil Fuel Furnace	Natural Gas	53	kBtu/h	None	-	kBtu/h
PSZ_Retail	System 3 - PSZ-AC	Retail	6	Fossil Fuel Furnace	Natural Gas	1,204	kBtu/h	Direct Expansion	768	kBtu/h
PTAC_Apts	System 1 - PTAC	Apartments and Corridors	90	Hot-Water Fossil Fuel Boiler	Natural Gas	1,898	kBtu/h	Direct Expansion	2,088	kBtu/h

2. Heating and cooling types are shown in the Equipment Type columns and are auto-populated based on user selection in System Type column.
3. The values entered in the Total Capacity columns for heating and cooling must be based on the simulation results.
4. The cooling capacity inputs should be compared to the typical shown in Table 13. Projects with lower SF/Ton should be flagged as they may have an overly lenient (less efficient than required) baseline. Exaggerated baseline cooling system capacity may lead to the system operating at low fraction of design capacity for most of the year, lowering the annual average efficiency. For projects with constant volume systems in the baseline, this will also exaggerate the baseline fan energy use. In addition, if a project uses a utility rate structures with demand charges, this will exaggerate the baseline demand charges and energy cost.

The issue may be caused by one or more of the following:

- a) Design conditions are not entered correctly
- b) Higher than typical internal gains from lighting, occupancy or miscellaneous equipment during design day
- c) Lower than typical modeled design cooling temperature
- d) Cooling is oversized by more than 15% to reduce number of hours for which cooling load is not met in the simulation. However, the unmet load hours are often due to simulation mistakes and should be addressed in lieu of increasing cooling capacity. For example, cooling schedule may allow temperatures to go up significantly during unoccupied hours resulting in higher-than-expected load when the building switches to occupied mode.

Table 13: Cooling Capacity Rule of Thumb²⁰

Occupancy Type	Cooling Load, SF/Ton 1 Ton = 12,000 Btu/hr = 12 MBH
Apartment high-rise	400 - 450
Public assembly	250 - 400
Schools – universities	185 - 240
Hotels, motels, dormitories	300 - 350
Office buildings	280 - 360

²⁰ ASHRAE Pocket Guide for Air Conditioning, Heating, Ventilation, Refrigeration (I-P Edition), 7th Edition

AHVAC06–B,P Heating and cooling capacities of the air-side HVAC systems are modeled as reported in the Compliance Form

Review Tips

1. Spot-check simulation reports to verify that modeled heating and cooling capacities for a sample of air-side HVAC systems reflect values reported in the Compliance Form. (See Table 1a of the Proposed HVAC tab for reported capacities of the proposed systems; see Table 1a of the Budget HVAC ECB/ Baseline HVAC PRM tabs for budget/baseline system capacities that must be modeled. For alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations), if baseline capacities were requested under AHVAC05-B, compare the documentation provided to simulation reports.
2. For PRM baseline systems (excluding alterations subject to 90.1 2022 Section G3.3), use simulation input and output reports to verify that the ratio of the baseline system capacity to the simulated peak load is approximately 15% for cooling and 25% for heating. The oversizing may be higher due to the difference in internal gain and weather used for equipment sizing versus the annual simulation. Oversizing significantly higher than 15% should be flagged.
3. For ECB budget systems and PRM alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations):
 - a) Use simulation input and output reports to confirm that the ratio of equipment heating/cooling capacity to the simulated heating/cooling peak load should be the same or very similar for the budget systems as for the corresponding systems in the proposed design, based on the simulation output reports.
 - b) Calculate the effective heating/cooling full load hours (EFLH) as the ratio of the annual heating/cooling load to the heating/cooling equipment capacity. The effective heating/cooling EFLH should be similar between the proposed systems and the respective budget systems.
4. Common Mistakes:
 - a) Having the software auto-size the proposed systems instead of using heating and cooling capacities specified on mechanical schedules.

eQUEST Reports	LS-C (design conditions), SS-P (oversizing for baseline/budget systems), SV – A (modeled capacity)
Trane TRACE 700	System Information entered values report
Trane TRACE 3D Plus	System Component Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, System Loads Report, BPRM Report, Space Loads & Ventilation Report, Room Loads Report, Zone Loads Report, Detailed Simulation Report, PRM Compliance Report, ECB Compliance Report
EnergyPlus	eplustbl.html ‘Component Sizing Summary’ report, also available in the ‘Equipment Summary’ report, ‘HVAC Sizing Summary’ report, ‘Coil Sizing Summary’ section, and ‘Coil Sizing Details’ report if more sizing information is needed
OpenStudio	eplustbl.html ‘Component Sizing Summary’ report, also available in the ‘Equipment Summary’ report, ‘HVAC Sizing Summary’ report, ‘Coil Sizing

	Summary' section, and 'Coil Sizing Details' report if more sizing information is needed
Carrier HAP v5	"Air System Input Data" reports.
Design Builder	Air-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsM)

AHVAC07-P Reported air-side HVAC systems cooling and heating efficiencies reflect design documents.

Review Tips

1. Heating and cooling types and capacities of the air-side HVAC systems are reported in Table 1a of the Proposed System HVAC tab. Cross-check the provided information with the design documents for a sample of systems to confirm alignment.
2. 90.1 Section 6 includes tables with the minimum efficiency requirements for different types of HVAC systems. These requirements are mandatory and must be met by all specified systems. The requirements applicable to each specified system are shown in Table 1a. Efficiencies that are below the required minimum are highlighted in red and must be noted in the review comments.

Modeled System Name	Drawing System Name(s)	Drawing Plans/ Spec	Areas Served	Quantity	Single-zone or Multi-zone?	Specified Efficiency						Minimum Allowed Efficiency						
						Unitary Heating Eff.	Eff. Units	COP n/heatin g	Unitary Cool. Full Load Eff.	Eff. Units	Unitary Cool. Part load Eff.	Eff. Units	COP n/coo ling	Efficiency Heating	30.1 Ref. Table	Load Efficiency Cooling	Part Load Efficiency Cooling	30.1 Ref. Table
Retail_Sys	AHU_1	M-101	Retail	6	Single Zone Non Residential	0.85	AFUE	n/a	9.0	EER	12.9	IEER	4.40	81% AFUE	Table 6.8.1-5	11.0 EER	12.7 IEER	Table 6.8.1-1
Apt_Sys	FCU_1-80	M-103	Apartments	80	Single Zone Residential	n/a	-	n/a	n/a	-	n/a	-	n/a	n/a	n/a	n/a	n/a	-
DOAS_Sys	DOAS_1	M-103	Apartments	1	Single Zone Residential	0.8	Et	n/a	9.8	EER	11.2	IEER	4.10	80% Et	Table 6.8.1-5	9.5 EER	11.0 IEER	Table 6.8.1-1

AHVAC08-P Cooling and heating efficiencies of the specified air-side HVAC systems meet the mandatory minimums in 90.1 Section 6

Review Tips

1. 90.1 Section 6 includes tables with the minimum efficiency requirements for different types of HVAC systems. These requirements are mandatory and must be met by all specified systems. The requirements applicable to each specified system are shown in Table 1a of the Proposed HVAC tab. Efficiencies that are below the required minimum are highlighted in red and should be flagged. Spot check the validity of manual overrides of the minimum allowed efficiency values which would be shown in brown bold font. Existing systems and components not in the scope of the project do not need to comply with minimum efficiency requirements.

Modeled System Name	Drawing System Name(s)	Drawing Plans/ Spec	Areas Served	Quantity	Single-zone or Multi-zone?	Specified Efficiency						Minimum Allowed Efficiency						
						Unitary Heating Eff.	Eff. Units	COP n/heatin g	Unitary Cool. Full Load Eff.	Eff. Units	Unitary Cool. Part load Eff.	Eff. Units	COP n/coo ling	Efficiency Heating	30.1 Ref. Table	Load Efficiency Cooling	Part Load Efficiency Cooling	30.1 Ref. Table
Retail_Sys	AHU_1	M-101	Retail	6	Single Zone Non Residential	0.85	AFUE	n/a	9.0	EER	12.9	IEER	4.40	81% AFUE	Table 6.8.1-5	11.0 EER	12.7 IEER	Table 6.8.1-1
Apt_Sys	FCU_1-80	M-103	Apartments	80	Single Zone Residential	n/a	-	n/a	n/a	-	n/a	-	n/a	n/a	n/a	n/a	n/a	-
DOAS_Sys	DOAS_1	M-103	Apartments	1	Single Zone Residential	0.8	Et	n/a	9.8	EER	11.2	IEER	4.10	80% Et	Table 6.8.1-5	9.5 EER	11.0 IEER	Table 6.8.1-1

AHVAC08-B Baseline/budget air-side systems' heating and cooling efficiencies reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

All HVAC equipment in the budget building design must be modeled at the minimum part load and full load efficiencies in 90.1 Sections 6.4.

90.1 2016 and 2019 PRM

Baseline system efficiencies must be based on 90.1 Tables G3.5.1 through G3.5.6.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Requirements are the same as for the 90.1 2016 and 2019 PRM above.

G3.3 Minor Alterations

Systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) are required to be modeled at the minimum part load and full load efficiencies in 90.1 Section 6.4.1 in the baseline design model. All other baseline systems and equipment shall be modeled the same as in the proposed design.

Review Tips – 90.1 ECB

1. Heating and cooling system efficiencies are reported in Table 1a of the Budget HVAC ECB tab. The defaults are based on the efficiency tables referenced in “90.1 Ref Table” column. Any over-written defaults which are shown in brown font should be confirmed by the reviewer.

Modeled Budget Sys Name	Corresponding Proposed System	Budget Model Efficiency Heating				Budget Model Efficiency Cooling					
		Unitary Eff.	Eff. Units	Modeled Efficiency	90.1 Ref. Table	Unitary Full Load Eff.	Eff. Units	Unitary Part load Eff.	Eff. Units	COPnfcooling	90.1 Ref. Table
Cor_Sys	Cor_Sys	80%	Et	80% Et	Table 6.8.1-5	9.5	EER	11.0	IEER	3.78	Table 6.8.1-1
UH_HW	UH_HW				-	-	-	14.0	SEER	-	Table 6.8.1-1
Retail_Sys	Retail_Sys	80%	Et	80% Et	Table 6.8.1-5	9.8	EER	11.4	IEER	3.58	Table 6.8.1-1

Review Tips – 90.1 PRM

1. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) or review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations). Heating and cooling system efficiencies are reported in Table 1a of the Baseline HVAC PRM tab and are auto-populated based on user inputs in the System Type column and the Total Capacity columns for heating and cooling. In addition, the appropriate simulation inputs for heating and cooling efficiency are automatically established and shown in the Modeled Efficiency and COPnfcooling columns. The calculations reflect 90.1 requirements for extracting fan power from efficiency rating.

Modeled Sys Name	System Type	Baseline Efficiency Heating			Baseline Efficiency Cooling				
		Unitary Eff.	Eff. Units	Modeled Efficiency	Unitary Full Load Eff.	Eff. Units	Unitary Part load Eff.	Eff. Units	COPnfcooling
UH_Stairs	System 9 - Heating and ventilation	80%	Ec	78% Et	-	-	-	-	-
PSZ_Retail	System 3 - PSZ-AC	78% or 80%	AFUE or Et	80% Et	10.1	EER	-	-	3.52
PTAC_Apts	System 1 - PTAC	-	-	-	9.3	EER	-	-	2.88

AHVAC09-P Modeling inputs for the proposed heating and cooling efficiency are provided in the Compliance Form and established correctly

90.1 2016 and 2019/2022 ECB and PRM

90.1 Section 11.5.2/12.5.2, Table G3.1 #10

The modeled efficiency of the proposed systems must be adjusted to remove the supply fan energy corresponding to the conditions at which the unit was tested by the manufacturer. This requirement applies to all systems with a cooling efficiency rating expressed as EER and SEER. The cooling efficiency with the fan energy excluded is referred to as COP_{nfcooling} must be calculated based on manufacturer data at AHRI Rating Conditions, as follows (see also the 90.1 User's Manual):

$$\text{Indoor Fan Power [W]} = (\text{Gross Cooling [Btu/h]} - \text{Net Cooling [Btu/h]}) / 3.413 [\text{Btu/h} \times \text{W}]$$

$$\text{COP}_{\text{nfheating}} = \text{Gross Heating [Btu/h]} / (\text{Total Input Power [W]} - \text{Indoor Fan Power [W]}) \times 3.413 [\text{Btu/h} \times \text{W}]$$

Review Tips

1. COP_{nfcooling} and COP_{nfheating} for each proposed HVAC system with DX heating or cooling is included in Table 1a of the Proposed HVAC tab. Confirm that it is calculated as appropriate for a sample of HVAC systems and comment if incorrect. Focus the review on DX systems with the highest heating/cooling capacities and spot-check the rest.
- 2.

Modeled System Name	Drawing System Name(s)	Specified Efficiency								Minimum Allowed Efficiency				Basis of Modeled Performance Curves	
		Unitary Heating Eff.	Eff. Units	COP _{nfheating}	Unitary Cool. Full Load Eff.	Eff. Units	Unitary Cool. Part load Eff.	Eff. Units	COP _{nfcooling}	Efficiency Heating	90.1 Ref. Table	Load Efficiency Cooling	Part Load Efficiency Cooling		90.1 Ref. Table
Cor_Sys	RTU_1	0.82	Et	n/a	12.0	EER	13.0	IEER	4.14	80% Et	Table 6.8.1-5	11.0 EER	12.7 IEER	Table 6.8.1-1	Performance Rating Method Reference Manual
UH_HW	UH_1	n/a	-	n/a	n/a	-	n/a	-	n/a	n/a	n/a	n/a	n/a	-	n/a
Retail_Sys	AHLL1	0.8	Et	n/a	11.1	EER	12.8	IEER	4.40	80% Et	Table 6.8.1-5	11.0 EER	12.7 IEER	Table 6.8.1-1	Performance Rating Method Reference Manual
Apt_Sys	FCU_1-80	n/a	-	n/a	n/a	-	n/a	-	n/a	n/a	n/a	n/a	n/a	-	n/a
DOAS_Sys	DOAS_1	0.8	Et	n/a	9.8	EER	11.2	IEER	4.10	80% Et	Table 6.8.1-5	9.5 EER	11.0 IEER	Table 6.8.1-1	Performance Rating Method Reference Manual

Example: The specified air-handling unit has the following rated performance based on the manufacturer’s catalog:

Gross Cooling Capacity – Full Load [Btu/hr]	103,000
EER / IEER	12.6 / 22.5
AHRI Net Cooling Capacity – Full Load [Btu/hr]	99,000
System Power [kW]	7.86

$$\text{Indoor Fan Power [W]} = (\text{Gross Cooling [Btu/h]} - \text{Net Cooling [Btu/h]}) / 3.413 [\text{Btu/h} \times \text{W}] = (103,000 - 99,000) / 3.412 = 1,172 [\text{W}]$$

$$\text{COP}_{\text{nfcool}} = \text{Gross Cooling [Btu/h]} / ((\text{System Power [W]} - \text{Indoor Fan Power [W]}) * 3.412 [\text{Btu/h} \times \text{W}]) = 103,000 / ((7,860 - 1,172) * 3.412) = 0.2214$$

AHVAC09-B Modeling inputs for the baseline/budget heating and cooling efficiency are provided in the Compliance Form and established correctly

90.1 2016 and 2019/2022 ECB

Section 11.5.2 c/12.5.2 c: For Systems 3,4,6,8,9,10,11, supply fan energy at AHRI test conditions must be extracted from efficiency rating using the provided methodology.

90.1 2016 PRM

Section G3.1.2.1: For Systems 1 – 6, supply fan energy at AHRI test conditions must be extracted from efficiency rating using the provided methodology.

90.1 2019 PRM

The efficiency values included in 90.1 Tables G3.5.1 through G3.5.6 do not include supply fan energy so no adjustments are required.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Requirements are the same as for the 90.1 2019 PRM above.

G3.3 Minor Alterations

Systems and equipment included in the scope of the retrofit for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) are required to be modeled such that supply fan energy is extracted from the efficiency rating (where the efficiency rating includes supply fan energy) in accordance with 90.1 Section 12.5.2c.

Review Tips

1. The appropriate simulation inputs for heating and cooling efficiency are automatically established and shown in the Modeled Efficiency and COPnfcolling columns in Table 1a of the Baseline HVAC PRM or Budget HVAC ECB tabs (for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) see supplementary documentation, request this if not provided), depending on the compliance path. The calculations reflect 90.1 requirements for extracting fan power from efficiency ratings. For ECB projects, the defaults may be over-written by the modeler. The custom values may be verified.

AHVAC10-P The heating & cooling performance curves used in the proposed design simulation are based on an approved source

Review Tips

1. The modeled performance curves reflect variations in efficiency and capacity of the specified equipment at the range of operating conditions. The basis of the modeled performance curves must be specified in Table 1a of the Proposed HVAC tab.

Modeled System Name	Drawing System Name(s)	Drawing Plans/ Spec	Areas Served	Quantity	Single-zone or Multi-zone? Single Zone Non-Residential	Specified Efficiency						Minimum Allowed Efficiency				Basis of Modeled Performance Curves Custom curves based on manufacturer data			
						Unitary Heating Eff.	AFUE	COP _{nheating}	Unitary Cool. Full Load Eff.	EER	Unitary Cool. Part load Eff.	IEER	COP _{ncooling}	Efficiency Heating	90.1 Ref. Table 6.8.1.5		Load Efficiency Cooling	Part Load Efficiency Cooling	90.1 Ref. Table 6.8.1.1
Cor_Sys	RTU_1	M-101	Corridors	1	Single Zone Non-Residential	0.82	AFUE	n/a	12.0	EER	13.0	IEER	0.22	8% AFUE	Table 6.8.1.5	11.0 EER	12.7 IEER	Table 6.8.1.1	Performance Rating Method Reference Manual
UH_HV	BBrd	M-102	Stairs	26	Single Zone Non-Residential	n/a			n/a	-	n/a	-	n/a			n/a	n/a	-	n/a
Retail_Sys	AHU_1	M-101	Retail	6	Single Zone Non-Residential	0.85	AFUE	n/a	12.6	EER	12.8	IEER	0.23	8% AFUE	Table 6.8.1.5	11.0 EER	12.7 IEER	Table 6.8.1.1	Performance Rating Method Reference Manual

The performance curves may be available from equipment manufacturers or developed based on the performance data provided by the manufacturer. If the performance curves for the specified equipment are not available, the default curves from the ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual²¹ (or latest available version) may be used.

- When custom performance curves based on manufacturer data are used for any of the systems, supporting documentation must be provided. Refer to Submittal Checklist tab #22 to confirm that it is included in the submittal. The provided calculations may be reviewed for a sample of performance curves. Alternatively, reviewer may verify that, based on the simulation reports, the realized annual average efficiency is similar to the rated IEER of the unit.

AHVAC10-B The heating & cooling performance curves used in the baseline/budget design simulation are based on an approved source

Review Tips

- The modeled performance curves reflect variations in efficiency and capacity of the specified equipment at the range of operating conditions. The basis of the modeled performance curves must be specified in the last column of Table 1a on the Baseline HVAC PRM tab for PRM projects and on the Budget HVAC ECB tab for ECB projects. The curves from the ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual²² or more recent version should be used; projects with other sources selected may be flagged for further review. The modeled performance curves may be verified by checking that, based on the simulation reports, the realized annual average efficiency is similar to the rated IEER of the unit. For alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) refer to the Notes section under Table 1a on the Proposed HVAC tab for clarifications as to the performance curves modeled in the baseline design model.

AHVAC11-B,P Modeled heating and cooling efficiency of the air-side systems reflect values reported in the Compliance

Review Tips

- Use simulation reports to spot-check that the modeled cooling and heating efficiencies is as reported for selected air-side systems as follows:
 - COP_{ncooling} and COP_{nheating} reported in the Compliance Form is aligned with the simulation reports. The reported values are found in Table 1a of the Proposed HVAC for the proposed systems and in Table 1a of the Budget HVAC ECB/ Baseline HVAC PRM tabs for

²¹ https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

²² https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

budget/baseline systems. Refer to/request supplemental documentation for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) for modeled baseline values.

- b) Warm-air furnaces may have efficiency expressed as the Annual Fuel Utilization Efficiency (AFUE), thermal efficiency (Et) or combustion efficiency (Ec). The conversions below (from the Performance Rating Method Reference Manual) may be used if the efficiency input supported by the simulation tool differs from the efficiency metric available from the manufacturer for the specified equipment:

$$Et=0.0051427 \times AFUE + 0.3989$$

$$Et=Ec - 2\%$$

The calculations is performed automatically for the baseline/budget systems and results are shown in Table 1a of the Budget HVAC ECB/ Baseline HVAC PRM tabs.

Modeled Sys Name	Baseline Efficiency Heating			Baseline Efficiency Cooling				Basis of Modeled Performance Curves	
	Unitary Eff.	Eff. Units	Modeled Efficiency	Unitary Full Load Eff.	Eff. Units	Unitary Part load Eff.	Eff. Units		COP/ncooling
UH_Stairs	80%	Ec	78% Et	-	-	-	-	-	Performance Rating Method Reference Manual
PSZ_Retail	78% or 80%	AFUE or Et	80% Et	10.1	EER	-	-	3.52	Performance Rating Method Reference Manual
PTAC_Apts	-	-	-	9.3	EER	-	-	2.88	Performance Rating Method Reference Manual

eQUEST Reports	SS-P, SV-A, PS-E (heat pump supplement)
Trane TRACE 700	Plant Information entered values report
Trane TRACE 3D Plus	System Component Summary report
IESVE SOFTWARE	BPRM Report, Detailed Simulation Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html 'Equipment Summary' report, 'DX Cooling Coils' section
OpenStudio	eplustbl.html 'Equipment Summary' report, 'DX Cooling Coils' section
Carrier HAP v5	"Air System Input Data" reports.
Design Builder	Air-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

AHVAC12-B,P Annual average realized DX cooling and heating system efficiencies reflect expected performance at the range of actual conditions

Review Tips

- Background:** The average annual cooling efficiency is the ratio of the annual cooling load to the annual cooling energy from the simulation output reports. It reflects the realized performance of the modeled system. Most simulation tools used for compliance modeling describe cooling system performance through the rated efficiency and performance curves that capture impact of part load, indoor and outdoor temperatures and various other design, operational and site parameters on system performance. The realized efficiency is typically different from the rated full load efficiency and is similar to IEER (part load efficiency)

2. The check should be performed when cooling is an impactful end use on the project or when heat pumps account for a significant share of heating capacity.
3. Calculate the realized efficiency based on the modeling results for a sample of air-side systems and compare the result to the rated part-load efficiency. Systems with substantial difference between modeled and rated part load efficiency should be flagged. Lower than expected realized efficiency for the baseline/budget systems and higher than expected realized efficiency for the proposed systems is of especial concern since it may be due to modeling discrepancies and lead to overly optimistic compliance outcomes.
4. Common Mistakes
 - a. Using inappropriate performance curves, such as software default performance curves instead of the performance curves provided in the PRM RM.
 - b. Modeled heat pumps incorrectly account for performance degradation at low ambient temperatures including the use of electric resistance heat. In a heating-dominated climate, the average realized heat pump heating efficiency is expected to be worse than the manufacturer’s rating at 47°F and slightly over the manufacture’s rating 17°F. For units that operate in electric resistance mode below 40 F, the average efficiency will be slightly higher than 1.

For example, air-source heat pumps (ASHPs) often operate in the heat pump mode only down to 35F and use electric resistance heating at the lower temperatures. Reviewers should request equipment cut sheets documenting low-temperature performance of the specified equipment, because it has significant impact on heating energy use and should be reflected in the average annual realized efficiency including heat pump supplement. See sample air-source heat pump specification below describing low temperature operation.

Heat Pump Reverse Cycle Heating Capacity (Btu)												
Model No. ¹	208			230			265			208		
Voltage ²	208	230	265	208	230	265	208	230	265	208	230	265
Amps	3.0	2.6	2.2	3.6	3.2	2.6	5.1	4.5	3.9	6.3	5.7	5.4
Watts	550	570	570	730	740	740	1000	1020	1020	1380	1390	1390
Btu/h	6200	6400	6400	8000	8100	8100	10600	10800	10800	13500	13300	13300
				2.2	2.2	2.2					2.8	2.8
	32	380	400	400	510	520	520	775	795	795	1055	1065
											1170	1180
											1285	1180

Notes:
 1. All 265 volt models must use Trane's subbase or Trane's hard-wire junction box kit.
 2. Heating capacity and efficiency is based on unit operation without condensate pump. Unit automatically switches to electric heat at 25°F outdoor coil temperature. Depending upon relative humidity conditions, this will occur at approximately 35 degrees outdoor ambient temperature.

eQUEST Reports	SS-P
Trane TRACE 700	Equipment Energy Consumption report for the total equipment consumption and Building Cool/Heat Demand report from the Visualizer for the total loads
Trane TRACE 3D Plus	Site Consumption Summary for the consumption and Site Load Profile for the loads
IESVE SOFTWARE	Plant Loops & Equipment Report, System Loads Report, BPRM Report, Detailed Simulation Report
EnergyPlus	eplustbl.html 'Annual Building Utility Performance' report, 'End Uses By Subcategory' section

OpenStudio	eplustbl.html 'Annual Building Utility Performance' report, 'End Uses By Subcategory' section
Carrier HAP v5	"Monthly Simulation Results" reports for air-side DX HVAC systems. Use annual totals for "cooling equipment load", "cooling input kWh", "supply fan kWh".
Design Builder	Air-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

AHVAC13-B,P Average realized heating efficiency of air-side systems reflect expected performance.

Review Tips

1. **Background:** The average heating system efficiency is the ratio of the annual heating load to the annual heating energy use of the system, with both values taken from the simulation output reports.
2. The check should be performed when heating is an impactful end use. Calculate the realized efficiency based on the modeling results for a sample of air-side systems and compare the result to the rated part-load efficiency. Systems with substantial difference between modeled and rated part load efficiency should be flagged. Lower than expected realized efficiency for the baseline/budget systems and higher than expected realized efficiency for the proposed systems is of especial concern since it may be due to modeling discrepancies and lead to overly optimistic compliance outcomes.
3. For warm air furnaces with an AFUE rating, the average realized efficiency is expected to be similar to AFUE. For other units, the average realized efficiency is expected to be about 5% below thermal efficiency, based on the furnace part load efficiency curves included in the Performance Rating Method Reference Manual. For example, if a unit is rated at $E_c=80\%$, its $E_t = E_c - 2\% = 78\%$ and the average efficiency is expected to be $\sim 73\%$. The average efficiencies exceeding the above estimates should be flagged.
4. Efficiency degradation at part load is not prescribed in 90.1, but the average annual baseline (budget) efficiency below 75% should be flagged in the review. Table 14 shows efficiency degradation based on the performance curves in the Performance Rating Method Reference Manual. For example, furnace operates at 74% efficiency when the heating load is equal to the half of its rated capacity.

Table 14: Fossil Fuel Furnace Part Load Efficiency Degradation

% of Design Load $Q_{partload}/Q_{rated}$	100%	90%	80%	70%	60%	50%	40%	30%	25%
Realized Furnace Efficiency	80%	79%	78%	77%	76%	74%	73%	71%	70%

5. Common mistakes
 - a) Modeling the baseline/budget systems as having continuously on pilot light.

eQUEST Reports	SS-P, SV-A, PS-E (heat pump supplemental for electric meters and pump & aux column for fuel meters)
Trane TRACE 700	Equipment Energy Consumption report for the total equipment consumption and Building Cool/Heat Demand report from the Visualizer for the total loads

Trane TRACE 3D Plus	Site Consumption Summary for the consumption and Site Load Profile for the loads
IESVE SOFTWARE	Plant Loops & Equipment Report, BPRM Report, Detailed Simulation Report
EnergyPlus	eplustbl.html 'Annual Building Utility Performance' report, 'End Uses By Subcategory' section
OpenStudio	eplustbl.html 'Annual Building Utility Performance' report, 'End Uses By Subcategory' section
Carrier HAP v5	"Monthly Simulation Results" reports for air-side DX HVAC systems. For fuel-fired heaters: Use annual totals for "heating equipment load", "heating input" For heat pumps: Use annual totals for heating equipment load, heating input kWh", "supply fan kWh".
Design Builder	Air-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xslm)

AHVAC14-P Design supply, return, relief and exhaust fans' flow rates reported in the Compliance Form are as specified in the Design Documents

Review Tips

1. Design flow rates for the specified supply, return, relief and exhaust fans are listed in Table 2a of the Proposed HVAC tab. Cross-check Compliance Form inputs with the information provided in the mechanical schedules for a sample of specified systems to ensure alignment.

Modeled System Name	Fan Operation, Occupied Hours	Supply Fan						Relief/Return Fan					Exhaust Fan				
		Total Supply CFM	Total Outdoor Air CFM	Total BHP	Motor Eff.	Fan Flow Control	kW	Total CFM	Total BHP	Motor Eff.	Fan Flow Control	kW	Total CFM	Total BHP	Motor Eff.	Fan Flow Control	kW
Cor_Sys	Continuous	4,000	363	2.5	89.5%	Constant volume	2.08	4,000	1.5	89.5%	Constant volume	1.25					
UH_HV	Cycling	1,500	0	0.5	89.5%	Constant volume, cycling	0.42										
Retail_Sys	Continuous	14,500	5,812	10.0	89.5%	Constant volume	8.34	13,500	5.0	86.5%	Constant volume	4.31					
ApL_Sys	Cycling	48,000	0	10.0	82.0%	Constant volume, cycling	9.1										
DOAS_Sys	Continuous	6,400	6,400	5.0	89.5%	Constant volume	4.17					6,400	3.0	89.5%	Constant volume	2.5	

The figure below illustrates how fan system performance is typically shown in the design documents.

SYMBOL	MANUFACTURER/ MODEL NUMBER	LOCATION	UNIT SIZE	CFM	FAN TYPE	SUPPLY FAN DATA					MOTOR DATA				VFD REQ'D (DIV.23)	
						MIN O.A. (CFM)	O.A. (CFM)	ESP (IN WG)	TSP (IN WG)	SPEED (RPM)	BHP	HP	RPM	VOLTS		PH
AHU-1		NORTH PENTHOUSE 318	17	8,000	FL	900	3500	2.0	4.58	2431	9.65	5.0	1800	208	3	YES
AHU-2		SOUTH PENTHOUSE 302	30	15,000	FL	930	4230	2.0	4.89	3191	19.99	7.5	1800	208	3	YES

AHVAC14-B Baseline/budget design fans flow rates reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

Section 11.5.2 g/12.5.2 g: Design supply air rates for the budget building must be based on a supply-air-to-room-air temperature difference of 20°F. If return or relief fans are specified in the proposed design, the budget building design must also have the same fan type sized for the budget system supply fan air quantity less the minimum outdoor air, or 90% of the supply fan air quantity, whichever is larger.

90.1 2016 and 2019

Section G3.1.2.8: Design supply airflow rates must be based on a supply-air-to-room temperature difference of 20°F or the minimum baseline ventilation rate, whichever is greater. If return or relief fans are specified in the proposed design, the baseline building design must also have fans serving the same functions and sized for the baseline system supply fan air quantity less the minimum outdoor air, or 90% of the supply fan air quantity, whichever is larger.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Section G3.2.2.7: Same as the requirement for the 90.1 2016 and 2019 PRM in Section G3.1.2.8.

G3.3 Minor Alterations

The design supply air flowrates for systems included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) shall be autosized using the same supply-air-to-room temperature difference as was used for sizing in the design or the minimum baseline ventilation rate, whichever is greater. If this design sizing parameter information is unavailable, then design supply airflow rates can be autosized based on a supply-air-to-room temperature difference of 20°F or the minimum baseline ventilation rate, whichever is greater. If return or relief fans are specified in the proposed design, the baseline building design must also have fans serving the same functions and sized for the baseline system supply fan air quantity less the minimum outdoor air, or 90% of the supply fan air quantity, whichever is larger.

Review Tips – ECB

1. Design flow rate of the budget systems is reported in Table 2a of the Budget HVAC ECB tab.

Modeled Budget Sys Name	Corresponding Proposed System	Supply Fan					Relief/Return Fan				Exhaust Fan			
		Total Supply CFM	Total Outdoor Air CFM	Total BHP	Motor Eff.	kW	Total CFM	Total BHP	Motor Eff.	kW	Total CFM	Total BHP	Motor Eff.	kW
Cor_Sys	Cor_Sys	2,000	363	2.5	89.5%	2.08	1,800	1.5	86.5%	1.29	0			
Retail_Sys	Retail_Sys	5,500	5,812	4.57	89.5%	3.81	4,950	2.29	89.5%	1.91	0			

2. Supply fan flow is a user input and must reflect the value determined through the simulation. Relief/return and exhaust flows are auto populated in the Compliance Form based on the 90.1 requirements quoted above. Spot-check supply fan flow rates for a sample of air-side systems compared to typical show in Table 15 and outliers should be flagged.

Table 15: Typical Supply Air Flow Rates²³

Occupancy Type	Supply Air CFM/SF
Apartment high-rise	0.5 – 0.8
Office buildings	0.8 – 1.6

3. **Common Mistakes**

- a) The causes for higher-than-expected design flow rates are similar to those that lead to exaggerated cooling loads described in AHVAC05-B.

²³ ASHRAE Pocket Guide for Air Conditioning, Heating, Ventilation, Refrigeration (I-P Edition), 7th Edition

- b) Sizing flow based on supply air to room air temperature difference less than 20°F exaggerates the flow.
- c) For Appendix G, exaggerated design flow rate may also be caused by applying the over-sizing factor in 90.1 Section G3.1.2.2 to design flows in addition to coil capacities, which is incorrect – only coil capacities must be oversized.

Review Tips – PRM

1. Design flow rate of the baseline systems is reported in Table 3b of the Baseline HVAC PRM tab. Refer to/request supplemental documentation for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) for modeled baseline values. The flows may be compared to typical shown in Table 15 above.
2. Common Mistakes
 - a) Refer to common mistakes listed for this check under ECB.
 - b) The exaggerated design flow rate may also be caused by applying the over-sizing factor in 90.1 Section G3.1.2.2 to design flows in addition to coil capacities, which is incorrect – only coil capacities must be oversized.

AHVAC15-P Design supply, return, relief and exhaust fan power reported in the Compliance Form is as specified in the design documents

Review Tips

1. Design power of the specified supply, return, relief and exhaust fans is listed in Table 2a of the Proposed HVAC tab for all specified systems. Cross-check Compliance Form inputs with the information provided in the mechanical schedules for a sample of the specified systems to ensure alignment.
2. Common Mistakes
 - a) External static pressure (ESP) is used in lieu of the total static pressure (TSP). This significantly underestimates the proposed fan energy.
 - b) Only supply fan power is entered. Other specified fans such as return, exhaust and relief omitted from the template.
 - c) Indoor fans for split air source heat pump and variable refrigerant flow heat pump systems excluded or incorrectly entered under the “Terminal Unit” columns. The “Terminal Unit” columns are for terminal units in multi-zone variable air volume systems (i.e., VAV boxes).

AHVAC15-B Baseline/budget fan power reported in the Compliance Form is established correctly

90.1 2016 and 2019/2022 ECB

Section 11.5.2 h/12.5.2 h

BHP per CFM of supply air, including the effect of belt losses but excluding motor and motor drive losses must be the same as the proposed design or up to the limit prescribed in 90.1 Section 6.5.3.1, whichever is smaller. If this limit is reached, BHP of each fan must be proportionally reduced until the limit is met.

Fan electrical power must be determined by dividing the calculated fan BHP by the minimum motor efficiency in 90.1 Section 10.4.1 for the appropriate motor size for each fan.

90.1 2016 and 2019 PRM

Section G3.1.2.9

The section provides formulas for calculating the total combined power of supply, return, exhaust and relief fans excluding fan-powered VAV boxes. For Systems 3 – 8 and 12 - 13, the baseline BHP allowance provided in 90.1 Table G3.1.2.9 may be increased to account for certain design features included in the proposed design. Common examples of the allowed baseline pressure drop adjustments include proposed systems with MERV 9 or higher air filters, sound attenuation devices and ducted returns (90.1 Table 6.5.3.1-2).

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Requirements are the same as for the 90.1 2016 and 2019 PRM above.

G3.3 Minor Alterations

Systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) are required to be modeled with baseline fan power as described above for 90.1 2016 and 2019/2022 ECB with the exception that when a proposed design includes energy recovery, but it is not required in the baseline building design per 90.1 Sections 6.1.4 and 6.5.6, the fan power of the baseline system shall be equal to either the proposed design system or the fan power limit in Section 6.5.3.1 calculated without fan power credit for energy recovery, whichever is less. 90.1 Based on the language in 90.1 Section 6.1.4, 90.1 Section 6.5.6 requirements would only be relevant to the baseline when an alteration includes new cooling systems installed to serve previously uncooled spaces.

Review Tips – 90.1 ECB

1. Fan power for individual HVAC systems in the budget design is included in Table 2a of the Budget HVAC ECB tab and is calculated automatically by applying the applicable 90.1 rules quoted above. The total budget power by fan type is shown in Table 3. Since these values are auto populated in the Compliance Form, they do not need to be checked.

Modeled Budget Sys Name	Corresponding Proposed System	Fan Operation Occ. Hours	Fan Speed Control	Fan System Total BHP	Supply Fan				Relief/Return Fan				Exhaust Fan					
					Total Supply CFM	Total Outdoor Air CFM	Total BHP	Motor Eff.	kW	Total CFM	Total BHP	Motor Eff.	kW	Total CFM	Total BHP	Motor Eff.	kW	
Cor_Sys	Cor_Sys	Continuous	Two-speed	4.0	2,000	363	2.5	89.5%	2.08	1,800	1.5	86.5%	1.29	0				
Retail_Sys	Retail_Sys	Continuous	Two-speed	6.86	5,500	5,812	4.57	89.5%	3.81	4,950	2.29	89.5%	1.91	0				

Review Tips – 90.1 PRM

1. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for the location of baseline fan power in the Compliance Form for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. The allowed pressure drop adjustments for calculating the total baseline fan power allowance are entered in Table 2a of the Baseline HVAC PRM tab. Spot-check sample systems to confirm that the design flow rate CFM_D entered for each category includes only flow to the zones that include the allowed device in the proposed design. For example, if in the proposed design sound attenuation is

AHVAC16-P Air flow and supply temperature controls reported in the Compliance Form for the proposed design are as specified in the design documents

Review Tips

1. Air flow control method for each specified air-side HVAC system is reported in Table 1a of the Proposed HVAC tab.

Modeled System Name	Fan Operation, Occupied Hours	Supply Fan				Fan Flow Control	kW
		Total Supply CFM	Total Outdoor Air CFM	Total BHP	Motor Eff.		
Cor_Sys	Continuous	4,000	363	2.5	89.5%	Variable flow, VSD w/SP reset	2.08
UH_HW	Cycling	1,500	0	0.5	89.5%	Constant volume, cycling	0.42
Retail_Sys	Continuous	14,500	5,812	10.0	89.5%	Constant volume	8.34

Additional details are included in Table 4 of the Proposed HVAC tab.

Modeled System Name	Air-side Controls		
	Min. Vol. Set Points for VAV Boxes, % of Peak	Design Supply Air Temp., °F (Cooling)	Supply Air Temperature Control (Cooling) Settings
Cor_Sys	30.0%	55	Fixed (constant)

Cross-check Compliance Form inputs with the information provided in the mechanical schedules and specifications for a sample of the specified systems to ensure alignment.

2. Refer to Table 2b for a bird-eye view of the specified fan systems and controls.

Table 2b: Fan System Design and Outdoor Air Flows, Power and Controls Summary

Fan Type	Constant Volume			Variable Flow			Two-speed			Constant Volume, Cycling		
	CFM	kW	kW/CFMs	CFM	kW	kW/CFMs	CFM	kW	kW/CFMs	CFM	kW	kW/CFMs
Supply Fan (SF)	20,900	12.5	0.0006	4,000	2.08	0.00052	0	0	0	49,500	9.51	0.00019
Relief/Return Fan (RF)	13,500	4.31	0.00021	4,000	1.25	0.00031	0	0	0	0	0	0
Exhaust Fan (EF)	6,400	2.5	0.00012	0	0	0	0	0	0	0	0	0
Subtotal	40,800	19.32	0.00092	8,000	3.33	0.00083	0	0	0	49,500	9.51	0.00019
Terminal Units Fan (TUF)		0			0			0			0	
Total		19.32			3.33			0			9.51	

AHVAC16-B Baseline (budget) air flow and supply temperature control is established correctly

90.1 2016 and 2019/2022 ECB

Section 11.5.2/12.5.2: Supply and return/relief system fans shall be modeled as operating at least whenever the spaces served are occupied, except as specifically noted in 90.1 Table 11.5.2-1. Minimum volume set points for VAV reheat boxes shall be 30% of zone peak airflow or the minimum ventilation rate, whichever is larger (90.1 Table 11.5.2-1/12.5.2-1 Note b). Baseline supply, return, or relief fans in Systems 1-4 must be modeled assuming a variable-speed drive and fan part-load performance in 90.1 Section G3.1.3.15/G3.2.3.15 (see Table 6 below). If the proposed design’s system has a DDC at the zone level, static pressure set point reset based on Section 6.5.3.2.3 must be modeled in the budget design.

Table 11.5.2 – 1 Note b/ Table 12.5.2 – 1 Note b: The supply air temperature for cooling shall be reset higher by 5°F under the minimum cooling load conditions for all budget VAV systems with reheat.

90.1 2016 and 2019 PRM

Table G3.1.3.15: For baseline Systems 5 and 7, the minimum volume set points for VAV reheat boxes must be 30% of zone peak airflow, the minimum outdoor airflow rate, or the airflow rate required to comply with the applicable codes or accreditation standards, whichever is larger. The part load performance of VAV system supply fans must have the part-load performance characteristics specified in 90.1 Table G3.1.3.15. There is no static pressure set-point reset in the baseline.

Section G3.1.3.12: The air temperature for cooling shall be reset higher by 5°F under the minimum cooling load conditions for Systems 5 – 8.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Table G3.2.3.15 and Section G3.2.3.12 requirements are the same as for the analogous sections in the 90.1 2016 and 2019 PRM as described above.

G3.3 Minor Alterations

Systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 G3.3 (i.e., Minor Alterations) are required to model baseline systems as minimally compliant with 90.1 Sections 6.5.3.2.1 and any other relevant sections as applicable based on the requirements of 90.1 Section 6.1.4.

Review Tips

1. PRM: Baseline flow and temperature controls for the baseline VAV systems is shown in Table 3a of the Baseline HVAC PRM tab. The values are set automatically based on the relevant 90.1 rules quoted above and should only be checked if any auto-populated defaults are overwritten. (Such values will be shown in brown font.) Refer to the Notes sections under Table 4 on the Proposed HVAC tab for baseline modeling inputs for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

Modeled Sys Name	Air-side Controls		
	Min. Flow Set Points % (VAV reheat boxes & Sys. 11)	If Min. Setpoints > 30%, Describe Reason	Supply Air Temp. Reset under Min. Cooling Load, F
UH_Stairs	n/a	n/a	n/a
PSZ_Retail	30.0%	n/a	Reset higher by 5 F
PTAC_Apts	n/a	n/a	n/a

2. ECB: Fan speed control of the budget HVAC systems is shown in Table 2a of the Budget HVAC ECB tab. Minimum flow setpoints in temperature reset under minimum cooling load conditions for VAV systems are shown in Table 3. The values are set automatically based on the relevant 90.1 rules quoted above and should only be checked if any auto-populated defaults are overwritten. (Such values will be shown in brown font.)

AHVAC17-P Fan power performance curves reported for the proposed design in the Compliance Form are based on an approved source

Review Tips

1. The modeled performance curves reflect correlation between energy used by the fan and flow rate relative to the design maximum. The input applies only to the variable flow systems, and must be provided in the last column of Table 2a of the Proposed HVAC tab. The default VAV performance curves included in 90.1 Table G3.1.3.15 (Table G3.2.3.15 in 90.1 2022) and the fan curves provided in ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual, Table 50 should be used, depending on the specified flow control strategy²⁴.
2. The curves should be reviewed for a sample of HVAC systems if ventilation fans are an impactful end use and performance curves other than 90.1 default are specified.
3. Supporting documentation must be included in the submittal if the basis of the performance curves is specified as “Other” in Table 2a. Refer to the Submittal Checklist tab #18 to confirm that the necessary documentation is included in the submittal.

AHVAC17-B Fan power performance curves used in the simulation are based on an approved source

Review Tips

1. The fan performance curves for VAV systems are specified in the last column of Table 2a Baseline HVAC PRM tab or Budget HVAC ECB tab and must be based on 90.1 Table G3.1.3.15 (Table G3.2.3.15 in 90.1 2022). The values are auto-populated and do not need to be checked.
2. Refer to the Notes sections under Table 2a on the Proposed HVAC tab for modeled baseline fan curves for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations). If the fan curves differ from Table G3.2.3.15 or the fan curves in the PNNL PRM RM request documentation from the submitter to justify the modeled curves.

AHVAC18- B, P Fan power, flow rate and controls are modeled as reported in the Compliance Form

Review Tips

1. Spot-check simulation reports to verify that the following simulation inputs reflect information provided in the Compliance Form:
 - a. power of supply, exhaust, return and relief fans (Watt)
 - b. supply, exhaust, return and relief flow (CFM)
 - c. minimum flow fraction for representative thermal blocks

The review should focus on HVAC systems with large air flow.

eQUEST Reports	SS-P, SV-A, SS-L, ERV Energy Recovery Summary (for projects with ERV)
Trane TRACE 700	Room Information entered values report for flows, System Information entered values report for fan power

²⁴ https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

Trane TRACE 3D Plus	System Component Summary for fan power and flow rate, System Cooling Checksums for minimum flow
IESVE SOFTWARE	System Loads Report, Detailed Simulation Report, Space Loads & Ventilation Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html 'Equipment Summary' report, 'Fans' section
OpenStudio	eplustbl.html 'Equipment Summary' report, 'Fans' section
Carrier HAP v5	"Air System Sizing Summary", "Zone Sizing Summary" system design reports.
Design Builder	Air-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

AHVAC19–B, P Modeled peak demand of ventilation fans is generally consistent with design fan power and control reported in the Compliance Form

Review Tips

- Spot-check simulation reports for a sample of HVAC systems with high air flows in the proposed and baseline/budget design to find the non-coincident peak demand for the system fans. Compare the simulated values to the estimates obtained as described below. Flag proposed systems with the simulated non-coincident peak demand is lower than estimated. Flag baseline/budget systems that have simulated non-coincident peak demand that is higher than expected.
 - For the constant volume systems, the peak demand is equal to the design fan kW.
 - Variable volume system fans often reach the maximum flow no greater than 70% of the design CFM, drawing approximately 50% of the design power (Table 16).
- These relationships may also be used to verify fan energy use patterns for the project as a whole, for example to confirm that the fan power reported in Table 3b of the Baseline HVAC PRM tab (shown below) or Table 2b of the Budget HVAC ECB tab is generally consistent with non-coincident peak demand reported in the Compliance Calculations tab Table 2 for both baseline/budget and proposed designs. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for the location of baseline fan power in the Compliance Form for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

Table 3b: Fan System Design, Power and Controls Summary

Fan Type	Constant Volume						Variable Volume					
	Proposed Design			Baseline Design			Proposed Design			Baseline Design		
	CFM	kW	kW/CFMs	CFM	kW	kW/CFMs	CFM	kW	kW/CFMs	CFM	kW	kW/CFMs
Supply Fan (SF)	74,400	24.1	0.00032	70,766	23.47	0.00033	0	0	0	0	0	0
Relief/Return Fan (RF)	17,500	5.56	0.00007	12,997	5.13		0	0	0	0	0	
Exhaust Fan (EF)	6,400	2.5	0.00003	6,763	3.39		0	0	0	0	0	
Subtotal	98,300	32.16	0.00043	90,526	31.99	0.00045	0	0	0	0	0	0
Terminal Units Fan (TUF)		0			0			0			0	
Total		32.16			31.99			0			0	

eQUEST Reports	SS-H, SS-P
Trane TRACE 700	Equipment Energy Consumption report
Trane TRACE 3D Plus	LEED Summary Section 1.6

IESVE SOFTWARE	PRM Compliance Report, ECB Compliance Report, BPRM Report, Detailed Simulation Report, IECC Compliance Report, System Loads Report, Energy Model Output Report
EnergyPlus	eplustbl.html 'Equipment Summary' report, 'Fans' section, 'Demand End Use Components Summary' report. The user may need to set the fan subcategory field to report out for a fan pump if several are present.
OpenStudio	eplustbl.html 'Equipment Summary' report, 'Fans' section, 'Demand End Use Components Summary' report. The user may need to set the fan subcategory field to report out for a fan pump if several are present.
Carrier HAP v5	Peak fan kW for CAV system individual fans: "Air System Sizing Summary" design report. Peak fan kW for VAV system individual fans must be derived by exporting full year hourly simulation results to CSV ("Hourly Simulation Results" report, CSV option), and parsing in Excel to identify peak demand.
Design Builder	Fans Table in EnergyPlus Output Summary Document

AHVAC20-B, P Modeled equivalent full load hours of the ventilation fans are as expected.

Review Tips

1. **Background:** The EFLH of the fan system is the ratio of the fan energy use to fan peak demand. If a project has only the constant volume systems that run continuously when building is occupied, the fan EFLH will be slightly higher than the number of hours per year when the building is occupied, accounting for the energy consumed by the cycling fans during unoccupied hours and system runtime to bring the building to occupied temperatures in the morning.
2. Calculate EFLH for a for a sample of baseline/budget systems with high fan power reported in Table 2a of the Baseline HVAC PRM or Budget HVAC ECB tabs (see Table 3 on the Proposed HVAC tab and the Notes section under the table for alterations subject to 90.1 2022 Section G3.3) and check for the following patterns:
 - a. Part load performance of the baseline VAV systems are shown in the second row of Table 6 (Multizone VAV with VSD and fixed static pressure setpoint). If all baseline (budget) systems are variable air volume, the average flow during occupied hours is typically about 60% of the design flow, with the fan system drawing ~41% of the design power based on Table 6. Thus, the EFLH are expected to be ~ 41% of the number of occupied hours per year.
 - b. For the constant volume systems, EFLH are expected to be slightly higher than the total number of hours building is occupied, since the baseline/budget systems must be modeled as running continuously during occupied hours and cycle with load during un-occupied hours.

The baseline fan EFLH that exceed expectation should be flagged and may indicate incorrect modeled fan system control.

Table 16: Fraction of VAV Fan Power at Reduced Flow (PRM RM)

% of Design Flow	100%	90%	80%	70%	60%	50%	40%	30%	25%	20%	10%
Multizone VAV with VSD and fixed static pressure setpoint	1.00	0.83	0.68	0.54	0.41	0.30	0.21	0.13	0.10	0.07	0.03
Multi zone VAV with static pressure reset	1.00	0.75	0.55	0.39	0.27	0.18	0.12	0.09	0.07	0.06	0.05
Single zone VAV fan	1.00	0.73	0.52	0.36	0.24	0.15	0.09	0.06	0.05	0.04	0.03

c. **Common Mistakes:**

- Modeled minimum flow for VAV systems are higher than 30%
- Fans are modeled as running continuously instead of cycling with load during un-occupied hours.

3. Calculate EFLH for a for a sample of proposed systems with high fan power reported in Table 2a of the Proposed HVAC tab and check for the patterns described for the baseline/budget systems. The proposed fan system EFLH that are lower than expected should be flagged. Common mistakes include the following:

- Modeling fans that supply ventilation air as cycling with load instead of running continuously during occupied hours results in significantly under-estimate fan, heating and cooling energy use.

eQUEST Reports	SS-P
Trane TRACE 700	Equipment Energy Consumption report
Trane TRACE 3D Plus	LEED Summary Section 1.6
IESVE SOFTWARE	PRM Compliance Report, ECB Compliance Report, BPRM Report, System Loads Report, Energy Model Output Report, Detailed Simulation Report
EnergyPlus	eplustbl.html 'Equipment Summary' report, 'Fans' section, 'Annual Building Utility Performance Summary' report. The user may need to set the fan subcategory field to report out for a fan pump if several are present.
OpenStudio	eplustbl.html 'Equipment Summary' report, 'Fans' section, 'Annual Building Utility Performance Summary' report. The user may need to set the fan subcategory field to report out for a fan pump if several are present.
Carrier HAP v5	Design Fan kW: "Air System Sizing Summary" or "Zone Sizing Summary" system design reports:. Annual fan kWh for individual fans: "Monthly Simulation Results" reports.
Design Builder	Air-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

AHVAC21-P Air-side economizers reported in the Compliance Form are as specified in the design documents

Review Tips

1. The specified economizer controls are reported in Table 4 of the Proposed HVAC tab. Cross-check the provided information with the design documents for a sample of HVAC systems to ensure alignment.

Modeled System Name	Air-Side Economizer			
	Economizer Type	High-Limit Shutoff	Req'd per 90.1 6.5.1?	Section 6.5.1 Exceptions, If Any
Cor_Sys	Fixed dry-bulb (DB) temperature (T)	65	Yes	
UH_HW	None	n/a	No	
Retail_Sys	Fixed dry-bulb (DB) temperature (T)	65	Yes	
Apt_Sys	None	n/a	No	
DOAS_Sys	None	n/a	Yes	

2. The check should be completed where cooling is an impactful end use except in climate zones 0 and 1.
3. Projects without economizers are expected to have higher cooling energy use in fall, winter and spring and higher simultaneous heating & cooling during these months.

AHVAC21-B Air-side economizers reported in the Compliance Form for the baseline/budget systems are established correctly

90.1 2016 and 2019 ECB

Section 11.5.2(e)

Each system in the budget building must have the same economizer type (outdoor air or water) as the corresponding system in the proposed design. If economizer is not specified in the proposed design, an air-side economizer must be modeled in the budget building where required in Section 6.5.1. For example, in New York climate zones 4A, 5A, 6A economizers must be modeled for budget systems with cooling capacity of 54 kBtu/hr or greater, unless exceptions apply. The high-limit shutoff must be modeled per 90.1 Table 11.5.2-4.

90.1 2022 ECB

Section 12.5.2(e)

Each system in the budget building must have an air-side economizer modeled where required in Section 6.5.1 based on the capacity establish in 12.5.1(i). For example, in New York climate zones 4A, 5A, 6A economizers must be modeled for budget systems located outside of the building with cooling capacity of 33 kBtu/hr or greater, unless exceptions apply. The high-limit shutoff must be modeled per 90.1 Table 11.5.2-4.

90.1 2016 and 2019 PRM

Section G3.1.2.6: Economizers must not be included in baseline HVAC System 1,2,9 and 10. Air economizers must be included in baseline HVAC Systems 3 through 8 and 11, 12 and 13 (unless exception to 90.1 Section G3.1.2.6 apply), based on climate as specified in 90.1 Table G3.1.2.6. For example, projects in New York climate zone 4A do not have an economizer in the baseline. Projects in climate zone 5A and 6A must be modeled with an economizer in the baseline. Economizer high-limit shutoff temperature must be modeled per Table G3.1.2.7.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Sections G3.2.2.5, G3.2.2.6 requirements are the same as for the 90.1 2016 and 2019 PRM described above.

G3.3 Minor Alterations

Systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) are required to model an air-side economizer where required by Section 6.1.4. For example, for a project located in climate zone 4A in which a new cooling system is installed to serve previously uncooled spaces the baseline requirements would be established according to 90.1 Section 6.1.4.2 which references all 90.1 Section 6 mandatory and prescriptive requirements including 90.1 Section 6.5.1 (Economizers). Because the project is in climate 4A economizers must be modeled for baseline systems located outside of the building with a cooling capacity of 33 kBtu/hr or greater based on 90.1 Section 6.5.1 requirements (unless exceptions apply). The high-limit shutoff for this example would be modeled based on the minimum requirements associated with 90.1 Table 6.5.1.1.3.

Review Tips

1. Air-side economizers are shown in Table 3a of the Baseline HVAC PRM and in Table 3 of the Budget HVAC ECB (shown below). The values are auto-populated based on the applicable rules of the ECB or PRM. Over-written defaults are shown in brown font and should be verified by reviewer. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

Modeled Budget Sys Name	Corresponding Proposed System	Air-Side Economizer			
		Req'd per 90.1 6.5.1?	Applicable Section 6.5.1 Exceptions, If Any	Economizer Type	High-Limit Shutoff
Cor_Sys	Cor_Sys	Yes		Fixed dry-bulb (DB) temperature (T)	TDA > 75
UH_HW	UH_HW	No		None	
Retail_Sys	Retail_Sys	No	6.5.1 Exc. 3	None	

AHVAC22-P, AHVAC22-B Air-side economizers in the baseline/budget and proposed design is modeled as reported in the Compliance Form

Review simulation reports to verify that air-side economizer is modeled as reported in the Compliance Form.

eQUEST Reports	TBD
Trane TRACE 700	
Trane TRACE 3D Plus	
IESVE SOFTWARE	
EnergyPlus	
OpenStudio	
Carrier HAP v5	
Design Builder	

AHVAC23–P Design ventilation rates reported in the Compliance Form are consistent with the design documents

Review Tips

1. Outdoor air rates are reported in Table 2a of the Proposed HVAC tab. Cross-check reported rates with the design documents for a sample of specified systems to verify alignment.

Modeled System Name	Fan Operation, Occupied Hours	Supply Fan					
		Total Supply CFM	Total Outdoor Air CFM	Total BHP	Motor Eff.	Fan Flow Control	kW
Cor_Sys	Continuous	4,000	363	2.5	89.5%	Constant volume	2.08
UH_HW	Cycling	1,500	0	0.5	89.5%	Constant volume, cycling	0.42
Retail_Sys	Continuous	14,500	5,812	10.0	89.5%	Constant volume	8.34
Apt_Sys	Cycling	48,000	0	10.0	82.0%	Constant volume, cycling	9.1
DOAS_Sys	Continuous	6,400	6,400	5.0	89.5%	Constant volume	4.17

AHVAC23–B Baseline/budget ventilation rates reported in the Compliance Form are established correctly

90.1 2016 ECB

90.1 Section 11.5.2 d: Minimum outdoor air ventilation rates must be the same in the budget building design and proposed design.

90.1 2019/2022 ECB

90.1 Section 11.5.2 d/12.5.2 d: Minimum outdoor air ventilation rates must be the same in the budget building design and proposed design with the following exceptions.

1. When modeling demand control ventilation in the proposed design for spaces where demand control ventilation is not required per Section 6.4.3.8.
2. Where the minimum outdoor air intake flow in the proposed design is provided in excess of the amount required by Section 6.5.3.7/6.5.3.8, the budget building design shall be modeled to reflect the minimum amount required by Section 6.5.3.7/6.5.3.8.

90.1 2016 and 2019 PRM

90.1 Section G3.1.2.5: Minimum ventilation system outdoor air intake flow must be the same for the proposed design and baseline building design, with the following exceptions.

1. Baseline may have higher OA flow compared to the proposed design if the following applies:
 - a) The proposed system has Demand Control Ventilation AND the outdoor air capacity is less than or equal to 3000 cfm serving areas with an average design capacity of 100 people per 1000 ft² or less (90.1 Section G3.1.2.5 Exception 1).
 - b) The proposed system has zone air distribution effectiveness $E_z > 1.0$ based on ASHRAE Standard 62.1 Table 6-2 (90.1 Section G3.1.2.5 Exception 1).
2. The baseline must have a lower OA flow compared to the proposed design if the specified ventilation rate exceeds the minimum required by the applicable building code (90.1 Section G3.1.2.5 Exception 3). Ventilation rates may also differ between the baseline and proposed design for systems serving laboratory spaces (90.1 Section G3.1.2.5 Exception 4).

90.1 2022 PRM

G3.2 New Construction/Major Alterations

90.1 Section G3.2.4: Requirements are the same as the 90.1 2016 and 2019 PRM described above.

G3.3 Minor Alterations

Systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 shall be modeled the same in the baseline and proposed with the exception of the following scenarios:

1. The alteration includes new cooling systems installed to serve previously uncooled spaces. In this case the baseline shall be modeled as minimally compliant with Standard 90.1-2022 Section 6.5.3.8 with the same feature as the proposed design. Where the proposed design does not include one of these features it is recommended that the baseline be modeled according to Standard 90.1-2022 Section 6.5.3.8 option a with no more than 135% of the required minimum outdoor air rate modeled in the baseline.

Standard 90.1-2022 Section 6.5.3.8 states that the required minimum outdoor air rate is the larger of the minimum outdoor air rate or the minimum exhaust air rate required by Standard 62.1, Standard 62.2, Standard 170, or applicable codes or accreditation standards. The section also requires that outdoor air ventilation systems comply with one of the following:

- a. Design minimum system outdoor air provided shall not exceed 135% of the required minimum outdoor air rate.
 - b. Dampers, ductwork, and controls shall be provided that allow the system to supply no more than the required minimum outdoor air rate with a single set-point adjustment.
 - c. The system includes exhaust air energy recovery complying with Section 6.5.6.1.
2. If the following conditions are met,
 1. DCV is specified in the proposed design,
 2. Standard 90.1-2022 Section 6.4.3.8 is applicable based on the scope of the alteration and the requirements of 90.1-2022 Section 6.1.4, and
 3. DCV is not required to be modeled in the baseline according to 90.1 Section 6.4.3.8

then ventilation air flow may differ between the baseline and proposed due to DCV. See the Design Ventilation Rate: Demand Control Ventilation descriptor for the requirements of 6.4.3.8.

Review Tips - 90.1 ECB

1. Baseline ventilation rates are reported in Table 2a of Budget HVAC ECB tab and is set to be equal to the corresponding budget system. Over-written defaults are shown in brown font and should be verified by reviewer.

Table 2a: Air-side HVAC: Fan System Power and Efficiency

Instructions

1. The table helps determine the total budget HVAC system fan power that must be modeled, and allocates it to the supply air systems.
2. The total CFM entered into the table must be based on the annual simulation and transferred from the simulation results.
3. Fan power in the budget model must be as shown in this table.

Modeled Budget Sys Name	Corresponding Proposed System	Fan Operation Occ. Hours	Fan Speed Control	Fan System Total BHP	Total Supply CFM	Total Outdoor Air CFM	Supply
							Total BHP
Cor_Sys_B	Cor_Sys	Continuous	Two-speed	4.0	4,000	363	2.5
UH_HW_B	UH_HW	Cycling	Single-speed	0.5	1,500	0	0.5
Retail_Sys_B	Retail_Sys	Continuous	Two-speed	15.0	14,500	5,812	10.0
Apt_Sys_B	Apt_Sys	Cycling	Single-speed	10.0	48,000	0	10.0

> ... Proposed HVAC **Budget HVAC ECB** Service Water Heating Plug, Process and Other Loads Residential

Review Tips - 90.1 PRM

1. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3
2. Baseline ventilation rates are reported in Table 3a of Baseline HVAC PRM tab. For each baseline system, the modeled ventilation rate must be provided and it must be stated whether that ventilation rate is equal to the ventilation provided to the corresponding HVAC zones in the proposed design (which is the default selection) or whether it deviates from the proposed design due to exceptions to G3.1.2.5/G3.2.2.4.

Modeled Sys Name	Fan Air Flow		
	Design Supply CFM	Minimum Outdoor Air (OA) CFM	Method Used to Establish OA CFM (G3.1.2.5)
UH_Stairs	1,199	300	Lower than Proposed (G3.1.2.5 Exception 3)
PSZ_Retail	14,441	5,812	Higher than Proposed (G3.1.2.5 Exception 2)
PTAC_Apts	55,126	6,763	Equal to Proposed

3. Table 3b shows side-by-side the total OA rate reported in the Compliance Form for the baseline and proposed design. Confirm consistency between Table 3a and 3b. For example, if Table 3a indicates that the ventilation rate in all baseline systems is modeled as “Equal to Proposed”, the baseline and proposed rates are expected to be the same in Table 3b.

Fan Flow Control	Supply CFM _s		OA CFM	
	Proposed Design	Baseline Design	Proposed Design	Baseline Design
Constant	74,400	70,766		
Variable Volume	0	0		
Total	74,400	70,766	12,575	12,875

4. Common Mistakes

- a) It is not uncommon for specified ventilation rates to exceed the minimum required. In this case, the baseline ventilation would be lower than what is specified in the proposed design, but this penalty is often not modeled. For example, based on the NYS Mechanical Code, the minimum ventilation rate in the corridors of apartment buildings is 0.06 CFM/ft². If the specified ventilation exceeds this minimum, the ventilation rate in the baseline design must be modeled as 0.06 CFM/ft². Ventilation in the proposed design must be as specified and will be higher than in the baseline.

AHVAC24–P Demand control ventilation reported in the Compliance Form for the proposed design is consistent with the design documents

Review Tips

- 1. Demand control ventilation (DCV) is reported in Table 4 of the Proposed HVAC tab. Cross-check information provided in the table with the design documents for a sample of specified systems to verify alignment.

Modeled System Name	Demand Control Ventilation (DCV)				Exhaust Air Energy Recovery						
	DCV Specified?	Design Occ. Density for Ventilation, [people per 1000 ft ²]	DCV Required? (90.1 Section 6.4.3.8)	Section 6.4.3.8 Exceptions, If Any	System Type	OA CFM	Exhaust CFM	Enthalpy Recovery Ratio %	Ventilation Sys. Operates < 8000 Hrs/Yr?	Req'd per 90.1 Section 6.5.6.1?	Section 6.5.6.1 Exceptions, If Any
Cor_Sys	No	5	No		Heat Exchanger	363	363	75.0%	No	No	
UH_HW	No	5	No		None	0	0		Yes	No	
Retail_Sys	Yes	15	No		Heat Exchanger	5,812	4,812	75.0%	Yes	No	
Apt_Sys	No	10	No		None	0	0		No	No	
DOAS_Sys	No	25	No	6.4.3.8 Exc. 1	Heat Exchanger	6,400	6,400	75.0%	No	Yes	

AHVAC25–P Demand control ventilation reported in the Compliance Form for the proposed design meets mandatory requirements in 90.1 Section 6

Review Tips

- 1. Demand control ventilation may be required by 90.1 Section 6.4.3.8. These requirements are mandatory and thus DCV must be specified for systems where it is required. The applicability of the requirements are established automatically in Table 4 of the Proposed HVAC tab based on user-entered design and OA flow rates and occupant density. The default may be over-written by user if exceptions to 90.1 Section 6.4.3.8 apply. The over-written values are shown in bold brown font and applicable exceptions must be listed. Verify that DCV is specified where required.

Table 4: Air-side HVAC - Economizer, Demand Control Ventilation, Exhaust Air Energy Recovery and Controls

Instructions

1. The table includes a row for each air-side HVAC system entered in Table 1.
2. The ancillary features and controls of the specified HVAC systems described in this table must be reflected in the proposed design model.

Freeze Panes

Modeled System Name	Air-Side Economizer				Demand Control Ventilation (DCV)				
	Economizer Type	High-Limit Shutoff	Prescriptive Requirements per 90.1 6.5.1		DCV Specified?	Design Occ. Density for Ventilation, [people/1000 ft ²]	Occupant Outdoor Airflow Component, [cfm/1000 ft ²]	Min. Floor Area ft ² in which DCV is Req'd per 6.4.3.8. (Populates only after EAER columns are filled out.)	90.1 Section 6.4.3.8 Exceptions, If Any
			Req'd per 90.1 6.5.1? (Assumes Outside Location)	Exceptions to 6.5.1, If Any					
Cor_Sys	Fixed dry-bulb (DB) temperature (T)	65	Yes		No	5	0	Not Required	
UH_HW	None	n/a	No		No	5	0	Not Required	
Retail_Sys	Fixed dry-bulb (DB) temperature (T)	65	Yes		Yes	15	113	800	
Apt_Sys	None	n/a	No		No	10	0	Not Required	
DOAS_Sys	None	n/a	Yes		No	10	0	Not Required	

Applicable drawing plans/spec reference(s) for populating Table 4: M-104

Interior Lighting Counts Interior Lighting Summary Exterior Lighting Ventilation - Multifamily **Proposed HVAC** Baseline HVAC PRM Service Water Heat

AHVAC25–B Demand control ventilation reported in the Compliance Form for the baseline/budget design is established correctly.

90.1 2016, 2019, and 2022 ECB

See AHVAC23–B for relevant 90.1 sections.

90.1 2016, 2019, and 2022 PRM

See AHVAC23–B for relevant 90.1 sections.

Review Tips

1. Demand Control Ventilation requirements applicable to each baseline/budget HVAC system are shown in Table 3 of Budget HVAC ECB tab or Table 3a of the Baseline HVAC PRM tab. The values are auto-populated in the Compliance Form based on user-specified maximum occupant density. Overwritten defaults should be reviewed to verify that the exception referenced in the Compliance Form is properly applied. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

AHVAC26– B, P Ventilation rate and control are modeled as reported in the Compliance Form

Review Tips

2. Spot-check a sample of air-side HVAC systems to confirm that the minimum design ventilation rate CFM and DCV controls are modeled as reported in the Compliance Form for the corresponding systems.

eQUEST Reports	Request screenshot of DCV model inputs for a sample of system.
Trane TRACE 700	Room Information entered values report for ventilation rate, System Information entered values report for ventilation controls
Trane TRACE 3D Plus	Outside Air and ASHRAE 62.1 Analysis report
IESVE SOFTWARE	Space Loads & Ventilation Report, ASHRAE 62.1 Report, System Loads Report, Detailed Simulation Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html 'Standard 62.1 Summary' report, 'Zone Ventilation Parameters' and 'System Ventilation Parameters' sections
OpenStudio	eplustbl.html 'Standard 62.1 Summary' report, 'Zone Ventilation Parameters' and 'System Ventilation Parameters' sections
Carrier HAP v5	Input Data: "Air System Input Data" reports. Output Data: "Ventilation Sizing Summary" report.
Design Builder	Air-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

AHVAC27-P Exhaust air energy recovery reported in the Compliance Form reflects design documents

Review Tips

1. Exhaust air energy recovery is reported in Table 4 of the Proposed HVAC tab. Cross-check information provided in the table with the design documents for a sample of specified systems to verify alignment.

Modeled System Name	Exhaust Air Energy Recovery					Req'd per 90.1 Section 6.5.6.1?	Section 6.5.6.1 Exceptions, If Any
	System Type	OA CFM	Exhaust CFM	Enthalpy Recovery Ratio %	Ventilation Sys. Operates < 8000 Hrs/Yr?		
Cor_Sys	Recovery Wheel	363	363	75.0%	No	No	
UH_HW	None	0	0		Yes	No	
Retail_Sys	Heat Exchanger	5,812	4,812	75.0%	Yes	No	

AHVAC27-B Exhaust air energy recovery reported in the Compliance Form for the budget/baseline design is established correctly

90.1 2016 and 2019/2022 ECB

Section 11.5.2 d/12.5.2 d: Exhaust air heat recovery must be included in the budget building systems if required by 90.1 Section 6.5.6.1. For example, for 90.1 2019 and 2022 projects, all systems in climate zones 4A, 5A, 6A operating 8,000 or more hours per year, serving nontransient dwelling units, with 200 CFM or greater supply CFM, and a % outdoor air fraction of 10% or greater must have energy recovery modeled in the budget design model (90.1 Section 6.5.6.1.2), unless exceptions apply.

90.1 2016 and 2019 PRM

Section G3.1.2.10: Individual fan systems that have design supply air capacity of 5,000 cfm or greater AND a minimum design outdoor air supply of 70% or greater must have an energy recovery system with at least 50% enthalpy recovery ratio. 50% enthalpy recovery ratio means a change in the enthalpy of the outdoor air supply equal to 50% of the difference between the outdoor air and return air at design conditions. The most common exception to this rule applies to projects where the largest exhaust

source is less than 75% of the design outdoor airflow and that do not have exhaust air energy recovery in the proposed design (90.1 Section G3.1.2.10 Exception 6). An example of such configuration includes rooftop units supplying ventilation in multifamily buildings, with exhaust from apartment kitchens and bathrooms via multiple rooftop exhaust fans that serve vertical stacks of apartments.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Section G3.2.2.9: Requirements are similar to the 90.1 2016 and 2019 PRM requirements described above except an exception was added for systems serving laboratory HVAC zones with a total laboratory exhaust volume greater than 15,000 cfm. These systems are not required to model exhaust air energy recovery in the baseline design model.

G3.3 Minor Alterations

The systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 are required to model exhaust air energy recovery in the baseline model if it is minimally required based on 90.1 Section 6.5.6 and if 90.1 Section 6.5.6 applies to the alteration based on the language in 90.1 Section 6.1.4. Based on the language in 90.1 Section 6.1.4, 90.1 Section 6.5.6 requirements would only be applicable to the baseline when the alteration includes new cooling systems installed to serve previously uncooled spaces.

Review Tips

1. Exhaust air energy recovery that must be modeled in the budget/baseline systems is shown in Table 3 of the Budget HVAC ECB tab or Table 3a of the Baseline HVAC PRM tab. The values are auto populated based on the applicable rules of the Energy Cost Budget and Performance Rating Methods. Over-written defaults should be verified. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

AHVAC28-B, P Modeled exhaust air energy recovery is as reported in the Compliance Form

Review Tips

1. Spot-check a sample of HVAC systems with the highest ventilation flow to confirm that the exhaust energy recovery is modeled as reported in the Compliance Form including the following:
 - system type (e.g. enthalpy wheel, runaround coil, heat exchanger)
 - rated recovery effectiveness
 - supply and exhaust flow through the energy recovery device
 - controls (e.g. to allow economizer operation when appropriate)
 - added static pressure drop
2. Common mistakes:
 - a. Increased static pressure drop (and increased fan energy) and parasitic losses such as energy to operate recovery wheel and to provide defrost is not included in the proposed design model, exaggerating the benefit of energy recovery.
 - b. Modeled outdoor and exhaust air flow CFM passing through energy recovery device does not reflect design documents.

eQUEST Reports	ERV Energy Recovery Summary
Trane TRACE 700	System Information entered values report for type, effectiveness, controls and added static pressure drop, System Checksums report for flow rates
Trane TRACE 3D Plus	NA
IESVE SOFTWARE	System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report, Detailed Simulation Report
EnergyPlus	eplustbl.html 'Component Sizing Summary' report, 'HeatExchanger:AirToAir:SensibleAndLatent' section, System Information entered values report for type, effectiveness, controls and added static pressure drop
OpenStudio	eplustbl.html 'Component Sizing Summary' report, 'HeatExchanger:AirToAir:SensibleAndLatent' section, System Information entered values report for type, effectiveness, controls and added static pressure drop
Carrier HAP v5	Energy Recovery Data: "Air System Input Data" reports. Flow rates: "Ventilation Sizing Summary" system design report.
Design Builder	Air-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xls) m)

AHVAC29-P Additional HVAC efficiency measures reported in the Compliance Form are allowed for trade-off and reflect design documents

Review Tips

1. Additional HVAC Efficiency Measures inputs at the bottom of the Proposed HVAC tab may describe additional system and components affecting HVAC energy use of the proposed design but not covered elsewhere in the Compliance Form, such as thermal energy storage and ventilated façade. The following must be listed for each measure:
 - a) The key system parameters
 - b) An explanation of the source of expected savings
 - c) Whether the measure was modeled explicitly in the simulation tool or through exceptional calculations.
2. Verify the following for each listed system and component:
 - a) The reported measure involves systems and components are allowed for trade-offs
 - b) That the key reported efficiency parameters reflect design documents and manufacturer literature
 - c) The exceptional calculations are submitted as applicable and are based on peer-reviewed methods and not proprietary vendor's tools. Also refer to checks in the Exceptional Calculations (EC) group.

AHVAC30-P Additional HVAC efficiency measures were modeled for the proposed design as described in the Compliance Form

Review Tips

Review simulation input/output reports to confirm that additional HVAC efficiency measures reported for the proposed design in the Compliance Form are supported by the simulation tool and were modeled explicitly. Systems and components that are not explicitly supported must be reported as exceptional calculations method.

AHVAC31–B,P Modeled monthly patterns of heating and cooling loads are as expected with no excessive simultaneous heating and cooling

Review Tips

1. Background

Typical single zone systems such as Appendix G Baseline System 1 – PTAC or System 3 – PSZ operate either in heating or cooling mode, thus no simultaneous heating and cooling is expected on system level. In models with only single zone systems, such as in Appendix G baseline for a multifamily building, only a minimal simultaneous heating and cooling is expected on building level – for example, on a mild spring day, PTACs in the West-facing apartments may operate in cooling mode, while PTACs in North-facing apartments may operate in heating mode.

Typical multizone systems such as Appendix G Baseline System 5 and 7 have some simultaneous heating and cooling on system level as well as building level due to reheat, however it is expected to be low due to requirements in 90.1 Appendix G that limit reheat in the baseline (e.g., requiring a supply air temperature reset to be modeled in the baseline for systems 5 through 8 and 11).

2. Check monthly pattern of heating and cooling energy use on air-side system level and building level to confirm that patterns are as expected. Excessive simultaneous heating and cooling is often the reason for heating/cooling energy use exceeding typical based on the benchmarks.

3. Common Mistakes

- a. Section G3.1.1 Exception b (G3.2.1.2a in 90.1 2022) was not followed, which may lead to one zone having significantly higher cooling load than the rest of the zones served by the same baseline VAV system, leading to excessive reheat to prevent overcooling of those other zones.
- b. Temperature reset required in 90.1 Section G3.1.3.12 (G3.2.3.12 in 90.1 2022) (PRM) and 90.1 Table 11.5.2-1 Note b (Table 12.5.1-1 in 90.1 2022) (ECB) was not properly modeled.
- c. Supply temperature reset required during periods of low cooling load was not modeled resulting in excessive reheat.
- d. VAV minimum flow setpoint was not modeled as required in 90.1 Section G3.1.3.13 (G3.2.3.13 in 90.1 2022) (PRM) and 90.1 Table 11.5.2-1 Note b (Table 12.5.1-1 in 90.1 2022) (ECB).
- e. Minimum flow fraction was not modeled correctly on VAV systems. For example, 0.4 CFM/ft² minimum flow may be modeled instead of 30% of the zone peak as required for Appendix G baseline VAV systems.
- f. Economizer was not modeled where required.

eQUEST Reports	SS-C; SS-D (summer heating load exceeds 20% of winter heating load) ; SS-E
Trane TRACE 700	Building Cool/Heat Demand report from the Visualizer
Trane TRACE 3D Plus	Site Load Profile report
IESVE SOFTWARE	Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report, Detailed Simulation Report
EnergyPlus	eplustbl.html 'BUILDING ENERGY PERFORMANCE' report. Requires the user request Output:Table:Monthly report.

OpenStudio	eplustbl.html 'BUILDING ENERGY PERFORMANCE' report. Requires the user request Output:Table:Monthly report.
Carrier HAP v5	Building level data: "Monthly Energy Use by System Component" report. Individual system level data: "Monthly Simulation Results" reports.
Design Builder	Air-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

Waterside HVAC (WHVAC)

Overview

This group of checks covers water-side HVAC systems including chiller and boiler type, capacity efficiency and controls, chilled and hot water loop pumps and controls, and heat rejection. In addition, there are several checks to verify general consistency between simulation inputs and outputs, such as that when pumps are reported for the baseline/budget or proposed design, simulation results show pump energy use; that if electric resistance heating is reported in the compliance form, simulation results show heating energy use for electricity, etc. Table 17 summarizes the checks included in this group.

The following strategies may be used to prioritize the review:

1. Checks should focus on water-side systems with the highest heating or cooling capacity and spot-checking the rest.
2. 90.1 Section 6 has mandatory minimums for heating and cooling system efficiencies and ventilation controls. Checks verifying mandatory requirements should be completed where applicable.

Table 22: Water-side HVAC Quality Control Checks Overview

	Type of Check	Proposed Design	Baseline/Budget Design
Chiller Plant	CF inputs reflect design documents	WHVAC01-P (chiller), WHVAC04-P(loop T), WHVAC06-P(pump), WHVAC10-P(ht rej)	NA
	CF inputs reflect requirements of ECB/PRM	NA	WHVAC01-B (chiller), WHVAC04-B(loop T), WHVAC06-B (pump), WHVAC10-B(ht rej)
	Meet mandatory requirements	WHVAC01-P (chiller)	
	Simulation inputs consistent with CF	WHVAC02-P (chiller), WHVAC05-P(loop T), WHVAC07-P (pump), WHVAC08-P(loop flw), WHVAC11-P(ht rej)	WHVAC02-B (chiller), WHVAC05-B(loop T), WHVAC07-B (pump), WHVAC08-B(loop flw), WHVAC11-B(ht rej)
	Simulation outputs consistent with CF	WHVAC03-P (chiller), WHVAC09-P(pump)	WHVAC03-B (chiller), WHVAC09-B(pump)
Boiler Plant	CF inputs reflect design documents	WHVAC12-P (boiler), WHVAC15-P (loop T), WHVAC17-P(pump)	NA
	CF inputs reflect requirements of ECB/PRM	NA	WHVAC12-B (boiler), WHVAC15-B (loop T)
	Meet mandatory requirements	WHVAC12-P (boiler)	NA
	Simulation inputs consistent with CF	WHVAC13-P (boiler), WHVAC16-P (loop T), WHVAC18-P(pump), WHVAC19-P(loop flow)	WHVAC13-B (boiler), WHVAC15-B (loop T), WHVAC18-B(pump), WHVAC19-P(loop flow)
	Simulation outputs consistent with CF	WHVAC14-P (boiler), WHVAC20-P (pump), WHVAC21-P(pump), WHVAC22-P(h.energy)	WHVAC14-B (boiler), WHVAC20-B (pump), WHVAC21-B(pump), WHVAC22-B(h.energy)
LEGEND			
PASS/FAIL/NA outcome is determined automatically in the Quality Control Checks tab of the Compliance Form			

WHVAC01-P Proposed chillers reported in the Compliance Form reflect design documents and meet the minimum efficiency requirements.

Review Tips

1. Specified chillers are reported in Table 6a of the Proposed HVAC tab.

- Verify that chiller type, quantity, capacity and rated full and part load efficiency listed in the table reflect design documents. A reference to the place in the design documents where the reported information is found must be listed in a dedicated field below the table.

Modeled Plant Name	Drawing System Name(s)	Chiller										
		Chiller Type	Condenser Type	Number of Chillers	Total Capacity (ton)	Efficiency Units (Table 6.8.1-3,16)	Full load Efficiency	Part Load Efficiency IPLV	ASHRAE 90.1 Minimum Efficiency Full Load Path A/Path B	ASHRAE 90.1 Minimum Efficiency Part Load Path A/Path B	Ass.CHW Loop	Basis of Modeled Performance Curves
C_1, C_2	CP1	Screw	Air-cooled	2	110	EER	10.5	13.8	10.100/9.700	13.700/15.800	CHW_Loop	90.1 2022 Appendix J

- Verify that efficiency of the specified chillers meets the minimum required in 90.1 Table 6 for either Path A or Path B. The applicable requirements are quoted in Table 6a. If the specified chillers don't meet the requirements of either Path A or Path B, or if the default minimum requirements are over-written, the submittal must be flagged. These requirements are mandatory and must be met.
- Variations in chiller performance at a range of operating conditions are typically simulated using performance curves. The basis of performance curves may include the following:
 - 90.1 2022 Appendix J Table J-1 (for 90.1 2022 projects, where part-load performance of chillers in the proposed design is not available 90.1 2022 Appendix J Table J-1 curves must be used)
 - PNNL Performance Rating Method Reference Manual
 - Custom curves based on chiller performance data from the equipment manufacturer
 If custom curves are used, confirm that supporting information is included in the submittal as required (Submittal Checklist #19). The provided curves may be directly reviewed. Alternatively, the annual average achieved chiller efficiency may be verified to confirm general alignment with the rated part load efficiency (see WHVAC03). Reviewer may also request that the default performance curves from 90.1 2022 Appendix J Table J-1 or the PNNL Performance Rating Method Reference Manual for the specified chiller type are used.

WHVAC01–B Properties of the baseline/budget chillers reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.2-1/12.5.2-1 Note e: The chiller plant of budget Systems 1, 2, 5 and 7 must be modeled with chiller quantity based on Table 11.5.2-2/12.5.2-2 and chiller type based on Table 11.5.2-3/12.5.2-3. If the proposed design includes both electric and fossil fuel chillers, the budget building design must have chillers with the same fuel types and capacity allocation between electric and fossil fuel. If the proposed design uses purchased chilled water, the chillers should not be explicitly modeled in the budget design and chilled-water costs shall be as determined in Section 11.4.3/12.4.3. Budget chillers efficiency must be based on Table 6.8.1-3 Path A (11.5.2 b/12.5.2 b).

New in 90.1 2022 Section 12.5.2b the 90.1 Standard now prescribes that the sets of performance curves specified in 90.1 Appendix J Table J-1 should be used to represent part-load performance of chillers in the budget building design.

90.1 2016 and 2019 PRM

Section G3.1.3.7 Baseline Systems 7, 8, 11, 12 and 13 must be modeled with electric chillers, except for projects that use purchased chilled water (Sections G3.1.1.3.2 and G3.1.1.3.3). The number of chillers, chiller type and efficiency must be established based on the baseline peak cooling load as described in Tables G3.1.3.7 and G3.5.3.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Section G3.2.3.7 requirements are similar to the requirement described above for the 90.1 2016 and 2019 PRM except that G3.2.2.1 now prescribes that the sets of performance curves specified in Appendix J Table J-2 should be used to represent part-load performance of chillers in the baseline building design.

G3.3 Minor Alterations

The systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 are required to model the chiller type and quantity the same in the baseline and proposed. In addition, baseline systems shall meet the requirements in Section 6.1.4 and chillers shall meet the efficiency requirements in Table 6.8.1-3 using Path A or Path B, the same as the proposed design. If the proposed design meets both Path A and Path B requirements, Path A shall be used. The baseline performance curves can be modeled with the sets of performance curves specified in 90.1 Appendix J Table J-1 to represent part-load performance of chillers in the baseline building design.

Review Tips – PRM

1. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. Baseline chillers are shown in Table 4a on the Baseline HVAC PRM tab. User inputs are limited to the building peak cooling load and the basis of the modeled performance curves. The rest of the fields are auto-populated based on the applicable Appendix G rules and are non-editable.
3. Verify that the entered building peak cooling load reflects simulation results for the baseline model.
4. Verify that PNNL Performance Rating Method Reference Manual (PRM RM) is selected as the basis for baseline performance curves or, for 90.1 2022 projects, the performance curves specified in 90.1 2022 Appendix J Table J-2.

Cooling Plant Designation	Chiller						Basis of Modeled Performance Curves
	Building Coincident Peak Cooling Load (Ton)	Chiller Type	Condenser Type	Number of Chillers	Full Load Efficiency, FL [kW/ton]	Part Load Efficiency, IPLV, IP [kW/ton]	
Chiller 1	200	Screw	Liquid-cooled	1	0.718	0.628	90.1 2022 Table J-2

Review Tips – ECB

1. Chillers included in the budget design are shown in Table 4a of the Budget HVAC ECB tab. User inputs are limited to the chiller plant capacity, fuel type and the basis of the modeled performance curves. The rest of the fields are auto-populated based on the applicable rules of the ECB and are non-editable.

Chiller Plant									
Modeled Plant Name(s)	Total Chiller Plant Capacity (Ton)	Fuel Type	Number of Chillers	Chiller Type	Condenser Type	Eff. Units (Table 6.8.1-3)	Full Load Eff. (Path A)	Part Load Eff. (Path A)	Basis of Modeled Performance Curves
CH-1	120	Electricity	1	Screw	Liquid-cooled	kW/ton	0.720	0.560	90.1 2022 Table J-1

2. Verify that the entered chiller capacity reflects simulation results for the budget model.
3. For 90.1 2016 and 2019 projects, verify that PNNL Performance Rating Method Reference Manual (PRM RM) is selected as the basis for baseline performance curves or, if the PRM RM curves are not used, verify that the modeled curves are appropriate.
For 90.1 2022 projects, verify that “90.1 2022 Appendix J Table J-1” is selected as the “Basis of Modeled Performance Curves”.

WHVAC02 - B,P: Chillers are modeled as reported in the Compliance Form

Review Tips

1. Review simulation reports to verify that the modeled chiller type, capacity and efficiency matches information provided in the Compliance Form.

The following conversions may be used if chiller efficiency provided in the Compliance Form is expressed in different units than simulation tool inputs.

$$\text{EER} = \text{COP} * 3.412$$

$$\text{EER} = 12 / [\text{kW/ton}]$$

eQUEST Reports	PV-A, PS-H
Trane TRACE 700	Plant Information entered values report
Trane TRACE 3D Plus	System Component Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, System Loads Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report, Detailed Simulation Report
EnergyPlus	eplustbl.html ‘Equipment Summary’ report, ‘Central Plant’ section, ‘Component Sizing Summary’ report
OpenStudio	eplustbl.html ‘Equipment Summary’ report, ‘Central Plant’ section, ‘Component Sizing Summary’ report
Carrier HAP v5	“Plant Input Data”, “Chiller Input Data”, “Cooling Tower Input Data” reports.
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

WHVAC03-B, P Average annual realized chiller efficiency is as expected

Review Tips

1. Background

The annual average realized chiller efficiency is the ratio of the annual load on the chiller to the annual energy used by the chiller. The average realized efficiency is expected to be similar to chiller part load efficiency. Different than expected average efficiency may be due to the following:

- a) Inappropriate performance curves (e.g., using software defaults or incorrect custom performance curves)

- b) Incorrect rated full load efficiency input
 - c) Incorrect CHW loop controls such as design supply water temperature and temperature drop
 - d) Chiller operating conditions are significantly different from AHRI rated conditions.
2. The following should be flagged as it may result in overly optimistic compliance outcomes:
- a) Average realized baseline (budget) chiller efficiency worse than expected
 - b) Average annual realized proposed chiller efficiency better than expected

eQUEST Reports	PS-C
Trane TRACE 700	Equipment Energy Consumption report for the total equipment consumption and Building Cool/Heat Demand report from the Visualizer for the total loads
Trane TRACE 3D Plus	Site Consumption Summary for the consumption and Site Load Profile for the loads
IESVE SOFTWARE	Detailed Simulation Report, Plant Loops & Equipment Report, BPRM Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html 'Equipment Summary' report, 'Central Plant' section, 'Component Sizing Summary' report
OpenStudio	eplustbl.html 'Equipment Summary' report, 'Central Plant' section, 'Component Sizing Summary' report
Carrier HAP v5	"Monthly Simulation Results" report. Use annual totals of "Chiller Output" and "Chiller Input kWh".
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsM)

WHVAC04-P: Proposed chilled water loop configuration and temperature controls reported in the Compliance Form reflect design documents.

Review Tips

1. Chilled water (CHW) plant loop arrangement (e.g. primary/secondary) and controls are reported in Table 5a of the Compliance Form on the Proposed HVAC tab.

Modeled Loop Name	General Description		Primary Loop							Design Supply T (F)	Design Delta T (F)	Supply Temperature Reset Logic
	Loop Type	Configuration	Pump Control Type	Design Flow GPM	Variable Speed Drive?	Minimum Flow Fraction, %	Pump Qty	Total Pump BHP	Pump Motor Efficiency			
CHW_Loop	Chilled Water, On-site Plant	Primary only	Variable speed-variable flow	260	Yes	25.0%	1	5	91.0%	44	12	44°F at OAT 80°F and above, 54°F at OA temps 60°F & below, & ramped linearly between 44°F & 54°F

2. Verify that the reported CHW loop configuration and controls reported in the Compliance Form reflect design documents. The applicable design documents are referenced in a dedicated field below the table.

WHVAC04–B Baseline/budget chilled water loop configuration and temperature controls reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.2-1/12.5.2-1 Note e: 44°F design chilled-water supply temperature and 56°F return temperature must be modeled. The chilled-water supply water temperature must be reset in accordance with 90.1 Section 6.5.4.4.

90.1 2016 and 2019 PRM

The chilled-water design supply temperature for Systems 7,8,11,12 and 13 must be modeled at 44°F and return water temperature at 56°F (Section G3.1.3.8). Supply temperature must be reset based on outdoor dry-bulb temperature using the following schedule: 44°F at 80°F and above, 54°F at 60°F and below and ramped linearly between 44°F and 54°F at temperatures between 80°F and 60°F (Section G3.1.3.9). Exceptions apply to chilled water systems serving computer rooms or using purchased chilled water (exception to Section G3.1.3.9).

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Section G3.2.3.8 and Section G3.2.3.9 requirements are the same as described above for the 90.1 2016 and 2019 PRM.

G3.3 Minor Alterations

The systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 are required to model systems and equipment included in the scope of retrofit at efficiency levels meeting the mandatory and prescriptive requirements in Section 6.1.4. If there are no applicable requirements, then the systems and components are modeled identically in the baseline and proposed. For most alterations 90.1 Section 6.5.4.4 (Chilled- and Hot-Water Temperature Reset Controls) will not be applicable to the baseline and the reset schedule will be modeled identically in the baseline and proposed (if there is a reset scheduled specified in the proposed design). However, if the alteration includes new cooling systems installed to serve previously uncooled spaces, then the baseline is required to be modeled as meeting the minimum requirements of 90.1 Section 6.5.4.4 (Chilled- and Hot-Water Temperature Reset Controls).

Review Tips

1. CHW plant loop arrangement and controls are reported in Table 6a of the Budget HVAC ECB tab (shown) or Table 6a of the Baseline HVAC PRM tab, depending on the compliance path followed by the project. The inputs are auto-populated based on the applicable requirements of 90.1. Over-written defaults are shown in brown font and should be verified. Refer to [90.1 2022 Section G3.3 Performance Calculations for Other Alterations](#) 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

Modeled Loop Name(s)	Corresponding Proposed Loop (if Applicable)	General Description		Primary Loop					Loop Temperature Control		
		Loop Type	Configuration	Flow Controls	Total Design Flow GPM	VSD?	Minimum Flow Fraction, %	Pump Qty	Pump W/GPM	Design Supply and Return Temperature	Temperature Reset Control Strategy
CHW Loop 1	CHW_Loop	Chilled Water, On-site Plant	Primary only	Variable Flow	300	Yes	30.0%	1	15.77	CHW design supply temp.: 44°F & return water temp.: 56°F	Automatically reset supply water temps. by representative building loads (including return water temp.) or by OAT

WHVAC05-B,P Chilled water loop configuration and temperature controls are modeled as reported in the Compliance Form

Review Tips

Use simulation reports to verify that the modeled chilled water loop configuration (i.e. primary/secondary) and temperature controls are modeled as reported in the Compliance Form.

eQUEST Reports	NA
Trane TRACE 700	Plant Information entered values report
Trane TRACE 3D Plus	Plant Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, BPRM Report, Detailed Simulation Report, Florida Energy Code Compliance Report or California Title 24 Certificate of Compliance Report
EnergyPlus	Plant Information entered values report
OpenStudio	Plant Information entered values report
Carrier HAP v5	"Plant Input Data" reports.
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

WHVAC06-P: Proposed chilled water pump system parameters reported in the Compliance Form reflect design documents

Review Tips

1. Details of the specified CHW pumps are reported in Table 5a of the Proposed HVAC tab. Verify alignment between Compliance Form and design documents. (The applicable design documents must be listed below the table.)

Modeled Loop Name	General Description		Primary Loop							
	Loop Type	Configuration	Pump Control Type	Design Flow GPM	Variable Speed Drive?	Minimum Flow Fraction, %	Pump Qty	Total Pump BHP	Pump Motor Efficiency	Design Supply T (F)
CHW_Loop	Chilled Water, On-site Plant	Primary only	Variable speed-variable flow	260	Yes	25.0%	1	5	91.0%	44

2. If values provided on drawings (Figure 42) must be expressed in different units, the conversions must be documented in the submittal. Common conversions are included below.

$$\text{Pump Power [W]} = \text{BHP} * 746 / \text{Effy}$$

Effy = pump motor efficiency

Figure 42: Pump Design

UNIT NO	LOCATION	SYSTEM SERVED	FLUID	GPM	MAX TEMP °F	HEAD FT	MAX BHP
P-1	MECHANICAL ROOM	HEATING HOT WATER	WATER	105	200°F	82	3.49
P-2	MECHANICAL ROOM	HEATING HOT WATER	WATER	105	200°F	82	3.49

NOTES:
1. P-1 & P-2 PUMP MOTORS SHALL BE INVERTOR DUTY RATED FOR USE WITH VARIABLE FREQUENCY DRIVES.

WHVAC06–B Baseline/budget chilled water pump system parameters reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.2-1/12.5.2-1 Note e: The pump system power for each pumping system shall be the same as for the proposed design. If the proposed design has no chilled-water pumps, the budget building design pump power shall be 22 W/gpm (equal to a pump operating against a 75 ft head, 65% combined impeller and motor efficiency). The chilled-water system shall be modeled as primary-only variable flow with flow maintained at the design rate through each chiller using a bypass. Chilled-water pumps must be modeled as riding the pump curve or with variable-speed drives when required in 90.1 Section 6.5.4.2. Each chiller shall be modeled with separate condenser water and chilled-water pumps interlocked to operate with the associated chiller.

90.1 2016 and 2019 PRM

Section G3.1.3.10 Chilled-water systems shall be modeled as primary/secondary with constant flow primary loop and variable-flow secondary loop. For systems with a cooling capacity of 300 tons or more, the secondary pump shall be modeled with variable-speed drives and a minimum flow of 25% of the design flow rate. For systems with less than 300 tons cooling capacity, the secondary pump shall be modeled as riding the pump curve. The baseline building constant-volume primary pump power shall be modeled as 9 W/gpm and the variable-flow secondary pump power shall be modeled as 13 W/gpm at design conditions. See Section G3.1.3.10 for chilled water pump system parameters for baseline systems serving computer rooms (System 11) and projects with purchased chilled water (Section G3.1.1.3.2 and G3.1.1.3.3).

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Section G3.2.3.10 requirements are the same as described above for the 90.1 2016 and 2019 PRM Section G3.1.3.10.

G3.3 Minor Alterations

The systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) are required to model systems and equipment included in the scope of retrofit at efficiency levels meeting the mandatory and prescriptive requirements in Sections 6 and 10. Section 10.1.4 includes minimum motor efficiency requirements that should be modeled for the pump motors included in the scope of the alteration in the baseline. 90.1 Section 6 requirements depend on the scope of the alteration and the language in 90.1 Section 6.1.4. With regard to 90.1 Section 6, if there are no applicable requirements then the systems and components are modeled identically in the

baseline and proposed. For most alterations 90.1 Section 6.5.4.2 (Hydronic Variable Flow Systems) will not be applicable to the baseline and the flow systems and controls will be modeled identically in the baseline and proposed. However, if the alteration includes new cooling systems installed to serve previously uncooled spaces, then the baseline is required to be modeled as meeting the minimum requirements of 90.1 Section 6.5.4.2 (Hydronic Variable Flow Systems).

Review Tips

- Parameters of the baseline CHW pumps are reported in Table 6a of the Baseline HVAC PRM tab (shown) or Budget HVAC ECB tab. All required inputs are auto-populated based on the applicable 90.1 rules. Over-written defaults should be checked. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

Loop Designation	General Description		Primary Loop						Secondary Loop					
	Loop Type	Configuration	Flow Controls	Total Design Flow GPM	VSD?	Minimum Flow Fraction, %	Pump Qty	Pump W/GPM	Flow Controls	Total Design Flow GPM	VSD?	Minimum Flow Fraction, %	Pump Qty	Pump W/GPM
BL CHW	Chilled Water, On-site Plant	Primary/Secondary	Fixed speed, constant flow	175	No	-	1	9.0	Fixed speed, variable flow	300	No	25.0%	1	13.0

WHVAC07–B, P CHW pumps are modeled as reported in the Compliance Form

Review Tips

- Review simulation reports to verify that chilled water pumps were modeled as reported in the Compliance form including pump design flow (GPM), power (kW, or BHP and motor efficiency) and flow control (one/two speed, VSD).

eQUEST Reports	PV-A
Trane TRACE 700	Plant Information entered values report for power and flow control. Equipment Energy Consumption report to calculate pump gpm. There is no entry for pump motor efficiency. It is assumed to be 75% in the calculation engine.
Trane TRACE 3D Plus	System Component Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, BPRM Report, Detailed Simulation Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html ‘Equipment Summary’ report, ‘Pumps’ section, ‘Component Sizing Summary’ report
OpenStudio	eplustbl.html ‘Equipment Summary’ report, ‘Pumps’ section, ‘Component Sizing Summary’ report
Carrier HAP v5	“Plant Input Data” reports.
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

WHVAC08 (B, P) CHW loops flow control is modeled as reported in the Compliance Form

Review Tips

- Review simulation reports to confirm that CHW loop configuration (i.e. primary/secondary), design flow (GPM) and flow control (three-way or two-way valves) are modeled as reported in the Compliance Form.

eQUEST Reports	PV-A
Trane TRACE 700	Plant Information entered values report. Equipment Energy Consumption report to calculate pump gpm.
Trane TRACE 3D Plus	Plant Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, BPRM Report, Detailed Simulation Report, Florida Energy Code Compliance Report
EnergyPlus	Plant Information entered values report, eplustbl.html 'Component Sizing Summary' report, 'Plant Loop' section
OpenStudio	Plant Information entered values report, eplustbl.html 'Component Sizing Summary' report, 'Plant Loop' section
Carrier HAP v5	"Plant Input Data" reports.
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

WHVAC09-B,P Modeled annual chilled water pump energy is as expected

Review Tips

1. Background: Pump energy depends on pump design BHP, pump motor efficiency, whether the flow is constant or variable, with two-way valves in the loop, whether there is a VSD on pump motor and VSD controls such as differential pressure reset. The typical power draw at part load conditions is shown in Table 7, based on the same part load operation assumptions as for the part load cooling efficiency (IPLV), including 1% at 100% of the load, 42% at 25% of the load, 45% at 50% of the load and 12% at 25% of the load).

Table 7: Pump Performance at Part Load Conditions

$P_{\text{pump}}/P_{\text{design}}$	100%	90%	80%	70%	60%	50%	40%	30%	25%	20%	10%	Avg %
Riding Curve	1.03	0.92	0.86	0.82	0.79	0.75	0.70	0.62	0.56	0.48	0.28	0.78
VSD, no reset	1.01	0.81	0.64	0.51	0.39	0.30	0.23	0.16	0.14	0.11	0.05	0.43
VSD, pd reset	1.01	0.77	0.57	0.41	0.28	0.18	0.11	0.06	0.04	0.03	0.01	0.34

P_{pump} [W] = pump power at part load

P_{design} [W] = pump power at design load

The annual pump energy use may be estimated as follows:

$$\text{PEU} = P_{\text{design}} * \text{Avg\%} * \text{HRS}$$

PEU [kWh] = estimated annual pump energy use

HRS = number of hours per year the building is occupied

Avg% = the average pump power draw from Table 7 depending on pump capacity control

- Compare simulated pump energy use to PEU estimated above. The following should be flagged:
 - Simulated baseline pump energy use exceeding estimated PEU by more than 25%
 - Simulated proposed pump energy use below 75% of the estimated PEU

eQUEST Reports	PS-C
Trane TRACE 700	Equipment Energy Consumption report for pump kW and kWh, Library Members entered values report for number of occupied hours/year
Trane TRACE 3D Plus	System Component Summary report for pump inputs, Site Consumption Summary report for pump energy consumption
IESVE SOFTWARE	Thermal Template Report, Detailed Simulation Report, Plant Loops & Equipment Report, BPRM Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html 'Annual Building Utility Performance Summary' report, 'End Uses By Subcategory' section. The user may need to set the pump subcategory field to report out for a specific pump if several are present.
OpenStudio	eplustbl.html 'Annual Building Utility Performance Summary' report, 'End Uses By Subcategory' section. The user may need to set the pump subcategory field to report out for a specific pump if several are present.
Carrier HAP v5	"Monthly Simulation Results" report for plants.
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xism)

WHVAC10-P Proposed heat rejection system reported in the Compliance Form reflects design documents

Review Tips

- Parameters of the proposed condenser water (CW) loop are reported in Table 5a of the Proposed HVAC tab. Verify that information included in the Compliance Form reflects design documents.
- Cooling tower details are reported in Table 6a of the Proposed HVAC tab. Verify that information included in the Compliance Form reflects design documents.

WHVAC10–B Baseline/budget heat rejection system reported in the Compliance Form is established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.2-1/12.5.1-1 Note e The heat-rejection device is an open-circuit axial-fan cooling tower with variable-speed fan control if required in 90.1 Section 6.5.5 and must meet the performance requirements of 90.1 Table 6.8.1-7. Condenser water design supply temperature and controls must be as described in 90.1 Table 11.5.2-1/12.5.1-1 Note e. Pump system power for each pumping system shall be the same as the proposed design; if the proposed design has no condenser water pumps, the budget building design pump power must be 19 W/gpm (equal to a pump operating against a 60 ft head, 60% combined impeller and motor efficiency).

90.1 2016 and 2019 PRM

Section G3.1.3.11 The heat-rejection device is an axial-fan open-circuit cooling tower with variable speed fan control and efficiency of 38.2 gpm/hp at the conditions specified in 90.1 Table 6.8.1-7. Temperature controls must be as described in 90.1 Section G3.1.3.11 and 90.1 Table G3.1.3.11. The condenser-water pump power shall be 19 W/gpm and modeled as constant volume.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Section G3.2.3.11: Requirements are the same as described above for 90.1 2016 and 2019 PRM Section G3.1.3.11.

G3.3 Minor Alterations

The systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 are required to model heat rejection system parameters as minimally compliant with 90.1 2022 Section 6.1.4 in the baseline. This, at minimum, includes modeling the heat rejection equipment as minimally compliant with 90.1 Table 6.8.1-7 and 90.1 Section 6.5.5.2 which includes requirements for fan speed control. Other baseline requirements may be triggered in the case where a new cooling system is being installed to serve previously uncooled spaces as this makes it such that all 90.1 Section 6 mandatory and prescriptive requirements are applicable to establishing baseline modeling parameters. In all cases, the same type of heat rejection equipment shall be modeled in the baseline and proposed.

Review Tips – PRM

1. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. Baseline cooling tower(s) are described in Table 4a of the Baseline HVAC PRM tab. The prescribed inputs are auto-populated based on the applicable 90.1 rules and are non-editable.

Cooling Plant Designation	Cooling Tower (90.1 G3.1.3.11, PRM RM Section 3.7.3)										Other
	Cooling Tower Type	Cooling Tower Quantity	Fan Control	Efficiency [GPM/HP]	Design Flow per Tower [GPM]	0.4% Evaporation Design Wet-bulb Temp.	Design Temp. Rise, °F	Approach	Leaving Water Temp., °F	Basis of Modeled Performance Curves	Integrated Fluid Economizer?
Chiller 1	Axial-fan, open-circuit, single cell	1	Variable speed	38.2			10	26	75	PRM RM	No

- Baseline condenser loop is described in Table 6a of the Baseline HVAC PRM tab. The prescribed fields are auto populated based on 90.1 rules. Over-written defaults are shown in brown font and should be verified to confirm that changes are justified.

Loop Designation	General Description		Primary Loop					
	Loop Type	Configuration	Flow Controls	Total Design Flow GPM	VSD?	Minimum Flow Fraction, %	Pump Qty	Pump W/GPM
BLCW	Condenser Water	Primary only	Fixed speed, constant flow	60	No	-	1	19.0

Review Tips – ECB

- Budget cooling tower(s) are described in Table 4a of the Budget HVAC ECB tab. Budget condenser water loop parameters are shown in Table 6a. The prescribed inputs are auto populated with default based on the applicable rules of the ECB. Over-written defaults are shown in brown font and should be verified to confirm that changes are justified.

WHVAC11-B,P Heat rejection system is modeled as reported in the Compliance Form

Review Tips

Verify that modeled parameters of the heat rejection system(s) are as reported in the Compliance Form.

eQUEST Reports	PV-A
Trane TRACE 700	Plant Information entered values report, Library Members entered values report
Trane TRACE 3D Plus	System Component Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, BPRM Report, Detailed Simulation Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html 'Equipment Summary' report, 'Central Plant' section, 'Component Sizing Summary' report
OpenStudio	eplustbl.html 'Equipment Summary' report, 'Central Plant' section, 'Component Sizing Summary' report
Carrier HAP v5	"Cooling Tower Input Data" report.
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

WHVAC12-P Proposed space heating boilers reported in the Compliance Form reflect design documents and meet the minimum efficiency requirements

Review Tips

- Specified space heating boilers are reported in Table 7a of the Proposed HVAC tab.
- Confirm that reported boiler type, fuel source, quantity, capacity and efficiency reflect design documents. The design documents where the information may be found (e.g. drawing number) must be included in a dedicated field below the table.

Modeled Heating Plant Name	Heating Plants								
	Type	Fuel	Number of Boilers/Heat Pump Chillers	Total Output Capacity, Btu/hr	Eff. Units	Efficiency	Minimum Efficiency	Associated Loop	Basis of Modeled Performance Curves
B_1	Boiler, HW, Condensing	Natural Gas	2	3,000,000	Et	93%	80%	HW_Loop	Manufacturer data

3. Verify that efficiency of the specified space heating boilers meets 90.1 minimum efficiency requirements. (The applicable requirements are quoted in Table 7a.) If the specified boilers have lower efficiency or if the default minimum requirements are over-written, the submittal must be flagged. These requirements are mandatory and must be met.
4. Variations in boiler performance at a range of operating conditions are typically simulated using performance curves. The basis of the modeled performance curves may include the following:
 - d) PNNL Performance Rating Method Reference Manual
 - e) Custom curves based on chiller performance data from the equipment manufacturer.If custom curves are used, confirm that supporting information is included in the submittal as required (Submittal Checklist #21). The provided curves may be directly reviewed. Alternatively, the annual average achieved boiler efficiency may be verified to confirm general alignment with the rated efficiency (see WHVAC14). Reviewer may also request that the default performance curves from PNNL Performance Rating Method Reference Manual for the specified boiler type are used.

WHVAC12–B Properties of the space heating boilers in the budget/baseline design reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.2 – 1/Table 12.5.2 – 1, Note f: The budget building design boiler plant must be modeled with a single boiler if the budget building design plant load is 600,000 Btu/h or less and with two equally sized boilers for plant capacities exceeding 600,000 Btu/h. Boilers must be staged as required by the load. Boilers must use the same fuel as the proposed building design and be natural draft. Boiler efficiency must be the minimum required in 90.1 Table 6.8.1-6. If the proposed design uses purchased hot water or steam, then purchased water or steam must also be used in the budget design in lieu of boilers and the hot-water or steam costs must be based on actual utility rates.

90.1 2016 and 2019 PRM

Section G3.1.3.2: The boiler plant for baseline System 1, 5 and 7 must be natural draft and use natural gas. If natural gas is not available on-site as determined by AHJ, the boiler plant must use propane. Purchased heat must be modeled in the baseline instead of on-site boiler for projects that use purchased heat in the proposed design (Section G3.1.1.1). The on-site baseline boiler plant must be modeled with a single boiler if the baseline plant serves a conditioned floor area of 15,000 ft² or less and with two equally sized boilers for plants serving more than 15,000 ft². The boilers must be staged as required by the load.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Section G3.2.3.2 requirements are the same as described above for the 90.1 2016 and 2019 PRM Section G3.1.3.2.

G3.3 Minor Alterations

Alterations subject to Section G3.3 are required to model the same quantity and type of boiler in the baseline and proposed models. Boiler efficiency shall be modeled with the minimum requirements of Table 6.8.1-6 in the baseline.

Review Tips

1. For PRM projects, the baseline space heating boilers are reported in Table 5a of the Baseline HVAC PRM tab (shown). For ECB projects, budget design boilers are shown in Table 5a of the Budget HVAC ECB tab. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

Boiler Plant Designation	Boiler Plants					
	Type	Fuel	Number of Boilers	Total Input Capacity, Btu/hr	Efficiency (Table G3.5.6)	Basis of Modeled Performance Curves
Boiler 1	HW, Natural Draft	Natural Gas	2	1,872,000	75% Et	PRM RM

The fields are auto-populated except for the following:

- a) Total Input Capacity is a user input and must reflect sizing determined in the baseline model. See WHVAC13 for the applicable simulation reports.)
- b) Basis of the modeled performance curves must be set to Performance Rating Method Reference Manual (PRM RM). While the performance curves are not prescribed in 90.1, PRM RM reflect the industry standard defaults.

Overwritten defaults (if any) are shown in brown font and should be flagged by reviewer.

WHVAC-13-B,P Space heating boilers are modeled as reported in the Compliance Form

Review Tips

The proposed boiler quantity, type, capacity and efficiency is modeled as reported. The following relationships may be used when necessary to convert between different efficiency units:

- a. From AFUE to Et:
 $75\% \leq AFUE < 80\%: Et = 0.1 \times AFUE + 72.5\%$
 all other: $Et = 0.875 \times AFUE + 10.5\%$
- b. From Ec to Et: $Et = Ec - 2\%$

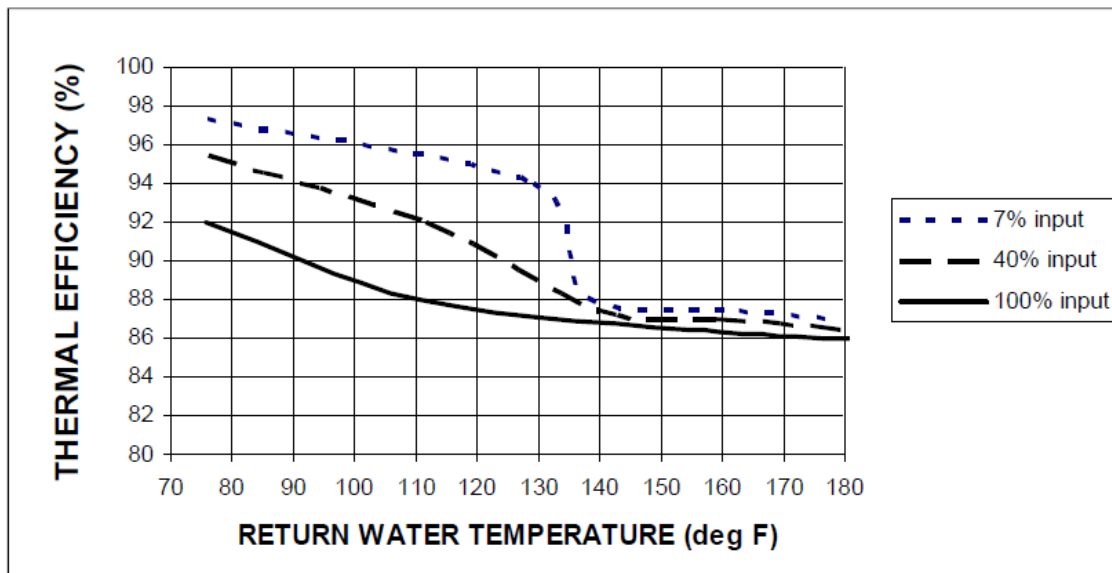
eQUEST Reports	PV-A
Trane TRACE 700	Plant Information entered values report
Trane TRACE 3D Plus	System Component Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, BPRM Report, Detailed Simulation Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html 'Equipment Summary' report, 'Central Plant' section, 'Component Sizing Summary' report
OpenStudio	eplustbl.html 'Equipment Summary' report, 'Central Plant' section, 'Component Sizing Summary' report
Carrier HAP v5	"Plant Input Data", "Boiler Input Data", "Chiller Input Data" (for A2W or W2W heat pumps) reports.
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xls/m)

WHVAC14–B,P Average annual realized boiler efficiency is as expected

Review Tips

1. Background

The annual average realized boiler efficiency is the ratio of the annual load on the boiler to the annual boiler energy use, as shown on simulation output reports. The average realized efficiency is expected to be lower than the rated efficiency. For example, the rated efficiency of condensing boilers corresponds to 80F return water temperature. A much higher design return water temperature is common (see WHVAC15-P), resulting in a significantly lower realized efficiency of condensing boilers, as illustrated below based on manufacturer data for a sample unit.



2. Common Mistakes

- a. Average annual realized efficiency over 86% for condensing boilers included in the proposed designs that with the specified return water temperature of 160F should be flagged as it is likely overly optimistic. Review comment should request cut sheets for the boiler with AHRI efficiency and performance characteristics at various return water temperature and loads to justify the modeled performance. Higher than expected average efficiency may be due to the following:
 - Inappropriate performance curves (e.g., using software defaults or incorrect custom performance curves)
 - Incorrect rated full load efficiency input
 - Incorrect HW loop controls such as lower than specified supply water temperature or higher than specified design temperature drop
- b. Budget/baseline space heating boilers are natural draft (for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) the baseline boiler type will depend on and be identical to the type specified in the proposed design). The average realized annual efficiency below 72% / 68% for the natural draft boilers that have 80% / 75% rated efficiency should be flagged. The expected part load efficiency degradation of such boilers based on the performance curves in PRM RM results in the efficiencies shown in Table 18. The annual average efficiency of a boiler

that operates at 75% of design capacity 43% of the time, 50% of design capacity 45% of the time and 25% of design capacity 12% of the time is shown in Typ. Avg. column of Table 9. The average annual boiler efficiency that is lower than expected should be flagged and may be due to the following:

- Budget/baseline boilers are oversized by more than 25% and run at low part load for most of the year.
- Budget/baseline boilers are not controlled correctly in the model.
- Inappropriate performance curves (e.g., using software defaults or incorrect custom performance curves)

Table 18: Natural Draft Boiler Efficiency at Part Load Conditions

% of Design Load	100%	90%	80%	70%	60%	50%	40%	30%	25%	Typ. Avg.
80% efficient boiler (Note 1)	80%	79%	77%	76%	74%	71%	68%	64%	61%	72%
75% efficient boiler (Note 2)	75%	74%	72%	71%	69%	67%	64%	60%	57%	68%

Note 1: All ECB budget boilers and PRM baseline boilers with heating capacity over 2,500 kBtu/h or under 300 kBtu/h

Note 2: PRM baseline boilers with 300 kBtu/h – 2,500 kBtu/h

eQUEST Reports	PS-C
Trane TRACE 700	Equipment Energy Consumption report for the total equipment consumption and Building Cool/Heat Demand report from the Visualizer for the total loads
Trane TRACE 3D Plus	Site Consumption Summary for the consumption and Site Load Profile for the loads
IESVE SOFTWARE	Detailed Simulation Report, Plant Loops & Equipment Report, BPRM Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html 'Equipment Summary' report, 'Central Plant' section, 'Component Sizing Summary' report, 'Annual Building Utility Performance Summary' report, 'End Uses By Subcategory' section. The user may need to set the boiler subcategory field to report out for a specific boiler if several are present.
OpenStudio	eplustbl.html 'Equipment Summary' report, 'Central Plant' section, 'Component Sizing Summary' report, 'Annual Building Utility Performance Summary' report, 'End Uses By Subcategory' section. The user may need to set the boiler subcategory field to report out for a specific boiler if several are present.
Carrier HAP v5	"Monthly Simulation Results" report for a hot water plant. Use annual totals for "Boiler Output" and "Boiler Input".
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xism)

WHVAC15-P Proposed hot water loop configuration temperature controls reported in the Compliance Form reflect design documents

Review Tips

1. The configuration (primary/secondary) and temperature controls of the specified hot water loops are shown in Table 5a of the Proposed HVAC tab.

Loop Type	Configuration	Design Supply T (F)	Design Delta T (F)	Supply Temperature Reset Logic
Hot Water, On-site Plant	Primary only	160	50	160°F at OAT 20°F and below, 100°F at OA temps 60°F & above, & ramped linearly between 100°F & 160°F

2. Verify that the reported hot water loop configuration and controls including design supply and return water temperature and temperature reset reflect design documents. Controls may have a significant impact on the realized efficiency. For example, the rated efficiency of condensing boilers corresponds to 80F return water temperature. A much higher design return water temperature is common, such as 160 F shown below, resulting in a significantly lower realized efficiency (see WHVAC13).

DESIGNATION	LOCATION	SERVICE	NOMINAL CAPACITY BOILER MBH	GROSS INPUT MBTUHR	NET OUTPUT MBTUHR	BURNER PERFORMANCE DATA				ELECTRICAL			HOT WATER			
						GAS				BOILER POWER			GPM	MAX PD (FT)	EWT (°F)	LWT (°F)
						FUEL TYPE	GAS FIRING RATE (SCFH)	GAS TRAIN SIZE (IN)	MIN/MAX PRE. (IN W.C.)	FLA	MCB	V/□/Hz				
B-1D-182	MECH. ROOM	HEATING	1,000	1,000	870	NG	1,000	1	4/14	13	20	120/160	12/175	6.47	180	160

WHVA15-B Budget/baseline hot water loop configuration and temperature controls reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.2 – 1/ Table 12.5.2 – 1, Note f: The hot-water space heating loop must be modeled with 180°F design supply temperature and 130°F return temperature. The supply water temperature must be reset in accordance with 90.1 Section 6.5.4.4.

90.1 2016 and 2019 PRM

The hot-water space heating loop must be modeled with 180°F design supply and 130°F design return temperature (90.1 Section G3.1.3.3). Hot-water supply temperature must be reset based on outdoor dry-bulb temperature using the following schedule: 180°F at 20°F and below, 150°F at 50°F and above and ramped linearly between 180°F and 150°F at temperatures between 20°F and 50°F (G3.1.3.4). See Exception to 90.1 Section G3.1.3.4 for projects that use purchased heat in the proposed design.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

90.1 Section G3.2.3.3 and G3.2.3.4 requirements are the same as described above for the 90.1 2016 and 2019 PRM.

G3.3 Minor Alterations

The systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 are required to model systems and equipment included in the scope of retrofit at efficiency levels meeting the mandatory and prescriptive requirements in Section 6.1.4. If there are no applicable

requirements, then the systems and components are modeled identically in the baseline and proposed. For most alterations 90.1 Section 6.5.4.4 (Chilled- and Hot-Water Temperature Reset Controls) will not be applicable to the baseline and the reset schedule will be modeled identically in the baseline and proposed (if there is a reset scheduled specified in the proposed design). However, if the alteration includes new cooling systems installed to serve previously uncooled spaces, then the baseline is required to be modeled as meeting the minimum requirements of 90.1 Section 6.5.4.4 (Chilled- and Hot-Water Temperature Reset Controls).

Review Tips

1. HW plant loop arrangement and controls are reported in Table 6a of the Budget HVAC ECB tab (shown) or Table 6a of the Baseline HVAC PRM tab, depending on the compliance path followed by the project. The inputs are auto-populated based on the applicable requirements of 90.1. Over-written defaults are shown in brown font and should be verified. For alterations subject to 90.1 Section G3.3 (i.e., Minor Alterations) examine Table 5a on the Proposed HVAC tab for the parameters that should be modeled in the baseline and proposed.

WHVAC16-B,P Hot water loops temperature controls are modeled as reported in the Compliance Form

Review Tips

Use simulation reports to verify that the modeled hot water loop configuration and controls such as supply and return hot water temperature and temperature reset are modeled as reported in the Compliance Form.

eQUEST Reports	NA
Trane TRACE 700	Library Members entered values report
Trane TRACE 3D Plus	Plant Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, BPRM Report, Detailed Simulation Report, Florida Energy Code Compliance Report
EnergyPlus	
OpenStudio	
Carrier HAP v5	“Plant Input Data” reports.
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)
Energy Gauge	

WHVAC17-P Proposed hot water pump system parameters reported in the Compliance Form reflect design documents

Review Tips

1. Details of the specified HW pumps are reported in Table 5a of the Proposed HVAC tab. Verify alignment between Compliance Form and design documents. (The applicable design documents must be listed below the table.)

WHVAC17–B Baseline/budget hot water pumps reported in the Compliance Form are established correctly

90.1 2016 and 2019/2022 ECB

Table 11.5.2 – 1/12.5.2-1, Note f: Pump system power for each pumping system must be the same as for the proposed building design; if the proposed building design has no hot-water pumps, the budget building design pump power must be 19 W/gpm, which is equal to a pump operating against a 60 ft head, 60% combined impeller and motor efficiency. The hot-water system shall be modeled as primary-only with continuous variable flow. The hot-water pumps must be modeled as riding the pump curve or with variable-speed drives when required by 90.1 Section 6.5.4.2.

90.1 2016 and 2019 PRM

Section G3.1.3.5: The baseline building design hot-water pump power must be 19 W/gpm. The pumping system must be primary-only with continuous variable flow and a minimum of 25% of the design flow rate. Hot-water systems serving 120,000 ft² or more must be modeled with variable-speed drives and systems serving less than 120,000 ft² must be modeled as riding the pump curve.

90.1 2022 PRM

G3.2 New Construction/Major Alterations

Section G3.2.3.5 requirements are the same as described above for the 90.1 2016 and 2019 PRM Section G3.1.3.5.

G3.3 Minor Alterations

The systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor Alterations) are required to model systems and equipment included in the scope of retrofit at efficiency levels meeting the mandatory and prescriptive requirements in Sections 6 and 10. Section 10.1.4 includes minimum motor efficiency requirements that should be modeled for the pump motors included in the scope of the alteration in the baseline. 90.1 Section 6 requirements depend on the scope of the alteration and the language in 90.1 Section 6.1.4. With regard to 90.1 Section 6, if there are no applicable requirements then the systems and components are modeled identically in the baseline and proposed. For most alterations 90.1 Section 6.5.4.2 (Hydronic Variable Flow Systems) will not be applicable to the baseline and the flow systems and controls will be modeled identically in the baseline and proposed. However, if the alteration includes new cooling systems installed to serve previously uncooled spaces, then the baseline is required to be modeled as meeting the minimum requirements of 90.1 Section 6.5.4.2 (Hydronic Variable Flow Systems).

Review Tips

1. Parameters of the baseline HW pumps are reported in Table 6a of the Baseline HVAC PRM tab (shown) or Budget HVAC ECB tab. All required inputs are auto-populated based on the applicable 90.1 rules. Over-written defaults should be checked. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).

WHVAC18-B,P Hot water pumps are modeled as reported in the Compliance Form

Review Tips

1. Review simulation reports to verify that hot water pumps were modeled as reported in the Compliance form including pump design flow (GPM), power (kW, or BHP and motor efficiency) and flow control (one/two speed, VSD).

eQUEST Reports	PV-A
Trane TRACE 700	Plant Information entered values report. Equipment Energy Consumption report and Library Members entered values report to calculate pump gpm. There is no entry for pump motor efficiency. It is assumed to be 75% in the calculation engine.
Trane TRACE 3D Plus	System Component Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, Detailed Simulation Report, BPRM Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html 'Equipment Summary' report, 'Pumps' section, 'Component Sizing Summary' report
OpenStudio	eplustbl.html 'Equipment Summary' report, 'Pumps' section, 'Component Sizing Summary' report
Carrier HAP v5	"Plant Input Data" reports.
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

WHVAC19-B,P Hot water loops flow control is modeled as reported in the Compliance Form

1. Review simulation reports to confirm that HW loop configuration (i.e. primary/secondary), design flow (GPM) and flow control (three-way or two-way valves) are modeled as reported in the Compliance Form.

eQUEST Reports	PV-A
Trane TRACE 700	Plant Information entered values report. Equipment Energy Consumption report and Library Members entered values report to calculate pump gpm.
Trane TRACE 3D Plus	Plant Summary
IESVE SOFTWARE	Plant Loops & Equipment Report, Detailed Simulation Report, BPRM Report, Florida Energy Code Compliance Report
EnergyPlus	Plant Information entered values report, eplustbl.html 'Component Sizing Summary' report, 'Plant Loop' section
OpenStudio	Plant Information entered values report, eplustbl.html 'Component Sizing Summary' report, 'Plant Loop' section
Carrier HAP v5	"Plant Input Data" reports.
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)

WHVAC20-B,P Modeled annual hot water pump energy is as expected

Review Tips

1. Follow the steps described for HVAVC09 to confirm that the modeled annual hot water pump energy is as expected.

eQUEST Reports	PS-C
Trane TRACE 700	Equipment Energy Consumption report for pump kW and kWh, Library Members entered values report for number of occupied hours/year
Trane TRACE 3D Plus	System Component Summary report for pump inputs, Site Consumption Summary report for pump energy consumption
IESVE SOFTWARE	Thermal Template Report, Energy Model Output Report, PRM Compliance Report, ECB Compliance Report, BPRM Report, Detailed Simulation Report
EnergyPlus	eplustbl.html 'Annual Building Utility Performance Summary' report, 'End Uses By Subcategory' section. The user may need to set the pump subcategory field to report out for a specific pump if several are present.
OpenStudio	eplustbl.html 'Annual Building Utility Performance Summary' report, 'End Uses By Subcategory' section. The user may need to set the pump subcategory field to report out for a specific pump if several are present.
Carrier HAP v5	"Monthly Simulation Results" report for a hot water plant.
Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xls)
Energy Gauge	

WHVAC21 Pump energy use is reported on the Compliance Calculations tab if applicable.

Review Tips

1. If proposed/budget/baseline design includes chilled water, hot water or condenser loops based on the information reported in the Compliance Form (as noted below), pumps are expected to be modeled and non-zero "Pump" end use is expected to be reported on the Compliance Calculations tab Table 2. Loops are found on the following locations within the Compliance Form:
 - Proposed HVAC tab Table 5a (Examine the Notes field under the table for notes as to what was modeled in the baseline design model for 90.1 2022 alterations subject to G3.3)
 - Baseline HVAC PRM tab Table 6a
 - Budget HVAC ECB tab Table 6a
2. The following should be flagged in the review comments:
 - a) Model is expected to have pumps, but no pump energy is reported
 - b) Model is not expected to have pumps, but pump energy is reported.

WHVAC22 Modeled budget/baseline and proposed heating energy use by fuel is consistent with heating energy source reported in the Compliance Form

Review Tips – ECB

1. When **Section 11.5.2 j** (12.5.2 j in 90.1 2022) is properly applied to determine the budget HVAC system, the allocation of heating and cooling energy use between fuels is expected to be similar in the budget building and the proposed design. For example, if based on the simulation output

reports about one third of the annual heating MMBtu is associated with natural gas and two thirds with electricity, similar allocation is expected in the budget design. Explanation should be requested when allocation of heating energy use between fuels differ by more than 15% in the budget design vs proposed design. For example, if in the budget design heating energy MMBtu are split 50/50 between electricity and gas, and in the proposed design the split is 30/70.

2. All fuel types reported in the Proposed HVAC tab Table 1a or 7a should have the corresponding modeled energy use reported for the proposed design in the Compliance Calculations tab Table 2. All fuel types that are not listed in the above-referenced tables of the Proposed HAC tab are expected to have no energy user reported in the Compliance Calculations tab.
3. All heating fuels reported in the Budget HVAC ECB tab Table 1a or 5a should have the corresponding modeled energy use reported for the budget design in the Compliance Calculations tab Table 2. All fuel types that are not listed in the above-referenced tables of the Proposed HAC tab are expected to have no energy user reported in the Compliance Calculations tab.

Review Tips – PRM

1. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. All fuel types reported in the Proposed HVAC tab Table 1a or 7a should have the corresponding modeled energy use reported for the proposed design in the Compliance Calculations tab Table 2. All fuel types that are not listed in the above-referenced tables of the Proposed HAC tab are expected to have no energy user reported in the Compliance Calculations tab.
3. All heating fuels reported in the Baseline HVAC PRM tab Table 1a or 5a should have the corresponding modeled energy use reported for the budget design in the Compliance Calculations tab Table 2. All fuel types that are not listed in the above-referenced tables of the Proposed HAC tab are expected to have no energy user reported in the Compliance Calculations tab.
4. Common mistake includes modeling electric heating in the baseline for projects located in climate zones 3B, 3C and 4-8. Based on 90.1 Table G3.1.1-3 and G3.1.1-4, such projects should have no electric heating in the baseline model.

eQUEST Reports	BEPU
Trane TRACE 700	Energy Cost Budget report
Trane TRACE 3D Plus	LEED Summary Section 1.6
IESVE SOFTWARE	PRM Compliance Report, ECB Compliance Report, BPRM Report, IECC Compliance Report, Plant Loops & Equipment Report, Energy Model Output Report, Detailed Simulation Report
EnergyPlus	eplustbl.html 'Annual Building Utility Performance Summary' report
OpenStudio	eplustbl.html 'Annual Building Utility Performance Summary' report
Carrier HAP v5	"LEED Summary" report, Section 2 "Minimum Energy Performance Calculator", table titled "Proposed Energy Summary by End Use"

Design Builder	Water-Side HVAC sheet in LEED Minimum Energy Performance Calculator (.xlsm)
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Renewable Energy (RE)

Renewable Energy Checks Overview

This group of quality control checks focus on verifying renewable thermal and electricity generation systems. The checks only apply to projects that include such systems.

For projects subject to 90.1 G3.3 (i.e., Minor alterations) energy generated by existing system capacity shall be subtracted from the baseline design energy consumption prior to calculating the building performance. Additional capacity and/or a new system included in the scope of the alteration is not required to be subtracted from baseline design energy consumption.

RE01 The renewable electricity generation systems reported in the Compliance Form reflect design documents

Review Tips

Renewable electricity generation systems are reported in on the Renewable Energy tab Tables 1 and 2. Confirm that all required information is provided and consistent with the design documents.

PV system details included in the submittal must at minimum include system type, orientation and generation capacity (kW). If PV system was not modeled explicitly in the whole building simulation tool used for the project, the external calculations used to estimate electricity generation must be included in the submittal as described in Exceptional Calculations group of QC checks.

RE02 The renewable thermal energy systems reported in the Compliance Form reflect design documents

Review Tips

Renewable thermal energy systems are reported in Table 3 of the Renewable Energy tab.

RE03 Savings from renewable energy savings reported in the Compliance Form are substantiated

Review Tips

1. Refer to Table 4 in the Renewable Energy Tab
2. To verify that the reported PV system electricity generation is reasonable, calculate the system EFLH that is equal to the ratio of the reported annual electricity generation (kWh) to the total rated PV system capacity (kW).
3. If renewable energy was modeled in the whole building simulation tool, verify that savings reported in the Compliance Form reflect simulation results based on the simulation reports referenced below.
4. Projects often model renewable energy using external calculations.

eQUEST Reports	PS-H
Trane TRACE 700	LEED Summary Section 1.4
Trane TRACE 3D Plus	NA

IESVE SOFTWARE	PRM Compliance Report, ECB Compliance Report, BPRM Report, IECC Compliance Report, Energy Model Output Report
EnergyPlus	eplustbl.html 'LEED Summary' report, section L-1 Renewable Energy Source Summary
OpenStudio	eplustbl.html 'LEED Summary' report, section L-1 Renewable Energy Source Summary
Carrier HAP v5	NA. On-site renewable energy generation is calculated external to the program.
Design Builder	LEED Summary Reports in EnergyPlus Output Summary Document

RE04 Contribution of renewable energy toward compliance does not exceed the allowed limit

90.1 2016 and 2019/2022 ECB

11.4.3.1/12.4.3.1: The reduction in design energy cost associated with on-site renewable energy shall be no more than 5% of the calculated energy cost budget.

90.1 2016 PRM

There is no limit on the contribution of renewable energy toward compliance. However, such contribution should be verified to ensure that it is not overly optimistic.

90.1 2019 and 2022 PRM

4.2.1.1: The formula used to establish compliance provided in this section limits contribution of renewable energy toward compliance to no greater than 5% of the baseline energy cost.

G3.3 Minor Alterations

For projects subject to 90.1 G3.3 (i.e., Minor alterations) energy generated by existing system capacity shall be subtracted from the baseline design energy consumption prior to calculating the building performance. Additional capacity and/or a new system included in the scope of the alteration is not required to be subtracted from baseline design energy consumption.

Review Tips

1. The applicable cap is automatically accounted for in the Compliance Calculations tab of the Compliance Form.

2. 90.1 Section 3 defines on-site renewable energy as "... energy generated from renewable sources produced at the building site." Based on this definition, savings associated with systems such as PV panels, solar service water preheaters, etc. are subject to the cap. As with any systems, the renewable energy systems can only contribute toward compliance if they are included in the permit application.

3. Example

Q: A project following the ECB path has modeled an energy cost budget of \$100,000. The modeled proposed energy cost is \$98,000 including \$8,000 savings from on-site PV panels which were explicitly modeled in the simulation tool and are included in the permit application. Does the project comply with ECB?

A: The proposed energy cost without accounting for on-site renewables is $\$98,000 + \$8,000 = \$106,000$. The allowed maximum contribution of renewable energy toward savings is $5\% * 100,000 = \$5,000$. The

proposed energy cost with the allowed renewable energy savings is $\$106,000 - \$5,000 = \$101,000$, which exceeds the energy cost budget. The project does not comply with the ECB.

RE05 Prescriptive on-site renewable energy requirements reported in the Compliance Form are established correctly

90.1 2016 and 2019 ECB and PRM

Not applicable.

90.1 2022 ECB

Table 12.5.1 #15 Budget Building Design column

On-site renewable energy shall be included in the budget building design when required by Section 10.5.1, and shall be determined as follows:

a. Where a system providing on-site renewable energy has been modeled in the proposed design, the same system shall be modeled identically in the budget building design, except the rated capacity shall meet the requirements of Section 10.5.1.1. Where more than one type of on-site renewable energy system is modeled, the total capacities shall be allocated in the same proportion as in the proposed design.

b. Where no system exists or is specified to provide on-site renewable energy in the proposed design, on-site renewable energy shall be modeled as an unshaded photovoltaic system with the following physical characteristics:

- Size: Rated capacity per Section 10.5.1.1
- Module Type: Crystalline silicon panel with a glass cover, 19.1% nominal efficiency and temperature coefficient of $-0.19\%/^{\circ}\text{F}$; performance shall be based on a reference temperature of 77°F and irradiance of $317 \text{ Btu}/\text{ft}^2\cdot\text{h}$.
- Array Type: Rack-mounted array with an installed nominal operating cell temperature (INOCT) of 103°F
- Total system losses (DC output to AC output): 11.3%
- Tilt: 0-degrees (mounted horizontally)
- Azimuth: 180 degrees

90.1 2022 PRM

The Performance Cost Index Target (PCIt) and compliance calculations in Section 4.2.1.1 includes the requirement to account for proposed building performance, excluding any renewable energy system in the proposed design and including an on-site renewable energy system that meets but does not exceed the requirements of Section 10.5.1.1 modeled following the requirements for a budget building design in Table 12.5.1, row 15 (requirements are shown directly above in the 90.1 2022 ECB section).

Review Tips

1. Refer to the prescriptive on-site renewable energy system inputs in Tables 5, 6, and 7 on the Renewable Energy tab in the Compliance Form.
2. Review Table 5 to verify that prescriptive on-site renewable energy system minimum rated capacity requirements in Section 10.5.1.1 were established correctly.

3. To verify that the reported on-site renewable energy system generation is reasonable, calculate the system EFLH which is equal to the ratio of the reported prescriptive annual energy generation to the total rated system capacity using the inputs in Table 6.
4. Review Table 6 and the proposed renewable energy tables (Tables 1-3) to verify that the same system(s) that are specified in the proposed design are modeled to determine the prescriptive annual energy generation, except with the rated capacity meeting the requirements of Section 10.5.1.1. Where more than one type of on-site renewable energy system is specified, the total capacities shall be allocated in the same proportion as in the proposed design. If no on-site renewable energy systems are specified in the proposed design, then confirm that prescriptive annual energy generation was modeled following Table 12.5.1 #15 Budget Building Design column b.
5. If renewable energy was modeled in the whole building simulation tool, verify that savings reported in the Compliance Form reflect simulation results based on the simulation reports referenced in check RE03.
Projects often model renewable energy using external calculations.

Exceptional Calculations (EC)

EC Review Checks Overview

This group of quality control checks focuses on verifying calculations performed outside of the whole building simulation tool. The checks only apply to projects that include such calculations.

EC01 Documentation submitted for each exceptional calculation method reported in the Compliance Form meets 90.1 requirements.

90.1 2016 and 2019/2022 ECB

Section 11.4.5/12.4.5

When the simulation program does not model a design, material, or device in the proposed design, an exceptional calculation method must be used. Where there are multiple designs, materials, or devices that the simulation program does not model, each must be calculated separately, and exceptional savings determined for each. The following documentation must be submitted for each exceptional calculation method:

- a. Theoretical and empirical information verifying the method's accuracy, and step-by-step documentation of the exceptional calculation method performed, detailed enough to reproduce the results.
- b. Copies of all spreadsheets used to perform the calculations.
- c. A sensitivity analysis of energy consumption when each of the input parameters that are estimated is varied from half to double the value assumed.

90.1 2016, 2019, and 2022 PRM

Section G2.5

When the simulation program does not model a design, material, or device in the proposed design, an exceptional calculation method must be used. Where there are multiple designs, materials, or devices that the simulation program does not model, each must be calculated separately, and exceptional

savings determined for each. The following documentation must be submitted for each exceptional calculation method:

- a. Step-by-step documentation of the exceptional calculation method performed, detailed enough to reproduce the results.
- b. Copies of all spreadsheets used to perform the calculations.
- c. A sensitivity analysis of energy consumption when each of the input parameters is varied from half to double the value assumed.
- d. The calculations must be performed on a time-step basis consistent with the simulation program used.

Review Tip

1. Exceptional calculations are listed in Table 1 of the Exceptional Calculations tab of the Compliance Form. Prioritize review of exceptional calculations that are expected to generate the greatest savings based on the information provided in Table 2 of the tab.
2. Refer to Submittal Checklist #35 for the list of files and documents substantiating the exceptional calculations. Locate the material and confirm that the provided details meet 90.1 requirements quoted above for each exceptional calculation.
3. Common mistakes
 - a. Submittal includes screenshots or printouts of the calculations but not the spreadsheet files where formulas can be examined.
 - b. Savings are estimated using proprietary calculators from the vendor of specified system and equipment.
 - c. Calculation methodology not based on peer-reviewed reference or fundamental principles of physics or thermodynamics.
 - d. The whole building simulation tool used on the project must be able to explicitly model all systems and components of the baseline/budget design (Section G2.2.1 b, Section 11.4.1.1/12.4.1.1 h), thus exceptional calculations may only apply to the proposed design.

EC02 Calculation methodology is acceptable and inputs reflect specified systems and equipment

90.1 2016, 2019, and 2022 The Energy Cost Budget and Performance Rating Methods

90.1 Sections 11.4.5 (12.4.5 in 90.1 2022), G2.5

Each exceptional calculation is subject to approval by the authority having jurisdiction or rating authority.

Review Tip.

1. The Energy Cost Budget and Performance Rating Methods require that all building systems and equipment are modeled identically in the baseline/budget and proposed design except when specifically allowed to be different (see Table 11.5.1 No 1 (12.5.1 No 1 in 90.1 2022) and Table G3.1 No 1. Confirm that system or equipment that is the subject of exceptional calculation method is an allowed trade-off opportunity.
2. Verify methodology used for the exceptional calculation methods to confirm that it is acceptable.

3. Confirm that calculation inputs reflect properties of the relevant systems and equipment specified in the design documents.
4. Ensure that operating conditions assumptions and other inputs not inherent in system design are conservative and do not exaggerate savings.
5. Verify that applicable interactive effects are accounted for.

EC03 Contribution of exceptional calculations toward compliance does not exceed the allowed limits

90.1 2016, 2019, and 2022 ECB

There is no limit on the contribution of savings documented via exceptional calculations toward compliance.

90.1 2016, 2019 and 2022 PRM

Section G2.5: When the simulation program does not model a design, material, or device associated with the proposed design, an approved exceptional calculation method may be used. The total Exceptional Savings must not account for more than half of the difference between the baseline building performance and the proposed building performance.

Review Tips

1. The required cap is automatically accounted for in the Compliance Calculations tab of the Compliance Form based on the compliance path followed by the project.
2. Even though the ECB does not limit contribution of exceptional calculations toward compliance, the AHJ may choose to limit contribution of exceptional calculations towards trade-offs since such calculations often involve in-house spreadsheets developed by the Permit Applicant and are not peer-reviewed, or based on savings estimates by the vendor of the system and component being specified.

3. Example EC03

Q: The modeled baseline energy cost is \$100,000 and the modeled proposed energy cost is \$92,000. In addition, the submittal includes \$9,000 savings from a ventilated façade which could not be modeled in the simulation tool. The savings were determined using exceptional calculations and documented as required in 90.1 Section G2.5. What proposed building performance should be used to calculate PRM compliance following 90.1 Section G1.2.2?

A: The difference between the baseline and proposed energy cost without accounting for exceptional calculations is $\$100,000 - \$92,000 = \$8,000$. The savings from exceptional calculations are greater than $\$8,000 * 0.5 = \$4,000$, thus the allowed contribution of the exceptional calculations toward savings is capped at \$4,000. The proposed energy cost that must be used in the compliance calculations is $\$92,000 - \$4,000 = \$88,000$. The Performance Cost Index is equal to $\$88,000 / \$100,000 = 0.88$.

A: The difference between the baseline and proposed energy cost without accounting for exceptional calculations is $\$100,000 - \$92,000 = \$8,000$. This means that savings from exceptional calculations are capped at \$8,000 (i.e., at \$8,000 the total exceptional savings would constitute half

of the difference between the baseline and the proposed building performance including the savings from exceptional calculations, the total savings would be \$16,000 if exceptional calculation savings were \$8,000). The proposed energy cost that must be used in the compliance calculations is $\$92,000 - \$8,000 = \$84,000$. The Performance Cost Index is equal to $\$84,000 / \$100,000 = 0.84$.

90.1 2022 Section G3.3 Performance Calculations for Other Alterations

90.1 2022 Performance Rating Method

Section G3.3 Performance Calculations for Other Alterations was added to 90.1 in 90.1 2022. It specifies that where an alteration does not meet 90.1 Section G3.1.4a and is therefore required to follow Section G3.3, the baseline building systems and equipment in the scope of the retrofit should be modeled at efficiency levels meeting the mandatory and prescriptive requirements in Section 5 through 10 and as described in Section G3.3.2. All other baseline systems and equipment shall be modeled the same as in the proposed design. For reference Section G3.1.4 language is provided directly below.

G3.1.4 Alterations. The simulation model for calculating the proposed building performance and baseline building performance for alterations, excluding additions, shall be developed in accordance with the applicable subparagraph (a) or (b).

a. In accordance with Section G3.2 for alterations that include replacement of two or more of the following:

1. HVAC systems that account for more than 50% of the capacity serving either the heating or cooling loads of the alteration area. This includes HVAC unitary systems, HVAC terminal units, or components of HVAC central heating or cooling equipment. HVAC terminal units, for the purposes of this section, can include VAV boxes, fan-coil units, VRF room units, or water-loop heat pumps;
2. 50% or more of the luminaires in the alteration area;
3. 25% or more of the building envelope area of the alteration portion of the building, including new exterior cladding, fenestration, or insulation.

b. In accordance with Section G3.3 for all other alterations.

Example 1

Question: A project is replacing a chiller that accounts for 75% of the project alteration area cooling capacity and is replacing 80% of the luminaires in the alteration area, would the project be required to follow G3.2 or G3.3?

Answer: G3.2 because it meets the criteria associated with both G3.1.4a #1 and #2.

G3.1.4a #1 applies to the cooling OR heating capacity and because the chiller serves more than 50% of the cooling capacity associated with the alteration area cooling loads the project meets #1.

The project is replacing 50% or more of the luminaires in the alteration area so it meets #2.

Example 2

Question: A project is only replacing a chiller that accounts for 75% of the project alteration area cooling capacity, would the project be required to following G3.2 or G3.3?

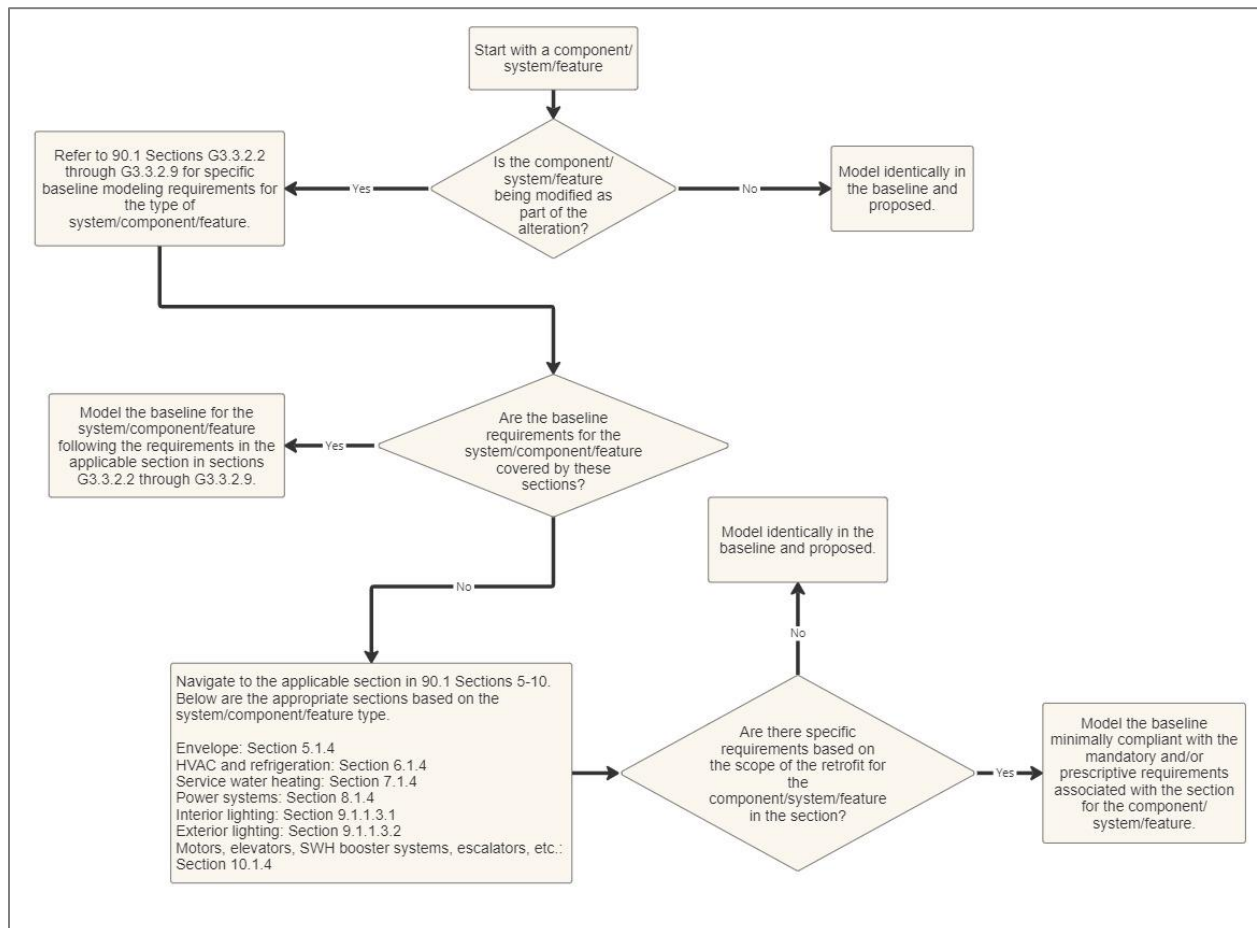
Answer: G3.3 because it only meets the criteria associated with G3.1.4a #1. To be required to follow G3.2 the project would need to meet two or more of the scenarios described in G3.1.4a #s 1-3 and it only meets one.

Example 3

Question: A project is replacing a chiller that accounts for 75% of the project alteration area cooling capacity and is replacing 50% of luminaires in 25% of the alteration area covered by the chiller replacement, would the project be required to following G3.2 or G3.3?

Answer: G3.3 because it only meets the criteria associated with G3.1.4a #1. To be required to follow G3.2 the project would need to meet two or more of the scenarios described in G3.1.4a #s 1-3. The reason the project does not meet G3.1.4a #2 is because the luminaire replacement only applies to 25% of the alteration area so it does not meet the criteria of a 50% or more luminaire replacement in the alteration area.

The figure below is a flowchart to assist with determining the baseline requirement for alterations following 90.1-2022 Section G3.3.



The instructions for filling out the Compliance Form when following G3.3 are as follows:

Submit supplementary documentation where modeled values and assumptions cannot be captured using the methods described in the bullets below. Some examples include baseline HVAC system capacities and modeled baseline efficiency values with fan energy extracted.

- **For projects with no new construction building area in the project (i.e., project only includes floor area subject to G3.3).** The project only needs to fill out the tabs and tables associated with proposed design inputs. The baseline tabs/tables do not need to be filled out because the 90.1 Section 5 to 10 prescriptive/mandatory requirements generally auto-populate on the tabs and in tables with proposed design inputs. Because Section G3.3 requires that baseline building systems and equipment in the scope of the retrofit be modeled at efficiency levels meeting the mandatory and prescriptive requirements in Section 5 through 10 it means that the proposed tables will show both proposed and baseline model inputs. However, care should be taken by projects when establishing required model inputs because some Section 5 through 10 prescriptive/mandatory requirements are different for new construction versus alterations and auto populated values in the Compliance Form assume new construction. To address this, projects are instructed to provide an explanation of what inputs values were modeled in the notes sections below relevant Compliance Form tables and to make manual overrides of prescriptive/mandatory requirements, where allowed and as needed, to document compliance with the modeling requirements of Section G3.3.
- **For projects with a combination of new construction and alterations following G3.3.** Projects are instructed to provide a comment in the relevant notes sections under tables in the Compliance Form indicating which components/systems were modeled in the baseline following Section G3.3 and what inputs values were modeled.

Review tips for conducting specific review checks for projects following 90.1 Section G3.3 are described below.

Review Tips

General requirement: all systems and components not included in the scope of the alteration should be modeled identically in the baseline and proposed.

1. [SG10-P](#), [SG11-P](#), [SG-12-P](#), [SG-13-P](#), [SG14-P](#), [SG15-P](#), [SG16-P](#), [SG17-P](#), [SG18-P](#), [SG19-P](#). The benchmarks for the proposed designs are selected in Table 4 of the Energy Performance Summary tab of the Compliance Form. The default benchmarks are set based on DOE/PNNL prototype models¹⁰ (the prototype models) as described below.
 - a. Proposed design documenting minimum code compliance: the prototype model of the appropriate building type and climate zone, compliant with the same edition of 90.1.
 - b. Proposed design documenting performance above code: the prototype model of the appropriate building type and climate zone, compliant with 90.1 2019.
 - c. For mixed use buildings, the benchmark energy use is calculated as an area-weighted average.

A note of caution for projects that include alterations subject to 90.1 Section G3.3: Because alterations following 90.1 Section G3.3 are minor alterations, and many systems and components may be modeled with existing conditions in the proposed per the requirements of 90.1 G3.3.1b, the project may significantly exceed benchmark values for end uses not affected by the scope of the alteration.

2. [SG10-B](#), [SG11-B](#), [SG-12-B](#), [SG-13-B](#), [SG14-B](#), [SG15-B](#), [SG16-B](#), [SG17-B](#), [SG18-B](#), [SG19-B](#). The benchmarks for the proposed designs are selected in Table 4 of the Energy Performance Summary tab of the Compliance Form. The default benchmarks for projects following the PRM baseline are set based on DOE/PNNL prototype models¹⁰ (the prototype models) using the appropriate building type and climate zone, compliant with 90.1 2004. For mixed use buildings, the benchmark energy use is calculated as an area-weighted average.

Cautionary note for projects involving alterations following 90.1 Section G3.3: When reviewing projects with alterations following 90.1 Section G3.3, which are by definition minor in nature, it's important to consider that many systems and components will be modeled with existing conditions in the baseline and proposed models due to the requirements of 90.1 G3.3.1b (i.e., systems and equipment excluded from the scope of retrofit shall be modeled as reflecting the existing conditions in the baseline and proposed models). On the other hand, for systems and components included in the scope of the retrofit, 90.1 Section G3.3.2.1 requires that the baseline be modeled at efficiency levels that align with the mandatory and prescriptive requirements in Sections 5 through 10. Consequently, the default benchmark may not be an appropriate comparison for the baseline results since the 90.1 Section G3.3 rules deviate significantly from the logic used to create the prototype models minimally compliant with 90.1 2004.

Depending on the relative square footage of the alteration building area following Section G3.3 compared to the total square footage, the benchmark source can be modified in Table 4 on the Energy Performance Summary tab to a more appropriate selection. For example, if the entire project is an alteration following Section G3.3 than a more appropriate benchmark for the baseline may be the version of 90.1 that the project is subject to since systems and components included in the scope of the retrofit are modeled at efficiency levels that align with the mandatory and prescriptive requirements in Sections 5 through 10.

3. [BE05-B](#). Baseline opaque thermal properties will automatically populate in the Compliance Form based on project climate zone and space conditioning category in the "ASHRAE Prescriptive Requirement" column on the Envelope Areas tab in Table 1. Examine the notes field under the table for additional clarifications and explanations as to what was modeled because 90.1 Section 5.1.4 includes exceptions to the requirements to comply with the auto populated prescriptive requirements.

Modeled Construction Name	New, Existing to Remain, or Retrofitted	Building Area Type (for Appendix G Projects Only, 90.1 Section G3.1.1-1)	Orientation	Building Envelope Conditioning Category	Proposed Design			Baseline Design			ASHRAE 90.1 Prescriptive Requirement	
					Net Area, ft ²	Plans / Specs	Software Reports	Assembly U/F/C-Factor (Populates Uclearfield for AGWs)	U _{tot} (only applies to constructions part of alteration building areas that do not meet G3.1.4a)	Solar Reflectance/Thermal Emittance	Assembly U/F/C-Factor per 90.1 Tables 5.5-1 through 5.5-8	Solar Reflectance/Thermal Emittance
SOGFL	New	Other	Horizontal	Residential	8,436	A-301		F-0.73	n/a	n/a	F-0.52	n/a
AGW1	New	Other	North	Residential	3,606	A-301		U-0.064	0.100	0.25/0.9	U-0.064	n/a
AGW1	New	Other	East	Residential	9,881	A-301		U-0.064	0.100	0.25/0.9	U-0.064	n/a
AGW1	New	Other	South	Residential	3,606	A-301		U-0.064	0.100	0.25/0.9	U-0.064	n/a
AGW1	New	Other	West	Residential	9,881	A-301		U-0.064	0.100	0.25/0.9	U-0.064	n/a
AGW2	New	Retail (stand alone)	North	Nonresidential	2,498	A-302		U-0.124	0.100	0.25/0.9	U-0.064	n/a
AGW2	New	Retail (stand alone)	East	Nonresidential	2,736	A-302		U-0.124	0.100	0.25/0.9	U-0.064	n/a
AGW2	New	Retail (stand alone)	South	Nonresidential	2,498	A-302		U-0.124	0.100	0.25/0.9	U-0.064	n/a
AGW2	New	Retail (stand alone)	West	Nonresidential	6,840	A-302		U-0.124	0.100	0.25/0.9	U-0.064	n/a

4. [BE15-B](#). Baseline fenestration U-factor, SHGC and VT will automatically populate in the Compliance Form based on project climate zone and space conditioning category in the “ASHRAE Prescriptive Requirement” column on the Envelope Areas tab in Table 2. Examine the notes field under the table for additional clarifications and explanations as to what was modeled because Section 5.1.4 includes exceptions to the requirements to comply with the auto populated prescriptive requirements.

5. [LI03-B](#). Baseline interior lighting is found in the following tables of the Compliance Form:
 - a. Table 1 on the Lighting Space Types tab shows whether the project used space-by-space or the building area method.
 - b. Baseline LPDs are shown in Table 1 of the Interior Lighting Counts tab in the 90.1 Prescriptive group of columns. These values are set automatically by the Compliance Form based on user-provided description of the building area types and space types. Manual overrides may be needed if requirements differ due to the alteration meeting 90.1 Section 9.1.1.3.1b. Manual overrides will show in a bold brown color. Examine the last column of the table for clarifying notes.

Spot-check the baseline LPDs in spaces where the proposed LPD is substantially lower than the baseline LPD (based on Table 1 of the Interior Lighting Counts tab). LPD difference over 30% should be flagged.

6. [LI04-P](#). Only the lighting controls in the proposed design that exceed the minimum requirements of 90.1 Section 9.1.1.3.1 may be modeled differently in the proposed design compared to the baseline. The credits will not auto populate correctly in Table 1 on the Interior Lighting Counts tab. Examine the Additional Notes column on the right end of the table for clarifications regarding what was modeled.

7. [LI05-P](#). Mandatory lighting control requirements for each space are determined automatically and are shown in Table 1 of the Interior Lighting Counts tab of the Compliance Form in the section labeled “90.1 Mandatory Lighting Control Requirements (For Reference)”. Clarifying notes explaining what is required and why may be needed if requirements differ due to the alteration meeting 90.1 Section 9.1.1.3.1b. Examine the last column of the table for clarifying notes.

8. [LI05-B](#). Baseline lighting control requirements for each space are determined automatically and are shown in Table 1 of the Interior Lighting Counts tab of the Compliance Form in the section labeled

“90.1 Mandatory Lighting Control Requirements (For Reference)”. Clarifying notes explaining what was modeled and why may be needed if requirements differ due to the alteration meeting Section 9.1.1.3.1b. Examine the last column of the table for clarifying notes.

9. [LI06-B](#). Table 2 of the Compliance Calculations tab shows non-coincident peak demand for interior lighting. The value is taken from the simulation reports and reflects the maximum modeled interior lighting load (kW). Peak lighting demand depends on the modeled lighting wattage, the hourly lighting schedule, adjustments to the hourly schedule to reflect reduced runtime due to occupancy sensors (if applicable) and modeled daylighting controls. The modeled interior lighting peak demand may be compared to the interior lighting wattage reported on the Interior Lighting Summary tab Table 1 “90.1 Prescriptive” column for baseline values. For 90.1 2022 alterations following 90.1 Section G3.3 the coincident peak demand is expected to be lower than the total lighting wattage reported in the Compliance Form due to occupancy sensor and daylighting controls. A multiplier of 0.7 may be used to roughly approximate the impact of such controls on coincident demand, as follows:

$MLD_{prop} < 0.7 * TLW_{prop}$

$MLD_{baseline} > 0.7 * TLW_{baseline}$

MLD = modeled noncoincident lighting peak demand from simulation reports [kW]

TLW = total lighting wattage from Table 1 of the Interior Lighting Summary tab [kW]

As part of this check, it is also helpful to verify that the non-coincident lighting peak demand reported in the Compliance Calculations tab Table 2 matches simulation reports.

10. [LI08-B](#), [LI08-P](#). For alterations subject to 90.1 2022 Section G3.3, the credits will not auto populate correctly in Table 1 on the Interior Lighting Counts tab since credit can only be modeled when projects exceed the minimum requirements of 90.1 Section 9.1.1.3. Examine the Additional Notes column on the right end of the table for clarifications regarding what was modeled.
11. [LE01-B](#). The baseline exterior lighting power for each exterior lighting application are determined automatically and are shown in Table 1 of the Exterior Lighting Counts tab of the Compliance Form in the section labeled “90.1 Individual Lighting Power Allowance [Watt]”. Clarifying notes explaining what was modeled and why may be needed if requirements differ due to the alteration meeting 90.1 Section 9.1.1.3.2b. Examine the Notes field under Table 1 for clarifying notes.
12. [LE02-P](#). The review tips in the main section can be followed, however, clarifying notes explaining what is required and why may be needed if requirements differ from auto populated values due to the alteration meeting 90.1 Section 9.1.1.3.2b. Examine the Notes sections for clarifying notes.
13. [LE03-B](#). The modeled baseline exterior lighting wattage must reflect the values reported in Table 2 of the Exterior Lighting tab in the “Total Exterior Lighting Power Allowance, per 90.1 Table 9.4.2-2 + Exempt [Watt]” column. Clarifying notes explaining what was modeled and why may be needed if requirements differ due to the alteration meeting 90.1 Section 9.1.1.3.2b. Examine the Notes field

under Table 2 for clarifying notes.

Table 2: Exterior Lighting Summary

Instructions

1. The table shows the modeling inputs for exterior lighting.
2. The same schedules reflecting the mandatory exterior lighting controls are to be modeled in the baseline/budget and proposed design models.

Type	Proposed Design Lighting Power including Exempt Lighting [Watt]	Baseline Design [Watt] including Exempt Lighting	Total Exterior Lighting Power Allowance, per 90.1 Table 9.4.2-2 + Exempt [Watt]	% Savings of Proposed Design Relative to Allowance
Total Tradeable	250	1,000	500	50.0%
Total Non-tradeable	-	-	-	-
Base Site Allowance	-	-	280	-
Total	250	1,000	780	67.9%

> ... Lighting Space Types Interior Lighting Counts Interior Lighting Summary **Exterior Lighting** Ventil

14. **PPO05-B.** Energy use of the regulated refrigerators and freezers in the baseline design is established automatically in Table 3 of the Plug, Process and Other Loads tab. However, the calculations are based on the characteristic of the corresponding proposed unit reported in Table 3 below, thus the related inputs should be verified. Cross-check information provided in the Compliance Form to design documents for a sample of units focusing on the units that account for largest difference between baseline and proposed design accounting for unit quantity. Reference to appropriate design documents where each unit is described must be provided in the last column of Table 3. If details that must be captured in Table 3 are not available in the design documents, request equipment cutsheets or manufacturer literature. The baseline kWh/day value will be shown in the "ASHRAE 90.1 2022 Prescriptive Requirement kWh/Day/Unit" column since the baseline is required to be modeled as minimally compliant with Section 6. Examine the Notes field under the Table for clarifying notes.

Table 3: Regulated Commercial Refrigerators & Freezers

Instructions
Select a Compliance Path on the General Information tab to populate table instructions.

Equipment Category	Equipment Family	Condensing Unit Configuration	Rating Temperature	Equipment Tag from Design Documents (If Available)	Equipment Classification	V, ft ³ or TDA, ft ²	Enter V, ft ³ or TDA, ft ²	Qty of Units	Proposed kWh/Day per Unit	Baseline Design kWh/Day per Unit	ASHRAE 90.1 - 2022 Prescriptive Requirement kWh/Day/Unit
Self-Contained Commercial Refrigerators and Commercial Freezers With and Without Doors	Semivertical Open (SVO)	Self-Contained (SC)	38F (Medium)	REF12	SVO.SC.M	TDA	250	3	320.0	562.09	429.59

Table 9 on the Plug, Process and Other Loads tab includes information about walk-in cooler and freezer equipment. Similar to above, cross-check information provided in the Compliance Form to design documents for a sample of units.

15. **PPO06.** Since regulated refrigerators and freezers are rated in kWh/day, annual energy use reported in Table 2 of the Compliance Calculations tab, should be equal to the sumproduct of the "ASHRAE 90.1 2022 Prescriptive Requirement kWh/Day/Unit" and the "Qty of Units" columns in Table 3. Discrepancies should be flagged. Examine the Notes field under the Table for clarifying notes.

16. [SWH02-B](#). Baseline SWHs are required to be modeled with the same system types as specified in the proposed design and as meeting Section 7.1.4. Table 1 on the Service Water Heating tab shows the SWHs specified in the proposed design model and in the “ASHRAE 90.1 Minimum Eff.” and the “ASHRAE 90.1 Maximum Stand-by Loss” columns the minimum efficiency requirements of Section 7.1.4 autopopulate. Default values over-written by the modeler are shown in brown bold font in the table and should be verified by reviewer. Examine the Notes field under the Table for clarifying notes.

Table 1: Proposed Water Heaters

Instructions

- All proposed SWH systems must be modeled as designed, with parameters including but not limited to equipment capacities, efficiencies, water flow rates, pump power and controls consistent with the design documents.
- For projects documenting compliance via Appendix G, if no service water-heating system exists or has been specified but the building will have service water heating loads, one service water-heating system must be modeled for each anticipated building area type in the proposed design (enter the baseline model information in Table 2 and enter “n/a” in the first column of Table 1 and leave the remaining columns blank). Each system shall meet the minimum efficiency requirements of Section 7.4.2 and be modeled identically to the proposed design.
- Enter the minimum efficiency requirements if no value autopopulates. See Table 7.8 (Table 7.4-1 for 90.1 2022) footnote g for further information.

Freeze Panes

Modeled Water Heater Name	Design Drawing Water Heater Name	Plans/Specs	Building Area Served	Number of Identical Water Heaters	Energy Source	Equipment Type	Nameplate Input Rate per Heater [Q, Btu/h]	Rated Heater Volume per Heater [gal]	Subcategory or Rating Condition	Eff. Units	Rated Eff.	ASHRAE 90.1 Minimum Eff.	Rated Stand by Loss [SL, Btu/hr]	ASHRAE 90.1 Maximum Stand-by Loss
SWH_1	SWH-1	P-104	Multifamily	3	Natural Gas	Gas storage water heaters	399,000	100	>105,000 Btu/h, <4000 (Btu/h)/gal	Et	96%	80%	1,000	1,599 btu/h
SWH_2	SWH-2	P-104	Retail	1	Electricity	Electric water heaters	37,352	80	≤12 kW, <4000 (Btu/h)/gal, >55 gal and ≤100 gal, Low DP	UEF	2.00	1.96	n/a	n/a

Add Row Delete Row

Describe hot water pre-heat system: None

Notes
Please include applicable notes as needed.

Proposed HVAC Baseline HVAC PRM Service Water Heating Plug, Process and Other Loads Renewable Energy Results from eQuest Compliance Calculations Energy Performance Summary Quality Control

17. [AHVAC03-B](#). Baseline HVAC system types are reported in Table 1a of the Proposed HVAC tab since the baseline HVAC system type is required to be modeled the same as the proposed design with the exception that if the proposed design includes variable refrigerant flow heat pumps or single-zone systems with electric resistance heat, then air source heat pumps shall be used in the baseline design. Spot-check to confirm that the baseline system types were established correctly based on this exception. Examine the Notes field under the Table for clarifying notes.
18. [AHVAC05-B](#). Assess heating, cooling, fan, and pump savings in Table 1 on the Energy Performance Summary tab. If savings appear greater than expected based upon the specified efficiency of the proposed design systems and equipment (i.e., there are few systems and components that impact HVAC that exceed the minimum requirements in Sections 5-10, yet the project is showing significant savings) then check the supplemental documentation showing the modeled baseline capacities using review tips #2 under Review Tips – ECB and #4 under Review Tips – PRM under AHVAC05-B.
19. [AHVAC08-B](#). Heating and cooling system efficiencies are reported in Table 1a of the Proposed HVAC tab in the “ASHRAE 90.1 Minimum Allowed Efficiency” column and are auto-populated based on user inputs in upstream columns for heating and cooling. Any over-written defaults which are shown in brown font should be confirmed by the reviewer. Examine the Notes field under the

Table for clarifying notes.

Specified Efficiency					ASHRAE 90.1 Minimum Allowed Efficiency				
Primary Cool. Load Eff.	Eff. Units	Unitary Cool. Part load Eff.	Eff. Units	COPnfcooling	Efficiency Heating	90.1 Ref. Table	Full Load Efficiency Cooling	Part Load Efficiency Cooling	90.1 Ref. Table
2.0	EER	14.6	IEER	4.20	80% Et	Table 6.8.1-5	11.0 EER	14.6 IEER	Table 6.8.1-1
n/a	-	n/a	-	n/a	n/a	n/a	n/a	n/a	-
1.1	EER	14.6	IEER	3.90	80% Et	Table 6.8.1-5	11.0 EER	14.6 IEER	Table 6.8.1-1
n/a	-	n/a	-	n/a	n/a	n/a	n/a	n/a	-
0.8	EER	12.3	IEER	3.20	81% Et	Table 6.8.1-5	9.5 EER	12.3 IEER	Table 6.8.1-1

Lighting | Ventilation - Multifamily | **Proposed HVAC** | Baseline HVAC PRM | Service Water Heating | Plug, Process

20. [AHVAC15-B](#). Specified fan power is entered on the Proposed HVAC tab in Table 2a with fan system pressure drop adjustments entered in Table 3. If the proposed design includes energy recovery but it is not required in the baseline building design per Sections 6.1.4 and 6.5.6 then the pressure drop adjustment for energy recovery should be removed from Table 3 so that the required baseline fan power populates. The total specified fan power is shown in Table 3 in the “Total Specified Fan System Power” section of columns. Each row with a cell in the “BHP” column that has a green border should be modeled with the corresponding kW/CFMs shown in the “kW/CFMs” column in the baseline. If a red border is shown, then the baseline fan power should be capped at the BHP shown in the “ASHRAE 90.1 Max. Allowed BHP (for reference)” column.

Primary exhaust systems.	Pressure Drop Deductions (Table 6.5.3.1-2)	Total Specified Fan System Power			ASHRAE 90.1 Max. Allowed BHP (for reference)
		BHP	kW	kW/CFM _s	
	PD [in w.c.]				
		4.0	3.33	0.00083	-
	-0.6	0.5	0.42	0.00028	-
		15.0	12.65	0.00087	20.02
		10.0	9.1	0.00019	45.12
		8.0	6.67	0.00104	10.97

Lighting Summary | Exterior Lighting | Ventilation - Multifamily | **Proposed HVAC** | Baseline HVAC PRM | Service Water Heating | Plug, Process

21. [AHVAC16-B](#). Refer to the Notes sections under Table 4 on the Proposed HVAC tab for baseline modeling inputs for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
22. [AHVAC17-B](#). Refer to the Notes sections under Table 2a on the Proposed HVAC tab for baseline fan curves for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations). Fan curves should be modeled based on the minimum requirements of 90.1 Section 6.1.4.
23. [AHVAC19-B,P](#). Refer to Table 3 on the Proposed HVAC tab and the Notes section under the table for modeled baseline fan power and confirm that it is generally consistent with non-coincident peak demand reported in the Compliance Calculations tab Table 2 for both baseline and proposed designs.
24. [AHVAC21-B](#). Refer to Table 4 on the Proposed HVAC tab for baseline requirements for air-side economizers. Note that unless the scope of the alteration includes the installation of a new cooling system to serve previously uncooled spaces an economizer is likely not required to be modeled in the baseline because 90.1 Section 6.5.1 is not included under 90.1 Section 6.1.4.1. Examine the Notes field under the Table for clarifying notes and the ‘Exceptions to 6.5.1, if Any’ column for applicable exceptions.

Table 4: Air-side HVAC - Economizer, Demand Control Ventilation, Exhaust Air Energy Recovery and Controls

Instructions

1. The table includes a row for each air-side HVAC system entered in Table 1.
2. The ancillary features and controls of the specified HVAC systems described in this table must be reflected in the proposed design model.

Freeze Panes

Modeled System Name	Air-Side Economizer				Demand Control Ventilation (DCV)			
	Economizer Type	High-Limit Shutoff	Prescriptive Requirements per 90.1 6.5.1 Req'd per 90.1 6.5.1? (Assumes Outside Location)	Exceptions to 6.5.1, if Any	DCV Specified?	Design Occ. Density for Ventilation, [people/1000 ft ²]	Occupant Outdoor Airflow Component, [cfm/1000 ft ²]	Min. Floor Area ft ² in which DCV is Req'd per 6.4.3.8. (Populates only after EAER columns are filled out.)
Cor_Sys	Fixed dry-bulb (DB) temperature (T)	65	Yes		No	5	0	Not Required
UH_HW	None	n/a	No		No	5	0	Not Required
Retail_Sys	Fixed dry-bulb (DB) temperature (T)	65	Yes		Yes	15	113	800
Apt_Sys	None	n/a	No		No	10	0	Not Required
DOAS_Sys	None	n/a	Yes		No	10	0	Not Required

Applicable drawing plans/spec reference(s) for populating Table 4: M-104

25. [AHVAC23-B](#). Refer to the Notes section under Table 2a on the Proposed HVAC tab for clarifying notes regarding the OA CFM rates modeled in the baseline design model. If different rates are modeled in the baseline and proposed design models the reviewer should verify that this was required based on the scope of the alteration and the language and corresponding Sections associated with 90.1 Section 6.1.4.

26. [AHVAC25-B](#). Demand control ventilation requirements applicable to each baseline HVAC system are shown in Table 4 on the Proposed HVAC tab in the “Min. Floor Area ft² in which DCV is Req’d per 6.4.3.8. (Populates only after EAER columns are filled out.)” column. The values are auto-populated in the Compliance Form based on user-specified maximum occupant density. Overwritten defaults should be reviewed to verify that the exception referenced in the Compliance Form is properly applied. Examine the Notes field under the table for clarifying notes. 90.1 Section 6.1.4.1 only requires DCV for single-zone equipment. If the alteration includes the installation of a new cooling system to serve previously uncooled spaces, then it is subject to 90.1 Section 6.1.4.2 and the baseline should be modeled as minimally compliant with all mandatory and prescriptive requirements in 90.1 Section 6 including 90.1 Section 6.4.3.8 for all equipment types.

Table 4: Air-side HVAC - Economizer, Demand Control Ventilation, Exhaust Air Energy Recovery and Controls

Instructions

1. The table includes a row for each air-side HVAC system entered in Table 1.
2. The ancillary features and controls of the specified HVAC systems described in this table must be reflected in the proposed design model.

Freeze Panes

Modeled System Name	Air-Side Economizer				Demand Control Ventilation (DCV)				
	Economizer Type	High-Limit Shutoff	Prescriptive Requirements per 90.1 6.5.1		DCV Specified?	Design Occ. Density for Ventilation, [people/1000 ft ²]	Occupant Outdoor Airflow Component, [cfm/1000 ft ²]	Min. Floor Area ft ² in which DCV is Req'd per 6.4.3.8. (Populates only after EAER columns are filled out.)	90.1 Section 6.4.3.8 Exceptions, If Any
			Req'd per 90.1 6.5.1? (Assumes Outside Location)	Exceptions to 6.5.1, If Any					
Cor_Sys	Fixed dry-bulb (DB) temperature (T)	65	Yes		No	5	0	Not Required	
UH_HW	None	n/a	No		No	5	0	Not Required	
Retail_Sys	Fixed dry-bulb (DB) temperature (T)	65	Yes		Yes	15	113	800	
Apt_Sys	None	n/a	No		No	10	0	Not Required	
DOAS_Sys	None	n/a	Yes		No	10	0	Not Required	

Applicable drawing plans/spec reference(s) for populating Table 4: M-104

Notes

> ... Interior Lighting Counts Interior Lighting Summary Exterior Lighting Ventilation - Multifamily Proposed HVAC Baseline HVAC PRM Service Water Heat

27. [AHVAC27-B](#). The systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 are likely required to model exhaust air energy recovery identically in the baseline and proposed. This is because 90.1 Section 6.1.4.1 does not include a reference to 90.1 Section 6.5.6 (the section that set requirements for Exhaust Air Energy Recovery). However, if the alteration includes the installation of a new cooling system to serve previously uncooled spaces, then the baseline should be modeled as minimally compliant with all mandatory and prescriptive requirements in 90.1 Section 6 including 90.1 Section 6.5.6. Examine the Notes section under Table 4 on the Proposed HVAC tab for clarifying notes as to what was modeled and why in the baseline.
28. [WHVAC01-B](#). Minimum efficiency requirements are reported in Table 6a on the Proposed HVAC tab in the “ASHRAE 90.1 Minimum Efficiency Full Load Path A/Path B” and “ASHRAE 90.1 Minimum Efficiency Part Load Path A/Path B” columns and are auto-populated based on user inputs in upstream columns. Any over-written defaults, which are shown in brown font, should be confirmed by the reviewer. The baseline chillers are auto-sized, and the resultant chiller capacity will likely

differ from the proposed and may put the systems in a different efficiency bracket in Table 6.8.1-3 compared to the proposed. In this case, the auto populated efficiency values would not be accurate since the proposed capacity is entered in Table 6a. Examine the Notes field under the table for clarifying notes as to what was modeled in the baseline design model and for the capacity of the baseline chillers.

Modeled Plant Name	Drawing System Name(s)	Chiller Type	Condenser Type	Number of Chillers	Total Capacity (ton)	Efficiency Units (Table 6.8.1-3,16)	Full load Efficiency	Part Load Efficiency IPLV	Chiller		Ass. CHW Loop	Basis of Modeled Performance Curves
									ASHRAE 90.1 Minimum Efficiency Full Load Path A/Path B	ASHRAE 90.1 Minimum Efficiency Part Load Path A/Path B		
C_1, C_2	CP1	Screw	Air-cooled	2	110	EER	10.5	13.8	10.100/9.700	13.700/15.800	CHW_Loop	Manufacturer data

29. [WHVAC04-B](#). Chilled water loop proposed design parameters are entered in Table 5a on the Proposed HVAC tab. Examine the Notes field under the table for notes regarding what was modeled in the baseline design model. The baseline and proposed design loop configuration and temperature controls should be modeled the same because 90.1 Section 6.1.4.1 does not include any relevant references to sections that pertain to loop design parameters and controls. Exception: if the alteration includes the installation of a new cooling system to serve previously uncooled spaces, then it is subject to 90.1 Section 6.1.4.2 and the baseline should be modeled as minimally compliant with all mandatory and prescriptive requirements in 90.1 Section 6 including all those that relate to chilled water systems and controls.
30. [WHVAC06-B](#). Chilled water pump proposed design parameters are entered in Table 5a on the Proposed HVAC tab. Examine the Notes field under the table for notes regarding what was modeled in the baseline design model. Section 10.1.4, which is applicable to alterations, includes minimum motor efficiency requirements that should be modeled for the pump motors in the baseline.
31. [WHVAC10-B](#). Proposed heat rejection systems are entered in Table 6a on the Proposed HVAC tab. The same heat rejection system type should be modeled in the baseline and proposed. Examine the Notes field under the table for notes as to what was modeled in the baseline design model. Baseline system parameters should be modeled as minimally compliant with Table 6.8.1-7 and Section 6.5.5.2 which includes requirements for fan speed control.
32. [WHVAC12-B](#). Proposed boiler type and quantity are defined in Table 7a on the Proposed HVAC tab. The same boiler quantity and type should be modeled in the baseline design model. Boiler efficiency shall be modeled with the minimum requirements of Table 6.8.1-6 in the baseline. If the auto-sized baseline boiler system falls into the same capacity bracket as the proposed, the baseline efficiency will auto-populate in the “ASHRAE 90.1 Minimum Performance Requirement” column. Examine the Notes field under the table for notes as to what was modeled in the baseline design model.

Modeled Heating Plant Name	Drawing System Name(s)	Type	Fuel	Number of Boilers/Heat Pump Chillers	Heating Plants				Associated Loop
					Total Input Capacity, Btu/hr	Eff. Units	Efficiency	ASHRAE 90.1 Minimum Performance Requirement	
B_1, B_2	HP1	Boiler, HW, Condensing	Natural Gas	2	3,000,000	Et	93%	80%	HW_Loop

33. [WHVAC17-B](#). Proposed hot water pump parameters are defined in Table 5a on the Proposed HVAC tab. Examine the Notes field under the table for notes as to what was modeled in the baseline design model. The baseline and proposed design loop configuration and temperature controls

should be modeled the same because 90.1 Section 6.1.4.1 does not include any relevant references to sections that pertain to loop design parameters and controls. Exception: if the alteration includes the installation of a new cooling system to serve previously uncooled spaces, then it is subject to 90.1 Section 6.1.4.2 and the baseline should be modeled as minimally compliant with all mandatory and prescriptive requirements in 90.1 Section 6 including all those that relate to hot water systems and controls. Section 10.1.4, which is applicable to alterations, includes minimum motor efficiency requirements that should be modeled for the pump motors in the baseline included in the scope of the alteration.

34. [WHVAC22](#). All fuel types reported in the Proposed HVAC tab Table 1a or 7a should have the corresponding modeled energy use reported for the proposed design on the Compliance Calculations tab in Table 2. All fuel types that are not listed in the above-referenced tables of the Proposed HAC tab are expected to have no energy user reported in the Compliance Calculations tab.

7. Simulation Reports

Carrier HAP v5

1. Carrier HAP v5 is a licensed product. Product details available at <https://www.carrier.com/commercial/en/us/software/hvac-system-design/hourly-analysis-program/>. Product licensing information available at <https://www.carrier.com/commercial/en/us/software/hvac-system-design/software-ordering/>.
2. HAP has an extensive help system. Information about report options and the content of output reports is found in Sections 9.6 (Weather), 14.0 (System Design), 15.0 (Plant Design), and 16.0 (Energy Simulations).
3. Program operating information is found in Chapter 1 (Getting Started), Chapter 2 (Tutorials), Chapters 3 and 4 (Example Problems), and Chapters 5-8 (Applications).
4. Free training videos are available at <https://www.carrier.com/commercial/en/us/software/hvac-system-design/software-support/hap-training-videos>.

General

1. Reports can be viewed, printed, or exported. When exporting, the report must be viewed first; the export option appears in the Report Viewer window.

Simulation Reports to Be Submitted

HAP reports providing data needed for the compliance tasks described in this manual are listed below, arranged by subject.

A. Building-Level Output Reports

- A1. LEED Summary Report
- A2. Energy Budget by System Component
- A3. Energy Budget by Energy Type
- A4. Monthly Energy Use by System Component Report
- A5. Billing Details Report

B. Plant-Level Output Reports

- B1. (Plant) Monthly Simulation Results

C. Air-Side HVAC System-Level Output Reports

- C1. (Air System) Monthly Simulation Results Report
- C2. (Air System) Hourly Simulation Results, CSV Version
- C3. Air System Sizing Summary Report
- C4. Zone Sizing Summary Report
- C5. Ventilation Sizing Summary Report
- C6. Air System Design Load Summary Report

D. Input Data Reports

- D1. Building Input Data Report
- D2. Plant Input Data Report
- D3. Air System Input Data Report
- D4. Simulation Weather Summary Report,
- D5. Space Input Data
- D6. Wall Constructions Report
- D7. Roof Constructions Report
- D8. Window Constructions Report
- D9. Chiller Input Data Report
- D10. Cooling Tower Input Data Report
- D11. Boiler Input Data Report
- D12. Electric Rate Input Data Report
- D13. Fuel Rate Input Data Report

Annotated Reports

TBD

DesignBuilder

Resources

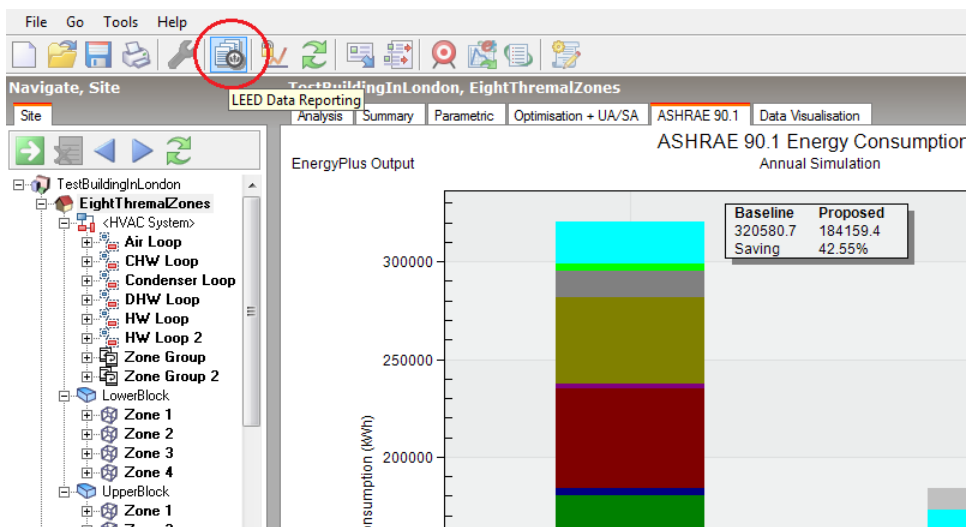
1. The DesignBuilder software can be [downloaded](#) from the DesignBuilder website. Licenses can be ordered from the [buy page](#) of the website or by contacting sales@designbuilder.co.uk.
2. The DesignBuilder online help system provides detailed information on modeling for ASHRAE 90.1 compliance and certification reporting, including An [ASHRAE 90.1 modeling guide](#) which can be downloaded in pdf format.
3. Free [tutorial videos](#) on a wide range of specific topics, including those related to ASHRAE 90.1 modeling are available from the DesignBuilder website.

General

1. The reports referred to below can be accessed from within DesignBuilder. The main sources of data are a) EnergyPlus summary output document, b) LEED submission calculator spreadsheet, c) simulated results and d) model input data.
2. The reports and relevant files submitted are in different format, such as html, csv, idf.

Simulation Reports to be Submitted

1. The EnergyPlus summary output document is provided in html format for both proposed and rotated baseline buildings. It is broken down into various report sections. The summary document can be viewed either from within DesignBuilder on the Summary tab of the Simulation screen or as an .htm file in a web browser.
2. LEED Minimum Energy Performance Calculator in .xlsm format contains similar but more organized data for submittal in the standard format required by LEED. This Excel file can be automatically generated by DesignBuilder via clicking the toolbar icon shown in the screenshot below after ASHRAE 90.1 simulations have been completed for both proposed and baseline buildings:



3. EnergyPlus input (.idf) files for both proposed and baseline buildings. Idf files can be viewed in a text editor such as notepad.
4. EnergyPlus simulated results file (.eso). These are most easily viewed through the freely available DesignBuilder ResultsViewer application which can be downloaded from the DesignBuilder website.

Annotated Reports

EnergyPlus Output Summary Document (eplustbl_P000.htm or eplustbl_Bxxx.htm, xxx can be 000, 090, 180 or 270 which denote baseline rotations)

General Table in Input Verification and Results Summary report

	Value
Program Version and Build	EnergyPlus, Version 8.9.0-40101eaafd, YMD=2019.11.28 14:25
RunPeriod	TESTBUILDINGINLONDON (01-01-31-12)
Weather File	LONDON/GATWICK - GBR IWEC Data WMO#=037760
Latitude [deg]	51.15
Longitude [deg]	-0.2
Elevation [ft]	203.42
Time Zone	0.00
North Axis Angle [deg]	0.00
Rotation for Appendix G [deg]	0.00
Hours Simulated [hrs]	8760.00

SG03: Weather

SG06: Number of hours modeled. Full year indicates

LEED Summary report

Sec1.1A-General Information

	Data
Weather File	TESTBUILDINGINLONDON (01-01-31-12) ** LONDON/GATWICK - GBR IWEC Data WMO#=037760
Total gross floor area [ft2]	9564.73
Principal Heating Source	Natural Gas

SG05: Conditioned Floor Area

EAp2-1. Space Usage Type

	Space Area [ft2]	Regularly Occupied Area [ft2]	Unconditioned Area [ft2]	Typical Hours/Week in Operation [hr/wk]
LOWERBLOCK:ZONE3	1110.86	1110.86	0.00	103.56
LOWERBLOCK:ZONE2	793.65	793.65	0.00	93.67
LOWERBLOCK:ZONE4	1750.10	1750.10	0.00	93.67
LOWERBLOCK:ZONE1	1250.36	1250.36	0.00	113.30
UPPERBLOCK:ZONE3	1037.30	1037.30	0.00	103.56
UPPERBLOCK:ZONE2	744.61	744.61	0.00	93.67
UPPERBLOCK:ZONE4	1676.54	1676.54	0.00	93.67
UPPERBLOCK:ZONE1	1201.31	1201.31	0.00	113.30
Totals	9564.73	9564.73	0.00	

EAp2-2. Advisory Messages

	Data
Number of hours heating loads not met	17.00
Number of hours cooling loads not met	0.00
Number of hours not met	17.00

SG08: Unmet

Opaque Exterior

	Construction	Reflectance	U-Factor with Film [Btu h-r2-F]	U-Factor no Film [Btu h-r2-F]	Gross Area [ft2]	Net Area [ft2]	Azimuth [deg]	Tilt [deg]	Cardinal Direction
LOWERBLOCK_ZONE3_WALL_3_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	423.07	253.84	0.00	90.00	N
LOWERBLOCK_ZONE3_WALL_4_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	346.25	207.75	270.00	90.00	W
LOWERBLOCK_ZONE2_WALL_2_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	346.25	207.75	90.00	90.00	E
LOWERBLOCK_ZONE2_WALL_3_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	302.26	181.36	0.00	90.00	N
LOWERBLOCK_ZONE4_WALL_4_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	545.50	327.30	270.00	90.00	W
LOWERBLOCK_ZONE4_WALL_5_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	423.07	253.84	180.00	90.00	S
LOWERBLOCK_ZONE1_WALL_2_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	545.50	327.30	90.00	90.00	E
LOWERBLOCK_ZONE1_WALL_3_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	302.26	181.36	180.00	90.00	S
UPPERBLOCK_ZONE3_WALL_3_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	423.07	253.84	0.00	90.00	N
UPPERBLOCK_ZONE3_WALL_4_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	346.25	207.75	270.00	90.00	W
UPPERBLOCK_ZONE2_WALL_2_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	346.25	207.75	90.00	90.00	E
UPPERBLOCK_ZONE2_WALL_3_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	302.26	181.36	0.00	90.00	N
UPPERBLOCK_ZONE2_ROOF_1_0_0	CZ4 NON-RES ROOF INS ENTIRELY ABOVE DECK R-19.9C1 (3.5C1) U-.048 (2.73)	0.30	0.048	0.050	793.65	744.61	180.00	0.00	
UPPERBLOCK_ZONE4_WALL_4_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	545.50	327.30	270.00	90.00	W
UPPERBLOCK_ZONE4_WALL_5_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	423.07	253.84	180.00	90.00	S
UPPERBLOCK_ZONE1_WALL_2_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	1750.10	1676.54	180.00	0.00	
UPPERBLOCK_ZONE1_WALL_3_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	545.50	327.30	90.00	90.00	E
UPPERBLOCK_ZONE1_WALL_4_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1-R-7.4 (2.3+1.3) U-.064 (3.65)	0.30	0.064	0.068	302.26	181.36	180.00	90.00	S
UPPERBLOCK_ZONE1_ROOF_1_0_0	CZ4 NON-RES ROOF INS ENTIRELY ABOVE DECK R-19.9C1 (3.5C1) U-.048 (2.73)	0.30	0.048	0.050	1250.36	1201.31	180.00	0.00	
LOWERBLOCK_ZONE3_GROUNDFLOOR_0_0_0	CZ4 NON-RES SLAB-ON-GRADE FLOOR UNHEATED R-0 (0.0) F-.73 (1.264)	1.00		0.044	1110.86	1110.86	0.00	180.00	
LOWERBLOCK_ZONE2_GROUNDFLOOR_0_0_0	CZ4 NON-RES SLAB-ON-GRADE FLOOR UNHEATED R-0 (0.0) F-.73 (1.264)	1.00		0.044	793.65	793.65	0.00	180.00	
LOWERBLOCK_ZONE4_GROUNDFLOOR_0_0_0	CZ4 NON-RES SLAB-ON-GRADE FLOOR UNHEATED R-0 (0.0) F-.73 (1.264)	1.00		0.044	1750.10	1750.10	0.00	180.00	
LOWERBLOCK_ZONE1_GROUNDFLOOR_0_0_0	CZ4 NON-RES SLAB-ON-GRADE FLOOR UNHEATED R-0 (0.0) F-.73 (1.264)	1.00		0.044	1250.36	1250.36	0.00	180.00	

Fans Table in Equipment Summary report

Fans

	Type	Total Efficiency [Btu/h-Btu/h]	Delta Pressure [psi]	Max Air Flow Rate [ft3/min]	Rated Electric Power [W]	Rated Power Per Max Air Flow Rate [W-min-ft3]	Motor Heat In Air Fraction	End Use	Design Day Name for Fan Sizing Peak	Date/Time for Fan Sizing Peak
SYSTEM NO 7 AIR LOOP AHU EXTRACT FAN	Fan, VariableVolume	0.60	0.06	10463.0	3385.10	0.32	1.00	General	AHVAC19: Fan design value is reported	00
SYSTEM NO 7 AIR LOOP AHU SUPPLY FAN	Fan, VariableVolume	0.60	0.12	10463.0	6769.95	0.65	1.00	General		00

Interior Lighting Table in Lighting Summary report

Interior Lighting

	Zone	Lighting Power Density [Btu/h-ft2]	Zone Area [ft2]	Total Power [Btu/h]	End Use Subcategory	Schedule Name	Scheduled Hours Week [hr]	Hours/Week > 1% [hr]	Full Load Hours Week [hr]	Return Air Fraction	Conditioned (Y/N)	Consumption [kWh]
LOWERBLOCK_ZONE3	LOWERBLOCK_ZONE3	2.4722	1110.86	2746.33	General	ASHRAE 90.1 HVAC AVAILABILITY - ASSEMBLY	124.01	122.28	122.28	0.0000	Y	5132.06
LOWERBLOCK_ZONE2	LOWERBLOCK_ZONE2	3.7401	793.65	2968.31	General	ASHRAE 90.1 HVAC AVAILABILITY - ASSEMBLY	91.04	89.60	89.60	0.0000	Y	4064.47
LOWERBLOCK_ZONE4	LOWERBLOCK_ZONE4	5.7369	1750.10	10040.12	General		91.04	89.60	89.60	0.0000	Y	13747.79
LOWERBLOCK_ZONE1	LOWERBLOCK_ZONE1	3.3280	1250.36	4161.21	General		50.90	113.30	49.97	0.0000	Y	3177.74
UPPERBLOCK_ZONE3	UPPERBLOCK_ZONE3	2.4722	1037.30	2564.45	General		124.01	122.28	122.28	0.0000	Y	4792.19
UPPERBLOCK_ZONE2	UPPERBLOCK_ZONE2	3.7401	744.61	2784.88	General		91.04	89.60	89.60	0.0000	Y	3813.30
UPPERBLOCK_ZONE4	UPPERBLOCK_ZONE4	5.7369	1676.54	9618.07	General		91.04	89.60	89.60	0.0000	Y	13169.89
UPPERBLOCK_ZONE1	UPPERBLOCK_ZONE1	3.3280	1201.31	3997.99	General		50.90	113.30	49.97	0.0000	Y	3053.10
Interior Lighting Total		4.0651	9564.73	38881.36								50950.54

Zone Sensible Cooling/Heating Tables in HVAC Sizing Summary report

Zone Sensible Cooling

	Calculated Design Load [Btu/h]	User Design Load [Btu/h]	User Design Air Flow [ft3/min]	Calculated Design Air Flow [ft3/min]	User Design Air Flow [ft3/min]	Design Day Name	Date/Time Of Peak (TIMESTAMP)	Thermostat Setpoint Temperature at Peak Load [F]	Indoor Temperature at Peak Load [F]	Indoor Humidity Ratio at Peak Load [lbWater/lbAir]	Outdoor Temperature at Peak Load [F]	Outdoor Humidity Ratio at Peak Load [lbWater/lbAir]	Minimum Outdoor Air Flow Rate [ft3/min]	Heat Gain Rate from DOAS [Btu/h]
LOWERBLOCK_ZONE3	13432.58	15447.47	13.91	569.388	654.796	SUMMER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12) JUL	15 17:00:00	78.80	78.79	0.01048	78.59	0.01011	188.903	0.00
LOWERBLOCK_ZONE2	14769.56	16984.99	21.40	675.913	777.300	SUMMER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12) JUL	15 09:30:00	78.80	78.76	0.01264	73.09	0.01011	285.670	0.00
LOWERBLOCK_ZONE4	50960.82	58604.94	33.49	2332.167	2681.992	SUMMER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12) JUL	15 16:10:00	78.80				0.01011	1085.008	0.00
LOWERBLOCK_ZONE1	16266.48	18706.45	14.96	744.418	856.081	SUMMER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12) JUL	15 13:30:00	78.80				0.01011	106.310	0.00
UPPERBLOCK_ZONE3	17391.36	20000.07	19.28	795.897	915.282	SUMMER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12) JUL	15 17:00:00	78.80				0.01011	176.393	0.00
UPPERBLOCK_ZONE2	16286.16	18729.09	25.15	745.319	857.117	SUMMER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12) JUL	15 14:40:00	78.80	78.77	0.01211	80.96	0.01011	268.017	0.00
UPPERBLOCK_ZONE4	56522.68	65001.09	38.77	2586.700	2974.705	SUMMER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12) JUL	15 16:20:00	78.80	78.79	0.00966	79.49	0.01011	1039.399	0.00
UPPERBLOCK_ZONE1	19490.46	22414.03	18.66	891.960	1025.754	SUMMER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12) JUL	15 14:10:00	78.80	78.80	0.00940	80.96	0.01011	102.140	0.00

The Design Load is the zone sensible loads only; it does not include any system effects or ventilation loads.

Zone Sensible Heating

	Calculated Design Load [Btu/h]	User Design Load [Btu/h]	User Design Load per Area [Btu/h-ft ²]	Calculated Design Air Flow [ft ³ /min]	User Design Air Flow [ft ³ /min]	Design Day Name	Date/Time Of Peak (TIMESTAMP)	Thermostat Setpoint Temperature at Peak Load [F]	Indoor Temperature at Peak Load [F]	Indoor Humidity Ratio at Peak Load [lbWater/lbAir]	Outdoor Temperature at Peak Load [F]	Outdoor Humidity Ratio at Peak Load [lbWater/lbAir]	Minimum Outdoor Air Flow Rate [ft ³ /min]	Heat Gain Rate from DOAS [Btu/h]
LOWERBLOCK_ZONE3	14943.37	18679.21	16.82	255.570	319.462	WINTER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12)	1:15 24:00:00	68.00	68.00	0.00357	24.08	0.00263	188.903	0.00
LOWERBLOCK_ZONE2	8159.16	10198.95	12.85	376.824	471.030	WINTER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12)	1:15 24:00:00	68.00	68.00	0.00394	24.08	0.00263	285.670	0.00
LOWERBLOCK_ZONE4	17589.11	21986.38	12.56	812.338	1085.008	WINTER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12)	1:15 24:00:00	68.00	68.00	0.00384	24.08	0.00263	1085.008	0.00
LOWERBLOCK_ZONE1	18905.14	23631.42	18.90	873.118	1091.397	WINTER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12)	1:15 24:00:00	68.00	68.00	0.00376	24.08	0.00263	106.310	0.00
UPPERBLOCK_ZONE3	16660.29	20825.36	20.08	769.441	961.801	WINTER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12)	1:15 24:00:00	68.00	68.00	0.00382	24.08	0.00263	176.393	0.00
UPPERBLOCK_ZONE2	9870.37	12337.96	16.57	455.854	569.818	WINTER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12)	1:15 24:00:00	68.00	68.00	0.00395	24.08	0.00263	268.017	0.00
UPPERBLOCK_ZONE4	19490.01	24362.52	14.53	900.129	1125.162	WINTER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12)	1:15 24:00:00	68.00	68.00	0.00385	24.08	0.00263	1039.399	0.00
UPPERBLOCK_ZONE1	20227.28	25284.10	21.05	934.179	1167.724	WINTER DESIGN DAY IN TESTBUILDINGINLONDON (01-01-31-12)	1:15 24:00:00	68.00	68.00	0.00378	24.08	0.00263	102.140	0.00

The Design Load is the zone sensible load only. It does not include any system effects or ventilation loads.

LEED Minimum Energy Performance Calculator

"General Information" sheet

Energy Model Information	
Energy modeler	John Smith, Sustainable Building Solutions Ltd
Energy model based on	100% Construction Documents
Simulation program	EnergyPlus
Energy code used	ASHRAE 90.1 2010 Appendix G
Simulation weather file	GBR_LONDON_GATWICK_IWEC
Climate zone	4A

SG03: Weather

"Lighting" sheet

General Information			Baseline					Proposed					
Building ID	Table 9.6.1 Space Type	Total Space Type Area (sq m)	Maximum Allowance (W/sq m)	Section 9.6.3 Room Geometry Adjustment (Only complete for spaces where credit is taken for room geometry)				Total Baseline LPD Allowance (W/sq m)	Design LPD (W/sq m)	Describe Automatic Lighting Controls	Section 9.6.2(c) Control Factor Adjustment		Design LPD (W/sq m)
				Luminaire Mounting Height (m)	Work-plane (m)	Room Perimeter Length (m)	Room Cavity Ratio				Lighting Power Under Control (W)	Table 9.6.2 adjustment	
Helpful Notes													
LI07: Lighting power densities for the space-by-space method													
EightThermalZo	Library - card file and cataloging	206	7.80					7.80	17.11				17.11
EightThermalZo	Retail - mall concourse	148	11.80					11.80	9.68				9.68
EightThermalZo	Sales area	325	18.10					18.10	13.80				13.80
EightThermalZo	Office - open plan	232	10.50					10.50	10.50				10.50
Total		911	12.81					12.81	13.04				13.04

- Lighting power should be modeled as designed (or installed) including all lighting system components (lamps and ballasts)
- Enter the design (or installed) lighting power density (excluding any additional lighting lighting power from Section 9.6.2 or any process lighting) for this space type in the Proposed case. This value should not include Table G3.2 adjustments.
- Credit for automatic lighting controls should be modeled using the appropriate power adjustment from Table G3.2, applied only to the controlled lighting power and not where required by 9.4.1, per Table G3.1fR(g).
- Automatic daylighting controls must either be modeled directly in the simulation, or modeled using schedule adjustments determined by a separate daylighting analysis per Table

Exterior Lighting

Instructions: Select the applicable exterior lighting categories and then complete the corresponding lighting table(s). An example of the expected level of detail has been provided for each input. Please refer to the column header notes for information about Appendix G modeling protocol. For any information not applicable to the project, simply enter "N/A".

Exterior Lighting Requirements

No additional lighting power allowance has been claimed in the baseline for surfaces that are not p...-counte

LE03: Baseline Exterior Lighting Power **LE03: Proposed Exterior Lighting Power**

Table 9.4.3A Exterior Lighting Zone

Lighting Zone	Zone Description	Base Allowance (W)

Input Parameter	Baseline	Proposed
Total modeled exterior lighting power, including base allowance, based on inputs above (kW)	0.0	0.0

Space by Space Method

If attempting to take additional credit/adjustments in the baseline for room geometry and/or in the proposed for automatic lighting controls, further work will be required. Taking the additional credit is optional. Note: This method employs Addendum cg to 90.1-2010 due to contradictions in the originally published standard. If the project team does not wish to apply the addendum, provide a substantially similar spreadsheet to verify the inputs for the interior lighting power.

Are adjustments being taken for room geometry in the baseline? (Optional)

Are adjustments being taken for automatic lighting controls beyond what is required by Section 9.4.1 in the proposed? (Optional)

LE03: Baseline lighting control

LI07: Space-by-Space lighting definition for baseline building

General Information		Total Space Type Area (sq m)	Maximum Allowance (W/sq m)	Section 9.4.1 (Only complete for Section 9.4.1)				Total Baseline LPD Allowance (W/sq m)	Design LPD (W/sq m)	Describe Automatic Lighting Controls	Section 9.6.2(c) Control Factor Adjustment		Design LPD (W/sq m)
Building ID	Table 9.6.1 Space Type			Luminaire Mounting Height (m)	Work-plane (m)	Perimeter Length (m)	Room Cavity Ratio				Lighting Power Under Control (W)	Table 9.6.2 adjustment	
Helpful Notes													
EightThermalZo	Library - card file and cataloging	206	7.80				0.0	7.80	17.11				17.11
EightThermalZo	Retail - mall concourse	144	11.80				0.0	11.80	9.68				9.68
EightThermalZo	Sales area	325	18.10				0.0	18.10	13.80				13.80
EightThermalZo	Office - open plan	232	10.50				0.0	10.50	10.50				10.50
Total		911	12.81					12.81	13.04				13.04

"Service Water Heating" sheet

Service Water Heaters

Model Input Parameter	Baseline	Proposed
Helpful Notes:	<ul style="list-style-type: none"> New systems: minimum performance requirements from Table 7.8 per Table G3.1#11(b) Existing systems: actual system inputs per Table G3.1#11(a) Model separate service water heating system when design uses combined system with space heating per Table G3.1#11(e) Condenser heat recovery as required by 6.5.6.2 per Table G3.1#11(f) 	<ul style="list-style-type: none"> Service water heaters modeled as designed (or installed) per Table G3.1#11(a&b) Where no service hot water system exists or has been specified but the building will have service hot water loads, a service hot water system should be modeled identical to the Baseline per Table G3.1#11(c) For buildings with no service hot water loads, no service hot water system should be modeled per
Building ID	EightThermalZones	
System type and fuel	Heating with storage using Electricity	Heating with storage using Electricity
Input rating (kW, kBtu/h, etc.)	13.58 kW	13.98 kW
Efficiency (EF, SL, %, etc.)	90%	90%
Storage volume (L)	170	170
Storage temperature (°C)	55	55
Peak hot water demand (L/s)	0.076	0.079
Condenser heat recovery	Not required	Not required
Number of pumps	1	1
Total pump power (kW)	0	0
Type of pump	Variable speed	Variable speed

SWH05: SWH system type, efficiency, and capacity

“General HVAC” sheet

Baseline HVAC System Type(s)

Building ID	Model Input Parameter	Table G3.1.1A System Type (or Semiconditioned System Description)	G3.1.1 Exception (or Semiconditioned Capacity and Area)	Spaces Modeled
	Helpful Notes	<ul style="list-style-type: none"> Refer to Section G3.1.1 and Table G3.1.1A (including footnotes) for Primary HVAC System selection A system with any combination of fossil fuel and electric heat is considered fossil/electric hybrid Systems 1-4: each thermal block shall be modeled with its own system Systems 5-10: each floor shall be modeled with a separate system Additional system types for conditioned spaces only permitted using Exceptions to G3.1.1 (min 20,000 sq ft (1860 sq m) required for exception (a)) Systems serving semiconditioned spaces should be modeled identically to the system in the Proposed case (see definition of space in Section 3.2 of ASHRAE 90.1 For California Title-24 projects, type in the appropriate system type 	<ul style="list-style-type: none"> Conditioned: describe the exception from G3.1.1 used to model this additional Baseline system type (example: Exception (b) used since peak loads differ by more than 10 Btu/h-sq ft (0.03 kW/sq m)) Semiconditioned: list the total system capacity and floor area it serves 	<ul style="list-style-type: none"> List the spaces modeled with the primary system type (example: all spaces except kitchen)
	All	System 7 - VAV with Reheat		
	EightThermalZones			
	EightThermalZones			

AHVAC04: Baseline HVAC system modelled

Proposed HVAC System Type(s)

Building ID	System Description	Spaces Modeled
	Helpful Notes	<ul style="list-style-type: none"> List the spaces modeled with the proposed system type (example: all spaces except kitchen) The HVAC system modeled is designed (or modeled) per Table G3.1#10(a&b) Where no heating system exists or has been designed, the classification is assumed to be electric and the heating system is modeled identically to the Baseline case per Table G3.1#10(c) Where no cooling system exists or has been designed, the cooling system is modeled identically to the Baseline case per Table G3.1#10(d), unless using baseline HVAC system types 9 or 10.
	EightThermalZones	GSHP Water-to-water HP, Heated Floor, Chilled Beams
	EightThermalZones	

AHVAC04: Proposed HVAC system modelled

“Air-Side HVAC” sheet

Air-Side HVAC System Schedule

Add Baseline Add Proposed

Model Input Parameter	Helpful Notes	Units	Totals		Baseline	Proposed
			Baseline	Proposed	Building ID	Building ID
Total cooling capacity	Enter the modeled cooling capacity for the Baseline HVAC system (or the total cooling capacity for a group of similar systems) (example: 195 kBtu/h (33.7 kW)) Note: Auto-sized with 15% oversizing per G3.1.2.2	kW	146	18	146	18
Table 6.8.1 unitary cooling capacity range	Enter the modeled unitary cooling capacity for the Baseline HVAC system (or the total cooling capacity for a group of similar systems) (example: 195 kBtu/h (33.7 kW)) Units should be consistent with the ASHRAE 90.1 minimum efficiency rating requirements for this system type. If modeled units are different than ASHRAE 90.1 units (e.g. EIR rather than SEER), report both units.	W			n/a	n/a
* Table 6.8.1 Unitary Cooling (Systems 1 through 6)	Since the packaged cooling efficiency ratings are calculated at ARI-rated conditions, the fans must also be broken out at ARI-rated conditions (fan power at ARI conditions is typically much lower than fan power at design conditions). If the simulation software does not perform this step automatically, provide the calculations. For the Baseline Case, the project team may use ASHRAE 90.1 – 2010 Addendum bi or the RMI/EMIT translator as optional methods for breaking out the fan power. For the Proposed case, use the method documented in the ASHRAE 90.1 User's Manual to break out the fan power.	EER			n/a	n/a
Unitary cooling efficiency						
Unitary cooling part-load efficiency (if applicable)	Enter the modeled unitary cooling efficiency for the Baseline HVAC system (or group of similar systems) in units consistent with the appropriate Table 6.8.1 (example: 11.0 EER (3.23 COP))	IEER			n/a	n/a

AHVAC06, AHVAC08 Air-Side HVAC system capacities and efficiencies

Total heating capacity		AHVAC08: Air-Side heating system efficiencies are reported	KW	27	10	27	10
* Table 6.8.1 Unitary Heating (Systems 2, 3, 4, and 9)	Table 6.8.1 unitary heating capacity range		KW			n/a	n/a
	Unitary heating efficiency	db(43°F wb, 2.0 COP at 17°F db/15°F wb outdoor air) (e.g. 3.2 COP at 8.3°C db/6.1°C wb, 2.0 COP at -8.3°C db/-9.4°C wb outdoor air)	HSPF			n/a	n/a

* Fan control		<ul style="list-style-type: none"> Systems 1-4, 9 & 10: Constant Volume Systems 5-8: Variable Volume 				Variable volume	Constant volume
Supply airflow		<ul style="list-style-type: none"> Systems 1-8: Auto-sized based on 20°F (11.1°C) ΔT Systems 9-10: Auto-sized based on 105°F (40.6°C) SAT 	L/s	4,940	548	4,940	548
Outdoor airflow		<ul style="list-style-type: none"> If DCV modeled in Proposed only: ASHRAE 62.1 minimum ventilation rates reported in EQ Prerequisite 	L/s	1,530	548	1,530	548
Demand control ventilation			n/a			No	No
* Economizer high-limit shutoff			°C			21.1	25
* Supply air temperature reset			n/a			Supply air temperature reset of 5°F under minimum cooling load conditions	
* Energy Recovery per 6.5.6.1	For Baseline, any individual systems where supply airflow rate exceeds value in Table 6.5.6.1 based on climate zone and percent outdoor air? For proposed, indicate if energy recovery is modeled.	<ul style="list-style-type: none"> Exhaust air energy recovery required for individual systems exceeding Table 6.5.6.1 per G3.1.2.11 unless any exceptions apply 50% energy recovery effectiveness Bypass or control to permit economizer 	% energy recovery effectiveness			n/a	
Fan Power	Supply fan power Return or relief fan power Exhaust fan power System fan power Allowed fan power	Report exhaust fans not interlocked with HVAC operation (such as parking garage ventilation fans, or unconditioned electrical room exhaust fans), and exhaust fans not required in the calculations (such as those applying Exception 6.5.3.1.1, or kitchen hoods operation independent of the building HVAC system) in	KW	10	0	10.2	0.5
* Energy Recovery per 6.5.6.1	For Baseline, any individual systems where supply airflow rate exceeds value in Table 6.5.6.1 based on climate zone and percent outdoor air? For proposed, indicate if energy recovery is modeled.	<ul style="list-style-type: none"> Exhaust air energy recovery required for individual systems exceeding Table 6.5.6.1 per G3.1.2.11 unless any exceptions apply 50% energy recovery effectiveness Bypass or control to permit economizer 	% energy recovery effectiveness			n/a	
Fan Power	Supply fan power Return or relief fan power Exhaust fan power System fan power Allowed fan power	Report exhaust fans not interlocked with HVAC operation (such as parking garage ventilation fans, or unconditioned electrical room exhaust fans), and exhaust fans not required in the calculations (such as those applying Exception 6.5.3.1.1, or kitchen hoods operation independent of the building HVAC system) in	KW	10	0	10.2	0.5

“Water-Side HVAC” sheet

Chilled Water

Model Input Parameter	Baseline Systems Helpful Notes	Units	Baseline	Proposed
Number and type of chillers (and capacity per chiller if more than one type or size of chiller)	<ul style="list-style-type: none"> ≤300 tons (±1055 kW) building peak: 1 water-cooled screw chiller 300-600 tons (1055 - 2110 kW) building peak: 2 equally-sized water-cooled screw chillers ≥600 tons (≥2110 kW) building peak: At least 2 water-cooled centrifugal chillers (800 tons max per chiller) 	n/a	1	
Purchased chilled water rate (cost per unit energy)	Describe how the purchased chilled water rate was determined. Local purchased energy rates must be used when available; when not available, the rates must account for the total costs associated with maintaining the district equipment, and generating and delivering the energy to the project site.	\$		
Total chiller capacity	Auto-sized with 15% oversizing (unless oversized at the system coil) per G3.1.2.2	KW	495.2	
Chiller efficiency - full load	Per Table 6.8.1C efficiencies	COP	5.5	
Chiller efficiency - part load	Per Table 6.8.1C efficiencies	IPLV	6.11	
Chilled water (CHW) supply temp	<ul style="list-style-type: none"> 44°F (6.7°C) per G3.1.3.8 ASHRAE 90.1 (Path 1): Baseline supply temperature based on actual chilled water loop conditions in Proposed Case. 	°C	6.7	
CHW ΔT	<ul style="list-style-type: none"> 12°F (6.3°C) per G3.1.3.8 ASHRAE 90.1 (Path 1): CHW ΔT based on actual chilled water loop conditions in Proposed Case. 	°C	6.7	
CHW supply temp reset parameters	<ul style="list-style-type: none"> 44°F (7°C) at outdoor temps 80°F (27°C) and above, 54°F (12°C) at outdoor temps 60°F (16°C) and below, and ramped linearly between 44°F (7°C) and 54°F (12°C) at outdoor temps between 80°F (27°C) and 60°F (16°C) per G3.1.3.9 ASHRAE 90.1 (Path 1): CHW Temp Reset based on actual CHW loop conditions in Proposed Case. 	n/a	44°F (7°C) at outdoor temps 80°F (27°C) and above, 54°F (12°C) at outdoor temps 60°F (16°C) and below, and ramped linearly between 44°F (7°C) and 54°F (12°C) at outdoor temps between 80°F (27°C) and 60°F (16°C)	
CHW loop configuration	<ul style="list-style-type: none"> Primary/secondary per G3.1.3.10 ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): only building distribution pumps shall be modeled, in which case pump controls shall match the Baseline secondary CHW pump control requirements. 	n/a	Primary/secondary	
Number of primary or DES plant CHW pumps	<ul style="list-style-type: none"> 1 per chiller per G3.1.3.11 ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): no primary CHW pumps should be modeled (since these are considered part of the upstream source) 	#	1	
Primary or DES plant CHW pump power	<ul style="list-style-type: none"> The sum of primary and secondary must be 22 W/gpm (349 kW/1000 Us) per G3.1.3.10. Recommended that the pump power be split as one-third (primary) and two-thirds (secondary). 	W/gpm	12.2	
Primary or DES plant CHW pump flow	<ul style="list-style-type: none"> ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): Not applicable 	L/s	4.4	
Primary or DES plant CHW pump control	Auto-sized with a capacity ratio of 1.0 based on CHW temperatures	n/a	Constant Flow - each primary pump interlocked with associated chiller	
Number of secondary or building booster CHW pumps	<ul style="list-style-type: none"> 1 per G3.1.3.10 ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): one on-site CHW distribution pump shall only be modeled if CHW distribution pumps are present on site (these would otherwise be considered part of the upstream source) (per G3.1.3.4) The sum of primary and secondary must be 22 W/gpm (349 kW/1000 Us) per G3.1.3.10. 	#	1	

Hot Water or Steam

AHVAC06: Baseline/proposed equipment size

Model Input Parameter	Baseline Systems Helpful Notes	Units	Baseline	Proposed
Number and type of boilers	<ul style="list-style-type: none"> ≤15,000 sq ft (1400 m²): 1 natural draft hot water boiler >15,000 sq ft (1400 m²): 2 equally-sized natural draft hot water boilers staged as required by the load 	n/a	1 natural draft hot water boiler	1 boiler
Purchased heating rate (cost per unit energy)	Describe how the purchased heating rate was determined. Local purchased energy rates must be used when available, when not available, the rates must account for the total costs associated with maintaining the district equipment, and generating and delivering the energy to the proposed site.	\$		
Total boiler capacity	Auto-sized with 25% oversizing (unless oversized at the system coil) per G3.1.2.2	MBH	98.8	183.5
Boiler efficiency	Per Table 6.8.1F minimum efficiencies	%	80	89
Hot water or steam (HHW) supply temp	<ul style="list-style-type: none"> 180°F (82°C) per G3.1.3.3 ASHRAE 90.1 (Path 1) or Full DES (Path 2): Purchased Energy - Baseline supply temperature based on actual HHW/Steam loop conditions in Proposed Case 50°F (28°C) per G3.1.3.3 ASHRAE 90.1 (Path 1): Baseline ΔT based on actual HHW/Steam loop conditions in Proposed Case 	°C	82.2	80
HHW ΔT	<ul style="list-style-type: none"> 50°F (28°C) per G3.1.3.3 ASHRAE 90.1 (Path 1): Baseline ΔT based on actual HHW/Steam loop conditions in Proposed Case 	°C	27.8	10
HHW temp reset parameters	<ul style="list-style-type: none"> 180°F (82°C) at outdoor temps 20°F (-7°C) and 50°F (10°C) per G3.1.3.4 ASHRAE 90.1 (Path 1): Baseline Temp Reset based on actual HHW/Steam loop conditions in Proposed Case 	n/a	below, 150°F (66°C) at outdoor temps 50°F (10°C) and above, and ramped linearly between 180°F (83°C) and 150°F (66°C) at outdoor temps between 20°F (-7°C) and 50°F (10°C)	
HHW loop configuration	<ul style="list-style-type: none"> Primary-only per G3.1.3.5 ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): Baseline pumps shall only be modeled if distribution pumps are present in the building, in which case buildings shall be modeled as primary-only per G3.1.3.5 	n/a	Primary-only	
Number of primary or DES plant HHW pumps	<ul style="list-style-type: none"> One pump ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): equal to the number of distribution pumps present in the building 	#	1	
Primary or DES plant HHW pump power	<ul style="list-style-type: none"> ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): - 14 W/gpm (222 kW/1000 L/s) per exception to G3.1.3.5 ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3) - same as the W/gpm (kW/1000 L/s) for the Proposed Case pumps (or alternatively 14 W/gpm (222 kW/1000 L/s) limit from Addendum at G3.1.3.5 would be acceptable) 	W/gpm	22.9	
Primary or DES plant HHW pump flow	Auto-sized with a capacity ratio of 1.0 based on HHW temperatures	L/s	0.9	
Primary or DES plant HHW pump control	<ul style="list-style-type: none"> <120,000 sq ft (11,160 m²): riding the pump curve ≥120,000 sq ft (11,160 m²): variable speed 	n/a	Riding the pump curve	
Number of secondary or building booster HHW pumps	Baseline is primary-only	#	N/A (Primary-only)	
Secondary or building booster HHW pump power	Baseline is primary-only	n/a	N/A (Primary-only)	
Secondary or building booster HHW pump flow	Baseline is primary-only	n/a	N/A (Primary-only)	
Secondary or building booster HHW pump control	Baseline is primary-only	n/a	N/A (Primary-only)	

Chilled Water

Model Input Parameter	Baseline Systems Helpful Notes	Units	Baseline	Proposed
			EightThermalZones	EightThermalZones
Number and type of chillers (and capacity per chiller if more than one type or size of chiller)	<ul style="list-style-type: none"> 1 water-cooled screw chiller 	n/a	1 water-cooled screw chiller	
Purchased chilled water rate (cost per unit energy)		\$		
Total chiller capacity	Auto-sized with 15% oversizing (unless oversized at the system coil) per G3.1.2.2	kW	493.01	
Chiller efficiency - full load	Per Table 6.8.1C efficiencies	COP	5.5	
Chiller efficiency - part load	Per Table 6.8.1C efficiencies	IPLV	6.08	
Chilled water (CHW) supply temp	<ul style="list-style-type: none"> 44°F (6.7°C) per G3.1.3.8 ASHRAE 90.1 (Path 1): Baseline supply temperature based on actual chilled water loop conditions in Proposed Case. 	°C	6.7	
CHW ΔT	<ul style="list-style-type: none"> 12°F (6.7°C) per G3.1.3.8 ASHRAE 90.1 (Path 1): CHW ΔT based on actual chilled water loop conditions in Proposed Case. 	°C	6.7	
CHW supply temp reset parameters	<ul style="list-style-type: none"> 44°F (7°C) at outdoor temps 80°F (27°C) and above, 54°F (12°C) at outdoor temps 60°F (16°C) and below, and ramped linearly between 44°F (7°C) and 54°F (12°C) at outdoor temps between 80°F (27°C) and 60°F (16°C) per G3.1.3.9 ASHRAE 90.1 (Path 1): CHW Temp Reset based on actual CHW loop conditions in Proposed Case. 	n/a	44°F (7°C) at outdoor temps 80°F (27°C) and above, 54°F (12°C) at outdoor temps 60°F (16°C) and below, and ramped linearly between 44°F (7°C) and 54°F (12°C) at outdoor temps between 80°F (27°C) and 60°F (16°C)	
CHW loop configuration	<ul style="list-style-type: none"> Primary/secondary per G3.1.3.10 ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): only building distribution pumps shall be modeled, in which case pump controls shall match the Baseline secondary CHW pump control requirements. 	n/a	Primary/secondary	
Number of primary or DES plant CHW pumps	<ul style="list-style-type: none"> 1 per chiller per G3.1.3.11 ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): no primary CHW pumps should be modeled (since these are considered part of the upstream source) The sum of primary and secondary must be 22 W/gpm (349 kW/1000 L/s) per G3.1.3.10. Recommended that the pump power be split as one-third (primary) and two-thirds (secondary). ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): Not applicable 	#	1	
Primary or DES plant CHW pump power		W/gpm	12.24	
Number of primary or DES plant CHW pumps	<ul style="list-style-type: none"> 1 per chiller per G3.1.3.11 ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): no primary CHW pumps should be modeled (since these are considered part of the upstream source) The sum of primary and secondary must be 22 W/gpm (349 kW/1000 L/s) per G3.1.3.10. Recommended that the pump power be split as one-third (primary) and two-thirds (secondary). ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): Not applicable 	#	1	
Primary or DES plant CHW pump power		W/gpm	12.24	
Primary or DES plant CHW pump flow	Auto-sized with a capacity ratio of 1.0 based on CHW temperatures	L/s	4.4	
Primary or DES plant CHW pump control	<ul style="list-style-type: none"> Constant Flow - each primary pump interlocked with associated chiller 	n/a	Constant Flow - each primary pump interlocked with associated chiller	
Number of secondary or building booster CHW pumps	<ul style="list-style-type: none"> 1 per G3.1.3.10 ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): one on-site CHW distribution pump shall only be modeled if CHW distribution pumps are present on site (these would otherwise be considered part of the upstream source) (per G3.1.1.3.4) The sum of primary and secondary must be 22 W/gpm (349 kW/1000 L/s) per G3.1.3.10. Recommended that the pump power be split as one-third (primary) and two-thirds (secondary). ASHRAE 90.1 (Path 1): 16 W/gpm (254 kW/1000 L/s) per exception to G3.1.3.10 California Title 24 (Path 4): Same W/gpm (kW/1000 L/s) as Proposed or 22 W/gpm (349 kW/1000 L/s) 	#	1	
Secondary or building booster CHW pump power		W/gpm	12.24	
Secondary or building booster CHW pump flow	Auto-sized with a capacity ratio of 1.0 based on CHW temperatures	L/s	4.4	
Secondary or building booster CHW pump control	<ul style="list-style-type: none"> <300 tons (1055 kW): riding the pump curve ≥300 tons (1055 kW): variable speed 	n/a	Variable speed	n/a

Cooling Tower and Condenser Water

Model Input Parameter	Baseline Systems Helpful Notes	Units	EightThermalZones	EightThermalZones
Number of cooling towers or fluid coolers	1 per G3.1.3.11	#	1	
Cooling tower fan power	Minimum 38.2 gpm/hp (3.0 kW/HP) per Table 6.8.1G	HP	2.06	
Cooling tower fan control	Two-speed axial fans per G3.1.3.11	n/a	Two-speed axial fan	
Condenser water (CW) leaving temp	85°F (29°C) or 10°F (5.6°C) per G3.1.3.11	°C	29.44	29
CW ΔT	10°F (5.6°C) per G3.1.3.11	°C	5.56	5
CW loop temp reset parameters	Maintain a 70°F (21°C) leaving water temperature where weather permits, floating up to leaving water temperature at design conditions per G3.1.3.11	n/a	70°F (21°C) leaving water where weather permits, floating up to leaving water temperature at design conditions	
Number of CW pumps	1 per chiller per G3.1.3.11	#	1	1
CW pump power	19 W/gpm (310 kW/1000 L/s) per G3.1.3.11	W/gpm	21.14	1.8
CW pump flow	Auto-sized with a capacity ratio of 1.0 based on CW temperatures	L/s	6.27	4.42
CW pump control	Riding the pump curve per G3.1.3.11	n/a	Riding the Pump Curve	Variable speed

WHVAC11: Heat rejection system is modeled as reported

Hot Water or Steam

Model Input Parameter	Baseline Systems Helpful Notes	Units	EightThermalZones	EightThermalZones
Number and type of boilers	Modeled as required	n/a	1 natural draft hot water boiler	1 boiler
Purchased heating rate (cost per unit energy)	Energy rates the total costs of the energy	\$		
Total boiler capacity	1.22	MBH	394.8	183.47
Boiler efficiency		%	80	89
Hot water or steam (HHW) supply temp	Supply	°C	82.22	80
HHW ΔT	Conditions in	°C	27.78	10
HHW temp reset parameters	Door temps 50°F (10°C) at outdoor temps above 50°F (10°C) and below 50°F (10°C) at outdoor temps below 50°F (10°C)	n/a	180°F (83°C) at outdoor temps 20°F (-7°C) and below, 150°F (66°C) at outdoor temps 50°F (10°C) and above, and ramped linearly between 180°F (83°C) and 150°F (66°C) at outdoor temps between 20°F (-7°C) and 50°F (10°C)	
HHW loop configuration	• Primary-only per G3.1.3.5 • ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): Baseline pumps shall only be modeled if distribution pumps are present in the building, in which case buildings shall be modeled as primary-only per G3.1.3.5	n/a	Primary-only	
Number of primary or DES plant HHW pumps	• One pump • ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): equal to the number of distribution pumps present in the building	#	1	2
Primary or DES plant HHW pump power	• 19 W/gpm (301 kW/1000 L/s) per G3.1.3.5 • ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3): - 14 W/gpm (222 kW/1000 L/s) per exception to G3.1.3.5	W/gpm	15.2	1.8
Primary or DES plant HHW pump flow	• ASHRAE 90.1 (Path 1) or Streamlined DES (Path 3) - same as the W/gpm (kW/1000 L/s) for the Proposed Case pumps (or alternatively 14 W/gpm (222 kW/1000 L/s) limit from Addendum A to G3.1.3.5 would be acceptable)	L/s	3.22	2.94
Primary or DES plant HHW pump control	Auto-sized with a capacity ratio of 1.0 based on HHW temperatures • <120,000 sq ft (11,160 m ²): riding the pump curve • ≥120,000 sq ft (11,160 m ²): variable speed	n/a	Riding the pump curve	
Number of secondary or building booster HHW pumps	Baseline is primary-only	#	n/a (Primary-only)	
Secondary or building booster HHW pump power	Baseline is primary-only	n/a	n/a (Primary-only)	
Secondary or building booster HHW pump flow	Baseline is primary-only	n/a	n/a (Primary-only)	
Secondary or building booster HHW pump control	Baseline is primary-only	n/a	n/a (Primary-only)	

WHVAC13, WHVAC14, WHVAC16, WHVAC18, WHVAC19: Hot plant and controls, loop parameters, hot water pumps and boiler efficiencies are modeled as expected

“Performance_Outputs_1” sheet

Performance Rating Method Compliance Report

End Use	Unregulated?	Energy Type	Units of Annual Energy and Peak Demand	Baseline	Proposed
Interior lighting		Electricity	Consumption (kWh)	51,085	37,132
			Demand (kW)	11	11
Exterior lighting		Electricity	Consumption (kWh)	2,190	2,190
			Demand (kW)	0.5	1
Space heating		Natural Gas	Consumption (kWh)	180,067	4,564
			Demand (kW)	88.6	33
Space cooling		Electricity	Consumption (kWh)	3,673	18,360
			Demand (kW)	9.5	27
Pumps		Electricity	Consumption (kWh)	3,592	713
			Demand (kW)	3.2	0
Heat rejection		Electricity	Consumption (kWh)	133	
			Demand (kW)	1.5	
Fans - interior ventilation		Electricity	Consumption (kWh)	13,475	8,744
			Demand (kW)	7.9	2
Fans - parking garage	x	Electricity	Consumption (kWh)		37,265
Service water heating		Electricity	Demand (kW)	21,506	22,087
			Consumption (kWh)	9.3	10
Receptacle equipment	x	Electricity	Consumption (kWh)	44,726	10,605
			Demand (kW)	14.4	4

AHVAC04: Space heating end use
WHVAC22: Baseline and Proposed heating fuels

SG09: Heating, cooling and fan etc energy between the baseline and proposed

SG08: Unmet hours

PPO01, PPO03: Miscellaneous loads

Unmet Loads
Enter the non-coincident unmet load hours, consistent with the energy simulation output reports.

Unmet Loads	Baseline	Proposed
Number of hours heating loads not met	269	102
Number of hours cooling loads not met	0	125
Totals	269	227
Compliance		Yes

Energy Sources

Enter each energy source serving the project, the units for the energy consumption and demand, and the associated utility rate name and tariff structure. All project energy types and the demand and consumption units must be entered before entering energy simulation output data. Also enter the energy consumption and source energy consumption (generally, the IP units are Etu x 10⁶, the SI site energy units are kWh, and the SI source energy units are kWh).

UR03: Brief description for utility structure can be added here

Energy Type	Energy Consumption Units	Demand Units	Utility Rate Name	Utility Rate Structure	Unit Conversion Factors		
					Energy Type Consumption Units to Site Energy Consumption (kWh)	Energy Type Consumption Units to Source Energy Consumption (kWh)	
Electricity	kWh	kW	BLOCK ELECTRICITY AND DEMAND CHARGE	In block charges for both demand and energy, where energy < 20kWh, rate is 0.0474, between 20 kWh and 180 kWh, rate is 0.0424, energy > 180 kWh, rate is 0.0383; demand < 20W, rate is 5.36, between 20W and 80W, rate is 4.23, demand > 80W, rate is 3.60.	1.0000000	3.1400000	
Natural Gas	kWh	kW	MONTHLY RATE GAS CHARGE	Charged in monthly rates (Jan to Dec): 0.031, 0.027, 0.024, 0.023, 0.022, 0.018, 0.018, 0.023, 0.025, 0.028, 0.033 and 0.035.	1.0000000	1.0500000	
Site energy consumption units used to report energy consumption totals (sum of energy types)						kWh	
Source energy consumption units used to report energy consumption totals (sum of energy types)						kWh	

On-Site Renewable Energy Production

The project building uses on-site renewable energy systems. (Optional)

Exceptional Calculation Methods

The building energy analysis includes exceptional calculation methods. (Optional)

RE03: Renewable Energy

EC02: Exceptional Calculation

Performance Rating Method Compliance Report

Energy Type	Units of Annual Energy and Peak Demand	Baseline	Proposed	Energy / Demand Savings per End-Use	Annual Energy		Percent of Total Proposed Site Energy Consumption
					Savings	Total Cost Savings	
Interior lighting	Consumption (kWh)	51,085	37,132	27.3%	10.3%	34.4%	20.1%
	Demand (kW)	11	11	0.0%			
Exterior lighting	Consumption (kWh)	2,190	2,190	0.0%	0.0%	-0.1%	1.2%
	Demand (kW)	0.5	1	0.0%			
Space heating	Consumption (kWh)	180,266	1,745	99.0%	-	-	-
	Demand (kW)	88.6	28	68.7%			
Space cooling	Consumption (kWh)	3,655	18,367	-402.5%	-	-	-
	Demand (kW)	9.4	27	-186.2%			
Pumps	Consumption (kWh)	579	739	79.4%	-2.1%	7.4%	0.4%
	Demand (kW)	3.2	0	87.6%			
Heat rejection	Consumption (kWh)	192	0	100.0%	0.1%	0.3%	0.0%
	Demand (kW)	0.5	0	100.0%			
Fans - interior	Consumption (kWh)	1,135	739	34.9%	3.5%	11.8%	4.7%
	Demand (kW)	3.5	2	80.2%			
Fans - parking garage	x Electricity	Consumption (kWh) Demand (kW)			-27.5%	-99.2%	20.1%
Service water heating	Consumption (kWh)	21,506	22,087	-2.7%	-0.4%	-2.7%	11.9%
	Demand (kW)	9.3	10	-3.2%			
Receptacle equipment	Consumption (kWh)	44,726	10,605	76.3%	25.2%	88.4%	5.7%
	Demand (kW)	14.4	4	69.9%			
IT equipment	Consumption (kWh)				0.0%	0.0%	0.0%
	Demand (kW)						
Interior lighting - process	Consumption (kWh)				0.0%	0.0%	0.0%
	Demand (kW)						
Refrigeration equipment	Consumption (kWh)				0.0%	0.0%	0.0%
	Demand (kW)						
Fans - Kitchen Ventilation	Consumption (kWh)				0.0%	0.0%	0.0%
	Demand (kW)						

BE21: Baseline not rotated or 4 rotations averaged

LI10: Interior Lighting Annual Energy

LI10: Lighting Full Load Hours – This needs to be calculated as FLH = Energy Use/Demand

LI06: Interior Lighting Peak Demand

LE03, LE06: Exterior Lighting Energy

EnergyPlus Input Data idf file

UnityCost:Charge table

```

UtilityCost:Charge:Block,
  BlockEnergyCharge,
  Block electricity and demand charge,
  totalEnergy,
  Annual,
  EnergyCharges,
  ,
  1,
  20000,
  .0474,
  180000,
  .0424,
  remaining,
  .0383;

UtilityCost:Charge:Block,
  BlockDemandCharge,
  Block electricity and demand charge,
  totalDemand,
  Annual,
  DemandCharges,
  ,
  1,
  20,
  5.38,
  80,
  4.23,
  remaining,
  3.6;
  
```

!- Charge Variable Name
 !- Tariff Name
 !- Source Variable
 !- Season
 !- Category Variable Name
 !- Remaining Into Variable
 !- Block Size Multiplier Value or Variable Name
 !- Block Size 1 Value or Variable Name
 !- Block 1 Cost per Unit Value or Variable Name
 !- Block Size 2 Value or Variable Name
 !- Block 2 Cost per Unit Value or Variable Name
 !- Block Size 3 Value or Variable Name
 !- Block 3 Cost per Unit Value or Variable Name

UR03: Utility rate structure. The input for the utility rate used in both the proposed and baseline are displayed in this section

Simulated Results File (eso)

Chilled Water Pump Energy

Report Type	Area	Units	Monthly	RunPeriod
Pump Electric Power	SYSTEM NO 7 HW LOOP SUPPLY PUMP	kWh		
✓ Pump Electric Power	SYSTEM NO 7 CHW LOOP SUPPLY PUMP	kWh		
Site Diffuse Solar Radiation Rate per...	Environment	kWh/...	01/01/2002	
Site Direct Solar Radiation Rate per...	Environment	kWh/...		

WHVAC09: Chilled water pump energy is as expected

Pump Electric Power [kWh]
904.83421675935

Heating Pump Energy

Report Type	Area	Units	Monthly	RunPeriod
✓ Pump Electric Power	SYSTEM NO 7 HW LOOP SUPPLY PUMP	kWh		
Pump Electric Power	SYSTEM NO 7 CHW LOOP SUPPLY PUMP	kWh		
Site Diffuse Solar Radiation Rate per...	Environment	kWh/...	01/01/2002	
Site Direct Solar Radiation Rate per...	Environment	kWh/...		

WHVAC20: Heating pump energy is as expected

Pump Electric Power [kWh]
387.094830775161

Monthly heating and cooling loads - simultaneous heating and cooling check

Report Type	Area	Units	Monthly	RunPeriod	Zone Air System Sensible Heating Rate [kWh]	Zone Air System Sensible Cooling Rate [kWh]
Zone Heating Setpoint Not Met Time	LOWERBLOCK:ZONE1	hr				
✓ Zone Air System Sensible Cooling Rate	LOWERBLOCK:ZONE1	kWh				
Zone Cooling Setpoint Not Met While Oc...	LOWERBLOCK:ZONE1	hr				
Zone Cooling Setpoint Not Met Time	LOWERBLOCK:ZONE1	hr				
✓ Zone Air System Sensible Heating Rate	LOWERBLOCK:ZONE1	kWh				
Zone Infiltration Sensible Heat Loss Energy	LOWERBLOCK:ZONE1	kWh				
Zone Windows Total Transmitted Solar R...	LOWERBLOCK:ZONE1	kWh				
Zone Interior Windows Total Transmitted ...	LOWERBLOCK:ZONE1	kWh				
Zone Lights Electric Power	LOWERBLOCK:ZONE1	kWh				
Zone Air Relative Humidity	AHVAC31	%				
Zone Mechanical Equipment Total Heating Rate	LOWERBLOCK:ZONE1	kWh				
Zone Mean Radiant Temperature	LOWERBLOCK:ZONE1	C				
Zone People Sensible Heating Rate	LOWERBLOCK:ZONE1	kWh				
Zone Operative Temperature	LOWERBLOCK:ZONE1	C				
Zone Mean Air Temperature	LOWERBLOCK:ZONE1	C				
			01/01/2002		997.453698640376	0.638396465306164
			01/02/2002		810.505206523605	0.751900945451373
			01/03/2002		491.773445475716	12.4460648328704
			01/04/2002		260.722483401388	103.1373118118
			01/05/2002		65.7330058899191	371.436963150817
			01/06/2002		21.86196978092	486.317375445952
			01/07/2002		0.690377659515398	719.253844967048
			01/08/2002		5.74455720119424	628.721895944188
			01/09/2002		47.6331787687725	340.828732217015
			01/10/2002		224.537574439139	117.759066521126
			01/11/2002		487.536923901997	11.0828235755798
			01/12/2002		947.967048537566	0.604473643690288

EnergyPlus / OpenStudio

Program Version: **EnergyPlus, Version 9.2.0-921312fald, YMD=2019.12.10 14:18**

Tabular Output Report in Format: **HTML**

Building: **Building 1**

SG03: Weather File

Environment: RUN PERIOD 1 ** Chicago Ohare Intl Ap IL USA TMY3 WMO#=725300

Simulation Timestamp: **2019-12-10 14:19:08**

Annual Building Utility Performance Summary Report

Report: **Annual Building Utility Performance Summary**

For: **Entire Facility**

Timestamp: **2019-12-10 14:19:08**

SG06: Number of hours per year explicitly modeled is as required

Values gathered over 8760.00 hours

Site and Source Energy

SG09: Site Energy Use Intensity (EUI) of the budget (baseline) design does not exceed typical by more than 20%.

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	1347.66	278.96	330.43
Net Site Energy	427.10	88.41	104.72
Total Source Energy	4268.04	883.48	1046.49
Net Source Energy	1352.63	279.99	331.65

Report: **Input Verification and Results Summary**

For: **Entire Facility**

Timestamp: **2019-12-11 09:58:50**

General

	Value
Program Version and Build	EnergyPlus, Version 9.2.0-921312fa1d, YMD=2019.12.11 09:58
RunPeriod	RUN PERIOD 1
Weather File	Chicago Ohare Intl Ap IL USA TMY3 WMO#=725300
Latitude [deg]	41.98
Longitude [deg]	-87.9
Elevation [m]	201.00
Time Zone	-6.0
North Axis Angle [deg]	0.00
Rotation for Appendix G [deg]	0.00
Hours Simulated [hrs]	8760.00

BE21

ENVELOPE

Window-Wall Ratio

	Total	North (315 to 45 deg)	East (45 to 135 deg)	South (135 to 225 deg)	West (225 to 315 deg)
Gross Wall Area [m2]	2166.50	817.55	265.70	265.70	265.70
Above Ground Wall Area [m2]	2166.50	817.55	265.70	265.70	265.70
Window Opening Area [m2]	649.95	245.26	79.71	245.26	79.71
Gross Window-Wall Ratio [%]	30.00	30.00	30.00	30.00	30.00
Above Ground Window-Wall Ratio [%]	30.00	30.00	30.00	30.00	30.00

BE16

Conditioned Window-Wall Ratio

	Total	North (315 to 45 deg)	East (45 to 135 deg)	South (135 to 225 deg)	West (225 to 315 deg)
Gross Wall Area [m2]	1993.70	737.65	259.20	737.65	259.20
Above Ground Wall Area [m2]	1993.70	737.65	259.20	737.65	259.20
Window Opening Area [m2]	598.11	221.30	77.76	221.30	77.76
Gross Window-Wall Ratio [%]	30.00	30.00	30.00	30.00	30.00
Above Ground Window-Wall Ratio [%]	30.00	30.00	30.00	30.00	30.00

Component Sizing Summary Report

AirLoopHVAC

	Sum of Air Terminal Maximum Heating Flow Rates [m3/s]	Sum of Air Terminal Minimum Heating Flow Rates [m3/s]	Sum of Air Terminal Maximum Flow Rates [m3/s]	Adjusted Heating Design Air Flow Rate [m3/s]	Adjusted Cooling Design Air Flow Rate [m3/s]	Adjusted Main Design Air Flow [m3/s]	User Heating Air Flow Ratio []	Calculated Heating Air Flow Ratio []	Design Supply Air Flow Rate [m3/s]
CAV_BAS	3.81	0.761010	3.81	1.20	3.82	3.82	1.00	0.314487	3.82
DATACENTER_BASEMENT_ZN_6 ZN PSZ-AC DATA CENTER	0.000000	0.000000	18.34	0.000000	18.34	18.34	1.00	0.000000	18.34
DATACENTER_BOT_ZN_6 ZN PSZ-AC DATA CENTER	0.000000	0.000000	0.458429	0.000000	0.458429	0.458429	1.00	0.000000	0.458429

Initialization Summary Report

ZoneInfiltration Airflow Stats Nominal

	Name	Schedule Name	Zone Name	Zone Floor Area {m2}	# Zone Occupants	Design Volume Flow Rate {m3/s}	Volume Flow Rate/Floor Area {m3/s-m2}	Volume Rate/Envelope Surface Area {m3/s-m2}	ACH - Air Changes per Hour	Equation A - Constant Term Coefficient {}	Equation B - Temperature Term Coefficient {1/C}	Equation C - Velocity Term Coefficient {s/m}	Equation D - Velocity Squared Term Coefficient {s2/m2}
1	1_BDRM_1_2 INFILTRATION	ALWAYS ON DISCRETE	1_BDRM_1_2	55.74	1.6	5.292E-003	9.493E-005	2.848E-004	0.111	0.000	0.000	0.224	0.000
2	1_BDRM_1_3 INFILTRATION	ALWAYS ON DISCRETE	1_BDRM_1_3	55.74	1.6	5.292E-003	9.493E-005	2.848E-004	0.112	0.000	0.000	0.224	0.000
3	1_BDRM_1_4 INFILTRATION	ALWAYS ON DISCRETE	1_BDRM_1_4	55.74	1.6	5.292E-003	9.493E-005	7.120E-005	0.112	0.000	0.000	0.224	0.000

LEED Summary Report

EAp2-2. Advisory Messages

	Data
Number of hours heating loads not met	0.00
Number of hours cooling loads not met	46.17
Number of hours not met	46.17

SG08: Number of hours with unmet heating or cooling load does not exceed 300

Building Area

	Area [m2]
Total Building Area	4830.96
Net Conditioned Building Area	4078.44
Unconditioned Building Area	752.51

SG05: Modeled conditioned floor area is appropriate

Convert to ft2 by multiplying by 10.7639

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	487.25	1349.26
Natural Gas	0.00	0.00
Total	487.25	1349.26
Additional	0.00	0.00

EAp2-7. Energy Cost Summary

UR03

	Process Subtotal [\$]	Total Energy Cost [\$]
Electricity	9482.78	26259.01
Natural Gas	0.00	0.00
Other		3321.92
Total	9482.78	29580.93
Additional	0.00	

Process energy cost based on ratio of process to total energy.

RE03

L-1. Renewable Energy Source Summary

	Rated Capacity [kW]	Annual Energy Generated [GJ]
Photovoltaic	0.00	959.08
Wind	0.00	0.00

EAp2-17a. Energy Use Intensity - Electricity

	Electricity [MJ/m2]
Interior Lighting (All)	33.35
Space Heating	8.81
Space Cooling	53.87
Fans (All)	28.08
Service Water Heating	26.38
Receptacle Equipment	100.86
Miscellaneous (All)	279.29
Subtotal	279.29

EAp2-17b. Energy Use Intensity - Natural Gas

	Natural Gas [MJ/m2]
Space Heating	0.00
Service Water Heating	0.00
Miscellaneous (All)	0.00
Subtotal	0.00

Building Envelope Summary Report

Report: Envelope Summary

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For: Entire Facility

Timestamp: 2019-12-11 09:58:50

Opaque Exterior

	Construction	Reflectance	U-Factor with Film [W/m2-K]	U-Factor [W/m2-K]	Gross Area [m2]	Net Area [m2]	Azimuth [deg]	Tilt [deg]	Cardinal Direction
FACE 224	TYPICAL INSULATED WOOD FRAMED EXTERIOR WALL R-45.45	0.30	0.125	0.127	18.58	13.01	180.00	90.00	S
FACE 410	TYPICAL INSULATED WOOD FRAMED EXTERIOR WALL R-45.45	0.30	0.125	0.127	18.58	13.01	180.00	90.00	S
FACE 561	TYPICAL INSULATED WOOD FRAMED EXTERIOR WALL R-45.45	0.30	0.125	0.127	18.58	13.01	180.00	90.00	S

Exterior Fenestration

	Construction	Glass Area [m2]	Frame Area [m2]	Divider Area [m2]	Area of One Opening [m2]	Area of Multiplied Openings [m2]	Glass U-Factor [W/m2-K]	Glass SHGC	Glass Visible Transmittance	Frame Conductance [W/m2-K]	Divider Conductance [W/m2-K]	Shade Control	Parent Surface	Azimuth [deg]	Tilt [deg]	Cardinal Direction
SUB SURFACE 3	U 0.17 SHGC 0.31 SIMPLE GLAZING WINDOW U-0.17 SHGC 0.31	5.57	0.00	0.00	5.57	5.57	1.128	0.313	0.342			No	FACE 224	180.00	90.00	S
SUB SURFACE 17	U 0.17 SHGC 0.31 SIMPLE GLAZING WINDOW U-0.17 SHGC 0.31	5.57	0.00	0.00	5.57	5.57	1.128	0.313	0.342			No	FACE 410	180.00	90.00	S

...

SUB SURFACE 91	U 0.17 SHGC 0.31 SIMPLE GLAZING WINDOW U-0.17 SHGC 0.31	4.18	0.00	0.00	4.18	4.18	1.128	0.313	0.342			No	FACE 341	0.00	90.00	N
SUB SURFACE 92	U 0.17 SHGC 0.31 SIMPLE GLAZING WINDOW U-0.17 SHGC 0.31	4.18	0.00	0.00	4.18	4.18	1.128	0.313	0.342			No	FACE 494	0.00	90.00	N
Total or Average						649.95	1.128	0.330	0.361							
North Total or Average						245.26	1.128	0.330	0.361							
Non-North Total or Average						404.69	1.128	0.329	0.361							

Lighting Summary Report

Report: Lighting Summary

[Table of Contents](#)

For: Entire Facility

Timestamp: 2019-12-11 09:58:50

Interior Lighting

	Zone	Lighting Power Density [W/m ²]	Area [m ²]	Total Power [W]	End Use Category	Schedule Name	Scheduled Hours/Week [hr]	Hours/Week > 1% [hr]	Full Load Hours/Week [hr]	Return	Conditioned (Y/N)	Consumption [GJ]
RES LIGHTING INTERIOR BUILDING UNIT 14 1_BDRM_1_2	1_BDRM_1_2	1.9699	55.74	109.81	res lighting interior Building Unit 14 1_Bdrm_1_2	RES LIGHTING INTERIOR	63.60	168.00	63.60	0.0000	Y	1.31
RES LIGHTING INTERIOR BUILDING UNIT 29 1_BDRM_1_3	1_BDRM_1_3	1.9699	55.74	109.81	res lighting interior Building Unit 29 1_Bdrm_1_3	RES LIGHTING INTERIOR	63.60	168.00	63.60	0.0000	Y	1.31
RES LIGHTING INTERIOR BUILDING UNIT 44 1_BDRM_1_4	1_BDRM_1_4	1.9699	55.74	109.81	res lighting interior Building Unit 44 1_Bdrm_1_4	RES LIGHTING INTERIOR	63.60	168.00	63.60	0.0000	Y	1.31

...

STAIRWELL_2_3 STAIR LIGHTS	STAIRWELL_2_3	4.3056	27.87	120.00	General	HOTELSMALL BLDG_LIGHT_STAIR_SCH	92.40	168.00	92.40	0.0000	N	2.08
STAIRWELL_2_4 STAIR LIGHTS	STAIRWELL_2_4	4.3056	27.87	120.00	General	HOTELSMALL BLDG_LIGHT_STAIR_SCH	92.40	168.00	92.40	0.0000	N	2.08
Interior Lighting Total		2.6135	4756.64	12431.28								161.09

LI10

Exterior Lighting

	Total Watts	Astronomical Clock/Schedule	Schedule Name	Scheduled Hours/Week [hr]	Hours/Week > 1% [hr]	Full Load Hours/Week [hr]	Consumption [GJ]
BUILDING FACADES	371.00	AstronomicalClock	-		45.96	45.96	3.20
DRIVE THROUGH WINDOWS	60.00	AstronomicalClock	-		83.62	72.32	0.81
ENTRY CANOPIES	288.00	AstronomicalClock	-		83.62	72.32	3.91
MAIN ENTRIES	168.00	AstronomicalClock	-		83.62	72.32	2.28
OTHER DOORS	548.09	AstronomicalClock	-		83.62	72.32	7.44
PARKING AREAS AND DRIVES	0.00	AstronomicalClock	-		0.00		0.00
Exterior Lighting Total	1435.09						17.65

LE03

LE06

LE06,
LE07

Equipment Summary Report

For: Entire Facility

Timestamp: 2019-12-12 10:45:44

Central Plant

WHVAC02,
WHVAC03

WHVAC13,
WHVAC14

WHVAC11

	Type	Nominal Capacity [W]	Nominal Efficiency [W/W]	IPLV in SI Units [W/W]	IPLV in IP Units [Btu/W-h]
90.1-2013 WATERCOOLED CENTRIFUGAL CHILLER 0 726TONS 0.6KW/TON	Chiller:Electric:EIR	2348257.78	6.28	7.18	24.51
CENTRIFUGAL FAN CYCLING OPEN COOLING TOWER 40.2 GPM/HP	CoolingTower:SingleSpeed	2177672.44			
HEAT PUMP LOOP CENTRAL TOWER 20.0 GPM/HP	CoolingTower:TwoSpeed	366327.66			
HEAT PUMP LOOP SUPPLEMENTAL BOILER 1486KBTU/HR 0.8 THERMAL EFF	Boiler:HotWater	450801.21	0.80		
BOILER 7072KBTU/HR 0.8 THERMAL EFF	Boiler:HotWater	2099755.97	0.80		

DX Cooling Coils

	DX Cooling Coil Type	Standard Rated Net Cooling Capacity [W]	Standard Rated Net COP [W/W]	EER [Btu/W-h]	SEER [Btu/W-h]	IEER [Btu/W-h]
CORE_ZN ZN PSZ-AC-1 1SPD DX HP CLG COIL 18KBTU/HR 14.0SEER		5016.1	3.29	11.22	11.74	10.96
PERIMETER_ZN_1 ZN PSZ-AC-2 1SPD DX HP CLG COIL 20KBTU/HR 14.0SEER		5341.5	3.29	11.22	11.74	10.96
PERIMETER_ZN_2 ZN PSZ-AC-3 1SPD DX HP CLG COIL 21KBTU/HR 14.0SEER		5811.6	3.29	11.22	11.74	10.96

AHVAC11

Fans

	Type	Total Efficiency [W/W]	Delta Pressure [pa]	Max Air Flow Rate [m3/s]	Rated Electric Power [W]	Rated Power Per Max Air Flow Rate [W-s/m3]	Motor Heat I/Fraction	Fan Efficiency	End Use Subcategory	Design Day Name for Fan Sizing Peak	Date/Time for Fan Sizing Peak
CAV_BAS FAN	Fan:ConstantVolume	0.60	1018.77	3.82	6522.74	1709.21	1.00	1.17	CAV System Fans	CHICAGO OHARE INTL AP ANN CLG .4% CONDNS DB=>MWB	7/21 08:20:00
DATACENTER_BASEMENT_ZN_6 ZN PSZ-AC DATA CENTER FAN	Fan:OnOff	0.61	1018.77	18.34	30551.69	1665.62	1.00	1.13	General	CHICAGO OHARE INTL AP ANN CLG .4% CONDNS DB=>MWB	7/21 07:10:00
DATACENTER_BOT_ZN_6 ZN PSZ-AC DATA CENTER FAN	Fan:OnOff	0.56	622.72	0.46	513.67	1120.51	1.00	1.65	General	CHICAGO OHARE INTL AP ANN CLG .4% CONDNS DB=>MWB	7/21 07:10:00
DATACENTER_MID_ZN_6 ZN PSZ-AC DATA CENTER FAN	Fan:OnOff	0.60	1018.77	4.00	6832.31	1709.21	1.00	1.17	General	CHICAGO OHARE INTL AP ANN CLG .4% CONDNS DB=>MWB	7/21 18:40:00
DATACENTER_TOP_ZN_6 ZN PSZ-AC DATA CENTER FAN	Fan:OnOff	0.56	622.72	0.41	456.16	1120.51	1.00	1.71	General	CHICAGO OHARE INTL AP ANN CLG .4% CONDNS DB=>MWB	7/21 18:40:00
VAV_BOT WITH REHEAT FAN	Fan:VariableVolume	0.61	1389.92	11.48	26088.91	2272.40	1.00	1.11	VAV System Fans	CHICAGO OHARE INTL AP ANN CLG .4% CONDNS DB=>MWB	7/21 08:00:00
VAV_MID WITH REHEAT FAN	Fan:VariableVolume	0.62	1389.92	99.86	223826.83	2241.44	1.00	1.09	VAV System Fans	CHICAGO OHARE INTL AP ANN CLG .4% CONDNS DB=>MWB	7/21 08:00:00
VAV_TOP WITH REHEAT FAN	Fan:VariableVolume	0.61	1389.92	10.23	23360.56	2284.54	1.00	1.11	VAV System Fans	CHICAGO OHARE INTL AP ANN CLG .4% CONDNS DB=>MWB	7/21 08:00:00

Pumps

WHVAC07

	Type	Control	Head [pa]	Water Flow [m3/s]	Electric Power [W]	Power Per Water Flow Rate [W-s/m3]	Motor Efficiency [W/W]	End Use Subcategory
CHILLED WATER LOOP SECONDARY PUMP	Pump:VariableSpeed	Intermittent	134508.01	0.099702	18368.92	184237.36	0.94	General
CHILLED WATER LOOP PRIMARY PUMP	Pump:ConstantSpeed	Intermittent	44836.00	0.099702	6249.84	62684.90	0.92	General
CONDENSER WATER LOOP CONSTANT PUMP	Pump:ConstantSpeed	Intermittent	148556.63	0.117234	23728.07	202398.74	0.94	General
HEAT PUMP LOOP PUMP	Pump:ConstantSpeed	Intermittent	179344.02	0.009960	2558.73	256903.04	0.90	General
HOT WATER LOOP PUMP	Pump:VariableSpeed	Intermittent	179344.02	0.045928	11428.63	248840.07	0.92	General
MAIN SERVICE WATER LOOP CIRCULATOR PUMP	Pump:ConstantSpeed	Intermittent	29891.00	0.000439	24.04	54745.42	0.70	General

WHVAC18

Service Water Heating

SWH05

	Type	Storage Volume [m3]	Input [W]	Thermal Efficiency [W/W]	Recovery Efficiency [W/W]	Energy Factor
RES WH BUILDING UNIT 1	WaterHeater:Mixed	0.11	11722.84	1.00	7.41	2.71
RES WH BUILDING UNIT 10	WaterHeater:Mixed	0.11	11722.84	1.00	7.41	2.71
RES WH BUILDING UNIT 11	WaterHeater:Mixed	0.11	11722.84	1.00	7.41	2.71

Report: Equipment Summary

[Table of Contents](#)

For: Entire Facility

Timestamp: 2019-12-11 09:58:50

Central Plant

WHVAC02

	Type	Nominal Capacity [W]	Nominal Efficiency [W/W]	IPLV in SI Units [W/W]	IPLV in IP Units [Btu/W-h]
ZE AEDG MULTIFAMILY CHILLER 0.70TONS 1.1KW/TON	Chiller:Electric:EIR	238949.25	3.29	4.41	15.05

Demand End Use Components Summary Report

Report: **Demand End Use Components Summary**

For: **Entire Facility**

Timestamp: **2019-12-11 09:58:50**

End Uses

	Electricity [W]	Natural Gas [W]	Propane [W]	District Cooling [W]	Steam [W]	Water [m3/s]
Time of Peak	04-AUG-13:00	-	-	-	-	01-JAN-05:45
Heating	0.00	0.00	0.00	0.00	0.00	0.00
Cooling	34082.97	L106 0.00	0.00	0.00	0.00	0.00
Interior Lighting	5991.94	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	193128.94	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	5740.74	0.00	0.00	0.00	0.00	0.00
Pumps	2621.74	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	1844.07	0.00	0.00	0.00	0.00	0.00
Water Systems	5306.82	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	248717.21	0.00	0.00	0.00	0.00	0.00

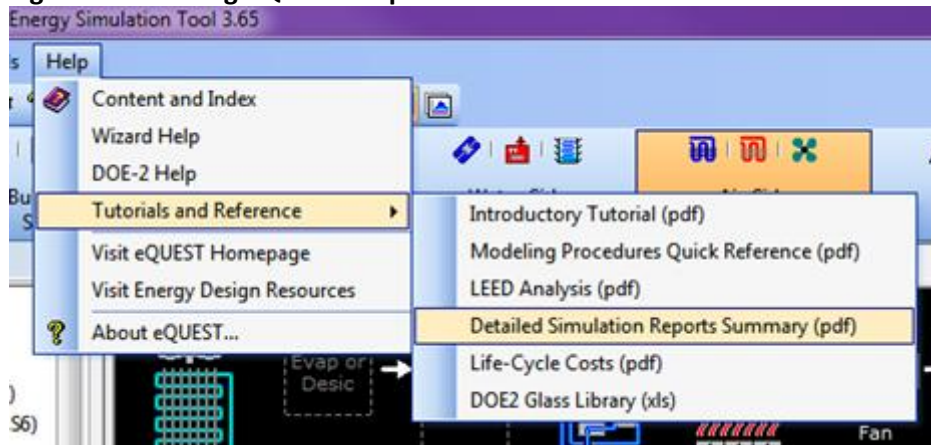
eQUEST

Resources

eQUEST Resources

1. eQUEST is free and can be downloaded from DOE2 website²⁵.
2. eQUEST download includes extensive reference documentation that can be accessed from eQUEST Help menu (Figure 3). The “Detailed Simulation Reports Summary” is extremely helpful for interpreting eQUEST input and output reports

Figure 3: Accessing eQUEST Help Menu

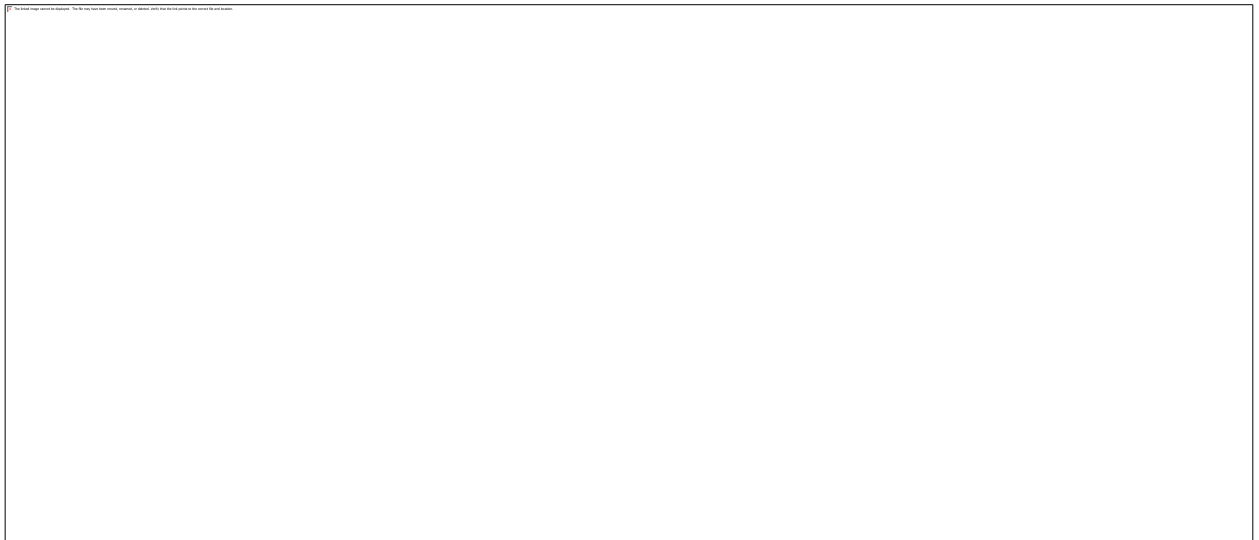


General

- a) Unless noted, the reports below are found in the *.sim files that must be included in the submittal. At least two *.sim files must be included – one for the baseline (budget) and another for the proposed design model.
- b) The *.sim reports are text files and may be opened in a text editor. SimViewer tool, which is part of the default eQUEST installation, is a better alternative as it simplifies navigation through the numerous available reports.
- c) There are separate reports for the baseline (budget) and proposed design model.
- d) Some output reports, such as BEPS, report energy use by the end use category. Systems and components that contributing toward each end use are described in the Detailed Simulation Reports Summary.pdf (available from the eQUEST’s Help ->Tutorial and References menu), Description of eQUEST/DOE-2.2 End Use Reporting Categories section.
- e) eQUEST can generate a handy HVAC Summary file (.csv) automatically with each simulation. To activate the feature, user must open the “eQUEST.INI” file and insert the line, “StoreResults_HVAC_Summary=1” as shown in the screen shot below. The eQUEST.INI file is found in the eQUEST Data directory, which can be located by selecting Tools -> View File Locations -> View eQUEST Data Directory from the main menu. Once you modify, and save the eQUEST.INI file, there will be a “YOUR_PROJECT_NAME – HVAC Summary.csv” file in the project

²⁵ <http://www.doe2.com/equest/>

folder after each simulation. The Air-Side System Summaries portion of the file is useful for automating or verifying fan power and EIR calculations for Baseline models.



Simulation Reports to Be Submitted

- a) <project name B>.SIM and <project name P>.SIM files with the detailed simulation reports for the baseline (budget) and proposed models;
- b) Model files including <project name P>.pd2, <project name P>.inp for the proposed design and <project name B>.pd2, <project name B>.inp for the baseline (budget) design. Projects that used eQUEST Parametric Runs must also include the appropriate *.prd file and the appropriate additional *.inp files.

Annotated Reports

BEPS Building Energy Performance

REPORT- BEPS Building Energy Performance													SG03: Weather	WEATHER FILE- NEW YORK LAGUARDI NY	
	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL		
EM1 ELECTRICITY															
MBTU	173.0	231.5	637.0	289.0	261.4	0.0	0.0	132.2	0.0	7.0	0.0	6.7	1737.7		
FM1 NATURAL-GAS															
MBTU	0.0	0.0	0.0	33.5	0.0	0.0	0.0	0.0	0.0	0.0	850.0	0.0	883.5		
MBTU	173.0	231.5	637.0	322.5	261.4	0.0	0.0	132.2	0.0	7.0	850.0	6.7	2621.2		
TOTAL SITE ENERGY				2621.21 MBTU		31.1 KBTU/SQFT-YR GROSS-AREA				31.1 KBTU/SQFT-YR NET-AREA					
TOTAL SOURCE ENERGY				6096.65 MBTU		72.3 KBTU/SQFT-YR GROSS-AREA				72.3 KBTU/SQFT-YR NET-AREA					
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE															5.30
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED															0.00
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE															5
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE															459
NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.															

BEPU Building Utility Performance

REPORT- BEPU Building Utility Performance WEATHER FILE- NEW YORK LAGUARDI NY

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY KWH	50677.	67833.	186640.	84677.	76588.	0.	0.	38722.	0.	2045.	0.	1971.	509152.
FM1 NATURAL-GAS THERM	0.	0.	0.	335.	0.	0.	0.	0.	0.	0.	8500.	0.	8835.

LI10, LI11: Annual LI kWh **PPO01, PPO03: Annual ML** **SG09** **SWH06, SWH07**

TOTAL ELECTRICITY	509152. KWH	6.035 KWH /SQFT-YR	GROSS-AREA	6.035 KWH /SQFT-YR	NET-AREA
TOTAL NATURAL-GAS	8835. THERM	0.105 THERM /SQFT-YR	GROSS-AREA	0.105 THERM /SQFT-YR	NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 5.30
 PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
 HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 5
 HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 459

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

LE04, LE06: Exterior lighting is often the only end use contributing to this category. However, it may include other direct loads on meter such as fans in un-enclosed parking.

LV-B Summary of Spaces

REPORT- LV-B Summary of Spaces WEATHER FILE- NEW YORK LAGUARDI NY

BE18: "Air-Change" infiltration modeling method adjusts user-entered infiltration to account for weather, as required by 90.1 Table G3.1 No5 (b). ACH column shows user-entered infiltration rate expressed as Air Changes per Hour (ACH).

SPACE	SPACE*FLOOR MULTIPLIER	SPACE TYPE	AEIM	LIGHTS (WATT / SQFT)	PEOPLE	EQUIP (WATT / SQFT)	INFILTRATION METHOD	ACH	AREA (SQFT)	VOLUME (CUFT)
Spaces on floor: EL1 Ground Flr										
MER	1.0	EXT	0.0	1.50	0.0	0.26	AIR-CHANGE	0.19	950.0	9500.0
Stairwell2	1.0	EXT	0.0	0.60	0.0	0.26	AIR-CHANGE	0.19	950.0	9500.0
Stairwell1	1.0	EXT	0.0	0.60	0.0	0.26	AIR-CHANGE	0.19	950.0	9500.0
Office	1.0	EXT	-90.0	1.10	1.7	0.50	AIR-CHANGE	0.19	950.0	9500.0
EL1 Core Spc (G.C5)	1.0	EXT	0.0	0.50	0.8	0.20	AIR-CHANGE	0.19	836.0	8360.0
EL1 WSW Perim Spc (G.WSW6)	1.0	EXT	90.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 West Perim Spc (G.W7)	1.0	EXT	180.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 West Perim Spc (G.W8)	1.0	EXT	180.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 WNW Perim Spc (G.WNW9)	1.0	EXT	180.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
Spaces on floor: EL1 Mid Flr										
EL1 ESE Perim Spc (M.ESE10)	8.0	EXT	0.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 East Perim Spc (M.E11)	8.0	EXT	0.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 East Perim Spc (M.E12)	8.0	EXT	0.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 ENE Perim Spc (M.ENE13)	8.0	EXT	-90.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 Core Spc (M.C14)	8.0	EXT	0.0	0.50	0.8	0.20	AIR-CHANGE	0.19	836.0	8360.0
EL1 WSW Perim Spc (M.WSW15)	8.0	EXT	90.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0

LI07: The total modeled wattage is the sum of products of Multiplier x LPD x Area. The same information is available in the CSV Space Loads report.

LS-C Building Peak Load Components

REPORT- LS-C Building Peak Load Components

DESIGN DAY WEATHER FILE- NEW YORK LAGUARDI NY

AHM06: HVAC Sizing Method; the tag is not included if sizing based on weather SG03: Name of weather

*** BUILDING ***

SG05: Modeled conditioned floor area, excluding plenum

AHVAC06: Modeled Design Day Conditions

FLOOR AREA	84360	SOFT	7837	M2			
VOLUME	843600	CUFT	23891	M3			

TIME	COOLING LOAD		HEATING LOAD	
	JUN 21	7PM	DEC 21	4PM
DRY-BULB TEMP	89 F	32 C	13 F	-11 C
WET-BULB TEMP	73 F	23 C	10 F	-12 C
TOT HORIZONTAL SOLAR RAD	90 BTU/H.SQFT	284 W/M2	12 BTU/H.SQFT	38 W/M2
WINDSPEED AT SPACE	4.4 KTS	2.2 M/S	8.7 KTS	4.5 M/S
CLOUD AMOUNT 0 (CLEAR)	-10	0	10	10

BE19: Contribution of envelope components toward internal heat gains and losses

	SENSIBLE (KBTU/H) (KW)		LATENT (KBTU/H) (KW)		SENSIBLE (KBTU/H) (KW)		
WALL CONDUCTION	101.726	29.806	0.000	0.000	-152.413	-44.657	
ROOF CONDUCTION	23.354	6.843	0.000	0.000	-27.812	-8.149	
WINDOW GLASS+FRM COND	95.701	28.040	0.000	0.000	-353.561	-103.593	
WINDOW GLASS SOLAR	403.215	118.142	0.000	0.000	44.332	12.989	
DOOR CONDUCTION	1.981	0.581	0.000	0.000	-2.656	-0.778	
INTERNAL SURFACE COND	0.000	0.000	0.000	0.000	0.000	0.000	
UNDERGROUND SURF COND	-3.249	-0.952	0.000	0.000	-4.904	-1.437	
OCCUPANTS TO SPACE	28.901	8.468	26.222	7.683	0.000	0.000	
LIGHT TO SPACE	106.279	31.140	0.000	0.000	22.281	6.528	
EQUIPMENT TO SPACE	66.882	19.597	10.958	3.211	54.438	15.950	
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000	
INFILTRATION	26.313	7.710	29.090	8.523	-157.877	-46.258	
TOTAL	851.103	249.373	66.271	19.417	-578.172	-169.404	
TOTAL / AREA	0.010	0.032	0.001	0.002	-0.007	-0.022	
TOTAL LOAD	917.374	KBTU/H	268.791	KW	-578.172	KBTU/H	-169.404
TOTAL LOAD / AREA	10.87	BTU/H.SQFT	34.296	W/M2	6.854	BTU/H.SQFT	21.615

Notes:

- Heat losses are shown as negative numbers; heat gains are shown as positive numbers. For example, in the report above, conduction heat losses through windows contribute 353.561 kBtu/H toward the heating load; while window solar heat gains reduce peak heating load by 44.332.

LV-D Details of Exterior Surfaces

REPORT- LV-D Details of Exterior Surfaces WEATHER FILE- NEW YORK LAGUARDI NY

BE1&2: U-values and areas of surfaces adjacent to the ambient conditions or ground for each modeled space
 BE3&4: U-value and areas of fenestration area for each modeled space

SURFACE	--- W I N D O W S ---		--- W A L L ---		-W A L L + W I N D O W S-		AZIMUTH
	U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	
EL1 North Wall (G.ENE4.E5) in space: Office	0.581	79.46	0.118	170.54	0.265	250.00	NORTH
EL1 North Wall (G.C5.E7) in space: EL1 Core Spc (G.C5)	0.531	16.50	0.063	38.50	0.203	55.00	NORTH
EL1 North Wall (G.WNW9.E14) in space: EL1 WNW Perim Spc (G.WNW9)	0.531	75.00	0.063	175.00	0.203	250.00	NORTH
EL1 North Slab (M.ENE13.S19) in space: EL1 ENE Perim Spc (M.ENE13)	0.000	0.00	0.481	100.00	0.481	100.00	NORTH
EL1 North Wall (M.ENE13.E19) in space: EL1 ENE Perim Spc (M.ENE13)	0.531	600.00	0.063	1400.00	0.203	2000.00	NORTH
EL1 North Slab (M.C14.S21) in space: EL1 Core Spc (M.C14)	0.000	0.00	0.481	22.00	0.481	22.00	NORTH

BE07, BE08, BE09, BE10 : The totals of Exterior Surfaces for the building by exposure are summarized at the end of the report

of Exterior Surfaces WEATHER FILE- NEW YORK LAGUARDI NY (CONTINUED)

	AVERAGE U-VALUE/WINDOWS (BTU/HR-SQFT-F)	AVERAGE U-VALUE/WALLS (BTU/HR-SQFT-F)	AVERAGE U-VALUE WALLS+WINDOWS (BTU/HR-SQFT-F)	WINDOW AREA (SQFT)	WALL AREA (SQFT)	WINDOW+WALL AREA (SQFT)
NORTH	0.533	0.090	0.218	1669.46	4130.29	5799.75
EAST	0.531	0.093	0.218	4535.20	11348.80	15884.00
SOUTH	0.533	0.090	0.218	1669.46	4130.29	5799.75
WEST	0.531	0.088	0.215	4535.20	11348.80	15884.00
ROOF	0.000	0.061	0.061	0.00	8436.00	8436.00
ALL WALLS	0.532	0.091	0.217	12409.33	30958.16	43367.50
WALLS+ROOFS	0.532	0.084	0.191	12409.33	39394.16	51803.50
UNDERGRND	0.000	0.038	0.038	0.00	8436.00	8436.00
BUILDING	0.532	0.076	0.170	12409.33	47830.16	60239.50

BE06, BE08: The model has the following area-weighted average U-values: roof U-0.061; exterior walls U-0.091; windows U-0.532

BE06, BE07: The model has the following total surface areas: 12,409 ft² windows; 51,804 ft² gross exterior wall including windows; 8,436 ft² roof area; 8,436 ft² below grade walls, floor and slab-on-grade.

BE14: Modeled WWR is 12409/43368=28.6%

Notes:

- Projects may have exaggerated area of roof or exposed and below grade floors due to common modeling mistake, when exposed horizontal surfaces are sandwiched between the floor that were modeled as different Building Shells when the project was created in the Wizard. If the proposed roof is better insulated than the baseline (budget) and its area is doubled, it's contribution toward the trade-offs will also be exaggerated by the factor of 2.

LS-F Building Monthly Load Components

REPORT- LS-F Building Monthly Load Component		WEATHER FILE- NEW YORK LAGUARDI NY										
(UNITS=MBTU)	WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
HEATING	-62.713	-12.466	0.000	-4.610	-58.153	-147.918	40.086	15.966	24.596	35.586	0.000	-169.646
JAN SEN CL	-4.764	-0.348	0.000	-0.407	-6.477	-14.477	21.926	1.877	8.703	4.863	0.000	10.893
LAT CL								1.611		0.769	0.000	2.389
HEATING			0.000					513	14.398	23.335	32.155	-174.460
FEB SEN CL			0.000					779	1.528	6.804	4.379	10.589
LAT CL								1.288		0.700	0.000	1.989
HEATING	-37.564										0.000	-85.920
MAR SEN CL	-8.103										0.000	38.275
LAT CL					0.090			4.005		2.166	0.000	6.461
HEATING												27.867
APR SEN CL												
LAT CL												
HEATING	-56.551	-11.409	0.000	-3.277	-53.854							
DEC SEN CL	-4.764	-0.314	0.000	-0.364	-6.702	-1.536	22.015	1.860	9.607	5.273	0.000	12.174
LAT CL					0.079			1.775		0.831	0.000	2.585
HEATING	-279.618	-60.462	0.000	-23.194	-269.949	-682.058	214.186	87.218	118.120	186.907	0.000	-708.850
TOT SEN CL	56.892	27.393	0.000	-12.872	-44.648	-131.624	922.821	120.791	277.033	291.908	0.000	1507.694
LAT CL					101.883			103.049		49.252	0.000	254.185

Notes:

1. Negative numbers indicate heat losses; positive numbers indicate heat gains
2. Jan – Dec values provided in the report indicate that the full annual simulation was completed for 8,760 hours/year.

SS-D Building HVAC Load Summary

REPORT- SS-D Building HVAC Load Summary							WEATHER FILE- NEW YORK LAGUARDI NY							
C O O L I N G							H E A T I N G						E L E C	
MONTH	COOLING ENERGY (MBTU)	TIME OF DAY	MAX BULB TEMP	DRY- BULB TEMP	WET- BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF DAY	MAX BULB TEMP	DRY- BULB TEMP	WET- BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC- TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	28.56705	11 8	25.F	20.F		257.824	-104.594	25 7	19.F	16.F		-720.587	36969.	129.831
FEB	29.97058	6 8	7.F	5.F		254.431	-103.721	6 8	7.F	5.F		-740.835	35847.	131.865
MAR	25.74771	15 16	69.F	55.F		484.179	-61.423	1 8	37.F	35.F		-604.330	39845.	150.022
APR	39.53304	27 16	78.F	65.F		712.008	-22.636	5 8	46.F	42.F		-330.268	39414.	170.084
MAY	83.86207	25 15	85.F	69.F		858.740	-7.373	20 8	48.F	45.F		-200.396	42753.	188.845
JUN	218.80797	18 17	91.F	77.F		1045.090	-0.906	1 22	60.F	59.F		-70.541	56485.	216.502
JUL	306.24469	8 14	95.F	80.F		1222.826	-0.133	14 22	72.F	70.F		-14.996	65341.	240.500
AUG	280.24261	24 14	91.F	75.F		1074.308	-0.200	19 22	68.F	56.F		-21.934	63048.	219.270
SEP	173.06245	10 14	82.F	74.F		994.159	-2.927	30 22	52.F	48.F		-154.073	50939.	199.313
OCT	80.79825	5 16	79.F	64.F		815.780	-12.397	18 8	44.F	37.F		-270.316	41904.	179.440
NOV	31.42019	4 16	70.F	57.F		612.884	-38.495	27 8	27.F	24.F		-546.697	36531.	158.274
DEC	27.46401	16 12	43.F	37.F		285.190	-87.754	6 8	28.F	27.F		-691.092	38356.	137.048
TOTAL	1325.722						-442.559						547429.	
MAX						1222.826						-740.835		240.500
	MAXIMUM DAILY INTEGRATED COOLING LOAD (DES DAY)						0.000 (KBTU)							
	MAXIMUM DAILY INTEGRATED COOLING LOAD (WTH FILE)						0.000 (KBTU)							

AHVAC31: Projects with significant simultaneous heating and cooling have high cooling energy use during winter months and high heating energy use during summer months.

SS-E Building HVAC Load Hours

REPORT SS-E Building HVAC Load Hours

WEATHER FILE- NEW YORK LAGUARDI NY

NUMBER OF HOURS											--COINCIDENT LOADS--	
MONTH	HOURS COOLING LOAD	HOURS HEATING LOAD	HOURS COINCIDENT COOL-HEAT LOAD	HOURS FLOATING	HOURS HEATING AVAIL.	HOURS COOLING AVAIL.	HOURS FANS ON	HOURS FANS CYCLE ON	HOURS NIGHT VENTING	HOURS FLOATING WHEN FANS ON	HEATING LOAD AT COOLING PEAK (KBTU/HR)	ELECTRIC LOAD AT COOLING PEAK (KW)
JAN	505	588	504	155	744	744	593	277	0	4	-709.923	82.295
FEB	491	574	486	93	672	672	579	273	0	0	-740.834	66.361
MAR	278	460	272	278	744	744	495	133	0	29	0.000	147.579
APR	187	298	96	331	720	720	440	92	0	51	0.000	167.165
MAY	312	154	65	343	744	744	435	105	0	34	0.000	187.281
JUN	433	58	58	287	720	720	435	87	0	2	0.000	212.929
JUL	477	20	20	267	744	744	477	133	0	0	0.000	240.500
AUG	462	26	26	282	744	744	462	114	0	0	0.000	219.270
SEP	387	113	82	302	720	720	423	89	0	5	0.000	199.313
OCT	264	237	118	361	744	744	405	75	0	22	0.000	178.396
NOV	193	340	155	342	720	720	396	76	0	18	0.000	155.707
DEC	438	543	430	193	744	744	553	219	0	2	-64.518	137.048
ANNUAL	4427	3411	2312	3234	8760	8760	5693	1673	0	167		

AHVAC31: Large hours of simultaneous heating/cooling, especially in summer, may indicate overcooling and excessive reheat.

AHVAC31: Hours when at least one air-side system is running to provide HVAC during occupied hours plus night cycling to maintain setback temperature.

SS-H: System Utility Energy Use

REPORT- SS-H System Utility Energy Use for RTU1 (PVAV) (G)

WEATHER FILE- NEW YORK LAGUARDI NY

MONTH	- FAN ELEC - -		- FUEL HEAT - -		- FUEL COOL - -		- ELEC HEAT - -		- ELEC COOL - -	
	FAN ENERGY (KWH)	MAXIMUM FAN LOAD (KW)	GAS OIL ENERGY (MBTU)	MAXIMUM GAS OIL LOAD (KBTU/HR)	GAS OIL ENERGY (MBTU)	MAXIMUM GAS OIL LOAD (KBTU/HR)	ELECTRIC ENERGY (KWH)	MAXIMUM ELECTRIC LOAD (KW)	ELECTRIC ENERGY (KWH)	MAXIMUM ELECTRIC LOAD (KW)
JAN	1093.	2.744	0.000	0.000	0.000	0.000	0.	0.000	1178.	10.371
FEB	1073.	2.809	0.000	0.000	0.000	0.000	0.	0.000	1187.	10.554
MAR	936.	2.933	0.000	0.000	0.000	0.000	0.	0.000	982.	13.521
APR	891.	4.052	0.000	0.000	0.000	0.000	0.	0.000	1256.	18.646
MAY	907.	4.261	0.000	0.000	0.000	0.000	0.	0.000	2604.	23.345
JUN	1002.	4.284	0.000	0.000	0.000	0.000	0.	0.000	5979.	30.978
JUL	1143.	5.038	0.000	0.000	0.000	0.000	0.	0.000	8506.	37.213
AUG	1164.	4.739	0.000	0.000	0.000	0.000	0.	0.000	7713.	31.434
SEP	983.	4.446	0.000	0.000	0.000	0.000	0.	0.000	4859.	26.681
OCT	913.	4.400	0.000	0.000	0.000	0.000	0.	0.000	2469.	21.777
NOV	789.	3.475	0.000	0.000	0.000	0.000	0.	0.000	1075.	15.813
DEC	1031.	2.811	0.000	0.000	0.000	0.000	0.	0.000	1130.	11.182
TOTAL	11925.		0.000		0.000		0.		38938.	
MAX		5.038				0.000		0.000		37.213

AHVAC19: Fan Peak Demand

SS-L Fan Electric Energy Use

REPORT- SS-L Fan Electric Energy Use for					RTU1 (PVAV) (G)											WEATHER FILE- NEW YORK LAGUARDI NY
MONTH	FAN ELEC DURING HEATING (KWH)	FAN ELEC DURING COOLING (KWH)	FAN ELEC DURING HEAT & COOL (KWH)	FAN ELEC DURING FLOATING (KWH)	Number of hours within each PART LOAD range											TOTAL RUN HOURS
					00-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100+	
JAN	1084.152	827.287	825.504	7.130	0	0	0	574	19	0	0	0	0	0	0	593
FEB	1058.964	812.834	803.922	5.134	0	0	0	556	22	0	0	0	0	0	0	578
MAR	855.060	507.156	489.272	63.429	0	0	0	454	41	0	0	0	0	0	0	495
APR	539.980	396.757	177.030	131.024	0	0	0	344	87	7	0	0	0	0	0	438
MAY	283.607	662.653	123.588	84.816	0	0	0	329	88	13	0	0	0	0	0	430
JUN	103.750	997.733	103.750	4.412	0	0	0	260	108	60	0	0	0	0	0	428
JUL	36.433	1142.660	36.433	0.000	0	0	0	267	101	90	2	0	0	0	0	460
AUG	47.278	1164.255	47.278	0.000	0	0	0	245	86	121	0	0	0	0	0	452
SEP	212.776	904.918	146.316	11.186	0	0	0	277	80	62	0	0	0	0	0	419
OCT	473.365	613.012	226.470	53.320	0	0	0	260	105	36	0	0	0	0	0	401
NOV	641.018	380.708	266.163	33.020	0	0	0	321	72	2	0	0	0	0	0	395
DEC	1012.801	723.145	710.372	5.347	0	0	0	521	32	0	0	0	0	0	0	553
ANNUAL	6349.336	9133.087	3956.077	398.819	0	0	0	4408	841	391	2	0	0	0	0	5642

BREAKDOWN OF ANNUAL FAN POWER USAGE

FAN TYPE	ANNUAL FAN ELEC (KWH)
SUPPLY	8347.
RETURN	3577.

AHVAC18: Fan in the example has minimum flow of 30% - 40% and never operates above 60% - 70% of the design CFM.

VAV system fans and constant volume systems with cycling fans will have hours with part load <100%.

SS-O Space Temperature Summary

REPORT- SS-O Space Temperature Summary for		EL2 North Perim Zn (T.N87)											WEATHER FILE- New York CityNY TMY2												
HOUR	TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY												TOTAL												
	1AM	2	3	4	5	6	7	8	9	10	11	12		1PM	2	3	4	5	6	7	8	9	10	11	12
ABOVE 85	3	3	3	2	1	2	2	2	2	4	4	6	6	6	6	5	5	5	5	5	4	4	4	3	92
80-85	41	39	35	31	33	34	36	37	46	48	52	53	58	62	64	63	61	59	56	53	52	49	47	42	1151
75-80	65	65	67	68	68	66	66	68	62	59	59	57	56	55	53	53	53	55	58	59	60	62	62	66	1462
70-75	228	223	217	210	203	199	200	255	252	252	249	248	245	242	242	244	246	246	246	248	249	249	251	236	5680
65-70	28	35	43	54	60	64	61	3	3	2	1	1	0	0	0	0	0	0	0	0	0	1	1	18	375
60-65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SG08: The zone is significantly under-cooled, with 80F+ space temperatures for over a thousand hours (see TOTAL column). Temperatures will not be listed for hours when zone is unoccupied and HVAC system is off.

This is a zone-level report. Reports for all modeled zones are included in the *.SIM file.

SS-P – Cooling (Heating) Performance Summary

REPORT- SS-P Cooling Performance Summary of EL1 Syst (PSS) (G.S1) WEATHER FILE- NEW YORK LAGUARDI NY

UNIT TYPE is PSS COOLING-CAPACITY = 45.891 (KBTU/HR) COOLING-EIR = 0.316 (BTU/BTU) SUPPLY-FLOW = 1236. (CFM)

MONTH	SUM	UNIT LOAD	ENERGY USE	COMPRESSOR	FAN ENERGY	Number of hours within each PART LOAD range										TOTAL		
		(KBTU/HR)	(KW)	(KW)	(KW)	80	90	100	+							RUN		
JAN	SUM	0.053	41.5	0.7	17.475	0	0	0	0	0	0	0	0	0	0	0	0	18
	PEAK	6.258	0.7	1.062	1.062	0	0	0	0	0	0	0	0	0	0	0	0	18
	DAY/HR	29/16	29/16	29/19	29/19	0	0	0	0	0	0	0	0	0	0	0	0	18
	SUM	0.057	32.7	0.7	17.482	0	0	0	0	0	0	0	0	0	0	0	0	31
NOV	SUM	1.602	152.186	38.735	254.909	0	80	45	2	0	0	0	0	0	0	0	0	163
	PEAK	27.695	2.091	2.091	1.062	0	0	0	0	0	0	0	0	0	0	0	0	163
	DAY/HR	4/15	4/15	4/15	30/19	0	0	0	0	0	0	0	0	0	0	0	0	163
DEC	SUM	0.240	56.740	24.490	274.028	0	39	8	0	0	0	0	0	0	0	0	0	47
	PEAK	13.886	1.102	1.102	1.062	0	0	0	0	0	0	0	0	0	0	0	0	47
	DAY/HR	29/15	29/15	29/15	30/19	0	0	0	0	0	0	0	0	0	0	0	0	47
YR	SUM	35.454	3178.511	318.211	3249.989	0	409	278	256	264	331	224	112	0	0	0	0	1904
	PEAK	38.817	3.780	3.780	1.062	0	0	0	0	0	0	0	0	0	0	0	0	1904
	MON/DAY	7/ 6	7/ 6	7/ 6	12/30	0	0	0	0	0	0	0	0	0	0	0	0	1904

AHVAC06: Oversizing = 45.9/38.8=1.18

AHVAC11: Rated Cooling Efficiency COP_{nfcool}=1/EIR

AHVAC18: Design flow rate

AHVAC12: Average realized DX efficiency excluding system supply & return fans: $COP_{nfcooling,avg} = 35.454 * 1000 / 3.412 / 3178.511 = 3.269$
 $EIR_{nfcooling,avg} = 1 / COP_{nfcooling,avg} = 0.305$

AHVAC18, AHVAC19: Peak fan demand for all fans of this system is 1.062 kW
 AHM12: Fan system energy 3250 kWh/yr;
 EFLH ~ 3250/1.1 = 2955

AHVAC06: Maximum cooling load is 80%-90% cooling capacity; cooling coil is oversized by 10%-20%

Notes:

1. An SS-P report is available for each air-handler.
2. An instance of SS-P report is also generated for each system with DX (heat pump) heating.

SS-R Zone Performance Summary

REPORT- SS-R Zone Performance Summary for EL1 Sys1 (PM2S) (B.C4)					WEATHER FILE- New York CityNY TMY2												
ZONE	ZONE OF MAXIMUM HTG DMND (HOURS)	ZONE OF MAXIMUM CLG DMND (HOURS)	ZONE UNDER HEATED (HOURS)	ZONE UNDER COOLED (HOURS)	Number of hours within each PART LOAD range											TOTAL RUN HOURS	
	00	10	20	30	40	50	60	70	80	90	100	+					
EL1 Core Zn (B.C4)	0	0	181	0	0	0	0	0	0	0	0	0	0	0	0	4631	4631
TOTAL	0	0	181	0													

SG08: Zones with UMLH are reported as underheated or undercooled. Zone floor area may be established based on the Space Loads Report (CSV).

SV-A System Design Parameters

REPORT- SV-A System Design Parameters for RTU1 (PVAV) (G)											WEATHER FILE- NEW YORK LAGUARDI NY				
SYSTEM TYPE	ALTITUDE FACTOR	FLOOR AREA (SQFT)	MAX PEOPLE	OUTSIDE AIR RATIO	COOLING CAPACITY (KBTU/HR)	SENSIBLE (SHR)	HEATING CAPACITY (KBTU/HR)	COOLING EIR (BTU/BTU)	HEATING EIR (BTU/BTU)	HEAT PUMP SUPP-HEAT (KBTU/HR)					
PVAVS	1.010	35735.7	89.	0.087	635.871	0.629	0.000	0.313	0.000	0.000					
FAN TYPE	CAPACITY (CFM)	DIVERSITY FACTOR (FRAC)	POWER DEMAND (KW)	FAN DELTA-T (F)	STATIC PRESSURE (IN-WATER)	TOTAL EFF (FRAC)	MECH EFF (FRAC)	FAN PLACEMENT	FAN CONTROL	MAX FAN RATIO (FRAC)	MIN FAN RATIO (FRAC)				
SUPPLY	17499.	1.00	11.764	2.08	0.0	0.00	0.00	DRAW-THRU	BY USER	1.10	0.30				
RETURN	17499.	1.00	5.042	0.89	0.0	0.00	0.00	RETURN	BY USER	1.10	0.30				
ZONE NAME	SUPPLY FLOW (CFM)	EXHAUST FLOW (CFM)	FAN (KW)	MINIMUM FLOW (FRAC)	OUTSIDE AIR FLOW (CFM)	COOLING CAPACITY (KBTU/HR)	SENSIB (FRA	EXTRACTION HEATING ADDITION							
EL1 South Perim Zn (G.S1)	4090.	0.	0.000	0.300	189.	0.00	0.	0.00	56.34	-44.02	-14.09	1.			
EL1 East Perim Zn (G.E2)	2566.	0.	0.000	0.300	120.	0.00	0.	0.00	94.49	-73.82	-23.62	1.			
EL1 North Perim Zn (G.N3)	3791.	0.	0.000	0.300	189.	0.00	0.	0.00							
EL1 West Perim Zn (G.W4)	2635.	0.	0.000	0.300	120.	0.00	0.	0.00							
EL1 Core Zn (G.C5)	4418.	0.	0.000	0.300	910.	0.00	0.	0.00							
EL1 Pl Zn (G.6)	0.	0.	0.000	0.000	0.	0.00	0.00	0.00	0.00	0.00	0.00	1.			

AHVAC06: System type

AHVAC06: System name

AHM4: cooling capacity

AHVAC06: unitary heating capacity

AHVAC11: DX equipment efficiency at AHRI rated conditions excluding system fan power; COP=1/EIR

AHVAC18: design flow

AHVAC18: Minimum fraction of design flow; minimum flow is 17,499*0.3=5,250 CFM

AHVAC02: Thermal blocks served by the system

AHVAC18: Power of system supply and return fans
 $kw=BHP*746/Effy$
 BHP= specified fan brake HP
 Effy = specified efficiency of fan motor

AHVAC26: Design ventilation (OA) flow rate; system design OA CFM is sum of zone OA CFM (Note 3).

Notes:

1. SV-A report is available for each modeled air handler.
2. Refer to eQUEST "Detailed Simulation Reports Summary" p.84 of the pdf for detailed description of other values shown in the SV-A report.
3. Design OA flow in the simulation may be different, based on the entered ventilation schedule.

ES-D Energy Cost Summary

REPORT- ES-D Energy Cost Summary			WEATHER FILE- NEW YORK LAGUARDI NY			
UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE (\$)	VIRTUAL RATE (\$/UNIT)	RATE USED ALL YEAR?
Custom Elec Rate	ELECTRICITY	EM1	509152. KWH	76373.	0.1500	YES
Custom Gas Rate	NATURAL-GAS	FM1	8835. THERM	8835.	1.0000	YES
				85208.		
ENERGY COST/GROSS BLDG AREA:				1.01		
ENERGY COST/NET BLDG AREA:				1.01		

UR03: Virtual Rate is the ratio of the Total Charge (\$) to the Metered Energy [units/yr]

PS-E Energy End Use Summary for all Electric Meters

REPORT- PS-E Energy End-Use Summary for all Electric Meters													WEATHER FILE- NEW YORK LAGUARDI NY	
	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL	
JAN														
KWH	4280.	5761.	15852.	23471.	0.	0.	0.	4613.	0.	417.	0.	167.	54561.	
MAX KW	6.572	39.710	26.181	85.473	0.046	0.000	0.000	11.163	0.000	45.419	0.000	0.450	195.200	
DAY/HR	1/8	1/19	1/7	22/10	28/16	0/0	0/0	8/8	0/0	22/8	0/0	1/1	22/8	
PEAK ENDUSE	6.572	23.826	26.181	82.039	0.000	0.000	0.000	11.163	0.000	45.419	0.000	0.000		
PEAK PCT	3.4	12.2	13.4	42.0	0.0	0.0	0.0	5.7	0.0	23.3	0.0	0.0		
FEB														
KWH	3886.	5204.	14318.	25338.	0.	0.	0.	4556.	0.	1604.	0.	151.	55057.	
MAX KW	6.572	39.710	26.181	90.242	0.068	0.000	0.000	11.163	0.000	96.859	0.000	0.450	230.452	
DAY/HR	1/8	1/19	1/7	22/10	17/16	0/0	0/0	5/21	0/0	6/5	0/0	1/1	6/7	
PEAK ENDUSE	6.572	23.826	26.181	82.039	0.000	0.000	0.000	11.163	0.000	89.965	0.000	0.000		
PEAK PCT	3.4	12.2	13.4	42.0	0.0	0.0	0.0	5.7	0.0	23.3	0.0	0.0		
DEC														
KWH	4302.	5761.	15852.	19164.	0.	0.	0.	4111.	0.	417.	0.	167.	54561.	
MAX KW	6.572	39.710	26.181	72.279	0.155	0.000	0.000	11.159	0.000	45.419	0.000	0.450	195.200	
DAY/HR	1/8	1/19	1/7	3/8	28/16	0/0	0/0	7/8	0/0	22/8	0/0	1/1	22/8	
PEAK ENDUSE	6.342	39.710	26.181	61.627	0.000	0.000	0.000	11.040	0.000	0.005	0.000	0.350		
PEAK PCT	4.4	27.3	18.0	42.4	0.0	0.0	0.0	7.6	0.0	0.0	0.0	0.3		
YTD														
KWH	50672.	67833.	186640.	84677.	76588.	0.	0.	38722.	0.	2045.	0.	1971.	509152.	
MAX KW	6.572	39.710	26.181	90.242	87.776	0.000	0.000	11.163	0.000	96.859	0.000	0.450	230.452	
MON/DY	1/4	1/1	1/1	2/7	7/6	0/0	0/0	1/8	0/0	2/6	0/0	1/1	2/6	
PEAK ENDUSE	5.763	23.826	26.181	73.554	0.000	0.000	0.000	11.163	0.000	89.965	0.000	0.000		
PEAK PCT	2.5	10.3	11.4	31.9	0.0	0.0	0.0	4.8	0.0	39.0	0.0	0.0		

LI06: Non-coincident annual lighting peak demand is the MAX KW for Lights + Task Lights.

AHVAC04: Heat Pump supplemental heat (electric resistance)

LE03: Exterior lighting non-coincident peak demand (may include other exterior loads on some projects).

PS-C Equipment Loads and Energy Use

REPORT- PS-C Equipment Loads and Energy Use				WEATHER FILE- NEW YORK LAGUARDI NY															
		COOL LOAD	HEAT LOAD	ELEC USE	FUEL USE	Number of hours within each PART LOAD range												TOTAL	
MON	PEAK	(MBTU)	(MBTU)	(KWH)	(MBTU)	00	10	20	30	40	50	60	70	80	90	100	+	RUN	
		(KBTU/HR)	(KBTU/HR)	(KW)	(KBTU/HR)	HOURS												HOURS	
Boiler 1																			
SUM			-375.2	0.0	556.2	LOAD	985	623	384	308	222	135	139	96	54	39	31	3016	
PEAK			-568.9	0.0	689.7	ELEC	0	0	0	0	0	0	0	0	0	0	0	0	
MON/DAY			12/13	0/ 0	12/13	FUEL	495	848	476	344	247	199	130	125	73	48	31	3016	
Boiler 2																			
SUM			-63.5	0.0	89.6	LOAD	87	78	37	24	24	26	47	17	6	5	19	370	
PEAK			-570.5	0.0	691.3	ELEC	0	0	0	0	0	0	0	0	0	0	0	0	
MON/DAY			1/12	0/ 0	1/12	FUEL	40	93	51	30	23	27	29	39	12	7	19	370	
DHW Plant 1 Wtr Htr (1)																			
SUM			-38.7	13107.2		LOAD	1271	826	918	535	554	664	500	310	168	163	23	5932	
PEAK			-18.4	5.4		ELEC	3156	1110	680	826	462	569	561	439	250	101	106	8760	
MON/DAY			3/ 1	2/ 1															
HW Pump																			
SUM				1113.5		FLOW	2212	774	293	101	30	1	0	0	0	0	0	3411	
PEAK				0.5		RPM	0	0	0	0	0	0	0	0	0	0	0	3411	
MON/DAY				1/ 2		ELEC	0	0	0	0	2754	519	125	13	0	0	0	3411	

WHVAC03, WHVAC14: The average realized plant (boiler or chiller) efficiency is the ratio of Heat Load to Fuel Use. In the example, the average efficiency of the Hot Water Plant (Boiler 1 and Boiler 2 combined) is 68%.

$$\text{Heat Load} = 375.2 + 63.5 = 438.7 \text{ MMBtu}$$

$$\text{Fuel Use} = 556.2 + 89.6 = 645.8$$

$$\text{Effy}_{\text{avg}} = 438.7 / 645.8 = 68\%$$

PV-A Plant Design Parameters

REPORT- PV-A Plant Design Parameters

WEATHER FILE- NEW YORK LAGUARDI NY

*** CIRCULATION LOOPS ***

WHVAC08, WHVAC19: flow (GPM), total head

HEATING CAPACITY (MBTU/HR)	COOLING CAPACITY (MBTU/HR)	LOOP FLOW (GAL/MIN)	TOTAL HEAD (FT)	SUPPLY UA PRODUCT (BTU/HR-F)	SUPPLY LOSS DT (F)	RETURN UA PRODUCT (BTU/HR-F)	RETURN LOSS DT (F)	LOOP VOLUME (GAL)	FLUID HEAT CAPACITY (BTU/LB-F)
-0.018	0.000	0.4	0.0	0.0	0.00	0.0	0.00	0.6	1.00
-0.661	0.000	26.5	50.0	0.0	0.00	0.0	0.00	39.7	1.00
0.000	0.649	128.4	51.6	0.0	0.00	0.0	0.00	192.6	1.00

WHVAC07, WHVAC18: Pump flow GPM, power [kW] and control. HW Pump in the example is 0.499/26.5=19

*** PUMPS ***

ATTACHED TO	FLOW (GAL/MIN)	HEAD (FT)	HEAD SETPOINT (FT)	CAPACITY CONTROL	POWER (KW)	MECHANICAL EFFICIENCY (FRAC)	MOTOR EFFICIENCY (FRAC)
HW Pump	1 PUMP (s)						
HW Loop	26.5	60.0	0.0	ONE-SPEED	0.499	0.600	1.000
PRIMARY LOOP							
CHW P1	1 PUMP (s)						
CH-1	141.3	56.8	37.6	VAR-SPEED	2.242	0.770	0.875
EVAPORATOR	PRIMARY						

WHVAC13: Boiler name, type, capacity in MMBtu/hr (shown as negative value), fuel efficiency Et = 1/HIR

*** PRIMARY EQUIPMENT ***

EQUIPMENT TYPE	ATTACHED TO	RATED CAPACITY (MBTU/HR)	FLOW (GAL/MIN)	RATED EIR (FRAC)	RATED HIR (FRAC)	AUXILIARY (KW)
Boiler 1						
HW-BOILER	HW Loop	-0.330	13.2	0.000	1.250	0.000
Boiler 2						
HW-BOILER	HW Loop	-0.330	13.2	0.000	1.250	0.000
CH-1						
ELEC-SCREW	CHW Loop A	0.655	129.6	0.354	0.000	0.000

*** DW-HEATERS ***

EQUIPMENT TYPE	ATTACHED TO	CAPACITY (MBTU/HR)	FLOW (GAL/MIN)	EIR (FRAC)	HIR (FRAC)	AUXILIARY (KW)	TANK (GAL)	TANK UA (BTU/HR-F)
DHW Plant 1 Wtr Htr (1)								
ELEC DW-HEATER	DHW Plant 1 Loop (1)	-0.018	0.4	1.000	0.000	0.000	100.0	10.00

WHVAC02: Chiller type, capacity in MMBtu/hr and rated efficiency. COP=1/EIR (COP in the example: 1/0.354=2.82)
12*0.354/3.412=1.245 kW/ton

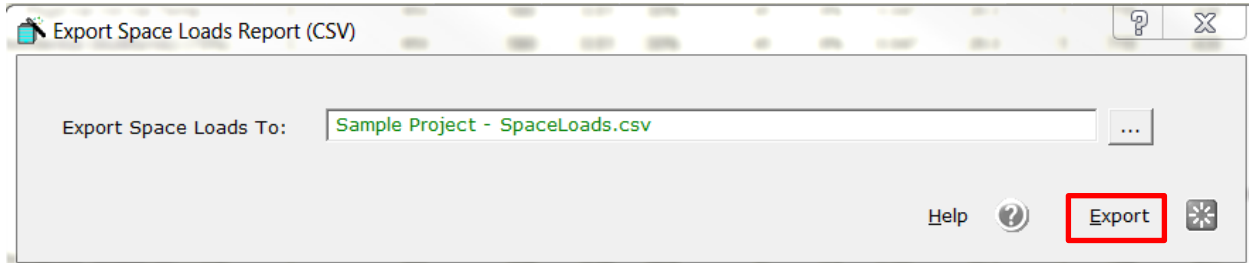
SWH05: 1/EIR = electric heater efficiency
1/HIR = non-electric heater efficiency

SWH05: Storage tank volume, surface area and insulation. The inputs affect stand-by losses.

SWH05: Modeled SWH capacity. Always shown as a negative number in the units of MMBtu/hr. The capacity of heater in the example is 265 MBH

Space Loads Report (CSV)

To generate the report, select File -> Export File -> Space Loads Report (CSV) from the main eQUEST interface and then click Export button.



	A	B	C	D	E	F	G	H	I	
4	eQUEST 3.65.7173									
5	Space/Zone Internal Loads Report									Occ
6										
7	Component Names:				Basic Specifications:			Multipliers:		Occ
8	Space	Thermal Zone	Parent Floor	HVAC System	Zone Type	Activity Description	Area	Space	Floor	pec
9										
10	MER	EL1 ESE Perim Zn (G.ESE1)	MER	Unit Heater	Conditioned	Residential (Multifamily)	950	1	1	
11	Stairw			Heater	Conditioned	Residential (Multifamily)	950	1	1	
12	Stairw			Heater	Conditioned	Residential (Multifamily)	950	1	1	
13	Office			er VRF	Conditioned	Residential (Multifamily)	950	1	1	
14	EL1 CC			Corridor VRF 1	Conditioned	Corridor	836	1	1	
15	EL1 W				Conditioned	Residential (Multifamily)	950	1	1	
16	EL1 W				Conditioned	Residential (Multifamily)	950	1	1	
17	EL1 W				Conditioned	Residential (Multifamily)	950	1	1	
18	EL1 W				Conditioned	Residential (Multifamily)	950	1	1	
19	EL1 ES				Conditioned	Residential (Multifamily)	950	1	8	
20	EL1 East Perim Spc (M.E11)	EL1 East Perim Zn (M.E11)	EL1 East Perim Spc (M.E11 VRF10)		Conditioned	Residential (Multifamily)	950	1	8	
21	EL1 East Perim Spc (M.E12)	EL1 East Perim Zn (M.E12)	EL1 East Perim Spc (M.E12 VRF11)		Conditioned	Residential (Multifamily)	950	1	8	
22	EL1 ENE Perim Spc (M.ENE13)	EL1 ENE Perim Zn (M.ENE13)	EL1 ENE Perim Spc (M.ENE VRF12)		Conditioned	Residential (Multifamily)	950	1	8	
23	EL1 Core Spc (M.C14)	EL1 Core Zn (M.C14)	EL1 Core Spc (M.C14)	Corridor VRF 2	Conditioned	Corridor	836	1	8	

SG05: Zone Types may be listed as Conditioned, Unconditioned, or Plenum. For each type, the total floor area is the sum of products of [Area] x [Space Multiplier] x [Floor Multiplier].

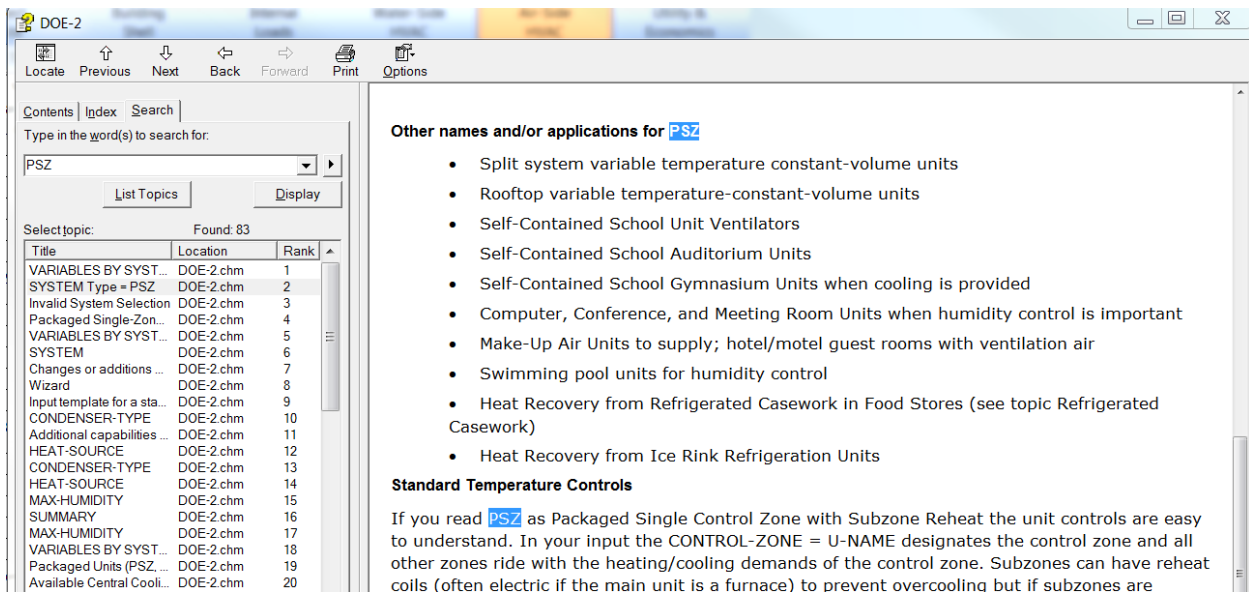
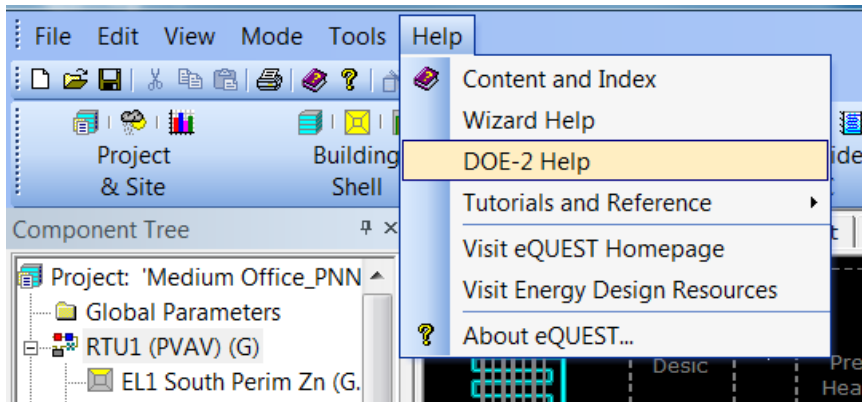
The report includes a detailed list of modeling inputs by space, including but not limited to lighting and equipment power density and full load hours. CSV (Excel) format easily supports data analysis.

Hourly Results (CSV)

To generate the report, select File -> Export File -> Hourly Results (CSV) from the main eQUEST interface and then click Export button. The values included in the report are specified by the modeler and may differ, however the report will have a value shown for each simulated hour. 8,760 hours indicate that the full hourly simulation was completed.

DOE-2 Help

The help is accessible from within eQUEST interface.



IESVE Software

Resources

1. Free Software for (AHJ) code reviewers or Utility Incentive Entities. Includes a reviewer-specific help guide.
2. Searchable Help Website: <https://help.iesve.com/ve2019/>
3. Free Getting Started video: <https://www.iesve.com/training/north-america/intro-to-ve-online>.
4. Video Library of Specific Topics (E.g. ASHRAE 90.1, Title 24 Compliance, Florida Energy Code Compliance, NECB Compliance, etc: <https://www.iesve.com/training/lunch-n-learn>
5. Technical Support: +1 617 502 2085 and support@iesve.com

General

6. The reports below are both entered values reports and simulation reports. All reports can be found by going to the Tools Menu in IESVE Software > Content Manager.
7. The reports can be viewed in the Content Manager as a report viewer or exported/opened independently as PDF/DOC/XLS etc. Most commonly, the reports are exported to .pdf files for submittals.

Simulation Reports to be Submitted

AHJ may require that all IESVE reports are submitted. Alternatively, the individual reports listed below may be requested. These reports are utilized in the Review Checks described in the Manual.

Room Loads Report

Zone Loads Report

Space Loads & Ventilation Report

Thermal Template Report

ASHRAE 62.1 Report

Plant Loops & Equipment Report

System Loads Report

Energy Model Output Report

Model Orientation and Rotation Check Report

ASHRAE 90.1 PRM/ECB Compliance Report

ModelIT Model Report

BPRM Report

Unmet Hours Report

Detailed Simulation Report

IECC Compliance Report

Florida Energy Code Compliance Report

ASHRAE 90.1-2016 PCI Report (Performance Cost Index - Proposed vs Baseline)

Room Loads Report

Room Loads Report					Design Model					IES VIRTUAL ENVIRONMENT																																																																																																																																																																																																																																																																																																																																																			
Zone: Pod 2 Corner Classroom					Pod 2 Corner Classroom					VE 2019																																																																																																																																																																																																																																																																																																																																																			
System: 07 a Variable Air V...					HVAC Methodology: ApacheHVAC																																																																																																																																																																																																																																																																																																																																																								
COOLING ROOM PEAK					HEATING ROOM PEAK					AREAS & THERMAL TRANSMITTANCE																																																																																																																																																																																																																																																																																																																																																			
Time of Peak (Mo/Hr/Min): 9 / 15:30					Time of Peak (Mo/Hr/Min): Heating Design					Total Area Glazing U-value*																																																																																																																																																																																																																																																																																																																																																			
Outside Air (DB/WB/RH): 84.2 °F / 63.7 °F / 31.3 %					Outside Air (DB/WB/RH): 39.4 °F / 33.3 °F / 50.4 %					Total Area Glazing U-value* Bluh/°F																																																																																																																																																																																																																																																																																																																																																			
<table border="1"> <thead> <tr> <th>Room</th> <th>Sensible</th> <th>Latent</th> <th>Net Value</th> <th>Per Floor Area</th> <th>Percent of Total</th> </tr> </thead> <tbody> <tr><td>Envelope Gains/Losses</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>External Walls</td><td>388</td><td>-</td><td>388</td><td>0.4</td><td>2.3</td></tr> <tr><td>Roofs</td><td>748</td><td>-</td><td>748</td><td>0.7</td><td>4.4</td></tr> <tr><td>Ground/Exposed Floors</td><td>-3,042</td><td>-</td><td>-3,042</td><td>-2.8</td><td>-18.1</td></tr> <tr><td>External Doors</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Windows Conduction</td><td>609</td><td>-</td><td>609</td><td>0.6</td><td>4.2</td></tr> <tr><td>Skylights Conduction</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Solar</td><td>5,067</td><td>-</td><td>5,067</td><td>4.7</td><td>30.1</td></tr> <tr><td>Infiltration</td><td>152</td><td>-395</td><td>-243</td><td>-0.2</td><td>-1.4</td></tr> <tr><td>Nat/Aux Vent</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Internal Building Gains/Losses</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>Internal Walls/Openings</td><td>-352</td><td>-</td><td>-352</td><td>-0.3</td><td>-2.1</td></tr> <tr><td>Internal Floors</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Internal Air & Furniture</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Ceilings</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Sub Total</td><td>3,661</td><td>-395</td><td>3,266</td><td>3.0</td><td></td></tr> <tr><td>Internal Gains</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>Lights</td><td>4,571</td><td>-</td><td>4,571</td><td>4.2</td><td>27.2</td></tr> <tr><td>People</td><td>5,925</td><td>2,625</td><td>8,250</td><td>7.6</td><td>49.6</td></tr> <tr><td>Misc. Computers, Equip</td><td>737</td><td>0</td><td>737</td><td>0.7</td><td>4.4</td></tr> <tr><td>Sub Total</td><td>10,934</td><td>2,625</td><td>13,558</td><td>12.5</td><td></td></tr> <tr><td>TOTAL</td><td>14,694</td><td>-2,200</td><td>16,824</td><td>15.6</td><td>100</td></tr> </tbody> </table>					Room	Sensible	Latent	Net Value	Per Floor Area	Percent of Total	Envelope Gains/Losses						External Walls	388	-	388	0.4	2.3	Roofs	748	-	748	0.7	4.4	Ground/Exposed Floors	-3,042	-	-3,042	-2.8	-18.1	External Doors	0	-	0	0.0	0.0	Windows Conduction	609	-	609	0.6	4.2	Skylights Conduction	0	-	0	0.0	0.0	Solar	5,067	-	5,067	4.7	30.1	Infiltration	152	-395	-243	-0.2	-1.4	Nat/Aux Vent	0	0	0	0.0	0.0	Internal Building Gains/Losses						Internal Walls/Openings	-352	-	-352	-0.3	-2.1	Internal Floors	0	-	0	0.0	0.0	Internal Air & Furniture	0	-	0	0.0	0.0	Ceilings	0	-	0	0.0	0.0	Sub Total	3,661	-395	3,266	3.0		Internal Gains						Lights	4,571	-	4,571	4.2	27.2	People	5,925	2,625	8,250	7.6	49.6	Misc. Computers, Equip	737	0	737	0.7	4.4	Sub Total	10,934	2,625	13,558	12.5		TOTAL	14,694	-2,200	16,824	15.6	100	<table border="1"> <thead> <tr> <th>Room</th> <th>Sensible</th> <th>Latent</th> <th>Net Value</th> <th>Per Floor Area</th> <th>Percent of Total</th> </tr> </thead> <tbody> <tr><td>Envelope Gains/Losses</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>External Walls</td><td>-490</td><td>-</td><td>-490</td><td>-0.5</td><td>-11.9</td></tr> <tr><td>Roofs</td><td>-1,086</td><td>-</td><td>-1,086</td><td>-1.0</td><td>-26.4</td></tr> <tr><td>Ground/Exposed Floors</td><td>-585</td><td>-</td><td>-585</td><td>-0.5</td><td>-14.3</td></tr> <tr><td>External Doors</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Windows Conduction</td><td>-1,522</td><td>-</td><td>-1,522</td><td>-1.4</td><td>-37.1</td></tr> <tr><td>Skylights Conduction</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Solar</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Infiltration</td><td>-506</td><td>-506</td><td>-1,012</td><td>-0.5</td><td>-12.3</td></tr> <tr><td>Nat/Aux Vent</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Internal Building Gains/Losses</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>Internal Walls/Openings</td><td>81</td><td>81</td><td>162</td><td>0.1</td><td>2.0</td></tr> <tr><td>Internal Floors</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Internal Air & Furniture</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Ceilings</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Sub Total</td><td>-4,108</td><td>-4,108</td><td>-8,216</td><td>-3.8</td><td></td></tr> <tr><td>Internal Gains</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>Lights</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>People</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Misc. Computers, Equip</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Sub Total</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>TOTAL</td><td>-4,108</td><td>-4,108</td><td>-8,216</td><td>-3.8</td><td>100</td></tr> </tbody> </table>					Room	Sensible	Latent	Net Value	Per Floor Area	Percent of Total	Envelope Gains/Losses						External Walls	-490	-	-490	-0.5	-11.9	Roofs	-1,086	-	-1,086	-1.0	-26.4	Ground/Exposed Floors	-585	-	-585	-0.5	-14.3	External Doors	0	-	0	0.0	0.0	Windows Conduction	-1,522	-	-1,522	-1.4	-37.1	Skylights Conduction	0	-	0	0.0	0.0	Solar	0	-	0	0.0	0.0	Infiltration	-506	-506	-1,012	-0.5	-12.3	Nat/Aux Vent	0	0	0	0.0	0.0	Internal Building Gains/Losses						Internal Walls/Openings	81	81	162	0.1	2.0	Internal Floors	0	0	0	0.0	0.0	Internal Air & Furniture	0	0	0	0.0	0.0	Ceilings	0	0	0	0.0	0.0	Sub Total	-4,108	-4,108	-8,216	-3.8		Internal Gains						Lights	0	0	0	0.0	0.0	People	0	0	0	0.0	0.0	Misc. Computers, Equip	0	0	0	0.0	0.0	Sub Total	0	0	0	0.0	0.0	TOTAL	-4,108	-4,108	-8,216	-3.8	100	<table border="1"> <thead> <tr> <th>External</th> <th>Total Area</th> <th>Glazing</th> <th>U-value*</th> </tr> </thead> <tbody> <tr><td>Wall (above grade)</td><td>792.1</td><td>216.0</td><td>27.3</td><td>0.09</td></tr> <tr><td>Below Grade Walls</td><td>-</td><td>-</td><td>-</td><td>-</td></tr> <tr><td>Windows*</td><td>216.0</td><td>216.0</td><td>100.0</td><td>0.24</td></tr> <tr><td>Doors</td><td>-</td><td>-</td><td>-</td><td>-</td></tr> <tr><td>Floors</td><td>1,080.4</td><td>-</td><td>-</td><td>0.02</td></tr> <tr><td>Roofs*</td><td>1,080.4</td><td>-</td><td>-</td><td>0.03</td></tr> <tr><td>COMBINED</td><td>2,953.0</td><td>216.0</td><td>7.3</td><td>0.04</td></tr> <tr><td>Internal</td><td></td><td></td><td></td><td></td></tr> <tr><td>Ceilings</td><td>-</td><td>-</td><td>-</td><td>-</td></tr> <tr><td>Floors</td><td>-</td><td>-</td><td>-</td><td>-</td></tr> <tr><td>Partitions*</td><td>792.1</td><td>-</td><td>-</td><td>0.33</td></tr> </tbody> </table> <p>*Area-weighted U-value; *Windows/glazing include glass and frames; *Roofs incl. skylights; *Partitions incl. internal windows and doors.</p>					External	Total Area	Glazing	U-value*	Wall (above grade)	792.1	216.0	27.3	0.09	Below Grade Walls	-	-	-	-	Windows*	216.0	216.0	100.0	0.24	Doors	-	-	-	-	Floors	1,080.4	-	-	0.02	Roofs*	1,080.4	-	-	0.03	COMBINED	2,953.0	216.0	7.3	0.04	Internal					Ceilings	-	-	-	-	Floors	-	-	-	-	Partitions*	792.1	-	-	0.33
Room	Sensible	Latent	Net Value	Per Floor Area	Percent of Total																																																																																																																																																																																																																																																																																																																																																								
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Lights	4,571	-	4,571	4.2	27.2																																																																																																																																																																																																																																																																																																																																																								
People	5,925	2,625	8,250	7.6	49.6																																																																																																																																																																																																																																																																																																																																																								
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Roofs	-1,086	-	-1,086	-1.0	-26.4																																																																																																																																																																																																																																																																																																																																																								
Ground/Exposed Floors	-585	-	-585	-0.5	-14.3																																																																																																																																																																																																																																																																																																																																																								
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Windows Conduction	-1,522	-	-1,522	-1.4	-37.1																																																																																																																																																																																																																																																																																																																																																								
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Infiltration	-506	-506	-1,012	-0.5	-12.3																																																																																																																																																																																																																																																																																																																																																								
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Internal Walls/Openings	81	81	162	0.1	2.0																																																																																																																																																																																																																																																																																																																																																								
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Sensible cooling load (Btu/h): 14,594					Sensible heating load (Btu/h): 4,108					Supply Air (design): 55.0 90.0																																																																																																																																																																																																																																																																																																																																																			
Latent cooling load (Btu/h): 2,235					Design zone air temp for Supply Airflow calculation (°F): 69.0					Room Setpoint (design): 75.0 69.0																																																																																																																																																																																																																																																																																																																																																			
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										R/ton - Cooling (sensible): 888.39																																																																																																																																																																																																																																																																																																																																																			
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BE19: Design cooling loads for baseline and proposed

BE19: Design heating loads for baseline and proposed

BE06, BE07, BE08, BE09, BE10: Areas of the building envelope for the proposed and baseline.
BE14: Baseline and Proposed Fenestration Properties.

BE18: Infiltration (cfm)

Zone Loads Report

Zone Loads Report					Design Model					IES VIRTUAL ENVIRONMENT																																																																																																																																																																																																																																																																																																																																																			
System: 07 a Variable Air V...					Pod 3 Corner Classroom					VE 2019																																																																																																																																																																																																																																																																																																																																																			
COOLING ZONE PEAK					HEATING ZONE PEAK					AREAS & THERMAL TRANSMITTANCE																																																																																																																																																																																																																																																																																																																																																			
Time of Peak (Mo/Hr/Min): 5 / 17:30					Time of Peak (Mo/Hr/Min): Heating Design					Total Area Glazing U-value*																																																																																																																																																																																																																																																																																																																																																			
Outside Air (DB/WB/RH): 78.2 °F / 60.2 °F / 33.4 %					Outside Air (DB/WB/RH): 39.4 °F / 33.3 °F / 50.4 %					Total Area Glazing U-value* Bluh/°F																																																																																																																																																																																																																																																																																																																																																			
<table border="1"> <thead> <tr> <th>Zone</th> <th>Sensible</th> <th>Latent</th> <th>Net Value</th> <th>Per Floor Area</th> <th>Percent of Total</th> </tr> </thead> <tbody> <tr><td>Envelope Gains/Losses</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>External Walls</td><td>267</td><td>-</td><td>267</td><td>0.2</td><td>1.8</td></tr> <tr><td>Roofs</td><td>474</td><td>-</td><td>474</td><td>0.4</td><td>3.3</td></tr> <tr><td>Ground/Exposed Floors</td><td>-2,657</td><td>-</td><td>-2,657</td><td>-2.5</td><td>-18.2</td></tr> <tr><td>External Doors</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Windows Conduction</td><td>275</td><td>-</td><td>275</td><td>0.3</td><td>1.9</td></tr> <tr><td>Skylights Conduction</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Solar</td><td>3,334</td><td>-</td><td>3,334</td><td>3.1</td><td>22.9</td></tr> <tr><td>Infiltration</td><td>63</td><td>-465</td><td>-402</td><td>-0.4</td><td>-2.8</td></tr> <tr><td>Nat/Aux Vent</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Internal Building Gains/Losses</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>Internal Walls/Openings</td><td>-261</td><td>-</td><td>-261</td><td>-0.2</td><td>-1.8</td></tr> <tr><td>Internal Floors</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Internal Air & Furniture</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Ceilings</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Sub Total</td><td>1,495</td><td>-465</td><td>1,030</td><td>1.0</td><td></td></tr> <tr><td>Internal Gains</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>Lights</td><td>4,571</td><td>-</td><td>4,571</td><td>4.2</td><td>31.3</td></tr> <tr><td>People</td><td>5,925</td><td>2,625</td><td>8,250</td><td>7.6</td><td>56.8</td></tr> <tr><td>Misc. Computers, Equip</td><td>737</td><td>0</td><td>737</td><td>0.7</td><td>5.1</td></tr> <tr><td>Sub Total</td><td>10,934</td><td>2,625</td><td>13,558</td><td>12.5</td><td></td></tr> <tr><td>TOTAL</td><td>12,428</td><td>2,160</td><td>14,588</td><td>13.5</td><td>100</td></tr> </tbody> </table>					Zone	Sensible	Latent	Net Value	Per Floor Area	Percent of Total	Envelope Gains/Losses						External Walls	267	-	267	0.2	1.8	Roofs	474	-	474	0.4	3.3	Ground/Exposed Floors	-2,657	-	-2,657	-2.5	-18.2	External Doors	0	-	0	0.0	0.0	Windows Conduction	275	-	275	0.3	1.9	Skylights Conduction	0	-	0	0.0	0.0	Solar	3,334	-	3,334	3.1	22.9	Infiltration	63	-465	-402	-0.4	-2.8	Nat/Aux Vent	0	0	0	0.0	0.0	Internal Building Gains/Losses						Internal Walls/Openings	-261	-	-261	-0.2	-1.8	Internal Floors	0	-	0	0.0	0.0	Internal Air & Furniture	0	-	0	0.0	0.0	Ceilings	0	-	0	0.0	0.0	Sub Total	1,495	-465	1,030	1.0		Internal Gains						Lights	4,571	-	4,571	4.2	31.3	People	5,925	2,625	8,250	7.6	56.8	Misc. Computers, Equip	737	0	737	0.7	5.1	Sub Total	10,934	2,625	13,558	12.5		TOTAL	12,428	2,160	14,588	13.5	100	<table border="1"> <thead> <tr> <th>Zone</th> <th>Sensible</th> <th>Latent</th> <th>Net Value</th> <th>Per Floor Area</th> <th>Percent of Total</th> </tr> </thead> <tbody> <tr><td>Envelope Gains/Losses</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>External Walls</td><td>-493</td><td>-</td><td>-493</td><td>-0.5</td><td>-12.0</td></tr> <tr><td>Roofs</td><td>-1,066</td><td>-</td><td>-1,066</td><td>-1.0</td><td>-25.9</td></tr> <tr><td>Ground/Exposed Floors</td><td>-585</td><td>-</td><td>-585</td><td>-0.5</td><td>-14.2</td></tr> <tr><td>External Doors</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Windows Conduction</td><td>-1,538</td><td>-</td><td>-1,538</td><td>-1.4</td><td>-37.4</td></tr> <tr><td>Skylights Conduction</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Solar</td><td>0</td><td>-</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Infiltration</td><td>-506</td><td>-506</td><td>-1,012</td><td>-0.5</td><td>-12.3</td></tr> <tr><td>Nat/Aux Vent</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Internal Building Gains/Losses</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>Internal Walls/Openings</td><td>79</td><td>79</td><td>158</td><td>0.1</td><td>1.9</td></tr> <tr><td>Internal Floors</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Internal Air & Furniture</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Ceilings</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Sub Total</td><td>-4,109</td><td>-4,109</td><td>-8,218</td><td>-3.8</td><td></td></tr> <tr><td>Internal Gains</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>Lights</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>People</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Misc. Computers, Equip</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>Sub Total</td><td>0</td><td>0</td><td>0</td><td>0.0</td><td>0.0</td></tr> <tr><td>TOTAL</td><td>-4,109</td><td>-4,109</td><td>-8,218</td><td>-3.8</td><td>100</td></tr> </tbody> </table>					Zone	Sensible	Latent	Net Value	Per Floor Area	Percent of Total	Envelope Gains/Losses						External Walls	-493	-	-493	-0.5	-12.0	Roofs	-1,066	-	-1,066	-1.0	-25.9	Ground/Exposed Floors	-585	-	-585	-0.5	-14.2	External Doors	0	-	0	0.0	0.0	Windows Conduction	-1,538	-	-1,538	-1.4	-37.4	Skylights Conduction	0	-	0	0.0	0.0	Solar	0	-	0	0.0	0.0	Infiltration	-506	-506	-1,012	-0.5	-12.3	Nat/Aux Vent	0	0	0	0.0	0.0	Internal Building Gains/Losses						Internal Walls/Openings	79	79	158	0.1	1.9	Internal Floors	0	0	0	0.0	0.0	Internal Air & Furniture	0	0	0	0.0	0.0	Ceilings	0	0	0	0.0	0.0	Sub Total	-4,109	-4,109	-8,218	-3.8		Internal Gains						Lights	0	0	0	0.0	0.0	People	0	0	0	0.0	0.0	Misc. Computers, Equip	0	0	0	0.0	0.0	Sub Total	0	0	0	0.0	0.0	TOTAL	-4,109	-4,109	-8,218	-3.8	100	<table border="1"> <thead> <tr> <th>External</th> <th>Total Area</th> <th>Glazing</th> <th>U-value*</th> </tr> </thead> <tbody> <tr><td>Wall (above grade)</td><td>792.1</td><td>216.0</td><td>27.3</td><td>0.09</td></tr> <tr><td>Below Grade Walls</td><td>-</td><td>-</td><td>-</td><td>-</td></tr> <tr><td>Windows*</td><td>216.0</td><td>216.0</td><td>100.0</td><td>0.24</td></tr> <tr><td>Doors</td><td>-</td><td>-</td><td>-</td><td>-</td></tr> <tr><td>Floors</td><td>1,080.4</td><td>-</td><td>-</td><td>0.02</td></tr> <tr><td>Roofs*</td><td>1,080.4</td><td>-</td><td>-</td><td>0.03</td></tr> <tr><td>COMBINED</td><td>2,953.0</td><td>216.0</td><td>7.3</td><td>0.04</td></tr> <tr><td>Internal</td><td></td><td></td><td></td><td></td></tr> <tr><td>Ceilings</td><td>-</td><td>-</td><td>-</td><td>-</td></tr> <tr><td>Floors</td><td>-</td><td>-</td><td>-</td><td>-</td></tr> <tr><td>Partitions*</td><td>792.1</td><td>-</td><td>-</td><td>0.33</td></tr> </tbody> </table> <p>*Area-weighted U-value; *Windows/glazing include glass and frames; *Roofs incl. skylights; *Partitions incl. internal windows and doors.</p>					External	Total Area	Glazing	U-value*	Wall (above grade)	792.1	216.0	27.3	0.09	Below Grade Walls	-	-	-	-	Windows*	216.0	216.0	100.0	0.24	Doors	-	-	-	-	Floors	1,080.4	-	-	0.02	Roofs*	1,080.4	-	-	0.03	COMBINED	2,953.0	216.0	7.3	0.04	Internal					Ceilings	-	-	-	-	Floors	-	-	-	-	Partitions*	792.1	-	-	0.33
Zone	Sensible	Latent	Net Value	Per Floor Area	Percent of Total																																																																																																																																																																																																																																																																																																																																																								
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Solar	3,334	-	3,334	3.1	22.9																																																																																																																																																																																																																																																																																																																																																								
Infiltration	63	-465	-402	-0.4	-2.8																																																																																																																																																																																																																																																																																																																																																								
Nat/Aux Vent	0	0	0	0.0	0.0																																																																																																																																																																																																																																																																																																																																																								
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Internal Walls/Openings	-261	-	-261	-0.2	-1.8																																																																																																																																																																																																																																																																																																																																																								
Internal Floors	0	-	0	0.0	0.0																																																																																																																																																																																																																																																																																																																																																								
Internal Air & Furniture	0	-	0	0.0	0.0																																																																																																																																																																																																																																																																																																																																																								
Ceilings	0	-	0	0.0	0.0																																																																																																																																																																																																																																																																																																																																																								
Sub Total	1,495	-465	1,030	1.0																																																																																																																																																																																																																																																																																																																																																									
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Lights	4,571	-	4,571	4.2	31.3																																																																																																																																																																																																																																																																																																																																																								
People	5,925	2,625	8,250	7.6	56.8																																																																																																																																																																																																																																																																																																																																																								
Misc. Computers, Equip	737	0	737	0.7	5.1																																																																																																																																																																																																																																																																																																																																																								
Sub Total	10,934	2,625	13,558	12.5																																																																																																																																																																																																																																																																																																																																																									
TOTAL	12,428	2,160	14,588	13.5	100																																																																																																																																																																																																																																																																																																																																																								
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Ground/Exposed Floors	-585	-	-585	-0.5	-14.2																																																																																																																																																																																																																																																																																																																																																								
External Doors	0	-	0	0.0	0.0																																																																																																																																																																																																																																																																																																																																																								
Windows Conduction	-1,538	-	-1,538	-1.4	-37.4																																																																																																																																																																																																																																																																																																																																																								
Skylights Conduction	0	-	0	0.0	0.0																																																																																																																																																																																																																																																																																																																																																								
Solar	0	-	0	0.0	0.0																																																																																																																																																																																																																																																																																																																																																								
Infiltration	-506	-506	-1,012	-0.5	-12.3																																																																																																																																																																																																																																																																																																																																																								
Nat/Aux Vent	0	0	0	0.0	0.0																																																																																																																																																																																																																																																																																																																																																								
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Internal Walls/Openings	79	79	158	0.1	1.9																																																																																																																																																																																																																																																																																																																																																								
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Lights	0	0	0	0.0	0.0																																																																																																																																																																																																																																																																																																																																																								
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Windows*	216.0	216.0	100.0	0.24																																																																																																																																																																																																																																																																																																																																																									
Doors	-	-	-	-																																																																																																																																																																																																																																																																																																																																																									
Floors	1,080.4	-	-	0.02																																																																																																																																																																																																																																																																																																																																																									
Roofs*	1,080.4	-	-	0.03																																																																																																																																																																																																																																																																																																																																																									
COMBINED	2,953.0	216.0	7.3	0.04																																																																																																																																																																																																																																																																																																																																																									
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Floors	-	-	-	-																																																																																																																																																																																																																																																																																																																																																									
Partitions*	792.1	-	-	0.33																																																																																																																																																																																																																																																																																																																																																									
COOLING SUMMARY					HEATING SUMMARY					TEMPERATURES & SETPOINTS																																																																																																																																																																																																																																																																																																																																																			
Sensible cooling load (Btu/h): 12,428					Sensible heating load (Btu/h): 4,109					Supply Air (design): 55.0 90.0																																																																																																																																																																																																																																																																																																																																																			
Latent cooling load (Btu/h): 2,160					Design zone air temp for Supply Airflow calculation (°F): 69.0					Room Setpoint (design): 75.0 69.0																																																																																																																																																																																																																																																																																																																																																			
Sensible heat ratio: 0.85										Master Room Setpoint (design): 75.0 69.0																																																																																																																																																																																																																																																																																																																																																			
Design Supply Airflow calculated per: Sensible Loads										Master Room (actual): 75.0 69.0																																																																																																																																																																																																																																																																																																																																																			
Design zone air temp for Supply Airflow calculation (°F): 75.0										Mean Radiant Temperature: 75.9 67.6																																																																																																																																																																																																																																																																																																																																																			
										Dry Resultant Temperature: 75.9 68.3																																																																																																																																																																																																																																																																																																																																																			
										RH (Design Max Setpoint) (%): 70.0 70.0																																																																																																																																																																																																																																																																																																																																																			
										AIRFLOW																																																																																																																																																																																																																																																																																																																																																			
										Supply (design): 568 cfm																																																																																																																																																																																																																																																																																																																																																			
										Reheat Minimum (design): 315 cfm																																																																																																																																																																																																																																																																																																																																																			
										Leakage at Design Flow: 0 cfm																																																																																																																																																																																																																																																																																																																																																			
										Ventilation (requirement): 315 cfm																																																																																																																																																																																																																																																																																																																																																			
										Infiltration: 16 cfm																																																																																																																																																																																																																																																																																																																																																			
										CHECKS																																																																																																																																																																																																																																																																																																																																																			
										Number of People: 25.00																																																																																																																																																																																																																																																																																																																																																			
										R/Person: 43.22																																																																																																																																																																																																																																																																																																																																																			
										Average Ceiling Height (ft): 12.00																																																																																																																																																																																																																																																																																																																																																			
										Btu/h/ft² - Cooling (sensible): 11.50																																																																																																																																																																																																																																																																																																																																																			
										Btu/h/ft² - Heating: 3.80																																																																																																																																																																																																																																																																																																																																																			
										R/ton - Cooling (sensible): 1,043.19																																																																																																																																																																																																																																																																																																																																																			
										R/ton - Heating: 3,155.13																																																																																																																																																																																																																																																																																																																																																			
										cfm/ft² - Cooling: 0.53																																																																																																																																																																																																																																																																																																																																																			
										cfm/ft² - Heating: 0.29																																																																																																																																																																																																																																																																																																																																																			
										% Outside Air - Cooling: 55.51																																																																																																																																																																																																																																																																																																																																																			
										% Outside Air - Heating: 100.00																																																																																																																																																																																																																																																																																																																																																			
										Outdoor Air cfm/ft²: 0.29																																																																																																																																																																																																																																																																																																																																																			
										Outdoor Air cfm/person: 12.62																																																																																																																																																																																																																																																																																																																																																			

BE19: Design cooling loads for baseline and proposed

BE19: Design heating loads for baseline and proposed

BE06, BE07, BE08, BE09, BE10: Areas of the building envelope for the proposed and baseline.
BE14: Baseline and Proposed Fenestration Properties.

BE18: Infiltration (cfm)

Space Loads & Ventilation Report

Zone	Rooms	Sensible Cooling Load (kBtu/h)	Latent Cooling Load (kBtu/h)	Total Cooling Load (kBtu/h)	Total Cooling Load (kBtu/h)	Cooling Airflow (cfm)	Cooling Airflow (cfm)	Heating Load (kBtu/h)	Heating Load (kBtu/h)	Heating Airflow (cfm)	Heating Airflow (cfm)	Outdoor Airflow Req. (cfm)	Outdoor Airflow Req. (cfm)	Min OA Airflow (cfm)	Min OA Airflow (cfm)
System		100,192	84,539	374,741	9,501	17,313	0.393	32,844	3,011	10,027	0.227	10,027	0.227	10,027	-
Pod 1 Classrooms		57,293	9,480	66,773	12.78	2,819	0.501	14,840	2.88	1,017	0.195	1,017	0.195	1,017	-
	Pod 1 Classroom 1	14,759	2,347	17,106	12.14	679	0.482	3,963	2.81	294	0.187	-	-	-	-
	Pod 1 Classroom 3	14,059	2,379	16,438	13.23	640	0.516	3,583	2.89	248	0.200	-	-	-	-
	Pod 1 Classroom 4	14,301	2,984	16,965	12.80	694	0.503	3,741	2.87	294	0.195	-	-	-	-
	Pod 1 Classroom 2	14,174	2,370	16,544	13.02	648	0.508	3,603	2.87	251	0.197	-	-	-	-
Pod 1 Corner Classroom		14,652	2,230	16,882	15.63	670	0.620	4,136	3.83	315	0.292	315	0.292	315	-
	Pod 1 Corner Classroom	14,652	2,230	16,882	15.63	670	0.620	4,136	3.83	315	0.292	-	-	-	-
Pod 1 Corridor		4,878	0.000	4,878	2.33	223	0.106	4,281	2.04	196	0.089	157	0.075	125	-
	Pod 1 Corridor	4,878	0.000	4,878	2.33	223	0.106	4,281	2.04	196	0.089	-	-	-	-
Pod 1 Corner Classroom		12,339	2,160	14,499	13.42	564	0.522	4,108	3.80	315	0.292	315	0.292	306	-
	Pod 1 Corner Classroom	12,339	2,160	14,499	13.42	564	0.522	4,108	3.80	315	0.292	-	-	-	-
Pod 1 Multiple Classrooms		44,990	9,276	54,266	10.39	2,056	0.394	14,603	2.80	1,329	0.254	1,329	0.254	1,136	-
	Pod 1 Multiple Classrooms	44,990	9,276	54,266	10.39	2,056	0.394	14,603	2.80	1,329	0.254	-	-	-	-
Pod 2 Corner Classroom		14,600	2,230	16,829	15.58	667	0.618	4,108	3.80	315	0.292	315	0.292	315	-
	Pod 2 Corner Classroom	14,600	2,230	16,829	15.58	667	0.618	4,108	3.80	315	0.292	-	-	-	-
Pod 2 Multiple Classrooms		51,091	9,460	60,552	11.59	2,335	0.447	14,522	2.78	1,329	0.254	1,329	0.254	1,136	-
	Pod 2 Multiple Classrooms	51,091	9,460	60,552	11.59	2,335	0.447	14,522	2.78	1,329	0.254	-	-	-	-
Pod 2 Corridor		4,810	0.000	4,810	2.30	220	0.105	4,325	2.06	188	0.090	157	0.075	121	-
	Pod 2 Corridor	4,810	0.000	4,810	2.30	220	0.105	4,325	2.06	188	0.090	-	-	-	-
Pod 2 Corner Classroom		12,429	2,160	14,589	13.00	568	0.506	4,110	3.80	315	0.292	315	0.292	300	-
	Pod 2 Corner Classroom	12,429	2,160	14,589	13.00	568	0.506	4,110	3.80	315	0.292	-	-	-	-
Pod 2 Multiple Classrooms		45,041	9,276	54,317	10.40	2,059	0.394	14,610	2.80	1,329	0.254	1,329	0.254	1,134	-
	Pod 2 Multiple Classrooms	45,041	9,276	54,317	10.40	2,059	0.394	14,610	2.80	1,329	0.254	-	-	-	-
Pod 3 Corner Classroom		14,532	2,230	16,762	15.51	664	0.615	4,111	3.81	315	0.292	315	0.292	315	-
	Pod 3 Corner Classroom	14,532	2,230	16,762	15.51	664	0.615	4,111	3.81	315	0.292	-	-	-	-

AHVAC01: Thermal Blocks

BE19: Design cooling loads for baseline and proposed

AHVAC26: Modeled ventilation rate

BE19: Design heating loads for baseline and proposed

Thermal Template Report

Thermal Templates Data

1. Thermal Template Summary

The following templates are used in this project

1.1. SPACE: Office - Open plan

SPACE: Office - Open plan - People

Occupancy Density (ft ² /person)	200.0
Sensible Gain (W/person)	73.3
Latent Gain (W/person)	58.6

SPACE: Office - Open plan - Equipment

Power Consumption (W/ft ²)	1.5
Sensible Gain (W/ft ²)	1.5
Latent Gain (W/ft ²)	0
Radiant Fraction	0.2

SPACE: Office - Open plan - Lighting

Lighting Power Consumption (W/ft ²)	0.98
Lighting Heat Gain (W/ft ²)	0.98
Radiant Fraction	0.4

WHVAC09: Annual chilled water pump energy occupied hours/year

WHVAC20: Annual hot water pump energy occupied hours/year

LI07: Baseline and proposed lighting power density

Thermal Templates Data

Heating

Heating profile is set to 'on continuously'. Heating set point is defined as an absolute profile:

Cooling

Cooling profile is set to 'on continuously'. Cooling set point is defined as an absolute profile:

Infiltration

Infiltration Rate (ach)

0.1

BE18: Infiltration

LEED Model 01.mit
ASHRAE 62.1
INTEGRATED ENVIRONMENTAL SOLUTIONS LTD

10/July/18

TRANSLATE

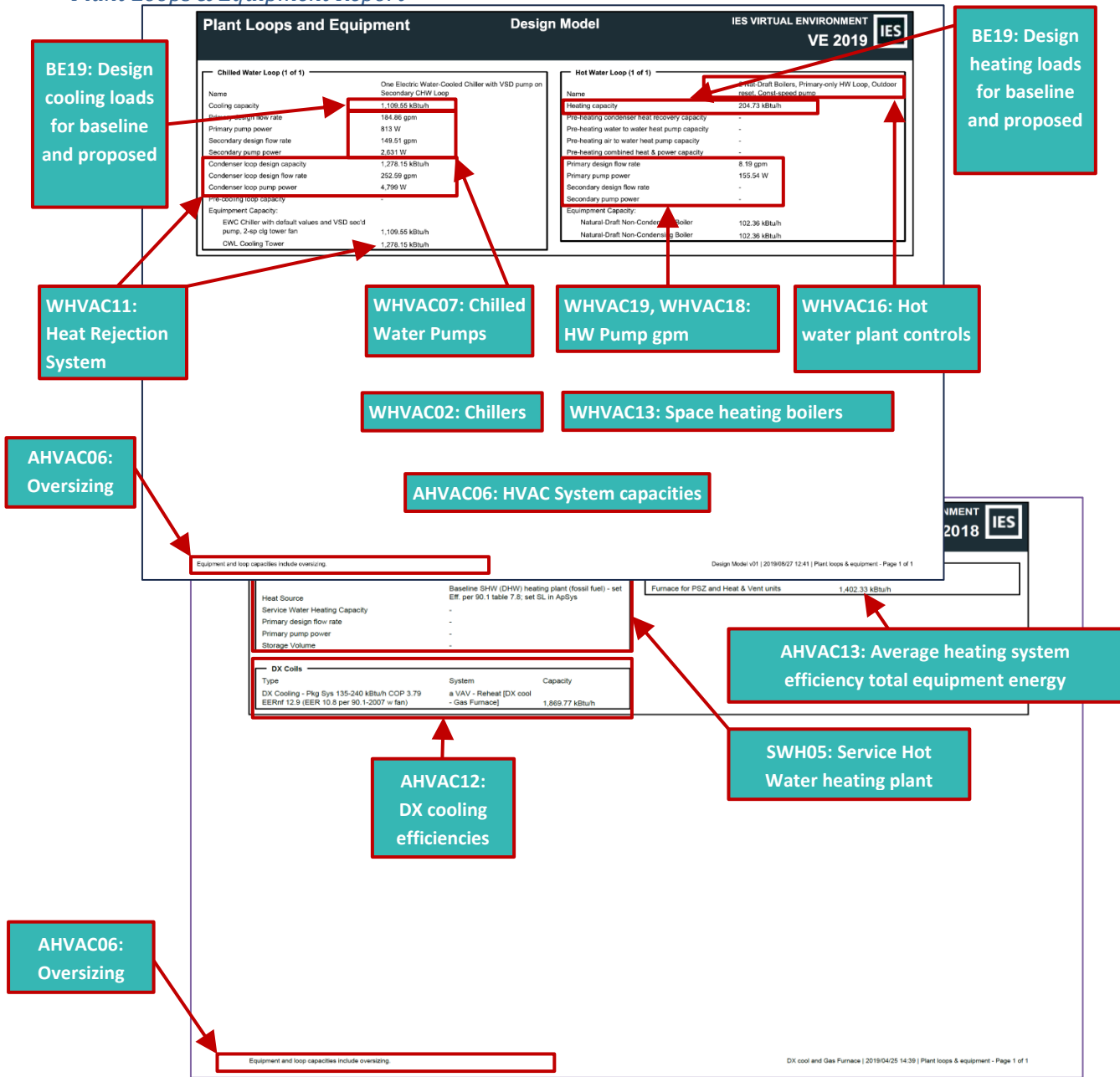
System ID - PR034_07

System data:	System name n Adv VAV - sys OA reset, DCV, low VAV min flow	Maximum zone Zp 0.75	System Ventilation efficiency Ev 0.60	Uncorrected OA rate (cfm) Vou 636	Occupant diversity factor (D) 0.00	System OA rate at Intake (cfm) Vot 1058
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ASHRAE 62.1 - PR034_07	Zone data				Standard case: ASHRAE 62.1 (2010) - Ventilation Rate Procedure							Design Case				
	Zone name	Occupancy Category	Area (ft ²)	No. of people Pz	Table 6-1			Table 6-2		Table 6-3		Design OA Intake flow Vot (cfm)	Zone primary air flow Vpz (cfm)	Primary OA fraction Zp=Voz/Vpz	A62.1 Calc Completed? (Y/N)	% Increase over standard
					People OA rate Rp (cfm/person)	Area OA rate Ra (cfm/ft ²)	Breathing zone OA flow Vbz (cfm)	Zone air distribution effectiveness Ez	Zone supplied OA air flow Voz (cfm)	System ventilation efficiency Ev	Min. OA intake flow Vot (cfm)					
	Sort A-Z	Sort A-Z	HiLo	HiLo	HiLo	HiLo	HiLo	HiLo	HiLo	HiLo	HiLo	HiLo	HiLo	HiLo	HiLo	HiLo
	L1 Open Plan Office - East	Office Buildings - Office Space	300	0.00	5.0	0.06	25.0	0.8	31	0.60	1058.47	1376.02	101	0.31	Y	30.0%
	L1 Cellular Office 04 - NW	Office Buildings - Office Space	225	0.00	5.0	0.06	18.7	0.8	23	0.60	1058.47	1376.02	92	0.25	Y	30.0%
	L1 Conferences - South	General - Conferencemeeting	1050	28.25	5.0	0.06	306.9	0.8	384	0.60	1058.47	1376.02	512	0.75	Y	30.0%
	L1 Cellular Office 03 - NE	Office Buildings - Office Space	225	0.00	5.0	0.06	18.7	0.8	23	0.60	1058.47	1376.02	73	0.32	Y	30.0%
	L1 Open Plan Offices - North	Office Buildings - Office Space	1050	2.63	5.0	0.06	87.4	0.8	109	0.60	1058.47	1376.02	306	0.36	Y	30.0%
	L1 Cellular Office 01 - SW	Office Buildings - Office Space	225	0.00	5.0	0.06	18.7	0.8	23	0.60	1058.47	1376.02	99	0.24	Y	30.0%
	L1 Open Plan Offices - Interior	Office Buildings - Office Space	1400	3.50	5.0	0.06	116.5	0.8	146	0.60	1058.47	1376.02	420	0.35	Y	30.0%
	L1 Open Plan Office - West	Office Buildings - Office Space	300	0.00	5.0	0.06	25.0	0.8	31	0.60	1058.47	1376.02	116	0.27	Y	30.0%
	L1 Cellular Office 02 - SE	Office Buildings - Office Space	225	0.00	5.0	0.06	18.7	0.8	23	0.60	1058.47	1376.02	95	0.25	Y	30.0%

AHVAC26: Modeled ventilation rate & controls

Plant Loops & Equipment Report



System Loads Report (examples: DOAS, VAV)

System Loads Report										Design Model										IES VIRTUAL ENVIRONMENT																																																																																																																																																																																																																																																																																																																																																																																																																																									
AHU COOLING COIL PEAK										SYSTEM PEAK										ZONE HEATING OR REHEAT COIL PEAK																																																																																																																																																																																																																																																																																																																																																																																																																																									
Time of Peak (Mo:W:Mi): 6/14/30										Time of Peak (Mo:W:Mi): 6/14/30										Heating Design																																																																																																																																																																																																																																																																																																																																																																																																																																									
Outside Air (DB/WB/RRH): 82.4 / 62.5 / 31.3										Outside Air (DB/WB/RRH): 82.4 / 62.5 / 31.3										Outside Air (DB/WB/RRH): 39.4 / 33.3 / 50.4																																																																																																																																																																																																																																																																																																																																																																																																																																									
<table border="1"> <thead> <tr> <th>Zones</th> <th>RA</th> <th>Plenum</th> <th>Net Value</th> <th>Percent of Total</th> <th>Zones</th> <th>RA</th> <th>Plenum</th> <th>Net Value</th> <th>Percent of Total</th> </tr> </thead> <tbody> <tr> <td>Envelope Gains/Losses</td> <td>Btu/h</td> <td>Btu/h</td> <td>%</td> <td></td> <td>Btu/h</td> <td>%</td> <td></td> <td></td> <td></td> </tr> <tr> <td>External Walls</td> <td>2,644</td> <td>-</td> <td>2,644</td> <td>1.2</td> <td>2,644</td> <td>1.1</td> <td>-</td> <td>-5,472</td> <td>-</td> </tr> <tr> <td>Roofs</td> <td>21,087</td> <td>-</td> <td>21,087</td> <td>9.4</td> <td>21,087</td> <td>8.8</td> <td>-</td> <td>-26,365</td> <td>-</td> </tr> <tr> <td>Ground/Exposed Floors</td> <td>-70,744</td> <td>-</td> <td>-70,744</td> <td>-31.5</td> <td>-70,744</td> <td>-29.6</td> <td>-</td> <td>-12,838</td> <td>-</td> </tr> <tr> <td>External Doors</td> <td>1,340</td> <td>-</td> <td>1,340</td> <td>0.6</td> <td>1,340</td> <td>0.6</td> <td>-</td> <td>-1,911</td> <td>-</td> </tr> <tr> <td>Windows Conduction</td> <td>4,301</td> <td>-</td> <td>4,301</td> <td>1.9</td> <td>4,301</td> <td>1.8</td> <td>-</td> <td>-11,523</td> <td>-</td> </tr> <tr> <td>Skylights Conduction</td> <td>826</td> <td>-</td> <td>826</td> <td>0.4</td> <td>826</td> <td>0.3</td> <td>-</td> <td>-5,570</td> <td>-</td> </tr> <tr> <td>Solar</td> <td>47,122</td> <td>-</td> <td>47,122</td> <td>21.0</td> <td>47,122</td> <td>19.7</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Infiltration</td> <td>965</td> <td>-</td> <td>965</td> <td>0.4</td> <td>965</td> <td>0.4</td> <td>-</td> <td>-5,102</td> <td>-</td> </tr> <tr> <td>Nat/Aux Vent</td> <td>0</td> <td>-</td> <td>0</td> <td>0.0</td> <td>0</td> <td>0.0</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Internal Building Gains/Losses</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Internal Walls/Openings</td> <td>2,308</td> <td>-</td> <td>2,308</td> <td>1.0</td> <td>2,308</td> <td>1.0</td> <td>-</td> <td>-257</td> <td>-</td> </tr> <tr> <td>Internal Floors/Air/Furn.</td> <td>-1,545</td> <td>-</td> <td>-1,545</td> <td>-0.7</td> <td>-1,545</td> <td>-0.6</td> <td>-</td> <td>4</td> <td>-</td> </tr> <tr> <td>Ceilings</td> <td>0</td> <td>-</td> <td>0</td> <td>0.0</td> <td>0</td> <td>0.0</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Duct Conduction</td> <td>0</td> <td>-</td> <td>0</td> <td>0.0</td> <td>0</td> <td>0.0</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Duct Leakage †</td> <td>0</td> <td>-</td> <td>0</td> <td>0.0</td> <td>0</td> <td>0.0</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Non-Principal Spaces</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> </tr> <tr> <td>Sub Total</td> <td>8,326</td> <td>0</td> <td>8,326</td> <td></td> <td>8,326</td> <td></td> <td></td> <td>-69,034</td> <td>0</td> </tr> </tbody> </table>										Zones	RA	Plenum	Net Value	Percent of Total	Zones	RA	Plenum	Net Value	Percent of Total	Envelope Gains/Losses	Btu/h	Btu/h	%		Btu/h	%				External Walls	2,644	-	2,644	1.2	2,644	1.1	-	-5,472	-	Roofs	21,087	-	21,087	9.4	21,087	8.8	-	-26,365	-	Ground/Exposed Floors	-70,744	-	-70,744	-31.5	-70,744	-29.6	-	-12,838	-	External Doors	1,340	-	1,340	0.6	1,340	0.6	-	-1,911	-	Windows Conduction	4,301	-	4,301	1.9	4,301	1.8	-	-11,523	-	Skylights Conduction	826	-	826	0.4	826	0.3	-	-5,570	-	Solar	47,122	-	47,122	21.0	47,122	19.7	-	0	-	Infiltration	965	-	965	0.4	965	0.4	-	-5,102	-	Nat/Aux Vent	0	-	0	0.0	0	0.0	-	0	-	Internal Building Gains/Losses										Internal Walls/Openings	2,308	-	2,308	1.0	2,308	1.0	-	-257	-	Internal Floors/Air/Furn.	-1,545	-	-1,545	-0.7	-1,545	-0.6	-	4	-	Ceilings	0	-	0	0.0	0	0.0	-	0	-	Duct Conduction	0	-	0	0.0	0	0.0	-	0	-	Duct Leakage †	0	-	0	0.0	0	0.0	-	0	-	Non-Principal Spaces	-	-	-	-	-	-	-	-	-	Sub Total	8,326	0	8,326		8,326			-69,034	0	<table border="1"> <thead> <tr> <th>Zones</th> <th>RA</th> <th>Plenum</th> <th>Net Value</th> <th>Percent of Total</th> <th>Zones</th> <th>RA</th> <th>Plenum</th> <th>Net Value</th> <th>Percent of Total</th> </tr> </thead> <tbody> <tr> <td>Envelope Gains/Losses</td> <td>Btu/h</td> <td>Btu/h</td> <td>%</td> <td></td> <td>Btu/h</td> <td>%</td> <td></td> <td></td> <td></td> </tr> <tr> <td>External Walls</td> <td>-5,472</td> <td>-</td> <td>-5,472</td> <td>-</td> <td>-5,472</td> <td>-</td> <td>-</td> <td>-12,838</td> <td>-</td> </tr> <tr> <td>Roofs</td> <td>-26,365</td> <td>-</td> <td>-26,365</td> <td>-</td> <td>-26,365</td> <td>-</td> <td>-</td> <td>-1,911</td> <td>-</td> </tr> <tr> <td>Ground/Exposed Floors</td> <td>-12,838</td> <td>-</td> <td>-12,838</td> <td>-</td> <td>-12,838</td> <td>-</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>External Doors</td> <td>-1,911</td> <td>-</td> <td>-1,911</td> <td>-</td> <td>-1,911</td> <td>-</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Windows Conduction</td> <td>-11,523</td> <td>-</td> <td>-11,523</td> <td>-</td> <td>-11,523</td> <td>-</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Skylights Conduction</td> <td>-5,570</td> <td>-</td> <td>-5,570</td> <td>-</td> <td>-5,570</td> <td>-</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Solar</td> <td>0</td> <td>-</td> <td>0</td> <td>0.0</td> <td>0</td> <td>0.0</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Infiltration</td> <td>-5,102</td> <td>-</td> <td>-5,102</td> <td>-</td> <td>-5,102</td> <td>-</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Nat/Aux Vent</td> <td>0</td> <td>-</td> <td>0</td> <td>0.0</td> <td>0</td> <td>0.0</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Internal Building Gains/Losses</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Internal Walls/Openings</td> <td>-257</td> <td>-</td> <td>-257</td> <td>-</td> <td>-257</td> <td>-</td> <td>-</td> <td>4</td> <td>-</td> </tr> <tr> <td>Internal Floors/Air/Furn.</td> <td>4</td> <td>-</td> <td>4</td> <td>0.0</td> <td>4</td> <td>0.0</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Ceilings</td> <td>0</td> <td>-</td> <td>0</td> <td>0.0</td> <td>0</td> <td>0.0</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Duct Conduction</td> <td>0</td> <td>-</td> <td>0</td> <td>0.0</td> <td>0</td> <td>0.0</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Duct Leakage †</td> <td>0</td> <td>-</td> <td>0</td> <td>0.0</td> <td>0</td> <td>0.0</td> <td>-</td> <td>0</td> <td>-</td> </tr> <tr> <td>Non-Principal Spaces</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> <td>-</td> </tr> <tr> <td>Sub Total</td> <td>-69,034</td> <td>0</td> <td>-69,034</td> <td></td> <td>-69,034</td> <td></td> <td></td> <td>1,614</td> <td>0</td> </tr> </tbody> </table>										Zones	RA	Plenum	Net Value	Percent of Total	Zones	RA	Plenum	Net Value	Percent of Total	Envelope Gains/Losses	Btu/h	Btu/h	%		Btu/h	%				External Walls	-5,472	-	-5,472	-	-5,472	-	-	-12,838	-	Roofs	-26,365	-	-26,365	-	-26,365	-	-	-1,911	-	Ground/Exposed Floors	-12,838	-	-12,838	-	-12,838	-	-	0	-	External Doors	-1,911	-	-1,911	-	-1,911	-	-	0	-	Windows Conduction	-11,523	-	-11,523	-	-11,523	-	-	0	-	Skylights Conduction	-5,570	-	-5,570	-	-5,570	-	-	0	-	Solar	0	-	0	0.0	0	0.0	-	0	-	Infiltration	-5,102	-	-5,102	-	-5,102	-	-	0	-	Nat/Aux Vent	0	-	0	0.0	0	0.0	-	0	-	Internal Building Gains/Losses										Internal Walls/Openings	-257	-	-257	-	-257	-	-	4	-	Internal Floors/Air/Furn.	4	-	4	0.0	4	0.0	-	0	-	Ceilings	0	-	0	0.0	0	0.0	-	0	-	Duct Conduction	0	-	0	0.0	0	0.0	-	0	-	Duct Leakage †	0	-	0	0.0	0	0.0	-	0	-	Non-Principal Spaces	-	-	-	-	-	-	-	-	-	Sub Total	-69,034	0	-69,034		-69,034			1,614	0	<table border="1"> <thead> <tr> <th>AREAS</th> <th>Gross</th> <th>Glass</th> <th>Glass</th> </tr> <tr> <td></td> <td>ft²</td> <td>ft²</td> <td>%</td> </tr> </thead> <tbody> <tr> <td>Wall</td> <td>7,928.1</td> <td>1,608.0</td> <td>20.3</td> </tr> <tr> <td>Roof</td> <td>26,741.4</td> <td>324.0</td> <td>1.2</td> </tr> <tr> <td>External Floor</td> <td>26,678.1</td> <td>-</td> <td>-</td> </tr> <tr> <td>Door</td> <td>88.0</td> <td>-</td> <td>-</td> </tr> <tr> <td>Partition/Door</td> <td>11,958.7</td> <td>-</td> <td>-</td> </tr> <tr> <td>Internal Ceiling</td> <td>0.0</td> <td>-</td> <td>-</td> </tr> <tr> <td>Internal Floor</td> <td>0.0</td> <td>-</td> <td>-</td> </tr> </tbody> </table>										AREAS	Gross	Glass	Glass		ft²	ft²	%	Wall	7,928.1	1,608.0	20.3	Roof	26,741.4	324.0	1.2	External Floor	26,678.1	-	-	Door	88.0	-	-	Partition/Door	11,958.7	-	-	Internal Ceiling	0.0	-	-	Internal Floor	0.0	-	-
Zones	RA	Plenum	Net Value	Percent of Total	Zones	RA	Plenum	Net Value	Percent of Total																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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External Walls	2,644	-	2,644	1.2	2,644	1.1	-	-5,472	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Roofs	21,087	-	21,087	9.4	21,087	8.8	-	-26,365	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Ground/Exposed Floors	-70,744	-	-70,744	-31.5	-70,744	-29.6	-	-12,838	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
External Doors	1,340	-	1,340	0.6	1,340	0.6	-	-1,911	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Windows Conduction	4,301	-	4,301	1.9	4,301	1.8	-	-11,523	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Skylights Conduction	826	-	826	0.4	826	0.3	-	-5,570	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Solar	47,122	-	47,122	21.0	47,122	19.7	-	0	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Infiltration	965	-	965	0.4	965	0.4	-	-5,102	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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Internal Walls/Openings	2,308	-	2,308	1.0	2,308	1.0	-	-257	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Internal Floors/Air/Furn.	-1,545	-	-1,545	-0.7	-1,545	-0.6	-	4	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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External Walls	-5,472	-	-5,472	-	-5,472	-	-	-12,838	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Roofs	-26,365	-	-26,365	-	-26,365	-	-	-1,911	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Ground/Exposed Floors	-12,838	-	-12,838	-	-12,838	-	-	0	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
External Doors	-1,911	-	-1,911	-	-1,911	-	-	0	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Windows Conduction	-11,523	-	-11,523	-	-11,523	-	-	0	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Skylights Conduction	-5,570	-	-5,570	-	-5,570	-	-	0	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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Infiltration	-5,102	-	-5,102	-	-5,102	-	-	0	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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Internal Walls/Openings	-257	-	-257	-	-257	-	-	4	-																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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<table border="1"> <thead> <tr> <th>TEMPERATURES</th> <th>Cooling</th> <th>Heating</th> </tr> <tr> <td></td> <td>°F</td> <td>°F</td> </tr> </thead> <tbody> <tr> <td>Supply Air (design)</td> <td>60.0</td> <td>60.0</td> </tr> <tr> <td>Supply Air (actual)</td> <td>60.0</td> <td>60.0</td> </tr> <tr> <td>Return Air (actual)</td> <td>76.1</td> <td>68.9</td> </tr> <tr> <td>Plenum (actual)</td> <td>-</td> <td>-</td> </tr> <tr> <td>Mixed Air (actual)</td> <td>-</td> <td>-</td> </tr> <tr> <td>Fan Blade Temperature Rise (dT)</td> <td>0.9</td> <td>0.9</td> </tr> <tr> <td>Fan Motor Temperature Rise (dT)</td> <td>0.1</td> <td>0.1</td> </tr> <tr> <td>Fan Configuration</td> <td>Blow-through</td> <td>Blow-through</td> </tr> </tbody> </table>										TEMPERATURES	Cooling	Heating		°F	°F	Supply Air (design)	60.0	60.0	Supply Air (actual)	60.0	60.0	Return Air (actual)	76.1	68.9	Plenum (actual)	-	-	Mixed Air (actual)	-	-	Fan Blade Temperature Rise (dT)	0.9	0.9	Fan Motor Temperature Rise (dT)	0.1	0.1	Fan Configuration	Blow-through	Blow-through	<table border="1"> <thead> <tr> <th>AIRFLOW</th> <th>Cooling</th> <th>Heating</th> </tr> <tr> <td></td> <td>cfm</td> <td>cfm</td> </tr> </thead> <tbody> <tr> <td>Supply (design)</td> <td>5,919</td> <td>5,919</td> </tr> <tr> <td>Supply (actual)</td> <td>5,919</td> <td>155</td> </tr> <tr> <td>Reheat Minimum (design)</td> <td>155</td> <td>155</td> </tr> <tr> <td>Leakage at Design Flow</td> <td>0</td> <td>0</td> </tr> <tr> <td>Return (actual)</td> <td>5,919</td> <td>155</td> </tr> <tr> <td>Subtotal and Balance (actual)</td> <td>5,919</td> <td>155</td> </tr> <tr> <td>Ventilation (Requirement)</td> <td>6,906</td> <td>6,906</td> </tr> <tr> <td>Ventilation (actual)</td> <td>5,919</td> <td>155</td> </tr> <tr> <td>Infiltration</td> <td>108</td> <td>108</td> </tr> </tbody> </table>										AIRFLOW	Cooling	Heating		cfm	cfm	Supply (design)	5,919	5,919	Supply (actual)	5,919	155	Reheat Minimum (design)	155	155	Leakage at Design Flow	0	0	Return (actual)	5,919	155	Subtotal and Balance (actual)	5,919	155	Ventilation (Requirement)	6,906	6,906	Ventilation (actual)	5,919	155	Infiltration	108	108																																																																																																																																																																																																																																																																																																																																																																											
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BE19: Design heating loads for baseline and proposed

BE19: Design cooling loads for baseline and proposed

AHVAC18: Modeled fan flow rates

AHVAC06: HVAC System capacities

BE06, BE07, BE08, BE09, BE10: Areas of the building envelope for the proposed and baseline.

AHVAC28: Modeled exhaust air energy recovery airflows

AHVAC26: Modeled ventilation

BE18: Infiltration (cfm)

System Loads Report										Design Model				IES VIRTUAL ENVIRONMENT																																																																																								
07 a Variable Air Volume Reheat [AHU 2 - Classrooms]														VE 2019																																																																																								
AHU COOLING COIL PEAK					SYSTEM PEAK					ZONE HEATING OR REHEAT COIL PEAK																																																																																												
Time of Peak (MoHr:Min)					9 / 15:30					Time of Peak (MoHr:Min)																																																																																												
Outside Air (DBWB/RH)					84.2 / 63.7 / 31.3					Outside Air (DBWB/RH)																																																																																												
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Zones		RA Plenum	Net Value	Percent of Total	Zones	RA Plenum	Net Value	Percent of Total	Zones	RA Plenum	Net Value	Percent of Total	AREAS																																																																																									
														Gross	Glass	Glass %																																																																																						
														RF	RF	%																																																																																						
Envelope Gains/Losses		Bluh	Bluh	%	Bluh	%			Envelope Gains/Losses		Bluh	Bluh	%	Wall	17,640.9	4,824.0	27.3																																																																																					
External Walls		7,532	-	7,532	1.8	7,532	2.6			-11,212	-	-11,212	Roof	44,109.6	0.0	0.0																																																																																						
Roofs		20,872	-	20,872	5.1	20,872	7.2			-44,905	-	-44,905	External Floor	44,109.6	-	-																																																																																						
Ground/Exposed Floors		-103,668	-	-103,668	-25.1	-103,668	-35.7			-28,566	-	-28,566	Door	0.0	-	-																																																																																						
External Doors		0	-	0	0.0	0	0.0			0	-	0	Partition/Door	20,883.3	-	-																																																																																						
Windows Conduction		15,335	-	15,335	3.7	15,335	5.3			-35,021	-	-35,021	Internal Ceiling	0.0	-	-																																																																																						
Skylights Conduction		0	-	0	0.0	0	0.0			0	-	0	Internal Floor	0.0	-	-																																																																																						
Solar		51,392	-	51,392	12.5	51,392	17.7			0	-	0																																																																																										
Infiltration		3,452	-	3,452	0.8	3,452	1.2			-11,499	-	-11,499																																																																																										
Nat/Aux Vent		0	-	0	0.0	0	0.0			0	-	0																																																																																										
Internal Building Gains/Losses										Internal Building Gains/Losses																																																																																												
Internal Walls/Opening		141	-	141	0.0	141	0.0			-1,631	-	-1,631																																																																																										
Internal Floors/AirFurn		-174	-	-174	-0.1	-174	-0.1			-7	-	-7																																																																																										
Ceilings		0	-	0	0.0	0	0.0			0	-	0																																																																																										
Duct Conduction		0	-	0	0.0	0	0.0			0	-	0																																																																																										
Duct Leakage †		0	-	0	0.0	0	0.0			0	-	0																																																																																										
Non-Principal Spaces		0	-	0	0.0	0	0.0			0	-	0																																																																																										
Sub Total		-5,117	0	-5,117	-	-5,117	-			-132,841	0	-132,841																																																																																										
Internal Gains										Internal Gains																																																																																												
Lights		126,181	-	126,181	30.6	126,181	43.5			0	-	0																																																																																										
People		151,874	-	151,874	38.8	151,874	52.3			0	-	0																																																																																										
Misc. Computers, Equip		17,195	-	17,195	4.2	17,195	5.9			0	-	0																																																																																										
Sub Total		295,250	0	295,250		295,250				0	0	0																																																																																										
Mechanical Gains/Losses										Mechanical Gains/Losses																																																																																												
Ventilation (sensible)		94,293	-	94,293	22.9	-	-			-337,592	-	-337,592																																																																																										
Transfer Air †		0	-	0	-	-	-			0	-	0																																																																																										
SA Duct Leakage †		0	-	0	-	-	-			0	-	0																																																																																										
Fans		28,154	-	28,154	6.8	-	-			16,308	-	16,308																																																																																										
SA Duct (conduction)		0	-	0	0.0	-	-			0	-	0																																																																																										
Supply Air Plenum		0	-	0	0.0	-	-			0	-	0																																																																																										
Room Units, Coils, etc.		0	-	0	0.0	-	-			160,462	-	160,462																																																																																										
Latent Cooling		0	-	0	0.0	-	-			0	-	0																																																																																										
Dehumid Oversizing †		0	-	0	0.0	-	-			0	-	0																																																																																										
Sub Total		122,447	0	122,447	0	-	-			-160,824	0	-160,824																																																																																										
TOTAL		412,580	0	412,580	100	290,133				-293,665	0	-293,665																																																																																										
COOLING COILS					HEATING COILS																																																																																																	
Total Capacity		Sensible Cap	Airflow	Enter DB / WB / RH	Leave DB / WB / RH	Total Capacity		Airflow	Enter	Leave																																																																																												
ton		Mbh	cfm	°F °F %	°F °F %	Mbh		cfm	°F	°F																																																																																												
System Cooling †		39.5	474.4	474.5	17.31	81.3	63.6	36.9	59.5	55.4	77.8																																																																																											
Ventilation		-	-	-	-	-	-	-	-	-	-																																																																																											
Indirect Evap		-	-	-	-	-	-	-	-	-	-																																																																																											
Direct Evap		-	-	-	-	-	-	-	-	-	-																																																																																											
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BE19: Design heating loads for baseline and proposed

BE19: Design cooling loads for baseline and proposed

AHVAC18: Modeled fan flow rates

AHVAC06: HVAC System capacities

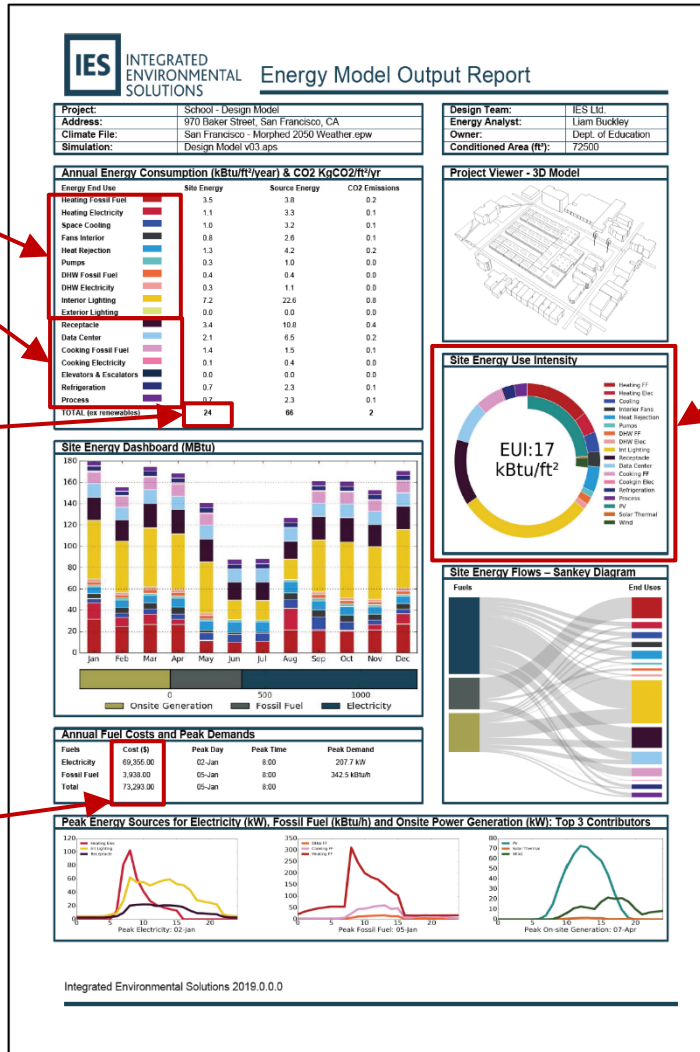
BE06, BE07, BE08, BE09, BE10: Areas of the building envelope for the proposed and baseline.

AHVAC28: Modeled exhaust air energy recovery airflows

AHVAC26: Modeled ventilation

BE18: Infiltration (cfm)

Energy Model Output Report



Regulated Energy

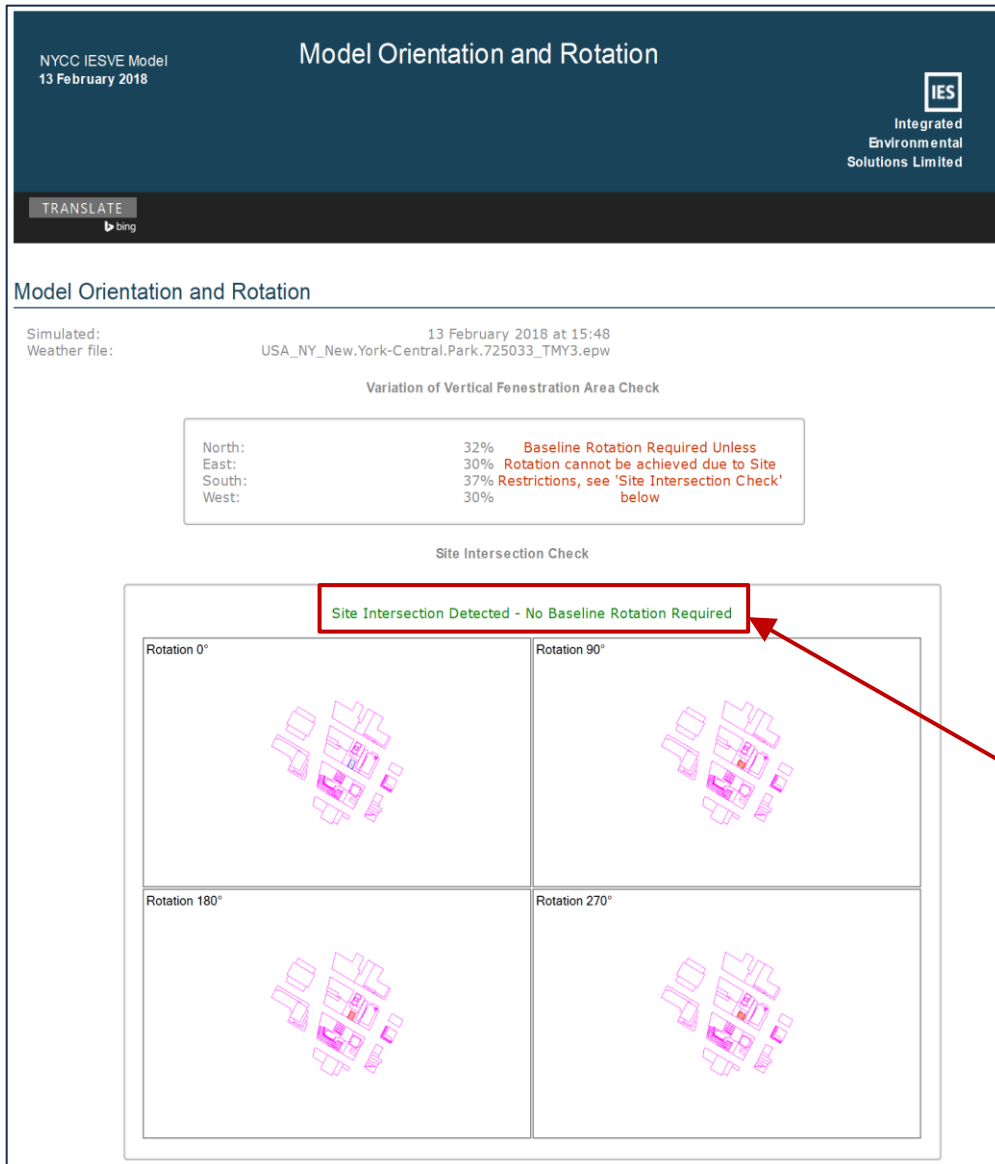
Unregulated Energy

SG10: Site Energy Use Intensity (EUI) [without Renewables]

UR03: Modeled utility rate structure as reported. Take the dollar values on the Utility Costs report divided by these values to determine the virtual rate

SG10: Site Energy Use Intensity (EUI) [with Renewables]

Model Orientation and Rotation Check Report



BE21: Baseline 4 rotations checked for any site restrictions to determine if 1 or 4 baseline models are required

BPRM Report

NYCC IESVE Model.mt
 General info Space summary Advisory messages Proceed vs Baseline
 Energy type summary On site renewables Reciprocal rate measure Report

TRANSLATE
 English

1.1 General information

1.1.1 General information

Company name: Mayor of the City of New York
Simulation program: Integrated Environmental Solutions Virtual Environment version 2017
Energy Code: ASHRAE 90.1 - 2013 Appendix G
Model data: Project file: NYCC IESVE Model.mt
 Model floor area? 21500.00 sq ft
 Building floor area? 21600.00 sq ft
 Building volume? 302400.16 cu ft
 Number of conditioned spaces 92
 No. of floors 9

Heating calculation data:
 Parcelled heating system Elevating
 Results file Room and Zone Loads_0819_10 Calculated
 Date 12/19/2018 17:11

Cooling calculation data:
 Parcelled cooling system Elevating
 Results file Room and Zone Loads_0819_10 Calculated
 Date 12/19/2018 17:11

Design weather:
 Model location NYCC Center Park, New York
 Results file C:\NYCC\VirtualEnvironment\DesignWeather\DesignWeather_0819_10
 Date 12/19/2018 17:11

Climate zone: ASHRAE 90.1 - 2013 Appendix G
 Climate zone 6A
 Cooperating design 026

Construction:
 New construction % 100
 Existing construction % 0

SG05: Conditioned Floor Area

1.2 - Space Summary

Building Use (Occupancy type)	Conditioned Area		Un-conditioned Area		Total Area
	H/L	H/L	H/L	H/L	
AZ					
SPACE: Dining area - Cafeteria or fast food dining	375		0		375
SPACE: Electrical/Mechanical	123		0		123
SPACE: Lobby	667		0		667
SPACE: Office - Open plan	20,420		0		20,420
Totals	21,600.0		0.0		21,600.0

1.3 - Advisory Messages

Advisory Messages	Proposed Building	Baseline Building	Difference
Number of hours heating loads not met	0.0	0.5	-0.5
Number of hours cooling loads not met	0.0	0.5	-0.5
Number of warning messages	0	0	0.0
Number of defaults or errors	0	0	0.0

SG08: Unmet hours

BE06, BE07, BE08, BE09, BE10:
 Thermal properties of the building envelope for the proposed and baseline

BE16: Baseline and Proposed Fenestration Properties

BE14: Baseline and Proposed Fenestration Areas

1.4 - Comparison of Proposed versus Baseline Design

Model Input parameter Construction	Proposed		Baseline	
	Description	Input U value / % (area weighted)	Description	Input U value / % (area weighted)
Exterior wall construction	Steel Framing at 24 in. OC (R-15 Ins. + R-25.0 Cont. Ins.)	0.03	C24 Ext Wall (Non-Res) - Steel Framed, R=13.0 + 7.5 c.i. U=0.064 (0.363)	0.06
Roof construction	Roofs with Insulation Entirely Above Deck (R-30 Ins.)	0.03	C24 Roof (Non-Res) - Ins Above Deck, R=30 U=0.032 (0.182)	0.03
Floor/slab construction	Steel Joists Floor with Batt Insulation (R-25 Ins. + R-10.0 Cont. Ins.)	0.03	Ground contact floor.	0.06
Floor/slab construction			C24 Floor (Non-Res) - Steel Joist, R=30.0; U=0.038 (R 218)	0.04
Window to gross wall ratio	Overall	32% Overall	Overall	31%
Window to gross wall ratio	North / South / East / West	32 / 37 / 30 / 30%	North / South / East / West	31 / 37 / 29 / 29%
Fenestration U-Value (North)	High Performance Glazing U-0.26 SHGC-0.25 VLT-0.70	0.26	C24 Window (Non-Res) - Metal Framing (operable) U=0.50; SHGC=0.40; VT=0.44	0.50
Fenestration U-Value (non - North)	High Performance Glazing U-0.26 SHGC-0.25 VLT-0.70	0.26	C24 Window (Non-Res) - Metal Framing (operable) U=0.50; SHGC=0.40; VT=0.44	0.50
Fenestration SHGC - North	High Performance Glazing U-0.26 SHGC-0.25 VLT-0.70	0.26	C24 Window (Non-Res) - Metal Framing (operable) U=0.50; SHGC=0.40; VT=0.44	0.40
Fenestration SHGC - non - North	High Performance Glazing U-0.26 SHGC-0.25 VLT-0.70	0.26	C24 Window (Non-Res) - Metal Framing (operable) U=0.50; SHGC=0.40; VT=0.44	0.40
Fenestration visual light transmittance (N)	High Performance Glazing U-0.26 SHGC-0.25 VLT-0.70	0.70	C24 Window (Non-Res) - Metal Framing (operable) U=0.50; SHGC=0.40; VT=0.44	0.44
Fenestration visual light transmittance	High Performance Glazing U-0.26 SHGC-0.25 VLT-0.70	0.70	C24 Window (Non-Res) - Metal Framing (operable) U=0.50; SHGC=0.40; VT=0.44	0.44
Shading devices	Local shading	Geometry None		n/a

Model Input parameter	Description	Proposed	Baseline
MEP			
Other Lighting Controls	Photocell Sensors	Yes	No
Interior lighting power density	Total power density (Btu/h-ft²)	1.76	1.76
Day lighting controls	Radiance simulation	Yes	Yes
Exterior lighting power	consumption (kBtu/h)	1.36	3.07
Process lighting	Total power density (Btu/h-ft²)	0.00	0.00
Receptacle equipment	Total power density (Btu/h-ft²)	4.93	4.93
Elevators/escalators	Total power consumption (kBtu/h)	13.65	13.65
Refrigeration equipment	Total power density (Btu/h-ft²)	0.06	0.06
Cooking equipment	Total power density (Btu/h-ft²)	0.09	0.09
Data processing/centre equipment	Total power density (Btu/h-ft²)	0.03	0.03
HVAC			
Primary HVAC system	System with DCV	11546 cfm	Varies
Other HVAC system	CRAC, DOASH+FCU	106 & 444 cfm	Varies
Fan supply power	Advanced VAV	11,546 cfm	Varies per system
Economiser control	Dry-bulb high-limit economizer with mixed-air target	55F	55F
Demand control ventilation	Yes	800-1200 ppm	n/a
Unitary equip cooling efficiency	n/a	n/a	n/a
Unitary equip heating efficiency	n/a	n/a	n/a
Chiller	EWC Chiller, VSD sec' pump	566.8 kBtu/h	893.63 kBtu/h
Chilled water loop and pump	Primary/Secondary	566.8 kBtu/h and 2.2 kW	893.63 kBtu/h
Boiler	Condensing Boilers, Primary-only HW Loop, w/ HR, Outdoor reset, Var-speed pump	171.8 kBtu/h each	370.54 kBtu/h
Hot water loop and pump	Preheat from CWL	343.73 kBtu/h and 0.56 kW	741 kBtu/h & 0.56 kW
Cooling tower	CWL Cooling Tower	672 kBtu/h	1058.9 kBtu/h
Condenser water loop and pump	Connected Single Pump	672 kBtu/h & 2.2 kW	4,022 kW

LI07: Lighting Power Densities for the Space-By-Space Method

LE03: Baseline & Proposed Exterior Lighting Power

AHVAC06: Baseline Equipment Size

WHVAC16: Hot water plant controls

AHVAC04: HVAC System type and system type information

AHVAC06: HVAC System capacities

SG09: Space heating end use.
WHVAC22: Baseline and Proposed heating fuels

Energy Type	Proposed / Baseline design	Utility rate description	Units of Energy	Units of demand
Electricity			kBtu	MBH
Gas			kBtu	MBH

Renewable Source	Backup Energy Type	Annual Energy Generated (kBtu)	Rated Capacity (MBH)	Renewable Energy (kBtu)
Photovoltaic Panels	Electricity	14,100.83	14.25	0.00
Wind Power	Electricity	30,700.21	27.30	0.00
Combined Heat and Power (electricity)	Electricity	0.00	0.00	0.00
Solar Water Heating	Electricity	0.00	0.00	0.00

EC03: Exceptional Calculations

RE03: Renewable Energy

End Use	Process	Baseline Energy Type	Units of Energy	Baseline	Proposed	Baseline	Proposed	Baseline	Proposed
Combined Heat and Power	No	Gas	Energy use kBtu	0.00	0.00	0.00	0.00	0.00	0.00
Combined Heat and Power	No	Gas	Demand MBH	0.00	0.00	0.00	0.00	0.00	0.00
Interior Lighting	Yes	Electricity	Energy use kBtu	10,140.00	10,140.00	10,140.00	10,140.00	10,140.00	10,140.00
Interior Lighting	Yes	Electricity	Demand MBH	18.15	18.15	18.15	18.15	18.15	18.15
Space Heating (Fossil Fuels)	No	Gas	Energy use kBtu	282,911.50	282,911.50	282,911.50	282,911.50	282,911.50	282,911.50
Space Heating (Fossil Fuels)	No	Gas	Demand MBH	484.09	484.09	484.09	484.09	484.09	484.09
Space Heating	No	Electricity	Energy use kBtu	0.00	0.00	0.00	0.00	0.00	0.00
Space Heating	No	Electricity	Demand MBH	0.00	0.00	0.00	0.00	0.00	0.00
Space Cooling	No	Electricity	Energy use kBtu	109,791.36	0.00	0.00	0.00	109,791.36	0.00
Space Cooling/Demand	No	Electricity	Demand MBH	199.58	0.00	0.00	0.00	199.58	0.00
Pumps	No	Electricity	Energy use kBtu	20,874.11	0.00	0.00	0.00	20,874.11	0.00
Fan Process	No	Electricity	Energy use kBtu	2.88	0.00	0.00	0.00	2.88	0.00
Fan Process/Demand	No	Electricity	Demand MBH	0.00	0.00	0.00	0.00	0.00	0.00
Fan Process	No	Electricity	Energy use kBtu	12.54	0.00	0.00	0.00	12.54	0.00
Fan Process/Demand	No	Electricity	Demand MBH	0.00	0.00	0.00	0.00	0.00	0.00
Fan Process	No	Electricity	Energy use kBtu	0.00	0.00	0.00	0.00	0.00	0.00
Fan Process/Demand	No	Electricity	Demand MBH	0.00	0.00	0.00	0.00	0.00	0.00
Device Water Heating (Fossil Fuels)	No	Gas	Energy use kBtu	0.00	0.00	0.00	0.00	0.00	0.00
Device Water Heating (Fossil Fuels)	No	Gas	Demand MBH	0.00	0.00	0.00	0.00	0.00	0.00
Service Water Heating (Fossil Fuels)	No	Electricity	Energy use kBtu	48,847.28	0.00	0.00	0.00	48,847.28	0.00
Service Water Heating	No	Electricity	Demand MBH	18.15	0.00	0.00	0.00	18.15	0.00
Receptacle Equipment	Yes	Electricity	Energy use kBtu	287,479.36	0.00	0.00	0.00	287,479.36	0.00
Receptacle Equipment	Yes	Electricity	Demand MBH	99.75	0.00	0.00	0.00	99.75	0.00
Interior Lighting Process	Yes	Electricity	Energy use kBtu	0.00	0.00	0.00	0.00	0.00	0.00
Interior Lighting	Yes	Electricity	Demand MBH	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	Yes	Electricity	Energy use kBtu	11,208.06	0.00	0.00	0.00	11,208.06	0.00
Refrigeration/Demand	Yes	Electricity	Demand MBH	20.20	0.00	0.00	0.00	20.20	0.00
Data Centre Equipment	Yes	Electricity	Energy use kBtu	3,078.07	0.00	0.00	0.00	3,078.07	0.00
Data Centre	Yes	Electricity	Demand MBH	5.66	0.00	0.00	0.00	5.66	0.00
Cooling (Fossil Fuels)	Yes	Gas	Energy use kBtu	1,884.36	0.00	0.00	0.00	1,884.36	0.00
Cooling (Fossil Fuels)	Yes	Gas	Demand MBH	3.45	0.00	0.00	0.00	3.45	0.00
Cooling/Demand	Yes	Electricity	Energy use kBtu	4,391.98	0.00	0.00	0.00	4,391.98	0.00
Cooling	Yes	Electricity	Demand MBH	1.27	0.00	0.00	0.00	1.27	0.00
Heat Recovery	Yes	Electricity	Energy use kBtu	49,841.18	0.00	0.00	0.00	49,841.18	0.00
Heat Recovery/Demand	Yes	Electricity	Demand MBH	13.98	0.00	0.00	0.00	13.98	0.00
Heat Recovery	No	Electricity	Energy use kBtu	94,700.91	0.00	0.00	0.00	94,700.91	0.00
Heat Recovery/Demand	No	Electricity	Demand MBH	24.07	0.00	0.00	0.00	24.07	0.00
Humidification	No	Electricity	Energy use kBtu	0.00	0.00	0.00	0.00	0.00	0.00
Humidification/Demand	No	Electricity	Demand MBH	0.00	0.00	0.00	0.00	0.00	0.00
Humidification (Fossil Fuels)	No	Gas	Energy use kBtu	0.00	0.00	0.00	0.00	0.00	0.00
Humidification (Fossil Fuels)	No	Gas	Demand MBH	0.00	0.00	0.00	0.00	0.00	0.00
Other Processes	Yes	Electricity	Energy use kBtu	0.00	0.00	0.00	0.00	0.00	0.00
Other Processes/Demand	Yes	Electricity	Demand MBH	0.00	0.00	0.00	0.00	0.00	0.00
Other Processes (Fossil Fuels)	No	Gas	Energy use kBtu	0.00	0.00	0.00	0.00	0.00	0.00
Other Processes (Fossil Fuels)	No	Gas	Demand MBH	0.00	0.00	0.00	0.00	0.00	0.00
Total Process Energy Use (kWh)				1,138,840.30	1,138,840.30	1,138,840.30	1,138,840.30	1,138,840.30	1,138,840.30

BE21: Baseline 4 rotations and average

LI11: Interior Lighting Annual Energy
LI10: Interior Lighting Peak Demand

LE06, LE07: Exterior Lighting Energy

LI11: Lighting Full Load Hours – This needs to be calculated as FLH = Energy Use/Demand

Unmet Hours Report

NYCC IESVE Model		Unmet Load Hours		INTEGRATED ENVIRONMENTAL SOLUTIONS LTD
Building Unmet Load Hours Report				
Simulated: 13/Feb/2018 at 17:43				
Weather file: USA_NY_New.York-Central.Park.725033_TMY3.epw				
	Building	Heating set-point Unmet load hours	Cooling set-point Unmet load hours	Total Unmet load hours
Unmet Load Hours	Proposed	0	0	0
	Baseline 0 deg	0	0	0
	Baseline 90 deg	0	0	0
	Baseline 180 deg	0	0	0
	Baseline 270 deg	0	0	0
	Baseline average	0	0	0
	Checks: Are all Unmet load hours less than 300 hours?			
Proposed versus average baseline unmet load hours is less than 50 hours?				Yes
Note: The following spaces have undergone an ASHRAE 55 analysis in the proposed model and are excluded from the UMLH calculation shown in Table 1.3: L1 Office (RAPenum), L1 Office (c) (RAPenum), L1 Office (p 1) (RAPenum), L1 Office (p 2) (RAPenum), L1 Office (p 3) (RAPenum), L1 Office (p 4) (RAPenum), L2 Office (1) (c) (RAPenum), L2 Office (1) (p 1) (RAPenum), L2 Office (1) (p 2) (RAPenum), L2 Office (1) (p 3) (RAPenum), L2 Office (1) (p 4) (RAPenum), L3 Office (1) (c) (RAPenum), L3 Office (1) (p 1) (RAPenum), L3 Office (1) (p 2) (RAPenum), L3 Office (1) (p 3) (RAPenum), L3 Office (1) (p 4) (RAPenum), L4 Office (1) (c) (RAPenum), L4 Office (1) (p 1) (RAPenum), L4 Office (1) (p 2) (RAPenum), L4 Office (1) (p 3) (RAPenum), L4 Office (1) (p 4) (RAPenum), L5 Office (1) (c) (RAPenum), L5 Office (1) (p 1) (RAPenum), L5 Office (1) (p 2) (RAPenum), L5 Office (1) (p 3) (RAPenum), L5 Office (1) (p 4) (RAPenum), L6 Office (1) (c) (RAPenum), L6 Office (1) (p 1) (RAPenum), L6 Office (1) (p 2) (RAPenum), L6 Office (1) (p 3) (RAPenum), L6 Office (1) (p 4) (RAPenum), L7 Office (1) (c) (RAPenum), L7 Office (1) (p 1) (RAPenum), L7 Office (1) (p 2) (RAPenum), L7 Office (1) (p 3) (RAPenum), L7 Office (1) (p 4) (RAPenum), L8 Office (1) (c) (RAPenum), L8 Office (1) (p 1) (RAPenum), L8 Office (1) (p 2) (RAPenum), L8 Office (1) (p 3) (RAPenum), L8 Office (1) (p 4) (RAPenum), L9 Office (1) (c) (RAPenum), L9 Office (1) (p 1) (RAPenum), L9 Office (1) (p 2) (RAPenum), L9 Office (1) (p 3) (RAPenum), L9 Office (1) (p 4) (RAPenum), L1 Kitchen and L1 Data Center				

Detailed Simulation Report

LEED Model 01		Building Energy Performance															INTEGRATED ENVIRONMENTAL SOLUTIONS LTD IES								
10/Jul/2018																									
Simulated: 10/Jul/2018 at 15:58 Weather file: SAN-FRANCISCO-INTL_724940_CZ2010.epw																									
Building Energy Performance	Fuel type	Internal Lighting Electricity MBtu	Exterior Lighting Electricity MBtu	Space Heating Fossil Fuel MBtu	Space Cooling Electricity MBtu	Pumps Electricity MBtu	Heat Rejection Electricity MBtu	Fans Process Electricity MBtu	Fans Interior Electricity MBtu	Fans Parking Garage Electricity MBtu	Service Water Heating Fossil Fuel MBtu	Service Water Heating Electricity MBtu	Receptacle Equipment Electricity MBtu	Interior Lighting Process Electricity MBtu	Refrigeration Electricity MBtu	Data Centre Equipment Electricity MBtu	Elevators Escalators Electricity MBtu	Space Heating Electricity MBtu	Cooking Electricity MBtu	Cooking Fossil Fuel MBtu	Cooking Fossil Fuel MBtu	Generated Electricity MBtu	Total Electricity MBtu	Total kBTU ^h gross	Total kBTU ^h net
	Electricity	16.1	1.6	0.0	10.4	13.7	29.0	0.0	9.2	0.0	0.0	0.0	61.3	0.0	0.0	0.0	20.5	0.3	0.0	0.0	0.0	-18.3	143.7	28.74	NaN
	Fossil Fuels	0.0	0.0	62.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	72.0	14.40	NaN
Totals		16.1	1.6	62.8	10.4	13.7	29.0	0.0	9.2	0.0	9.2	0.0	61.3	0.0	0.0	0.0	20.5	0.3	0.0	0.0	0.0	-18.3	215.7		
Total Site energy:																						43.14	NaN		
		TOTAL SITE ENERGY										215.70 MBtu										43.1 kBtu / ft ² -yr gross-area			
Notes:		Energy is reported hourly to all end use categories This report lists delivered or site energy (energy summated across the building boundary or metering point)																							

LEED Model 01		Building Utility Performance															INTEGRATED ENVIRONMENTAL SOLUTIONS LTD IES								
10/Jul/2018																									
TRANSLATE																									
Simulated: 10/Jul/2018 at 15:58 Weather file: SAN-FRANCISCO-INTL_724940_CZ2010.epw																									
Building Utility Performance	Fuel type	Internal Lighting Electricity kWh	Exterior Lighting Electricity kWh	Space Heating Fossil Fuel kWh	Space Cooling Electricity kWh	Pumps Electricity kWh	Heat Rejection Electricity kWh	Fans Process Electricity kWh	Fans Interior Electricity kWh	Fans Parking Garage Electricity kWh	Service Water Heating Fossil Fuel kWh	Service Water Heating Electricity kWh	Receptacle Equipment Electricity kWh	Interior Lighting Process Electricity kWh	Refrigeration Electricity kWh	Data Centre Equipment Electricity kWh	Elevators Escalators Electricity kWh	Space Heating Electricity kWh	Cooking Electricity kWh	Cooking Fossil Fuel kWh	Cooking Fossil Fuel kWh	Generated Electricity kWh	Total Electricity kWh	Total kWh gross	Total kWh net
	All fuels SI units:	4,712	482	0	3,043	4,008	8,495	0	2,689	0	0	0	17,959	0	0	0	5,996	95	0	0	0	-5,364	42,114	8.42	NaN
	Fossil Fuels	0	0	18,406	0	0	0	0	0	0	0	2,695	0	0	0	0	0	0	0	0	0	0	21,100	4.22	NaN
Renewables	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	NaN
Totals		4,712	482	18,406	3,043	4,008	8,495	0	2,689	0	2,695	0	17,959	0	0	0	5,996	95	0	0	0	-5,364	63,215	12.64	NaN
Fossil Fuels only alternative units (MBtu):																									
Fossil Fuels	0.0	0.0	62.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	72.0	0.01	NaN	
Totals		0.0	0.0	62.8	0.0	0.0	0.0	0.0	0.0	0.0	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	72.0	0.01	NaN
		TOTAL ELECTRICITY										42,114.5 kWh										8.423 kWh / ft ² -yr gross area			
		TOTAL FOSSIL FUELS										72.0 MBtu										0.014 MBtu / ft ² -yr gross area			
Notes:		Energy is reported hourly to all end use categories This report lists delivered or site energy (energy summated across the building boundary or metering point)																							

Month	Category	Annual Energy Use (kBtu)	Annual Energy Intensity (kBtu/sq ft)	Peak Demand (kW)	Peak Demand Intensity (kW/sq ft)	Annual Energy Cost (\$)	Annual Energy Intensity Cost (\$/sq ft)	Peak Demand Cost (\$/hr)	Peak Demand Intensity Cost (\$/sq ft)
January	WH	2,268.9	3.98	0.0	0.0	1,289.9	2.20	0.0	0.0
February	WH	1,620.0	2.80	0.0	0.0	900.0	1.62	0.0	0.0
March	WH	1,125.0	1.93	0.0	0.0	625.0	1.13	0.0	0.0
April	WH	825.0	1.42	0.0	0.0	450.0	0.83	0.0	0.0
May	WH	675.0	1.17	0.0	0.0	367.5	0.68	0.0	0.0
June	WH	525.0	0.91	0.0	0.0	283.5	0.53	0.0	0.0
July	WH	420.0	0.73	0.0	0.0	224.0	0.42	0.0	0.0
August	WH	375.0	0.66	0.0	0.0	206.25	0.38	0.0	0.0
September	WH	330.0	0.58	0.0	0.0	181.5	0.34	0.0	0.0
October	WH	285.0	0.50	0.0	0.0	157.5	0.29	0.0	0.0
November	WH	240.0	0.42	0.0	0.0	132.0	0.24	0.0	0.0
December	WH	202.5	0.36	0.0	0.0	111.375	0.21	0.0	0.0
Annual	WH	26,906.4	46.86	0.0	0.0	15,026.0	27.62	0.0	0.0

Month	Category	Space Heating	Service Water Heating	Cooling	Other
January	WH	2,268.9	0.0	0.0	0.0
February	WH	1,620.0	0.0	0.0	0.0
March	WH	1,125.0	0.0	0.0	0.0
April	WH	825.0	0.0	0.0	0.0
May	WH	675.0	0.0	0.0	0.0
June	WH	525.0	0.0	0.0	0.0
July	WH	420.0	0.0	0.0	0.0
August	WH	375.0	0.0	0.0	0.0
September	WH	330.0	0.0	0.0	0.0
October	WH	285.0	0.0	0.0	0.0
November	WH	240.0	0.0	0.0	0.0
December	WH	202.5	0.0	0.0	0.0
Annual	WH	26,906.4	0.0	0.0	0.0

AHVAC19: Fan Peak Demand & AHVAC18

SWH06: Service Hot Water full load hours, SWH06: Service Hot Water proposed

Month	Total Heating Load (MMBtu)	Total Cooling Load (MMBtu)	Total Elec. Input (MMBtu)	Recovered Energy (MMBtu)	Cooling Energy (MMBtu)	Fuel Input Heating (MMBtu)	Fuel Input Cooling (MMBtu)	Total Fuel Input (MMBtu)	Site Total Energy (MMBtu)	Pumps (MMBtu)	Heat Rejection (MMBtu)
January	72.2	0.0	0.0	0.0	145.4	0.0	0.0	70.0	118.70	123.1	1.9
February	50.7	0.0	0.0	0.0	101.4	0.0	0.1	46.6	87.47	94.9	1.8
March	38.9	0.0	0.0	0.1	86.1	0.0	0.8	32.6	89.32	88.1	2.0
April	24.8	0.0	0.0	0.9	45.5	0.0	1.3	17.9	54.18	60.5	2.1
May	16.1	0.0	0.0	3.9	6.8	0.0	6.6	9.2	3.8	9.3	6.1
June	10.0	0.0	0.0	8.8	-8.9	0.0	13.9	2.1	4.1	2.3	6.0
July	8.4	0.0	0.0	133.2	0.0	-51.6	0.0	24.9	0.7	3.9	0.8
August	9.6	0.0	0.0	114.1	0.0	-34.2	0.0	20.5	1.7	4.2	1.8
September	11.8	0.0	0.0	63.6	0.0	-7.8	0.0	10.5	4.3	3.9	4.5
October	20.6	0.0	0.0	10.4	0.0	-31.3	0.0	1.9	14.0	3.9	14.2
November	32.5	0.0	0.0	5.9	0.0	-58.0	0.0	0.1	26.8	4.8	26.9
December	57.1	0.0	0.0	0.1	0.0	-120.0	0.0	0.0	52.6	8.8	52.7
Total	352.7	0.0	0.0	456.6	0.0	600.2	0.0	79.8	278.5	72.3	280.0

Hour	Hourly Heating Load (MMBtu)	Sensible Heat Ratio	Hourly Heating Temp (F)	Hourly Heating Load (MMBtu)	Hourly Cooling Load (MMBtu)	Hourly Cooling Temp (F)	Sensible Heat Ratio	Hourly Cooling Temp (F)	Hourly Heating Load (MMBtu)	Hourly Cooling Load (MMBtu)
00:00	0.0	0.0	68.1	68.9	0.0	0.0	0.0	0.0	0.0	68.1
01:00	0.0	0.0	68.0	68.0	0.0	0.0	0.0	0.0	0.0	68.0
02:00	0.0	0.0	68.0	68.0	0.0	0.0	0.0	0.0	0.0	68.0
03:00	0.0	0.0	68.0	68.0	0.0	0.0	0.0	0.0	0.0	68.0
04:00	0.0	0.0	68.1	68.8	0.0	0.0	0.0	0.0	0.0	68.1
05:00	0.0	0.0	68.1	68.1	0.0	0.0	0.0	0.0	0.0	68.1
06:00	347.4	2.54	68.1	68.1	0.0	0.0	0.0	347.4	2.54	68.1
07:00	0.0	0.0	68.1	68.1	0.0	0.0	0.0	0.0	0.0	68.1
08:00	5,198.6	2.97	70.0	68.0	0.0	0.0	0.0	5,198.6	2.97	70.0
09:00	4,907.8	1.62	71.1	69.6	0.0	0.0	0.0	4,907.8	1.62	71.1
10:00	4,784.2	1.33	72.0	70.7	0.0	0.0	0.0	4,784.2	1.33	72.0
11:00	4,271.1	1.20	72.0	70.7	0.0	0.0	0.0	4,271.1	1.20	72.0
12:00	3,937.7	1.11	73.9	70.6	0.0	0.0	0.0	3,937.7	1.11	73.9
13:00	3,822.2	1.08	75.0	71.6	0.0	0.0	0.0	3,822.2	1.08	75.0
14:00	3,828.1	1.08	76.1	71.6	0.0	0.0	0.0	3,828.1	1.08	76.1
15:00	3,828.9	1.07	76.1	72.0	0.0	0.0	0.0	3,828.9	1.07	76.1
16:00	3,776.8	1.06	75.0	69.0	0.0	0.0	0.0	3,776.8	1.06	75.0
17:00	3,798.0	1.07	75.0	69.0	0.0	0.0	0.0	3,798.0	1.07	75.0
18:00	0.0	0.0	73.9	68.0	0.0	0.0	0.0	0.0	0.0	73.9
19:00	623.4	1.00	72.0	69.2	0.0	0.0	0.0	623.4	1.00	72.0
20:00	0.0	0.0	70.0	66.9	0.0	0.0	0.0	0.0	0.0	70.0
21:00	0.0	0.0	70.0	64.8	0.0	0.0	0.0	0.0	0.0	70.0
22:00	0.0	0.0	68.0	64.1	0.0	0.0	0.0	0.0	0.0	68.0
23:00	0.0	0.0	66.9	63.7	0.0	0.0	0.0	0.0	0.0	66.9
PEAK:	5,198.6							5,198.6		

NYCC IESVE Model Equipment Loads and Energy Use
 13/Feb/2018
 Simulation: 13/Feb/2018 at 17:43
 Weather file: USA_NY_NewYork-CentralPark-725023_TMY3.epw

WHVAC19, WHVAC18: HW pump

Reference	Cooling Load (kBtu/h)	Heating Load (kBtu/h)	Electric Use (kBtu/h)	Fuel Use (kBtu/h)	Number of hours within each Part Load range											Total
Sum	Peak	Month/Day	Sum	Peak	00-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100+	
BWC Chiller with default values and VSD screw pump, 2-40 deg tower fan [CR000001, Loop: WL000000]	46875.1	79795.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2855
CWL Pump [Loop: WL000000]	-	-	1407.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7850
CWL Cooling Tower [CR000001, Loop: CD000001]	55708.1	1260.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7850
CW Pump [Loop: CD000001]	646.9	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7850
Natural-Draft Condensing Boiler [BR000015, Loop: HS000000]	167.3	0.0	0.0	20960.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4200
Natural-Draft Condensing Boiler (1) [BR000001, Loop: HS000000]	34824.2	0.0	0.0	27489.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10000

WHVAC03: Average annual realized chiller efficiency

WHVAC09: Annual chilled water pump energy

WHVAC03, WHVAC14: The average realized plant (boiler or chiller) efficiency is the ratio of Heat Load to Fuel Use. In the example, the average efficiency of the Hot Water Plant (Boiler 1 and Boiler 2 combined) is 93.4%.

HW Pump [Loop: HS000000]

Sum	Peak	Month/Day	Flow	Elec	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow
165.7	1.3	8/17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DX Cooling - Pkg Sys 65x15 MBurn COP 3.65 EERnt 13.1 IBER 15.6 IBER 11.0 IBER 12.7 per 90-1-2015 w fan

Sum	Peak	Month/Day	Load	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow	
1658.8	2.6	8/10	43	84	227	77	24	12	20	256	343	125	0	0	0	0	0	0	0	0	1205

AHVAC11: DX cooling efficiencies

NYCC IESVE Model Detailed Equipment Loads and Energy Usage
 13/Feb/2018
 Simulation: 13/Feb/2018 at 17:43
 Weather file: USA_NY_NewYork-CentralPark-725023_TMY3.epw

Chilled Water Loop: One Electric Water-Cooled Chiller with VSD pump on Secondary CEW Loop [RL000000]

Month	Heating Capacity (kBtu/h)		Cooling Capacity (kBtu/h)		Loop Flow (gpm)		% Loss
	Sum	Peak	Sum	Peak	Sum	Peak	
Jan	1095.5	79.8	1036.2	268.0	0.0	0.0	289
Feb	2281.4	102.1	2293.3	307.1	0.0	0.0	368
Mar	7754.7	326.1	7137.0	619.1	15.2	6.5	659
Apr	10157.1	586.1	13075.1	881.1	13.4	6.5	716
May	4898.9	1382.5	4269.1	524.1	61.8	22.3	784
Jun	9406.5	1725.5	9040.4	301.1	140.8	33.5	720
Jul	13075.6	1764.8	12368.6	134.1	105.2	26.3	784



HW Loop: 2 Cooling Boiler, Primary only HW Loop, = BE, Outdoor reset, Variable speed (31400000)

Heating Capacity (kBtu/h)			Cooling Capacity (kBtu/h)												Loop Flow (gpm)		% Load	
341.25			0.00												13.7		0.0	
Month	Sum	Peak	Cool Load (kBtu/h)	Flow (gpm)	Set Point (°F)	Number of hours within each Part Load range												Year Tot (hours)
						0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100		
Jan																		
Sum	8897.3	0.0	8897.3	Heat	138	177	175	133	42	30	22	7	1	0	0	0	74	
Peak	376.6	0.0	376.6	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	187	00	187															
Feb																		
Sum	4930.0	0.0	4930.0	Heat	175	188	165	67	41	28	24	6	0	0	0	0	618	
Peak	274.0	0.0	274.0	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	97	00	97															
Mar																		
Sum	3425.6	0.0	3425.6	Heat	228	142	71	59	28	20	15	2	0	0	0	0	539	
Peak	272.7	0.0	272.7	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	17	00	17															
Apr																		
Sum	2146.3	0.0	2146.3	Heat	309	102	43	26	24	13	2	0	0	0	0	0	435	
Peak	273.0	0.0	273.0	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	97	00	97															
May																		
Sum	1578.2	0.0	1578.2	Heat	143	137	35	5	21	0	0	0	0	0	0	0	344	
Peak	187.1	0.0	187.1	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	97	00	97															
Jun																		
Sum	13173.9	0.0	13173.9	Heat	136	185	71	5	0	0	0	0	0	0	0	0	347	
Peak	120.0	0.0	120.0	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	156	00	156															
Jul																		
Sum	12765.4	0.0	12765.4	Heat	132	208	7	0	0	0	0	0	0	0	0	0	335	
Peak	87.8	0.0	87.8	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	98	00	98															
Aug																		
Sum	12882.7	0.0	12882.7	Heat	129	181	17	1	1	0	0	0	0	0	0	0	341	
Peak	141.3	0.0	141.3	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	306	00	306															

HW Loop: 2 Cooling Boiler, Primary only HW Loop, = BE, Outdoor reset, Variable speed (31400000)

Heating Capacity (kBtu/h)			Cooling Capacity (kBtu/h)												Loop Flow (gpm)		% Load	
341.25			0.00												13.7		0.0	
Month	Sum	Peak	Cool Load (kBtu/h)	Flow (gpm)	Set Point (°F)	Number of hours within each Part Load range												Year Tot (hours)
						0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100		
Sep																		
Sum	12817.2	0.0	12817.2	Heat	143	153	18	10	6	0	0	0	0	0	0	0	335	
Peak	150.0	0.0	150.0	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	306	00	306															
Oct																		
Sum	12255.5	0.0	12255.5	Heat	178	82	47	21	26	4	0	0	0	0	0	0	300	
Peak	181.2	0.0	181.2	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	297	00	297															
Nov																		
Sum	27759.2	0.0	27759.2	Heat	201	104	71	34	30	17	6	2	0	0	0	0	407	
Peak	253.4	0.0	253.4	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	287	00	287															
Dec																		
Sum	14520.2	0.0	14520.2	Heat	196	144	149	70	46	31	30	6	3	0	0	0	660	
Peak	288.9	0.0	288.9	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Day/Hour	337	00	337															
Year																		
Sum	22022.5	0.0	22022.5	Heat	1962	1635	750	375	289	148	91	40	10	1	0	0	5502	
Peak	318.6	0.0	318.6	Flow	0	0	0	0	0	0	0	0	0	0	0	0	0	
Month/Day	179	00	179															

IECC Compliance Report

SG03: Weather File

SG08: Unmet hours

Compliance Forms | International Energy Conservation Code | IE 2018.1.0.0

IES INTEGRATED ENVIRONMENTAL SOLUTIONS

International Energy Conservation Code (IECC) 2012 Page 1 of 2

Project Name: Warehouse
 Project Address: Cedar Club, Cleveland, OH, 44130
 Date: 14-Sept-2018
 Designer of Record: Liam Buckley
 Contact Person: Liam Buckley
 Telephone: 6178101101
 Email: Liam.Buckley@ies.com
 City: Cleveland

Weather File: Comstock171214

Principal Heating Source:
 Fossil Fuel
 Electricity
 Solar/Ge recovered
 Other

Space Summary

Building Use	Conditioned Area (SF)	Unconditioned Area (SF)	Total (SF)
IECC SPACE: Office - Open plan	2018.1	0	2018.1
IECC SPACE: Warehouse - Free overhead storage	10480.0	0	10480.0
IECC SPACE: Warehouse - Medium Duty material storage	34480.0	0	34480.0
Total	15907.1	0	15907.1

Advisory Messages

	Proposed Building Design	Standard Reference Building	Difference Proposed/Standard %
Number of hours heating loads not met (system/plant)	0.0	0.0	0.0
Number of hours cooling loads not met (system/plant)	0.0	0.0	0.0
Number of unmet hours	-	-	-
Number of unmet conditions	-	-	-

Compliance Result:
 The design obtained in the above referenced plans complies with the mandatory provisions of the 2012 International Energy Conservation Code and the design energy cost does not exceed the energy cost standard reference. Therefore, this design DOES COMPLY with the 2012 International Energy Conservation Code.

Signature: _____ Title: _____

AHVAC19: Fan peak demand

Integrated Environmental Solutions Virtual Environment 2018.1.0.0

Compliance Forms | International Energy Conservation Code | IE 2018.1.0.0

IES INTEGRATED ENVIRONMENTAL SOLUTIONS

International Energy Conservation Code (IECC) 2012 Page 2 of 2

Project Name: Warehouse
 Contact Person: Liam Buckley
 Email: Liam.Buckley@ies.com
 Telephone: 6178101101

Energy Results

End Use	Energy Type	Proposed Building Energy (kBtu/yr)	Proposed Building Peak (kBtu/hr)	Standard Reference Building Energy (kBtu/yr)	Standard Reference Building Peak (kBtu/hr)	Proposed/Standard Energy (%)	Proposed/Standard Peak (%)
Lighting - conditioned	Electricity	275,107.2	2.7	307,498.1	135.9	90.3%	30.3%
Lighting - unconditioned	Electricity	275,107.2	2.7	307,498.1	135.9	90.3%	30.3%
Space Heating	Gas	480.5	4.0	1,778,364.5	207.8	27.0%	19.2%
Space Heating	Electricity	79,703.8	125.0	300,220.9	207.8	26.5%	49.0%
Space Heating	Electricity	41,367.7	143.8	60,162.1	217.0	68.8%	34.4%
Local Refrigeration	Electricity	405.5	5.4	1,031.5	2.3	39.3%	24.7%
Refrigeration	Electricity	2,228.8	10.0	4,303.8	17.4	51.8%	57.5%
Water Heating	Electricity	2,420.7	10.0	4,248.0	10.4	57.0%	96.2%
Refrigeration Equipment	Electricity	68,009.3	30.4	68,009.3	30.4	100.0%	100.0%
Office Equipment	Electricity	38,107.0	11.7	38,107.0	11.7	100.0%	100.0%
Process Equipment	Electricity	298,903.8	34.1	298,903.8	34.1	100.0%	100.0%
Total building consumption		1,699,843.3		2,625,527.0		64.7%	37.2%

Energy and Cost Summary by Fuel Type

Fuel Type	Proposed Building		Standard Reference Building		Proposed/Standard Reference	
	Energy (kBtu/yr)	Cost (\$/yr)	Energy (kBtu/yr)	Cost (\$/yr)	Energy (%)	Cost (%)
Electricity	1,625,176.6	153,776.5	1,317,135.5	202,070.9	23.9%	23.9%
Gas	64,666.5	31,268.1	1,716,229.0	183,010.4	3.7%	10.1%
Total on-site generation	1,689,843.1	185,044.6	2,033,364.5	285,081.3	64.7%	38.3%
From Gas PV	146,040.7	21,407.8	0	0	0%	0%
Total on-site generation	1,835,883.8	206,452.4	2,033,364.5	285,081.3	72.7%	38.3%

Note:
 The results are based on 8760 simulated hours.
 11 hours included in the unmet hour check.

RE03: Renewable

Integrated Environmental Solutions Virtual Environment 2018.1.0.0

SG09: Space heating end use. WHVAC22: Baseline and Proposed heating fuels

SG09: Heating, cooling and fan energy between the baseline and proposed

SG06: Number of hours modeled. Full year indicates 8,760 hours.

Florida Energy Code Compliance Report

Florida Building Code, Sixth Edition (2017) - Energy Conservation
ASHRAE 90.1 2013 Energy Cost Budget Method

Applications for compliance with the Florida Building Code, Energy Conservation shall include:

- This Checklist
- The full compliance report generated by the software that contains the project summary, compliance summary, notifications and detailed component compliance reports.
- Results appropriately checked in the Mandatory Section of the compliance report

Project Summary

Description	Inspector	City	Use
Address 1	Address 1	City	Use
Address 2	Address 2	City	Use

Certifications

I certify that this building is in compliance with the Florida Energy Efficiency Code

Design Agent: _____ Date: 10/10/19

Inspector: _____ Date: 10/10/19

Approved by Florida law, I hereby certify that the building design is in compliance with the Florida Energy Efficiency Code

Inspector: _____ Date: 10/10/19

Electrical Designer: _____ Reg. No. 12160

Lighting Designer: _____ Reg. No. 12160

Mechanical Designer: _____ Reg. No. 12160

Plumbing Designer: _____ Reg. No. 12160

Integrated Environmental Solutions
Florida Building Code, Sixth Edition (2017) Energy Conservation - ASHRAE 90.1 2013 ECB Compliance Option

Florida Compliance Report

Project Name: Title _____ Date: 17 May 2019

Address 2, City, Florida, 32140

Designer of Record: First Name Last Name _____ Email: toad@ied.com Telephone: 321400

Contact Person: First Name Last Name _____ Email: toad@ied.com Telephone: 321400

City, State _____

Weather Data: USA_FL_Jacksonville-Craig Field 72269_1M13.csv

Project Heating Source: Fuel Fuel Electricity Solar site received Other

Space Summary

Building Use	Conditioned Area (SF)	Unconditioned Area (SF)	Total (SF)
SPACE - Office - Enclosed -250R2	10300.0	0	10300.0
Total	10300.0	0	10300.0

Advisory Messages

Project Building Design	Budget Building Design	Difference
Number of hours heating loads not met (system/zone)	0.0	0.0
Number of hours cooling loads not met (system/zone)	0.0	0.0
Number of warnings	-	-
Number of critical warnings	-	-

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Florida Building Code, Sixth Edition (2017) Energy Conservation - ASHRAE 90.1 2013 ECB Compliance Option

Florida Compliance Report

Project Name: Title _____ Date: 17 May 2019

Contact Person: First Name Last Name _____ Email: toad@ied.com Telephone: 321400

Energy Results

End Use	Energy Type	Proposed Building		Budget Building		Budget Building Energy (kBtu/yr)	Budget Building Energy (kBtu/yr)
		Energy (kBtu/yr)	Peak (kW)	Energy (kBtu/yr)	Peak (kW)		
Lighting - unconditioned	Electricity	19,363.7	0.0	19,363.7	0.0	19,363.7	0.0%
Lighting - conditioned	Electricity	3,359,409.8	1,191.4	3,220,131.5	1,250.9	3,220,131.5	35.4%
Space Heating	Gas	22,430.7	140.2	0.0	0.0	0.0	0.0%
Space Heating	Electricity	0.0	0.0	107,064.0	406.1	107,064.0	35.9%
Space Cooling	Electricity	3,270,490.2	1,171.8	1,476,541.9	1,003.9	1,476,541.9	28.9%
Heat Rejection	Electricity	394,433.7	105.9	492,942.7	150.7	492,942.7	46.4%
Pumps	Electricity	37,561.9	24.3	192,368.9	72.9	192,368.9	57.4%
Fan Inance	Electricity	152,160.8	177.2	1,386,642.3	265.7	1,386,642.3	63.1%
Service Water Heating	Gas	1,076.0	0.0	1,980.5	0.7	1,980.5	16.2%
Reception Equipment	Electricity	0.0	0.0	0.0	0.0	0.0	0.0%
Office Equipment	Electricity	1,830,704.3	563.0	1,830,704.3	563.0	1,830,704.3	0.0%
Total Heating	Electricity	8,330,000.0	232,022.05	11,105,010.1	296,211.30	11,105,010.1	34.8%

Energy and Cost Summary by Fuel Type

Fuel Type	Proposed Building		Budget Building		Proposed Building	
	Energy (kBtu/yr)	Cost (\$/yr)	Energy (kBtu/yr)	Cost (\$/yr)	Energy (kBtu/yr)	Cost (\$/yr)
Electricity	8,331,000.2	232,496.52	11,105,010.1	296,165.48	25.14%	24.81%
Gas	24,664.8	215.63	1,980.5	26.91	1,164.5%	73.64%
Total on Oracle Generation	8,330,000.0	232,622.05	11,105,010.1	296,211.30	24.0%	24.84%
Total on Oracle Generation	8,330,000.0	232,622.05	11,105,010.1	296,211.30	24.0%	24.84%

Notes: The results are based on 8760 unconditioned hours. 9 hours included in the general heat loads check.

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Florida Building Code, Sixth Edition (2017) Energy Conservation - ASHRAE 90.1 2013 ECB Compliance Option

Lighting Controls

Room	Thermal Template	Area	Result
L00. Room	SPACE - Office - Enclosed -250R2	1895.2	PASSES
L01. Room	SPACE - Office - Enclosed -250R2	1895.2	PASSES
L02. Room	SPACE - Office - Enclosed -250R2	1895.2	PASSES
L03. Room	SPACE - Office - Enclosed -250R2	1895.2	PASSES
L04. Room	SPACE - Office - Enclosed -250R2	1895.2	PASSES
L05. Room	SPACE - Office - Enclosed -250R2	1895.2	PASSES
L06. Room	SPACE - Office - Enclosed -250R2	1895.2	PASSES
L07. Room	SPACE - Office - Enclosed -250R2	1895.2	PASSES
L08. Room	SPACE - Office - Enclosed -250R2	1895.2	PASSES

AHVAC11: Heating system efficiency

AHVAC11: DX cooling efficiencies

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Florida Building Code, Sixth Edition (2017) Energy Conservation - ASHRAE 90.1 2013 ECB Compliance Option

HVAC System Compliance

Type	Component	Capacity (kBtu/h)	Design COP/Efficiency	Min COP/Efficiency	Compliance	
a Packaged Terminal Air Conditioner (PTAC)	Heating	2 Nat-Draft Boilers, Primary-only HW Loop, Outdoor reset, Const-speed ...	226.23	0.8	0.8	PASSES
	Cooling	DX Cooling - PTAC >15 kWh/ton - COP 3.20 EERref 10.9 (EER 9.3 per 90.1-2)	582.8	3.2	2.78	PASSES
a Packaged Terminal Heat Pump (PTHP)	Heating	PTHP >15 kWh/ton COP 3.31 EERref 11.3 (EER 9.59 COP 2.81 per 90.1-2007 w...	198.82	2.78	2.92	FAILED
	Cooling	DX Cooling - PTHP >15 kWh/ton - COP 2.56 EERref 8.7 (EER 7.61 per 90.1-2)	575.78	2.56	2.23	PASSES
a Packaged Single Zone Air Conditioner (PSZ-AC)	Heating	Flame - fixed AFUE accounting for on-off cycles, rather than steady...	160.22	0.86	0.8	PASSES
	Cooling	DX Cooling - Pkg Sys >760 kWh/ton COP 3.28 EERref 11.2 (EER 9.5 per 90...	565.69	3.28	2.87	PASSES
a Packaged Single Zone Heat Pump (PSC-HP)	Heating	PSZ-HP >135 kWh/ton COP 3.84 EERref 13.11 (EER 10.92 COP 3.2 per 90.1-2007 w...	187.27	3.2	3.3	PASSES
	Cooling	DX Cooling - PSZ-HP >240 kWh/ton COP 3.20 EERref 10.9 (EER 9.3 per 90.1-2)	566.73	3.2	2.73	PASSES
a Variable Air Volume Reheat (VAVvRH - DX ER)	Heating	Electric resistance heating	0.03	-	-	-
	Cooling	DX Cooling - Pkg Sys 240-760 kWh/ton COP 3.4 EERref 11.6 (EER 9.8 per 90...	566.82	3.4	2.87	PASSES
a Variable Air Volume Parallel Fan Powered Boxes (VAVvPFP Boxes - DX ER)	Heating	Electric resistance heating	4.11	-	-	-
	Cooling	DX Cooling - Pkg Sys 240-760 kWh/ton COP 3.4 EERref 11.6 (EER 9.8 per 90...	567.66	3.4	2.87	PASSES
a Variable Air Volume Reheat (VAVvRH - Chir HW)	Heating	2 Nat-Draft Boilers, Primary-only HW Loop, Outdoor reset, Const-speed ...	9.73	0.8	0.8	PASSES
	Cooling	One Electric Water-Cooled Chiller with VSD pump on Secondary CHW Loop	569.74	5.48	4.69	PASSES
a Variable Air Volume Parallel Fan Powered Boxes (VAVvPFP Boxes - Chir ER)	Heating	Electric resistance heating	9.15	-	-	-
	Cooling	One Electric Water-Cooled Chiller with VSD pump on Secondary CHW Loop	569.84	5.48	4.69	PASSES
a Dedicated Outdoor Air - Four Pipe Fan Coil Unit / Separate Outdoor Air (DOAS)	Heating	2 Nat-Draft Boilers, Primary-only HW Loop, Outdoor reset, Const-speed ...	87.52	0.8	0.8	PASSES
	Cooling	2 Nat-Draft Boilers, Primary-only HW Loop, Outdoor reset, Const-speed ...	139.02	0.8	0.8	PASSES

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DHW Equipment Compliance				
Description	Capacity (kBtu/h)	Design COP/ Efficiency	Min COP/ Efficiency	Compliance
Baseline SHW heating plant (fossil fuel) - set Eff. per 90.1 table 7.8, set SL I...	0.6	0.8	0.62	PASSES

SWH05: Service Hot Water heating plant

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Topic	Section	Component	Description	Yes	N/A	Exempt
1. To be checked by Designer or Engineer						
Insulation	C303.2	Envelope	Below-grade wall insulation per manufacturer's instructions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C303.2	Envelope	Slab-edge insulation installed per manufacturer's instructions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C303.2	Envelope	Above-grade wall insulation installed per manufacturer's instructions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C402.3	Envelope	High-albedo roofs satisfy one of the following: 3-year-aged solar reflectance ≥ 0.55 and thermal emittance ≥ 0.75 or 3-year-aged solar reflectance index ≥ 0.64 .	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fenestration	C402.4.4	Envelope	U-factor of opaque doors associated with the building thermal envelope meets requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.2.12.1	Mechanical	HVAC fan systems at design conditions do not exceed allowable fan system motor nameplate hp or fan system bhp.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.2.12.2	Mechanical	HVAC fan motors not oversized beyond allowable limits.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.2.3(8) Table	Mechanical	Heat Rejection Equipment. Minimum Efficiency Requirement meet those listed in Table C403.2.3(8).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HVAC	C403.2.7	Mechanical	Exhaust air energy recovery on systems meeting Table C403.2.7(1) and C403.2.7(2).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.3	Mechanical	Air economizers provided where required, meet the requirements for design capacity, control signal, ventilation controls, high-limit shut-off, integrated economizer control, and provide a means to relieve excess outside air during operation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.3.2	Mechanical	Economizer operation will not increase heating energy use during normal operation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.3.4, C403.3.4.1, C403.3.4.2, C403.3.1	Mechanical	Water economizers provided where required, meet the requirements for design capacity, minimum pressure drop and integrated economizer control.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.2.1	Mechanical	Three-pipe hydronic systems using a common return for hot and chilled water are not used.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.2.3.1	Mechanical	Hydronic heat pump systems connected to a common water loop meet heat rejection and heat addition requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.3.4	Mechanical	Open-circuit cooling towers having water cooled chiller systems and multiple or variable speed condenser pumps, are designed so that tower cells can run in parallel with larger of flow criteria.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C404.2	Mechanical	Service water heating equipment meets efficiency requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wattage	C405.3	Interior Lighting	Exit signs do not exceed 5 watts per face.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Integrated Environmental Solutions

Florida Building Code, Sixth Edition (2017) Energy Conservation - ASHRAE 90.1 2013 ECB Compliance Option



Topic	Section	Component	Description 2. To be checked by Plan Reviewer	Yes	N/A	Exempt
Plan Review	C103.2	Envelope	Plans and/or specifications provide all information with which compliance can be determined for the building envelope and document where exceptions to the standard are claimed. Load calculations per accepted engineering standards and handbooks.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Plan Review	C103.2	Mechanical	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the mechanical systems and equipment and document where exceptions to the standard are claimed. Load calculations per accepted engineering standards and handbooks.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Plan Review	C103.2	Mechanical	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the service water heating systems and equipment and document where exceptions to the standard are claimed. Hot water system sized per manufacturer's sizing guide.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Plan Review	C103.2	Interior Lighting	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the interior lighting and electrical systems and equipment and document where exceptions to the standard are claimed. Information provided should include interior lighting power calculations, wattage of bulbs and ballasts, transformers and control devices.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Plan Review	C103.2	Exterior Lighting	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the exterior lighting and electrical systems and equipment and document where exceptions to the standard are claimed. Information provided should include exterior lighting power calculations, wattage of bulbs and ballasts, transformers and control devices.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C402.2.5	Envelope	Slab edge insulation depth/length. Slab insulation extending away from building is covered by pavement or ≥ 10 inches of soil.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C402.2.6	Project	Radiant heating systems panels insulated to $\geq R-3.5$ on face opposite space being heated.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HVAC	C402.2.8	Mechanical	Thermally ineffective panel surfaces of sensible heating panels have insulation $\geq R-3.5$.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C402.2.8	Envelope	Radiant panels and associated components, designed for heat transfer from the panel surfaces to the occupants or indoor space are insulated with a minimum of R-3.5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air Leakage	C402.5.7	Envelope	Vestibules are installed on all building entrances. Doors have self-closing devices.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.2.12.3	Mechanical	Fans have efficiency grade (FEG) ≥ 63 . The total efficiency of the fan at the design point of operation $\geq 15\%$ of maximum total efficiency of the fan.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HVAC	C403.2.13	Mechanical	Unenclosed spaces that are heated use only radiant heat.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HVAC	C403.2.4.2	Mechanical	Each zone equipped with setback controls using automatic time clock or programmable control system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.2.4.4	Mechanical	Zone isolation devices and controls installed where applicable.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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Florida Building Code, Sixth Edition (2017) Energy Conservation - ASHRAE 90.1 2013 ECB Compliance Option



SYSTEM_SPECIFIC	C403.2.4.7	Mechanical	Fault detection and diagnostics installed with air-cooled unitary DX units having economizers.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.2.5	Mechanical	Hot water boilers supplying heat via one- or two-side systems include outdoor setback control.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
HVAC	C403.2.6.1	Mechanical	Demand control ventilation provided for spaces <100 ft ² and >25 people/1000 ft ² occupant density and served by systems with air side economizer, auto modulating outside air damper control, or design airflow $>3,000$ cfm.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.1.1	Mechanical	Hydronic and multi-zone HVAC system controls and VAV fans driven by mechanical or electrical variable speed drive per Table C403.4.1.1.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.1.3	Mechanical	Reset static pressure setpoint for DDC controlled VAV boxes reporting to central controller based on the zones requiring the most pressure.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.2	Mechanical	Temperature reset by representative building loads in pumping systems for chiller and boiler systems $>500,000$ Btu/h.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.2.2.1	Mechanical	Closed-circuit cooling tower within heat pump loop have either automatic bypass valve or lower leakage pressure closure dampers. Open-circuit tower within heat pump loop have automatic valve to bypass all heat pump water flow around the tower.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.2.4	Mechanical	Hydronic systems greater than 500,000 Btu/h designed for variable fluid flow.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.2.5	Mechanical	System function requirement met through multiple single-input boilers, one or more modulating boilers, or a combination of single-input and modulating boilers. Boiler input between 1.0 MBtu/h and 5 MBtu/h has 3:1 turndown ratio, boiler input between 5.0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.2.6	Mechanical	Chilled water plants with multiple chillers have capability to reduce flow automatically through the chiller plant when a chiller is shut down. Boiler plants with multiple boilers have the capability to reduce flow automatically through the boiler plant.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.3 C403.4.3.2	Mechanical	Fan systems with motors >7.5 hp associated with heat rejection equipment to have capacity to operate at 20% of full speed and auto speed controls to control the leaving fluid temperature or condensing temperature/pressure of heat rejection device.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.4.5	Mechanical	Multiple zone HVAC systems have supply air temperature reset controls.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C403.4.4.6	Mechanical	Multiple zone VAV systems with DDC of individual zone boxes have static pressure setpoint reset controls.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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Florida Building Code, Sixth Edition (2017) Energy Conservation - ASHRAE 90.1 2013 ECB Compliance Option

SYSTEM_SPECIFIC	Code	Category	Description	Y	N/A	Exempt
			Gas-fired water-heating equipment installed in new buildings where a singular piece of water-heating equipment \Rightarrow 1,000 MBtu/h serves the entire building, thermal efficiency \geq 90. Et, where multiple pieces of water-heating equipment serve the building with combined rating \leq 1,000 MBtu/h, the combined input-capacity-weighted-average thermal efficiency, thermal efficiency must be \geq 90 Et. Exclude input rating of equipment in individual dwelling units and equipment \Rightarrow 100 MBtu/h.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C404.2.1	Mechanical		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C404.4	Mechanical	All piping insulated in accordance with section details and Table C403.2.15.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C404.5	Mechanical	Heated water supply piping conforms to pipe length and volume requirements. Refer to section details.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C404.5.1	Mechanical		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C404.5.2	Mechanical		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C404.6.3	Mechanical	Pumps that circulate water between a header and storage tank have controls that limit operation from startup to \leq 5 minutes after end of heating cycle.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C404.7	Mechanical	A water distribution system having one or more recirculation pumps that pump water from a heated-water supply pipe back to the heated-water source through a cold-water supply pipe shall be a demand recirculation water system. Pumps shall have controls that comply with both of the following. The controls shall start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance. The control shall limit the temperature of the water entering the cold-water piping to 104F (40C).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Wattage	C405.5.1	Exterior Lighting	Exterior lighting power is consistent with what is shown on the approved lighting plans, demonstrating proposed watts are less than or equal to allowed watts.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Plan Review	C406.6	Project	Group R-2 dwelling units have separate electrical meters.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Plan Review	C406	Project	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the additional energy efficiency package options.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C408.2.2	Mechanical	HVAC systems heating and cooling coils have means to balance and have pressure test connections.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SYSTEM_SPECIFIC	C409.2.2	Mechanical	HVAC systems heating and cooling coils have means to balance and have pressure test connections.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Topic	Section	Component	Description	Yes	N/A	Exempt
3. To be checked by inspector						
Insulation	C303.1	Envelope	Roof insulation installed per manufacturer's instructions. Above or ground-level roof insulation is installed only where the roof slope is \leq 3 in 12.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C303.1	Envelope	Building envelope insulation is labeled with R-value of insulation certificate providing R-value and other relevant data.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fenestration	C303.1.3	Envelope	Fenestration products used in accordance with NFRC.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fenestration	C303.1.3	Envelope	Fenestration products are certified as to performance labels or certificates provided.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C303.2	Envelope	Floor insulation installed per manufacturer's instructions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C402.2.4	Envelope	Cavity or structural slab insulation installed in permanent contact with underside of decking or structural slabs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C303.2.1	Envelope	Exterior insulation protected against damage, sunlight, moisture, wind, landscaping and equipment maintenance activities.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C303.2.1	Envelope	Exterior insulation is protected from damage with a protective material. Verification for exposed foundation insulation may need to occur during foundation inspection.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C402.1.3	Envelope	Non-swinging operable doors have R-4.75 insulation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C402.2.2	Envelope	Skylight curbs are insulated to the level of roof with insulation above deck or R-5.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Insulation	C402.2.2	Envelope	Insulation intended to meet the roof insulation requirements cannot be installed on top of a suspended ceiling. Mark this requirement compliant if insulation is installed accordingly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air Leakage	C402.5	Envelope	Building envelope contains a continuous air barrier that has been tested and deemed to limit air leakage \Rightarrow 0.40 cfm/ft ² .	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air Leakage	C402.5.1	Envelope	The building envelope contains a continuous air barrier that is sealed in an approved manner and either constructed or tested in an approved manner. Air barrier penetrations are sealed in an approved manner.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air Leakage	C402.5.1.1	Envelope	All sources of air leakage in the building thermal envelope are sealed, caulked, gasketed, weather stripped or wrapped with moisture vapor permeable wrapping material to minimize air leakage.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air Leakage	C402.5.1.2.1	Envelope	The building envelope contains a continuous air barrier that is sealed in an approved manner and tested permeability \Rightarrow 0.054 cfm/ft ² . Air barrier penetrations are sealed in an approved manner.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air Leakage	C402.5.1.2.2	Envelope	The building envelope contains a continuous air barrier that is sealed in an approved manner and average assembly air leakage \Rightarrow 0.04 cfm/ft ² . Air barrier penetrations are sealed in an approved manner.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Air Leakage	C402.5.2, C402.5.4	Envelope	Factory-built fenestration and doors are labeled as meeting air leakage requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Topic	Section	Component	Description	Yes	N/A	Exempt
4. To be checked by Inspector at Project Completion and Prior to Issuance of Certificate of Occupancy						
Post Construction	C303.3, C408.2.5.2	Interior Lighting	Furnished O&M instructions for systems and equipment to the building owner or designated representative.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Post Construction	C303.3, C408.2.5.3	Mechanical	Furnished O&M manuals for HVAC systems within 90 days of system acceptance.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fenestration	C402.4.2.2	Envelope	Skylights in office, storage, automotive service, manufacturing, non-refrigerated warehouse, retail store, and distribution/sorting area have a measured haze value > 90 percent unless designed to exclude direct sunlight.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Post Construction	C408.2.1	Mechanical	Commissioning plan developed by registered design professional or approved agency.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Post Construction	C408.2.3.1	Mechanical	HVAC equipment has been tested to ensure proper operation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Post Construction	C408.2.3.3	Mechanical	Economizers have been tested to ensure proper operation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Post Construction	C408.2.4	Mechanical	Preliminary commissioning report completed and certified by registered design professional or approved agency.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Post Construction	C408.2.5.1	Mechanical	Furnished HVAC as-built drawings submitted within 90 days of system acceptance.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Post Construction	C408.2.5.1	Interior Lighting	Furnished as-built drawings for electric power systems within 90 days of system acceptance.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Post Construction	C408.2.5.3	Mechanical	An air and/or hydronic system balancing report is provided for HVAC systems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Post Construction	C408.2.5.4	Mechanical	Final commissioning report due to building owner within 90 days of receipt of certificate of occupancy.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Post Construction	C408.3	Interior Lighting	Lighting systems have been tested to ensure proper calibration, adjustment, programming, and operation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Integrated Environmental Solutions

Florida Building Code, Sixth Edition (2017) Energy Conservation - ASHRAE 90.1 2013 ECB Compliance Option

ASHRAE 90.1-2016 PCI Report (Performance Cost Index - Proposed vs Baseline)

The 'Proposed Vs Baseline Results' script is available from the IES Content Store (www.iesve.com/content-store) or is embedded into most ASHRAE/IECC/NECB/Florida/California-Title 24 Compliance Navigators.

PRM_Results_30-1

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p_LEED Model 01				Energy Savings 64.4%			Energy Cost Savings 45.7%			
End Use	Fuel	Proposed Energy (MMBtu)	Baseline Energy (MMBtu)	Energy Savings %	Proposed Energy Cost (\$/Year)	Baseline Energy Cost (\$/Year)	Proposed EUI (kWh/ft²/year)	Baseline EUI (kWh/ft²/year)	Proposed EUI Savings %	
Interior Lighting	Electricity (MMBtu)	16.07	25.99	38.2%	6.4%	4.1%	3.21	5.12	37.1%	
Exterior Lighting	Electricity (MMBtu)	1.84	3.98	72.6%	0.7%	1.0%	0.33	0.72	54.3%	
Space Heating	Gas (MMBtu)	62.80	338.88	81.5%	25.2%	166.0%	12.54	66.0%	81.0%	
Space Heating	Electricity (MMBtu)	100.44	130.38	0.0%	0.1%	0.0%	0.07	0.0%	0.0%	
Space Heating	Electricity (MMBtu)	0.33	0.00	0.0%	0.0%	0.0%	0.00	0.0%	0.0%	
Space Cooling	Electricity (MMBtu)	35.52	0.00	0.0%	4.2%	12.7%	2.08	0.0%	0.0%	
Space Cooling	Electricity (MMBtu)	23.38	72.30	66.5%	11.6%	0.8%	5.70	0.0%	0.0%	
Heat Rejection	Electricity (MMBtu)	21.47	2.30	-89.0%	5.8%	0.0%	2.83	0.0%	0.0%	
Pumps	Electricity (MMBtu)	13.87	0.00	0.0%	5.1%	0.0%	5.70	0.0%	0.0%	
Pumps	Electricity (MMBtu)	23.28	0.00	0.0%	3.7%	12.0%	1.83	0.0%	0.0%	
Fans Interior	Electricity (MMBtu)	5.27	72.71	87.4%	5.9%	0.0%	4.94	0.0%	0.0%	
Services Water Heating	Gas (MMBtu)	24.48	0.00	0.0%	61.27	59.08	-3.7%	24.6%	9.8%	12.2%
Services Water Heating	Electricity (MMBtu)	19.49	19.49	0.0%	7.82	6.82	0.0%	8.2%	1.6%	4.9%
Elevators Escalators	Electricity (MMBtu)	20.46	20.46	0.0%	8.2%	6.82	0.0%	8.2%	1.6%	4.9%
Total (MMBtu)		249.46	605.12	58.8%						49.89
Total (\$/Year)					6,969.40	12,802.39				1.99

SG10: Site Energy Use Intensity (EUI).

End Use	Fuel	Proposed Energy (MMBtu)	Baseline Energy (MMBtu)	Cost Savings %	Proposed Energy Cost (\$/Year)	Baseline Energy Cost (\$/Year)	Proposed EUI (kWh/ft²/year)	Baseline EUI (kWh/ft²/year)	Proposed EUI Savings %	
Interior Lighting	Electricity	61.45	1,021.49	38.2%	4.1%	2.0%	0.31	0.51	37.1%	
Exterior Lighting	Electricity	64.52	235.21	72.6%	0.9%	1.0%	0.01	0.09	54.3%	
Space Heating	Gas	431.44	2,338.82	81.5%	6.2%	18.1%	0.09	0.60	81.0%	
Space Heating	Electricity	12.79	0.00	0.0%	0.2%	0.0%	0.00	0.00	0.0%	
Space Cooling	Electricity	48.03	3,030.07	96.0%	3.3%	20.7%	0.08	0.58	86.0%	
Heat Rejection	Electricity	1,139.17	193.41	-89.0%	16.3%	1.5%	0.23	0.13	43.1%	
Pumps	Electricity	57.17	0.00	0.0%	5.2%	0.0%	0.11	0.00	0.0%	
Pumps	Electricity	306.58	2,857.38	87.4%	5.2%	23.1%	0.07	0.23	70.0%	
Services Water Heating	Gas	130.31	0.00	0.0%	2.4%	0.0%	0.03	0.00	0.0%	
Services Water Heating	Electricity	2,467.78	2,322.66	-3.7%	34.5%	18.1%	0.48	0.48	0.0%	
Elevators Escalators	Electricity	803.96	803.96	0.0%	11.5%	6.3%	0.36	0.36	0.0%	
Total Energy Cost (\$)		6,969.40	12,802.39	45.6%						24.4%

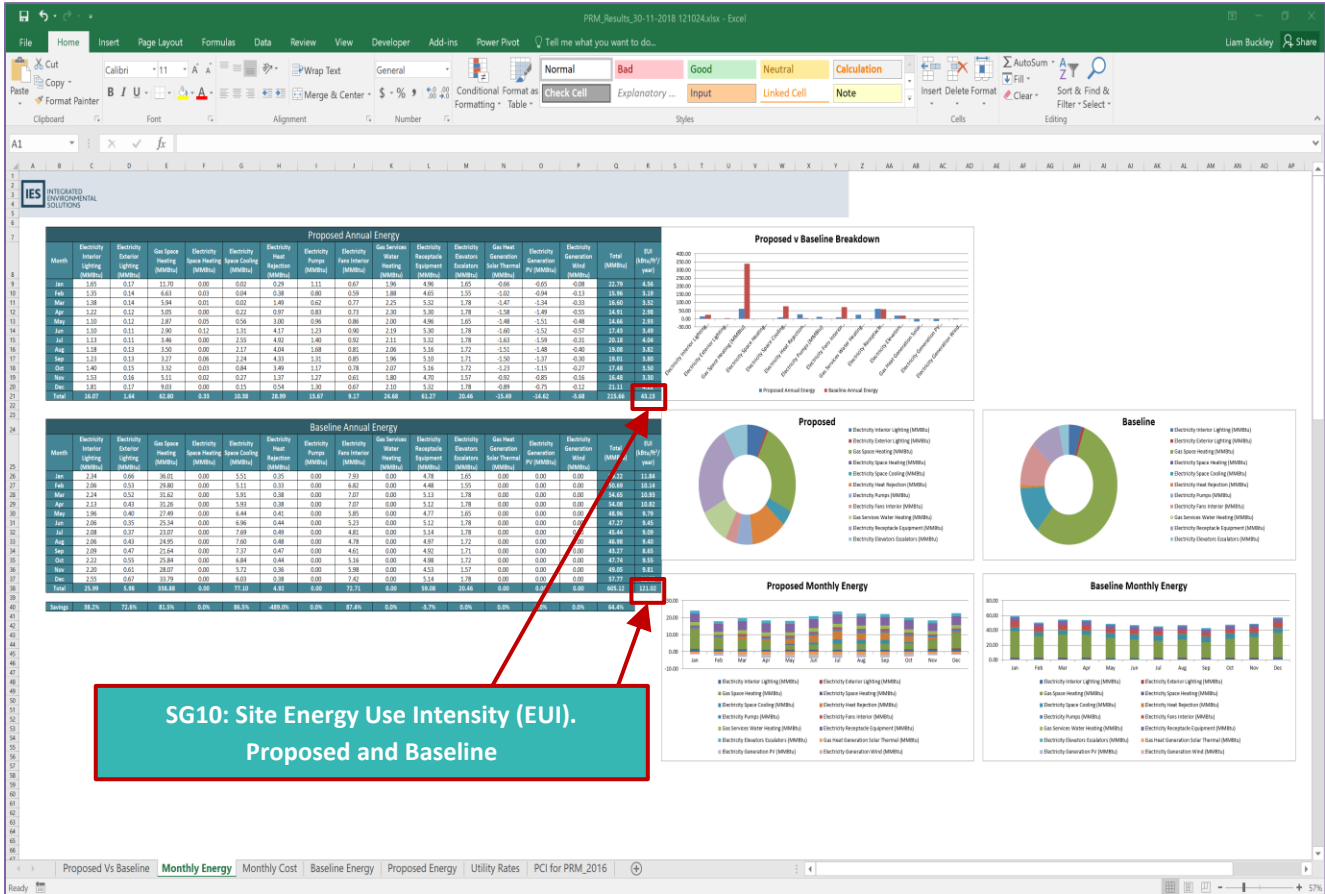
Renewable and CHP Energy Generated (MMBtu)

End Use	Fuel	Proposed Energy (MMBtu)	Baseline Energy (MMBtu)	Cost Savings %	Proposed Energy Cost (\$/Year)	Baseline Energy Cost (\$/Year)	Proposed EUI (kWh/ft²/year)	Baseline EUI (kWh/ft²/year)	Proposed EUI Savings %	
Interior Lighting	Electricity	61.45	1,021.49	38.2%	4.1%	2.0%	0.31	0.51	37.1%	
Exterior Lighting	Electricity	64.52	235.21	72.6%	0.9%	1.0%	0.01	0.09	54.3%	
Space Heating	Gas	431.44	2,338.82	81.5%	6.2%	18.1%	0.09	0.60	81.0%	
Space Heating	Electricity	12.79	0.00	0.0%	0.2%	0.0%	0.00	0.00	0.0%	
Space Cooling	Electricity	48.03	3,030.07	96.0%	3.3%	20.7%	0.08	0.58	86.0%	
Heat Rejection	Electricity	1,139.17	193.41	-89.0%	16.3%	1.5%	0.23	0.13	43.1%	
Pumps	Electricity	57.17	0.00	0.0%	5.2%	0.0%	0.11	0.00	0.0%	
Pumps	Electricity	306.58	2,857.38	87.4%	5.2%	23.1%	0.07	0.23	70.0%	
Services Water Heating	Gas	130.31	0.00	0.0%	2.4%	0.0%	0.03	0.00	0.0%	
Services Water Heating	Electricity	2,467.78	2,322.66	-3.7%	34.5%	18.1%	0.48	0.48	0.0%	
Elevators Escalators	Electricity	803.96	803.96	0.0%	11.5%	6.3%	0.36	0.36	0.0%	
Total Energy Cost (\$)		6,969.40	12,802.39	45.6%						24.4%

Renewable and CHP Energy Cost Offset (\$)

End Use	Fuel	Proposed Energy (MMBtu)	Baseline Energy (MMBtu)	Cost Savings %	Proposed Energy Cost (\$/Year)	Baseline Energy Cost (\$/Year)	Proposed EUI (kWh/ft²/year)	Baseline EUI (kWh/ft²/year)	Proposed EUI Savings %	
Interior Lighting	Electricity	61.45	1,021.49	38.2%	4.1%	2.0%	0.31	0.51	37.1%	
Exterior Lighting	Electricity	64.52	235.21	72.6%	0.9%	1.0%	0.01	0.09	54.3%	
Space Heating	Gas	431.44	2,338.82	81.5%	6.2%	18.1%	0.09	0.60	81.0%	
Space Heating	Electricity	12.79	0.00	0.0%	0.2%	0.0%	0.00	0.00	0.0%	
Space Cooling	Electricity	48.03	3,030.07	96.0%	3.3%	20.7%	0.08	0.58	86.0%	
Heat Rejection	Electricity	1,139.17	193.41	-89.0%	16.3%	1.5%	0.23	0.13	43.1%	
Pumps	Electricity	57.17	0.00	0.0%	5.2%	0.0%	0.11	0.00	0.0%	
Pumps	Electricity	306.58	2,857.38	87.4%	5.2%	23.1%	0.07	0.23	70.0%	
Services Water Heating	Gas	130.31	0.00	0.0%	2.4%	0.0%	0.03	0.00	0.0%	
Services Water Heating	Electricity	2,467.78	2,322.66	-3.7%	34.5%	18.1%	0.48	0.48	0.0%	
Elevators Escalators	Electricity	803.96	803.96	0.0%	11.5%	6.3%	0.36	0.36	0.0%	
Total Energy Cost (\$)		6,969.40	12,802.39	45.6%						24.4%

Proposed Vs Baseline Monthly Energy Monthly Cost Baseline Energy Proposed Energy Utility Rates PCI for PRM_2016



PRM_Results_30-

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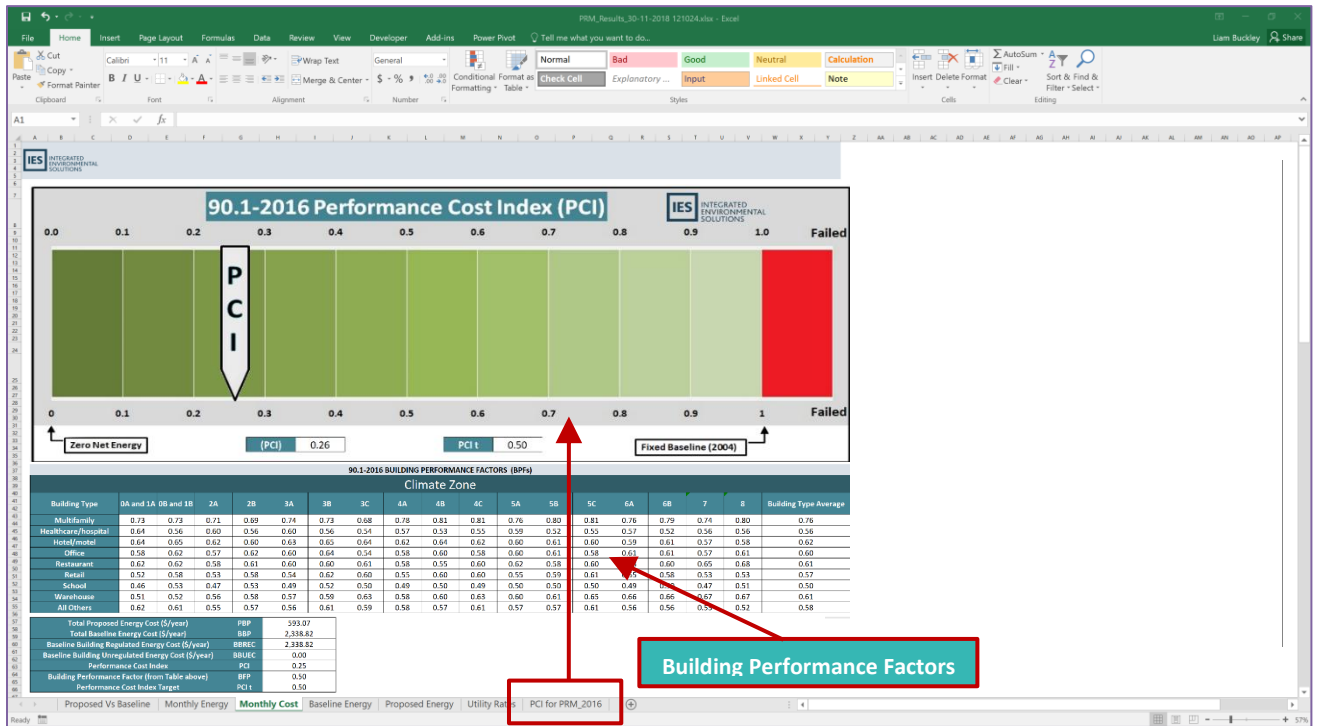
Ready

Proposed Vs Baseline Monthly Energy Monthly Cost Baseline Energy Proposed Energy **Utility Rates** PCI for PRM_2016

IES INTEGRATED ENVIRONMENTAL SOLUTIONS

Utility Rates:	
Electricity Cost	0.1341 \$/kWh
Gas Cost	0.69 \$/Therm

UR03: Utility rate structure.
The input for the utility rate used in both the proposed and baseline are displayed in this section



Trane TRACE 3D Plus

Climatic Summary

Overview

Location	La Crosse Municipal Arpt WI USA	Peaks	
Weather File	USA_WI_La.Crosse.Muni.AP.726430	Dry Bulb Temp. [F]	Dew Point Temp. [F]
Weather File Source	TMY3		
WMO Station	726430	Date	Jul 17
Latitude	N 43° 52'	Minimum	-27
Longitude	W 91° 15'	Date	Jan 31
Time Zone	GMT -6.0 Hours		
Elevation	650 ft		
Standard Pressure	0.99 Bar		
Heating Degree Days (base 65°F)	7,240		
Cooling Degree Days (base 50°F)	2,765		

SG03: Weather File

Section 1.3 - Advisory Messages

Table EAp2-2 - Advisory Messages

	Baseline 0°	Proposed Design
Number of Unmet Heating Hours	218.00	122.67
Number of Unmet Cooling Hours	20.33	0.00
Total	238.33	122.67

SG08: Unmet

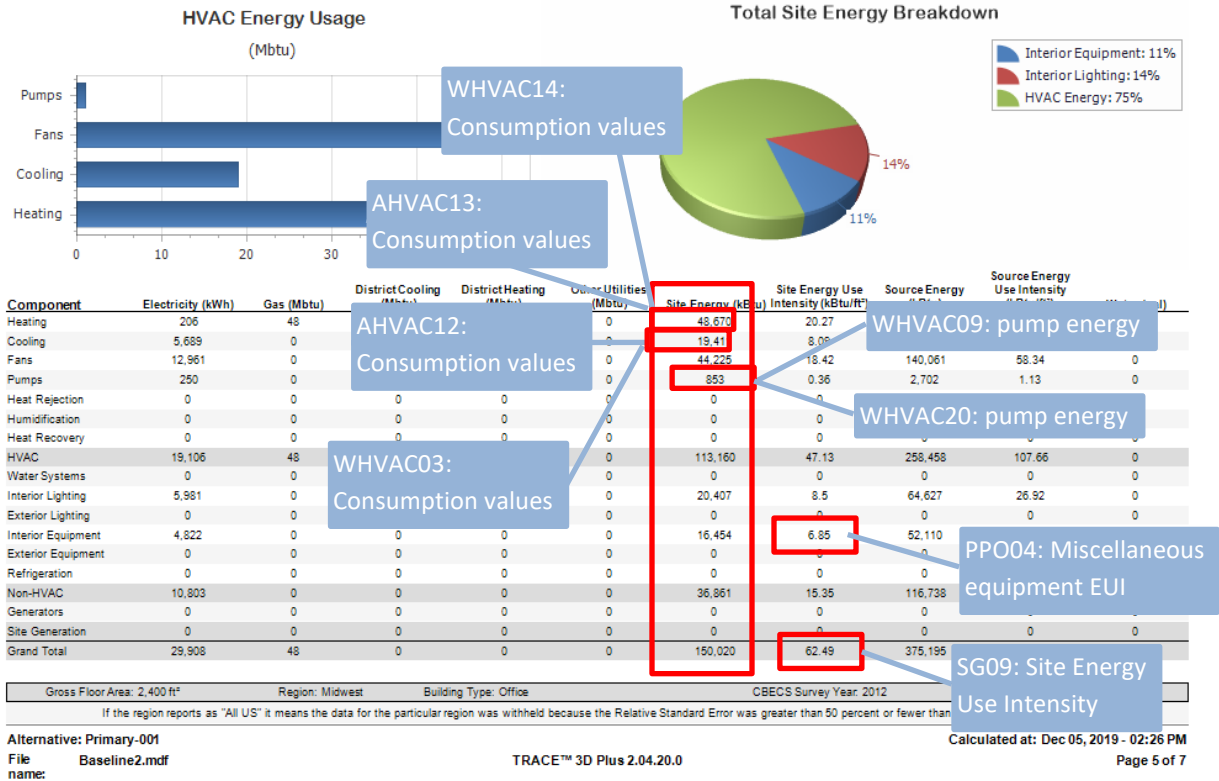
Section 1.2 - Space Summary

Space Name / Building Use (Occupancy Type)	Space Area (m ²)	Regularly Occupied Area (m ²)	Unconditioned Area (m ²)	Typical Heating Load (kW)
Zn-Room 00-05	400	400	0	95.9
Zn-Room 00-02	400	400	0	95.9
Zn-Room 00-00	400	400	0	95.9
Zn-Room 00-01	400	400	0	95.9
Zn-Room 00-03	400	400	0	95.9
Zn-Room 00-04	400	400	0	95.9
Totals	2400	2400	0	

SG05: Conditioned Floor Area

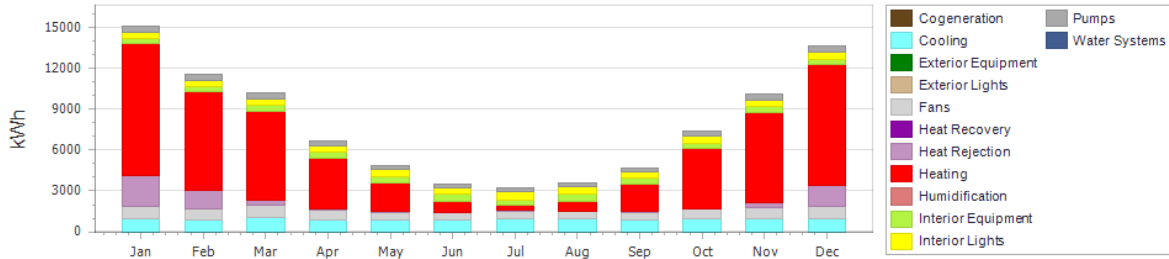
Site Consumption Summary

Energy Consumption



Monthly Energy End Use

Electricity



	January	February	March	April	May	June	July	August	September	October	November	December	Grand Total
Cogeneration	0	0	0	0	0	0	0	0	0	0	0	0	0
Cooling	959	932	1,089	937	918	945	1,044	1,020	927	992	997	1,021	11,784
Exterior Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0
Exterior Lights	0	0	0	0	0	0	0	0	0	0	0	0	0
Fans	925	832	884	681	573	517	528	539	566	738	863	927	8,572
Heat Recovery	0	0	0	0	0	0	0	0	0	0	0	0	0
Heat Rejection	2,218	1,204	362	69	19	23						1,441	5,730
Heating	9,707	7,328	6,501	3,728	2,085	816						8,909	53,145
Humidification	0	0	0	0	0	0						0	0
Interior Equipment	405	370	414	396	411	400						407	4,821
Interior Lights	485	467	542	486	523	520						489	5,982
Pumps	469	413	439	338	284	257						160	4,257
Water Systems	0	0	0	0	0	0						0	0
Grand Total	15,158	11,536	10,230	6,636	4,813	3,479						13,653	94,291

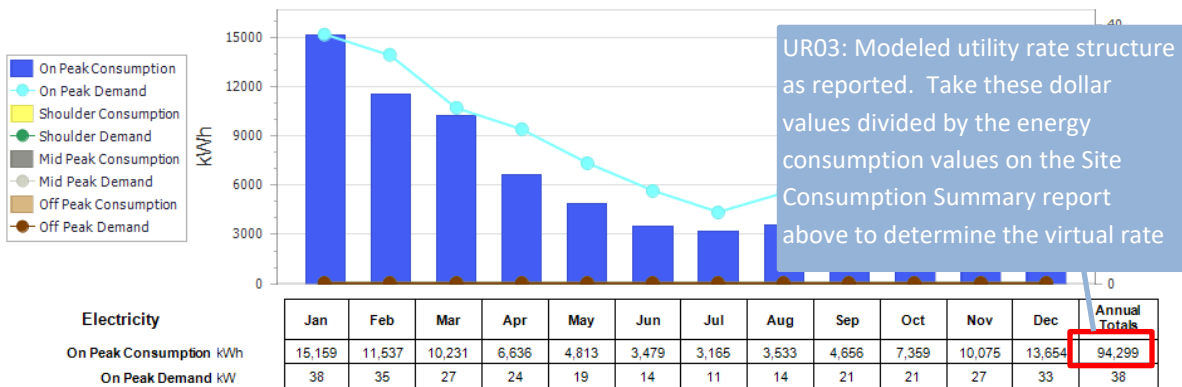
UR03: Modeled utility rate structure as reported. Take the dollar values on the Economic and Life Cycle Costs Summary report below divided by these values to determine the virtual rate

Alternative: Primary
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TRACE™ 3D Plus 2.04.20.0

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Monthly Utility Details



UR03: Modeled utility rate structure as reported. Take these dollar values divided by the energy consumption values on the Site Consumption Summary report above to determine the virtual rate

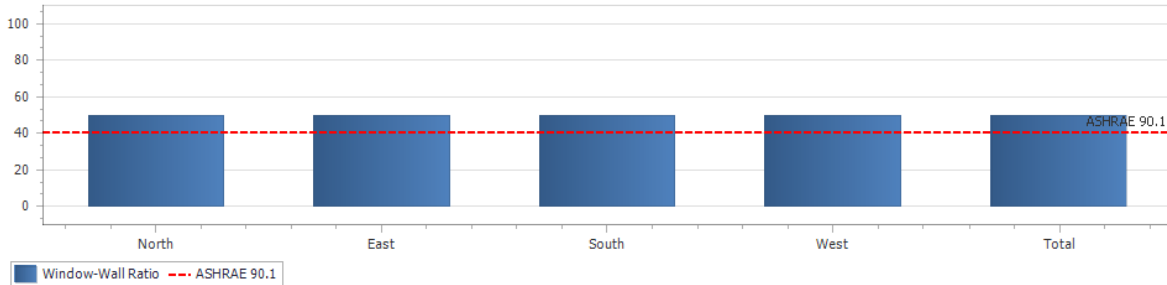
Opaque Exterior

	Construction	Exterior Reflectance	Gross Area (ft²)	U-Factor With Film (BTU/ft²·F)	U-Factor No Film (BTU/ft²·F)	Azimuth	Tilt	Cardinal Direction
Roof01-01-[0]	90.1-13 Min Roof Insulation Entirely Above	0.3	420	0.032	0.033	180°	0°	
Roof02-02-[0]		0.3	420	0.032	0.033	180°	0°	
Roof03-03-[0]		0.3	420	0.032	0.033	180°	0°	
Roof04-04-[0]		0.3	420	0.032	0.033	180°	0°	
Roof05-05-[0]	Deck Zone 5	0.3	420	0.032	0.033	180°	0°	
SLAB 00_0	Slab00_0_90.1-13 Min Slab On Grade Unheated Floor, R-15 For 24 In., Zone 4-5	1	420	0	0.001		180°	
SLAB 01_0	Slab01_0_90.1-13 Min Slab On Grade Unheated Floor, R-15 For 24 In., Zone 4-5	1	420	0	0.001		180°	
SLAB 02_0	Slab02_0_90.1-13 Min Slab On Grade Unheated Floor, R-15 For 24 In., Zone 4-5	1	420	0	0.001		180°	
SLAB 03_0	Slab03_0_90.1-13 Min Slab On Grade Unheated Floor, R-15 For 24 In., Zone 4-5	1	420	0	0.001		180°	
SLAB 04_0	Slab04_0_90.1-13 Min Slab On Grade Unheated Floor, R-15 For 24 In., Zone 4-5	1	420	0	0.001		180°	
SLAB 05_0	Slab05_0_90.1-13 Min Slab On Grade Unheated Floor, R-15 For 24 In., Zone 4-5	1	420	0	0.001		180°	
WALL 00-ROOM 00-00_0	90.1-13 Min Wall, Steel Framed Zone 5	0.3	267	0.055	0.058	180°	90°	S
WALL 01-ROOM 00-00_0	90.1-13 Min Wall, Steel Framed Zone 5	0.3	267	0.055	0.058	270°	90°	W
WALL 05-ROOM 00-01_0	90.1-13 Min Wall, Steel Framed Zone 5	0.3	267	0.055	0.058	180°	90°	S
WALL 07-ROOM 00-02_0	90.1-13 Min Wall, Steel Framed Zone 5	0.3	267	0.055	0.058	180°	90°	S
WALL 08-ROOM 00-02_0	90.1-13 Min Wall, Steel Framed Zone 5	0.3	267	0.055	0.058	90°	90°	E
WALL 10-ROOM 00-03_0	90.1-13 Min Wall, Steel Framed Zone 5	0.3	267	0.055	0.058	0°	90°	N
WALL 11-ROOM 00-03_0	90.1-13 Min Wall, Steel Framed Zone 5				0.058	270°	90°	W
WALL 14-ROOM 00-04_0	90.1-13 Min Wall, Steel Framed Zone 5				0.058	0°	90°	N
WALL 15-ROOM 00-05_0	90.1-13 Min Wall, Steel Framed Zone 5	0.3	267	0.055	0.058	90°	90°	E
WALL 16-ROOM 00-05_0	90.1-13 Min Wall, Steel Framed Zone 5	0.3	267	0.055	0.058	0°	90°	N

BE06, BE07, BE08, BE09, BE10: Thermal properties and areas of opaque envelope

BE21: Envelope orientation

Envelope Summary



	North	East	South	West	Total
Gross Window-Wall Ratio	49.93	49.93	49.93	49.93	49.93

Fenestration

	Construction	Area of One Opening (ft²)	Area of Openings (ft²)	U-Factor (BTU/h-ft²-F)	SHGC	Visible Transmittance	Shade Control	Parent Surface	Azimuth	Cardinal Direction
WINDOW 01 - WALL 11-ROOM 00-03_0	90.1-13 Window Zone 4-6 Metal Oper	133	133	0.501	0.395	0.441	No	WALL 11-ROOM 00-03_0	270°	W
WINDOW 03 - WALL 01-ROOM 00-00_0	90.1-13 Window Zone 4-6 Metal Oper	133	133	0.501	0.395	0.441	No	WALL 01-ROOM 00-00_0	270°	W
WINDOW 02 - WALL 00-ROOM 00-00_0	90.1-13 Window Zone 4-6 Metal Oper	133	133	0.501	0.395	0.441	No	WALL 00-ROOM 00-00_0	180°	S
WINDOW 04 - WALL 05-ROOM 00-01_0	90.1-13 Window Zone 4-6 Metal Oper	133	133	0.501	0.395	0.441	No	WALL 05-ROOM 00-01_0	180°	S
WINDOW 05 - WALL 07-ROOM 00-02_0	90.1-13 Window Zone 4-6 Metal Oper	133	133	0.501	0.395	0.441	No	WALL 07-ROOM 00-02_0	180°	S
WINDOW 00 - WALL 10-ROOM 00-03_0	90.1-13 Window Zone 4-6 Metal Oper	133	133	0.501	0.395	0.441	No	WALL 10-ROOM 00-03_0	0°	N
WINDOW 08 - WALL 16-ROOM 00-05_0	90.1-13 Window Zone 4-6 Metal Oper	133	133	0.501	0.395	0.441	No	WALL 16-ROOM 00-05_0	0°	N
WINDOW 09 - WALL 14-ROOM 00-04_0	90.1-13 Window Zone 4-6 Metal Oper	133	133	0.501	0.395	0.441	No	WALL 14-ROOM 00-04_0	0°	N
WINDOW 06 - WALL 08-ROOM 00-02_0	90.1-13 Window Zone 4-6 Metal Oper	133	133	0.501	0.395	0.441	No	WALL 08-ROOM 00-02_0	90°	E
WINDOW 07 - WALL 15-ROOM 00-05_0	90.1-13 Window Zone 4-6 Metal Oper	133	133	0.501	0.395	0.441	No	WALL 15-ROOM 00-05_0	90°	E
Non-North Total or Average			932	0.501	0.395	0.441				
North Total or Average			399	0.501	0.395	0.441				
Total or Average			1,331	0.501	0.395	0.441				

System Cooling Checksums

VAV RH (30% Min Default) (CW)

	Coil Peak					Fan Peak					Temperatures °F	
	Instant Sensible (Btu/h)	Time Delay Sensible (Btu/h)	Latent (Btu/h)	Percent Total (Btu/h)	of Total (%)	Instant Sensible (Btu/h)	Time Delay Sensible (Btu/h)	Total Sensible (Btu/h)	Percent Total (%)	Related Area (ft²)	Supply	Return
	Peak Time (Mo/D/H:M): 7/21/16:00 -					Peak Time (Mo/D/H:M): 7/21/16:00						
	Outside Air (DB/WB/HR): 87.6 / 72.9 / 101.0					Outside Air (DB/WB/HR): 87.6 / 72.9 / 101.0						
Roof	0	7,322	0	7,322	60.3	0	7,322	7,322	16.0	2,521	55.0	76.1
Other Roof	0	0	0	0	0.0	0	0	0	0.0	0	77.2	2.1
Glass	9,460	17,944	0	27,404	225.5	9,460	17,944	27,404	60.0	1,331		
Door	0	0	0	0	0.0	0	0	0	0.0	0		
Wall	0	1,861	0	1,861	15.3	0	1,861	1,861	4.1	3,731		
Below-Grade Wall	0	0	0	0	0.0	0	0	0	0.0	0		
Other Wall	0	0	0	0	0.0	0	0	0	0.0	0		
Partition	0	502	0	502	4.1	0	502	502	1.1	2,110		
Exterior Floor	0	0	0	0	0.0	0	0	0	0.0	0		
Interior Floor	0	0	0	0	0.0	0	0	0	0.0	0		
Slab	0	-4,074	0	-4,074	-33.5	0	-4,074	-4,074	-8.9	2,521		
Other Floor	0	0	0	0	0.0	0	0	0	0.0	0		
Infiltration	0	0	0	0	0.0	0	0	0	0.0	2,665		
Envelope Subtotal	9,460	23,556	0	33,015	271.7	9,460	23,556	33,015	72.3	2,400		
People	1,260	1,693	2,399	5,352	44.0	1,260	1,693	2,953	6.5	2,400	9.91	.88
Lights	2,167	2,960	0	5,126	42.2	2,167	2,960	5,126	11.2	2,400	26.32	403.09
RA Sensible (Lights)	2,243	0	0	2,243	18.5	-	-	-	-	-	456.18	12
Miscellaneous Loads	3,095	2,148	0	5,243	43.1	3,095	2,148	5,243	11.5	2,400	200.00	
Internal Subtotal	8,765	6,800	2,399	17,965	147.8	6,522	6,800	13,322	29.2	-		
Ventilation	2,855	0	5,151	8,007	65.9	-	-	-	-	-		
DOAS Direct to Zone	0	0	0	0	0.0	0	0	0	0.0	0		
Ceiling	0	0	0	0	0.0	0	0	0	0.0	0		
Refrigeration	0	0	0	0	0.0	0	0	0	0.0	2,400		
Service Water	0	0	0	0	0.0	0	0	0	0.0	2,400		
HVAC Equipment Losses	0	0	0	0	0.0	0	0	0	0.0	0		
Adj Air Transfer Heat	0	0	0	0	0.0	0	0	0	0.0	0		
Supply Fan Heat	4,781	0	-	4,781	39.3	-	-	-	-	-		
Time Delay Correction	0	-740	-	-740	-6.1	0	-740	-740	-1.6	-		
Sizing Factor Correction	0	-	-	0	0.0	0	-	-	-	-		
Airflow Correction	71	0	33	104	0.9	71	0	71	0.2	-		
Grand Total	25,932	29,615	7,584	63,131	100.0	16,052	29,615	45,667	100.0	0		

Airflows cfm	
Main Fan	2,121
Min Stop / Reheat	2,110
Infiltration	0

Engineering Checks	
% OA	9.91
cfm/ft²	.88
Btu/h-ft²	26.32
cfm/ton	403.09
ft²/ton	456.18
People	12
ft²/person	200.00

Areas ft²	
Roof	2,521
Other Roof	2,521
Ceiling	0
Window	1,331
Door	0
Wall	2,665
Below-Grade Wall	0
Other Wall	2,665
Partition	3,731
Exterior Floor	0
Interior Floor	0
Slab	2,521
Other Floor	0

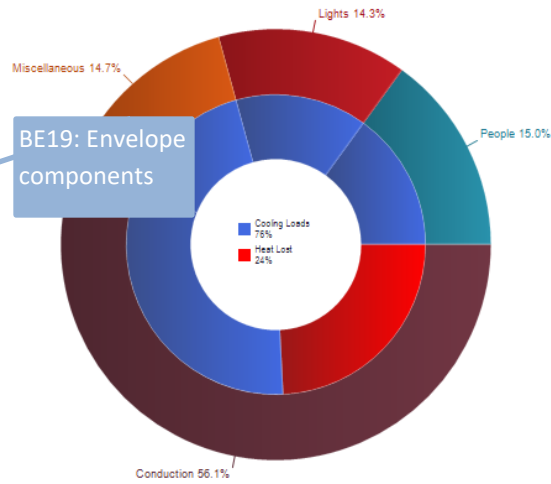
Room Cooling Loads by Component

ROOM_Room 00-00 8/21 16:40:00

Conditions at Time of Peak

Outside DB/WB/HR 83.7 °F / 71.7 °F / 100.4 gr/lb Room DB/RH/HR 75.0 °F / 50.3 % / 65.0 gr/lb

	Instant Sensible (btu/h)	Time Delay Sensible (btu/h)	Latent (btu/h)	Total (btu/h)	Percent of Total (%)
Roof	0	1263	0	1263	10.4
Other Roof	0	0	0	0	0.0
Glass	3001	5762	0	8763	72.4
Door	0	0	0	0	0.0
Wall	0	635	0	635	5.2
Below-Grade Wall	0	0	0	0	0.0
Other Wall	0	0	0	0	0.0
Partition	0	-276	0	-276	-2.3
Exterior Floor	0	0	0	0	0.0
Interior Floor	0	0	0	0	0.0
Slab	0	-1165	0	-1165	-9.6
Other Floor	0	0	0	0	0.0
Infiltration	0	0	0	0	0.0
Envelope Subtotal	3001	6239	0	9240	-
People	210	284	400	894	7.4
Lights	361	458	0	850	7.0
RA Sensible (Lights)	415	0	0	415	0.0
Miscellaneous Loads	516	357	0	873	7.2
Internal Subtotal	1502	1129	400	3031	-
RA (All Other)	0	0	0	0	0.0
DOA Direct to Room	0	0	0	0	0.0
Ceiling	0	0	0	0	0.0
Refrigeration	0	0	0	0	0.0
Service Water	0	0	0	0	0.0
HVAC Equipment Losses	0	0	0	0	0.0
Adj Air Transfer Heat	0	0	0	0	0.0
Sizing Factor Correction	0	0	0	0	0.0
Time Delay Correction	0	-132	0	-132	-1.1
Grand Total	4503	7237	400	12139	100.0



*Does not reflect Time Delay and Sizing Factor Correction effects

Interior Lighting

Zone Name	Zone Lighting Library Entry (Libraries>InternalLoads>Lights)	Schedules (Libraries>Schedules>Lighting)	Lighting Power Density (W/ft²)	Lighting Power (W)	Energy to Return Air	Consumption (kWh)	Load hours per Week
Zn-Room 00-00	Room 00-00_Light Load #001_Template	Lights - Low-Rise Office - Lighting	0.98	392	0.31	997	48.78
Zn-Room 00-01	Room 00-01_Light Load #001_Template	Lights - Low-Rise Office - Lighting	0.98	392	0.31	997	48.78
Zn-Room 00-02	Room 00-02_Light Load #001_Template	Lights - Low-Rise Office - Lighting	0.98	392	0.31	997	48.78
Zn-Room 00-03	Room 00-03_Light Load #001_Template	Lights - Low-Rise Office - Lighting	0.98	392	0.31	997	48.78
Zn-Room 00-04	Room 00-04_Light Load #001_Template	Lights - Low-Rise Office - Lighting	0.98	392	0.31	997	48.78
Zn-Room 00-05	Room 00-05_Light Load #001_Template	Lights - Low-Rise Office - Lighting	0.98	392	0.31	997	48.78

LI10: Full load hours (can be multiplied by 52 to get FLH per year)

LI07: Entered lighting power density

Section 1.6 - Performance Rating Method Compliance Report

Table EAp2-4 - Baseline Performance

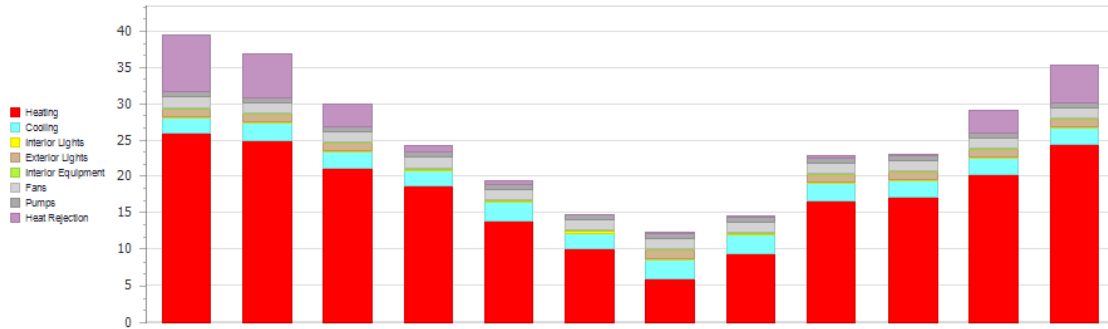
End Use	Process?	Energy Type	Units of Annual Energy Use & Peak Demand		Baseline 0*	Baseline 90*	Baseline 180*	Baseline 270*	Baseline Building Results
			Use	Demand					
Heating -- Boiler	No	Gas	Use	therms	480	477	480	477	478
			Demand	therms/hr	0.8	0.8	0.8	0.8	0.8
Heating -- Boiler Parasitic	No	Electricity	Use	kWh	206	192	206	192	199
			Demand	kW	0.3	0.3	0.3	0.3	0.3
Interior Lighting -- General	No	Electricity	Use	kWh	5981	5981	5981	5981	5981
			Demand	kW	2	2	2	2	2
Interior Equipment -- General	No	Electricity	Use	kWh	4822	4822	4822	4822	4822
			Demand	kW	1.1	1.1	1.1	1.1	1.1
Fans -- General	Yes	Electricity	Use	kWh	12961	14183	12961	14183	13572
			Demand	kW	2.2	2.3	2.2	2.3	2.2
Pumps -- General	Yes	Electricity	Use	kWh	250	267	250	267	258
			Demand	kW	0.1	0.1	0.1	0.1	0.1
Cooling -- Not Subdivided	No	Electricity	Use	kWh	5689	6083	5689	6083	5886
			Demand	kW	5.6	6	5.6	6	5.8
Total Energy Use (MMBtu/year)					150	155	150	155	153
Annual Process Energy (MMBtu/year)					16				

LI11: Interior lighting annual energy use

LI06: Interior lighting peak demand

Utility Peak Demand Summary

Electricity (kW)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Peak Facility Demand	39.5	36.7	30	24.2	19.4	14.8	12.2	14.5	22.7	22.7	29.3	35.5
Time of Peak (Day/Hour)	31/05:00	06/05:00	01/05:00	10/05:00	10/05:19	08/05:00	10/19:00	17/05:00	29/05:00	12/05:00	01/05:00	01/05:00
Heating	25.9	25	21.1	18.7	13.8	10	6.1	9.4	16.7	17	20.1	24.5
Cooling	2.2	2.3	2.3	2.1	2.6	2.2	2.5	2.5	2.3	2	2.3	2.2
Interior Lights	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Exterior Lights	1	1	1	0	0	0	1	0	1	1	1	1
Interior Equipment	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2
Exterior Equipment	0	0	0	0	0	0	0	0	0	0	0	0
Fans	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Pumps	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Heat Rejection	7.9	6	3	0.9	0.5	0.1	0.1	0.1	0.3	0.1	3	5.3
Humidification	0	0	0	0	0	0	0	0	0	0	0	0
Heat Recovery	0	0	0	0	0	0	0	0	0	0	0	0
Water Systems	0	0	0	0	0	0	0	0	0	0	0	0
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0
Generators	0	0	0	0	0	0	0	0	0	0	0	0
Electricity Produced	0	0	0	0	0	0	0	0	0	0	0	0

LE06: Exterior lighting power

Table EAp2-5 - Performance Rating

End Use	Process?	Baseline				Proposed			
		Energy Type	Units of Annual Energy Use	Peak Demand	Energy Type	Units of Annual Energy Use & Peak Demand	Peak Demand	Efficiency	
Heating -- Boiler	No	Gas	Use therm		Gas	Use therm			
Heating -- Boiler	No	Electricity	Use kWh		Electricity	Use kWh	100 %		
Interior Lighting General	No	Electricity	Use kWh	5981	Electricity	Use kWh	5981	0 %	
Exterior Lighting Exterior Light 00	No	Electricity	Use kWh	4000	Electricity	Use kWh	4000	0 %	
Interior Equipment General	No	Electricity	Use kWh	4822	Electricity	Use kWh	4822	0 %	
Fans -- General	Yes	Electricity	Use kWh	13572	Electricity	Use kWh	8572	36.8 %	
Pumps -- General	Yes	Electricity	Use kWh	258	Electricity	Use kWh	4258	-1548.4 %	
Heating -- Other	No	Electricity	Use kWh	0	Electricity	Use kWh	53144	NA	
Cooling -- General	No	Electricity	Demand kW	0	Electricity	Demand kW	0	NA	
Heat Rejection General	Yes	Electricity	Use kWh	0	Electricity	Use kWh	0	NA	

LE07: Exterior lighting baseline vs proposed

LE06: Exterior lighting EFLH, Divide Use by Demand to get hours

PPO01: Miscellaneous Equipment

AHVAC19: Fan Peak

AHVAC20: Fan EFLH, Divide use by Demand to get hours

System Component Selection Summary

Primary

System Name: VAV RH (30% Min Default) (CW)	
System Type:	Variable Air Volume (VAV)
Number of Zones:	6
Number of Rooms:	6
Component	Quantity
Cooling Coils	1
Heating Coils	7
Fans	1

AHVAC04: HVAC Systems

AHVAC04: HVAC system type

Cooling Coils

Coil Location		Coil Selection at Design				Airflow Conditions at Design				Water Flow Conditions							
System	Zone	Type	Sizing Method	Time of Peak Mo/D/H	Total capacity (tons)	Sensible capacity (MBh)	Vent Load (MBh)	Ov/undr sizing (MBh)	Airflow (cfm)	Enter DB/HR (°F)	Leave DB/HR (°F)	Flow (gpm)	Enter Temp (°F)	Leave Temp (°F)			
SCC-1		Water	Block	7/21 16:00	6.0	72.0	59.3	8.0	11.7	2,121	77.2	68.97	52.9	60.86	14.34	54.0	44.0

*Values do not include effects of plenum loads, heat exchangers such as evaporative cooling devices, and similar components.

AHVAC04: HVAC system fuel

AHVAC06: System capacity

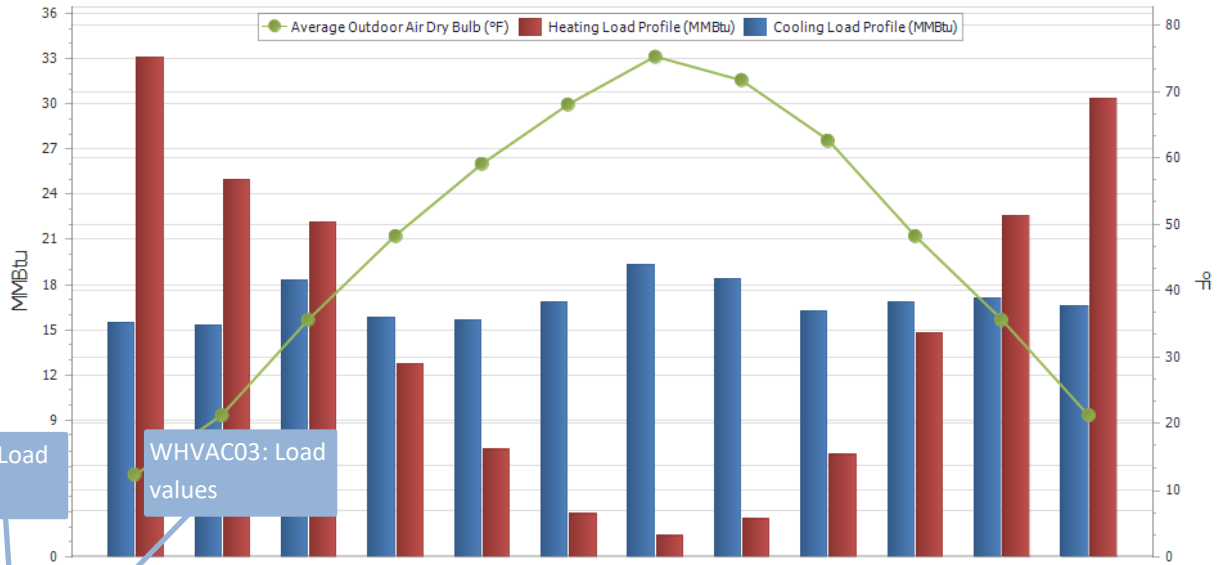
Coil Location		Coil Selection at Design				Airflow Conditions at Design				Water Flow Conditions			
System	Zone	Type	Sizing Method	Time of Peak Mo/D/H	Total capacity (MBh)	Vent Load (MBh)	Ov/undr sizing (MBh)	Airflow (cfm)	Enter DB (°F)	Leave DB (°F)	Flow (gpm)	Enter Temp (°F)	Leave Temp (°F)
SHC-1		Water	Block	2/21 20:00	0.0	7.0	0.0	2,110	95.7	55.0	N/A	90.0	140.0
	VRH-1 Zn-Room 00-00	Electric	Peak	1/21 24:00	17.1	0.0	0.2	403	55.0	95.0	N/A	N/A	N/A
	VRH-1 Zn-Room 00-01	Electric	Peak	1/21 24:00	10.4	0.0	0.1	246	55.0	95.0	N/A	N/A	N/A
	VRH-1 Zn-Room 00-02	Electric	Peak	1/21 24:00	16.8	0.0	0.2	398	55.0	95.0	N/A	N/A	N/A
	VRH-1 Zn-Room 00-03	Electric	Peak	1/21 24:00	17.3	0.0	0.2	409	55.0	95.0	N/A	N/A	N/A
	VRH-1 Zn-Room 00-04	Electric	Peak	1/21 24:00	10.6	0.0	0.1	252	55.0	95.0	N/A	N/A	N/A
	VRH-1 Zn-Room 00-05	Electric	Peak	1/21 24:00	17.1	0.0	0.2	403	55.0	95.0	N/A	N/A	N/A

Plant Equipment

Name	Type	Nominal Capacity (MBh)	Efficiency (%)
Single Boiler CV BO-1	Boiler:HotWater	0.00	82.0

Site Load Profile

Site HVAC Load Profile



AHVAC12: Load values

WHVAC03: Load values

	January	February	March	April	May	June	July	August	September	October	November	December
Cooling Load	0	0	1	3	7	12	15	13	8	2	0	0
Heating Load	14	7	3	1	0	0	0	0	0	1	4	10
Average OADB	12.6	22.1	35.7	48.9	58.8	67.5	74.7	70.9	62.9	48.2	36.3	20.7

AHVAC13: Load values

WHVAC14: Load values

WHVAC02

Plant Equipment

Name	Type	Nominal Capacity (tons)	Efficiency (COP)
Single Chiller CV WCH-1	Chiller:Electric:ER	6.00	5.55

WHVAC05, WHVAC08

Plant Summary

Cooling Plant Summary

	Sizing Method	Peak Time Mo./Day/Time	Capacity (tons)	Flow Rate (gpm)	Percent of Peak Plant Capacity	Coil ΔT (°F)	Plant Temps (°F)	
							Supply	Return
Single Chiller CV	Peak	Sum of Peaks	6	14.35	100 %			
VAV RH (30% Min Default) (CW) SCC-1	Peak	7/21 16:00:00	6	14.34	100 %	10	44.01	54

WHVAC07, WHAVC09

Loop Name: Single Chiller CV
 Loop Type: Chilled Water Loop
 Number of Assigned Coils: 1

Pumps

Name	Type	Contol	Head (psig)	Flow (gpm)	Power (W)	Power per Flow (W/gpm)
Single Chiller CV CHWP-1	Pump:ConstantSpeed	Intermittent	26	14.35	315	22

WHVAC11

Loop Name: Single Cooling Tower CV
 Loop Type: Condenser Loop
 Number of Assigned Coils: 0

Pumps

Name	Type	Contol	Head (psig)	Flow (gpm)	Power (W)	Power per Flow (W/gpm)
Single Cooling Tower CV CWP-1	Pump:ConstantSpeed	Intermittent	26	16.99	374	22

Plant Equipment

Name	Type	Nominal Capacity (tons)	Efficiency (COP)
Single Cooling Tower CV CT-1	Condenser Loop	5.64	0.00

WHVAC16 Hot water plant controls are modeled as reported
 WHVAC18 Hot water loop parameters are modeled as reported

Heating Plant Summary

	Sizing Method	Peak Time Mo./Day/Time	Capacity (MBh)	Flow Rate (gpm)	Percent of Peak Plant Capacity	Coil ΔT (°F)	Plant Temps (°F)	
							Supply	Return
Single Boiler CV	Peak	Sum of Peaks	0	0	100 %			
VAV RH (30% Min Default) (CW) SHC-1	Peak	2/21 20:40:00	0	0	0 %	50	180	129.99

WHVAC18 Hot water pumps are modeled as reported
 WHVAC20 Annual hot water pump energy is as expected

Loop Name: Single Boiler CV
 Loop Type: Hot Water Loop
 Number of Assigned Coils: 1

Pumps

Name	Type	Control	Head (psig)	Flow (gpm)	Power (W)	Power per Flow (W/gpm)
Single Boiler CV HWP-1	Pump.ConstantSpeed	Intermittent	23	0.00	0	NaN

Table EAp2-5- Performance Rating

End Use	Process?	Energy Type	Baseline			Proposed			Percent Savings
			Units of Annual Energy Use & Peak Demand	Building Results		Units of Annual Energy Use & Peak Demand	Building Results		
			Use	Demand		Use	Demand		
Heating -- Boiler	No	Gas	therms	478	Gas	therms	0	100 %	
			therms/yr	0.8		therms/yr	0		
Heating -- Boiler Parasitic	No	Electricity	kWh	199	Electricity	kWh	0	100 %	
			kW	0.3		kW	0		
Interior Lighting General	No	Electricity	kWh	5981	Electricity	kWh	5981	0 %	
			kW	2		kW	2		
Exterior Lighting Exterior Light 00	No	Electricity	kWh	4000	Electricity	kWh	4000	0 %	
			kW	1		kW	1		
Interior Equipment General	No	Electricity	kWh	4822	Electricity	kWh	4822	0 %	
			kW	1.1		kW	1.1		
Fans -- General	Yes	Electricity	kWh	13572	Electricity	kWh	8572	36.8 %	
			kW	2.2		kW	1.4		
Pumps -- General	Yes	Electricity	kWh	258	Electricity	kWh	4258	-1548.4 %	
			kW	0.1		kW	0.7		
Heating -- Other	No	Electricity	kWh	0	Electricity	kWh	53319	NA	
			kW	0		kW	26.2		
Cooling -- General	No	Electricity	kWh	0	Electricity	kWh	12219	NA	
			kW	0		kW	3.8		
Heat Rejection General	Yes	Electricity	kWh	0	Electricity	kWh	194	NA	
			kW	0		kW	0.2		

WHVAC22: Heating

SG09: Fans

WHVAC22: Heating

SG09: Cooling

Trane TRACE 700

Resources

4. Searchable database of documentation on various topics²⁶: The database covers topics such as “How do I model ventilation for ASHRAE 90.1/LEED analysis?”, “How do I set the ventilation for my proposed and baseline buildings to be identical?”, “Input VAV part-load performance for Table G3.1.3.15 for the ASHRAE Standard”, “Daylighting on LEED report”, “Why do the base utilities report incorrectly on the LEED Report”, “Common mistakes in LEED modeling”.
5. Free tutorial videos on specific topics²⁷, such as LEED Guide video.
6. If a TRACE 700 License has been purchased, a User’s Manual comes with the software

General

7. The reports below are both entered values reports and simulation reports. The entered values reports can be found by going to View > Entered Values and selecting the appropriate report. The simulation reports can be found by going to Calculate and View Results > View Results and selecting the appropriate report.
8. The reports can be viewed in the report viewer or exported. Most commonly the reports are exported to .pdf files for submittals.

Simulation Reports to be Submitted

AHJ may require that all TRACE 700 Entered Values and Output reports are submitted. Alternatively, the individual reports listed below may be requested. These reports are utilized in the Review Checks described in the Manual.

5. Title Page Report
6. Project Information Entered Values report
7. Energy Cost Budget/PRM Summary report
8. LEED Summary report
9. Monthly Energy Consumption report
10. Monthly Utility Costs report
11. Library Members Entered Values report
12. Building U-Values report
13. Building Areas report
14. Walls by Direction Entered Values report
15. Walls by Cardinal Direction entered values report
16. Room Information Entered Values report
17. Building Envelope Cooling Loads at Coil Peak
18. Building Envelope Heating Loads at Coil Peak
19. Plant Information Entered Values report
20. Equipment Energy Consumption Report
21. System Entered Values Report
22. System Checksums Report
23. Building Cool/Heat Demand report from the Visualizer

²⁶ <https://irtranecds.custhelp.com/app/answers/list>

²⁷ https://irtranecds.custhelp.com/app/e_learning

Annotated Reports

Title Page Report

PROJECT INFORMATION	
Location	
Building owner	
Program user	
Company	
Comments	
By	Trane
Dataset name	
Calculation time	09:50 AM on 01/25/2018
TRACE® 700 version	6.3.3
Location	8760 La Crosse, WI
Latitude	43.5 deg
Longitude	91.2 deg
Time Zone	6
Elevation	292 ft
Barometric pressure	29.6 in. Hg

SG03: Weather

Project Information entered values report

Entered Values	
TRACE® 700 version 6.3.3	
By Trane	
Project Name:	
Dataset Name:	
Location:	
Building Owner:	
Program User:	
Company:	
Comments:	
Cooling Design Period:	January thru December
Peak Hour Override:	0
Daylight Savings Period:	
Summer Period:	
Cooling Methodology:	TETD-TA1
Heating Methodology:	UATD
Infiltration Methodology:	Vary with wind speed
Outside Film Methodology:	Vary with wind speed
Terrain Methodology:	Flat terrain with some isolated objects
Room Circ Rate:	Medium
Wall Load To Plenum:	YES
Building Orientation:	0 degrees from north
Simulation Hours:	Full year
Calendar Code:	8760 Standard
Energy Simulation Period:	January thru December
Location:	8760 La Crosse, WI
Summer Design Dry Bulb:	92.00 °F
Summer Design Wet Bulb:	77.00 °F
Winter Design Dry Bulb:	-6.00 °F
Summer Clearness Number:	1.00
Winter Clearness Number:	1.00
Summer Ground Reflectance:	0.20
Winter Ground Reflectance:	0.20
Carbon Dioxide Level:	400 ppm
Nominal Ventilation at Design:	No
Recovery/Transfer at Design:	Yes
Retest Design Peaks:	Yes
Calculate Building Block Loads:	No
Users during unoccupied hours:	Yes

SG06: Number of hours modeled. Full year indicates 8,760 hours. (Reduced year indicates less than 8,760 hours)

Energy Cost Budget/PRM Summary report

		Energy Cost Budget / PRM Summary					
		By Trane					
Project Name: WHVAC22: Baseline and Proposed heating fuels		Date: January 25, 2018					
City:		Weather Data: 8760 La Crosse, WI					
Note: The percent column of the base total energy consumption		* Alt-2 ASHRAE Baseline 90.1-0		Alt-1 Proposed			
* Denotes the base alternative for the ECB study.		Energy 10 ⁶ Btu/yr	Proposed / Base %	Peak kBTuh	Energy 10 ⁶ Btu/yr	Proposed / Base %	Peak kBTuh
Lighting - Conditioned	Electricity	748.6	33	290	572.5	76	222
Space Heating	Electricity	462.6	20	741	396.1	86	232
	Gas	0.0	0	0	1,929.2	0	1,345
Space Cooling	Electricity	249.0	11	449	209.2	84	333
Heat Rejection	Electricity	33.3	1	56	26.0	78	30
Fans - Conditioned	Electricity	504.7	22	148	49.7	10	16
Receptacles - Conditioned	Electricity	279.1	12	81	279.1	100	81
Stand-alone Base Utilities	Electricity	1.6	0	0	1.6	100	0
Total Building Consumption		2,278.8			3,463.5		
Total		* Alt-2 ASHRAE Baseline 90.1-0		Alt-1 Proposed			
	Number of hours heating load not met	0		494			
	Number of hours cooling load not met	0		0			
		* Alt-2 ASHRAE Baseline 90.1-0		Alt-1 Proposed			
		Energy 10 ⁶ Btu/yr	Cost/yr \$/yr	Energy 10 ⁶ Btu/yr	Cost/yr \$/yr		
Electricity		2,278.8	64,047	1,534.3	41,893		
Gas		0.0	0	1,929.2	9,646		
Total		2,279	64,047	3,463	51,539		

SG09: Space heating end use

SG09: Heating, cooling and fan energy between the baseline and proposed

PPO04: Miscellaneous loads

SG08: Unmet

LEED Energy Performance Summary Report

By Trane

Section 1.1 - General Information

Simulation Program: TRACE™ 700 v6.3.3
Principle Heating Source: Electric
Energy Code Used: ASHRAE 90.1-2007
Weather File: 8760 La Crosse, WI (Full Year - 8760)
Climate Zone: 6A
New Construction Percent: 100 %
Existing Renovation Percent: 0 %
Quantity of Floors: 1
Proposed: Alternative 1 - Proposed
Baseline: Alternative 2 - ASHRAE Baseline 90.1-07 Climate Zone 6A

SG05:
Conditioned Floor

Section 1.2 - Space Summary

Building Use (Occupancy Type)	Space Area (ft ²)	Regularly Occupied Area (ft ²)	Unconditioned Area (ft ²)
Wing 1	10,000.00	10,000.00	0.00
Wing 2	10,000.00	10,000.00	0.00
Wing 3	10,000.00	10,000.00	0.00
Wing 4	10,000.00	10,000.00	0.00
Wing 5	10,000.00	10,000.00	0.00
Total	50,000.00	50,000.00	0.00

Section 1.3 - Advisory Messages

Advisory Messages	Baseline Building (0 deg rotation)	Proposed Building
Number of hours heating load not met:	0	494
Number of hours cooling load not met:	0	0
Total	0	494

SG08: Unmet hours

Project Name :
Dataset Name : TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018

LEED Energy Performance Summary Report

By Trane

Section 1.4 - Comparison of Proposed Design Versus Baseline Design

Input Parameter	Proposed Design Input	Baseline Design Input
Exterior Wall Construction	Frame Wall, No Ins U-factor : 0.438 Btu/h-ft ² -°F	90.1-07 Min Wall Nonres Zone 4-8 U-factor : 0.065 Btu/h-ft ² -°F
Roof Construction	4" LW Conc U-factor : 0.214 Btu/h-ft ² -°F Reflectivity : 0.10	90.1-07 Min Roof Nonres Zone 2-8 U-factor : 0.048 Btu/h-ft ² -°F Reflectivity : 0.30
Window-to-gross wall ratio	33.8%	33.8%
Fenestration Type	Single Clear 1/4" U-factor : 0.950 Btu/h-ft ² -°F SHGC : 0.82 Visible Transmissivity : 0.779	90.1 Window Zone U-factor : 0.350 Btu/h-ft ² -°F Visible Transmissivity : 0.779
Interior Light Power Density	Lighting Compliance : Space-By-Space Method Daylighting Controls : No Building : 1.30 W/ft ²	Lighting Compliance : Space-By-Space Method Daylighting Controls : No Building : 1.70 W/ft ²
Interior Light Power Density	Room Type : Wing 1 - 1.30 W/ft ² Wing 2 - 1.30 W/ft ² Wing 3 - 1.30 W/ft ² Wing 4 - 1.30 W/ft ² Wing 5 - 1.30 W/ft ²	Room Type : Wing 1 - 1.70 W/ft ² Wing 2 - 1.70 W/ft ² Wing 3 - 1.70 W/ft ² Wing 4 - 1.70 W/ft ² Wing 5 - 1.70 W/ft ²
Receptacle Elec Eq Power Density	0.50 W/ft ²	0.50 W/ft ²
HVAC System Type	System - 001 Water Source Heat Pump Uses: Heat recov Supply vol : 62792 cfm Fan power : 4.19 kW Dedicated OA Config : Cool/Heat	System - 001 System 3 - 2007 /2010 - Packaged Rooftop Air Conditioner Uses: DB Icon Supply vol : 36845 cfm Fan power : 42.09 kW
Cooling Equipment	Plant: Cooling plant - 004 Type: Default air-cooled unitary Category: Air-cooled unitary Clg Cap: Design Engy Rate : 1 kW/ton	Plant: Cooling plant - 001 Type: Default air-cooled unitary Category: Air-cooled unitary Clg Cap: Design Engy Rate : 1.38 kW/ton
Cooling Equipment	Plant: Cooling plant - 001 Type: Default Water Source HP Category: Water source heat pump Clg Cap: Design Engy Rate : 0.65 kW/ton HR Cap: 10.88 Mbt/ton Engy Rate : 0.05 kW/Mbt	

LI07: Lighting Power Densities for the Space-By-Space Method

AHVAC06: Baseline Equipment Size

Project Name :
Dataset Name : TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018

LEED Energy Performance Summary Report

By Trane

Section 1.4 - Comparison of Proposed Design Versus Baseline Design

Input Parameter	Proposed Design Input	Baseline Design Input
Chilled Water Pump	Type: Crst vol chill water pump Full load consumption : 0 ft water	
Heat Rejection Parameters	Type: WSHP - Cooling tower HR Type: Cooling tower (DOE) Energy Consumption : 0.066000 kW/ton	Type: Condenser fan for Heat Pump HR Type: Air-cooled condenser Energy Consumption : 0.120000 kW/ton
Heat Rejection Parameters	Type: Condenser fan for Heat Pump HR Type: Air-cooled condenser Energy Consumption : 0.120000 kW/ton	
Heating Equipment	Plant: Heating plant - 003 Type: Default gas-fired heat exchanger Category: Gas-fired heat exchanger Capacity: Design Energy Rate : 90 Percent efficient	Plant: Heating plant - 002 Type: Default electric resistance Category: Electric resistance Capacity: Design Energy Rate : 100 Percent efficient
Heating Equipment	Plant: Heating plant - 002 Type: Default Boiler Category: Boiler Capacity: Design Energy Rate : 95 Percent efficient	
Hot Water Pump	Type: Heating water circ pump Full load consumption : 0 kW	
Base Utility	Type: Parking lot lights Description: Parking lot lights Energy Type: Electricity Hourly Consumption : 0.1 kW Schedule: Parking lot lights	Type: Parking lot lights Description: Parking lot lights Energy Type: Electricity Hourly Consumption : 0.1 kW Schedule: Parking lot lights

AHVAC06: Baseline Equipment

RE03: Renewable Energy

EC02: Exceptional Calculation

LE03: Proposed Exterior Lighting Power

LE03: Baseline Exterior Lighting Power

Section 1.5 - Energy Type Summary (Proposed)

Energy Type	Utility Rate Description	Units
Electric Consumption	A sample with all utilities	kWh
Electric Demand	A sample with all utilities	kW
Gas	A sample with all utilities	therms

Project Name :
Dataset Name : TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018

Note: For RE03 and EC02, most renewable energy sources such as solar and wind power cannot be modeled directly in TRACE 700. They must be modeled outside of the program and then input as a

negative base utility. A positive base utility consumes energy whereas a negative base utility adds energy. They will appear as separate line items here.

LEED Energy Performance Summary Report

By Trane

BE21: Baseline 4 rotations and average

Section 1.6 Baseline Performance - Performance Rating Method Compliance

End Use	Process	Baseline Design Energy Type	Units of Annual Energy & Peak Demand	Baseline (0 deg rotation)	Baseline (90 deg rotation)	Baseline (180 deg rotation)	Baseline (270 deg rotation)	Baseline Design
Space Heating	No	Electricity	Energy Use (kWh)	136,297	134,434	135,309	136,081	135,309
			Demand (kW)	216.3	216.5	219.1	214.9	217.2
Space Cooling	No	Electricity	Energy Use (kWh)	71,760	73,946	73,566	72,501	72,943
			Demand (kW)	128.9	131.4	133.3	132.3	131.5
Heat Rejection	No	Electricity	Energy Use (kWh)	9,588	9,880	9,825	9,683	9,744
Fans - Interior	No	Electricity	Energy Use (kWh)	143,078	143,078	143,078	143,078	143,078
			Demand (kW)	42.1	42.1	42.1	42.3	42.1
Receptacle Equipment	Yes	Electricity	Energy Use (kWh)	81,791	81,791	81,791	81,791	81,791
			Demand (kW)	23.8	23.8	23.8	23.8	23.8
Interior Lighting	No	Electricity	Energy Use (kWh)	219,353	219,353	219,353	219,353	219,353
			Demand (kW)	65.0	65.0	65.0	65.0	65.0
Parking lot lights - Base Utility	Yes	Electricity	Energy Use (kWh)	475	475	475	475	475
			Demand (kW)	0.1	0.1	0.1	0.1	0.1
Space Heating	No	Gas	Energy Use (therms)	0	0	0	0	0
			Demand (therms)	0.0	0.0	0.0	0.0	0.0
Baseline Energy Totals:			Energy Use (MMBtu/yr)	2,260.5	2,259.4	2,260.5	2,260.5	2,278.8
			Process (MMBtu/yr)	280.8	280.8	280.8	280.8	280.8

LI11: Lighting Full Load Hours – This needs to be calculated as FLH = Energy Use/Demand

LI11: Interior Lighting Annual Energy

LI10: Interior Lighting Peak

LE06, LE07: Exterior Lighting Energy

Section 1.6 Proposed Performance - Performance Rating Method Compliance

End Use	Process	Proposed Design Energy Type	Units of Annual Energy & Peak Demand	Proposed Design
Space Heating	No	Electricity	Energy Use (kWh)	116,062
			Demand (kW)	68.0
Space Cooling	No	Electricity	Energy Use (kWh)	61,296
			Demand (kW)	97.5
Heat Rejection	No	Electricity	Energy Use (kWh)	7,805
			Demand (kW)	8.7
Fans - Interior	No	Electricity	Energy Use (kWh)	14,576
			Demand (kW)	4.6

Project Name :
Dataset Name : TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018

LEED Energy Performance Summary Report
By Trane

Section 1.6 Proposed Performance - Performance Rating Method Compliance

End Use	Units of A Energy & Dema	LI10, LI11: Interior Lighting Annual
Receptacle E	Energy Use (kWh)	61,751
	Demand (kW)	23.8
Interior Lighting	Electricity	LI10: Lighting Full Load Hours – This needs to be calculated as EFLH = Energy Use/Demand
	Energy Use (kWh)	167,740
	Demand (kW)	65.0
Parking lot lights - Base Utility	Electricity	LI06: Interior Lighting Peak Demand
	Energy Use (kWh)	475
	Demand (kW)	0.1
Space Heating	Gas	LI07: Exterior Lighting Energy
	Energy Use (therms)	19,292
	Demand (kW)	
Proposed Energy Totals:		
	Energy Use (MMBtu/yr)	280.77

Monthly Energy Consumption report

MONTHLY ENERGY CONSUMPTION

By Trane

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 1 Proposed													
Electric													
On-Pk Cons. (kWh)	48,913	40,855	40,975	29,464	31,888	38,140	35,778	38,564	31,430	31,825	37,252	44,456	449,541
On-Pk Demand (kW)	153	139	133	147	164	196	190	198	188	156	137	141	198
Gas													
On-Pk Cons. (therms)	4,614	3,496	2,638	850	252	14	1	10	207	771	2,448	3,990	19,292
On-Pk Demand (therms/hr)	12	12	11	10	9	3	0	6	10	10	11	11	12
Water													
Cons. (1000gal)	0	0	3	12	32	76	75	73	43	16	1		331
Energy Consumption						Environmental Impact Analysis							
Building	69,269	Btu/(ft2-year)		CO2		715,543		lbm/year					
Source	132,680	Btu/(ft2-year)		SO2		2,128		gm/year					
				NOX		844		gm/year					
Floor Area	50,000 ft2												
Alternative: 2 ASHRAE Baseline 90.1-07 Climate Zone 6A													
Electric													
On-Pk Cons. (kWh)	75,742	60,559	59,581	41,460	45,835	56,081	54,552						
On-Pk Demand (kW)	295	242	227	192	255	296	278						
Energy Consumption						Environmental Impact Analysis							
Building	45,577	Btu/(ft2-year)		CO2		1,054,251		lbm/year					
Source	136,744	Btu/(ft2-year)		SO2		3,135		gm/year					
Floor Area	50,000 ft2												

UR03: Modeled utility rate structure as reported. Take the dollar values on the Monthly Utility Costs report divided by these values to determine the virtual rate

SG10: Site Energy Use Intensity (EUI) must be calculated from the building energy consumption and floor area reported here.

Project Name: TEST FILE 2.TRC

Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
Alternative - 2 Monthly Energy Consumption report Page 1 of 1

Monthly Utility Costs report

MONTHLY UTILITY COSTS
By TRANE

Utility	Jan	Feb	Mar	Apr	----- May	----- Monthly Utility Costs June	----- July	----- Aug	Sept	Oct	Nov	Dec	Total
Alternative 1													
Electric													
On-Pk Cons. (\$)	2,467	2,062	2,070	1,494	1,616	1,927	1,809	1,949	1,592	1,613	1,884	2,244	22,728
On-Pk Demand (\$)	1,538	1,392	1,331	1,472	1,644	1,963	1,904	1,986	1,878	1,570	1,370	1,418	19,467
Total (\$):	4,005	3,454	3,401	2,967	3,261	3,890	3,713	3,934	3,470	3,183	3,254	3,662	42,194
Gas													
On-Pk Cons. (\$)	2,756	2,154	1,769	859	572	438	447	451	536	833	1,660	2,446	14,921
Water													
On-Pk Cons. (\$)	0	0	3	12	32	76	75	73	43	16	1	0	331
Monthly Total (\$):	6,761	5,608	5,173	3,837	3,865	4,404	4,236	4,469	4,048	4,032	4,915	6,107	57,445

Building Area = 50,000 ft²
Utility Cost Per Area = 1.15 \$/ft²

UR03: Modeled utility rate structure as reported. Take these values divided by the values on the Monthly Utility Costs report to determine the virtual rates

Project Name:
Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 04:39 PM on 03/02/2018
Monthly Utility Costs report Page 1 of 3

Library Members Entered Values report

Library Members						
Utility Rates						
A sample with all utilities			This is NOT a rate			
Electric demand	Min Charge	0	Start period:	January	Rate	
On peak	Min demand	0	End period:	December	\$/kW	10.00
	Fuel adjustment	0				
	kWh/kW flag	No				
	Customer charge	0				
Electric demand	Min Charge	0	Start period:	January	Rate	<u>Cutoff</u>
Off peak	Min demand	0	End period:	December	\$/kW	5.000
	Fuel adjustment	0				
	kWh/kW flag	No				
	Customer charge	0				
Electric consumption	Min Charge	0	Start period:	January	Rate	<u>Cutoff</u>
On peak	Min demand	0	End period:	December	\$/kW	0.050
	Fuel adjustment	0				
	kWh/kW flag	No				
	Customer charge	0				
Electric consumption	Min Charge	0	Start period:	January	Rate	<u>Cutoff</u>
Off peak	Min demand	0	End period:	December	\$/kW	0.030
	Fuel adjustment	0				
	kWh/kW flag	No				
	Customer charge	0				
Gas	Min Charge	0	Start period:	January	Rate	<u>Cutoff</u>
On peak	Min demand	0	End period:	December	\$/therm	0.500
	Fuel adjustment	0				
	kWh/kW flag	No				
	Customer charge	0				
Gas	Min Charge	0	Start period:	January	Rate	<u>Cutoff</u>
Off peak	Min demand	0	End period:	December	\$/therm	0.500
	Fuel adjustment	0				
	kWh/kW flag	No				
	Customer charge	0				
Water	Min Charge	0	Start period:	January	Rate	<u>Cutoff</u>
On peak	Min demand	0	End period:	December	\$/1000 gal	1.000
	Fuel adjustment	0				
	kWh/kW flag	No				
	Customer charge	0				

UR03 Utility rate structure. The input for the utility rate used in both the proposed and baseline are displayed in this section

Project Name: TEST FILE 2.TRC

Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3
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Library Members

Schedules

Parking lot lights

Simulation type: Reduced year

January - December	Cooling design to Sunday	<u>Start time</u>	<u>End time</u>	<u>Percentage</u>
		Midnight	7 a.m.	100.0
		7 a.m.	6 p.m.	0.0
		6 p.m.	Midnight	100.0
Heating Design		<u>Start time</u>	<u>End time</u>	<u>Percentage</u>
		Midnight	7 a.m.	100.0
		7 a.m.	6 p.m.	0.0
		6 p.m.	Midnight	100.0

WHVAC09: Annual chilled water pump energy occupied hours/year

WHVAC20: Annual hot water pump energy occupied hours/year

People - Office

Simulation type: Reduced year

January - December	Cooling design to Weekday	<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	Utilization
		Midnight	7 a.m.	0.0	
		7 a.m.	8 a.m.	30.0	
		8 a.m.	5 p.m.	100.0	
		5 p.m.	6 p.m.	30.0	
		6 p.m.	7 p.m.	1.0	
		7 p.m.	Midnight	0.0	
Heating Design		<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	Utilization
		Midnight	Midnight	0.0	
January - December		<u>Start time</u>	<u>End time</u>	<u>Percentage</u>	Utilization
	Saturday to Sunday	Midnight	Midnight	0.0	

Project Name:
Dataset Name: TEST FILE 1.TRC

TRACE® 700 v6.3.3
Page 6 of 17

Library Members

90.1-13 Min Boiler, HW, Gas <300 MBh

Comments	Boiler, Hot Water	
Category	Boiler	
Heat Source	Utility	es
Fuel Type	Gas	5 gal/btu
Capacity		3.5 KW
Energy Rate	84.000	Mbh Percent efficient
Hot Water Pump	Heating water circ pump	
Hot Water Pump Full Load	0.00	kW
Hot Water Leaving temp	180.00	°F
Storage tank	None	
Unloading Curve	Htg Straight Line	

WHVAC19, WHVAC18: Delta T used to calculate pump gpm

$$Gpm = Q / (500 * \Delta T)$$

WHVAC16: Hot water plant controls

Default gas-fired heat exchanger

Comments	ROOFTOP GAS HEAT	
Category	Gas-fired heat exchanger	<u>Miscellaneous Accessories</u>
Heat Source	Utility	
Fuel Type	Gas	
Capacity		Mbh
Energy Rate	77.000	Percent efficient
Hot Water Pump	None	
Hot Water Pump Full Load	0.00	kW
Hot Water Leaving temp		°F
Storage tank	None	
Unloading Curve	Htg Straight Line	

Project Name:
Dataset Name: TEST FILE 1.TRC

TRACE® 700 v6.3.3
Page 15 of 17

Library Members

Heat Rejection

Condenser fan for MZ rooftop

Comments	Multizone packaged rooftop cond fan	<u>Coil load assignmen</u>
Capacity	100.00 Percent	+Main
Energy consumption	0.08 kW/ton	Direct evaporator
Low speed consumpt	0.00 Percent full load	+Indirect evaporator
Fluid type	Water	+Auxiliary
Condenser type	Air-cooled condenser	+Optional ventilation
Number of cells	1	+Misc cooling load
% Air at low Speed	0.00	
Approach Temp	5.56 °C	
Temp Range	5.56 °C	
Wet bulb Temp	25.56 °C	
Design water flow rate	3.00 gpm/ton	
Makeup water flow rate	0.00 gal/ton-hr	
Hourly Amb WB Offset	°C	
Unloading curve	C-Tower on/off	

Cooling tower for Cent. Chillers

Comments	For Centrifugal Chillers.	<u>Coil load assignmen</u>
Capacity	100.00 Percent	+Main
Energy consumption	0.07 kW/ton	Direct evaporator
Low speed consumpt	0.00 Percent full load	+Indirect evaporator
Fluid type	Water	+Auxiliary
Condenser type	Cooling tower (DOE)	+Optional ventilation
Number of cells	1	+Misc cooling load
% Air at low Speed	0.00	
Approach Temp	7.00 °F	
Temp Range	10.00 °F	
Wet bulb Temp	78.00 °F	
Design water flow rate	3.00 gpm/ton	
Makeup water flow rate	3.20 gal/ton-hr	
Hourly Amb WB Offset	°F	
Unloading curve	C-Tower on/off	

WHVAC11: Heat Rejection System

Heat Recovery

Project Name:
Dataset Name: TEST FILE 1.TRC

TRACE® 700 v6.3.3
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Building U-Values report

BUILDING U-FACTORS
 By Trane

BE06, BE07, BE08, BE09, BE10: Thermal properties of the building envelope for the proposed and baseline

Description	Partition	Internal Door	Exposed Floor	ROOM U-FACTORS			Btu/h-ft ² -°F		External Door	Wall	Ceiling	Room Mass lb/ft ²	Room Capacitance Btu/lb-°F
				Summer Skylight	Winter Skylight	Roof	Summer Window	Winter Window					
Alternative 1													
W1-R1 N - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	42.8	9.5
W1-R2 E - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	43.9	9.7
W1-R3 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W1-R4 W - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	48.1	10.5
W1-R5 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W2-R6 N - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	42.8	9.5
W2-R7 E - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	43.9	9.7
W2-R8 S - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	46.0	10.1
W2-R9 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W2-R10 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W3-R11 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W3-R12 E - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	43.9	9.7
W3-R13 S - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	46.0	10.1
W3-R14 W - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	48.1	10.5
W3-R15 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W4-R17 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W4-R16 N - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	42.8	9.5
W4-R19 W - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	48.1	10.5
W4-R20 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W4-R18 S - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	46.0	10.1
W5-R21 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W5-R22 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W5-R23 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W5-R24 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
W5-R25 Int - Zone	0.000	0.000	0.000	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.317	31.1	7.1
System - 001 - System	0.000	0.000	0.000	0.000	0.000	0.214	0.950	0.947	0.000	0.438	0.317	34.2	7.7

BE16: Baseline and Proposed Fenestration Properties

Project Name:
 Dataset Name: TEST FILE 2.TRC

IESVE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
 Building U-Factors Report Page 1 of 4

Building Areas report

BUILDING AREAS
 By Trane

BE06, BE07, BE08, BE09, BE10:
 Areas of the building envelope for
 the proposed and baseline

Sys Zon Room	Number of Duplicate Floors	Number of Duplicate Rooms	Floor Area/ Duplicate Room ft²	Total Floor Area ft²	Partition Area ft²	Int Door Area ft²	Exposed Floor Area ft²	Skylight Area ft²	Net Roof Area ft²	Window Area ft²	Window/ Wall %	Ext Door Area ft²	Net Wall Area ft²
Alternative 1													
W1-R1 N	1	1	900	900	0	0	0	0	900	540	45	0	660
W1-R2 E	1	1	900	900	0	0	0	0	900	480	40	0	720
W1-R3 Int	1	1	900	900	0	0	0	0	900	0	0	0	0
W1-R4 W	1	1	900	900	0	0	0	0	900	240	20	0	960
W1-R5 Int	1	1	6,400	6,400	0	0	0	0	6,400	0	0	0	0
W2-R6 N	1	1	900	900	0	0	0	0	900	540	45	0	660
W2-R7 E	1	1	900	900	0	0	0	0	900	480	40	0	720
W2-R8 S	1	1	900	900	0	0	0	0	900	360	30	0	840
W2-R9 Int	1	1	900	900	0	0	0	0	900	0	0	0	0
W2-R10 Int	1	1	6,400	6,400	0	0	0	0	6,400	0	0	0	0
W3-R11 Int	1	1	900	900	0	0	0	0	900	0	0	0	0
W3-R12 E	1	1	900	900	0	0	0	0	900	480	40	0	720
W3-R13 S	1	1	900	900	0	0	0	0	900	360	30	0	840
W3-R14 W	1	1	900	900	0	0	0	0	900	240	20	0	960
W3-R15 Int	1	1	6,400	6,400	0	0	0	0	6,400	0	0	0	0
W4-R17 Int	1	1	900	900	0	0	0	0	900	0	0	0	0
W4-R16 N	1	1	900	900	0	0	0	0	900	540	45	0	660
W4-R19 W	1	1	900	900	0	0	0	0	900	240	20	0	960
W4-R20 Int	1	1	6,400	6,400	0	0	0	0	6,400	0	0	0	0
W4-R18 S	1	1	900	900	0	0	0	0	900	360	30	0	840
W5-R21 Int	1	1	900	900	0	0	0	0	900	0	0	0	0
W5-R22 Int	1	1	900	900	0	0	0	0	900	0	0	0	0
W5-R23 Int	1	1	900	900	0	0	0	0	900	0	0	0	0
W5-R24 Int	1	1	900	900	0	0	0	0	900	0	0	0	0
W5-R25 Int	1	1	6,400	6,400	0	0	0	0	6,400	0	0	0	0
System - 001				50,000	0	0	0	0	50,000	4,860	34	0	9,540

Total building Window Area: 4,860 ft²	Total building Wall Area: 14,400 ft²	Building Total Window %: 33.8%
Total building Skylight Area: 0 ft²	Total building Roof Area: 50,000 ft²	Building Total Skylight %: 0.0%
Total building Floor Area: 50,000 ft²		

BE14: Baseline and Proposed Fenestration Areas

Project Name: _____

Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
Building Areas ReportPage 1 of 2

Walls by Direction Entered Values report

ENTERED VALUES

Walls by Direction

By Trane

Alternative 1

North (0 degrees)

Room Description	Wall Description	Area	Tilt	Const Type	U Value Btu/h-ft ² -F	Alpha	Type	Glass			External Shading	Internal Shading
								Area ft ²	SHGC	U Value Btu/h-ft ² -F		
W1-R1 N	N Wall Opening - 1	1,200.0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	540.0	0.82	0.9500	Overhang - None	None
W2-R6 N	N Wall Opening - 1	1,200.0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	540.0	0.82	0.9500	Overhang - None	None
W4-R16 N	N Wall Opening - 1	1,200.0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	540.0	0.82	0.9500	Overhang - None	None
		3,600.0						1,620.0	0.82	0.9500		

BE14: Baseline and Proposed Fenestration Areas

East (90 degrees)

Room Description	Wall Description	Area	Tilt	Const Type	U Value Btu/h-ft ² -F	Alpha	Type	Glass			External Shading	Internal Shading
								Area ft ²	SHGC	U Value Btu/h-ft ² -F		
W1-R2 E	E Wall Opening - 1	1,200.0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	480.0	0.82	0.9500	Overhang - None	None
W2-R7 E	E Wall Opening - 1	1,200.0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	480.0	0.82	0.9500	Overhang - None	None
W3-R12 E	E Wall Opening - 1	1,200.0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	480.0	0.82	0.9500	Overhang - None	None
		3,600.0						1,440.0	0.82	0.9500		

BE16: Baseline and Proposed Fenestration Properties

South (180 degrees)

Room Description	Wall Description	Area	Tilt	Const Type	U Value Btu/h-ft ² -F	Alpha	Type	Glass			External Shading	Internal Shading
								Area ft ²	SHGC	U Value Btu/h-ft ² -F		
W2-R8 S	S Wall Opening - 1	1,200.0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	360.0	0.82	0.9500	Overhang - None	None
W3-R13 S	S Wall Opening - 1	1,200.0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	360.0	0.82	0.9500	Overhang - None	None
W4-R18 S	S Wall Opening - 1	1,200.0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	360.0	0.82	0.9500	Overhang - None	None
		3,600.0			0.4376			1,080.0	0.82	0.9500		

Project Name:
Dataset Name: C:\Users\iribgw\Documents\TRACE 700 Projects\LEED Automation testing\PID

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
Alternative - 1 Entered Values - Rooms Page 1 of 4

Walls by Cardinal Direction entered values report

ENTERED VALUES
Walls by Cardinal Direction
 By Trane

Alternative 1

East Facing

Room Description	Wall Description	Area	Dir	Tilt	Const Type	U Value Btu/h-ft ² -F	Alpha	Type	Glass			External Shading	Internal Shading
									Area ft ²	SHGC	U Value Btu/h-ft ² -F		
W1-R2 E	EWall Opening - 1	1,200.0	90	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	480.0	0.82	0.9500	Overhang - None	None
W2-R7 E	EWall Opening - 1	1,200.0	90	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	480.0	0.82	0.9500	Overhang - None	None
W3-R12 E	EWall Opening - 1	1,200.0	90	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	480.0	0.82	0.9500	Overhang - None	None
		3,600.0							1,440.0	0.82	0.9500		

BE14: Baseline and Proposed Fenestration Areas

North Facing

Room Description	Wall Description	Area	Dir	Tilt	Const Type	U Value Btu/h-ft ² -F	Alpha	Type	Glass			External Shading	Internal Shading
									Area ft ²	SHGC	U Value Btu/h-ft ² -F		
W1-R1 N	NWall Opening - 1	1,200.0	0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	540.0	0.82	0.9500	Overhang - None	None
W2-R6 N	NWall Opening - 1	1,200.0	0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	540.0	0.82	0.9500	Overhang - None	None
W4-R16 N	NWall Opening - 1	1,200.0	0	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	540.0	0.82	0.9500	Overhang - None	None
		3,600.0							1,620.0	0.82	0.9500		

BE16: Baseline and Proposed Fenestration Properties

South Facing

Room Description	Wall Description	Area	Dir	Tilt	Const Type	U Value Btu/h-ft ² -F	Alpha	Type	Glass			External Shading	Internal Shading
									Area ft ²	SHGC	U Value Btu/h-ft ² -F		
W2-R8 S	SWall Opening - 1	1,200.0	180	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	360.0	0.82	0.9500	Overhang - None	None
W3-R13 S	SWall Opening - 1	1,200.0	180	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	360.0	0.82	0.9500	Overhang - None	None
W4-R18 S	SWall Opening - 1	1,200.0	180	0	Frame Wall, No Ins Window	0.4376	0.90	Single Clear 1/4"	360.0	0.82	0.9500	Overhang - None	None
		3,600.0				0.4376			1,080.0	0.82	0.9500		

Project Name:
 Dataset Name: C:\Users\iribgw\Documents\TRACE 700 Projects\LEED Automation testing\PID

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
 Alternative - 1 Entered Values - Rooms Page 1 of 4

Room Information entered values report

AHVAC02: Thermal Blocks

ENTERED VALUES
ROOM BY ROOM
 By Trane

AHVAC26: Modeled ventilation rate

Room Description : W1-R1 N Zone Description : No Zone System Description: System - 001

GENERAL INFORMATION	PEOPLE	AIRFLOW INFORMATION
Floor Area: 900 ft² Fir-Fir Height: 12.0 ft Plenum Height: 3.0 ft Height Above Fir: Slab Cnstr Type: 4"LW Concrete Room Mass: Time delay based on actual mass Ceiling R-Value: 1.786 hr-ft²-F/Btu Is There Carpet?: YES Design Clg DB / Drift Point: 75.0 °F / 81.0 °F Design Htg DB / Drift Point: 70.0 °F / 64.0 °F Design Relative Humidity: 50 % Moisture Capacitance: None Clg Tstat: None Htg Tstat: None Thermostat Location/Room Floor Multiplier: 1 Humidistat Location/Room Room Multiplier: 1 CO2 Sensor Location/None Room Type: Conditioned	People Type: General Office # of People: 143 sqft/person People Sensible: 250 Btu/h People Latent: 200 Btu/h People Schedule: People-Office Workstation: 1.0 workstation/person % Load to RA: 20 % Lighting Schedule: Lights - Office Lighting Amount: 1.3 W/sq ft Ballast Factor: 1.0	Cooling (Peop-based) Heating (Area-based) Vent Type: Office space Office space Vent Value: 5.00 cfm/person 0.06 cfm/sq ft Vent Schedule: Vent - Office Infil Type: None None Infil Value: 0.00 air changes/hr 0.00 air changes/hr Infil Schedule: Available (100%) Vav Airflow: Vav Sched: Available (100%) To be calculated Supply: To be calculated To be calculated Aux Supply: To be calculated Room Exhaust: Rm Exh Sched: Available (100%) Cooling Ez: Ceiling cldg supply, ceiling return 100 % Heating Ez: Ceiling supply > Trm+15°F(8°C), ceiling return 80 % Er: Default based on system type

BE18: Infiltration

LI07: Baseline and proposed lighting power density

Description	Area/Amount	Dir	Const Type / Tilt Schedule	U Value Btu/h ft² °F Alpha	Type / Energy Type	Area ft²	Shade Coef	Glass		External Shading	Internal Shading	Adj Temp/Gmd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
								U Value Btu/h ft² °F	External Shading							
Roof - 1	900 ft²	0	90 4"LW Conc	0.2135	0.90	0				Overhang - None	None					
N Wall	1,200 ft²	0	0 Frame Wall, No Ins	0.4376	0.90											
Opening - 1			Window		Single Clear 1/4"	540	0.95	0.95		Overhang - None	None	0.00				
Misc Load 1	0.50 W/sq ft		Misc - Low rise office		Electricity								100	100		0 60.00

Note: Alternative 1 rooms are displayed first. Alternative 2 rooms are displayed later in the report.

ENTERED VALUES
ROOM BY ROOM
 By Trane

AHVAC18: Modeled fan flow rates

Room Description : W1-R1 N Zone Description : No Zone System Description: System - 001

GENERAL INFORMATION	PEOPLE	AIRFLOW INFORMATION
Floor Area: 900 ft² Fir-Fir Height: 12.0 ft Plenum Height: 3.0 ft Height Above Fir: Slab Cnstr Type: 4"LW Concrete Room Mass: Time delay based on actual mass Ceiling R-Value: 1.786 hr-ft²-F/Btu Is There Carpet?: YES Design Clg DB / Drift Point: 75.0 °F / 81.0 °F Design Htg DB / Drift Point: 70.0 °F / 64.0 °F Design Relative Humidity: 50 % Moisture Capacitance: None Clg Tstat: None Htg Tstat: None Thermostat Location/Room Floor Multiplier: 1 Humidistat Location/Room Room Multiplier: 1 CO2 Sensor Location/None Room Type: Conditioned	People Type: General Office Space # of People: 143 sqft/person People Sensible: 250 Btu/h People Latent: 200 Btu/h People Schedule: People-Office Workstation: 1.0 workstation/person % Load to RA: 20 % Lighting Schedule: Lights - Office Lighting Amount: 1.3 W/sq ft Ballast Factor: 1.0	Cooling (Peop-based) Heating (Area-based) Vent Type: Office space Office space Vent Value: 5.00 cfm/person 0.06 cfm/sq ft Vent Schedule: Vent - Office Infil Type: None None Infil Value: 0.00 air changes/hr 0.00 air changes/hr Infil Schedule: Available (100%) Vav Airflow: Vav Sched: Available (100%) To be calculated Supply: To be calculated To be calculated Aux Supply: To be calculated Room Exhaust: Rm Exh Sched: Available (100%) Cooling Ez: Ceiling cldg supply, ceiling return 100 % Heating Ez: Ceiling supply > Trm+15°F(8°C), ceiling return 80 % Er: Default based on system type

Description	Area/Amount	Dir	Const Type / Tilt Schedule	U Value Btu/h ft² °F Alpha	Type / Energy Type	Area ft²	Shade Coef	Glass		External Shading	Internal Shading	Adj Temp/Gmd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
								U Value Btu/h ft² °F	External Shading							
Roof - 1	900 ft²	0	90 4"LW Conc	0.2135	0.90	0				Overhang - None	None					
N Wall	1,200 ft²	0	0 Frame Wall, No Ins	0.4376	0.90											
Opening - 1			Window		Single Clear 1/4"	540	0.95	0.95		Overhang - None	None	0.00				
Misc Load 1	0.50 W/sq ft		Misc - Low rise office		Electricity								100	100		0 60.00

Building Envelope Cooling Loads at Coil Peak

BUILDING ENVELOPE COOLING LOADS at Coil Peak By Trane												
Alternative 1												
System Zone Room		WALL				WINDOW						
		Plenum Load Btu/h	Plenum CLTD °F	Space Load Btu/h	Space CLTD °F	Space Solar Btu/h	Plenum Solar Btu/h	Solar CLF	Space Conduction Btu/h	Space CLTD °F	Plenum Conduction Btu/h	Plenum CLTD °F
W1-R1 N	Zn Tot/Ave	2,441	18.6	4,362	27.7	18,086	0	0.955	9,342	18.2	0	0.0
W1-R2 E	Zn Tot/Ave	8,232	62.7	11,906	64.8	91,066	0	0.945	2,375	5.2	0	0.0
W1-R3 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W1-R4 W	Zn Tot/Ave	9,419	71.7	23,420	81.1	46,043	0	0.944	3,427	15.0	0	0.0
W1-R5 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W2-R6 N	Zn Tot/Ave	2,441	18.6	4,362	27.7	18,086	0	0.955	9,342	18.2	0	0.0
W2-R7 E	Zn Tot/Ave	8,232	62.7	11,906	64.8	91,066	0	0.945	2,375	5.2	0	0.0
W2-R8 S	Zn Tot/Ave	8,793	67.0	17,130	72.5	68,138	0	0.966	2,336	6.8	0	0.0
W2-R9 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W2-R10 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W3-R11 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W3-R12 E	Zn Tot/Ave	8,232	62.7	11,906	64.8	91,066	0	0.945	2,375	5.2	0	0.0
W3-R13 S	Zn Tot/Ave	8,793	67.0	17,130	72.5	68,138	0	0.966	2,336	6.8	0	0.0
W3-R14 W	Zn Tot/Ave	9,419	71.7	23,420	81.1	46,043	0	0.944	3,427	15.0	0	0.0
W3-R15 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W4-R17 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W4-R16 N	Zn Tot/Ave	2,441	18.6	4,362	27.7	18,086	0	0.955	9,342	18.2	0	0.0
W4-R19 W	Zn Tot/Ave	9,419	71.7	23,420	81.1	46,043	0	0.944	3,427	15.0	0	0.0
W4-R20 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W4-R18 S	Zn Tot/Ave	8,793	67.0	17,130	72.5	68,138	0	0.966	2,336	6.8	0	0.0
W5-R21 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W5-R22 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W5-R23 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W5-R24 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
W5-R25 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0
System - 001	Sys Tot/Ave	86,651	55.0	170,449	65.6	669,995	0	0.952	52,441	11.4	0	0.0
System - 001	Sys Block	60,577	38.5	127,309	49.0	271,611	0	0.438	78,731	17.1	0	0.0

BE19: Design cooling loads for baseline and proposed

Project Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
Alternative - 1 Envelope Loads at Coil Peak Report Page 1 of 8

Note: Alternative 1 loads are displayed first, alternative 2 loads are later in the report.

Building Envelope Heating Loads at Coil Peak

BUILDING ENVELOPE HEATING LOADS at Coil Peak By Trane													
Alternative 1													
System Zone Room	Zn Tot/Ave	WALL				WINDOW							
		Plenum Load Btu/h	Plenum CLTD °F	Space Load Btu/h	Space CLTD °F	Space Solar Btu/h	Plenum Solar Btu/h	Solar CLF	Space Conduction Btu/h	Space CLTD °F	Plenum Conduction Btu/h	Plenum CLTD °F	
W1-R1 N	Zn Tot/Ave	-8,786	-66.9	-11,973	-76.0	0	0	0.000	0	0	0.000	0	0.0
W1-R2 E	Zn Tot/Ave	-8,786	-66.9	-13,968	-76.0	0	0	0.000	-34,754	-76.4	0	0.0	
W1-R3 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W1-R4 W	Zn Tot/Ave	-8,786	-66.9	-21,950	-76.0	0	0	0.000	-17,377	-76.4	0	0.0	
W1-R5 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W2-R6 N	Zn Tot/Ave	-8,786	-66.9	-11,973	-76.0	0	0	0.000	0	0.0	0	0.0	
W2-R7 E	Zn Tot/Ave	-8,786	-66.9	-13,968	-76.0	0	0	0.000	-39,098	-76.4	0	0.0	
W2-R8 S	Zn Tot/Ave	-8,786	-66.9	-17,959	-76.0	0	0	0.000	-26,066	-76.4	0	0.0	
W2-R9 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W2-R10 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W3-R11 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W3-R12 E	Zn Tot/Ave	-8,786	-66.9	-13,968	-76.0	0	0	0.000	-17,377	-76.4	0	0.0	
W3-R13 S	Zn Tot/Ave	-8,786	-66.9	-17,959	-76.0	0	0	0.000	-26,066	-76.4	0	0.0	
W3-R14 W	Zn Tot/Ave	-8,786	-66.9	-21,950	-76.0	0	0	0.000	-17,377	-76.4	0	0.0	
W3-R15 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W4-R17 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W4-R16 N	Zn Tot/Ave	-8,786	-66.9	-11,973	-76.0	0	0	0.000	-39,098	-76.4	0	0.0	
W4-R19 W	Zn Tot/Ave	-8,786	-66.9	-21,950	-76.0	0	0	0.000	-17,377	-76.4	0	0.0	
W4-R20 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W4-R18 S	Zn Tot/Ave	-8,786	-66.9	-17,959	-76.0	0	0	0.000	-26,066	-76.4	0	0.0	
W5-R21 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W5-R22 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W5-R23 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W5-R24 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
W5-R25 Int	Zn Tot/Ave	0	0.0	0	0.0	0	0	0.000	0	0.0	0	0.0	
System - 001	Sys Tot/Ave	-105,435	-66.9	-197,554	-76.0	0	0	0.000	-351,884	-76.4	0	0.0	
System - 001	Sys Block	-105,435	-66.9	-197,554	-76.0	0	0	0.000	-351,884	-76.4	0	0.0	

BE19: Design heating loads for baseline and proposed

Project Name: TEST FILE 2.TRC
Dataset Name:

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
Alternative - 1 Envelope Htg Loads at Coil Peak Report Page 1 of 8

Note: Alternative 1 loads are displayed first, alternative 2 loads are later in the report.

Plant Information entered values report

**ENTERED VALUES
PLANTS**
By TRANE

Cooling Plant: Cooling plant - 001

Sizing method: Peak Heat rejection type: None Secondary distribution pump: None Secondary pump consumption: 0 Ft Water Thermal storage type: None Thermal storage capacity: 0 ton-hr Thermal storage schedule: Off (0%)	Geothermal Loop TLoop Ent Bldg: None TLoopschedule: None Flow rate: 100.00% of condenser flow rate Loop pump: None Pump F.L. rate: 0.00ft water Flowscheme: Fully mixed Loop fluid glycol: 0% Heat exchanger approach: 0°F
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Equipment tag: Water source heat pump - 001 Cooling Type: Default Water Source HP Cooling plant - 001

Operating Mode	Capacity	Energy Rate	Pumps	Type	Full Load Consumption
Cooling:		0.6500 kW/ton	Chilled water:	Cnst vol chill water pump	0.00 Ft Water
Heat recovery:	10.9 Mbt/ton	0.0500 kW/Mbt	Condenser water:	None	
Tank charging:			Heat recovery or aux cond:	None	
Tank charging & heat recovery:			Free cooling:	None	
Heat Rejection and Thermal Storage			Equipment Options		
Heat rejection type:	WSHP - Cooling tower	Sequencing type:	Single	Free clg type:	None
Thermal storage type:	Heat pump loop no storage	Demand lim priority:		Fluid cooler type:	None
T-storage capacity:	12 gallon	Dsn chilled water delta T:	10 °F	Load shed econ:	no
T-storage schedule:	Heat pump	Dsn cond water delta T:	10 °F	Evap precooling:	no
				Hot gas reheat:	No
Reset Based On		Reset Curve	Max Reset TD		
Chilled Water:	None	None	0°F		
Condenser Water:	None	None	0°F		

Cooling Plant: Cooling plant - 004

Sizing method: Peak Heat rejection type: None Secondary distribution pump: None Secondary pump consumption: 0 Ft Water Thermal storage type: None Thermal storage capacity: 0 ton-hr Thermal storage schedule: Off (0%)	Geothermal Loop TLoop Ent Bldg: None TLoopschedule: None Flow rate: 100.00% of condenser flow rate Loop pump: None Pump F.L. rate: 0.00ft water Flowscheme: Fully mixed Loop fluid glycol: 0% Heat exchanger approach: 0°F
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AHVAC11: DX cooling efficiencies

Equipment tag: Air-cooled unitary - 002 Cooling Type: Default air-cooled unitary Cooling plant - 004

Operating Mode	Capacity	Energy Rate	Pumps	Type	Full Load Consumption
Cooling:		1.0000 kW/ton	Chilled water:	None	
Heat recovery:			Condenser water:	None	
Tank charging:			Heat recovery or aux cond:	None	
Tank charging & heat recovery:			Free cooling:	None	
Heat Rejection and Thermal Storage			Equipment Options		
Heat rejection type:	Condenser fan for Heat Pump	Sequencing type:	Single	Free clg type:	None
Thermal storage type:	None	Demand lim priority:		Fluid cooler type:	None
T-storage capacity:	0 ton-hr	Dsn chilled water delta T:	10 °F	Load shed econ:	no
T-storage schedule:	Storage	Dsn cond water delta T:	10 °F	Evap precooling:	no
				Hot gas reheat:	No
Reset Based On		Reset Curve	Max Reset TD		

ENTERED VALUES PLANTS

By Trane

Chilled Water: None	None	0°F
Condenser Water: None	None	0°F

Heating Plant: Heating plant - 002

Sizing method: Peak
 Cogeneration type: None
 Secondary distribution pump: None
 Secondary pump consumption: 0 Ft Water
 Thermal storage type: None
 Thermal storage capacity: 0 ton-hr

Equipment tag: Boiler - 001	Heating Type: Default Boiler	Heating plant - 002
------------------------------------	------------------------------	---------------------

Heating capacity:	Thermal storage type: None	
Energy rate: 95.00 % Effic.	Thermal storage capacity: 0 ton-hr	
	Thermal storage schedule: Storage	
Hot water pump type: Heating water circ pump	Equipments schedule: Available(100%)	
Hot water pump cons: 0.00 kW	Demand limiting priority:	

Heating Plant: Heating plant - 003

Sizing method: Peak
 Cogeneration type: None
 Secondary distribution pump: None
 Secondary pump consumption: 0 Ft Water
 Thermal storage type: None
 Thermal storage capacity: 0 ton-hr

Equipment tag: Gas-fired heat exchanger - 002	Heating Type: Default gas-fired heat exchanger	Heating plant - 003
--	--	---------------------

Heating capacity:	Thermal storage type: None	
Energy rate: 90.00 % Effic.	Thermal storage capacity: 0 ton-hr	
	Thermal storage schedule: Storage	
	Equipments schedule: Available(100%)	
	Demand limiting priority:	

Base Utilities

Plant assigned to: Stand-alone	Description: Parking lot lights	Schedule: Parking lot lights
Type: Parking lot lights	Demand limiting priority:	Hourly demand: 0.10 kW

Miscellaneous accessories

Plant assigned to: Cooling plant - 001	Type: None	Schedule: Off (0%)
Equipment tag: All	Description:	Energy: 0.00 kW

LE03: Exterior Lighting Entered
Lighting Power

Project Name:
 Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
 Alternative - 1 Entered Values - Plants Page 2 of 4

ENTERED VALUES PLANTS By TRANE		
ChilledWater:None	None	0°F
CondenserWater:None	None	0°F
Heating Plant: Heating plant - 002		
Sizing method: Peak Cogeneration type: None Secondary distribution pump: None Secondary pump consumption: 0 Ft Water Thermal storage type: None Thermal storage capacity: 0 ton-hr		
AHVAC11: Heating system		
Equipment tag: Boiler - 001 Heating Type: Default Boiler Heating plant - 002		
Heating capacity: Energy rate: 95.00 % Effic.		
Thermal storage type: None Thermal storage capacity: 0 ton-hr Thermal storage schedule: Storage		
Hot water pump type: Heating water circ pump Hotwater pump cons: 0.00 kW		
Equipmentschedule: Available (100%) Demandlimiting priority:		
Heating Plant: Heating plant - 003		
Sizing method: Peak Cogeneration type: None Secondary distribution pump: None Secondary pump consumption: 0 Ft Water Thermal storage type: None Thermal storage capacity: 0 ton-hr		
Equipment tag: Gas-fired heat exchanger - 002 Heating Type: Default gas-fired heat exchanger Heating plant - 003		
Heating capacity: Energy rate: 90.00 % Effic.		
Thermal storage type: None Thermal storage capacity: 0 ton-hr Thermal storage schedule: Storage		
Equipmentschedule: Available (100%) Demandlimiting priority:		
Heating Plant: Heating plant - 005		
Sizing method: Peak Cogeneration type: None Secondary distribution pump: None Secondary pump consumption: 0 Ft Water Thermal storage type: None Thermal storage capacity: 0 ton-hr		
SWH05: Service Hot Water heating plant		
Equipment tag: Boiler - 003 Heating Type: Default boiler Heating plant - 005		
Heating capacity: Energy rate: 83.30 % Effic.		
Thermal storage type: None Thermal storage capacity: 0 ton-hr Thermal storage schedule: Storage		
Hot water pump type: Heating water circ pump Hotwater pump cons: 0.00 kW		
Equipmentschedule: Available (100%) Demandlimiting priority:		
Project Name: Dataset Name: TEST FILE 2.TRC		
TRACE® 700 v6.3.3 calculated at 04:39 PM on 03/02/2018 Alternative - 1 Entered Values - Plants Page 2 of 5		

ENTERED VALUES PLANTS By TRANE		
SWH05: Service Hot Water base utility		
Base Utilities		
Plant assigned to: Stand-alone Type: Parking lot lights	Description: Parking lot lights	Schedule: Parking lot lights Hourly demand: 0.10 kW
Plant assigned to: Heating plant - 005 Type: Domestic Hot Water Load	Description: Domestic Hot Water Load	Schedule: Available (100%) Hourly demand: 100.00 Mbh
Miscellaneous accessories		
Plant assigned to: Cooling plant - 001 Equipment tag: All	Type: None Description:	Schedule: Off (0%) Energy: 0.00 kW

ENTERED VALUES PLANTS

By TRANE

Cooling Plant: Cooling plant - 004

Sizing method: Peak
Heat rejection type: None
Secondary distribution pump: None
Secondary pump consumption: 0 Ft Water
Thermal storage type: None
Thermal storage capacity: 0 ton-hr
Thermal storage schedule: Off (0%)

Geothermal loop

TLoop Ent Bldg: None
TLoop schedule: None
Flow rate: 100.00% of condenser flow rate
Loop pump: None
Pump F.L. rate: 0.00ft water

Flowscheme: Fully mixed
Loop fluid glycol: 0%
Heat exchanger approach: 0°F

Equipment tag: Water-cooled chiller - 001		Cooling Type: Default water-cooled chiller		Cooling plant - 004	
Operating Mode	Capacity	Energy Rate	Pumps Type	Full Load Consumption	
Cooling		0.4800 kW/ton	Chilled water: Cnst vol chill water pump	50.00 Ft Water	
Heat recovery:			Condenser water: Cnst vol cnd water pump - Low Eff	30.00 Ft Water	
Tank charging:			Heat recovery or aux cond: None		
Tank charging & heat recovery:			Free cooling: Cnst vol chill water pump	10.00 Ft Water	
Heat Rejection and Thermal Storage		Sequencing and Thermal Storage		Equipment Options	
Heat rejection type: Cooling tower for Cent. Chillers	Sequencing type: Parallel	Free cly type: Plate & frame sc	Energy source:		
Thermal storage type: None	Demand lim priority:	Fluid co		WHVAC07: Chilled Water Pumps	
T-storage capacity: 0 ton-hr	Dsn chilled water delta T: 10 °F	Loadsh			
T-storage schedule: Storage	Dsn cond water delta T: 10 °F	Evapp			
		Hot q			
Reset Based On	Reset Curve	Max Reset TD			
Chilled Water: None	None	0°F			
Condenser Water: None	None	0°F			
Equipment tag: Water-cooled chiller - 002		Cooling Type: Default water-cooled chiller		Cooling plant - 004	
Operating Mode	Capacity	Energy Rate	Pumps Type	Full Load Consumption	
Cooling		0.4800 kW/ton	Chilled water: Cnst vol chill water pump	50.00 Ft Water	
Heat recovery:			Condenser water: Cnst vol cnd water pump - Low Eff	30.00 Ft Water	
Tank charging:			Heat recovery or aux cond: None		
Tank charging & heat recovery:			Free cooling: Cnst vol chill water pump	10.00 Ft Water	
Heat Rejection and Thermal Storage		Sequencing and Thermal Storage		Equipment Options	
Heat rejection type: Cooling tower for Cent. Chillers	Sequencing type: Parallel	Free cly type: Plate & frame sc	Energy source:		
Thermal storage type: None	Demand lim priority:	Fluid co		WHVAC07, WHVAC05: Pump delta T used to calculate pump gpm	
T-storage capacity: 0 ton-hr	Dsn chilled water delta T: 10 °F	Loadsh		Gpm = Q / (500 * Delta T)	
T-storage schedule: Storage	Dsn cond water delta T: 10 °F	Evapp		WHM4: Chilled Water Loop Parameters	
		Hot q			
Reset Based On	Reset Curve	Max Reset TD			
Chilled Water: None	None	0°F			
Condenser Water: None	None	0°F			

WHVAC04: Chilled Water Plant Controls

WHVAC02: Chilled Water Plant

Project Name:
Dataset Name: TEST FILE 1.TRC

TRACE® 700 v6.3.3 calculated at 07:56 PM on 03/04/2018
Alternative - 1 Entered Values - Plants Page 1 of 4

Equipment Energy Consumption Report

EQUIPMENT ENERGY CONSUMPTION
By TRANE

Alternative: 1 Proposed

Equipment - Utility	----- Monthly Consumption -----												Total
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Lights													
Electric (kWh)	13,923.0	12,597.0	15,249.0	13,260.0	14,586.0	14,586.0	13,260.0	15,249.0	13,260.0	14,586.0	13,923.0	13,260.0	167,739.0
Peak (kW)	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
Misc. Ld													
Electric (kWh)	6,810.0	6,160.0	7,370.0	6,500.0	7,090.0	7,060.0	6,530.0	7,370.0	6,500.0	7,090.0	6,780.0	6,530.0	81,790.0
Peak (kW)	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
Cooling Coil Condensate													
Recoverable Water (1000gal)	0.0	0.0	0.0	0.1	0.4	1.8							
Peak (1000gal/Hr)	0.0	0.0	0.0	0.0	0.0	0.0							
Bsu 1: Parking lot lights													
Electric (kWh)	40.3	36.4	40.3	39.0	40.3	39.0							
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Bsu 2: Domestic Hot Water Load													
Proc. Hot Water (therms)	744.0	672.0	744.0	720.0	744.0	720.0	744.0	744.0	720.0	744.0	720.0	744.0	8,760.0
Peak (therms/Hr)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cpl 1: Cooling plant - 001 [Sum of dsn coil capacities=182.7 tons]													
Water source heat pump - 001 [Clg Nominal Capacity/F.L.Rate=182.7 tons / 118.7 kW] (Cooling Equipment - Cooling Mode)													
Electric (kWh)	113.6	244.2	887.8	2,509.5	5,986.4	13,137.7	12,871.0	12,713.2	7,662.9	3,191.0	501.3	105.4	59,923.8
Peak (kW)	4.9	7.8	32.9	50.7	64.0	88.8	86.1	91.7	82.6	58.7	24.2	4.7	91.7
Water source heat pump - 001 [Htg Nominal Capacity/F.L.Rate=1,987 mbh / 99.4 kW] (Cooling Equipment - Heating Mode)													
Electric (kWh)	26,065.5	19,317.7	14,802.1	5,162.8	2,023.3	293.0	31.0	220.1	1,639.4	4,754.3	13,690.2	21,775.4	108,654.6
Peak (kW)	66.1	66.1	63.3	57.1	51.8	37.0	10.1	45.7	54.3	55.8	63.4	64.3	66.1
WSHP - Cooling tower [Design Heat Rejection/F.L.Rate=216.4 tons / 14.28 kW]													
Electric (kWh)	0.0	0.0	135.0	426.5	773.9	1,517.9	1,647.2	1,447.2	956.5	423.2	83.5	0.0	7,410.9
Peak (kW)	0.0	0.0	3.5	3.9	5.1	7.2	6.4	7.4	7.8	4.5	3.4	0.0	7.8
WSHP - Cooling tower													
Make Up Water (1000gal)	0.0	0.0	2.6	12.0	32.0	75.7	74.9	73.4	42.6	16.1	1.4	0.0	330.5
Peak (1000gal/Hr)	0.0	0.0	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.3	0.1	0.0	0.5

SWH07: Service Hot Water full load hours,
SWH06: Service Hot Water proposed

Project Name:
Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 04:39 PM on 03/02/2018
Alternative - 1 Equipment Energy Consumption report page 1 of 5

EQUIPMENT ENERGY CONSUMPTION By TRANE

Alternative: 2 ASHRAE Baseline 90.1-07 Climate Zone 6A

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Lights													
Electric (kWh)	18,207.0	16,473.0	19,941.0	17,340.0	19,074.0	19,074.0	17,340.0	19,941.0	17,340.0	19,074.0	18,207.0	17,340.0	219,351.0
Peak (kW)	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
Misc. Ld													
Electric (kWh)	6,810.0	6,160.0	7,370.0	6,500.0	7,090.0	7,060.0	6,530.0	7,370.0	6,500.0	7,090.0	6,780.0	6,530.0	81,790.0
Peak (kW)	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
Cooling Coil Condensate													
Recoverable Water (1000gal)	0.0	0.0	0.0	0.1	0.6	2.8	3.3	4.3	2.0	0.4	0.0	0.0	13.5
Peak (1000gal/Hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.1						
Bsu 1: Parking lot lights													
Electric (kWh)	40.3	36.4	40.3	39.0	40.3	39.0	40.3						
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Bsu 2: Domestic Hot Water Load													
Proc. Hot Water (therms)		672.0	744.0	720.0	744.0	720.0	744.0	744.0	720.0	744.0	720.0	744.0	8,760.0
Peak (therms/Hr)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cpl 1: Cooling plant - 001 [Sum of dsn coil capacities=127.8 tons]													
Air-cooled unitary - 001 [Clg Nominal Capacity/F.L.Rate=127.8 tons / 176.4 kW] (Cooling Equipment)													
Electric (kWh)	0.0	0.0	1.0	738.8	5,566.7	16,188.4	17,678.1	18,150.4	9,568.4	3,562.6	134.7	0.0	71,589.1
Peak (kW)	0.0	0.0	1.0	29.6	91.3	126.0	109.9	127.1	128.8	75.7	15.9	0.0	128.8
Condenser fan for Heat Pump [Design Heat Rejection/F.L.Rate=178.0 tons / 21.36 kW]													
Electric (kWh)	0.0	0.0	0.2	106.5	767.1	2,145.1	2,356.0	2,431.9	1,267.1	494.0	19.7	0.0	9,587.5
Peak (kW)	0.0	0.0	0.2	4.2	12.0	15.5	14.0						
Cntl panel & interlocks - 0.1 kW [F.L.Rate=0.10 kW] (Misc Accessory Equipment)													
Electric (kWh)	0.0	0.0	0.1	10.3	21.1	33.8	36.0						
Peak (kW)	0.0	0.0	0.1	0.1	0.1	0.1	0.1						
Hpl 1: Heating plant - 002 [Sum of dsn coil capacities=1,030 mbh]													
Electric Resistance - 001 [Nominal Capacity/F.L.Rate=1,030 mbh / 301.8 kW] (Heating Equipment)													
Electric (kWh)	35,483.8	24,505.4	17,989.4	5,633.4	1,869.7	150.7	0.0	78.0	1,568.7	5,152.3	16,043.1	27,821.0	136,295.5
Peak (kW)	216.3	199.7	178.6	153.5	129.9	41.9	0.0	39.4	104.1	150.5	164.1	179.3	179.3
Hpl 2: Heating plant - 003 [Sum of dsn coil capacities=100 mbh]													

SWH06: Service Hot Water baseline

AHVAC12: Average DX system efficiency total equipment energy consumption

AHVAC13: Average heating system efficiency total equipment energy consumption

Project Name:
Dataset Name: TEST FILE 2.TRC

TRANE 700 v6.3.3 calculated 11/14/20 PM on 03/02/2018

EQUIPMENT ENERGY CONSUMPTION
By TRANE

Alternative: 1 Proposed

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Hpl 3: Heating plant - 005 [Sum of dsn coil capacities=100 mbh]													
Boiler - 003 [Nominal Capacity/F.L.Rate=100 mbh / 1.20 Therms] (Heating Equipment)													
Gas (therms)	893.2	806.7	893.2	864.4	893.2	864.4	893.2	893.2	864.4	893.2	864.4	893.2	10,516.3
Peak (therms/Hr)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Boiler forced draft fan [F.L.Rate=0.10 kW] (Misc Accessory Equipment)													
Electric (kWh)	74.4	67.2	74.4	72.0	74.4	72.0	74.4	74.4	72.0	74.4	72.0	74.4	876.0
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cntl panel & interlocks - 0.5 kW [F.L.Rate=0.50 kW] (Misc Accessory Equipment)													
Electric (kWh)	372.0	336.0	372.0	360.0	372.0	360.0	372.0	372.0	360.0	372.0	360.0	372.0	4,380.0
Peak (kW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sys 1: System - 001													
Total-energy wheel (OA precondition) [Stage 1 Energy Recovery]													
Energy Recovered (therms)	502.8	395.7	417.7	214.5	123.4	54.4	30.1	37.5	93.8				
Peak (therms/Hr)	3.3	2.7	2.6	1.8	1.2	0.8	0.4	0.6	1.1				
Total-energy wheel (OA precondition) [Stage 1 Parasitics]													
Electric (kWh)	92.4	83.6	101.2	88.0	85.2	75.2	62.8	68.4	74.4	84.4	92.4	88.0	936.0
Peak (kW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
AF w/VFD Crit Zn Reset [DsnAirflow/F.L.Rate=62,792 cfm / 4.19 kW] (Main Clg Fan)													
Electric (kWh)	1,477.5	1,268.1	1,326.2	994.4	1,041.3	1,025.2	927.8	1,068.2	949.0	1,070.2	1,151.1	1,278.4	13,577.4
Peak (kW)	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2

AHVAC20: Fan equivalent full load hours

AHVAC19: Fan peak demand

Project Name:
Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 04:39 PM on 03/02/2018
Alternative - 1 Equipment Energy Consumption report page 3 of 5

EQUIPMENT ENERGY CONSUMPTION By TRANE

Alternative: 1 Proposed

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Lights													
Electric				227.0	21,149.7	21,149.7	19,227.0	22,111.1	19,227.0	21,149.7	20,188.4	19,227.0	243,221.6
Peak (kW)				94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.3
Misc. Ld													
Electric				425.0	10,280.5	10,237.0	9,468.5	10,686.5	9,425.0	10,280.5	9,831.0	9,468.5	118,595.5
Peak (kW)				34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4
Cooling Coil Condensate													
Recoverable Water (1000gal)				0.2	1.1	4.6	4.7	5.9	2.9				
Peak (1000gal/Hr)				0.0	0.0	0.1	0.0	0.1	0.1				
Bsu 1: Parking lot lights Proposed													
Electric (kWh)	403.0	364.0	403.0	390.0	403.0	390.0	403.0	403.0	390.0	403.0	390.0	403.0	4,745.0
Peak (kW)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cpl 1: Cooling plant - 004 [Sum of dsn coil capacities=687.6 tons]													
Water-cooled chiller - 001 [Ctg Nominal Capacity=153.7 tons / F.L.Rate=153.7 tons / 73.75 kW] (Cooling Equipment)													
Electric (kWh)	0.0	0.0	33.3	1,344.6	5,876.6	13,051.4	12,617.6	11,650.2	7,756.4	3,040.0	218.5	0.0	55,759.9
Peak (kW)	0.0	0.0	15.7	34.4	54.0	70.2	71.7	70.6	70.3	63.1	16.0	0.0	71.7
Cooling tower for Cent. Chillers [Design Heat Rejection=174.6 tons / F.L.Rate=174.6 tons / 11.53 kW]													
Electric (kWh)	7.6	23.1	77.1	1,337.5	2,754.9	4,254.9	4,483.4	4,137.1					22,516.0
Peak (kW)	7.6	8.8	9.2	11.5	11.5	11.5	11.5	11.5					11.5
Cooling tower for Cent. Chillers													
Make Up Water (1000gal)	0.0	0.0	0.2	10.0	45.2	102.0	97.8	89.3	58.5	22.5	1.2	0.0	426.8
Peak (1000gal/Hr)	0.0	0.0	0.1	0.3	0.5	0.6	0.6	0.6	0.5	0.5	0.1	0.0	0.6
Cnst vol chill water pump [F.L.Rate=4.33 kW] (Misc Accessory Equipment)													
Electric (kWh)	4.3	13.0	47.6	657.5	1,111.6	1,600.4	1,682.6	1,552.8	1,245.7	739.6	160.0	4.3	8,819.3
Peak (kW)	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Cnst vol cnd water pump - Low Eff [F.L.Rate=3.91 kW] (Misc Accessory Equipment)													
Electric (kWh)	0.0	0.0	23.5	594.2	1,004.6	1,446.3	1,520.6	1,403.3	1,125.8	664.5	140.7	0.0	7,923.4
Peak (kW)	0.0	0.0	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	0.0	3.9

WHVAC05, WHVAC07:
Equipment load used to
calculate pump gpm

$Gpm = Q / (500 * \Delta T)$

WHVAC03: Average annual
realized chiller efficiency

WHVAC09: Annual chilled
water pump energy

Project Name:
Dataset Name: TEST FILE 1.TRC

TRACE® 700 v6.3.3 calculated at 07:56 PM on 03/04/2018
Alternative - 1 Equipment Energy Consumption report page 1 of 6

EQUIPMENT ENERGY CONSUMPTION By TRANE

Alternative: 1 Proposed

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Cpl 1: Cooling plant - 004 [Sum of dsn coil capacities=307.3 tons]													
Cnst vol chill water pump [F.L.Rate=0.87 kW] (Misc Accessory Equipment)													
Electric (kWh)	0.9	2.6	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.9	10.4
Peak (kW)	0.9	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.9	0.9
Cntl panel & interlocks - 1 kW [F.L.Rate=1 kW] (Misc Accessory Equipment)													
Electric (kWh)	1.0	3.0	11.0	152.0	257.0	370.0	389.0	359.0	288.0	171.0	37.0	1.0	2,039.0
Peak (kW)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Water-cooled chiller - 002 [Clg Nominal Capacity/F.L.Rate=153.7 tons / 73.75 kW] (Cooling Equipment)													
Electric (kWh)	0.0	0.0	0.0	0.0	985.7	5,481.5	5,839.3	5,736.3	2,293.4	70.2	0.0	0.0	20,406.4
Peak (kW)	0.0	0.0	0.0	0.0	48.3	66.8	62.9	67.1	61.8	36.2	0.0	0.0	67.1
Cooling tower for Cent. Chillers [Design Heat Rejection/F.L.Rate=174.6 tons / 11.53 kW]													
Electric (kWh)	0.0	0.0	0.0	0.0	276.6	1,313.9	1,486.8	1,440.7	530.2	23.1	0.0	0.0	5,071.2
Peak (kW)	0.0	0.0	0.0	0.0	11.5	11.5	11.5	11.5	11.5	11.5	0.0	0.0	11.5
Cooling tower for C Make Up Water (WHVAC19, WHVAC18: Boiler capacity used to calculate pump gpm)													
Electric (kWh)	0.0	0.0	0.0	0.0	3.0	43.9	47.1	45.9	17.8	0.6	0.0	0.0	163.3
Peak (kW)	0.0	0.0	0.0	0.0	0.4	0.5	0.5	0.5	0.5	0.3	0.0	0.0	0.5
Cnst vol chill water (Equipment)													
Electric (kWh)	0.0	0.0	0.0	0.0	33.8	493.1	558.0	540.7	199.0	8.7	0.0	0.0	1,903.1
Peak (kW)	0.0	0.0	0.0	0.0	4.3	4.3	4.3	4.3	4.3	4.3	0.0	0.0	4.3
Cnst vol cond water (Equipment)													
Electric (kWh)	0.0	0.0	0.0	0.0	3.8	445.6	504.3	488.6	3.9	0.0	0.0	0.0	1,719.9
Peak (kW)	0.0	0.0	0.0	0.0	3.9	3.9	3.9	3.9	3.9	0.0	0.0	0.0	3.9
Cntl panel & interlocks - 1 kW [F.L.Rate=1 kW] (Misc Accessory Equipment)													
Electric (kWh)	0.0	0.0	0.0	0.0	24.0	114.0	129.0	125.0	1.0	1.0	0.0	0.0	440.0
Peak (kW)	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0
Hpl 1: Heating plant - 005 [Sum of dsn coil capacities=3,530 mbh]													
Boiler - 001 [Nominal Capacity/F.L.Rate=3,530 mbh / 39.23 Therms] (Heating Equipment)													
Gas (therms)	15,214.0	11,788.7	9,272.3	3,551.5	1,423.6	227.6	34.7	236.4	1,257.9	3,256.7	8,453.6	13,033.9	67,727.8
Peak (therms/Hr)	39.2	36.4	33.1	31.8	25.0	20.3	7.8	23.0	26.5	31.6	33.5	34.7	39.2

Project Name:
Dataset Name: TEST FILE 1.TRC

TRACE® 700 v6.3.3 calculated at 08:36 PM on 03/04/2018
Alternative - 1 Equipment Energy Consumption report page 2 of 6

EQUIPMENT ENERGY CONSUMPTION
By TRANE

Alternative: 1 Proposed

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Hpl 1: Heating plant - 005 [Sum of dsn coil capacities=3,530 mbh]													
Heating water circ pump [F.L.Rate=1.62 kW] (Misc Accessory Equipment)													
Electric (kWh)	1,180.6	1,057.2	1,128.7	805.5	540.8	168.9	112.1	211.1	490.4	844.5	1,101.1	1,179.0	8,819.8
Peak (kW)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Boiler forced draft fan [F.L.Rate=3.53 kW] (Misc Accessory Equipment)													
Electric (kWh)	2,566.6	2,298.3	2,463.6	1,751.1	1,175.6	367.2	243.6	459.0	1,066.2	1,835.8	2,393.6	2,563.1	19,173.7
Peak (kW)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Cntl panel & interlocks - 0.5 kW [F.L.Rate=0.50 kW] (Misc Accessory Equipment)													
Electric (kWh)	363.5	325.5	347.5	248.0	166.5	52.0	34.5	65.0	151.0	280.0	339.0	363.0	2,715.5
Peak (kW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sys 1: VAV System 1st Floor													
Total-energy wheel (OA precondition) [Stage 1 Energy Recovery]													
Energy Recovered (therms)	646.6	415.8	315.0	33.9	4.2	31.6	24.0	22.2	27.0	22.2	241.4	480.3	2,264.3
Peak (therms/Hr)	4.9	4.0	3.9	2.0	0.3	1.0	0.5	0.8	1.0	1.4	3.1	3.8	4.9
Total-energy wheel (OA precondition) [Stage 1 Parasitics]													
Electric (kWh)	92.4	82.8	85.2	27.6	26.0	63.6	82.4	94.4	42.8	39.6	68.0	88.0	792.8
Peak (kW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
AF w/VFD Crit Zn Reset [DsnAirflow/F.L.Rate=24,966 cfm / 13.32 kW] (Main Clg Fan)													
Electric (kWh)	447.8	399.0	427.9	339.0	657.2	1,453.9	1,407.7	1,466.4	820.9	442.6	352.6	392.0	8,606.8
Peak (kW)	2.2	2.6	2.5	5.5	10.7	13.3	13.3	13.3	13.3	7.4	2.5	2.1	13.3
Sys 2: RTU Single Zone													
Total-energy wheel (OA precondition) [Stage 1 Energy Recovery]													
Energy Recovered (therms)	18.6	6.9	4.3	4.8	3.2	7.1	5.7	4.9	26.8	7.2	17.2	11.6	74.3
Peak (therms/Hr)	1.0	0.5	0.3	0.5	0.4	0.2	0.1	0.2	0.4	0.4	0.4	0.4	1.0
Total-energy wheel (OA precondition) [Stage 1 Parasitics]													
Electric (kWh)	43.6	28.4	21.6	7.6	10.4	46.4	62.0	56.0	26.8	7.2	17.2	11.6	358.8
Peak (kW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
AF Centrifugal const vol [DsnAirflow/F.L.Rate=18,545 cfm / 12.36 kW] (Main Clg Fan)													
Electric (kWh)	3,996.8	3,328.3	3,258.7	2,166.1	2,171.9	2,572.0	2,558.6	2,721.8	2,199.9	2,327.8	2,993.1	3,614.1	33,909.0
Peak (kW)	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4

WHVAC20: Annual hot water pump energy

33,909.0
12.4

Project Name:
Dataset Name: TEST FILE 1.TRC

TRACE® 700 v6.3.3 calculated at 08:36 PM on 03/04/2018
Alternative - 1 Equipment Energy Consumption report page 3 of 6

System Checksums Report

System Checksums
By TRANE

System - 001

System 3 - 2007/2010 - Packaged Rooftop Air Conditioner

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time: Mo/Hr: 7 / 15				Mo/Hr: 8 / 11				Mo/Hr: Heating Design				Cooling Heating		
Outside Air: OADB/WB/HR: 92 / 78 / 123				OADB: 82				OADB: -6				SADB 55.0 75.2		
Space Sens. + Lat. Btu/h	Plenum Sens. + Lat. Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Of Total Btu/h (%)	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Of Total Btu/h (%)	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Of Total Btu/h (%)	Return	RA Plenum	Ret/OA
Envelope Loads														
Skylite Solar	0	0	0	0	0	0	0	0	0	0	0.00	36,845	36,845	36,845
Skylite Cond	0	0	0	0	0	0	0	0	0	0	0.00	0	0	0
Roof Cond	0	104,790	104,790	0	0	0	0	0	-172,925	20.99	0	0	0	0
Glass Solar	329,894	0	329,894	25	345,369	42	345,369	0	0	0.00	0	0	0	0
Glass/Door Cond	18,867	0	18,867	1	13,230	2	13,230	-129,410	-129,410	15.70	0	0	0	0
Wall Cond	15,257	8,311	23,568	2	14,445	2	14,445	-29,160	-46,052	5.59	0	0	0	0
Partition/Door	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
Floor	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Infiltration	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
Sub Total ==>	363,818	113,101	476,919	36	373,044	46	373,044	-158,571	-348,388	42.28	0	0	0	0
Internal Loads														
Lights	231,040	57,760	288,800	22	231,040	28	231,040	0	0	0.00	0	0	0	0
People	156,572	0	156,572	12	86,642	11	86,642	0	0	0.00	0	0	0	0
Misc	74,325	0	74,325	6	79,815	10	79,815	0	0	0.00	36,845	36,845	36,845	36,845
Sub Total ==>	461,936	57,760	519,696	39	397,496	49	397,496	0	0	0.00	5,935	5,935	5,935	5,935
Ceiling Load	47,363	-47,363	0	0	42,538	5	42,538	-53,228	0	0.00	0	0	0	0
Ventilation Load	0	0	345,949	26	0	0	0	0	-497,643	60.39	0	0	0	0
Adj Air Trans Heat	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
Dehumid. Ov Sizing	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
Ov/Undr Sizing	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
Exhaust Heat	0	-19,575	-19,575	-1	0	0	0	0	22,000	-2.67	0	0	0	0
Sup. Fan Heat	0	0	10,917	1	0	0	0	0	0	0.00	0	0	0	0
Ret. Fan Heat	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
Duct Heat Pkup	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
Supply Air Leakage	0	0	0	0	0	0	0	0	0	0.00	0	0	0	0
Grand Total ==>	873,117	103,923	1,333,906	100.00	813,078	100.00	813,078	-211	-211	0.00	0	0	0	0

AIRFLOWS		
	Cooling	Heating
Diffuser	36,845	36,845
Terminal	36,845	36,845
Main Fan	36,845	36,845
Sec Fan	0	0
Nom Vent	5,935	5,935
AHU Vent	5,935	5,935
Infil	0	0
MinStop/Rh	0	0
Return	36,845	36,845
Exhaust	5,935	5,935
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS
Cooling Heating
AHVAC28: Modeled exhaust air energy recovery airflows

COOLING COIL SELECTION								AREAS			HEATING COIL SELECTION				
	Total Capacity ton	Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR °F	Enter WB/HR °F	Leave DB/WB/HR °F	Gross Total	Glass ft² (%)	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F		
Main Clg	127.8	1,534.0	1,021.5	36,845	80.0	65.0	69.4	Floor	50,000		-1,030.0	36,845	54.9	75.2	
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	Part	0		0.0	0	0.0	0.0	
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	Int Door	0		0.0	0	0.0	0.0	
Total	127.8	1,534.0						Ext Door	0		0.0	0	0.0	0.0	
								Roof	50,000	0	0.0	0	0.0	0.0	
								Wall	14,400	4,860	34	0.0	0	0.0	
								Total			-1,030.0				

Project Name:
Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 04:39 PM on 03/02/2018
Alternative - 2 System Checksums Report Page 2 of 2

Building Cool/Heat Demand report from the Visualizer

Time/System Selection

First/Last Mo: Jan, Jan

First/Last Day: 1, 31

First/Last Hr: 1, 24

First/Last Sys: 1, 1

Comps: HVAC Equip

Miscellaneous: Weather

Airside: Clg Plant, Htg Plant

Table, Chart, Demand, Comsumption

3D, 2D, \$

Aux Htg Coil, Op/V Htg Coil, Erd Regen Stg 1, Erd Regen Stg 2, Erd Prehtg Stg 1, Erd Prehtg Stg 2, All Htg Coils

Month	Day Type	Day	Hour	OA Dry Bulb deg F	OA Wet Bulb deg F	All Clg Coils tons	All Htg Coils Mbh	All Htg Coils tons	All Htg Coils Mbh
Jan	Hol	1	1	25.00	25.00	0.00	0.00	0.00	0.00
Jan	Hol	1	2	27.00	26.00	0.00	-511.97	0.00	0.00
Jan	Hol	1	3	28.00	27.00	0.00	-546.74	0.00	-77.56
Jan	Hol	1	4	29.00	28.00	0.00	-498.02	0.00	-102.71
Jan	Hol	1	5	31.00	29.00	0.00	-454.69	0.00	-104.04
Jan	Hol	1	6	33.00	30.00	0.00	-410.17	0.00	-94.94
Jan	Hol	1	7	33.00	31.00	0.00	-385.32	0.00	-99.76
Jan	Hol	1	8	33.00	31.00	0.00	-659.01	0.00	-88.26
Jan	Hol	1	9	34.00	32.00	0.00	-582.03	0.00	-95.13
Jan	Hol	1	10	37.00	34.00	0.00	-327.95	0.00	-30.70
Jan	Hol	1	11	38.00	34.00	0.00	-328.78	0.00	-23.76
Jan	Hol	1	12	39.00	34.00	0.00	-238.60	0.00	-39.76
Jan	Hol	1	13	41.00	36.00	0.00	-207.07	0.00	-20.45
Jan	Hol	1	14	39.00	34.00	7.54	-126.82	0.00	-16.30
Jan	Hol	1	15	38.00	34.00	9.09	-99.25	0.00	-28.48
Jan	Hol	1	16	35.00	32.00	3.98	-127.75	0.00	-44.61
Jan	Hol	1	17	31.00	28.00	0.00	-227.13	0.00	-65.58
Jan	Hol	1	18	30.00	28.00	0.00	-349.83	0.00	-83.51
Jan	Hol	1	19	27.00	26.00	0.00	-456.84	0.00	-108.11
Jan	Hol	1	20	28.00	27.00	0.00	-518.47	0.00	-149.62
Jan	Hol	1	21	26.00	25.00	0.00	-561.89	0.00	-149.94
Jan	Hol	1	22	26.00	25.00	0.00	-667.65	0.00	-153.33
Jan	Hol	1	23	25.00	23.00	0.00	-714.12	0.00	-153.41
Jan	Hol	1	24	24.00	22.00	0.00	-722.65	0.00	-154.01
Jan	Hol	1	25	21.00	20.00	0.00	-563.78	0.00	-135.71
Jan	Hol	1	26	20.00	19.00	0.00	-729.87	0.00	-192.56
Jan	Hol	1	27	19.00	18.00	0.00	-737.16	0.00	-202.80
Jan	Hol	1	28	18.00	17.00	0.00	-895.32	0.00	-221.02
Jan	Hol	1	29	17.00	16.00	0.00	-940.26	0.00	-234.04
Jan	Hol	1	30	17.00	15.00	0.00	-978.69	0.00	-238.87
Jan	Hol	1	31	16.00	15.00	0.00	-992.09	0.00	-241.59
Jan	Hol	1	1	17.00	16.00	0.00	-994.59	0.00	-241.22
Jan	Hol	1	2	21.00	19.00	0.00	-857.63	0.00	-194.45
Jan	Hol	1	3	23.00	20.00	0.00	-705.02	0.00	-122.51
Jan	Hol	1	4	24.00	20.00	0.00	-601.58	0.00	-97.81
Jan	Hol	1	5	25.00	22.00	0.00	-599.70	0.00	-95.24
Jan	Hol	1	6	27.00	23.00	0.00	-609.88	0.00	-102.04
Jan	Hol	1	7	27.00	23.00	0.00	-589.95	0.00	-98.90
Jan	Hol	1	8	27.00	23.00	0.00	-582.67	0.00	-100.62
Jan	Hol	1	9	27.00	23.00	0.00	-610.19	0.00	-120.20
Jan	Hol	1	10	27.00	23.00	0.00	-646.70	0.00	-139.13
Jan	Hol	1	11	27.00	23.00	0.00	-637.05	0.00	-155.50
Jan	Hol	1	12	27.00	23.00	0.00	-607.85	0.00	-155.95
Jan	Hol	1	13	34.00	28.00	0.00	-618.84	0.00	-145.32

Building Cool/Heat Demand Save Draw Delete

AHVAC12: Average DX system efficiency total loads.

AHVAC13: Average heating system efficiency total loads.

WHVAC03: Average annual realized chiller efficiency

WHVAC14: Average annual boiler efficiency

AHVAC31: Monthly patterns of heating and cooling

See note below.

Note: The Visualizer is accessed by clicking the Graph Profiles and Energy button on the Analysis Reports tab of View Results. The Building Cool/Heat Demand report is selected from the dropdown at the bottom. The controls on the left are used to specify months, day types, etc. The Draw button is used to export the data to excel. For AHVAC12, AHVAC13, WHVAC03 and WHVAC14, it will be easiest to export this data to Excel to sum the hourly loads to determine the total loads for the year. If there are multiple systems assigned to different plants, this will need to be done separately for each system. The system data displayed can be changed by using the First/Last Sys inputs.

Appendix A: Typical Building Operating Schedules

Below are references for typical building operating schedules. These are included in the Compliance Form with notes describing which schedules were used for different components.

- 90.1 Section C3.5.5.3 Schedules and Internal Loads, <http://sspc901.ashraeecs.org/documents.php>.
- ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual, https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf.
- Comnet Appendix C Schedules, <https://comnet.org/appendix-c-schedules>.

For multifamily projects:

- ENERGY STAR Multifamily New Construction Program Simulation Guidelines Version 1.0, Rev01, https://www.energystar.gov/sites/default/files/asset/document/ENERGY_STAR_MFNC_Simulation_Guidelines_AppG2016_Version_1_Rev01.pdf.

Appendix B: Logic for Automatic Prioritization of Review Checks

Explanation of the “Ranking Logic” Column in Table 6 below

(Refer to the [Review Check Classifications](#) section for full context and greater detail regarding meaning of ranking.)

Rank 0

- Review check is automated via the Compliance Form and is always included.
- Always assigned Rank 0.

Rank 1

- Required for all Tiers 2–5.
- Includes high-priority items like EUI thresholds and general PRM/ECB requirements (e.g., unmet load hours).
- Always assigned Rank 1.

Rank 2

- Always assigned Rank 2.

Rank 3

- Always assigned Rank 3.

Rank 4

- Always assigned Rank 4.

Rank 1 or 4

- If the check affects an impactful end use, assign Rank 1.
- Otherwise, assign Rank 4.

Rank 2, 3, or 4

- Rank determined based on both the relevance of the check to impactful end uses and the project’s context:
 - *Rank 2:* Check targets an impactful end use and is especially significant due to building type, climate zone, or number of floors (e.g., a 24/7 facility in a cold climate).
 - *Rank 3:* Check targets an impactful end use, but without a context that makes it particularly critical.
 - *Rank 4:* Check does not target an impactful end use.

Rank 3 or 4

- *Rank 3:* Check targets an impactful end use, but its relative impact is always lower.
- *Rank 4:* Check does not target an impactful end use.

The following Table 6 presents the ranking logic implemented in the Compliance Form for each Review Check.

Table 6: Review Check Prioritization Logic Summary Table

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Simulation General	SG01	The same approved simulation program is used for the baseline/budget and proposed design models.	0	N/A	N/A	N/A	N/A	
Simulation General	SG02	Project climate zone reported in the Compliance Form is established correctly.	1	N/A	N/A	N/A	N/A	
Simulation General	SG03	The same approved weather file was used in the baseline/budget and proposed design simulations	1	N/A	N/A	N/A	N/A	
Simulation General	SG04	The reported project floor area is consistent with the design documents.	1	N/A	N/A	N/A	N/A	
Simulation General	SG05	The modeled floor area is as reported in the Compliance Form and is the same in the proposed and baseline/budget design.	1	N/A	N/A	N/A	N/A	
Simulation General	SG06	At least 8760 hours per year were explicitly modeled.	1	N/A	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Simulation General	SG07	The number of unmet load hours (UMLH) for the baseline/budget and proposed design reported in the Compliance Form for the baseline/budget and proposed designs does not exceed the prescribed limit.	0	N/A	N/A	N/A	N/A	
Simulation General	SG08	The number of unmet load hours reported in the compliance form for the baseline/budget and proposed design reflect simulation reports.	1	N/A	N/A	N/A	N/A	
Simulation General	SG09-P	Proposed energy use reported in the Compliance Form matches the simulation output reports.	1	N/A	N/A	N/A	N/A	
Simulation General	SG09-B	Baseline/budget energy use reported in the Compliance Form matches the simulation output reports.	1	N/A	N/A	N/A	N/A	
Simulation General	SG10-P	Site Energy Use Intensity (EUI) of the proposed design is generally consistent with the selected benchmark, with difference of less than 20%.	1	N/A	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Simulation General	SG10-B	Site Energy Use Intensity (EUI) of the baseline/budget design is generally consistent with the selected benchmark, with difference of less than 20%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG11-P	Site EUI of the lighting energy end-use in the proposed design is generally consistent with the selected benchmark, with a difference that does not exceed - 50%/50%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG11-B	Site EUI of the lighting energy end-use in the baseline/budget design is generally consistent with the selected benchmark, with a difference that does not exceed - 50%/50%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG12-P	Site EUI of the miscellaneous and process equipment end-use in the proposed design is generally consistent with the selected benchmark, with a difference that does not exceed -25%/25%.	0	N/A	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Simulation General	SG12-B	Site EUI of the miscellaneous and process equipment end-use in the baseline/budget design is generally consistent with the selected benchmark, with a difference that does not exceed - 25%/25%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG13-P	Site EUI of the heating energy end-use in the proposed design is generally consistent with the selected benchmark, with a difference that does not exceed - 50%/50%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG13-B	Site EUI of the heating energy end-use in the baseline/budget design is generally consistent with the selected benchmark, with a difference that does not exceed - 50%/50%.	0	N/A	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Simulation General	SG14-P	Site EUI of the cooling energy end-use in the proposed design is generally consistent with the selected benchmark, with a difference that does not exceed - 50%/50%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG14-B	Site EUI of the cooling energy end-use in the baseline/budget design is generally consistent with the selected benchmark, with a difference that does not exceed - 50%/50%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG15-P	Site EUI of the HVAC fan energy end-use in the proposed design is generally consistent with the selected benchmark, with a difference that does not exceed - 50%/50%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG15-B	Site EUI of the HVAC fan energy end-use in the baseline/budget design is generally consistent with the selected benchmark, with a difference that does not exceed - 50%/50%.	0	N/A	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Simulation General	SG16-P	Site EUI of the HVAC pump energy end-use in the proposed design is generally consistent with the selected benchmark, with a difference that does not exceed -50%/50%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG16-B	Site EUI of the HVAC pump energy end-use in the baseline/budget design is generally consistent with the selected benchmark, with a difference that does not exceed -50%/50%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG17-P	Site EUI of the heat rejection energy end-use in the proposed design is generally consistent with the selected benchmark, with a difference that does not exceed -50%/50%.	1	N/A	N/A	N/A	N/A	
Simulation General	SG17-B	Site EUI of the heat rejection energy end-use in the baseline/budget design is generally consistent with the selected benchmark, with a difference that does not exceed -50%/50%.	1	N/A	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Simulation General	SG18-P	Site EUI of the SWH end-use in the proposed design is generally consistent with the selected benchmark, with a difference that does not exceed -50%/50%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG18-B	Site EUI of the SWH end-use in the baseline/budget design is generally consistent with the selected benchmark, with a difference that does not exceed -50%/50%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG19-P	Site EUI of the elevator energy end-use in the proposed design is generally consistent with the selected benchmark, with a difference that does not exceed -50%/50%.	0	N/A	N/A	N/A	N/A	
Simulation General	SG19-B	Site EUI of the elevator energy end-use in the baseline/budget design is generally consistent with the selected benchmark, with a difference that does not exceed -50%/50%.	0	N/A	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Simulation General	SG20	Baseline energy use is correctly allocated to regulated versus unregulated energy uses and the compliance outcome is established correctly.	0	N/A	N/A	N/A	N/A	
Utility Rates	UR01	The utility rates for electricity, natural gas and other applicable energy sources are based on an approved source.	1	N/A	N/A	N/A	N/A	
Utility Rates	UR02	The difference between the average modeled baseline/budget and proposed utility rates for electricity, natural gas and other applicable energy sources are as expected.	0	N/A	N/A	N/A	N/A	
Utility Rates	UR03	The modeled utility rates for electricity, natural gas and other applicable energy sources are as reported in the Compliance Form and the same in the baseline/budget and proposed design model.	1	N/A	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Building Envelope	BE01-P	Thermal properties of the above-grade walls in the proposed design are established correctly.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	All	
Building Envelope	BE01-B	Thermal properties of the above-grade walls in the baseline/budget design are established correctly.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	All	
Building Envelope	BE02-P	Thermal properties of below-grade walls in the proposed design are established correctly.	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Warehouse, Multifamily, All Others	All	1-5	
Building Envelope	BE02-B	Thermal properties of below-grade walls in the baseline/budget design are established correctly.	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Warehouse, Multifamily, All Others	All	1-5	
Building Envelope	BE03-P	Thermal properties of the roof in the proposed design are established correctly.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	1-5	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Building Envelope	BE03-B	Thermal properties of the roof in the baseline/budget design are established correctly.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	1-5	
Building Envelope	BE04-P	Thermal properties of the exterior floors in the proposed design are established correctly.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	All	Also looks at whether the % of total exposure area is greater than 5%. If not, 3 instead of 2.
Building Envelope	BE04-B	Thermal properties of the exterior floors in the baseline/budget design are established correctly.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	All	Also looks at whether the % of total exposure area is greater than 5%. If not, 3 instead of 2.

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Building Envelope	BE05-P	Thermal properties of the slab-on-grade floor in the proposed design are established correctly.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	All	1-5	
Building Envelope	BE05-B	Thermal properties of the slab-on-grade floors in the baseline/budget design are established correctly.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	All	1-5	
Building Envelope	BE06-P	Modeled U-factors and areas of the above-grade walls in the proposed design are as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	All	
Building Envelope	BE06-B	Modeled U-factor and areas of the above-grade walls in the baseline/budget design are as reported on the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	All	
Building Envelope	BE07-P	Modeled C-factors and areas of the below-grade walls in the proposed design are as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Warehouse, Multifamily, All Others	All	1-5	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Building Envelope	BE07-B	Modeled C-factor and areas of below-grade walls in the baseline/budget design are as reported on the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Warehouse, Multifamily, All Others	All	1-5	
Building Envelope	BE08-P	Modeled U-factors and areas of the roof in the proposed design are as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	1-5	
Building Envelope	BE08-B	Modeled U-factor and areas of the roof in the baseline/budget design are as reported on the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	1-5	
Building Envelope	BE09-P	Modeled U-factor and areas of exposed floors in the proposed design are as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	All	Also looks at whether the % of total exposure area is greater than 5%. If not, 3 instead of 2.

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Building Envelope	BE09-B	Modeled U-factor and areas of the exposed floors in the baseline/budget design are as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	3A-8	All	Also looks at whether the % of total exposure area is greater than 5%. If not, 3 instead of 2.
Building Envelope	BE10-P	Modeled F-factors and slab-on-grade areas in the proposed design are as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	All	1-5	
Building Envelope	BE10-B	Modeled F-factors and areas of slab-on-grade in the baseline/budget design are as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Warehouse, Multifamily, All Others	All	1-5	
Building Envelope	BE11-P	Proposed roof and exterior wall reflectance is established correctly in the Compliance Form based on the design documents.	2, 3, or 4	Space Heating, Space Cooling	All	0-4	1-5 if check only applies to roof (i.e., prior to 90.1 2022)	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Building Envelope	BE11-B	Baseline/budget roof and exterior wall reflectance is established correctly in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	All	0-4	1-5 if check only applies to roof (i.e., prior to 90.1 2022)	
Building Envelope	BE12-P	Proposed roof and exterior wall reflectance was modeled as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	All	0-4	1-5 if check only applies to roof (i.e., prior to 90.1 2022)	
Building Envelope	BE12-B	Baseline/budget roof and exterior wall reflectance was modeled as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	All	0-4	1-5 if check only applies to roof (i.e., prior to 90.1 2022)	
Building Envelope	BE13-P	Fenestration area in the proposed design reported in the Compliance Form reflects design documents.	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Multifamily, All Others	All	All	
Building Envelope	BE13-B	Fenestration area in the baseline/budget design reported in the Compliance Form is established correctly.	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Multifamily, All Others	All	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Building Envelope	BE14-P	Modeled fenestration areas for the proposed design are as reported in the Compliance Form	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Multifamily, All Others	All	All	
Building Envelope	BE14-B	Modeled fenestration areas for the baseline/budget design are as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Multifamily, All Others	All	All	
Building Envelope	BE15-P	Proposed fenestration U-factor, SHGC and VT are established correctly and required documentation is provided.	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Multifamily, All Others	All	All	
Building Envelope	BE15-B	Baseline/budget fenestration U-factor, SHGC and VT reported in the Compliance Form are established correctly.	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Multifamily, All Others	All	All	
Building Envelope	BE16-P	Modeled U-factor, SHGC and VLT of the proposed fenestration are as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Multifamily, All Others	All	All	
Building Envelope	BE16-B	Modeled U-factor, SHGC and VLT of the baseline/budget fenestration are as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	Office, School, Hotel/motel, Multifamily, All Others	All	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Building Envelope	BE17-P	Proposed infiltration rate reported in the Compliance Form is established correctly.	2 or 4	Space Heating, Space Cooling	All	All	All	
Building Envelope	BE17-B	Baseline/budget infiltration rate reported in the Compliance Form is established correctly.	2 or 4	Space Heating, Space Cooling	All	All	All	
Building Envelope	BE18-P	Modeled infiltration rate for the proposed design reflects the values reported in the Compliance Form.	2 or 4	Space Heating, Space Cooling	All	All	All	
Building Envelope	BE18-B	Modeled infiltration rate for the baseline/budget design reflects the values reported in the Compliance Form.	2 or 4	Space Heating, Space Cooling	All	All	All	
Building Envelope	BE-19	Change in the proposed versus baseline/budget total annual and design loads from envelope components is reasonable given the difference in the proposed versus baseline/budget envelope parameters reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	School, Hotel/motel, Multifamily, All Others	3A-8	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Building Envelope	BE20-P	Proposed building orientation reflected in the Compliance Form is as specified.	2 or 4	Interior Lighting, Space Heating, Space Cooling	All	All	All	
Building Envelope	BE20-B	The baseline/budget building performance is an average of four orientations, if required.	0	Interior Lighting, Space Heating, Space Cooling	All	All	All	
Building Envelope	BE21-P	Proposed building orientation is modeled as reported in the Compliance Form.	2 or 4	Interior Lighting, Space Heating, Space Cooling	All	All	All	
Building Envelope	BE21-B	Building orientation of the baseline/budget design is modeled as reported in the Compliance Form.	2 or 4	Interior Lighting, Space Heating, Space Cooling	All	All	All	
Building Envelope	BE22-P	Proposed interior and exterior shading is established correctly in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	Office, Retail, School, Hotel/motel, Multifamily, All Others	0-4	All	
Building Envelope	BE22-B	Baseline/budget design interior and exterior shading is established correctly in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	Office, Retail, School, Hotel/motel, Multifamily, All Others	0-4	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Building Envelope	BE23-P	Proposed interior and exterior shading is modeled as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	Office, Retail, School, Hotel/motel, Multifamily, All Others	0-4	All	
Building Envelope	BE23-B	Baseline/budget design interior and exterior shading is modeled as reported in the Compliance Form.	2, 3, or 4	Space Heating, Space Cooling	Office, Retail, School, Hotel/motel, Multifamily, All Others	0-4	All	
Building Envelope	BE24-P	Proposed envelope complies with minimum mandatory envelope requirements.	1 or 4	Space Heating, Space Cooling	All	All	All	
Interior Lighting	LI01	The floor area used in the lighting calculations is consistent with the reported project floor area.	0	Interior Lighting	All	All	All	
Interior Lighting	LI02-P	Proposed Lighting Power in the Compliance Form reflects design documents for spaces where lighting is fully specified.	2 or 4	Interior Lighting	All	All	All	
Interior Lighting	LI03-P	Proposed LPD to be modeled for spaces where lighting is not specified or partially specified is established correctly in the Compliance Form.	2, 3, or 4	Interior Lighting	Hotel/motel, Multifamily, All Others	All	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Interior Lighting	LI03-B	Baseline/budget Lighting Power Density (LPD) is established correctly in the Compliance Form for spaces where proposed lighting is fully specified.	2 or 4	Interior Lighting	All	All	All	
Interior Lighting	LI04-P	Proposed lighting controls reported in the Compliance Form reflect design documents.	2 or 4	Interior Lighting	All	All	All	
Interior Lighting	LI05-P	Specified lighting controls meet mandatory requirements in 90.1 Section 9.	1 or 4	Interior Lighting	All	All	All	
Interior Lighting	LI05-B	Baseline/budget lighting controls are established correctly in the Compliance Form.	2 or 4	Interior Lighting	All	All	All	
Interior Lighting	LI06-P	Modeled interior lighting peak demand is consistent with the proposed design lighting wattage reported in the Compliance Form.	2 or 4	Interior Lighting	All	All	All	
Interior Lighting	LI06-B	Modeled interior lighting peak demand is consistent with the baseline/budget design lighting wattage reported in the Compliance Form.	2 or 4	Interior Lighting	All	All	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Interior Lighting	LI07-P	Proposed interior lighting wattage entered into simulation tool reflects values reported in the Compliance Form.	2 or 4	Interior Lighting	All	All	All	
Interior Lighting	LI07-B	Baseline/budget Design interior lighting wattage entered into simulation tool reflects values reported in the Compliance Form.	2 or 4	Interior Lighting	All	All	All	
Interior Lighting	LI08-P	Occupancy sensor controls in the proposed design are modeled as reported in the Compliance Form.	2 or 4	Interior Lighting	All	All	All	
Interior Lighting	LI08-B	Occupancy sensor controls in the baseline/budget design are modeled as reported in the Compliance Form.	2 or 4	Interior Lighting	All	All	All	
Interior Lighting	LI09-P	Daylighting controls in the proposed design are modeled as reported in the Compliance Form.	2, 3, or 4	Interior Lighting	Office, Retail, School, Healthcare/hospital, Restaurant, Hotel/motel, Warehouse, All Others	All	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Interior Lighting	LI09-B	Daylighting sensor controls in the baseline/budget design are modeled as reported in the Compliance Form.	2, 3, or 4	Interior Lighting	Office, Retail, School, Healthcare/hospital, Restaurant, Hotel/motel, Warehouse, All Others	All	All	
Interior Lighting	LI10	Modeled interior lighting runtime hours are realistic.	2 or 4	Interior Lighting	All	All	All	
Interior Lighting	LI11	The difference in the interior lighting annual energy use of the baseline/budget and proposed design is reasonable.	2 or 4	Interior Lighting	All	All	All	
Exterior Lighting	LE01-P	Proposed exterior lighting power reported in the Compliance Form reflects design documents.	2 or 4	Exterior Lighting	All	All	All	
Exterior Lighting	LE01-B	Baseline/budget exterior lighting power is established correctly in the Compliance Form.	2 or 4	Exterior Lighting	All	All	All	
Exterior Lighting	LE02-P	Specified exterior lighting meets 90.1 mandatory requirements.	1 or 4	Exterior Lighting	All	All	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Exterior Lighting	LE03-P	Modeled exterior lighting power in the proposed design reflects the wattages reported in the Compliance Form.	2 or 4	Exterior Lighting	All	All	All	
Exterior Lighting	LE03-B	Modeled exterior lighting power in the baseline/budget design reflects the wattages reported in the Compliance Form.	2 or 4	Exterior Lighting	All	All	All	
Exterior Lighting	LE04-P	Exterior lighting controls reported in the Compliance Form reflect design documents.	2 or 4	Exterior Lighting	All	All	All	
Exterior Lighting	LE04-B	Exterior lighting controls reported in the Compliance Form for the baseline/budget design are established correctly.	2 or 4	Exterior Lighting	All	All	All	
Exterior Lighting	LE05-P	Specified exterior lighting controls meet 90.1 mandatory requirements.	1 or 4	Exterior Lighting	All	All	All	
Exterior Lighting	LE06-P	Modeled exterior lighting runtime hours in the proposed design are reasonable.	2 or 4	Exterior Lighting	All	All	All	
Exterior Lighting	LE07	Difference between the baseline/budget and proposed exterior lighting energy is as expected.	0	N/A	All	All	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Plug, Process and Other Loads	PPO01	The difference between the modeled baseline/budget and proposed miscellaneous equipment and process energy use is as expected.	1	N/A	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO02-P	Proposed design miscellaneous unregulated plug and process loads reported in the Compliance Form are reasonable.	1	N/A	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO02-B	Miscellaneous unregulated baseline/budget plug and process loads reported in the Compliance Form are the same as proposed unless allowed to differ.	2 or 4	Misc equipment, Industrial process, Refrigeration equipment (unregulated), Other unregulated	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO03	Schedules used for the miscellaneous unregulated plug and process loads reported in the Compliance Form for the baseline/budget design are the same as for the proposed design unless allowed to differ.	2 or 4	Misc equipment, Industrial process, Refrigeration equipment (unregulated), Other unregulated	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Plug, Process and Other Loads	PPO04-P	Miscellaneous proposed plug and process loads are modeled as reported in the Compliance Form.	2 or 4	Misc equipment, Industrial process, Refrigeration equipment (unregulated), Other unregulated	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO04-B	Miscellaneous baseline/budget plug and process loads are modeled as reported in the Compliance Form.	2 or 4	Misc equipment, Industrial process, Refrigeration equipment (unregulated), Other unregulated	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO05-P	Regulated commercial refrigerators & freezers reported in the Compliance Form for the proposed design reflect design documents.	2 or 4	Misc equipment, Industrial process, Refrigeration equipment (unregulated), Other unregulated	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Plug, Process and Other Loads	PPO05-B	Baseline/budget design for the regulated commercial refrigerators & freezers reported in the Compliance Form is established correctly.	2 or 4	Misc equipment, Industrial process, Refrigeration equipment (unregulated), Other unregulated	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO06	Regulated refrigerators and freezers are modeled as reported in the Compliance Form for the baseline/budget and proposed design.	2 or 4	Refrigeration equipment (regulated)	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO07-P	Regulated motors reported in the Compliance Form for the proposed design reflect design documents.	2 or 4	Other regulated	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO07-B	Regulated motors reported in the Compliance Form for the baseline/budget design are established correctly.	2 or 4	Other regulated	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO08	Regulated motors are modeled as reported in the Compliance Form for the baseline/budget and proposed design.	2 or 4	Other regulated	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Plug, Process and Other Loads	PPO09-P	Elevators reported in the Compliance Form for the proposed design reflect design documents.	2 or 4	Elevators and escalators	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO09-B	Elevators reported in the Compliance Form for the baseline/budget design are established correctly.	2 or 4	Elevators and escalators	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO10	Elevators are modeled as reported in the Compliance Form for the baseline/budget/budget and proposed design.	0	N/A	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO11-P	Combined Heat and Power (CHP) systems reported in the Compliance Form for the proposed design reflect design documents.	2 if CHP is reported, otherwise excluded	N/A	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO11-B	CHP systems reported in the Compliance Form for the baseline/budget design are established correctly.	2 if CHP is reported, otherwise excluded	N/A	N/A	N/A	N/A	
Plug, Process and Other Loads	PPO12	CHP systems are modeled as reported in the Compliance Form for the baseline/budget and proposed design.	2 if CHP is reported, otherwise excluded	N/A	N/A	N/A	N/A	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Service Water Heating	SWH01-P	Proposed SWH system type, efficiency and capacity reported in the Compliance Form reflects design documents.	2 or 4	Service Water Heating	All	All	All	
Service Water Heating	SWH02-P	Proposed SWH efficiency reported in the Compliance Form meets the mandatory requirements of 90.1 Section 7.	0	N/A	N/A	N/A	N/A	
Service Water Heating	SWH02-B	Baseline/budget SWH system type, efficiency and capacity reported in the Compliance Form is established correctly.	2 or 4	Service Water Heating	All	All	All	
Service Water Heating	SWH03-P	The ancillary components of the proposed SWH system reported in the Compliance Form reflect design documents.	4	N/A	N/A	N/A	N/A	
Service Water Heating	SWH03-B	Ancillary components of the baseline/budget SWH system reported in the Compliance Form are established correctly.	4	N/A	N/A	N/A	N/A	
Service Water Heating	SWH04-P	Proposed service hot water demand reported in the Compliance Form is reasonable.	2 or 4	Service Water Heating	All	All	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Service Water Heating	SWH04-B	Difference between the baseline/budget and proposed hot water demand reported in the Compliance Form is as allowed.	2 or 4	Service Water Heating	All	All	All	
Service Water Heating	SWH05-P	Modeled proposed SWH system type, efficiency, capacity, ancillary features and HW demand reflect parameters reported in the Compliance Form.	2 or 4	Service Water Heating	All	All	All	
Service Water Heating	SWH05-B	Modeled baseline/budget SWH system type, efficiency, capacity, ancillary features and demand reflect parameters reported in the Compliance Form.	2 or 4	Service Water Heating	All	All	All	
Service Water Heating	SWH06	Difference in the baseline/budget and proposed hot water use is reasonable based on the system parameters reported in the Compliance Form.	2 or 4	Service Water Heating	All	All	All	
Service Water Heating	SWH07-P	Modeled proposed SWH effective full load hours are reasonable.	3 or 4	Service Water Heating	All	All	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Air-Side HVAC Systems	AHVAC01-P	Thermal blocks are listed in the Compliance Form and are established correctly.	2 or 4	All	All	All	All	This translates to always ranked as a 2
Air-Side HVAC Systems	AHVAC02-P	Thermal blocks are modeled for the proposed design as reported in the Compliance Form.	2 or 4	All	All	All	All	This translates to always ranked as a 2
Air-Side HVAC Systems	AHVAC02-B	Thermal blocks are modeled for the baseline/budget design as reported in the Compliance Form.	2 or 4	All	All	All	All	This translates to always ranked as a 2
Air-Side HVAC Systems	AHVAC03-P	All specified air-side HVAC systems are reported in the Compliance Form.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC03-B	Baseline/budget system types reported in the Compliance Form are established correctly.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Pumps, Heat Rejection, Fans Interior Ventilation	All	All	All	

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Air-Side HVAC Systems	AHVAC04-P	All proposed air-side HVAC systems reported in the Compliance Form are modeled.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC04-B	All baseline/budget air-side HVAC systems reported in the Compliance Form are modeled.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC05-P	Heating and cooling types and capacities of the proposed air-side HVAC systems reported in the Compliance Form reflect Design Documents.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC05-B	Heating and cooling types and capacities of the baseline/budget air-side HVAC systems reported in the Compliance Form are established correctly.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling	All	All	All	

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Air-Side HVAC Systems	AHVAC06-P	Heating and cooling capacities of the proposed air-side HVAC systems are modeled as reported in the Compliance Form.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC06-B	Heating and cooling capacities of the baseline/budget air-side HVAC systems are modeled as reported in the Compliance Form.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC07-P	Reported air-side HVAC systems cooling and heating efficiencies reflect design documents.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC08-P	Cooling and heating efficiencies of the specified air-side HVAC systems meet the mandatory minimums in 90.1 Section 6.	1 or 4	Space Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC08-B	Baseline/budget air-side systems' heating and cooling efficiencies reported in the Compliance Form are established correctly.	2 or 4	Space Heating, Space Cooling	All	All	All	

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Air-Side HVAC Systems	AHVAC09-P	Modeling inputs for the proposed heating and cooling efficiency are provided in the Compliance Form and established correctly.	2 or 4	Space Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC09-B	Modeling inputs for the baseline/budget heating and cooling efficiency are provided in the Compliance Form and established correctly.	0	N/A	N/A	N/A	N/A	
Air-Side HVAC Systems	AHVAC10-P	The heating & cooling performance curves used in the proposed design simulation are based on an approved source.	3 or 4	Space Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC10-B	The heating & cooling performance curves used in the baseline/budget design simulation are based on an approved source.	3 or 4	Space Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC11-P	Modeled heating and cooling efficiency of the proposed air-side systems reflect values reported in the Compliance Form.	3 or 4	Space Heating, Space Cooling	All	All	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Air-Side HVAC Systems	AHVAC11-B	Modeled heating and cooling efficiency of the baseline/budget air-side systems reflect values reported in the Compliance Form.	3 or 4	Space Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC12-P	Annual average realized DX cooling and heating efficiencies of the proposed systems reflect expected performance at the range of actual conditions.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC12-B	Annual average realized DX cooling and heating efficiencies of the baseline/budget systems reflect expected performance at the range of actual conditions.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC13-P	Annual average realized heating efficiencies of the proposed air-side systems reflect expected performance.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling	All	All	All	
Air-Side HVAC Systems	AHVAC13-B	Annual average realized heating efficiencies of the baseline/budget air-side systems reflect expected performance.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling	All	All	All	

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Air-Side HVAC Systems	AHVAC14-P	Design supply, return, relief and exhaust fan flow rates reported in the Compliance Form are as specified in the Design Documents.	2 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC14-B	Baseline/budget design fans flow rates reported in the Compliance Form are established correctly.	3 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC15-P	Design supply, return, relief and exhaust fan power reported in the Compliance Form is as specified in the design documents.	2 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC15-B	Baseline/budget fan power reported in the Compliance Form is established correctly.	2 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC16-P	Air flow controls reported in the Compliance Form are as specified in the design documents.	2 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC16-B	Air flow and supply temperature controls reported in the Compliance Form for the baseline/budget design are established correctly.	2 or 4	Fans Interior Ventilation	All	All	All	

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Air-Side HVAC Systems	AHVAC17-P	Fan power performance curves used in the simulation are based on an approved source.	3 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC17-B	Fan power performance curves reported for the baseline/budget design in the Compliance Form are based on an approved source.	3 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC18-P	Fan power, flow rate and controls are modeled in the proposed design as reported in the Compliance Form.	2 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC18-B	Fan power, flow rate and controls are modeled in the baseline/budget design as reported in the Compliance Form.	2 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC19-P	Modeled peak demand of ventilation fans in the proposed design is generally consistent with design fan power and control reported in the Compliance Form.	2 or 4	Fans Interior Ventilation	All	All	All	

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Air-Side HVAC Systems	AHVAC19-B	Modeled peak demand of ventilation fans in the baseline/budget design is generally consistent with design fan power and control reported in the Compliance Form.	2 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC20-P	Modeled equivalent full load hours of the ventilation fans in the proposed design are as expected.	2 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC20-B	Modeled equivalent full load hours of the ventilation fans in the baseline/budget design are as expected.	2 or 4	Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC21-P	Air-side economizers reported in the Compliance Form are as specified in the design documents.	2, 3, or 4	Space Cooling, Heat Rejection	Office, Retail, School, Healthcare/hospital, Restaurant, Hotel/motel, All Others	3A-8	All	
Air-Side HVAC Systems	AHVAC21-B	Air-side economizers reported in the Compliance Form for the baseline/budget systems are established correctly.	2, 3, or 4	Space Cooling, Heat Rejection	Office, Retail, School, Healthcare/hospital, Restaurant, Hotel/motel, All Others	3A-8	All	

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Air-Side HVAC Systems	AHVAC22-P	Air-side economizer is modeled in the proposed design as reported in the Compliance Form.	2, 3, or 4	Space Cooling, Heat Rejection	Office, Retail, School, Healthcare/hospital, Restaurant, Hotel/motel, All Others	3A-8	All	
Air-Side HVAC Systems	AHVAC22-B	Air-side economizer is modeled in the baseline/budget design as reported in the Compliance Form.	2, 3, or 4	Space Cooling, Heat Rejection	Office, Retail, School, Healthcare/hospital, Restaurant, Hotel/motel, All Others	3A-8	All	
Air-Side HVAC Systems	AHVAC23-P	Design ventilation rates reported in the Compliance Form are consistent with the design documents.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Pumps, Heat Rejection, Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC23-B	Baseline/budget ventilation rates reported in the Compliance Form are established correctly.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Pumps, Heat Rejection, Fans Interior Ventilation	All	All	All	

Review Check Section Title	Check ID	Check Description	Ranking Logic	End-Uses Affected by Rule	Building Types where Rule is Impactful	Climate Zones where Rule is Impactful	Number of Stories where Rule is Impactful	Helpful Notes
Air-Side HVAC Systems	AHVAC24-P	Demand control ventilation reported in the Compliance Form is consistent with the design documents.	2, 3, or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Pumps, Heat Rejection, Fans Interior Ventilation	Retail, School, Restaurant	All	All	
Air-Side HVAC Systems	AHVAC25-P	Demand control ventilation reported in the Compliance Form for the proposed design meets mandatory requirements in 90.1 Section 6.	1 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Pumps, Heat Rejection, Fans Interior Ventilation	Retail, School, Restaurant	All	All	
Air-Side HVAC Systems	AHVAC25-B	Demand control ventilation reported in the Compliance Form for the baseline/budget design is established correctly.	2, 3, or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Pumps, Heat Rejection, Fans Interior Ventilation	Retail, School, Restaurant	All	All	

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Air-Side HVAC Systems	AHVAC26-P	Ventilation rate and control are modeled for the proposed design as reported in the Compliance Form.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Pumps, Heat Rejection, Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC26-B	Ventilation rate and controls are modeled for the baseline/budget design as reported in the Compliance Form.	2 or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Pumps, Heat Rejection, Fans Interior Ventilation	All	All	All	
Air-Side HVAC Systems	AHVAC27-P	Exhaust air energy recovery reported in the Compliance Form reflects design documents.	2, 3, or 4	Space Heating (if CZ >=4), Space Cooling (if CZ <4), Fans Interior Ventilation	Office, Retail, School, Healthcare/hospital, Restaurant, Hotel/motel, Multifamily, All Others	All	All	

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Air-Side HVAC Systems	AHVAC27-B	Exhaust air energy recovery reported in the Compliance Form for the baseline/budget design is established correctly.	2, 3, or 4	Space Heating (if CZ >=4), Space Cooling (if CZ <4), Fans Interior Ventilation	Office, Retail, School, Healthcare/hospital, Restaurant, Hotel/motel, Multifamily, All Others	All	All	
Air-Side HVAC Systems	AHVAC28-P	Exhaust air energy recovery modeled in the proposed design is as reported in the Compliance Form.	2, 3, or 4	Space Heating (if CZ >=4), Space Cooling (if CZ <4), Fans Interior Ventilation	Office, Retail, School, Healthcare/hospital, Restaurant, Hotel/motel, Multifamily, All Others	All	All	
Air-Side HVAC Systems	AHVAC28-B	Exhaust air energy recovery modeled in the baseline/budget design is as reported in the Compliance Form.	2, 3, or 4	Space Heating (if CZ >=4), Space Cooling (if CZ <4), Fans Interior Ventilation	Office, Retail, School, Healthcare/hospital, Restaurant, Hotel/motel, Multifamily, All Others	All	All	
Air-Side HVAC Systems	AHVAC29-P	Additional HVAC efficiency measures reported in the Compliance Form are allowed for trade-off and reflect design documents.	2 if reported	N/A	N/A	N/A	N/A	

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Air-Side HVAC Systems	AHVAC30-P	Additional HVAC efficiency measures were modeled for the proposed design as described in the Compliance Form.	2 if reported	N/A	N/A	N/A	N/A	
Air-Side HVAC Systems	AHVAC31-P	Modeled monthly patterns of heating and cooling loads in the proposed design are as expected with no excessive simultaneous heating and cooling.	2, 3, or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Heat Rejection	Office, School, Healthcare/hospital, All Others	N/A	N/A	
Air-Side HVAC Systems	AHVAC31-B	Modeled monthly patterns of heating and cooling loads in the baseline/budget design are as expected with no excessive simultaneous heating and cooling.	2, 3, or 4	Space Heating, Heat Pump Supplemental Heating, Space Cooling, Heat Rejection	Office, School, Healthcare/hospital, All Others	N/A	N/A	
Water-Side HVAC Systems	WHVAC01-P	Proposed chillers reported in the Compliance Form reflect design documents and meet the minimum efficiency requirements.	2 or 4	Space Cooling	All	All	All	
Water-Side HVAC Systems	WHVAC01-B	Properties of the baseline/budget chillers reported in the Compliance Form are established correctly.	2 or 4	Space Cooling	All	All	All	

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Water-Side HVAC Systems	WHVAC02-P	Proposed chillers are modeled as reported in the Compliance Form.	2 or 4	Space Cooling	All	All	All	
Water-Side HVAC Systems	WHVAC02-B	Baseline/budget chillers are modeled as reported in the Compliance Form.	2 or 4	Space Cooling	All	All	All	
Water-Side HVAC Systems	WHVAC03-P	Average annual realized proposed chiller efficiency is as expected.	2 or 4	Space Cooling	All	All	All	
Water-Side HVAC Systems	WHVAC03-B	Average annual realized baseline/budget chiller efficiency is as expected.	2 or 4	Space Cooling	All	All	All	
Water-Side HVAC Systems	WHVAC04-P	Proposed chilled water loop configuration and temperature controls reported in the Compliance Form reflect design documents.	2 (if pump impactful end-use), 2 (if only space cooling is impactful), 4	Space Cooling, Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC04-B	Baseline/budget chilled water loop configuration and temperature controls reported in the Compliance Form are established correctly.	2 (if pump impactful end-use), 2 (if only space cooling is impactful), 4	Space Cooling, Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC05-P	Proposed chilled water loops configuration and temperature controls are modeled as reported in the Compliance Form.	2 (if pump impactful end-use), 2 (if only space cooling is impactful), 4	Space Cooling, Pumps	All	All	All	

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Water-Side HVAC Systems	WHVAC05-B	Baseline/budget chilled water loops configuration and temperature controls are modeled as reported in the Compliance Form.	2 (if pump impactful end-use), 2 (if only space cooling is impactful), 4	Space Cooling, Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC06-P	Proposed chilled water pump system parameters reported in the Compliance Form reflect design documents.	2 or 4	Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC06-B	Baseline/budget chilled water pump system parameters reported in the Compliance Form are established correctly	2 or 4	Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC07-P	Proposed CHW pumps are modeled as reported in the Compliance Form.	2 or 4	Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC07-B	Baseline/budget CHW pumps are modeled as reported in the Compliance Form.	2 or 4	Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC08-P	Proposed CHW loop flow control is modeled as reported in the Compliance Form.	2 or 4	Space Cooling, Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC08-B	Baseline/budget CHW loop flow control is modeled as reported in the Compliance Form.	2 or 4	Space Cooling, Pumps	All	All	All	

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Water-Side HVAC Systems	WHVAC09-P	Modeled proposed annual chilled water pump energy is as expected.	2 or 4	Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC09-B	Modeled baseline/budget annual chilled water pump energy is as expected.	2 or 4	Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC10-P	Proposed heat rejection system reported in the Compliance Form reflects design documents.	2 or 4	Heat Rejection, Fans Interior Ventilation	All	All	All	
Water-Side HVAC Systems	WHVAC10-B	Baseline/budget heat rejection system reported in the Compliance Form is established correctly.	2 or 4	Heat Rejection, Fans Interior Ventilation	All	All	All	
Water-Side HVAC Systems	WHVAC11-P	Proposed heat rejection system is modeled as reported in the Compliance Form.	2 or 4	Heat Rejection, Fans Interior Ventilation	All	All	All	
Water-Side HVAC Systems	WHVAC11-B	Baseline/budget heat rejection system is modeled as reported in the Compliance Form.	2 or 4	Heat Rejection, Fans Interior Ventilation	All	All	All	
Water-Side HVAC Systems	WHVAC12-P	Proposed space heating boilers reported in the Compliance Form reflect design documents and meet the minimum efficiency requirements.	2 or 4	Space Heating	All	All	All	

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Water-Side HVAC Systems	WHVAC12-B	Properties of the space heating boilers in the baseline/budget design reported in the Compliance Form are established correctly.	2 or 4	Space Heating	All	All	All	
Water-Side HVAC Systems	WHVAC13-P	Space heating boilers in the proposed design are modeled as reported in the Compliance Form.	2 or 4	Space Heating	All	All	All	
Water-Side HVAC Systems	WHVAC13-B	Space heating boilers in the baseline/budget design are modeled as reported in the Compliance Form.	2 or 4	Space Heating	All	All	All	
Water-Side HVAC Systems	WHVAC14-P	Average annual realized efficiency of the proposed boilers is as expected.	2 or 4	Space Heating	All	All	All	
Water-Side HVAC Systems	WHVAC14-B	Average annual realized efficiency of the baseline/budget boilers is as expected.	2 or 4	Space Heating	All	All	All	
Water-Side HVAC Systems	WHVAC15-P	Proposed hot water loop configuration and temperature controls reported in the Compliance Form reflect design documents.	2 (if pump impactful end-use), 2 (if only space cooling is impactful), 4	Space Heating, Pumps	All	All	All	

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Water-Side HVAC Systems	WHVAC15-B	Baseline/budget hot water loop configuration and temperature controls reported in the Compliance Form are established correctly.	0, if reported	N/A	N/A	N/A	N/A	
Water-Side HVAC Systems	WHVAC16-P	Proposed hot water loops configuration and temperature controls are modeled as reported in the Compliance Form.	2 (if pump impactful end-use), 2 (if only space cooling is impactful), 4	Space Heating, Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC16-B	Baseline/budget hot water loops temperature controls are modeled as reported in the Compliance Form.	2 (if pump impactful end-use), 2 (if only space cooling is impactful), 4	Space Heating, Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC17-P	Proposed hot water pump system parameters reported in the Compliance Form reflect design documents.	2 or 4	Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC17-B	Baseline/budget hot water pump system parameters reported in the Compliance Form are established correctly.	2 or 4	Pumps	All	All	All	

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Water-Side HVAC Systems	WHVAC18-P	Proposed hot water pumps are modeled as reported in the Compliance Form.	2 or 4	Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC18-B	Baseline/budget hot water pumps are modeled as reported in the Compliance Form.	2 or 4	Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC19-P	Proposed hot water loops configuration and flow control is modeled as reported in the Compliance Form.	2 or 4	Space Heating, Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC19-B	Baseline/budget hot water loops configuration and flow control is modeled as reported in the Compliance Form.	2 or 4	Space Heating, Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC20-P	Modeled proposed annual hot water pump energy is as expected.	2 or 4	Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC20-B	Modeled baseline/budget annual hot water pump energy is as expected.	2 or 4	Pumps	All	All	All	
Water-Side HVAC Systems	WHVAC21	Pump energy use is reported on the Compliance Calculations tab if applicable.	0	N/A	N/A	N/A	N/A	

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Water-Side HVAC Systems	WHVAC22	Modeled baseline/budget and proposed heating energy use by fuel is consistent with the heating energy source reported in the Compliance Form.	2 or 4	Space Heating	All	All	All	
Renewable Energy	RE01	The renewable electricity generation systems reported in the Compliance Form reflect design documents.	1 if achieving compliance depends on renewables otherwise, 4 or N/A if none reported.	N/A	N/A	N/A	N/A	
Renewable Energy	RE02	The renewable thermal energy systems reported in the Compliance Form reflect design documents.	Same as above	N/A	N/A	N/A	N/A	
Renewable Energy	RE03	Savings from renewable energy reported in the Compliance Form are substantiated.	Same as above	N/A	N/A	N/A	N/A	
Renewable Energy	RE04	Contribution of renewable energy toward compliance does not exceed the allowed limit.	Same as above	N/A	N/A	N/A	N/A	
Renewable Energy	RE05	Prescriptive on-site renewable energy requirements reported in the Compliance Form are established correctly.	1 or N/A if none reported.	N/A	N/A	N/A	N/A	

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Exceptional Calculations	EC01	Documentation submitted for each exceptional calculation method reported in the Compliance Form meets 90.1 requirements.	1 if reported otherwise not included	N/A	N/A	N/A	N/A	
Exceptional Calculations	EC02	Calculation methodology is acceptable and inputs reflect specified systems and equipment.	1 if reported otherwise not included	N/A	N/A	N/A	N/A	
Exceptional Calculations	EC03	Contribution of exceptional calculations toward compliance does not exceed the allowed limit.	1 if reported otherwise not included	N/A	N/A	N/A	N/A	