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

V04

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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. The methodology 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.

Table of Contents

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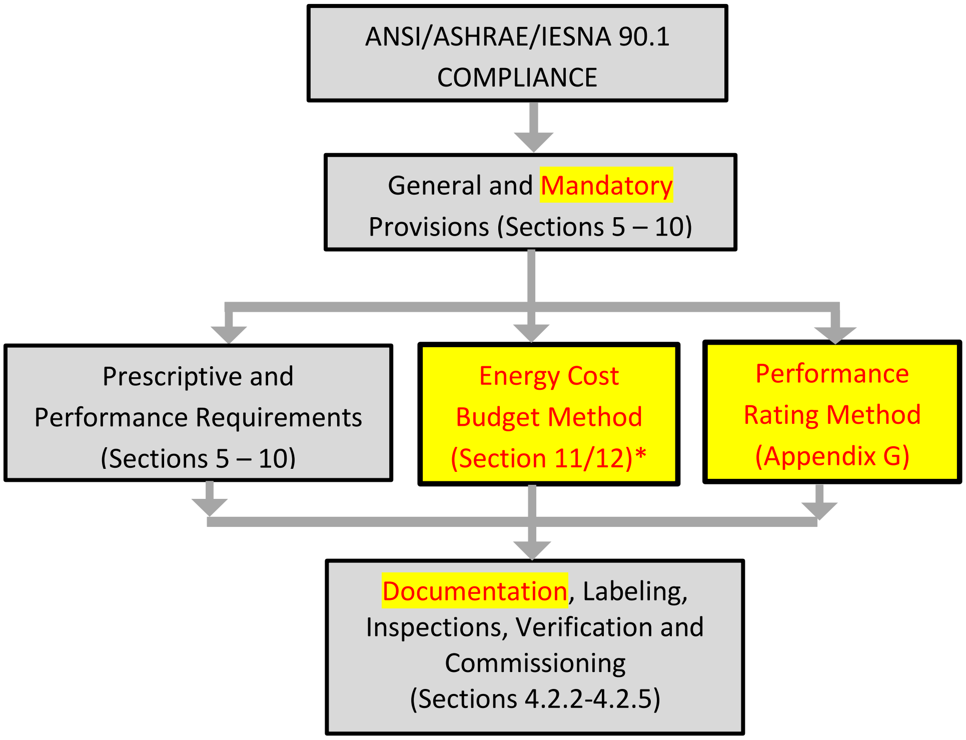
Abbreviations and Acronyms

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.

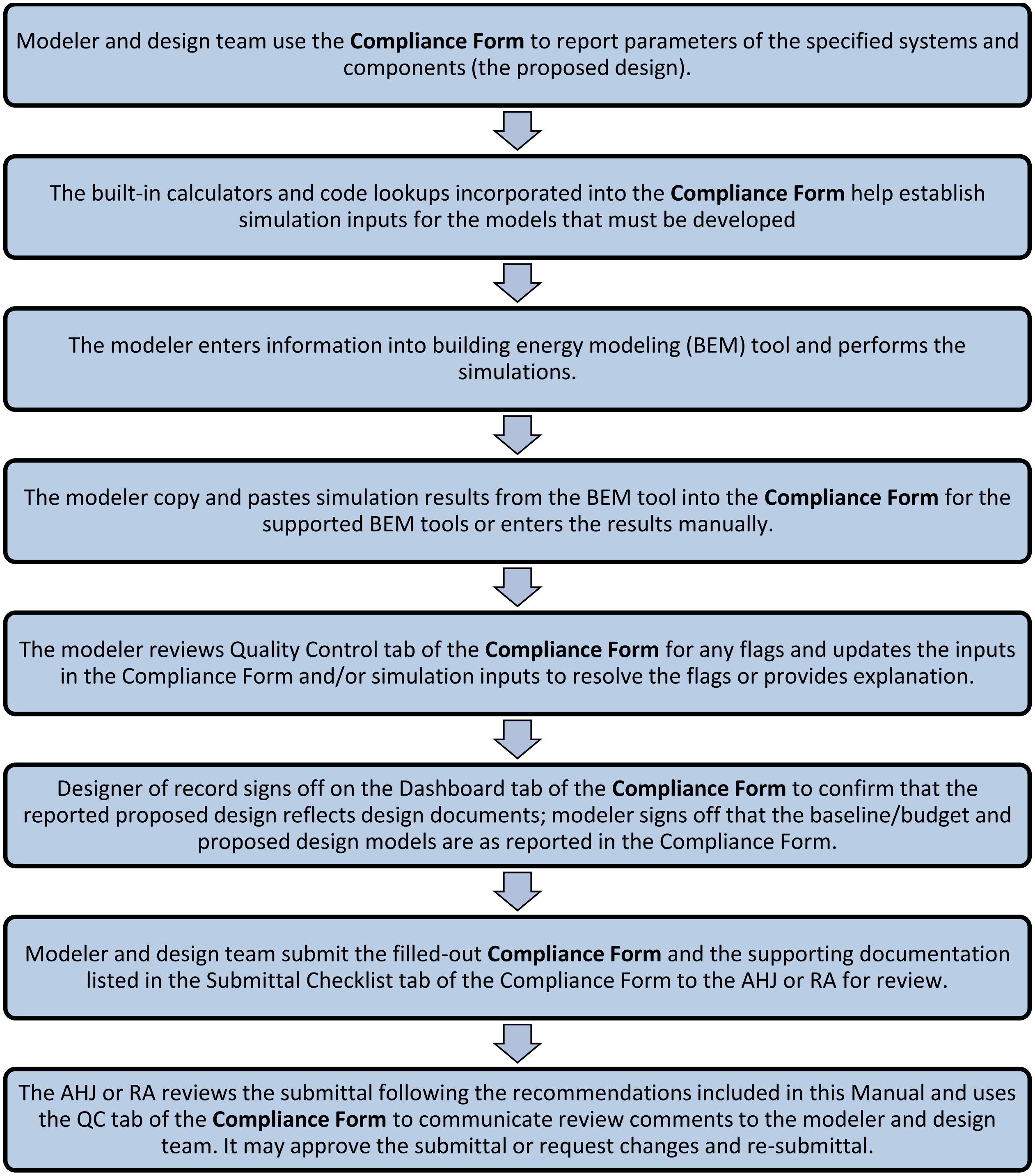


*The Energy Cost Budget Method is Section 11 in ASHRAE 90.1 2016 and 2019 and Section 12 in ASHRAE 90.1 2022.

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 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 pass/fail outcome and comments for each completed check. This Manual includes description of each check listed in the QC tab including references to the applicable 90.1 requirements, simulation reports, and common mistakes.



Modeler and design team use the **Compliance Form** to report parameters of the specified systems and components (the proposed design).

The built-in calculators and code lookups incorporated into the **Compliance Form** help establish simulation inputs for the models that must be developed

The modeler enters information into building energy modeling (BEM) tool and performs the simulations.

The modeler copy and pastes simulation results from the BEM tool into the **Compliance Form** for the supported BEM tools or enters the results manually.

The modeler reviews Quality Control tab of the **Compliance Form** for any flags and updates the inputs in the Compliance Form and/or simulation inputs to resolve the flags or provides explanation.

Designer of record signs off on the Dashboard tab of the **Compliance Form** to confirm that the reported proposed design reflects design documents; modeler signs off that the baseline/budget and proposed design models are as reported in the Compliance Form.

Modeler and design team submit the filled-out **Compliance Form** and the supporting documentation listed in the Submittal Checklist tab of the Compliance Form to the AHJ or RA for review.

The AHJ or RA reviews the submittal following the recommendations included in this Manual and uses the QC tab of the **Compliance Form** to communicate review comments to the modeler and design team. It may approve the submittal or request changes and re-submittal.

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) The methodology 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 recommendations for identifying impactful aspect of the submittal to help prioritize review effort. 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 of this Manual is a comprehensive library of checks that may be performed. The checks are organized in subsections baseline 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 Bookstore[1]. 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 Manual[3]. The document expands on requirements of 90.1-2016 and 2019 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 request[4]. The official interpretations are posted on ASHRAE website for 90.1-2013[5], 90.1-2016[6], 90.1-2019[7], and 90.1-2022[8] are a useful resource. As of the date this Review Manual was published no interpretations have been posted for 90.1 2022.
6. DOE Help Desk[9]
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.

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[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 check is not resolved, provide an explanation for reviewer.

b. To improve submittal quality, consider completing all checks for which "Include in Review" is automatically set to "Yes" in the QC Checks tab of the Compliance Form are completed. 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 particular checks.

4. Review Process

The section describes the submittal review process utilizing the QC Checks tab of the Compliance Form.

Step 1: Check submittal for completeness

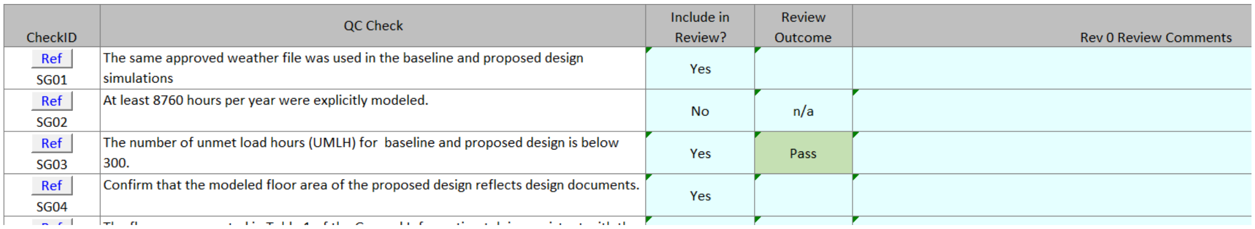
- Use the Submittal + Mand. Req. Checklists tab of the **Compliance Form** to verify that all required materials are provided. Request additional information if submittal is incomplete.
- Review the Dashboard tab of the **Compliance Form** to verify compliance outcome and confirm that modeler and design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

Step 2: Get general understanding of the project

- 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
- 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.)

Step 3: Establish Review Scope

- Open Quality Control Checks tab of the **Compliance Form** (Figure 3). The tab includes all review checks listed in the manual. For some checks, "Include in Review" box will be set to "Yes" by default based on the logic described in the Establishing Review Scope section of this Manual. It is recommended that review at minimum includes these checks.



CheckID	QC Check	Include in Review?	Review Outcome	Rev 0 Review Comments
Ref SG01	The same approved weather file was used in the baseline and proposed design simulations	Yes		
Ref SG02	At least 8760 hours per year were explicitly modeled.	No	n/a	
Ref SG03	The number of unmet load hours (UMLH) for baseline and proposed design is below 300.	Yes	Pass	
Ref SG04	Confirm that the modeled floor area of the proposed design reflects design documents.	Yes		

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.
- Follow recommendations in the Identifying Impactful Aspects of the Submittal and Establishing Review Scope sections of the Manual to identify additional checks to be performed on the project. For these checks, set "Include in Review" box to "Yes" in the Quality Control Checks tab of the Compliance Form (Figure 4).

Step 4: Perform the Review

- 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.

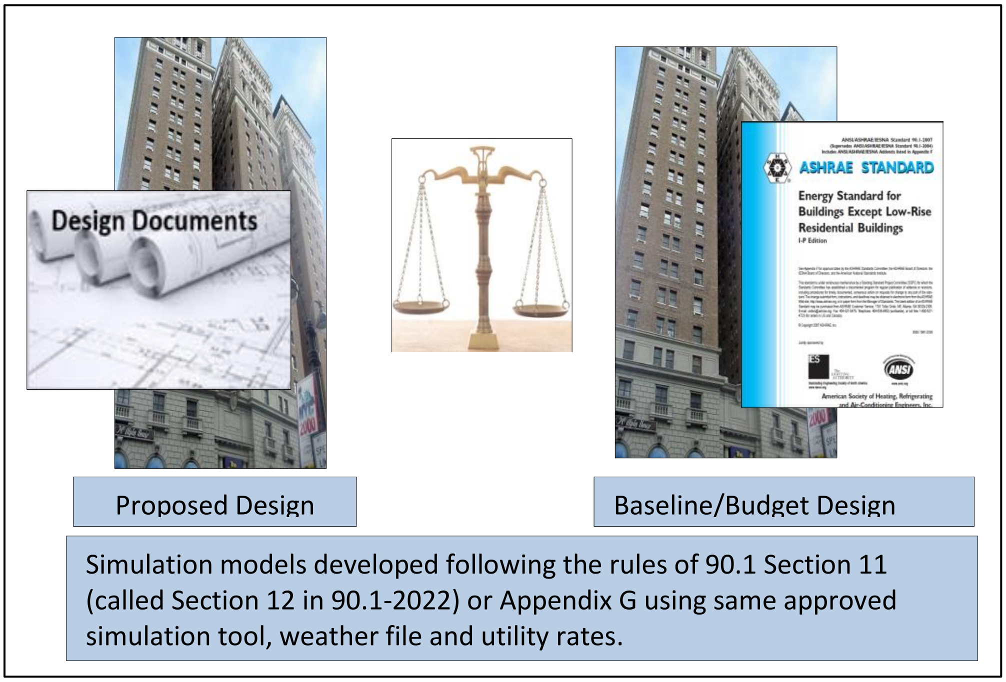
Step 5: Communicate review outcome to the Permit Applicant

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.

5. Review Methodology

General Concept of Standard 90.1 Energy Cost Budget and Performance Rating Method 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.



Simulation models developed following the rules of 90.1 Section 11 (called Section 12 in 90.1-2022) or Appendix G using same approved simulation tool, weather file and utility rates.

Figure 4: 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 website[10] .

     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.

Step 1: Identify the impactful end uses

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

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[10] https://www.energycodes.gov/prototype-building-models#Commercial

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 5). 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.

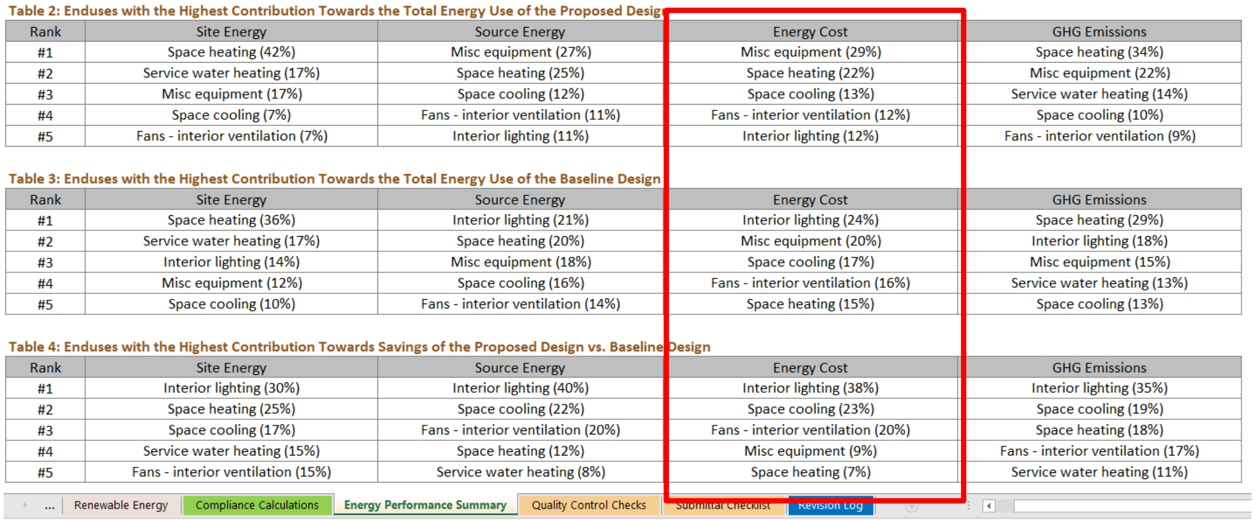

Table 2: Enduses with the Highest Contribution Towards the Total Energy Use of the Proposed Desig

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 5: 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.

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.

Table 1: Impactful Systems and Components to be Reviewed

Lighting End Use	
Performance Characteristics	**Operating Conditions**
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.	i. Lighting runtime hours in a representative sample of spaces.
Service Water-heating End Use	
Performance Characteristics	**Operating Conditions**
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.	i. Volume of hot water consumed. ii. Supply hot water temperature.
Space Heating End Use	
Performance Characteristics	**Operating Conditions**
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: - For each opaque surface type[11]: 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	i. Hourly heating thermostat setpoints ii. HVAC control setting iii. Mechanical ventilation schedule
Space Cooling and Heat Rejection End Use	
Performance Characteristics	**Operating Conditions**
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.	i. Hourly cooling thermostat setpoints ii. HVAC control setting iii. Mechanical ventilation schedule

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[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. ii. Mechanical ventilation rate and schedule relevant to the identified fans. iii. HVAC system controls relevant to the identified fans.	i. Fan full load hours ii. The hourly ratio of actual flow to design flow
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. ii. HVAC system controls relevant to the identified pumps	i. Pump full load hours 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 falling below the mandatory provisions), identifying issues pertaining to the impactful systems are likely to affect 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	Always, based on sampling	NA
3. Specified systems meet mandatory requirements	Always, based on sampling	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 IF passes #2	Only for impactful systems based on sampling IF passes #4
6. Simulation outputs are consistent with systems and components reported in the Compliance Form	Only for impactful systems, based on sampling IF passes #2	Only for impactful systems, based on sampling IF passes #4
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.

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 6). 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.

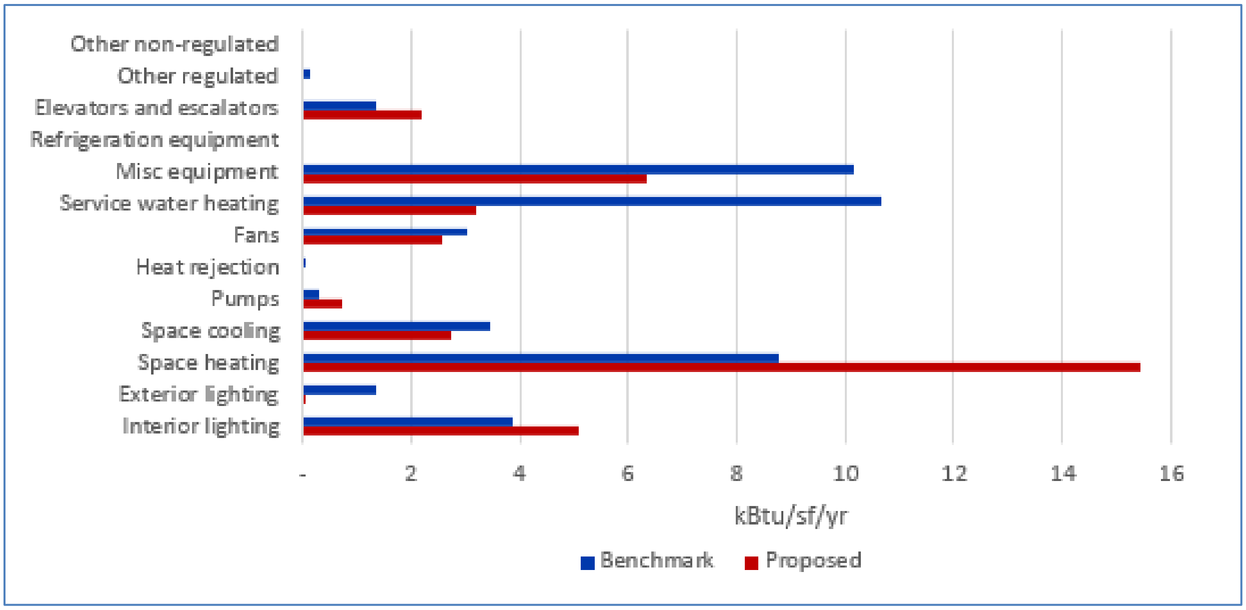


Figure 6: Energy Performance Summary tab of the Compliance Form, Benchmark Comparison

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

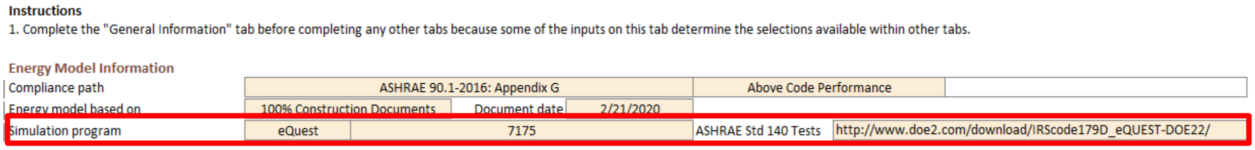
Section G2.2.1 has the same requirements as 90.1 2016 and 2019 ECB Section 11.4.1 summarized above.

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

Compliance path	ASHRAE 90.1-2016: Appendix G		Above Code Performance	
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 analysis[12]. 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.

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[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

4. 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.

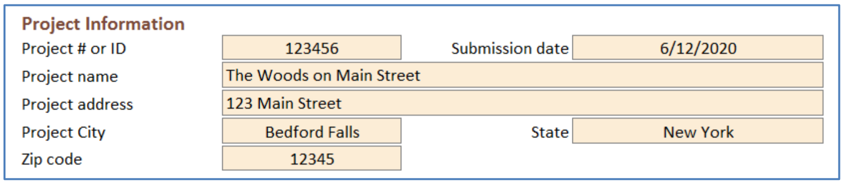
SG02 Project climate zone reported in the Compliance Form is established correctly

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

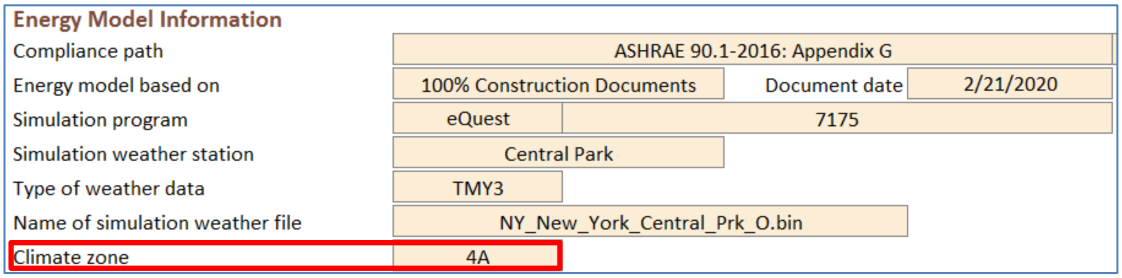
1. Project address is listed in the Project Information section of the Contact Information tab of the Compliance Form. Use the reported zip code to determine the county.



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		

2. 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.

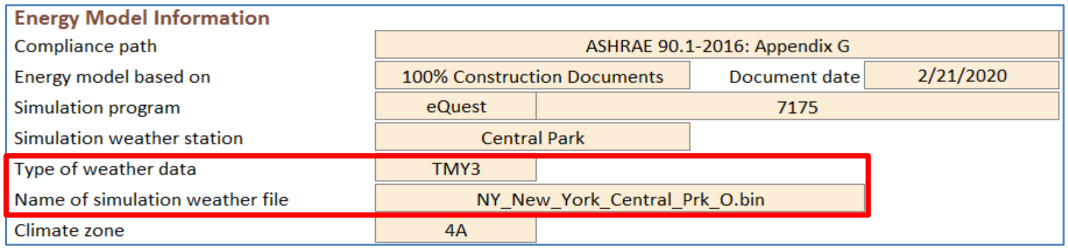
90.1 2016, 2019, and 2022 PRM

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, TMY2[13],TMY3[14], or TMYx[15] 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

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[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' sectionEnergyPlus 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 *(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)*
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

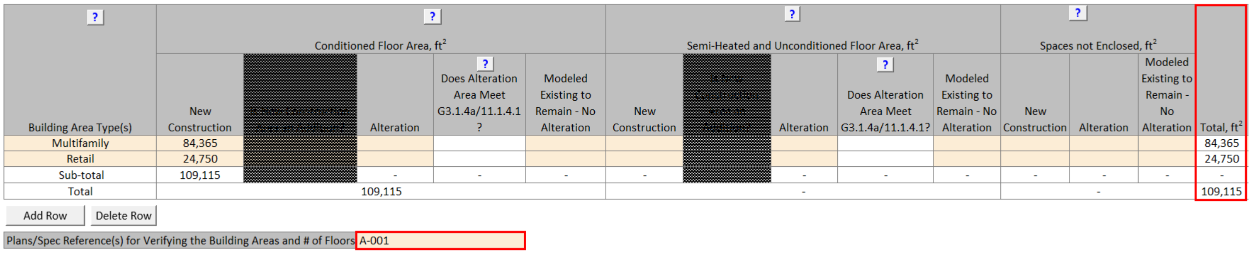
Table 11.5.1/12.5.1 Column A, #1a: The simulation model of the proposed design must be consistent with the design documents thus the modeled project area is expected to be as designed.

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).



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

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 IBC[16], 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.

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[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.

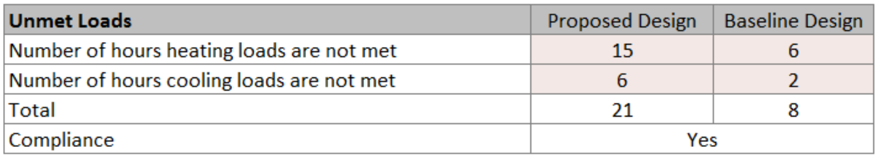
11.5.2 i/12.5.2 i: Unmet load hours for the proposed design or baseline designs shall not exceed 300 hours. In addition, the UMLHs for the proposed design shall not exceed the unmet load hours for the budget building design. Unmet load hours exceeding these limits may be accepted if sufficient justification 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 UMLH[3].

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 that 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 ≤ 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.

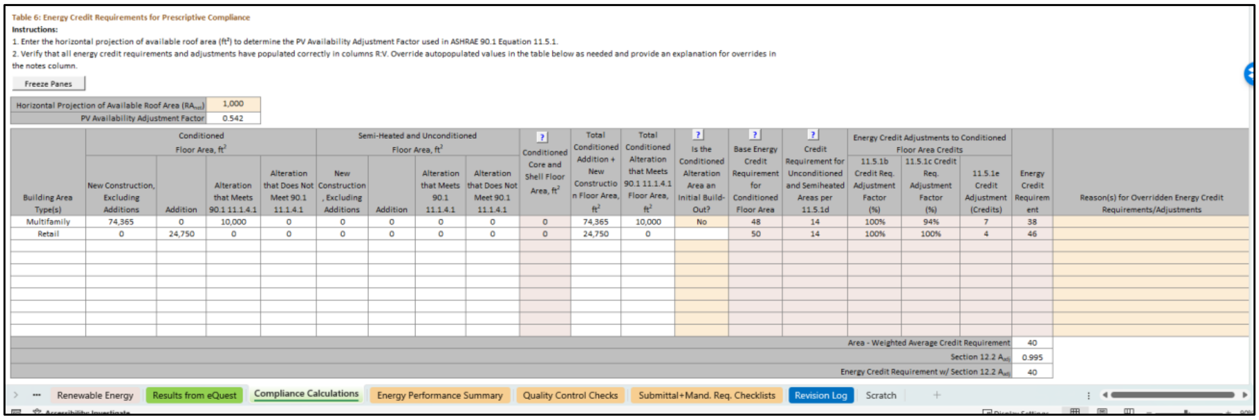


Table 6: Energy Credit Requirements for Prescriptive Compliance

Instructions:

1. Enter the horizontal projection of available roof area (ft²) 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 (RA_{net})	1,000
PV Availability Adjustment Factor	0.542

Building Area Type(s)	Conditioned Floor Area, ft²				Semi-Heated and Unconditioned Floor Area, ft²				? Conditioned Core and Shell Floor Area, ft²	Total Conditioned Addition + New Construction Floor Area, ft²	Total Conditioned Alteration that Meets 90.1 11.1.4.1 Floor Area, ft²	? Is the Conditioned Alteration Area an Initial Build-Out?	? Base Energy Credit Requirement for Conditioned Floor Area	? 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 90.1 11.1.4.1	Alteration that Does Not Meet 90.1 11.1.4.1	New Construction, Excluding Additions	Addition	Alteration that Meets 90.1 11.1.4.1	Alteration that Does Not Meet 90.1 11.1.4.1							11.5.1b Credit Req. Adjustment Factor (%)	11.5.1c Credit Req. Adjustment Factor (%)	11.5.1e Credit Adjustment (Credits)		
Multifamily	74,365	0	10,000	0	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	0	24,750	0		50	14	100%	100%	4	46	
																Area - Weighted Average Credit Requirement	40	
																Section 12.2 A_{adj}	0.995	
																Energy Credit Requirement w/ Section 12.2 A_{adj}	40	

Performance Rating Method

90.1 2016, 2019 and 2022

1. The PCI and PCIt 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

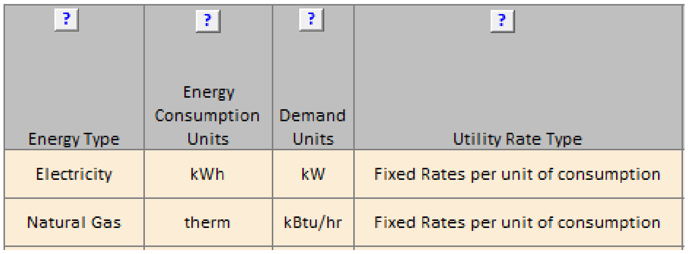
11.4.3.2/12.4.3.2: The rates for purchased energy (such as electricity, gas, oil, propane, steam and chilled water) must be approved by the AHJ.

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.

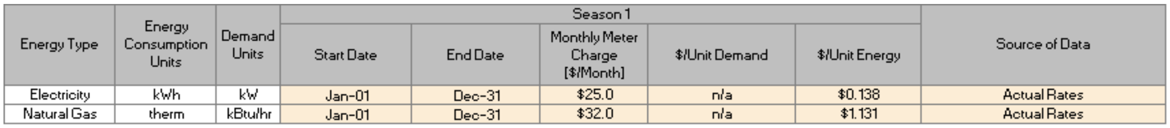
Review Tips

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.



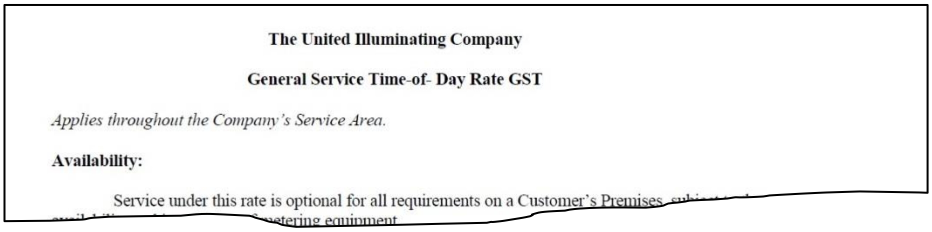
Energy Type	Energy Consumption Units	Demand Units	Utility Rate Type
Electricity	kWh	kW	Fixed Rates per unit of consumption
Natural Gas	therm	kBtu/hr	Fixed Rates per unit of consumption

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

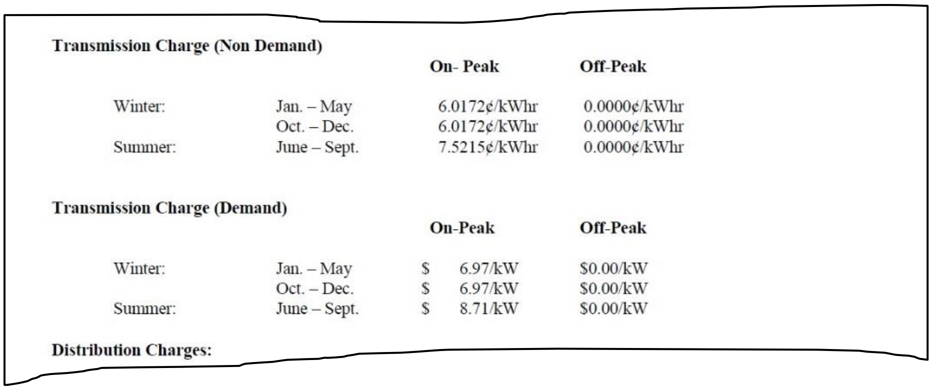
General Service Time-of- Day Rate GST

Applies throughout the Company's Service Area.

Availability:

Service under this rate is optional for all requirements on a Customer's Premises

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 / 509,150kWh = 0.15 $/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.

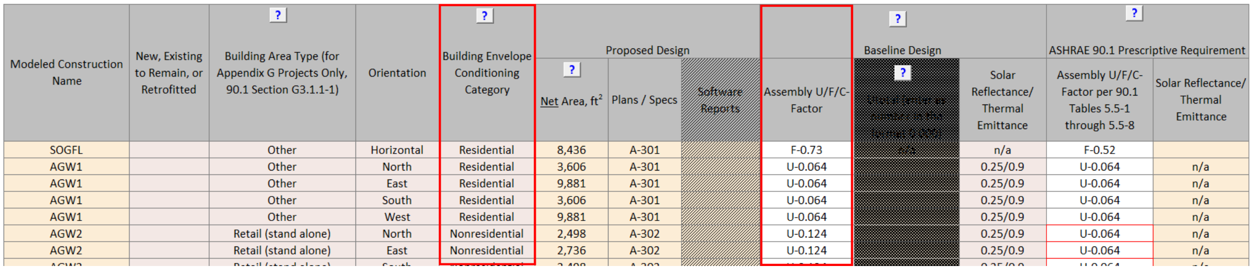
Exception: Envelope components of the HVAC zones that are semiheated in the proposed design must meet conditioned envelope requirements in Tables G3.4-1 through G3.4-8 if, based on the sizing runs, these zones are served by a baseline system with sensible cooling output capacity ≥5 Btu/h·ft^2 of floor 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				Baseline Design		ASHRAE 90.1 Prescriptive Requirement	
					Net Area, ft^2	Plans / Specs	Software Reports	Assembly U/F/C-Factor	[illegible]	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	n/a	n/a	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

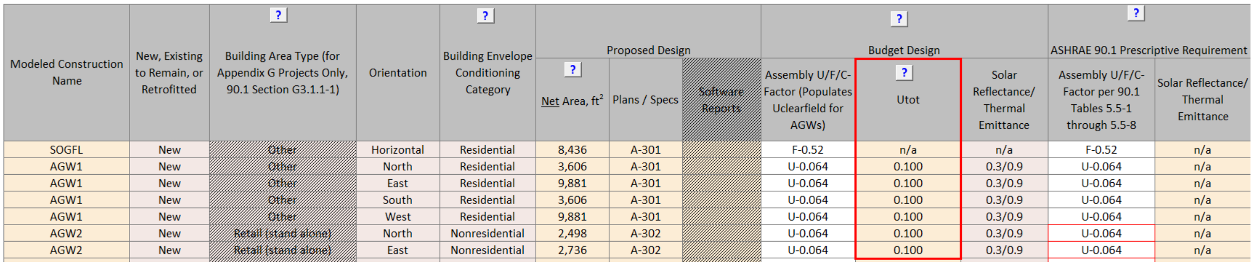
- Residential spaces are "spaces in buildings used primarily for living and sleeping. Residential spaces include, but are not limited to, dwelling units, hotel/motel guest rooms, dormitories, nursing homes, patient rooms in hospitals, lodging houses, fraternity/sorority houses, hostels, prisons, and 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

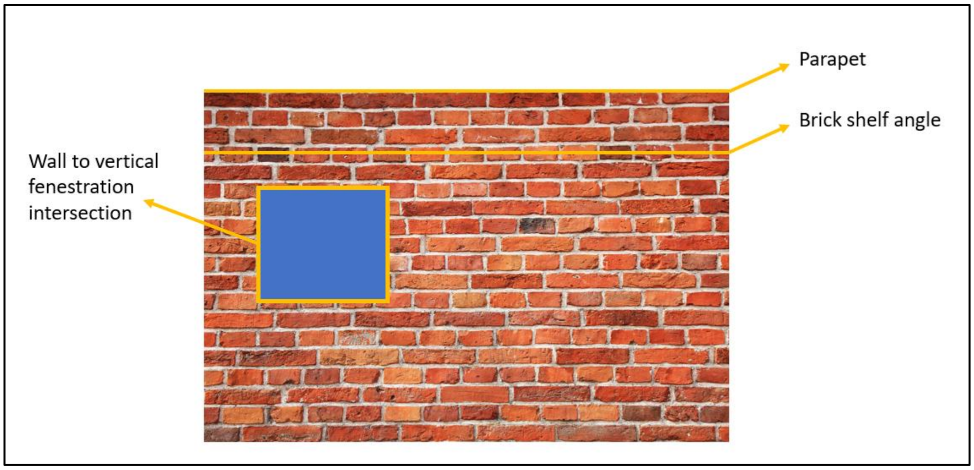
- Semiexterior Building Envelope: the elements of a building that separate conditioned space from unconditioned space or that enclose semiheated spaces through which thermal energy may be transferred to or from the exterior, to or from unconditioned spaces, or to or from conditioned spaces.
- Spaces 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 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.

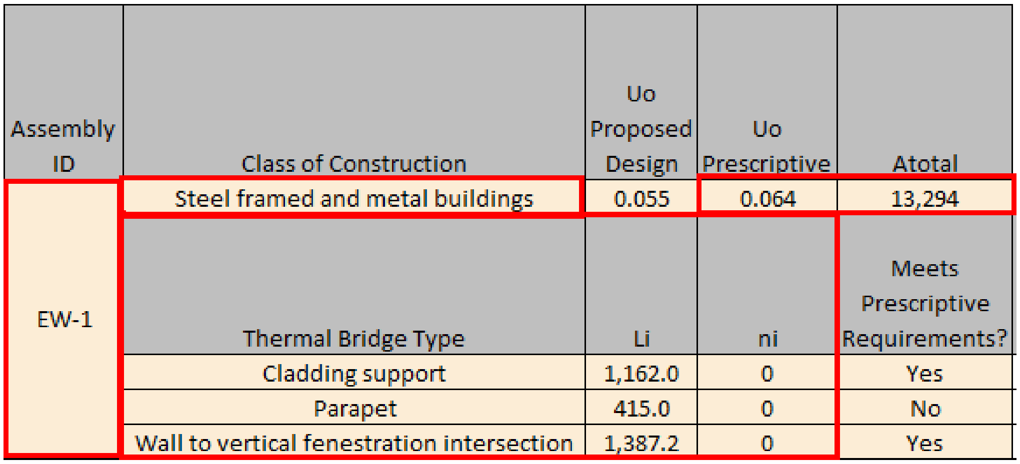


Modeled Construction Name	New, Existing to Remain, or Retrofitted	Building Area Type (for Appendix G Projects Only, 90.1 Section G3.1.1-1)	Orientation	Building Envelope Conditioning Category	Proposed Design			Budget Design			ASHRAE 90.1 Prescriptive Requirement	
					Net Area, ft^2	Plans / Specs	Software 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 (Li) and the number of occurrences of each type of point thermal bridge (ni). 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	Li	ni	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 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

Utot = overall thermal transmittance, including the effect of linear thermal bridges and point thermal bridges not included in the construction assembly Uo-factor, Btu/(h·ft^2·°F)

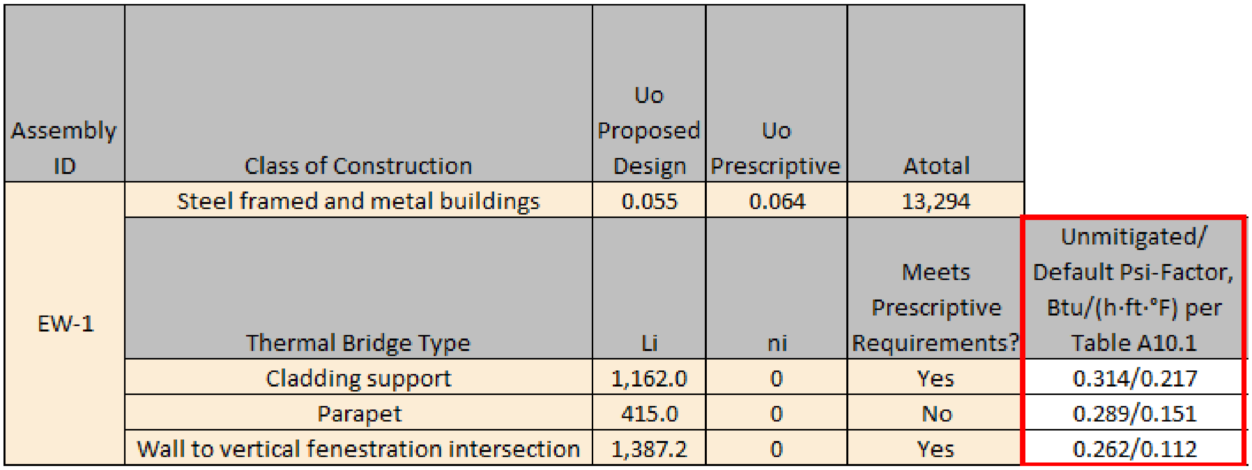
Uo = clear-field thermal transmittance of the construction assembly as determined from 90.1 2022 Tables 5.5, 0-8 based on the proposed design assembly type, Btu/(h·ft^2·°F)

Atotal = total opaque projected surface area of the construction assembly, ft^2

ψi = psi-factor, thermal transmittance for each type of linear thermal bridge from 90.1 2022 Table A10.1 “Default” column, Btu/(h·ft·°F)

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

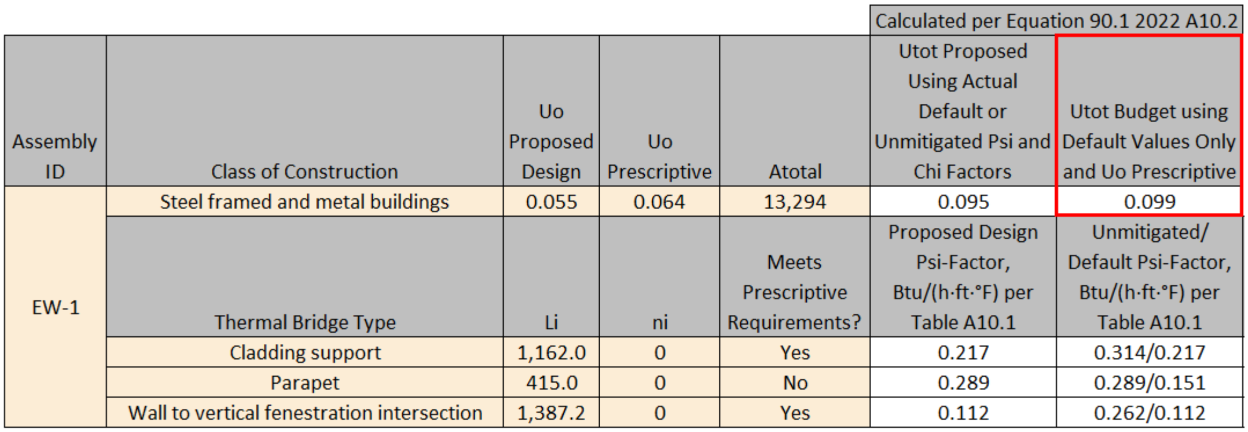


Assembly ID	Class of Construction	Uo Proposed Design	Uo Prescriptive	Atotal	
EW-1	Steel framed and metal buildings	0.055	0.064	13,294	
	Thermal Bridge Type	Li	ni	Meets Prescriptive Requirements?	Unmitigated/ Default Psi-Factor, Btu/(h·ft·°F) per Table A10.1
	Cladding support	1,162.0	0	Yes	0.314/0.217
	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:

Utot budget for EW-1 = 0.064 + [(1,162 ft * 0.217 Btu/(h·ft·°F)) + (415 ft* 0.151 Btu/(h·ft·°F)) + (1,387.2 ft * 0.112 Btu/(h·ft·°F))]/13,294 ft^2 = 0.064 + 0.0353 = 0.099 Btu/(h·ft^2·°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·°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

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

a. 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.
b. 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 stabs, 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 stabs, 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

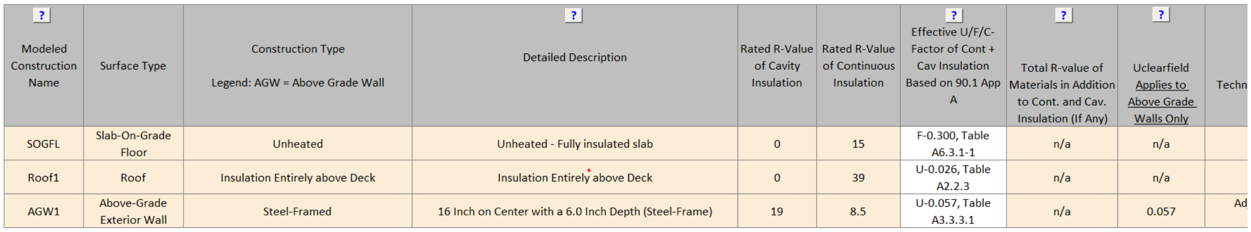
Requirements are similar to 90.1 2016 and 2019 PRM Table G3.1 #5 (a), Proposed Building Performance column requirements above except for the addition of the following.

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 Cont + Cav 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

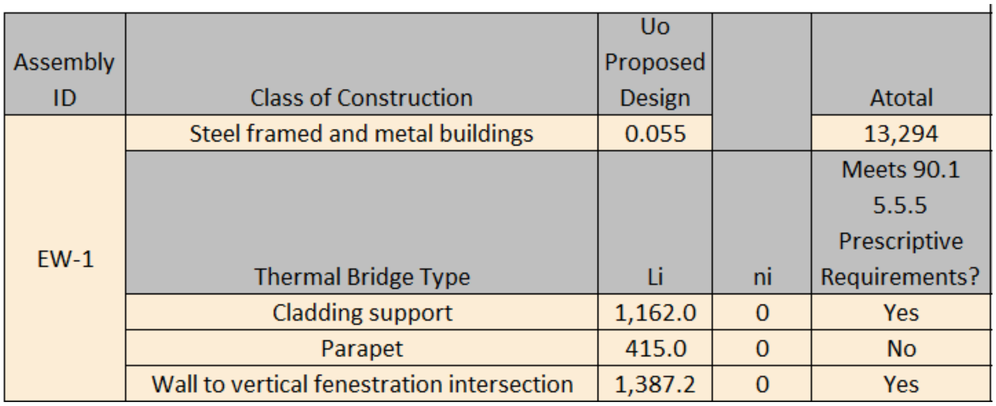
2. Verify that the description of the construction provided in the table reflects design documents. The location in the design documents where construction is described is included in the last column of Table 1 in the Proposed Envelope Assemblies tab of the Compliance Form shown above.
3. Verify that 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 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.

$Utot = \{[(\sum\psi i \times Li) + (\sum\chi j \times nj)]/Atotal) + Uo\}$

Where

Utot = overall thermal transmittance, including the effect of linear thermal bridges and point thermal bridges not included in the construction assembly Uo-factor, Btu/(h·ft^2·°F)

Uo = clear-field thermal transmittance of the construction assembly as determined in accordance with Section 5, Btu/(h·ft^2·°F)

Atotal = total opaque projected surface area of the construction assembly, ft^2

ψi = 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)

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

χi = 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)

ni = 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 Utot 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:

Utot proposed for EW-1 = 0.055 + [(1,162 ft * 0.217 Btu/(h·ft·°F)) + (415 ft* 0.289 Btu/(h·ft·°F)) + (1,387.2 ft * 0.112 Btu/(h·ft·°F))]/13,294 ft^2 = 0.055 + 0.0353 = 0.095 Btu/(h·ft^{2}·°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.

4. Review architectural details drawing to identify if project includes any uninsulated assemblies such as projecting balconies, perimeter edges of intermediate floor stabs, 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.

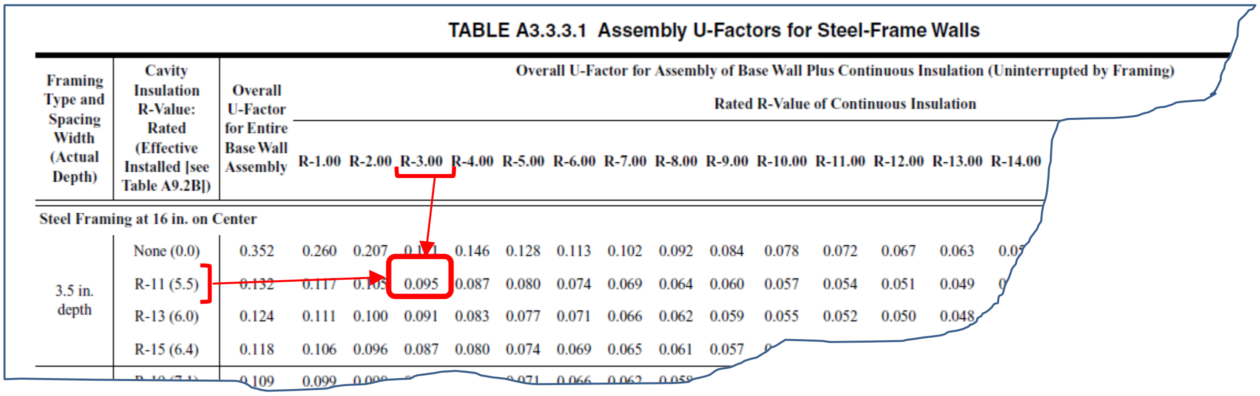


TABLE A3.3.3.1 Assembly U-Factors for Steel-Frame Walls

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	[illegible]	0.146	0.128	0.113	0.102	0.092	0.084	0.078	0.072	0.067	0.063	
	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	
	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	
	R-15 (6.4)	0.118	0.106	0.096	0.087	0.080	0.074	0.069	0.065	0.061	0.057					
		0.109	0.099			0.071	0.066	0.062								

   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 ft^2 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, ft^2 column is shown in light brown font. Override 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 58,000ft^2 gross wall area including 8,000 ft^2 of operable windows, 5,000 ft^2 of transparent glass block walls and 7,000 ft^2 of spandrel, has fenestration area of 8,000 ft^2 + 5,000 ft^2 = 13,000 ft^2 or 13,000 ft^2/58,000 ft^2=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

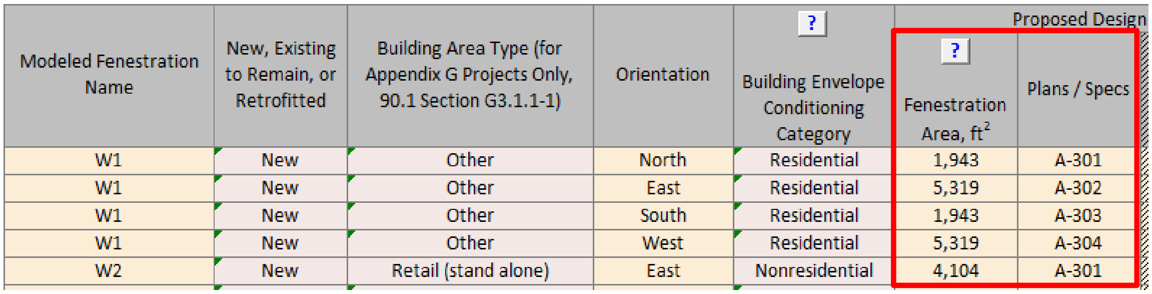
Table 11.5.1 No5, Column A/Table 12.5.1 No5, Column A: Fenestration area must be as shown on architectural drawings, or as installed for existing building envelopes.

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.



				?	Proposed Design	
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	? 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/ft^2 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/ft^2. 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/ft^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.

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

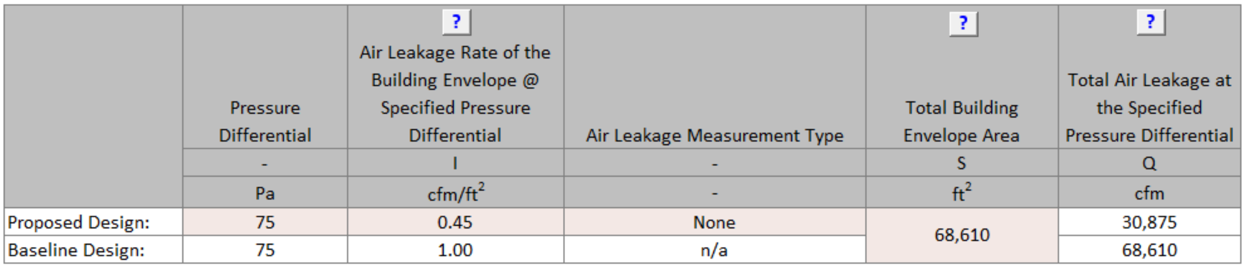
Section G3.3.2.5, which is applicable to alterations that do not meet the criteria in 90.1 G3.1.4a, requires that when Section 5.4.3.1.3 applies, the air leakage rate of the building envelope(I75Pa) shall be equal to 0.35 cfm/ft^2 of building envelope area at a pressure differential of 75 Pa (0.30 in. 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
	-	I	-	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 (I75Pa) at a fixed building pressure differential of 0.3 in. of water shall be 0.6 cfm/ft^2 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(I75Pa) 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 (I75Pa) at a fixed building pressure differential of 75 Pa (0.30 in. of water) shall be 0.45 cfm/ft^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 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 is 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. ($(U_{prop} \text{ x } A_{prop})/(U_{base} \text{ x } A_{base})$ =(40,000*0.5)/(30,000*0.5)~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

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)

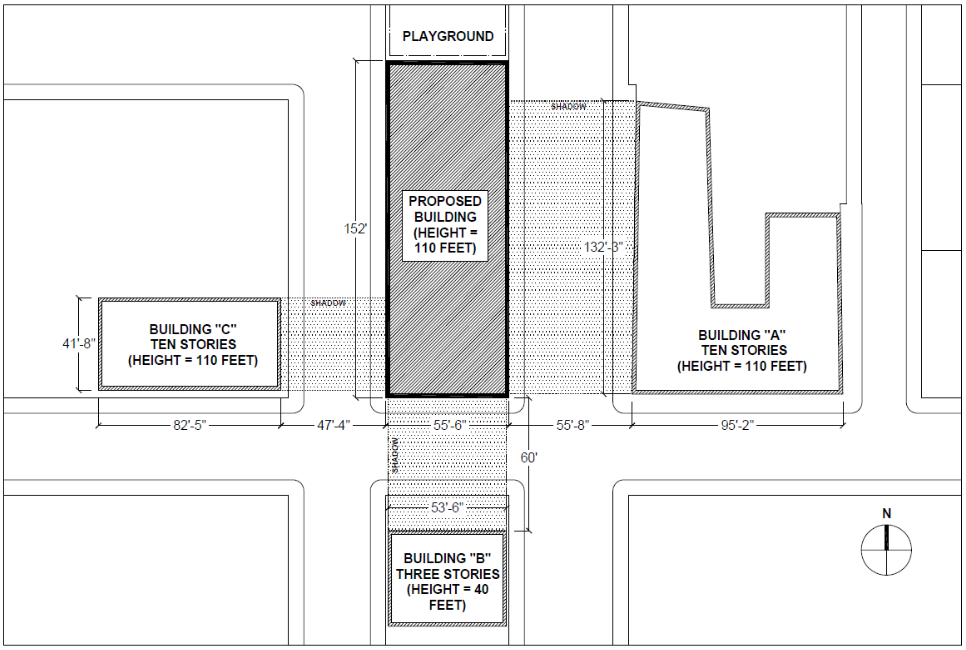
- All elements whose effective height is greater than their distance from a proposed building and whose width facing the proposed building is greater than one-third that of the proposed building shall be accounted for in the analysis.

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:

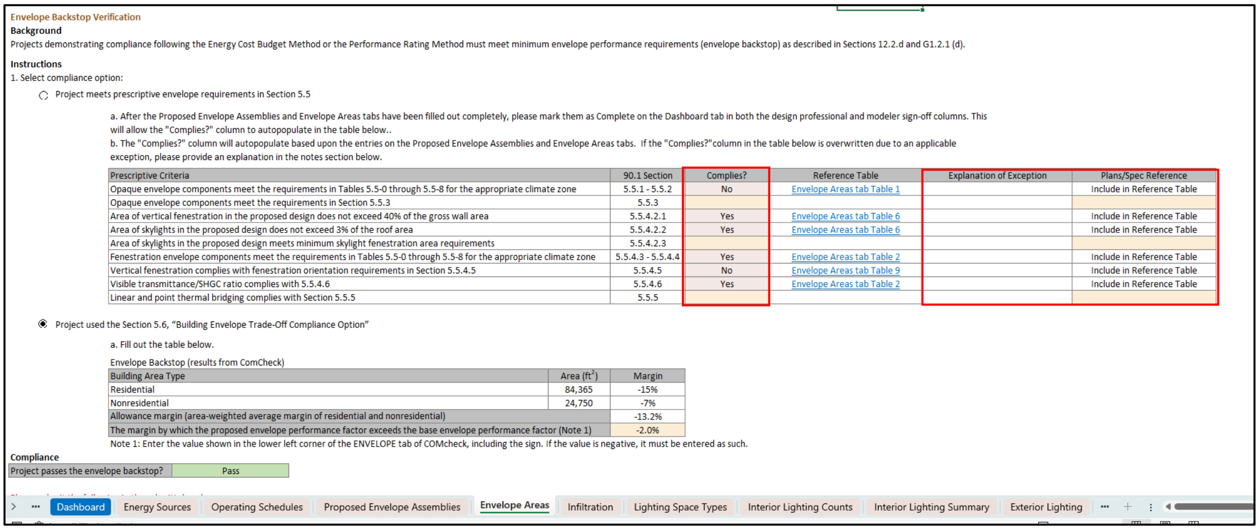
1. The building envelope complies with Section 5.5, “Prescriptive Building Envelope Compliance Path.”

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				
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%

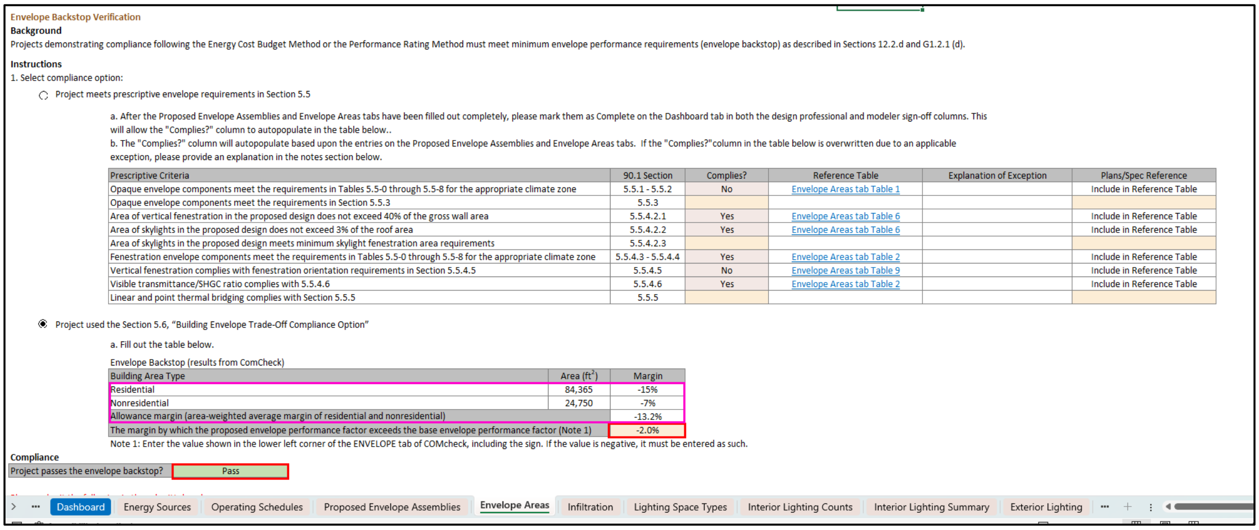
Note 1: Enter the value shown in the lower left corner of the ENVELOPE tab of COMcheck, including the sign. If the value is negative, it must be entered as such.

Compliance

Project passes the envelope backstop?	Pass

   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?	Pass

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	LI04-B
	Meet mandatory requirements	LI05	NA
	Simulation inputs consistent with CF	LI08, LI09	LI08, LI09
	Simulation outputs consistent with CF	LI10	LI10

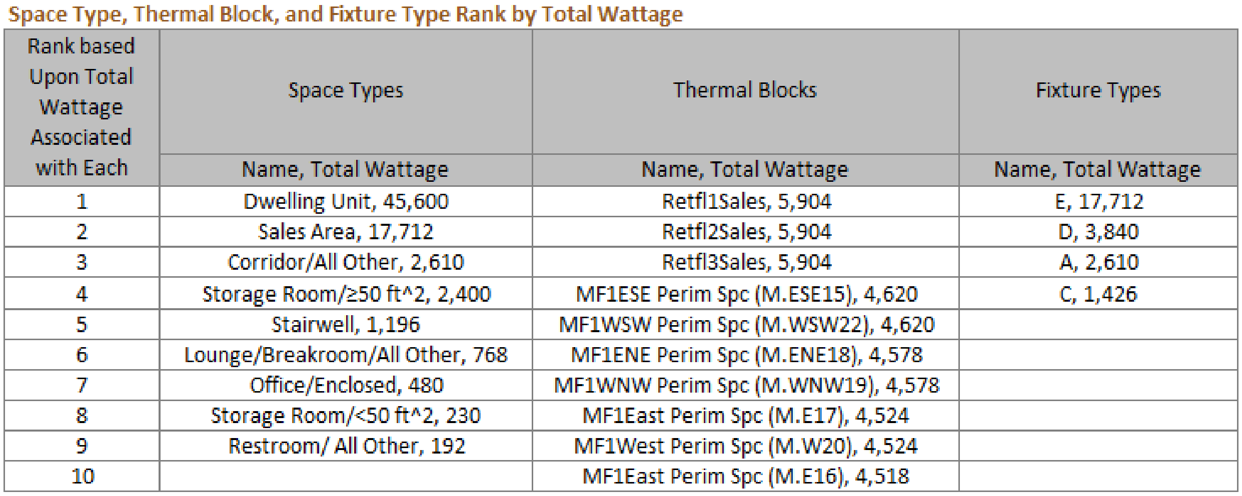
LEGEND

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

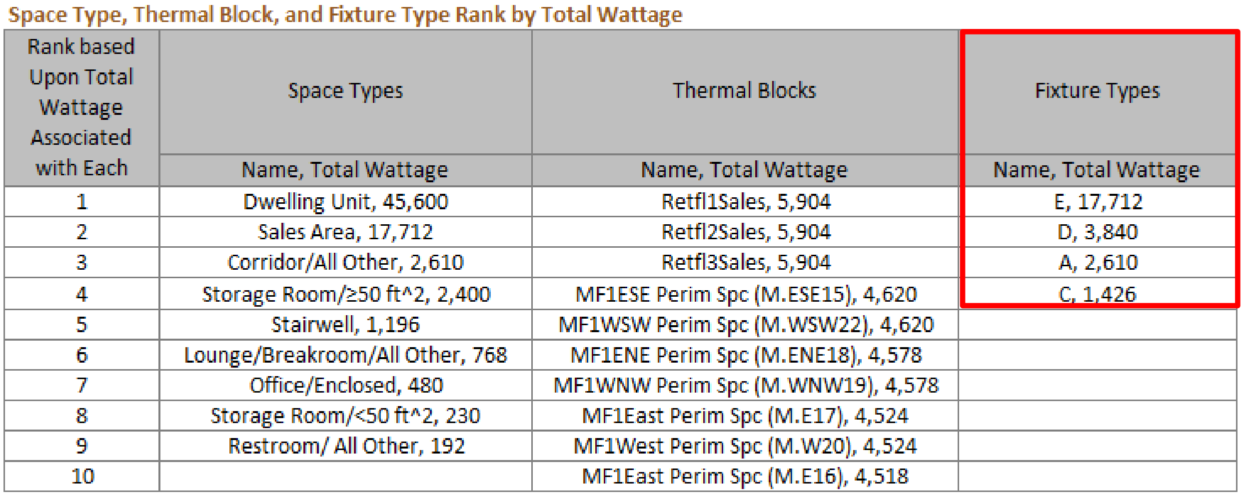
- Where a complete lighting system exists (e.g., in a renovation project where lighting is left as is), the actual lighting power must be modeled for each thermal block.
- Where a lighting system has been designed, lighting power must be determined in accordance with 90.1 Sections 9.1.3 and 9.1.4. Based 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

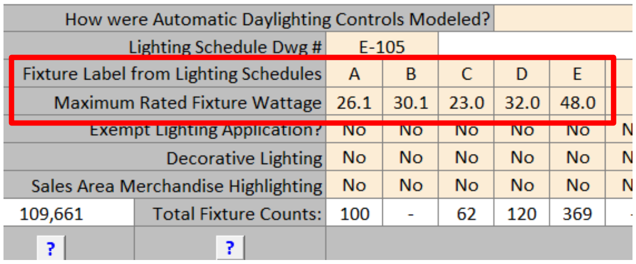
1. Refer to the table in the Interior Lighting section on the Quality Control Tab to identify lighting fixtures with the highest total wattage. Focus the review on these fixtures and spot-check others. data.



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	

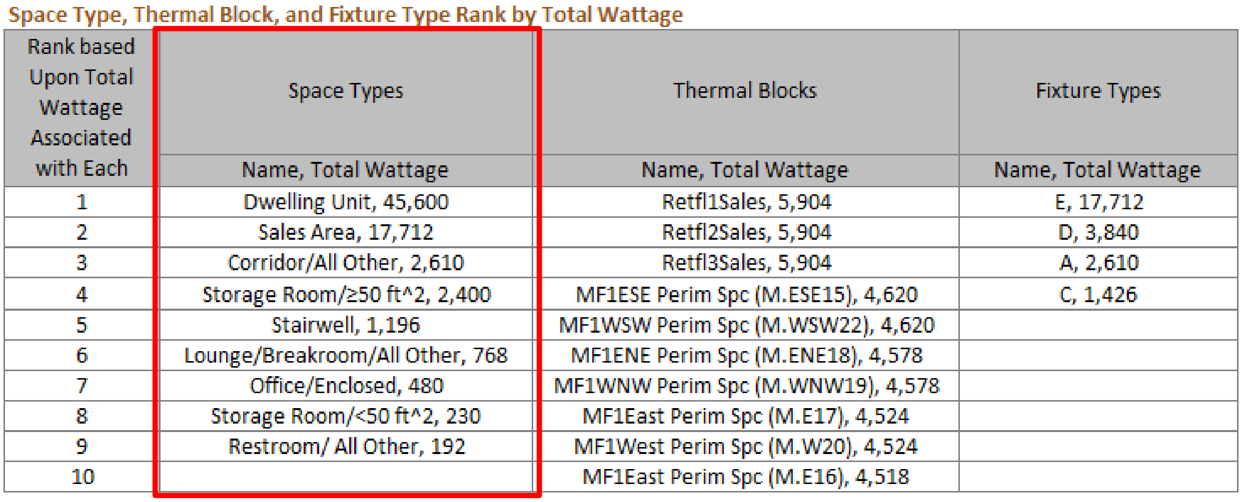
For these selected fixtures, locate fixture make and model on the lighting schedule drawings and verify that the manufacturer maximum rated wattage reported for the fixtures in Table of the Interior Lighting Counts tab is aligned with the manufacturer's maximum rated fixture wattage shown on the cutsheets.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

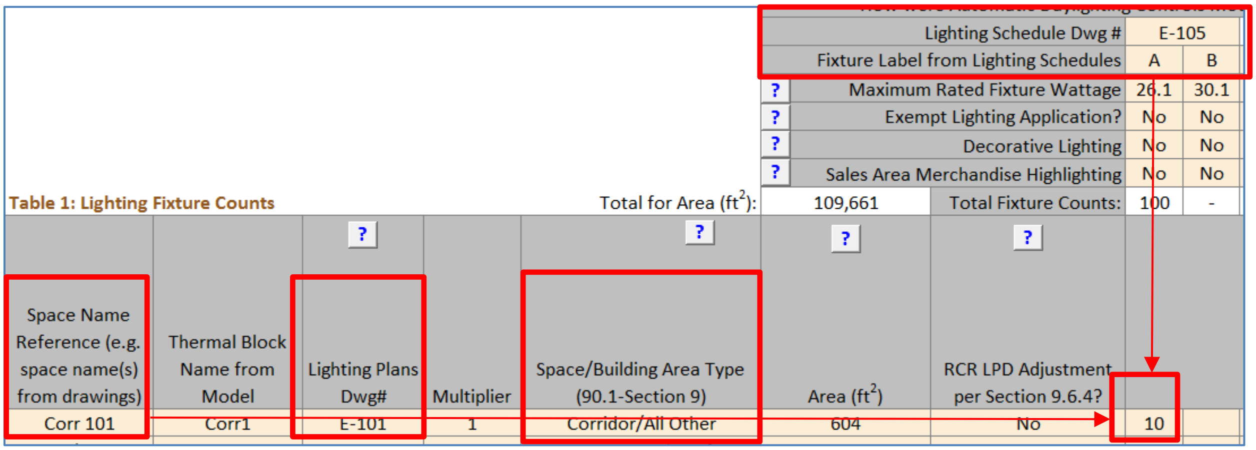
2. Refer to the table in the Interior Lighting section on the Quality Control Tab to identify space types that account for the greatest total lighting wattage.



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.



Lighting Schedule Dwg #	E-105	
Fixture Label from Lighting Schedules	A	B
? Maximum Rated Fixture Wattage	26.1	30.1
? Exempt Lighting Application?	No	No
? Decorative Lighting	No	No
? Sales Area Merchandise Highlighting	No	No

Table 1: Lighting Fixture Counts

Total for Area (ft^2): 109,661

Total Fixture Counts: 100 | -

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?	A	B
Corr 101	Corr1	E-101	1	Corridor/All Other	604	No	10	

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

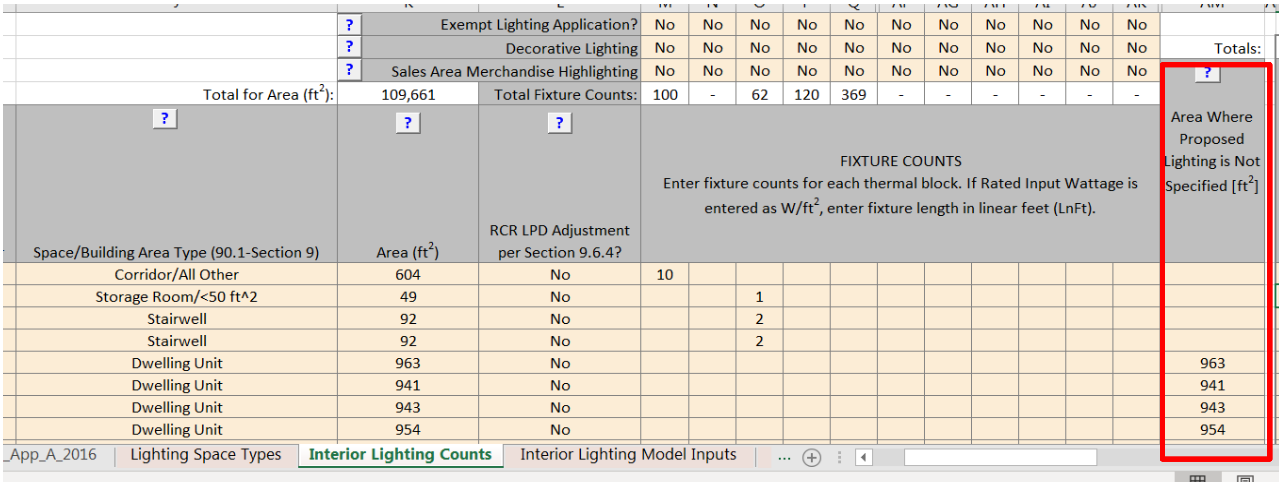
Table G3.1 #6, proposed Column, #c: Where lighting neither exists nor is submitted with the design documents, lighting power must be modeled as minimally complying with the prescriptive requirements of 90.1 Section 9, Building Area Method.

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.



	?	Exempt Lighting Application?	No	No	No	No	No	No	No	No	No	No	No	
	?	Decorative Lighting	No	No	No	No	No	No	No	No	No	No	No	Totals:
	?	Sales Area Merchandise Highlighting	No	No	No	No	No	No	No	No	No	No	No	?
Total for Area (ft²):	109,661	Total Fixture Counts:	100	-	62	120	369	-	-	-	-	-	-	
? Space/Building Area Type (90.1-Section 9)	? Area (ft²)	? 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/ft², enter fixture length in linear feet (LnFt).											Area Where Proposed Lighting is Not Specified [ft²]
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/ft^2 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 +ΣCF), where ∑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 ft^2 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.

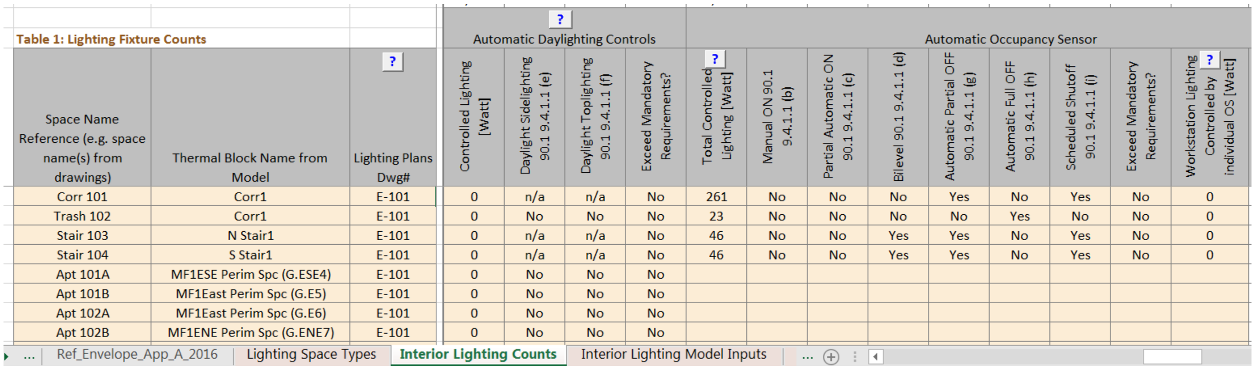


Table 1: Lighting Fixture Counts

			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.

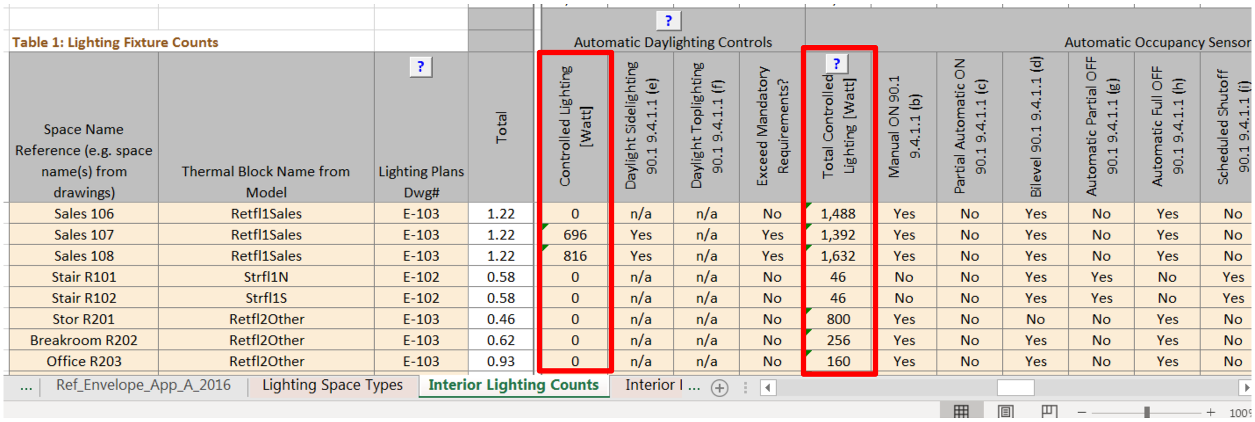


Table 1: Lighting Fixture Counts

				Automatic Daylighting Controls				Automatic Occupancy Sensor						
Space Name Reference (e.g. space name(s) from drawings)	Thermal Block Name from Model	Lighting Plans Dwg#	Total	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)
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.

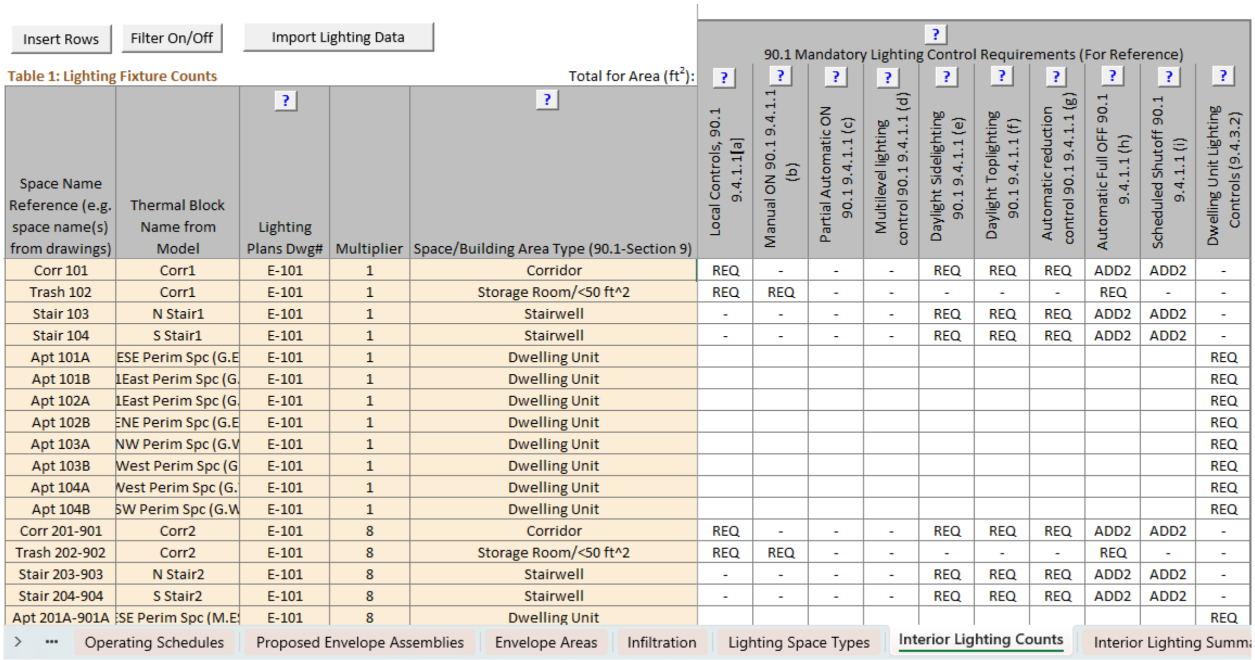


Table 1: Lighting Fixture Counts

Total for Area (ft²):

					90.1 Mandatory Lighting Control Requirements (For Reference)									
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)	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	1East Perim Spc (G.	E-101	1	Dwelling Unit										REQ
Apt 102A	1East Perim Spc (G.	E-101	1	Dwelling Unit										REQ
Apt 102B	ENE 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	Vest Perim Spc (G.	E-101	1	Dwelling Unit										REQ
Apt 104B	SW Perim Spc (G.W	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

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

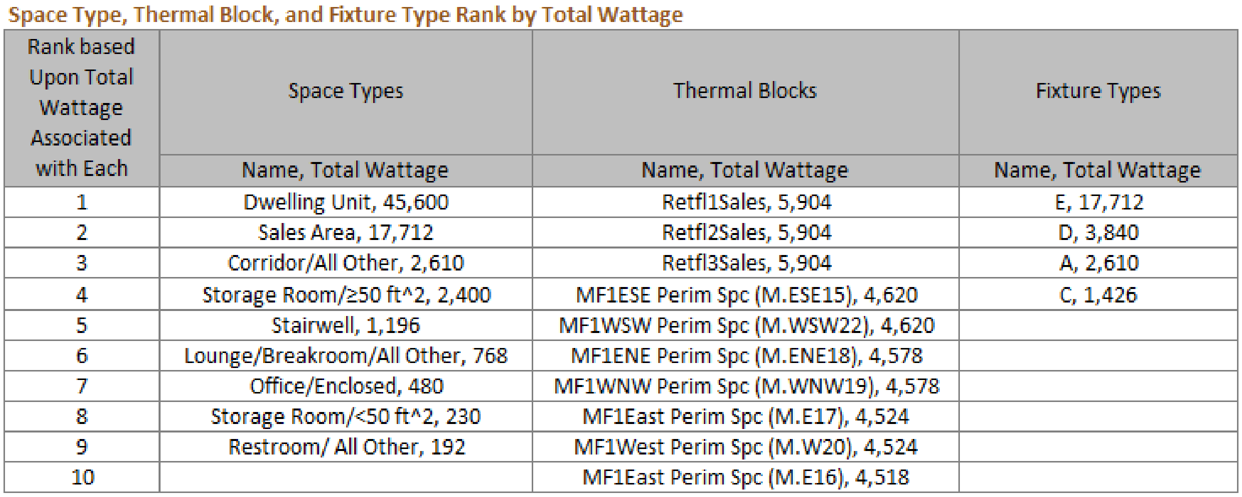
OpenStudio	eplustbl.html ‘Demand End Use Components Summary’ report, ‘End Uses’ section
Carrier HAP v5	“LEED Summary” report, Section 2, “Minimum Energy Performance Calculator”, table titled “Proposed Energy Summary by End Use”.
Design Builder	LEED Summary Reports in Output Summary Document

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.

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).

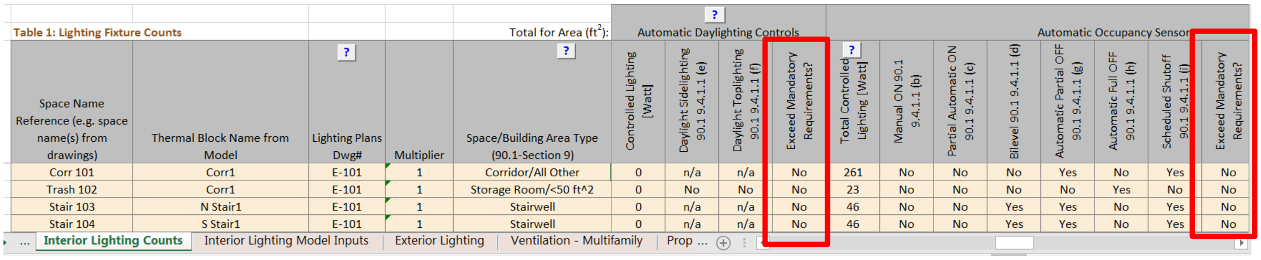


Table 1: Lighting Fixture Counts

Total for Area (ft²):

					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)	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?
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 ft^2 dormitory building includes 30,000 ft^2 of dorm rooms (dormitory living quarters space type) with 0.3 W/ ft^2 specified lighting and 30,000 ft^2 corridors (corridor space type) with 0.8 W/ ft^2 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/ ft^2 (90.1 Table 9.5.1). This LPD must be modeled for all spaces in the budget model. The proposed LPD is (30,000*0.3+30,000*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 ~ 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/ ft^2 for dormitory living quarters and 0.66 W/ ft^2 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*30,000*4+0.8*30,000*24*(1-0.25)/(0.54*30,000*4+0.66*30,000*24*(1-0.25)) ~ 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

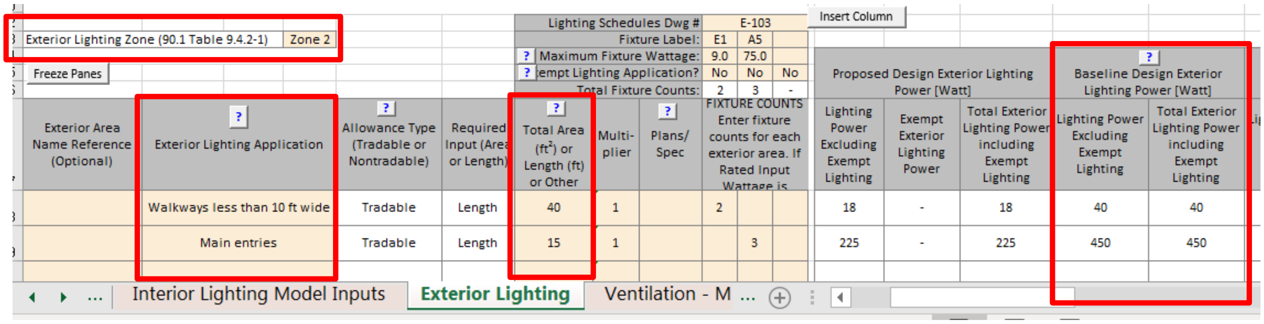
Same as the Table G3.1 No 6, Baseline Building Performance column requirements described above for the 90.1 2016 and 2019 PRM.

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 Lighting Zone (90.1 Table 9.4.2-1) Zone 2

Lighting Schedules Dwg # E-103

Fixture Label: E1 A5

Maximum Fixture Wattage: 9.0 75.0

empt Lighting Application? No No No

Total Fixture Counts: 2 3 -

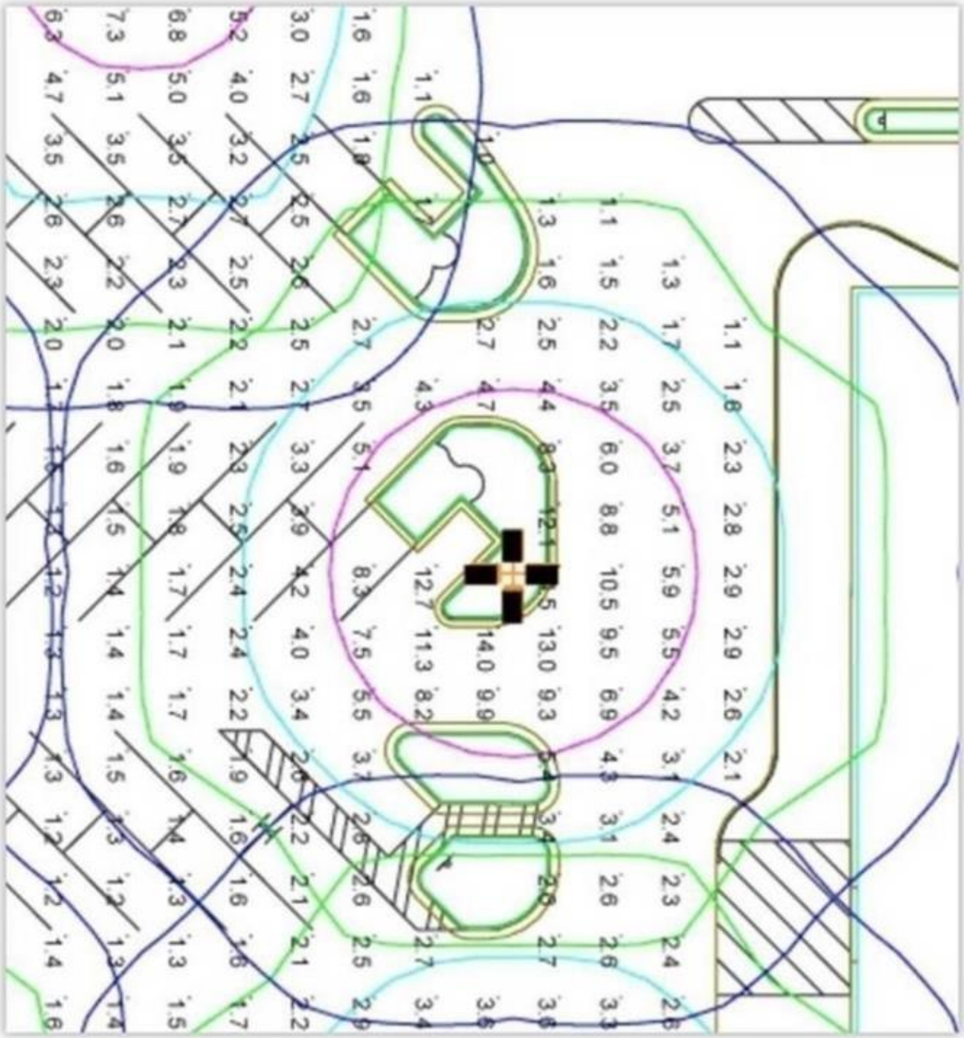
Exterior Area Name Reference (Optional)	Exterior Lighting Application	Allowance Type (Tradable or Nontradable)	Required Input (Are or Length)	Total Area (ft^2) or Length (ft) or Other	Multi-plier	Plans/ Spec	FIXTURE COUNTS Enter fixture counts for each exterior area. If Rated Input Wattage is			Proposed Design Exterior Lighting Power [Watt]: Lighting Power Excluding Exempt Lighting	Exempt Exterior Lighting Power	Total Exterior Lighting Power including Exempt Lighting	Baseline Design Exterior Lighting Power [Watt]: 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

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[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.

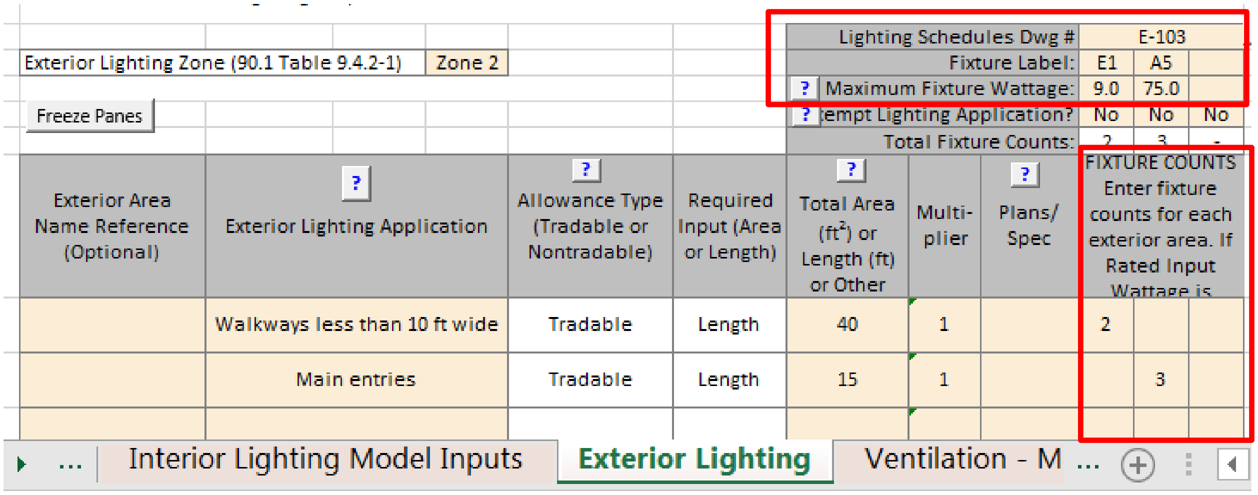
90.1 2016, 2019 and 2022 PRM

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 that 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.



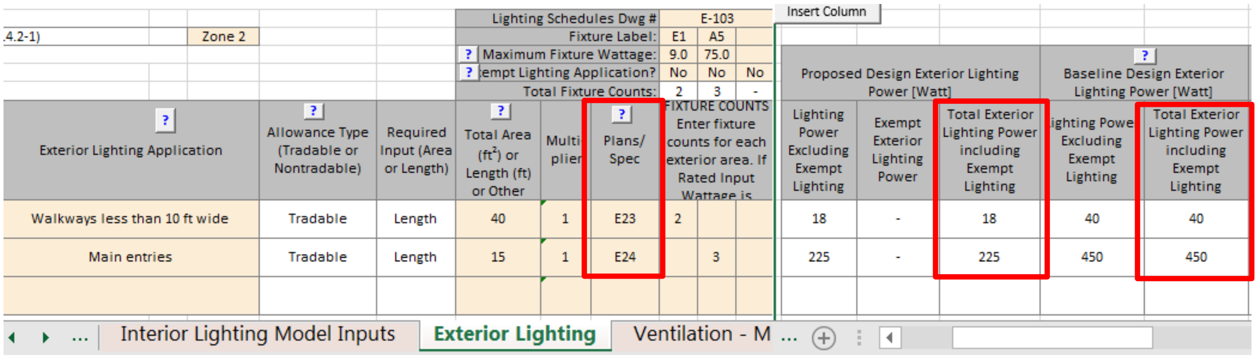
Exterior Lighting Zone (90.1 Table 9.4.2-1) | Zone 2

Lighting Schedules Dwg #: E-103
Fixture Label: E1 | A5
Maximum Fixture Wattage: 9.0 | 75.0
:empt Lighting Application?: No | 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 (ft²) or Length (ft) or Other	Multi-plier	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	

2. 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.

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. (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
Fixture Label: E1 | A5
Maximum Fixture Wattage: 9.0 | 75.0
:empt 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 (ft²) or Length (ft) or Other	Multi plier	Plans/ Spec	FIXTURE COUNTS Enter fixture counts for each exterior area. If Rated Input Wattage is			Proposed Design Exterior Lighting Power [Watt]: Lighting Power Excluding Exempt Lighting	Exempt Exterior Lighting Power	Total Exterior Lighting Power including Exempt Lighting	Baseline Design Exterior Lighting Power [Watt]: ighting Powe Excluding Exempt Lighting	Total Exterior Lighting Power including Exempt Lighting
Walkways less than 10 ft wide	Tradable	Length	40	1	E23	2			18	-	18	40	40
Main entries	Tradable	Length	15	1	E24		3		225	-	225	450	450

4. Common Mistakes
   a) Proposed fixture wattage is based on the specified lamps and not the manufacturer's labeled maximum wattage of the luminaire.
   b) 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

1. 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).

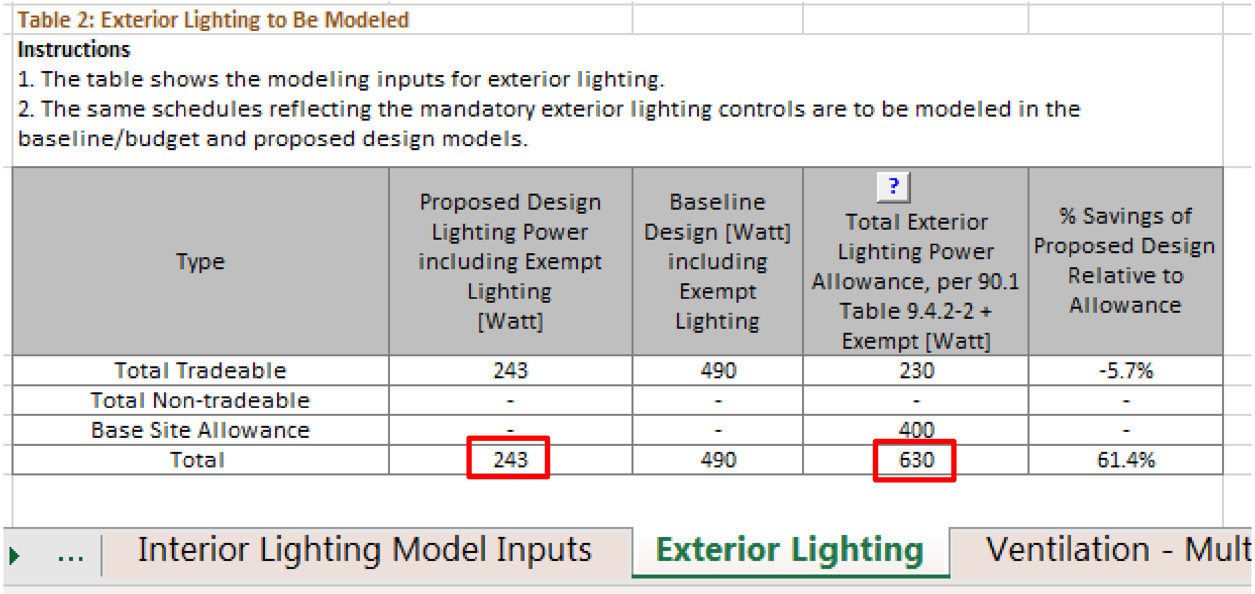


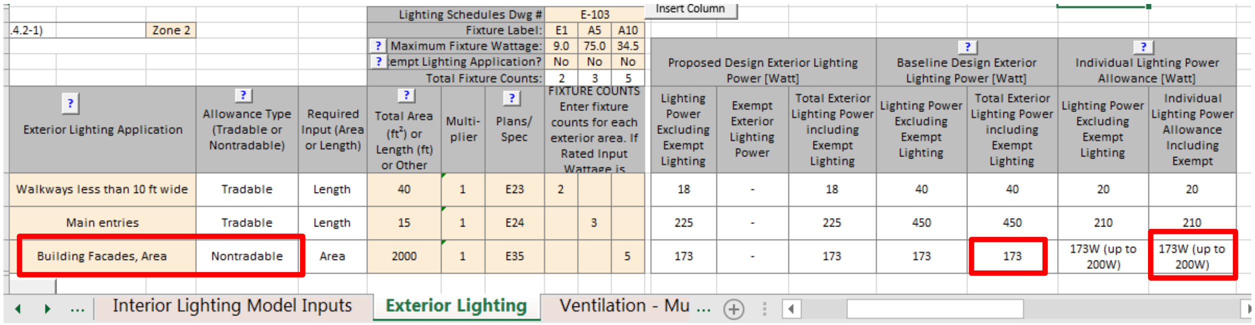
Table 2: Exterior Lighting to Be Modeled

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	? 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	-	-	-	-
Base Site Allowance	-	-	400	-
Total	243	490	630	61.4%

2. 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).



.4.2-1) Zone 2

					Lighting Schedules Dwg #	E-103									
					Fixture Label:	E1	A5	A10							
					? Maximum Fixture Wattage:	9.0	75.0	34.5							
					? empt 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]	
? 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 COUNTS Enter fixture counts for each exterior area. If Rated Input Wattage is			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)

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

Review Tips

1. 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).

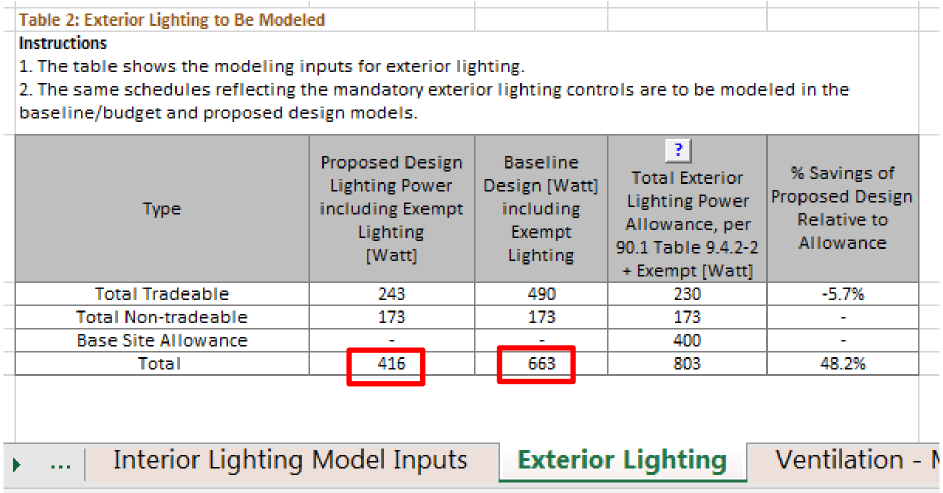


Table 2: Exterior Lighting to Be Modeled

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%

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 Budge 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 Budge 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 Budge 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 Budge 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.

Performance Rating Method : $LTW_{prop} / LTW_{base} = LEU_{prop} / LEU_{base}$
Energy Cost Budge Method : $LEU_{prop} = LEU_{budget}$

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	PP009-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

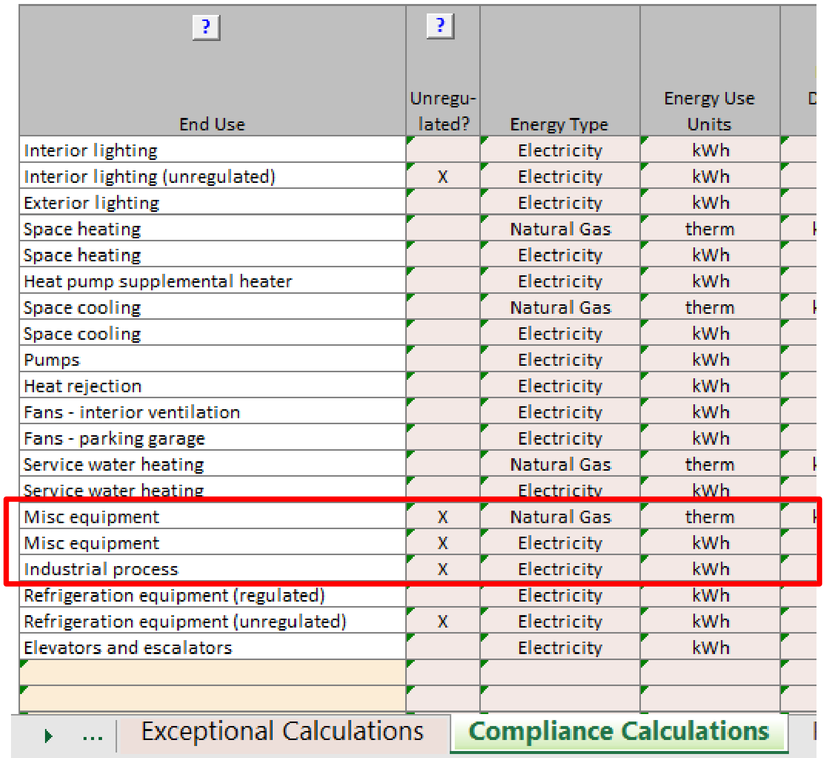
Review Tips

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 Budge 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	? Unregu-lated?	Energy Type	Energy Use Units	D
Interior lighting		Electricity	kWh	
Interior lighting (unregulated)	X	Electricity	kWh	
Exterior lighting		Electricity	kWh	
Space heating		Natural Gas	therm	k
Space heating		Electricity	kWh	
Heat pump supplemental heater		Electricity	kWh	
Space cooling		Natural Gas	therm	k
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	k
Service water heating		Electricity	kWh	
Misc equipment	X	Natural Gas	therm	k
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.

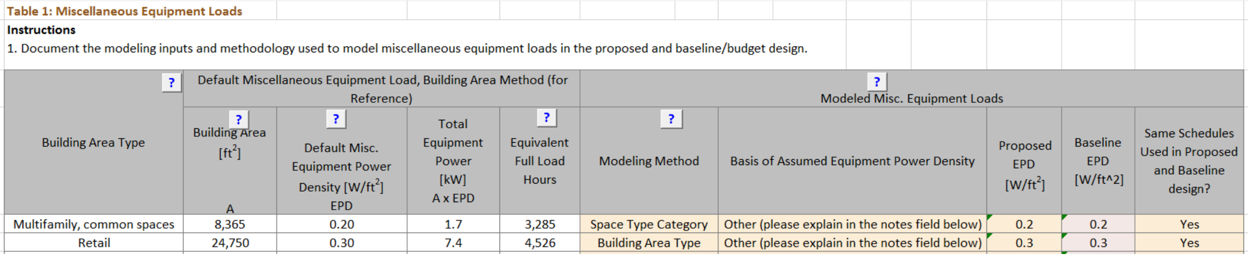


Table 1: Miscellaneous Equipment Loads

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] A	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.

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 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.

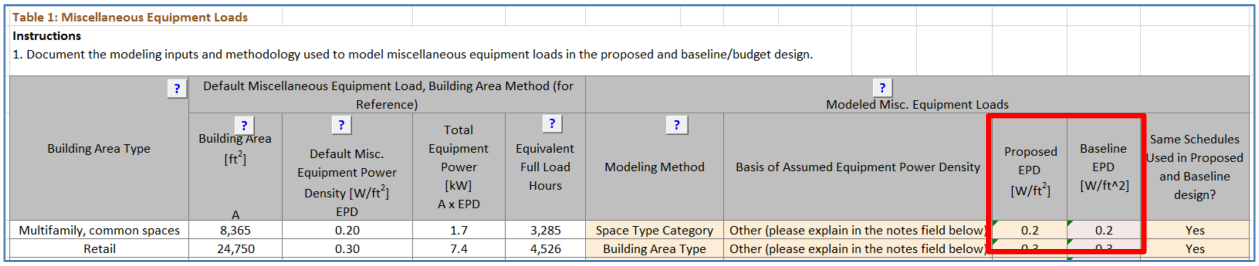
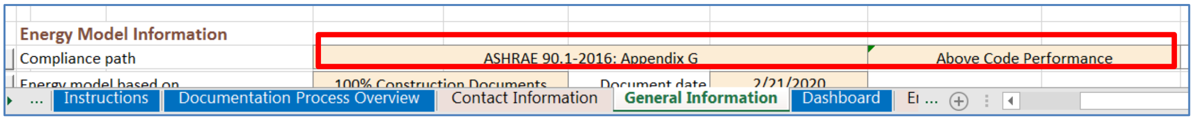


Table 1: Miscellaneous Equipment Loads

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 [ft²] A	Default Misc. Equipment Power Density [W/ft²] EPD	Total Equipment Power [kW] A x EPD	Equivalent Full Load Hours	Modeling Method	Basis of Assumed Equipment Power Density	Proposed EPD [W/ft²]	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



Energy Model Information				
Compliance path	ASHRAE 90.1-2016: Appendix G			Above Code Performance
Energy model based on	100% Construction Documents	Document date	2/21/2020	

2. 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

1. 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.

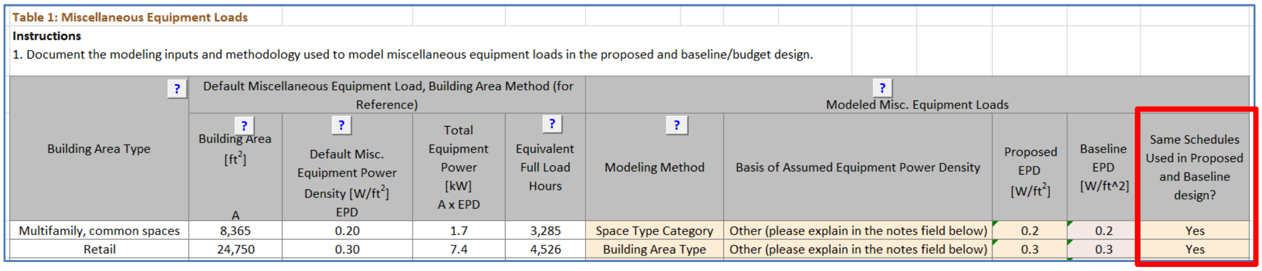


Table 1: Miscellaneous Equipment Loads

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] A	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. 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 listed above 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.

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.

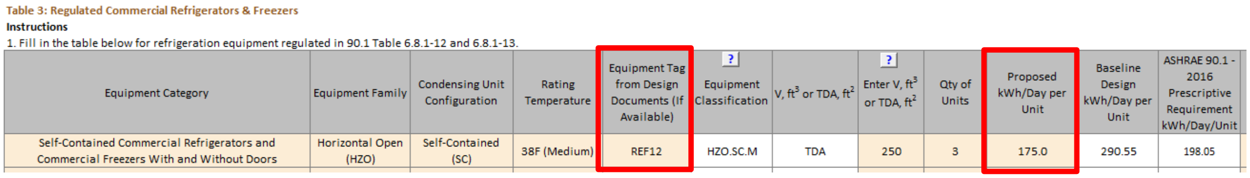


Table 3: Regulated Commercial Refrigerators & Freezers

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.

PPO05-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).

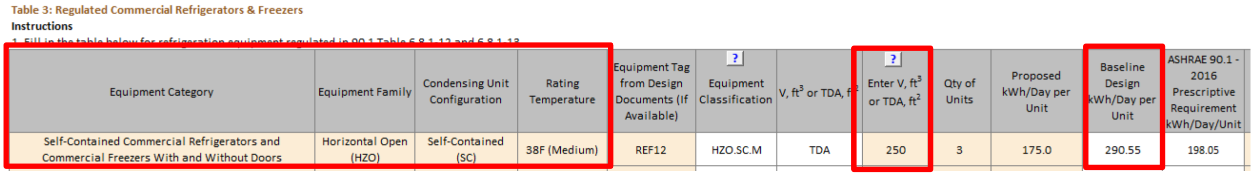


Table 3: Regulated Commercial Refrigerators & Freezers

Instructions

1. Fill in the table below for refrigeration equipment regulated in 90.1 Table 6.8.1-12 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, f	? 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. 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

1. 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).
2. Common Mistakes
    a) 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.)

    b) 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”.

    c) 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.

    d) Modeled energy use deviates from annual energy use inferred in kWh/Day efficiency ratings.

    e) Internal gains/losses to space where refrigeration systems are located are not modeled correctly. Refer to PNNL Performance Rating Method Reference Manual[18] 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

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

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[18] https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

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

<u>G3.2 New Construction/Major Alterations</u>

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 prosed 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.

PPO12 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

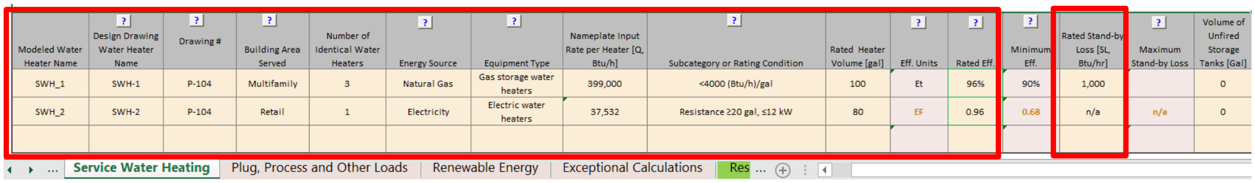
Table G3.1 #11, Proposed Building Performance

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 [Q, Btu/h]	Subcategory or Rating Condition	Rated Heater Volume [gal]	Eff. Units	Rated Eff.	Minimum Eff.	Rated Stand-by Loss [SL, 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 stand-by 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.

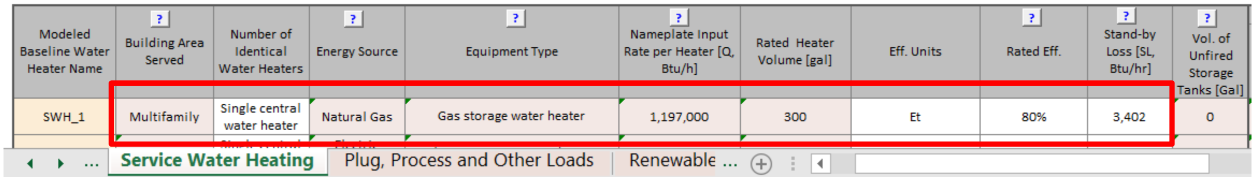
G3.3 Minor Alterations

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

2. 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

1. 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.
2. 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 Guidelines[19]. 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

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[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 (.xlsm)

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 (.xlsm)

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 (.xlsm)
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

Heading & 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.

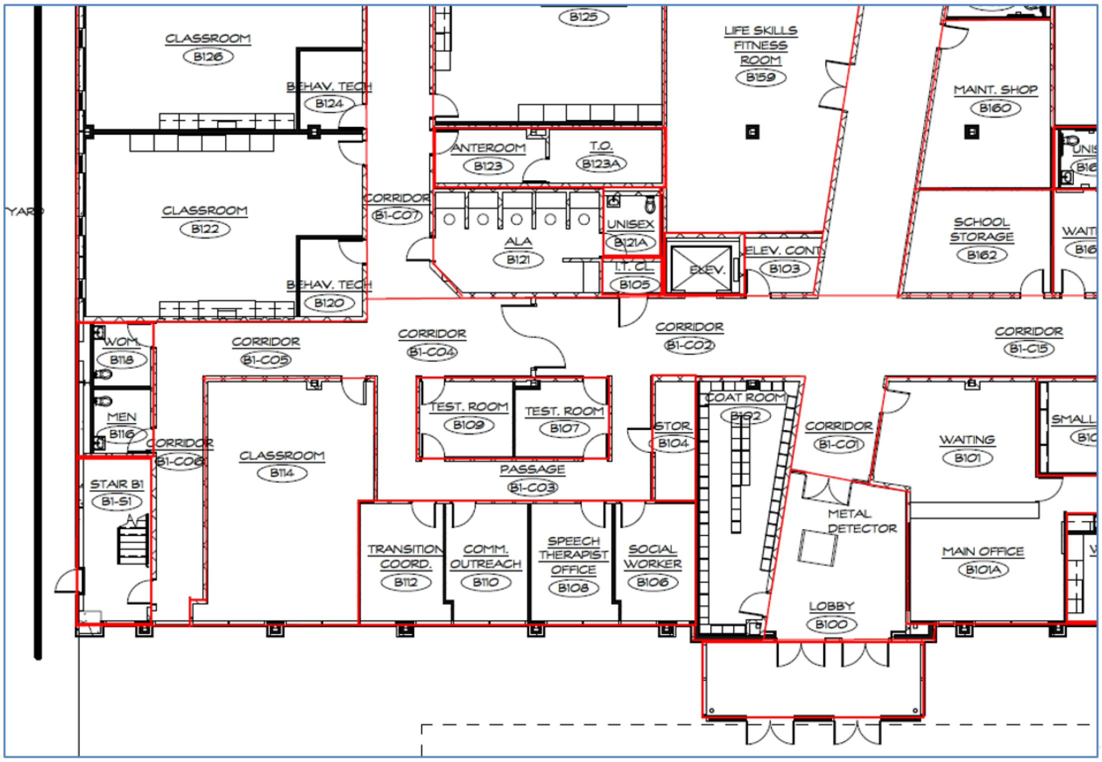
90.1 Table 11.5.1 #9/12.5.1 #9 and Table G3.1 #9

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.

3. 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 we correctly applied to the project.

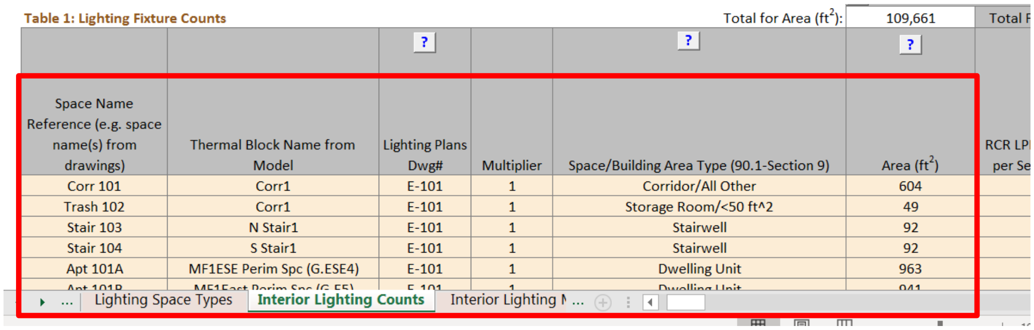
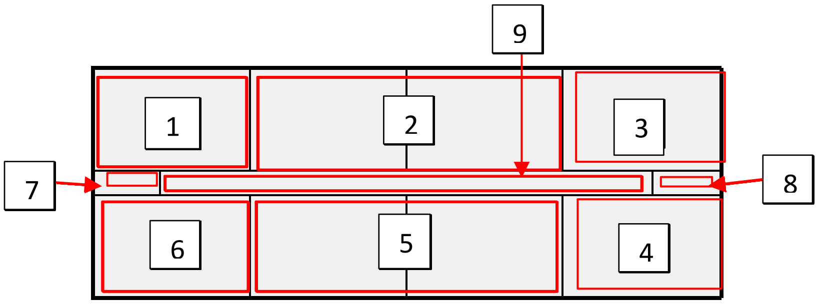


Table 1: Lighting Fixture Counts

Total for Area (ft^2): 109,661 | Total F

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 LPI per Se
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	MF1East Perim Spc (G.E5)	E-101	1	Dwelling Unit	941	

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 ft^2 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 ft^2
  System 12—SZ-CV-HW if >= 120,000 ft^2
- 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 ft^2
  System 5—Packaged VAV with reheat if 4 or 5 floors and <25,000 ft^2 or 5 floors or fewer and 25,000 ft^2 to 150,000 ft^2
  System 7—VAV with reheat if more than 5 floors or >150,000 ft^2

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 ft^2
  System 13—SZ-CV-ER if >= 120,000 ft^2

- 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 ft^2
  System 6—Packaged VAV with PFP boxes if 4 or 5 floors and <25,000 ft^2 or 5 floors or fewer and 25,000 ft2 to 150,000 ft^2
  System 8—VAV with PFP boxes if more than 5 floors or >150,000 ft^2

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 ft^2 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:

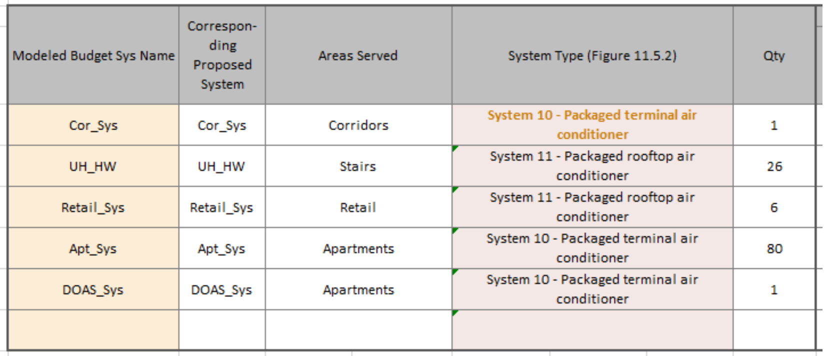
   a. Residential based on Section G3.2.1.1(a)
   b. Predominant nonresidential based on Section G3.2.1.1(b)
   c. Each additional nonresidential building area type with more than 20,000 ft^2 of combined area based on Section G3.2.1.1(a)

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

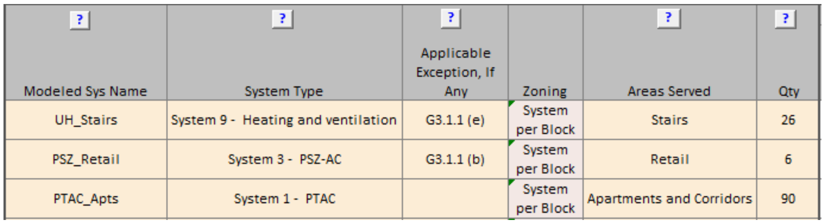
1. Budget HVAC system types are reported in Table 1a of the Budget HVAC ECB tab. Since ECB requires that each system in the proposed design has a corresponding budget system, the default budget system types are set in the table by applying the appropriate rules of ECB to each proposed system. The over-written defaults are shown in brown bold font and should be verified.



Modeled Budget Sys Name	Correspon-ding 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

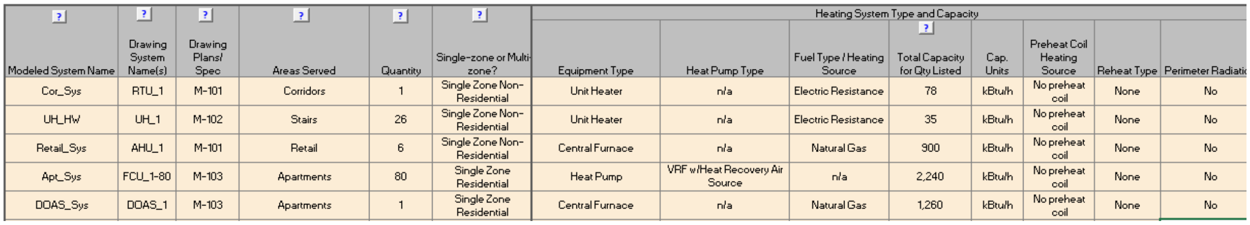
    a) Using incorrect “template” within the simulation tool to model specified system type, such as a constant volume system template to model a variable volume system.
    b) Omitting electric resistance space heaters and radiators from the model

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.



						Heating System Type and Capacity							
Modeled System Name	Drawing System Name(s)	Drawing Plans/ Spec	Areas Served	Quantity	Single-zone or Multi-zone?	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
UH_HW	UH_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	AHU_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	FCU_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 2016and 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

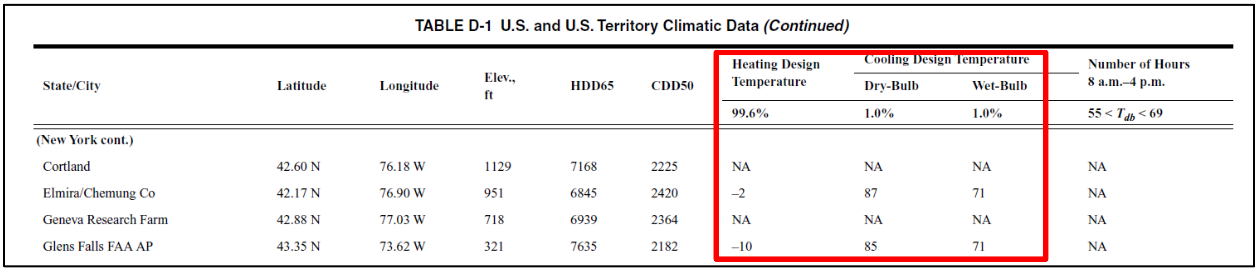


TABLE D-1 U.S. and U.S. Territory Climatic Data *(Continued)*

State/City	Latitude	Longitude	Elev., ft	HDD65	CDD50	Heating Design Temperature	Cooling Design Temperature		Number of Hours 8 a.m.–4 p.m.
							Dry-Bulb	Wet-Bulb	
						99.6%	1.0%	1.0%	$55 < T_{db} < 69$
(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

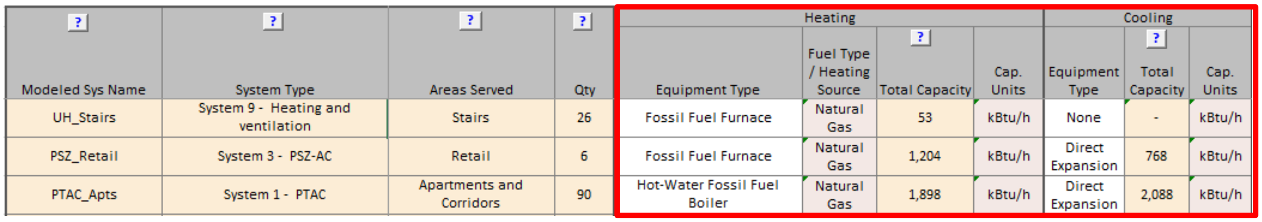
For the systems and equipment included in the scope of retrofit for alterations subject to 90.1 2022 Section G3.3 capacities for the baseline design are required to be sized proportionally to the capacities in the proposed design based on sizing runs—i.e., the ratio between the capacities used in the 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).



?	?	?	?	Heating				Cooling		
Modeled Sys Name	System Type	Areas Served	Qty	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 Thumb[20]

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

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[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 PRM budget systems and 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 EFHL 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.

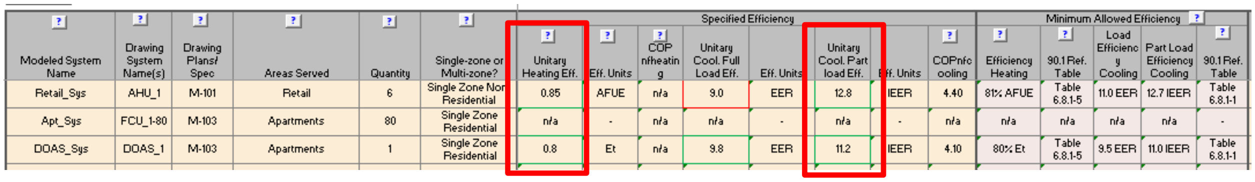
eQUEST Reports	LS-C (design conditions), SS-P (oversizing for baseline/budget systems), SV – A (modeled capacity)
Trane TRACE 700	System Information entered values report
Trane TRACE 3D Plus	System Component Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, System Loads Report, BPRM Report, 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 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.

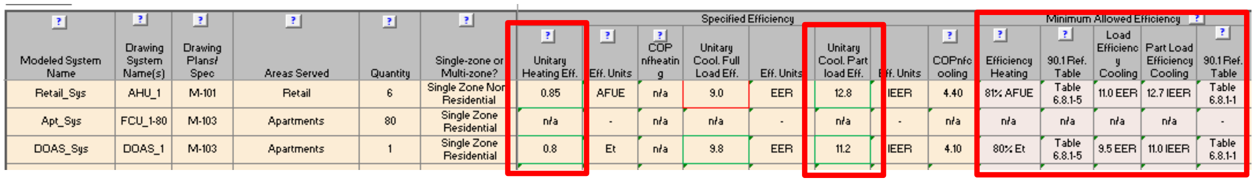


						Specified Efficiency								Minimum Allowed Efficiency				
Modeled System Name	Drawing System Name(s)	Drawing Plans/ Spec	Areas Served	Quantity	Single-zone or Multi-zone?	Unitary Heating Eff.	Eff. Units	COP nfheating	Unitary Cool. Full Load Eff.	Eff. Units	Unitary Cool. Part load Eff.	ff. Units	COPnfcooling	Efficiency Heating	90.1 Ref. Table	Load Efficiency Cooling	Part Load Efficiency Cooling	90.1 Ref. Table
Retail_Sys	AHU_1	M-101	Retail	6	Single Zone Nor Residential	0.85	AFUE	n/a	9.0	EER	12.8	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.



						Specified Efficiency								Minimum Allowed Efficiency				
Modeled System Name	Drawing System Name(s)	Drawing Plans/ Spec	Areas Served	Quantity	Single-zone or Multi-zone?	Unitary Heating Eff.	Eff. Units	COP nfheating	Unitary Cool. Full Load Eff.	Eff. Units	Unitary Cool. Part load Eff.	ff. Units	COPnfcooling	Efficiency Heating	90.1 Ref. Table	Load Efficiency Cooling	Part Load Efficiency Cooling	90.1 Ref. Table
Retail_Sys	AHU_1	M-101	Retail	6	Single Zone Nor Residential	0.85	AFUE	n/a	9.0	EER	12.8	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

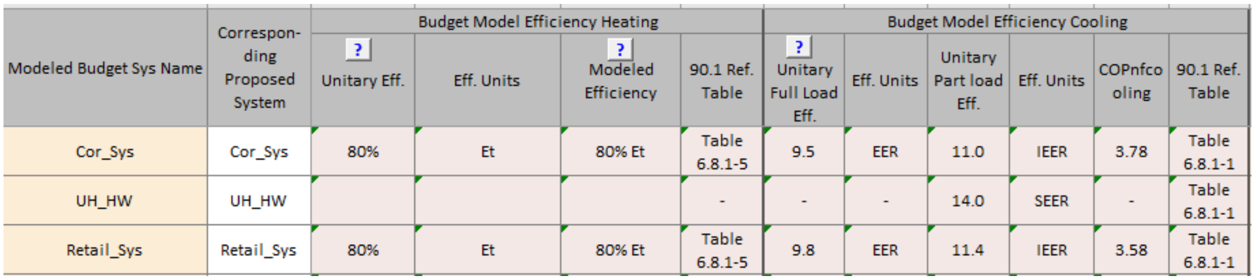
Requirements are the same as for the 90.1 2016 and 2019 PRM above.

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

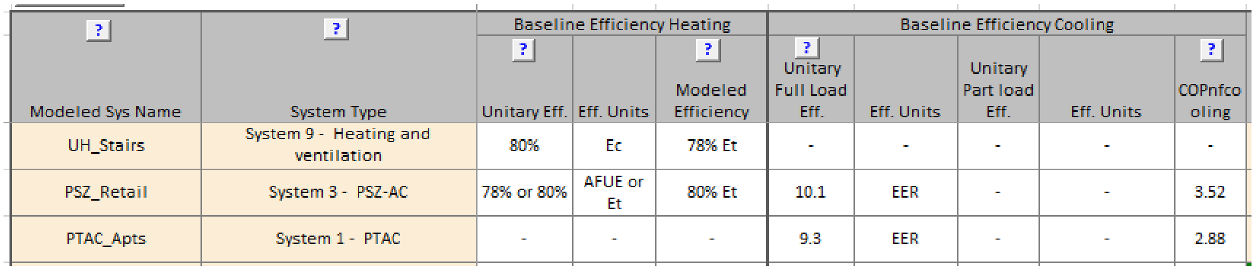
1. Heating and cooling system efficiencies are reported in Table 1a of the Budget HVAC ECB tab. The defaults are based on the efficiency tables referenced in "90.1 Ref Table" column. Any over-written defaults which are shown in brown font should be confirmed by the reviewer.



Modeled Budget Sys Name	Correspon-ding 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

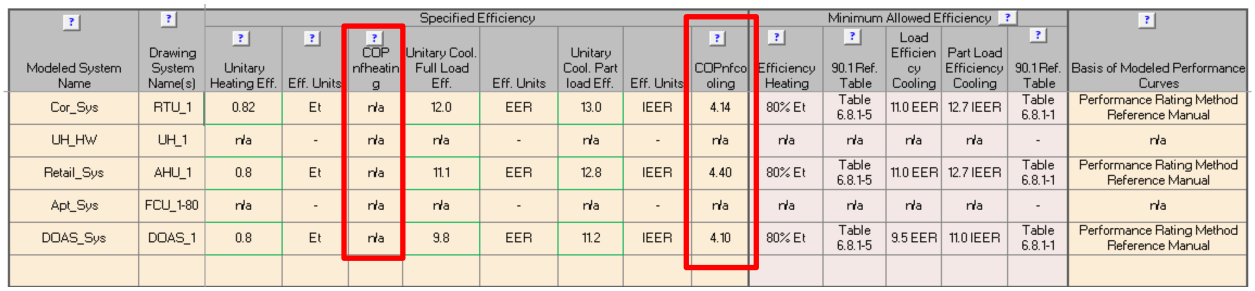
The modeled efficiency of the proposed systems must be adjusted to remove the supply fan energy corresponding to the conditions at which the unit was tested by the manufacturer. This requirement applies to all systems with a cooling efficiency rating expressed as EER and SEER. The cooling efficiency with the fan energy excluded is referred to as COPnfcooling must be calculated based on manufacturer data at AHRI Rating Conditions, as follows (see also the 90.1 User's Manual):

Indoor Fan Power [W] = (Gross Cooling [Btu/h]-Net Cooling [Btu/h])/3.413[Btu/h x W]

COPnfheating = Gross Heating [Btu/h]/(Total Input Power [W] - Indoor Fan Power [W]) x 3.413 [Btu/hx W])

Review Tips

1. COPnfcooling and COPnfheating 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.



		Specified Efficiency								Minimum Allowed Efficiency					
Modeled System Name	Drawing System Name(s)	Unitary Heating Eff.	Eff. Units	COP nfheating	Unitary Cool. Full Load Eff.	Eff. Units	Unitary Cool. Part load Eff.	Eff. Units	COPnfcooling	Efficiency Heating	90.1 Ref. Table	Load Efficiency Cooling	Part Load Efficiency Cooling	90.1 Ref. Table	Basis of Modeled Performance Curves
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	AHU_1	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

Indoor Fan Power [W]= (Gross Cooling [Btu/h] – Net Cooling [Btu/h])/3.413 [Btu/h x W]=
(103,000-99,000)/3.412=1,172 [W]

COP_{nfcool} = Gross Cooling [Btu/h] / ((System Power [W] – Indoor Fan Power[W])*3.412[Btu/h x 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.

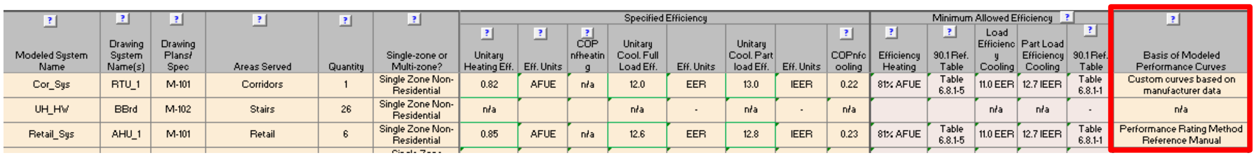
Review Tips

1. The appropriate simulation inputs for heating and cooling efficiency are automatically established and shown in the Modeled Efficiency and COPnfcooling 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.



						Specified Efficiency								Minimum Allowed Efficiency					
Modeled System Name	Drawing System Name(s)	Drawing Plans/ Spec	Areas Served	Quantity	Single-zone or Multi-zone?	Unitary Heating Eff.	Eff. Units	COP nfheating	Unitary Cool. Full Load Eff.	Eff. Units	Unitary Cool. Part load Eff.	Eff. Units	COPnfcooling	Efficiency Heating	90.1 Ref. Table	Load Efficiency Cooling	Part Load Efficiency Cooling	90.1 Ref. Table	Basis of Modeled Performance Curves
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	81% AFUE	Table 6.8.1-5	11.0 EER	12.7 IEER	Table 6.8.1-1	Custom curves based on manufacturer data
UH_HW	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	81% 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 Manual[21] (or latest available version) may be used.

2. 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

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 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 Manual[22] 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

1. Use simulation reports to spot-check that the modeled cooling and heating efficiencies is as reported for selected air-side systems as follows:
    a) $COP_{nfcooling}$ and $COP_{nfheating}$ 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 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:

$$Et=0.0051427 \times AFUE + 0.3989$$

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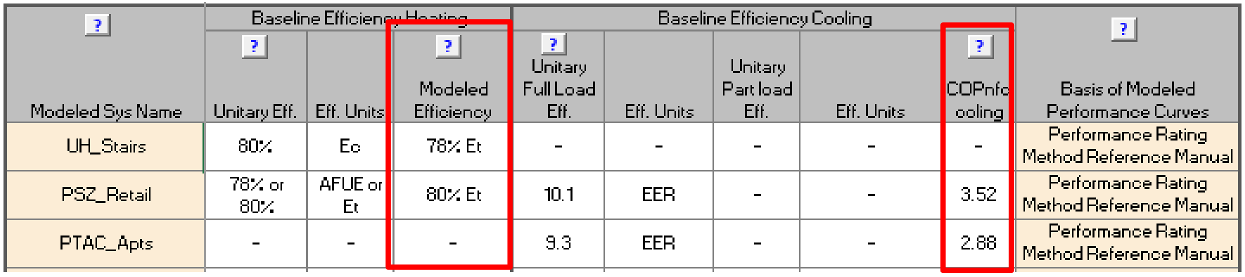
[21] https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

[22] https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

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.



	Baseline Efficiency Heating			Baseline Efficiency Cooling					
Modeled Sys Name	Unitary Eff.	Eff. Units	Modeled Efficiency	Unitary Full Load Eff.	Eff. Units	Unitary Part load Eff.	Eff. Units	COPnfc ooling	Basis of Modeled Performance Curves
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)

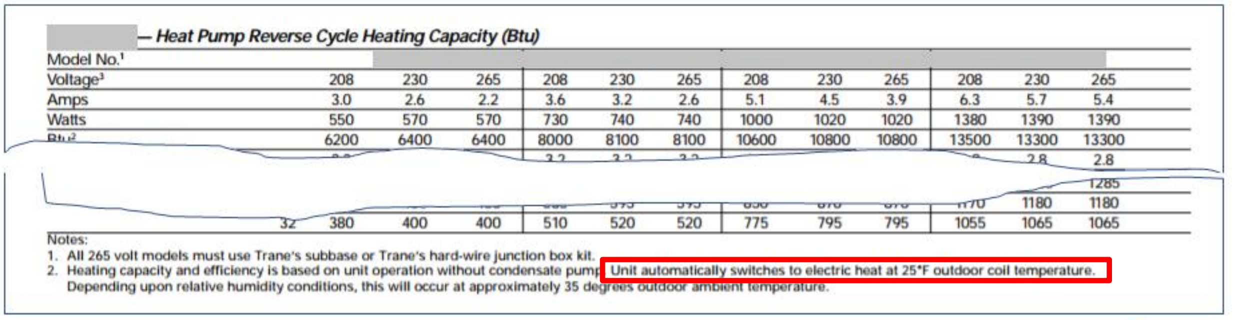
AHVAC12–B,P Annual average realized DX cooling and heating system efficiencies reflect expected performance at the range of actual conditions

Review Tips

1. 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.



[redacted] — ***Heat Pump Reverse Cycle Heating Capacity (Btu)***

Model No.[1]	[redacted]											
Voltage[3]	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[2]	6200	6400	6400	8000	8100	8100	10600	10800	10800	13500	13300	13300
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.8	2.8
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1285
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1180	1180
32	380	400	400	510	520	520	775	795	795	1055	1065	1065

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 Ec=80%, its Et = Ec – 2% = 78% and the average efficiency is expected to be ~ 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.

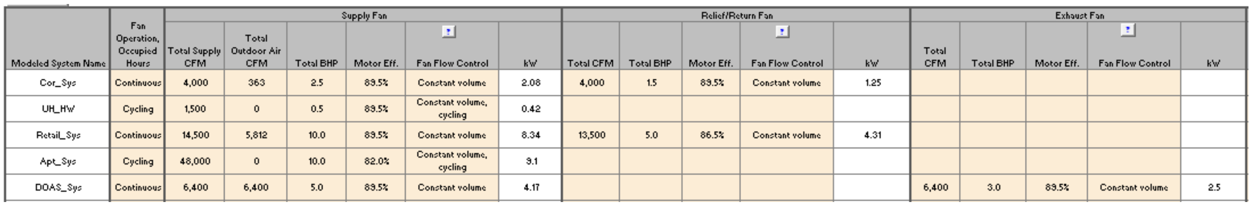
eQUEST Reports	SS-P, SV-A, PS-E (heat pump supplemental for electric meters and pump & aux column for fuel meters)
Trane TRACE 700	Equipment Energy Consumption report for the total equipment consumption and Building Cool/Heat Demand report from the Visualizer for the total loads
Trane TRACE 3D Plus	Site 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 (.xlsm)

AHVAC14-P Design supply, return, relief and exhaust fans' flow rates reported in the Compliance Form are as specified in the Design Documents

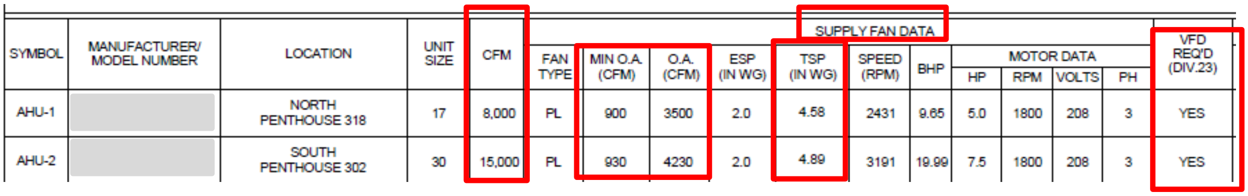
Review Tips

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.



		Supply Fan						Relief/Return Fan					Exhaust Fan				
Modeled System Name	Fan Operation, Occupied Hours	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_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	13,500	5.0	86.5%	Constant volume	4.31					
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						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	SUPPLY FAN DATA							MOTOR DATA				VFD REQ'D (DIV.23)
					FAN TYPE	MIN O.A. (CFM)	O.A. (CFM)	ESP (IN WG)	TSP (IN WG)	SPEED (RPM)	BHP	HP	RPM	VOLTS	PH	
AHU-1	[redacted]	NORTH PENTHOUSE 318	17	8,000	PL	900	3500	2.0	4.58	2431	9.65	5.0	1800	208	3	YES
AHU-2	[redacted]	SOUTH PENTHOUSE 302	30	15,000	PL	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

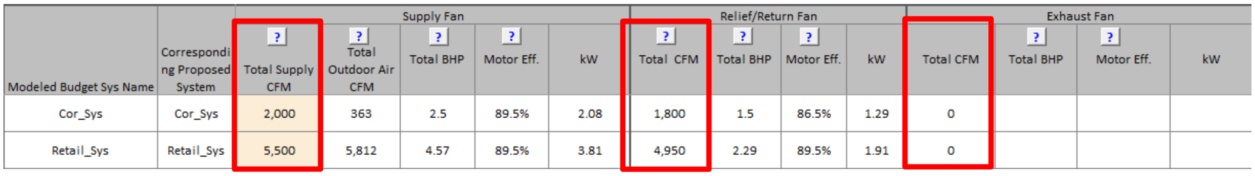
Section G3.2.2.7: Same as the requirement for the 90.1 2016 and 2019 PRM in Section G3.1.2.8.

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.



		Supply Fan					Relief/Return Fan				Exhaust Fan			
Modeled Budget Sys Name	Corresponding Proposed System	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 Rates[23]

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.
    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.,

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[23] ASHRAE Pocket Guide for Air Conditioning, Heating, Ventilation, Refrigeration (I-P Edition), 7th Edition

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 in Figure 39) 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

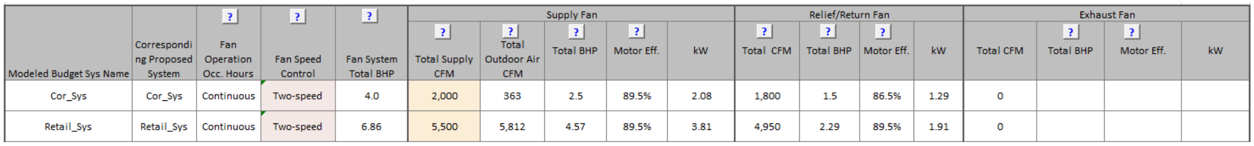
Requirements are the same as for the 90.1 2016 and 2019 PRM above.

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

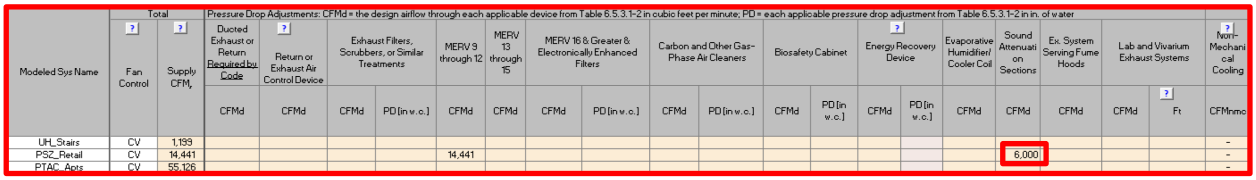
1. Fan power for individual HVAC systems in the budget design is included in Table 2a of the Budget HVAC ECB tab and is calculated automatically by applying the applicable 90.1 rules quoted above. The total budget power by fan type is shown in Table 3. Since these values are auto populated in the Compliance Form, they do not need to be checked.



					Supply Fan					Relief/Return Fan				Exhaust Fan			
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	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			

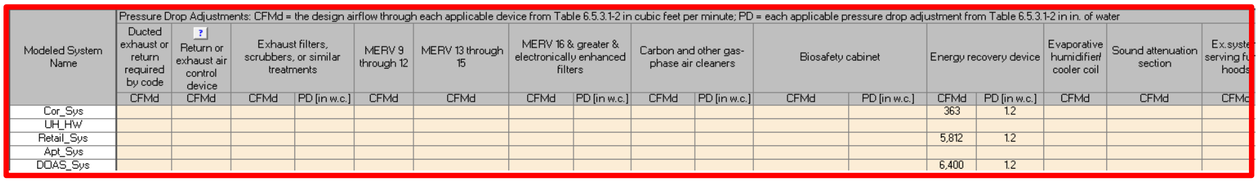
Review Tips – 90.1 PRM

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 specified only for some of the zones, CFM_D entered in the sound attenuation column must include only supply flow to these zones in the baseline design and not the total supply flow of the baseline system. Spot-check should focus on baseline systems with high CFM_D.



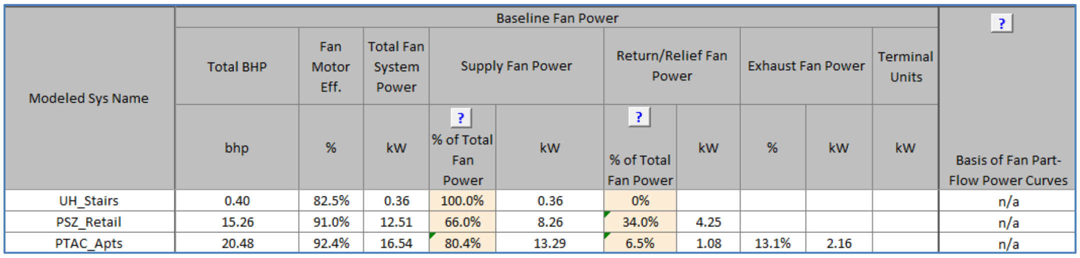
	Total		Pressure Drop Adjustments: CFMd = the design airflow through each applicable device from Table 6.5.3.1-2 in cubic feet per minute; PD = each applicable pressure drop adjustment from Table 6.5.3.1-2 in in. of water																			
Modeled Sys Name	Fan Control	Supply CFM,	Ducted Exhaust or Return Required by Code	Return or Exhaust Air Control Device	Exhaust Filters, Scrubbers, or Similar Treatments		MERV 9 through 12	MERV 13 through 15	MERV 16 & Greater & Electronically Enhanced Filters		Carbon and Other Gas-Phase Air Cleaners		Biosafety Cabinet		Energy Recovery Device		Evaporative Humidifier/ Cooler Coil	Sound Attenuation Sections	Ex. System Serving Fume Hoods	Lab and Vivarium Exhaust Systems		Non-Mechanical Cooling
			CFMd	CFMd	CFMd	PD [in w.c.]	CFMd	CFMd	CFMd	PD [in w.c.]	CFMd	PD [in w.c.]	CFMd	PD [in w.c.]	CFMd	PD [in w.c.]	CFMd	CFMd	CFMd	CFMd	Ft	CFMnmc
UH_Stairs	CV	1,199																				-
PSZ_Retail	CV	14,441					14,441											6,000				-
PTAC_Apts	CV	55,126																				-

Confirm that all devices included in Table 2a for the baseline are also included in the Proposed HVAC tab Table 3, and the total CFM$_D$ are similar between the baseline and proposed design except for energy recovery and ducted return as described in the Common Mistakes below.



Modeled System Name	Pressure Drop Adjustments: CFMd = the design airflow through each applicable device from Table 6.5.3.1-2 in cubic feet per minute; PD = each applicable pressure drop adjustment from Table 6.5.3.1-2 in in. of water																
	Ducted exhaust or return required by code	? Return or exhaust air control device	Exhaust filters, scrubbers, or similar treatments		MERV 9 through 12	MERV 13 through 15	MERV 16 & greater & electronically enhanced filters		Carbon and other gas-phase air cleaners		Biosafety cabinet		Energy recovery device		Evaporative humidifier/ cooler coil	Sound attenuation section	Ex.syste serving fu hoods
	CFMd	CFMd	CFMd	PD [in w.c.]	CFMd	CFMd	CFMd	PD [in w.c.]	CFMd	PD [in w.c.]	CFMd	PD [in w.c.]	CFMd	PD [in w.c.]	CFMd	CFMd	CFMc
Cor_Sys													363	1.2			
UH_HW																	
Retail_Sys													5,812	1.2			
Apt_Sys																	
DOAS_Sys													6,400	1.2			

3. The total design power of the baseline supply, return, relief and exhaust fans is shown in the second half of Table 2a of the Baseline HVAC App G. The total for all fans is calculated by applying the formulas in G3.1.2.9 to the user-specified supply flow rate accounting for the applicable pressure drop adjustments discussed above, and is allocated to the baseline supply, return, relief and exhaust fans based on user-entered values in the % of Total Fan Power columns for the corresponding fans.



Modeled Sys Name	Baseline Fan Power									?
	Total BHP	Fan Motor Eff.	Total Fan System Power	Supply Fan Power		Return/Relief Fan Power		Exhaust Fan Power		Terminal Units	
	bhp	%	kW	? % of Total Fan Power	kW	? % of Total Fan Power	kW	%	kW	kW	Basis of Fan Part-Flow Power Curves
UH_Stairs	0.40	82.5%	0.36	100.0%	0.36	0%					n/a
PSZ_Retail	15.26	91.0%	12.51	66.0%	8.26	34.0%	4.25				n/a
PTAC_Apts	20.48	92.4%	16.54	80.4%	13.29	6.5%	1.08	13.1%	2.16		n/a

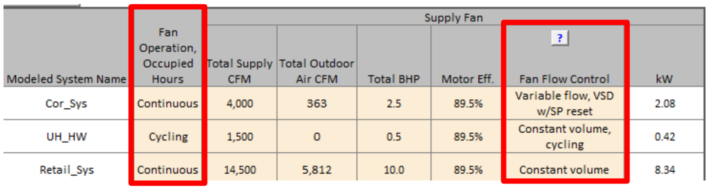
Optionally, cross-check user-specified allocation of fan power between supply, return/relief and exhaust fans for a sample of systems to verify consistency with how the fan power is allocated to these fans in the proposed design.

4. Common Mistakes for the PRM (excluding alterations subject to 90.1 2022 G3.3)
   a. CFM$_D$ is entered as a baseline system pressure drop adjustment in Table 2a for systems that have exhaust air energy recovery in the proposed design, but no exhaust air energy recovery in the baseline. Based on Table G3.1.2.9 Note 2, the pressure drop credit may only be claimed when the baseline system has energy recovery.
   b. CFM$_D$ is entered in Table 2a for the baseline systems that have ducted return in the proposed design, but the ducted return is not required by applicable code. In these cases, baseline should be assumed to have no ducted return.
   c. Power of exhaust or DOAS fans specified in the proposed design is added to the baseline fan power allowance determined following 90.1 Section G3.1.2.9. Instead, the baseline fan power allowance is inclusive of all baseline fans.

AHVAC16-P Air flow and supply temperature controls reported in the Compliance Form for the proposed design are as specified in the design documents

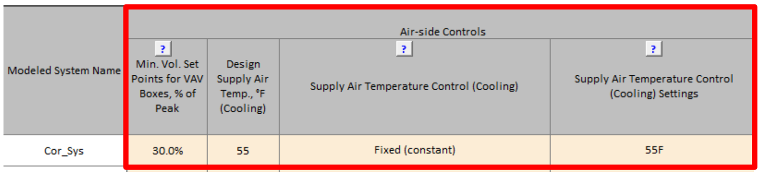
Review Tips

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					
		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%	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)	Supply Air Temperature Control (Cooling) Settings
Cor_Sys	30.0%	55	Fixed (constant)	55F

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.

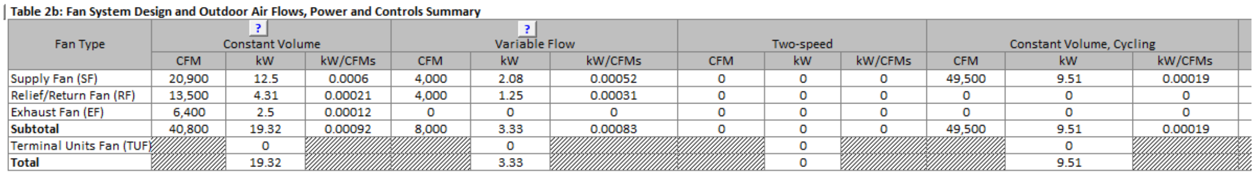


Table 2b: Fan System Design and Outdoor Air Flows, Power and Controls Summary

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

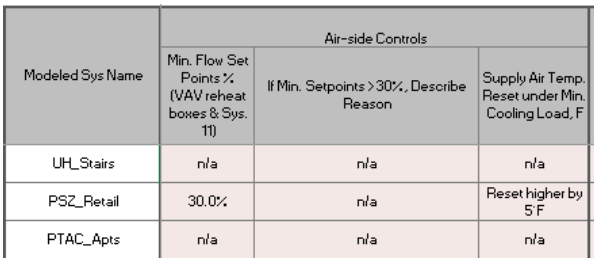
Table G3.2.3.15 and Section G3.2.3.12 requirements are the same as for the analogous sections in the 90.1 2016 and 2019 PRM as described above.

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 strategy[24].

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[24] https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

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
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

1. 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.
   a. For the constant volume systems, the peak demand is equal to the design fan kW.
   b. 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).

2. 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).

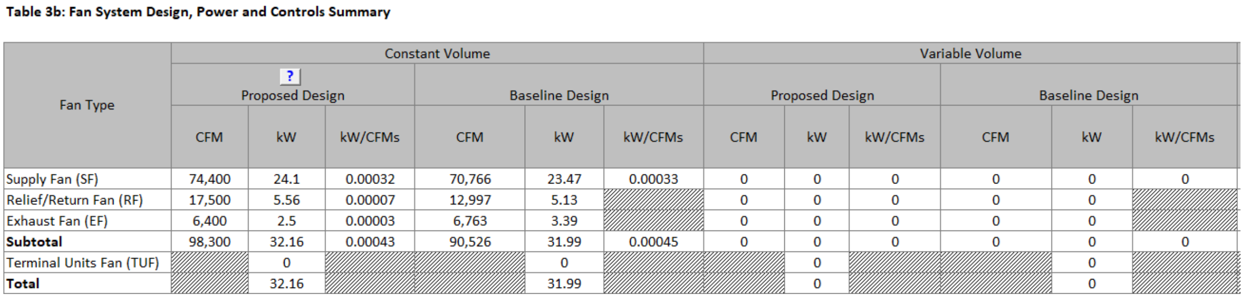


Table 3b: Fan System Design, Power and Controls Summary

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

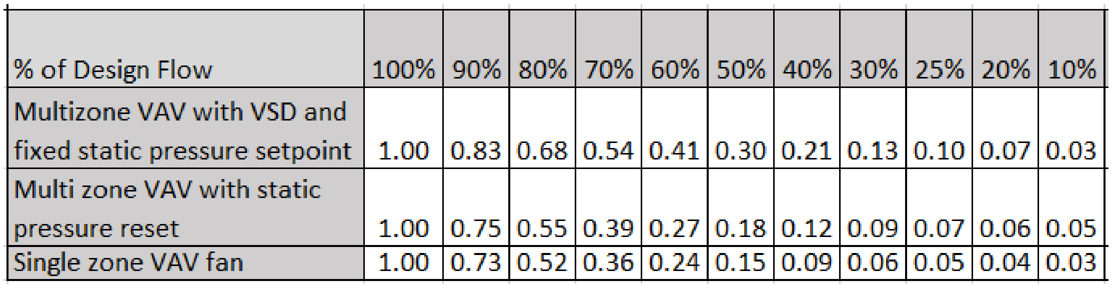
AHVAC20–B, P Modeled equivalent full load hours of the ventilation fans are as expected.

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.

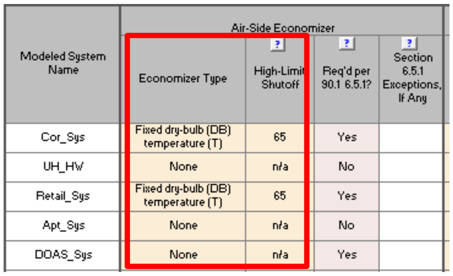
3. Calculate EFLH for a for a sample of proposed systems with high fan power reported in Table 2a of the Proposed HVAC tab and check for the patterns described for the baseline/budget systems. The proposed fan system EFLH that are lower than expected should be flagged. Common mistakes include the following:
    - 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 kWs: "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

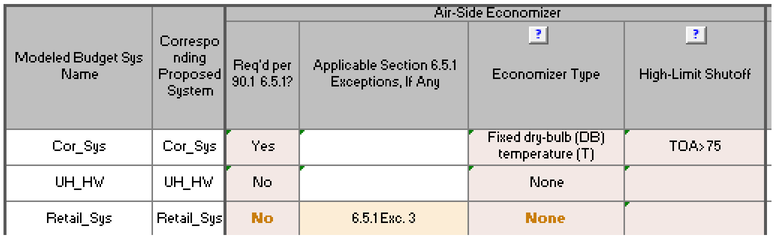
Sections G3.2.2.5, G3.2.2.6 requirements are the same as for the 90.1 2016 and 2019 PRM described above.

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).



		Air-Side Economizer			
Modeled Budget Sys Name	Corresponding Proposed System	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)	TOA>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

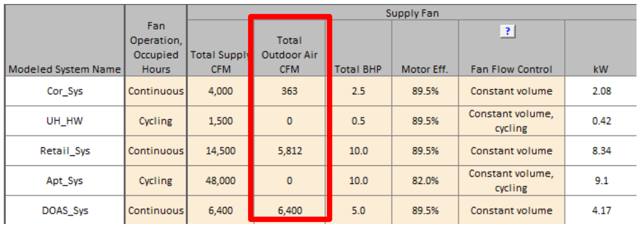
Review simulation reports to verify that air-side economizer is modeled as reported in the Compliance Form.

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.



		Supply Fan					
Modeled System Name	Fan Operation, Occupied Hours	Total Suppl 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 ft^2 or less (90.1 Section G3.1.2.5 Exception 1).
   b) The proposed system has zone air distribution effectiveness Ez > 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

<u>G3.2 New Construction/Major Alterations</u>

90.1 Section G3.2.4: Requirements are the same as the 90.1 2016 and 2019 PRM described above.

<u>G3.3 Minor Alterations</u>

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.

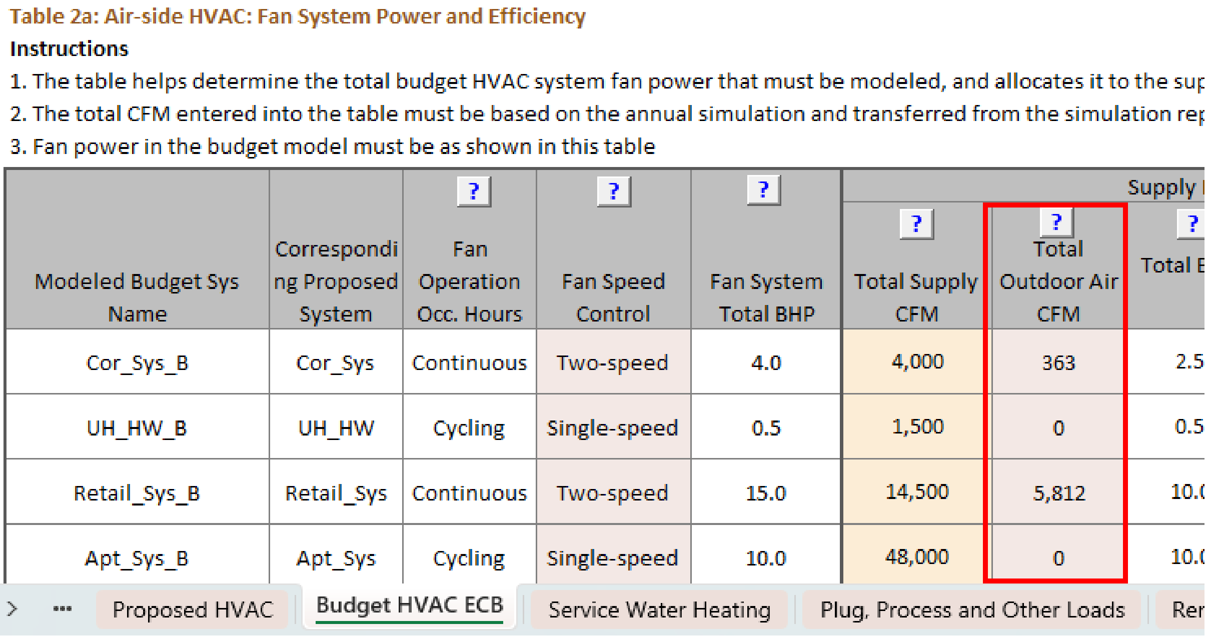


Table 2a: Air-side HVAC: Fan System Power and Efficiency

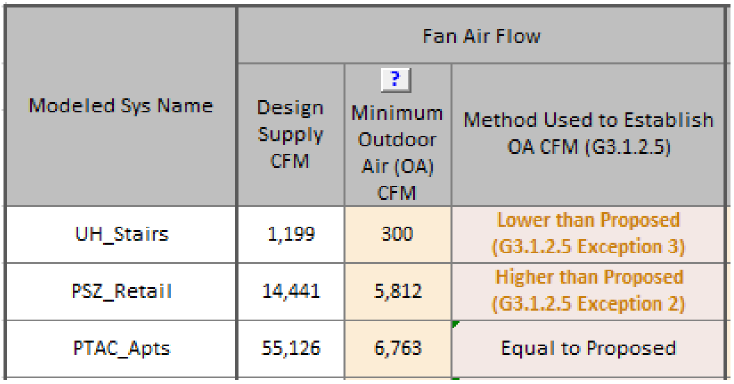
Instructions

1. The table helps determine the total budget HVAC system fan power that must be modeled, and allocates it to the sup
2. The total CFM entered into the table must be based on the annual simulation and transferred from the simulation rep
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	Supply		
					Total Supply CFM	Total Outdoor Air CFM	Total E
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.(
Apt_Sys_B	Apt_Sys	Cycling	Single-speed	10.0	48,000	0	10.(

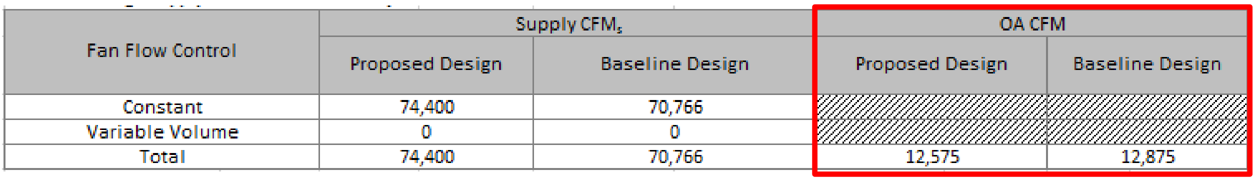
Review Tips - 90.1 PRM

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 are 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

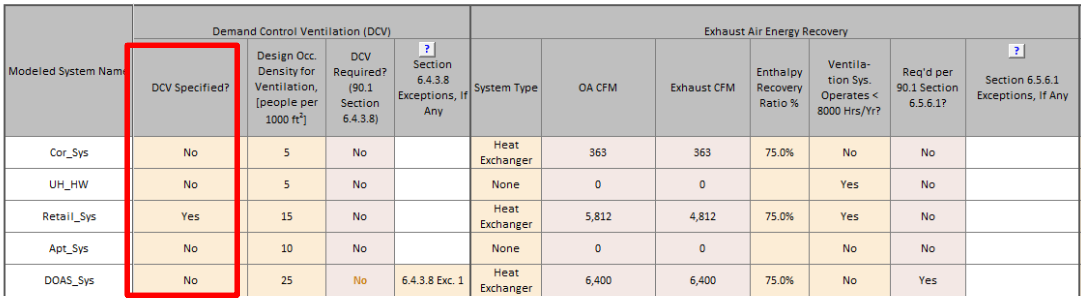
4. Common Mistakes

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/ft^2. If the specified ventilation exceeds this minimum, the ventilation rate in the baseline design must be modeled as 0.06 CFM/ft^2. 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 %	Ventila-tion 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.

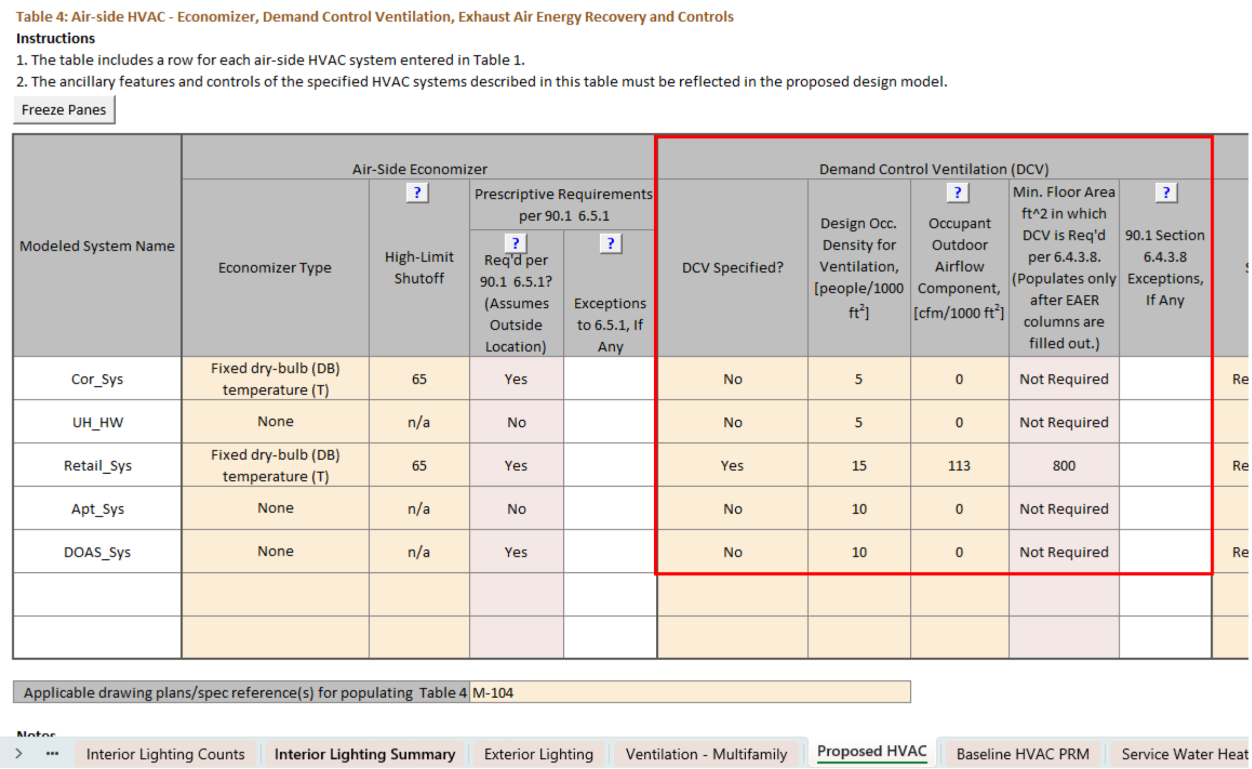


Table 4: Air-side HVAC - Economizer, Demand Control Ventilation, Exhaust Air Energy Recovery and Controls

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.

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		Re
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		Re
Apt_Sys	None	n/a	No		No	10	0	Not Required		
DOAS_Sys	None	n/a	Yes		No	10	0	Not Required		Re

Applicable drawing plans/spec reference(s) for populating Table 4	M-104

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

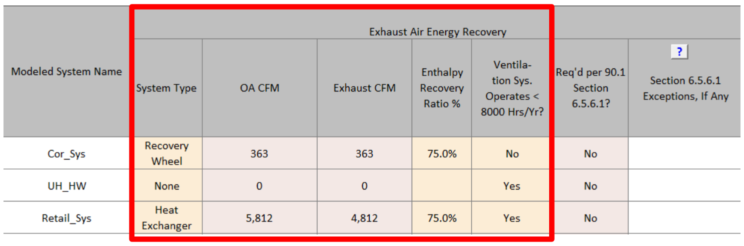
2. Spot-check a sample of air-side HVAC systems to confirm that the minimum design ventilation rate CFM and DCV controls are modeled as reported in the Compliance Form for the corresponding systems.

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 %	Ventila-tion 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 (.xlsm)

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. <u>Background</u>

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/ft^2 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

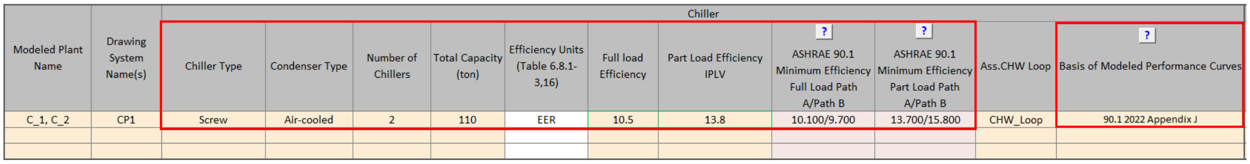
🟩 PASS/FAIL/NA outcome is determined automatically in the Quality Control Checks tab of the Compliance Form

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.

2. 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

3. 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.
4. 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:
    a) 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)
    b) PNNL Performance Rating Method Reference Manual
    c) 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

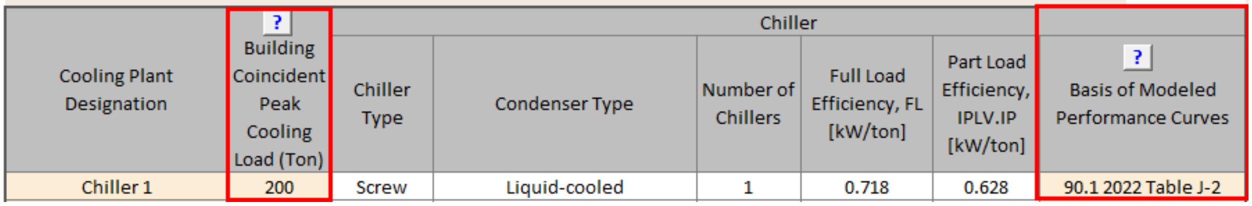
Section G3.2.3.7 requirements are similar to the requirement described above for the 90.1 2016 and 2019 PRM except that G3.2.2.1 now prescribes that the sets of performance curves specified in Appendix J Table J-2 should be used to represent part-load performance of chillers in the baseline building 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

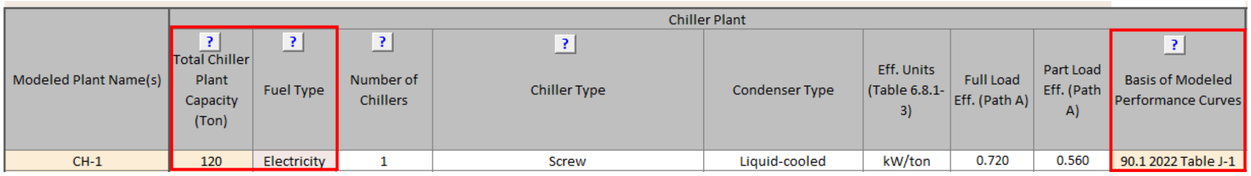
1. Refer to 90.1 2022 Section G3.3 Performance Calculations for Other Alterations for review tips for alterations subject to 90.1 2022 Section G3.3 (i.e., Minor alterations).
2. Baseline chillers are shown in Table 4a on the Baseline HVAC PRM tab. User inputs are limited to the building peak cooling 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	? Building Coincident Peak Cooling Load (Ton)	Chiller						? Basis of Modeled Performance Curves
		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.



Modeled Plant Name(s)	Chiller Plant								
	? 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.

   EER = COP*3.412
   EER = 12/ [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)

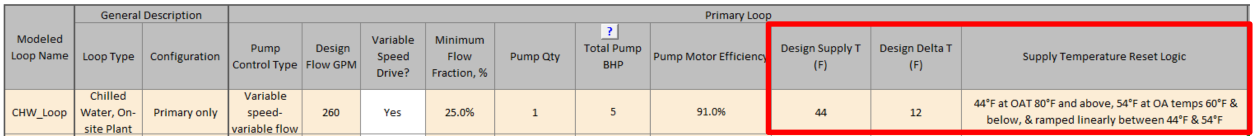
    b) Incorrect rated full load efficiency input
    c) Incorrect CHW loop controls such as design supply water temperature and temperature drop
    d) Chiller operating conditions are significantly different from AHRI rated conditions.
2. The following should be flagged as it may result in overly optimistic 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									
	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)	Design Delta T (F)	Supply Temperature Reset Logic
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

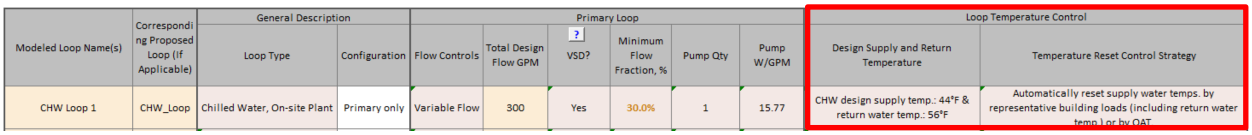
Section G3.2.3.8 and Section G3.2.3.9 requirements are the same as described above for the 90.1 2016 and 2019 PRM.

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

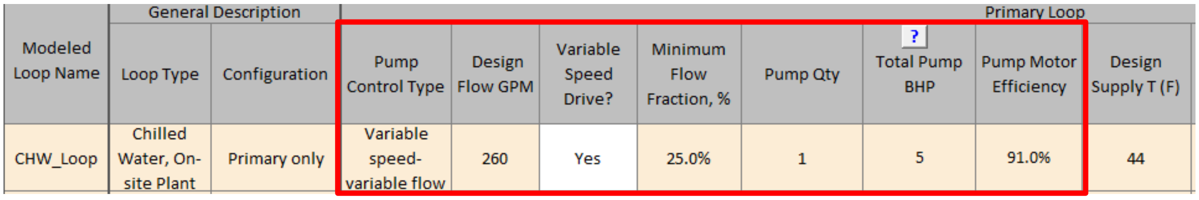
Use simulation reports to verify that the modeled chilled water loop configuration (i.e. primary/secondary) and temperature controls are modeled as reported in the Compliance Form.

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.)

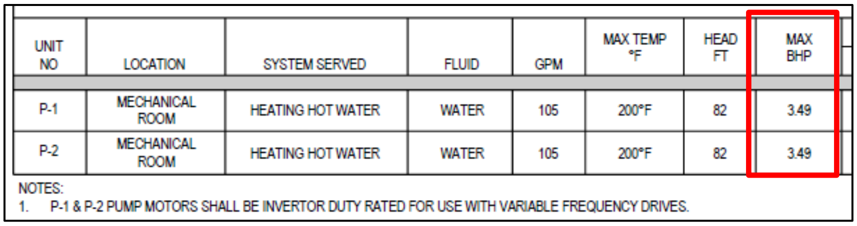


Modeled Loop Name	General Description		Primary Loop							
	Loop Type	Configuration	Pump Control Type	Design Flow GPM	Variable Speed Drive?	Minimum Flow Fraction, %	Pump Qty	? Total Pump BHP	Pump Motor Efficiency	Design Supply T (F)
CHW_Loop	Chilled Water, On-site Plant	Primary only	Variable speed-variable 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.

Pump Power [W] = BHP*746 / 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

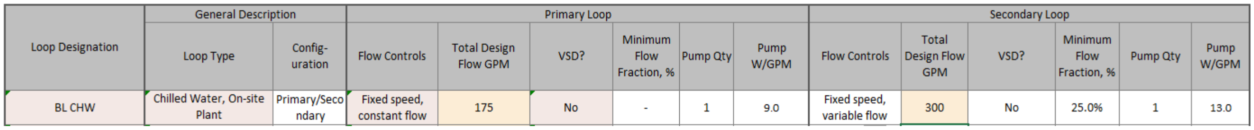
Section G3.2.3.10 requirements are the same as described above for the 90.1 2016 and 2019 PRM Section G3.1.3.10.

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

1. 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	Config-uration	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

1. 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

1. 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_{pump}/P_{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:

PEU= P_{design} * Avg% * 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

2. 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 (.xlsm)

WHVAC10–P Proposed heat rejection system reported in the Compliance Form reflects design documents

Review Tips

1. 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.
2. 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

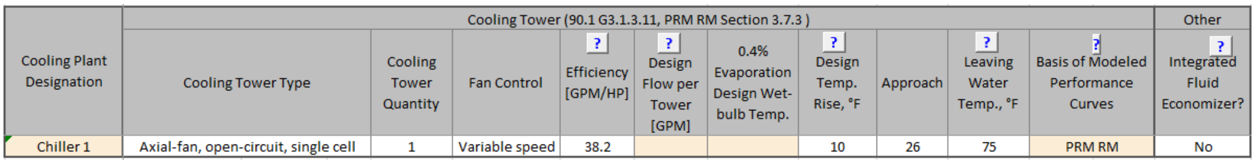
Section G3.2.3.11: Requirements are the same as described above for 90.1 2016 and 2019 PRM Section G3.1.3.11.

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.

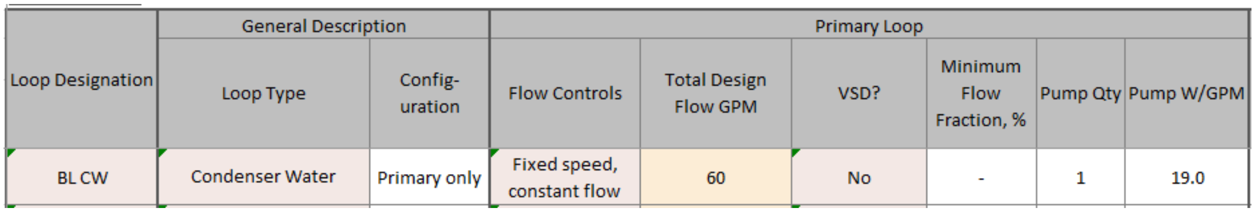
Review Tips – PRM

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 Tower (90.1 G3.1.3.11, PRM RM Section 3.7.3)										Other
Cooling Plant Designation	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

3. 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.



	General Description		Primary Loop					
Loop Designation	Loop Type	Config-uration	Flow Controls	Total Design Flow GPM	VSD?	Minimum Flow Fraction, %	Pump Qty	Pump W/GPM
BL CW	Condenser Water	Primary only	Fixed speed, constant flow	60	No	-	1	19.0

Review Tips – ECB

1. 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

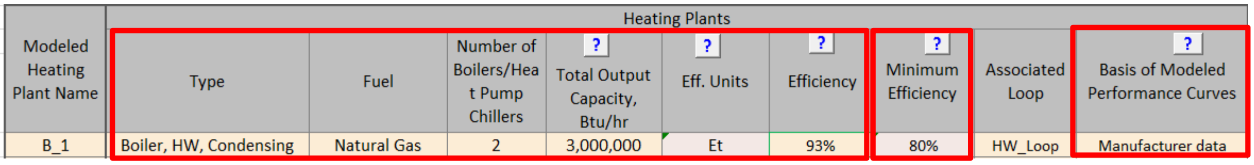
Verify that modeled parameters of the heat rejection system(s) are as reported in the Compliance Form.

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

1. Specified space heating boilers are reported in Table 7a of the Proposed HVAC tab.
2. 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.



	Heating Plants								
Modeled Heating Plant Name	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 spacy 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 ft^2 or less and with two equally sized boilers for plants serving more than 15,000 ft^2. The boilers must be staged as required by the load.

90.1 2022 PRM

<u>G3.2 New Construction/Major Alterations</u>

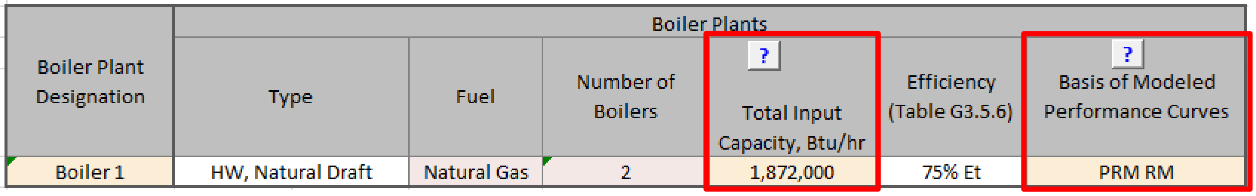
Section G3.2.3.2 requirements are the same as described above for the 90.1 2016 and 2019 PRM Section G3.1.3.2.

<u>G3.3 Minor Alterations</u>

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%<=AFUE<80%: Et=0.1xAFUE+72.5%
    all other: Et=0.875 x AFUE + 10.5%
b. From Ec to Et: Et=Ec-2%

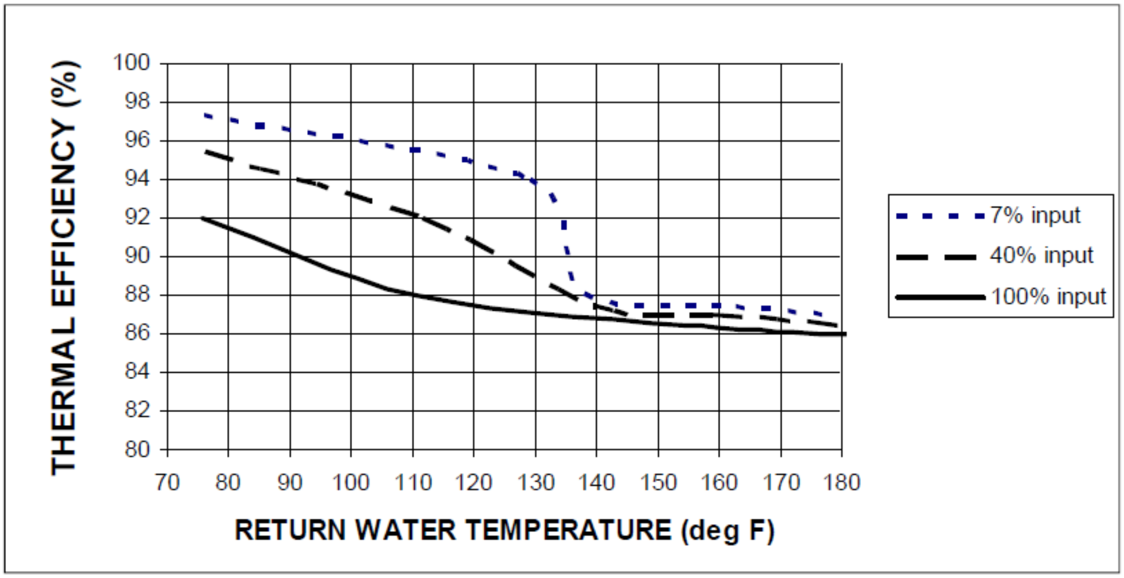
eQUEST Reports	PV-A
Trane TRACE 700	Plant Information entered values report
Trane TRACE 3D Plus	System Component Summary report
IESVE SOFTWARE	Plant Loops & Equipment Report, BPRM Report, Detailed Simulation Report, Florida Energy Code Compliance Report
EnergyPlus	eplustbl.html ‘Equipment Summary’ report, ‘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 (.xlsm)

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%

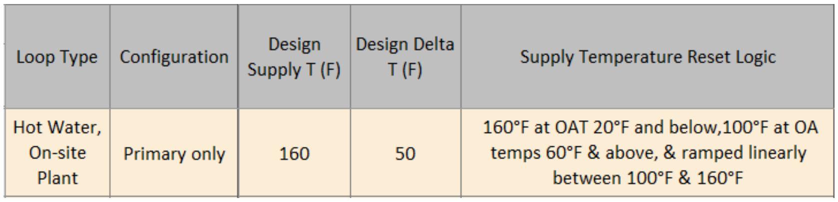
Note 1: All ECB budget boilers and PRM baseline boilers with heating capacity over 2,500 kBtu/h or under 300 kBtu/h
Note 2: PRM baseline boilers with 300 kBtu/h – 2,500 kBtu/h

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 (.xlsm)

WHVAC15-P Proposed hot water loop configuration temperature controls reported in the Compliance Form reflect design documents

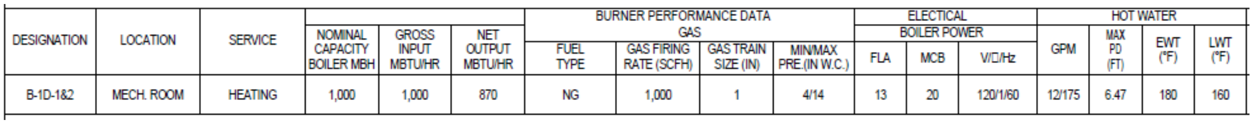
Review Tips

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. **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).



						BURNER PERFORMANCE DATA				ELECTICAL			HOT WATER			
						GAS				BOILER POWER						
DESIGNATION	LOCATION	SERVICE	NOMINAL CAPACITY BOILER MBH	GROSS INPUT MBTU/HR	NET OUTPUT MBTU/HR	FUEL TYPE	GAS FIRING RATE (SCFH)	GAS TRAIN SIZE (IN)	MIN/MAX PRE.(IN W.C.)	FLA	MCB	V/□/Hz	GPM	MAX PD (FT)	EWT (°F)	LWT (°F)
B-1D-1&2	MECH. ROOM	HEATING	1,000	1,000	870	NG	1,000	1	4/14	13	20	120/1/60	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 ft^2 or more must be modeled with variable-speed drives and systems serving less than 120,000 ft^2 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 (.xlsm)
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 in 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)

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%/°F; performance shall be based on a reference temperature of 77°F and irradiance of 317 Btu/ft^2·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 following 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?

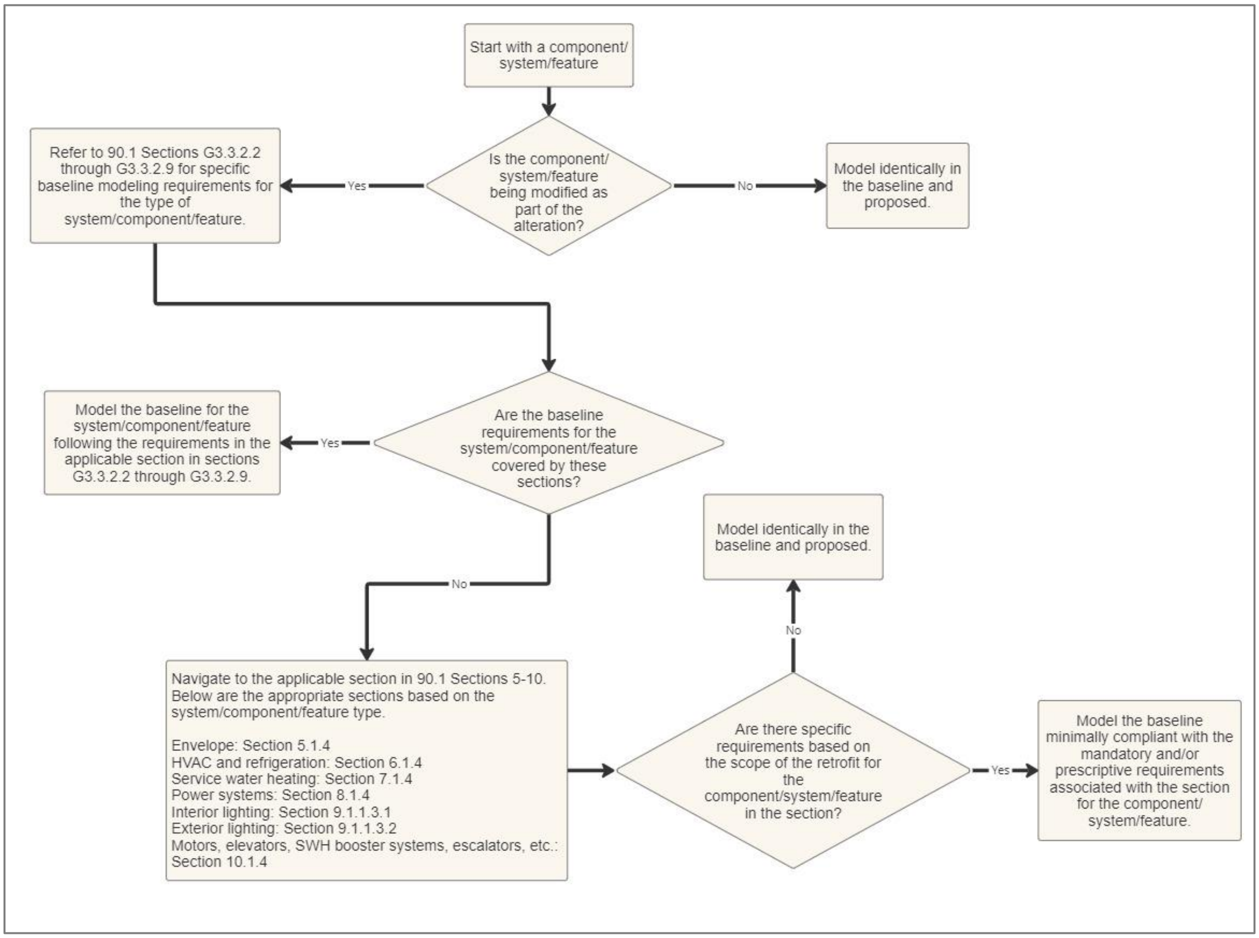
Answer: G3.3 because it only meets the criteria associated with G3.1.4a #1. To be required to follow G3.2 the project would need to meet two or more of the scenarios described in G3.1.4a #s 1-3 and it only meets one.

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 models[10] (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.

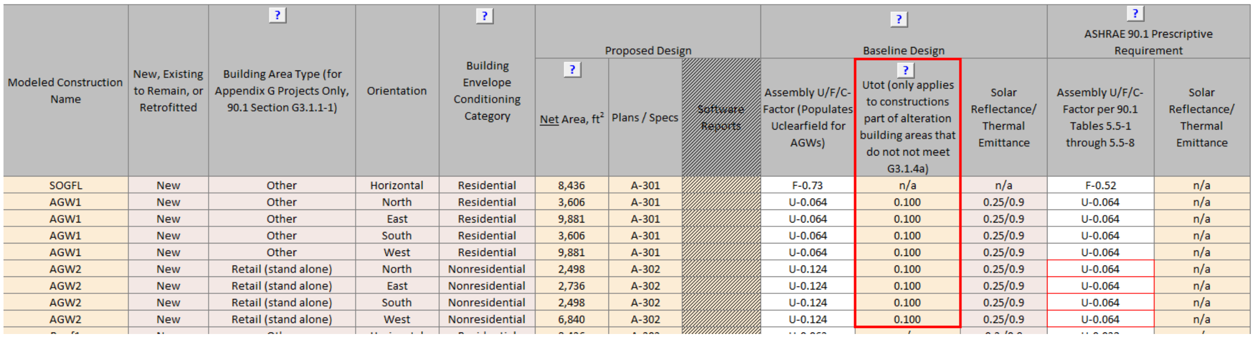
A note of caution for projects that include alterations subject to 90.1 Section G3.3: Because alterations following 90.1 Section G3.3 are minor alterations, and many systems and components may be modeled with existing conditions in the proposed per the requirements of 90.1 G3.3.1b, the project may significantly 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 models[10] (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 deviant 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.



		?		?	Proposed Design			? Baseline Design			? ASHRAE 90.1 Prescriptive Requirement	
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	? Net Area, ft^2	Plans / Specs	Software Reports	Assembly U/F/C-Factor (Populates Uclearfield for AGWs)	? Utot (only applies to constructions part of alteration building areas that do not 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.

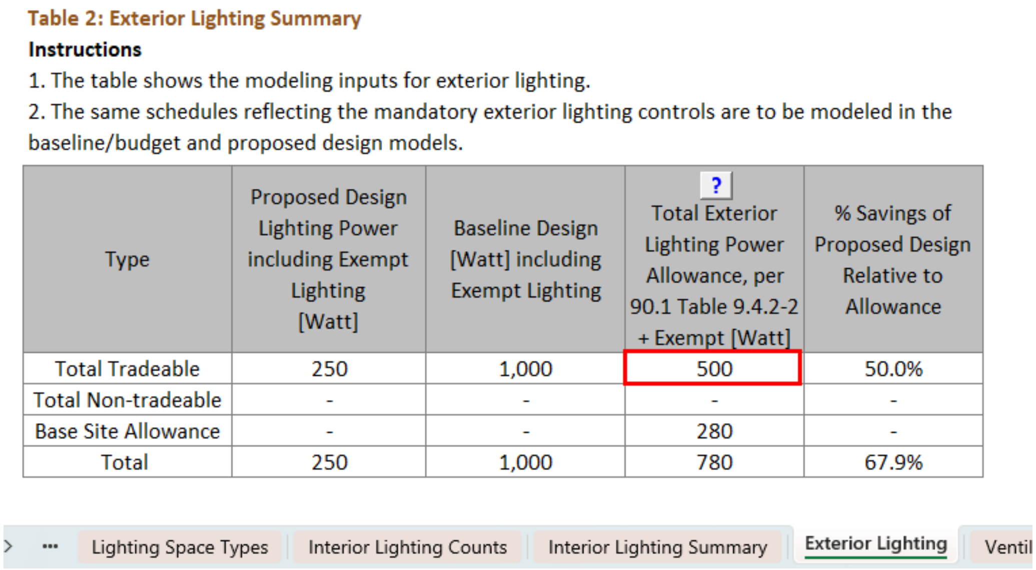


Table 2: Exterior Lighting Summary

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%

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.

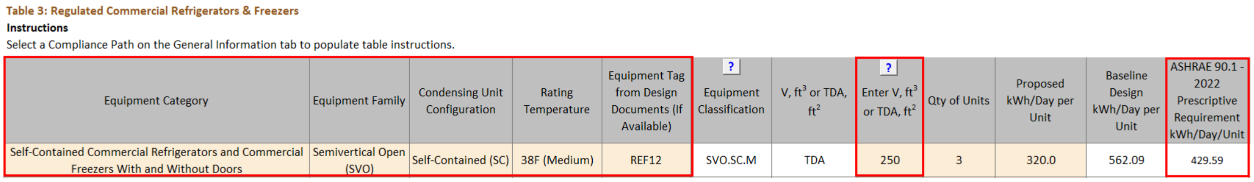


Table 3: Regulated Commercial Refrigerators & Freezers

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.

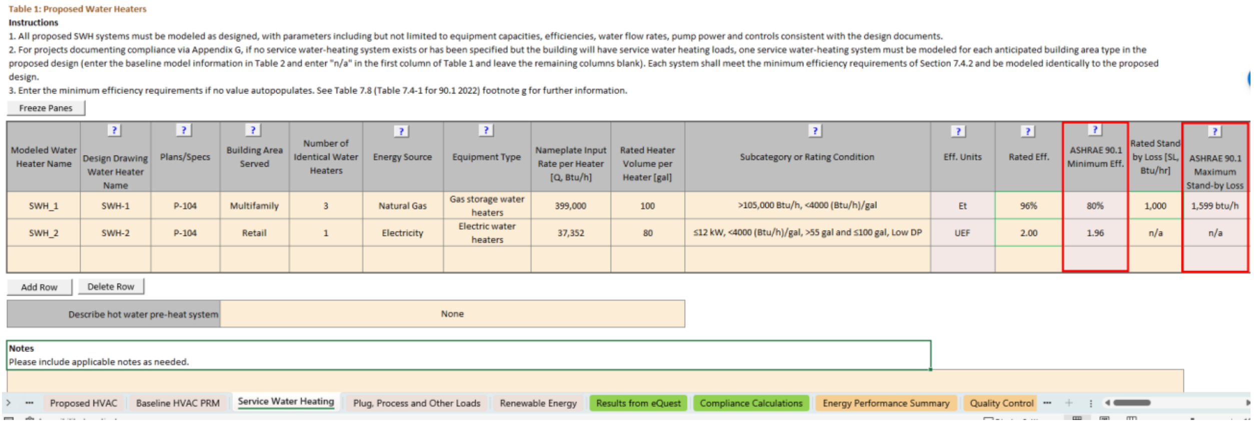


Table 1: Proposed Water Heaters

Instructions

1. 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.
2. 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.
3. 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.

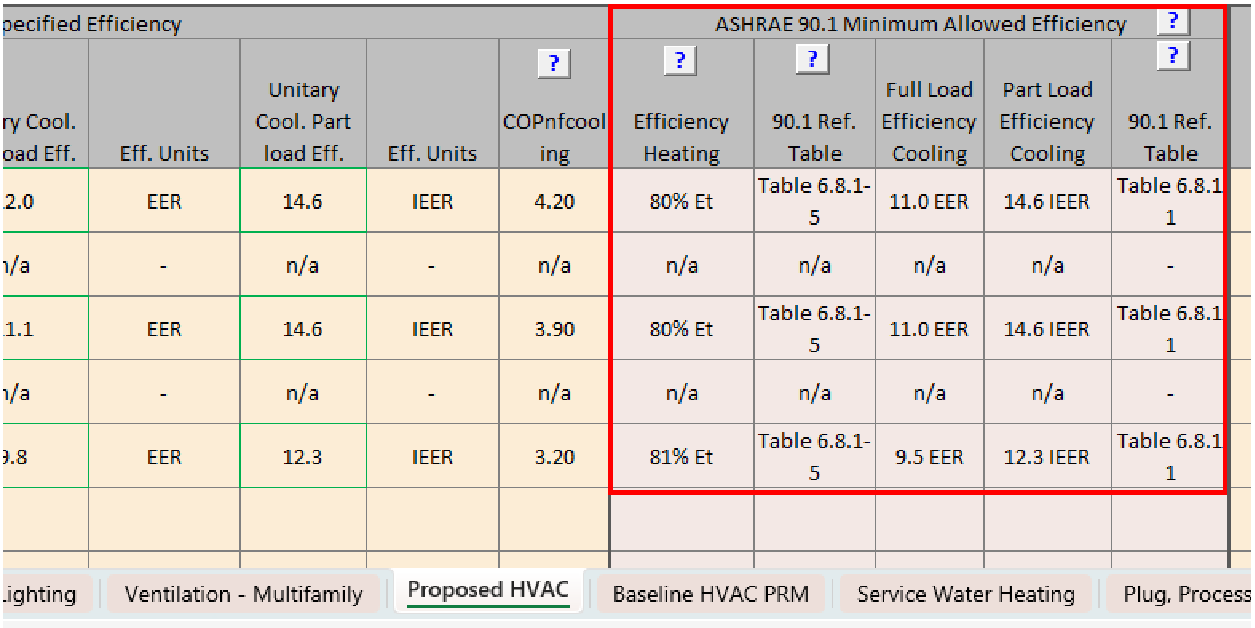
Modeled Water Heater Name	Design Drawing Water Heater Name	Plans/Specs	Building Area Served	Number of Identical Water Heaters	Energy Source	Equipment Type	Nameplate Input Rate per Heater [Q, Btu/h]	Rated Heater Volume per Heater [gal]	Subcategory or Rating Condition	Eff. Units	Rated Eff.	ASHRAE 90.1 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

Describe hot water pre-heat system	None

Notes
Please include applicable notes as needed.

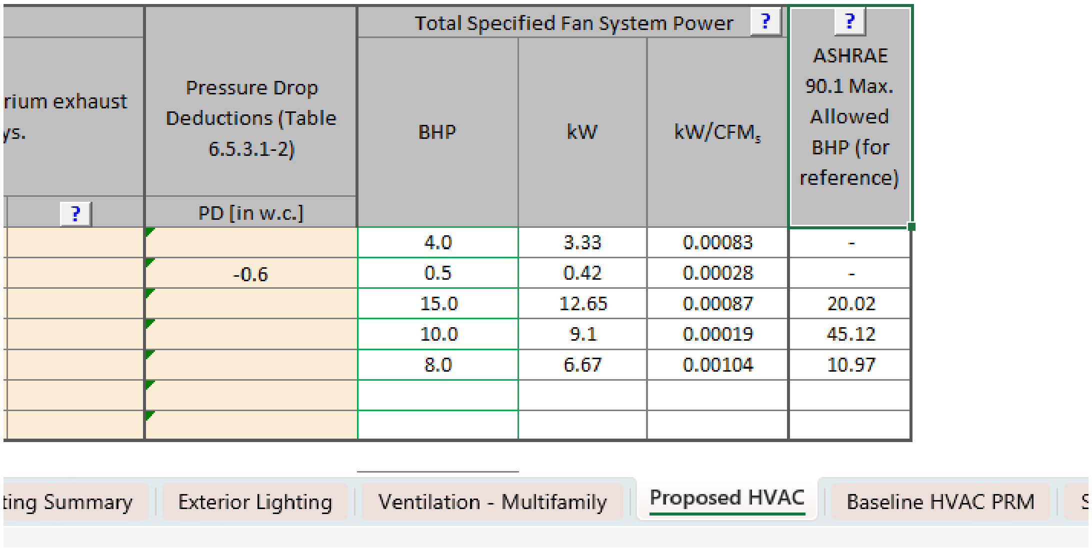
17. AHVAC03-B. Baseline HVAC system types are reported in Table 1a of the Proposed HVAC tab since the baseline HVAC system type is required to be modeled the same as the proposed design with the exception that if the proposed design includes variable refrigerant flow heat pumps or single-zone systems 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.



pecified Efficiency					ASHRAE 90.1 Minimum Allowed Efficiency ?				
ry Cool. oad 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
/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
/a	-	n/a	-	n/a	n/a	n/a	n/a	n/a	-
.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

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.



		Total Specified Fan System Power ?			?
rium exhaust ys.	Pressure Drop Deductions (Table 6.5.3.1-2)	BHP	kW	kW/CFM$_s$	ASHRAE 90.1 Max. Allowed BHP (for reference)
?	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

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.

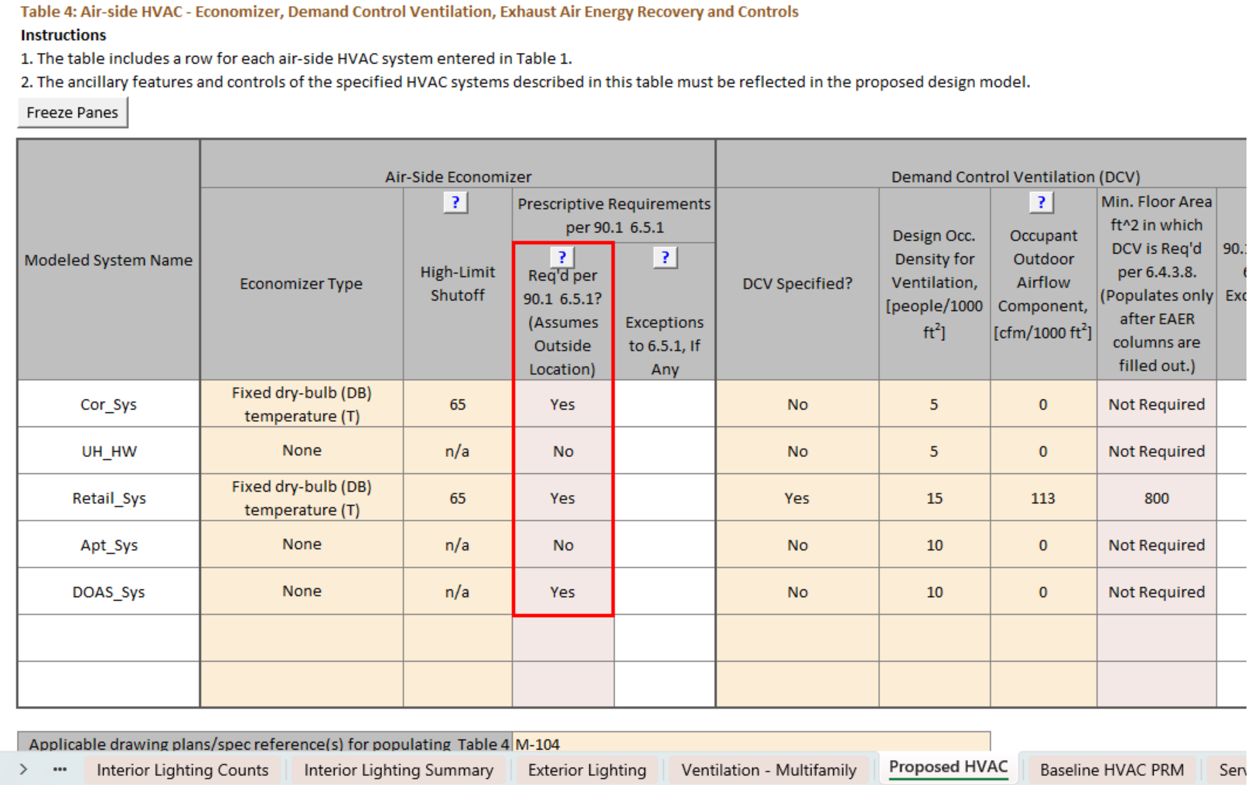


Table 4: Air-side HVAC - Economizer, Demand Control Ventilation, Exhaust Air Energy Recovery and Controls

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.

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. Exc
			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

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 ft^2 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.

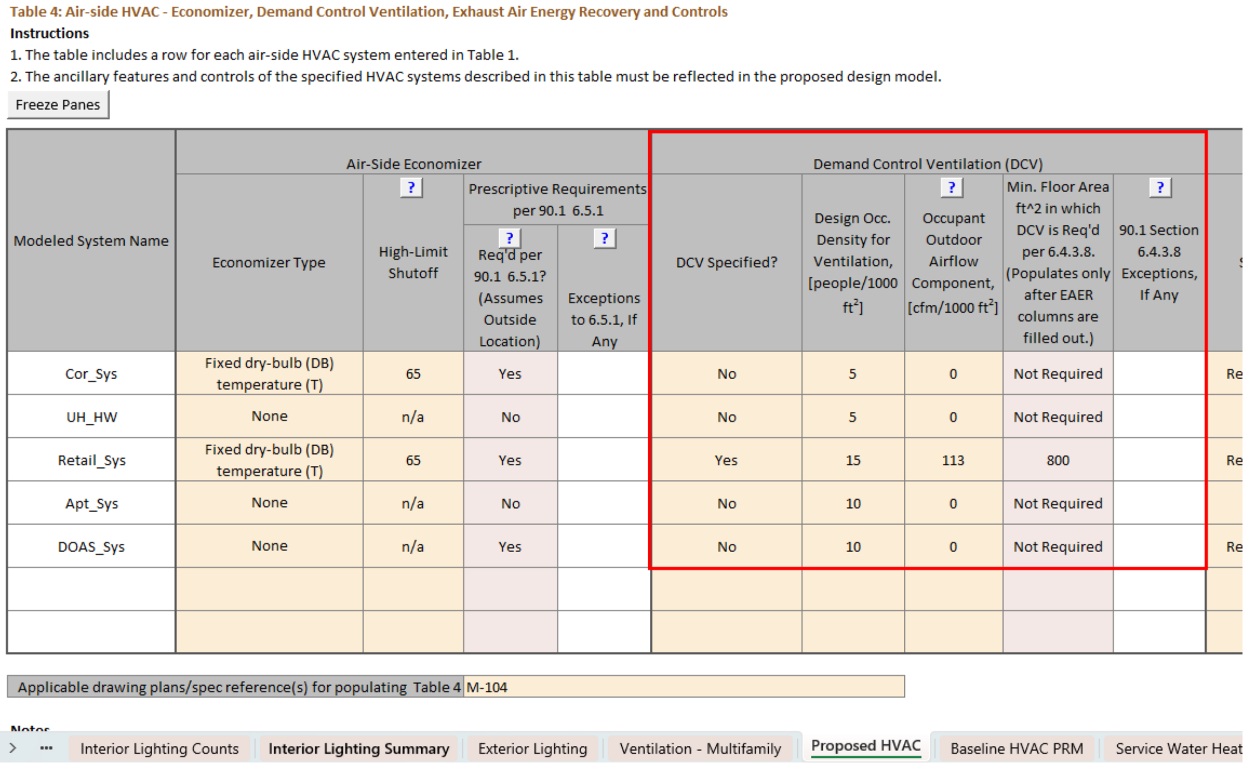


Table 4: Air-side HVAC - Economizer, Demand Control Ventilation, Exhaust Air Energy Recovery and Controls

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.

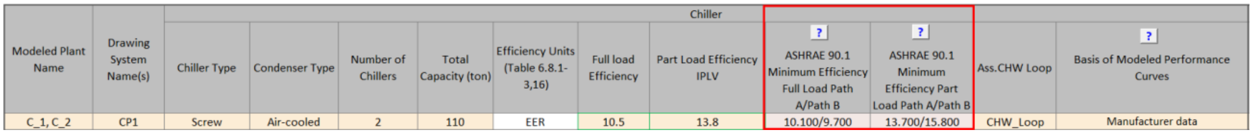
Modeled System Name	Air-Side Economizer				Demand Control Ventilation (DCV)					
	Economizer Type	High-Limit Shutoff	Prescriptive Requirements per 90.1 6.5.1		DCV Specified?	Design Occ. Density for Ventilation, [people/1000 ft^2]	Occupant Outdoor Airflow Component, [cfm/1000 ft^2]	Min. Floor Area ft^2 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		Re
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		Re
Apt_Sys	None	n/a	No		No	10	0	Not Required		
DOAS_Sys	None	n/a	Yes		No	10	0	Not Required		Re

Applicable drawing plans/spec reference(s) for populating Table 4: M-104

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.

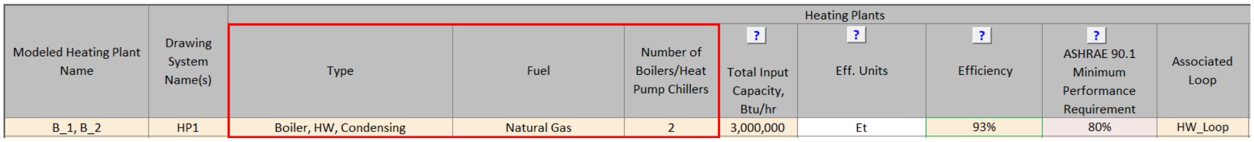
28. WHVAC01-B. Minimum efficiency requirements are reported in Table 6a on the Proposed HVAC tab in the “ASHRAE 90.1 Minimum Efficiency Full Load Path A/Path B” and “ASHRAE 90.1 Minimum Efficiency Part Load Path A/Path B” columns and are auto-populated based on user inputs in upstream columns. Any over-written 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.



		Chiller										
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	? 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	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.



		Heating Plants							
Modeled Heating Plant Name	Drawing System Name(s)	Type	Fuel	Number of Boilers/Heat Pump Chillers	? Total Input Capacity, Btu/hr	? Eff. Units	? Efficiency	? ASHRAE 90.1 Minimum Performance Requirement	Associated Loop
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

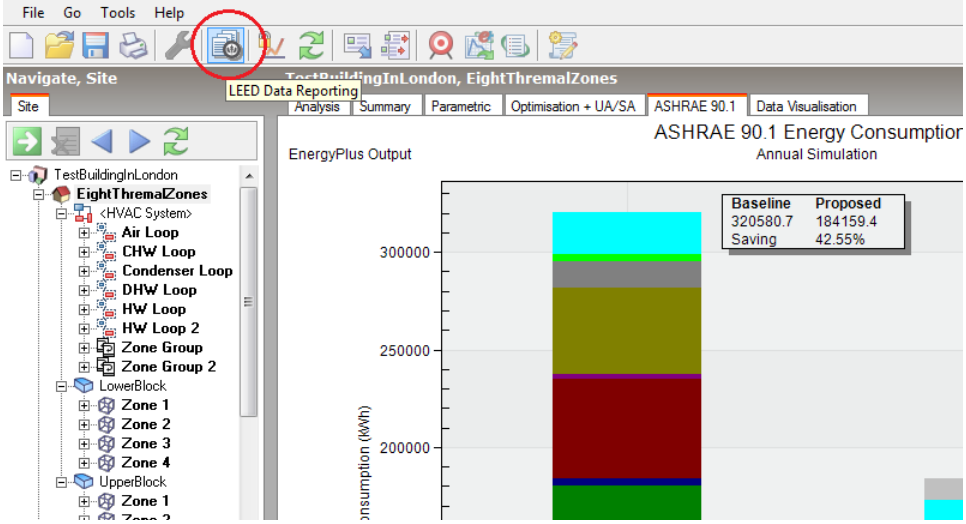
1. The DesignBuilder software can be downloaded from the DesignBuilder website. Licenses can be ordered from the buy page of the website or by contacting sales@designbuilder.co.uk.
2. The DesignBuilder online help system provides detailed information on modeling for ASHRAE 90.1 compliance and certification 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:

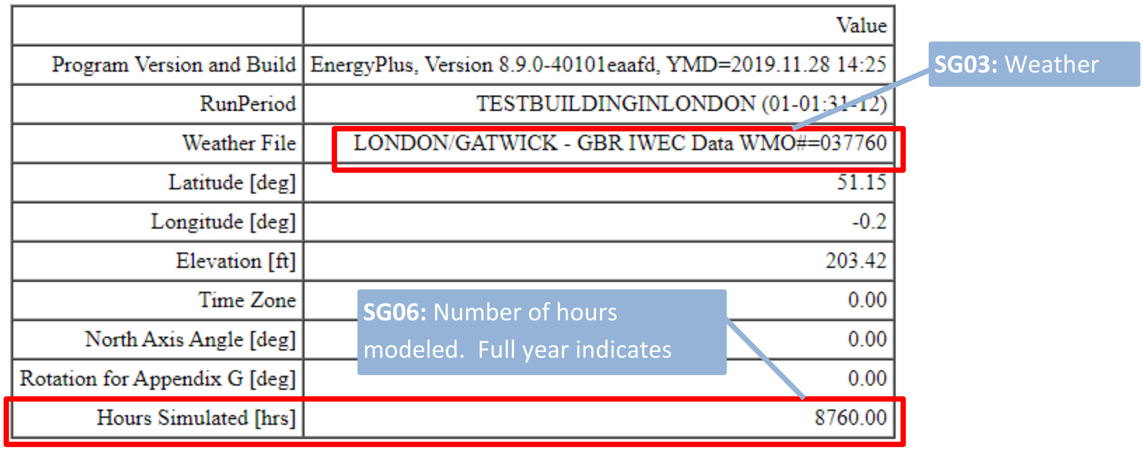


3. EnergyPlus input (.idf) files for both proposed and baseline buildings. Idf files can be viewed in a text editor such as notepad.
4. EnergyPlus simulated results file (.eso). These are most easily viewed through the freely available DesignBuilder ResultsViewer application which can be downloaded from 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

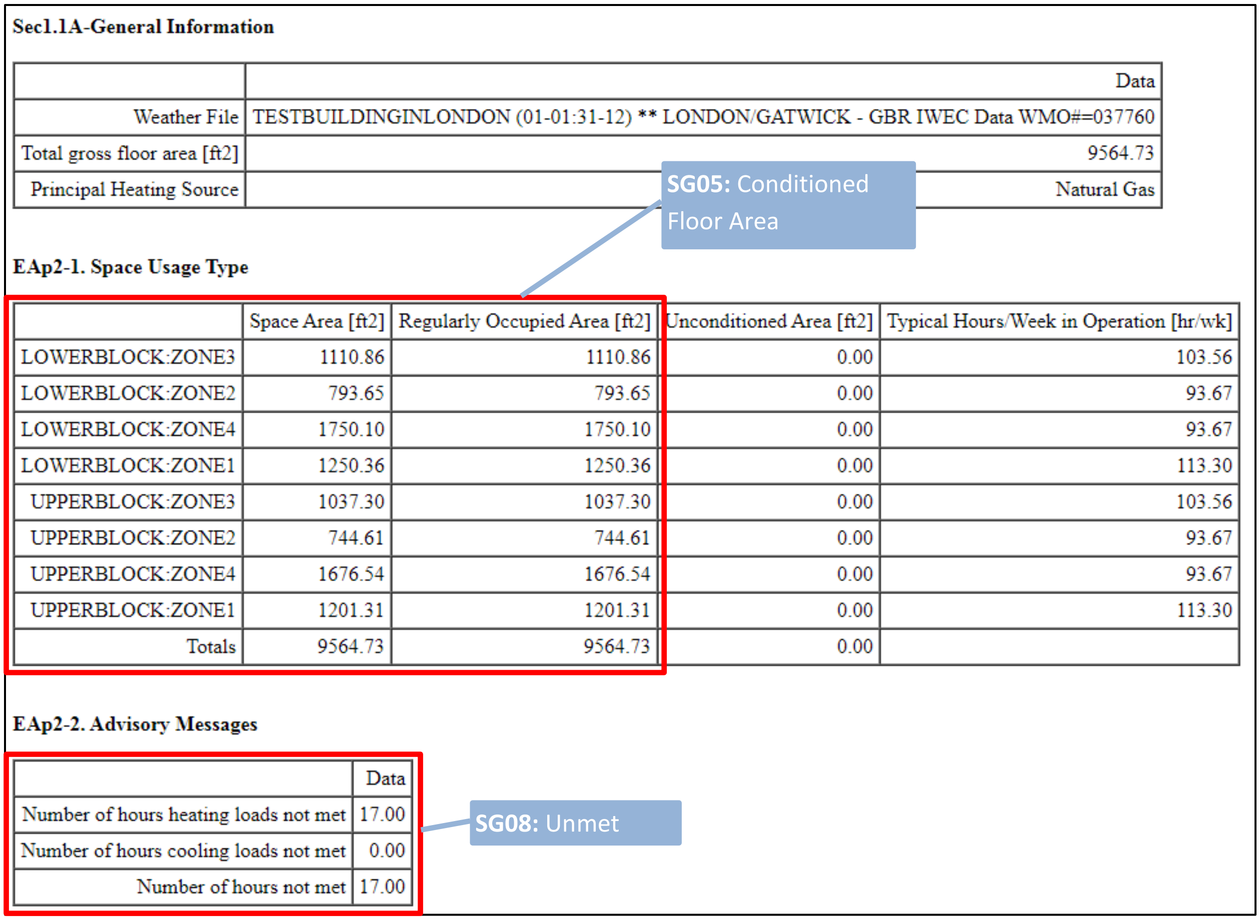


	Value
Program Version and Build	EnergyPlus, Version 8.9.0-40101eaafd, YMD=2019.11.28 14:25
RunPeriod	TESTBUILDINGINLONDON (01-01:31-12)
Weather File	LONDON/GATWICK - GBR IWEC Data WMO#=037760
Latitude [deg]	51.15
Longitude [deg]	-0.2
Elevation [ft]	203.42
Time Zone	0.00
North Axis Angle [deg]	0.00
Rotation 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

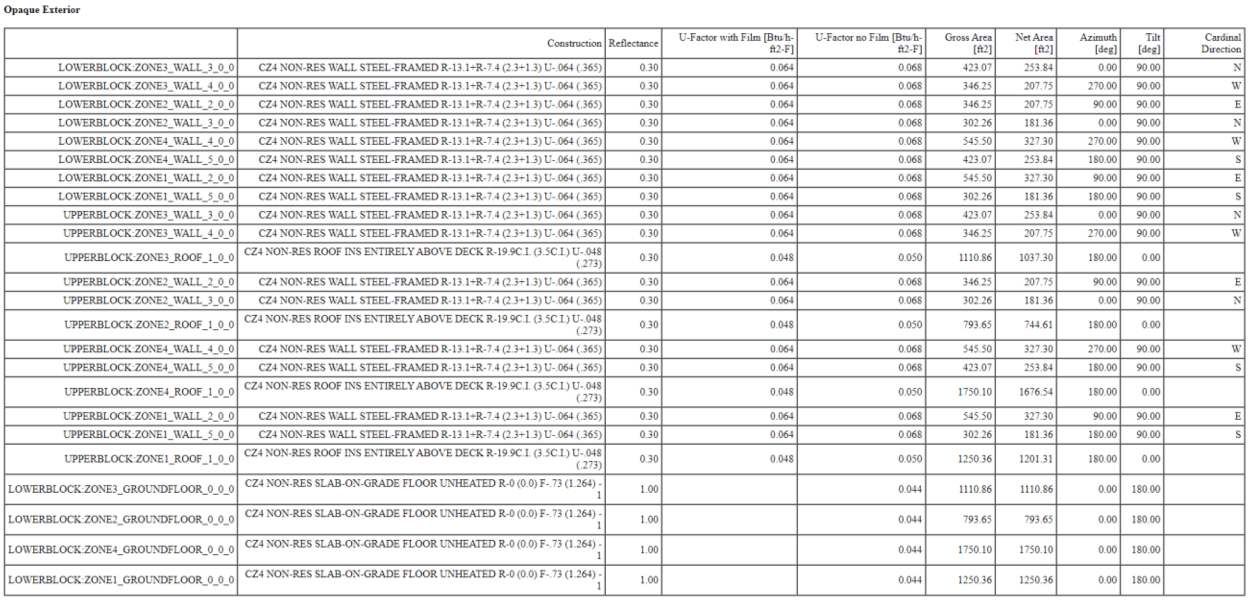
EAp2-1. Space Usage Type

	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

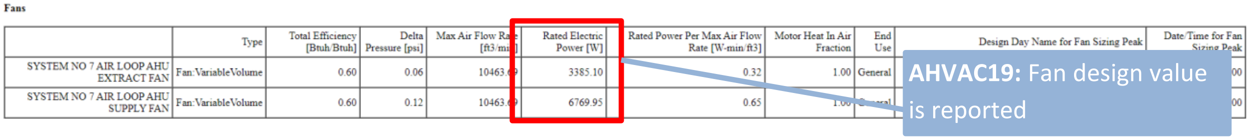
SG08: Unmet



Opaque Exterior

	Construction	Reflectance	U-Factor with Film [Btu/h-ft2-F]	U-Factor no Film [Btu/h-ft2-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 (.365)	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 (.365)	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 (.365)	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 (.365)	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 (.365)	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 (.365)	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 (.365)	0.30	0.064	0.068	545.50	327.30	90.00	90.00	E
LOWERBLOCK:ZONE1_WALL_5_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1+R-7.4 (2.3+1.3) U-.064 (.365)	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 (.365)	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 (.365)	0.30	0.064	0.068	346.25	207.75	270.00	90.00	W
UPPERBLOCK:ZONE3_ROOF_1_0_0	CZ4 NON-RES ROOF INS ENTIRELY ABOVE DECK R-19.9C.I. (3.5C.I.) U-.048 (.273)	0.30	0.048	0.050	1110.86	1037.30	180.00	0.00	
UPPERBLOCK:ZONE2_WALL_2_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1+R-7.4 (2.3+1.3) U-.064 (.365)	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 (.365)	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-19.9C.I. (3.5C.I.) U-.048 (.273)	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 (.365)	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 (.365)	0.30	0.064	0.068	423.07	253.84	180.00	90.00	S
UPPERBLOCK:ZONE4_ROOF_1_0_0	CZ4 NON-RES ROOF INS ENTIRELY ABOVE DECK R-19.9C.I. (3.5C.I.) U-.048 (.273)	0.30	0.048	0.050	1750.10	1676.54	180.00	0.00	
UPPERBLOCK:ZONE1_WALL_2_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1+R-7.4 (2.3+1.3) U-.064 (.365)	0.30	0.064	0.068	545.50	327.30	90.00	90.00	E
UPPERBLOCK:ZONE1_WALL_5_0_0	CZ4 NON-RES WALL STEEL-FRAMED R-13.1+R-7.4 (2.3+1.3) U-.064 (.365)	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-19.9C.I. (3.5C.I.) U-.048 (.273)	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	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	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	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	1.00		0.044	1250.36	1250.36	0.00	180.00	

Fans Table in Equipment Summary report

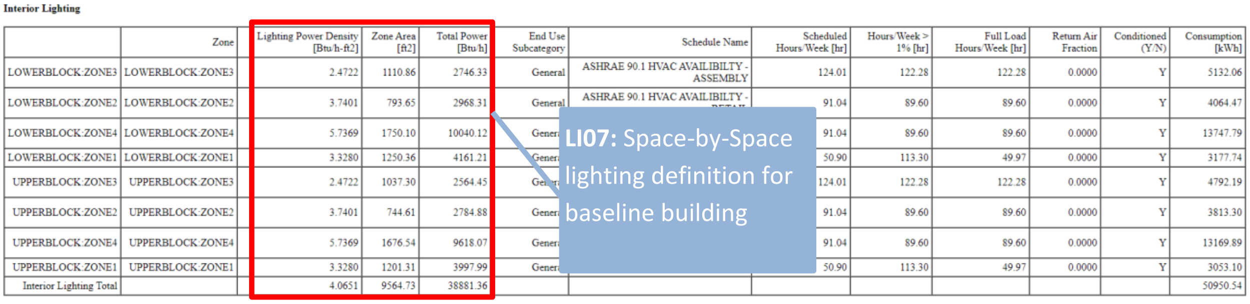


Fans

	Type	Total Efficiency [Btuh/Btuh]	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.[illegible]9	3385.10	0.32	1.00	General		00
SYSTEM NO 7 AIR LOOP AHU SUPPLY FAN	Fan:VariableVolume	0.60	0.12	10463.[illegible]9	6769.95	0.65	1.00	General		00

AHVAC19: Fan design value is reported

Interior Lighting Table in Lighting Summary report

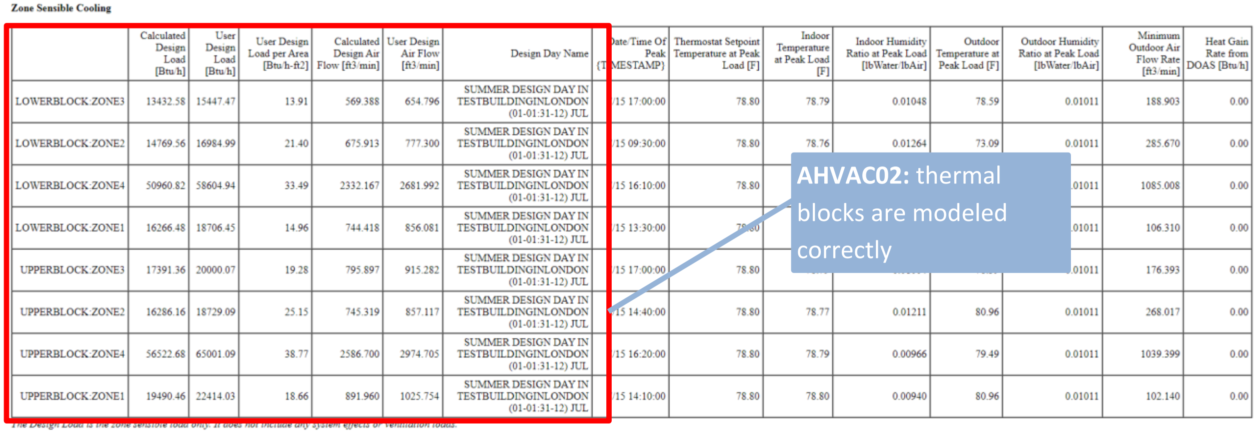


Interior Lighting

	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 AVAILIBILTY - 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 AVAILIBILTY -	91.04	89.60	89.60	0.0000	Y	4064.47
LOWERBLOCK:ZONE4	LOWERBLOCK:ZONE4		5.7369	1750.10	10040.12	Genera		91.04	89.60	89.60	0.0000	Y	13747.79
LOWERBLOCK:ZONE1	LOWERBLOCK:ZONE1		3.3280	1250.36	4161.21	Genera		50.90	113.30	49.97	0.0000	Y	3177.74
UPPERBLOCK:ZONE3	UPPERBLOCK:ZONE3		2.4722	1037.30	2564.45	Ge		124.01	122.28	122.28	0.0000	Y	4792.19
UPPERBLOCK:ZONE2	UPPERBLOCK:ZONE2		3.7401	744.61	2784.88	Genera		91.04	89.60	89.60	0.0000	Y	3813.30
UPPERBLOCK:ZONE4	UPPERBLOCK:ZONE4		5.7369	1676.54	9618.07	Genera		91.04	89.60	89.60	0.0000	Y	13169.89
UPPERBLOCK:ZONE1	UPPERBLOCK:ZONE1		3.3280	1201.31	3997.99	Genera		50.90	113.30	49.97	0.0000	Y	3053.10
Interior Lighting Total			4.0651	9564.73	38881.36								50950.54

LI07: Space-by-Space lighting definition for baseline building

Zone Sensible Cooling/Heating Tables in HVAC Sizing Summary report

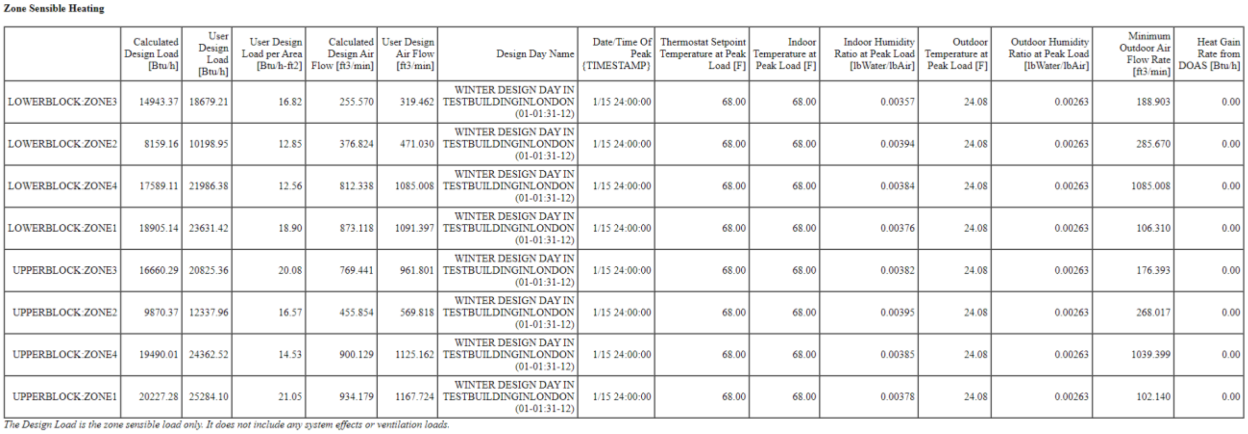


Zone Sensible Cooling

	Calculated Design Load [Btu/h]	User Design Load [Btu/h]	User Design Load per Area [Btu/h-ft2]	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				.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				.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				.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 load only. It does not include any system effects or ventilation loads.

AHVAC02: thermal blocks are modeled correctly



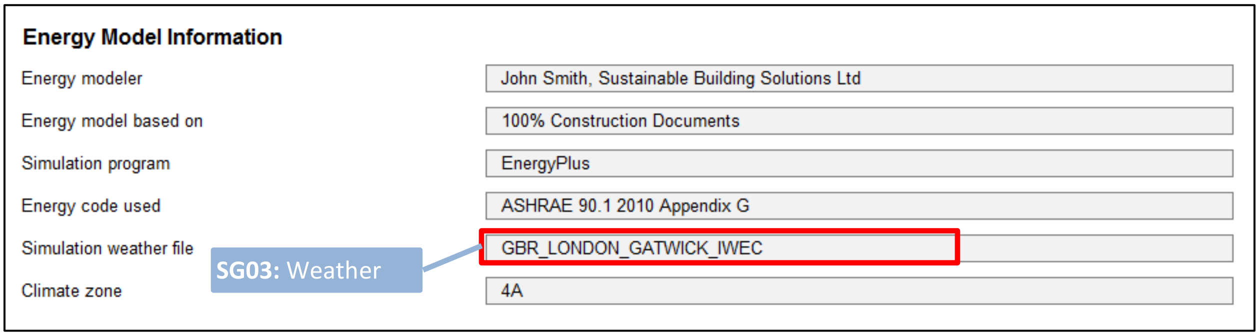
Zone Sensible Heating

	Calculated Design Load [Btu/h]	User Design Load [Btu/h]	User Design Load per Area [Btu/h-ft2]	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	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

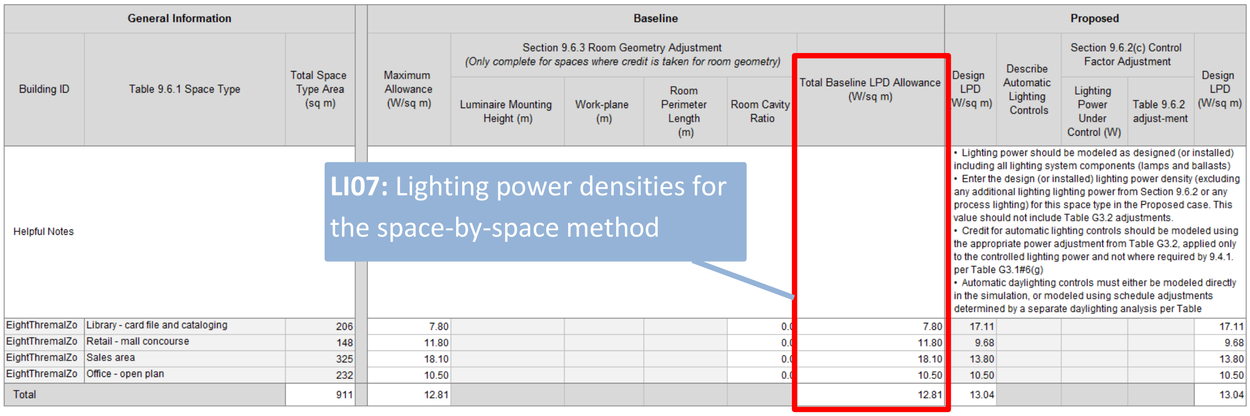


Energy Model Information

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

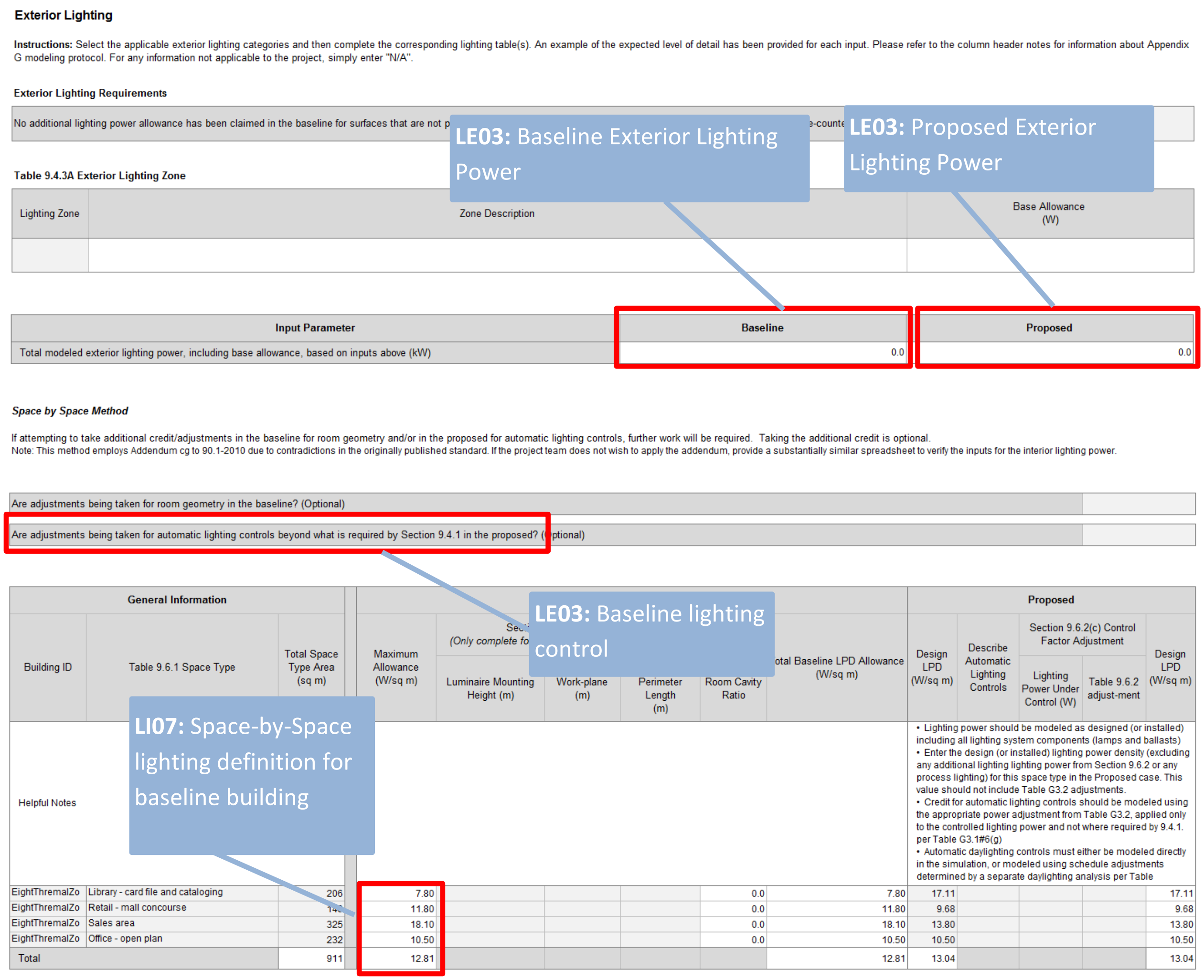
SG03: Weather

"Lighting" sheet



General Information			Baseline						Proposed				
				Section 9.6.3 Room Geometry Adjustment (Only complete for spaces where credit is taken for room geometry)							Section 9.6.2(c) Control Factor Adjustment		
Building ID	Table 9.6.1 Space Type	Total Space Type Area (sq m)	Maximum Allowance (W/sq m)	Luminaire Mounting Height (m)	Work-plane (m)	Room Perimeter Length (m)	Room Cavity Ratio	Total Baseline LPD Allowance (W/sq m)	Design LPD (W/sq m)	Describe Automatic Lighting Controls	Lighting Power Under Control (W)	Table 9.6.2 adjust-ment	Design LPD (W/sq m)
Helpful Notes									• 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 G3.1#6(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				
EightThremalZo	Library - card file and cataloging	206	7.80				0.0	7.80	17.11				17.11
EightThremalZo	Retail - mall concourse	148	11.80				0.0	11.80	9.68				9.68
EightThremalZo	Sales area	325	18.10				0.0	18.10	13.80				13.80
EightThremalZo	Office - open plan	232	10.50				0.0	10.50	10.50				10.50
Total		911	12.81					12.81	13.04				13.04

LI07: Lighting power densities for the space-by-space method



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 e-counte

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

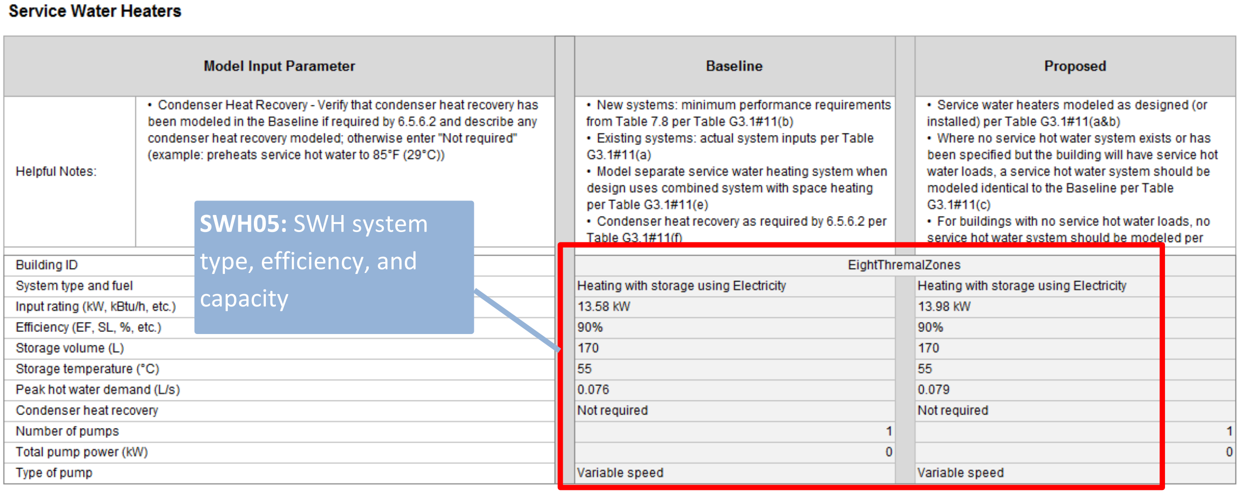
If attempting to take additional credit/adjustments in the baseline for room geometry and/or in the proposed for automatic lighting controls, further work will be required. Taking the additional credit is optional.
Note: This method employs Addendum cg to 90.1-2010 due to contradictions in the originally 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? (ptional)

General Information				Sec *(Only complete fo*					Proposed				
											Section 9.6.2(c) Control Factor Adjustment		
Building ID	Table 9.6.1 Space Type	Total Space Type Area (sq m)	Maximum Allowance (W/sq m)	Luminaire Mounting Height (m)	Work-plane (m)	Perimeter Length (m)	Room Cavity Ratio	otal Baseline LPD Allowance (W/sq m)	Design LPD (W/sq m)	Describe Automatic Lighting Controls	Lighting Power Under Control (W)	Table 9.6.2 adjust-ment	Design LPD (W/sq m)
Helpful Notes									• 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 G3.1#6(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				
EightThremalZo	Library - card file and cataloging	206	7.80				0.0	7.80	17.11				17.11
EightThremalZo	Retail - mall concourse	14	11.80				0.0	11.80	9.68				9.68
EightThremalZo	Sales area	325	18.10				0.0	18.10	13.80				13.80
EightThremalZo	Office - open plan	232	10.50				0.0	10.50	10.50				10.50
Total		911	12.81					12.81	13.04				13.04

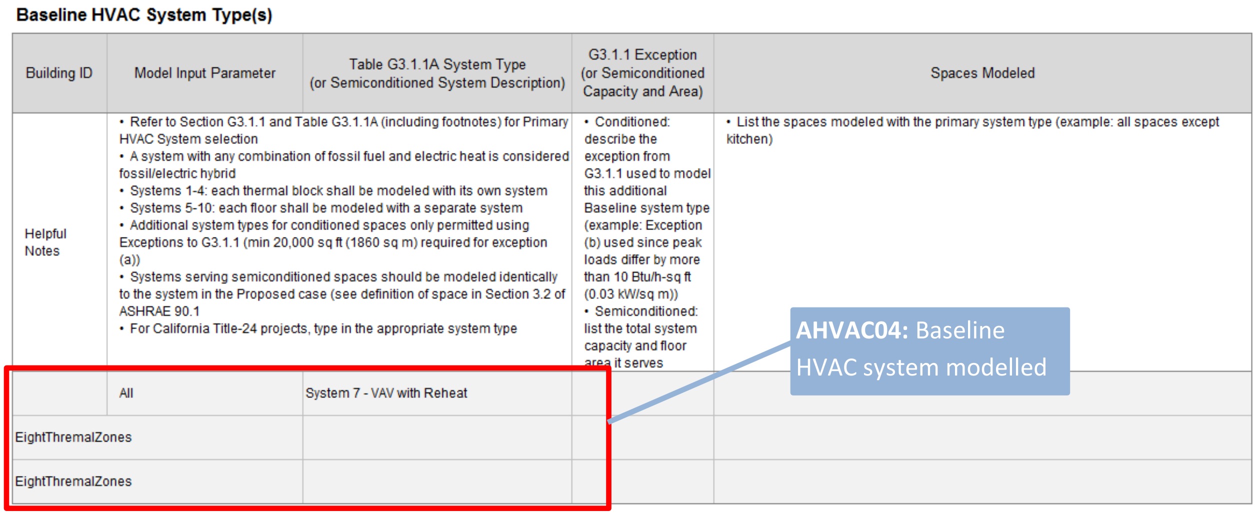
“Service Water Heating” sheet



Service Water Heaters

Model Input Parameter		Baseline	Proposed
Helpful Notes:	• Condenser Heat Recovery - Verify that condenser heat recovery has been modeled in the Baseline if required by 6.5.6.2 and describe any condenser heat recovery modeled; otherwise enter "Not required" (example: preheats service hot water to 85°F (29°C))	• 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)	• 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		EightThremalZones	
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

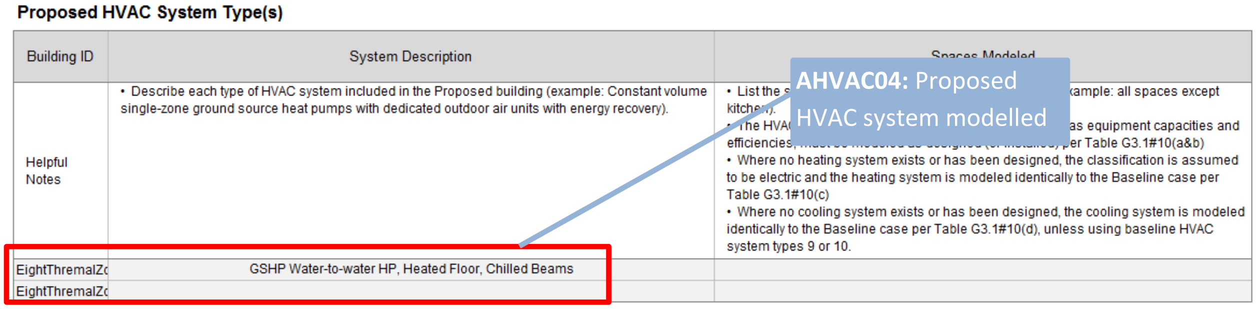
“General HVAC” sheet



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	• 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		• 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	• List the spaces modeled with the primary system type (example: all spaces except kitchen)
	All	System 7 - VAV with Reheat		
EightThremalZones				
EightThremalZones				

AHVAC04: Baseline HVAC system modelled

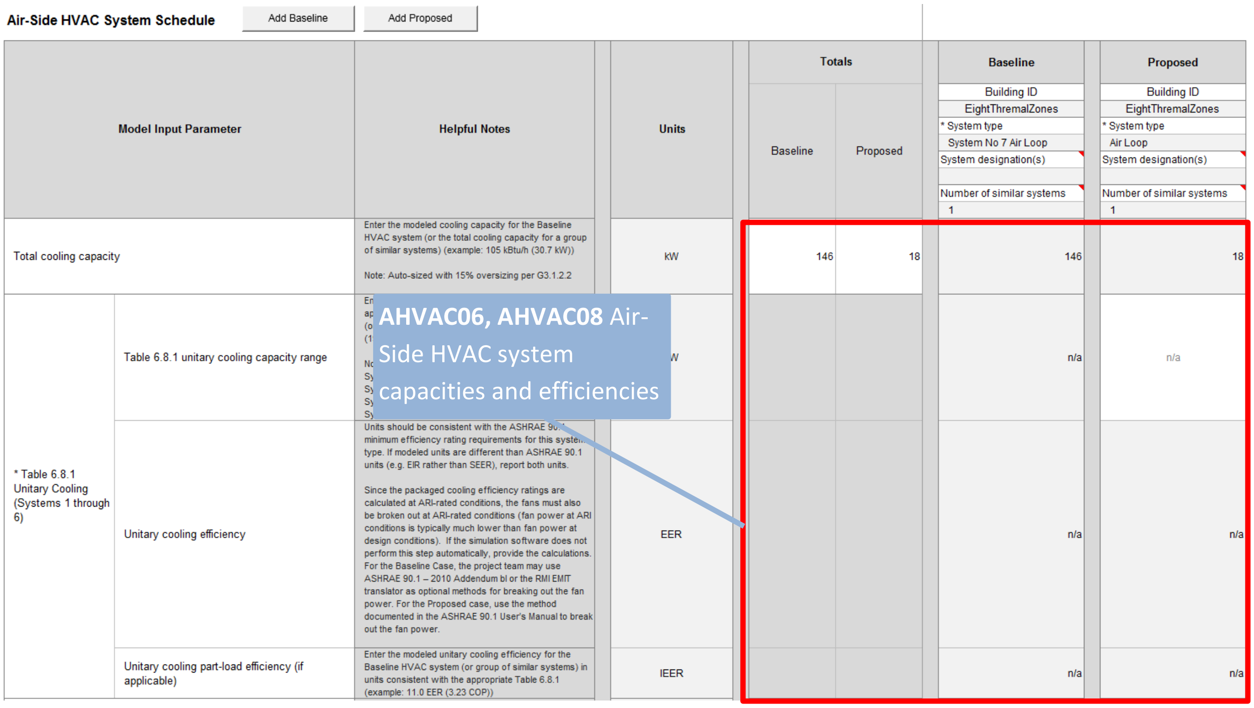


Proposed HVAC System Type(s)

Building ID	System Description	Spaces Modeled
Helpful Notes	• Describe each type of HVAC system included in the Proposed building (example: Constant volume single-zone ground source heat pumps with dedicated outdoor air units with energy recovery).	• List the s xample: all spaces except kitchen). • The HVA as equipment capacities and efficiencies, 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.
EightThremalZc	GSHP Water-to-water HP, Heated Floor, Chilled Beams	
EightThremalZc		

AHVAC04: Proposed HVAC system modelled

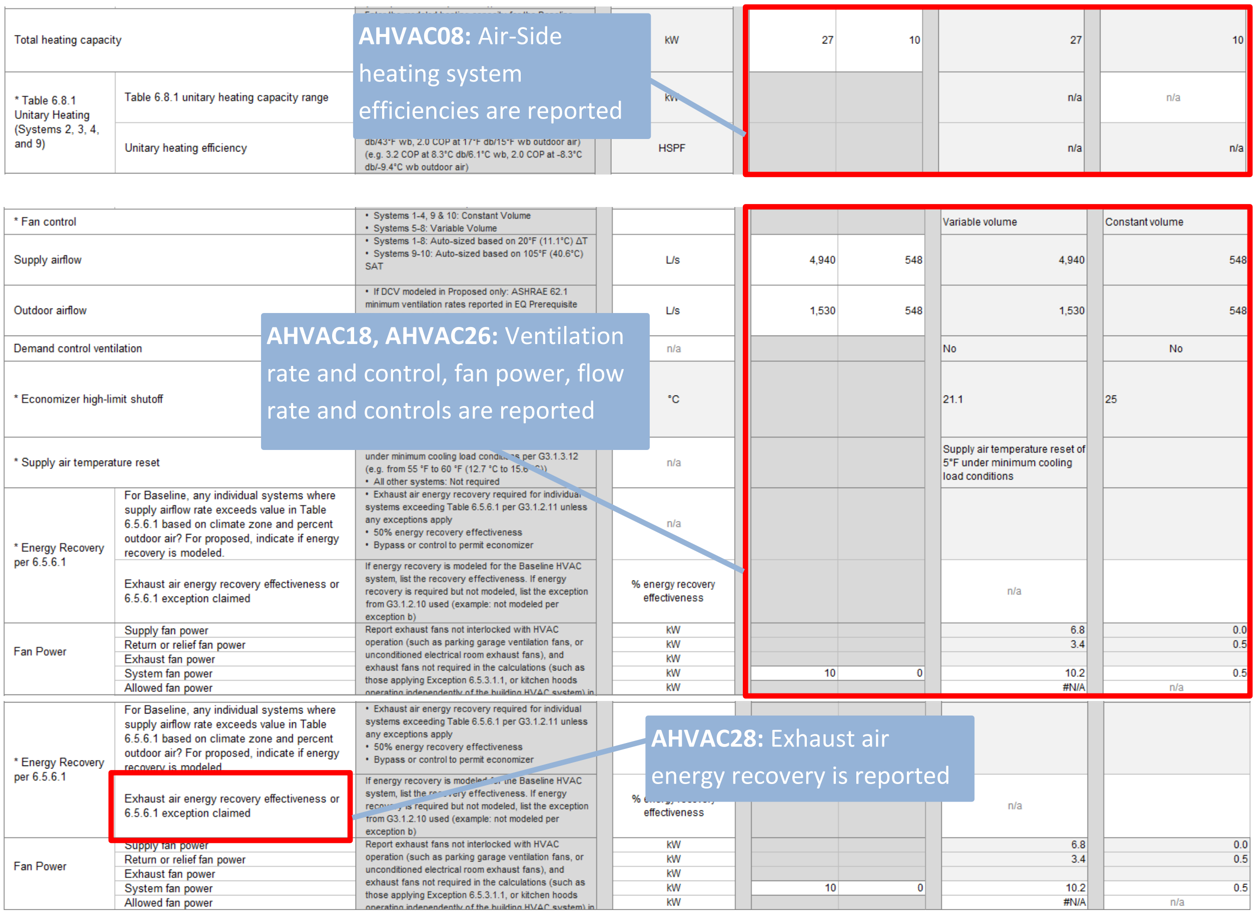
“Air-Side HVAC” sheet



Air-Side HVAC System Schedule

Model Input Parameter		Helpful Notes	Units	Totals		Baseline	Proposed
				Baseline	Proposed	Building ID EightThremalZones * System type System No 7 Air Loop System designation(s) Number of similar systems 1	Building ID EightThremalZones * System type Air Loop System designation(s) Number of similar systems 1
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: 105 kBtu/h (30.7 kW)) Note: Auto-sized with 15% oversizing per G3.1.2.2	kW	146	18	146	18
* Table 6.8.1 Unitary Cooling (Systems 1 through 6)	Table 6.8.1 unitary cooling capacity range		W			n/a	n/a
	Unitary cooling efficiency	Units should be consistent with the ASHRAE 90 minimum efficiency rating requirements for this syste type. If modeled units are different than ASHRAE 90.1 units (e.g. EIR rather than SEER), report both units. 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 bl 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 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



AHVAC08: Air-Side heating system efficiencies are reported

AHVAC18, AHVAC26: Ventilation rate and control, fan power, flow rate and controls are reported

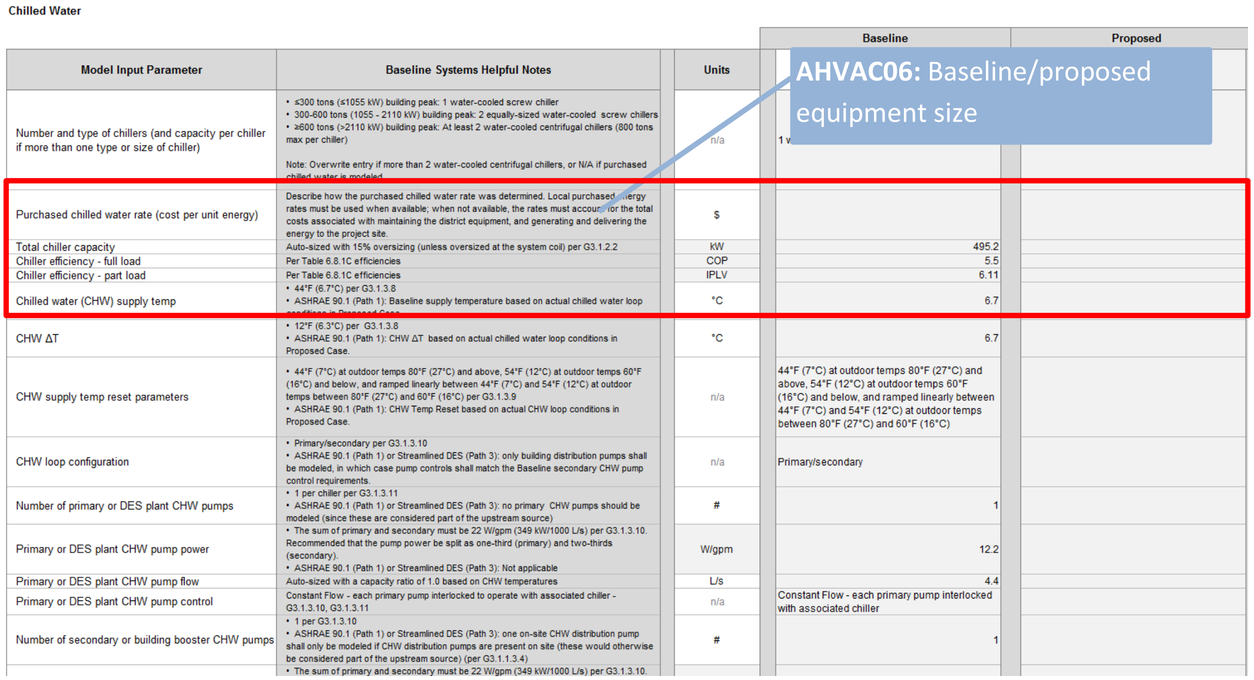
AHVAC28: Exhaust air energy recovery is reported

Total heating capacity			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		• Systems 1-4, 9 & 10: Constant Volume • Systems 5-8: Variable Volume				Variable volume	Constant volume
Supply airflow		• 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		• 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		under minimum cooling load conditions per G3.1.3.12 (e.g. from 55 °F to 60 °F (12.7 °C to 15.6 °C)) • All other systems: Not required	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.	• 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	n/a				
	Exhaust air energy recovery effectiveness or 6.5.6.1 exception claimed	If energy recovery is modeled for the Baseline HVAC system, list the recovery effectiveness. If energy recovery is required but not modeled, list the exception from G3.1.2.10 used (example: not modeled per exception b)	% energy recovery effectiveness			n/a	
Fan Power	Supply 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 operating independently of the building HVAC system) in	kW			6.8	0.0
	Return or relief fan power		kW			3.4	0.5
	Exhaust fan power		kW				
	System fan power		kW	10	0	10.2	0.5
	Allowed fan power		kW			#N/A	n/a

* 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.	• 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					
	Exhaust air energy recovery effectiveness or 6.5.6.1 exception claimed	If energy recovery is modeled for the Baseline HVAC system, list the recovery effectiveness. If energy recovery is required but not modeled, list the exception from G3.1.2.10 used (example: not modeled per exception b)	% energy recovery effectiveness			n/a	
Fan Power	Supply 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 operating independently of the building HVAC system) in	kW			6.8	0.0
	Return or relief fan power		kW			3.4	0.5
	Exhaust fan power		kW				
	System fan power		kW	10	0	10.2	0.5
	Allowed fan power		kW			#N/A	n/a

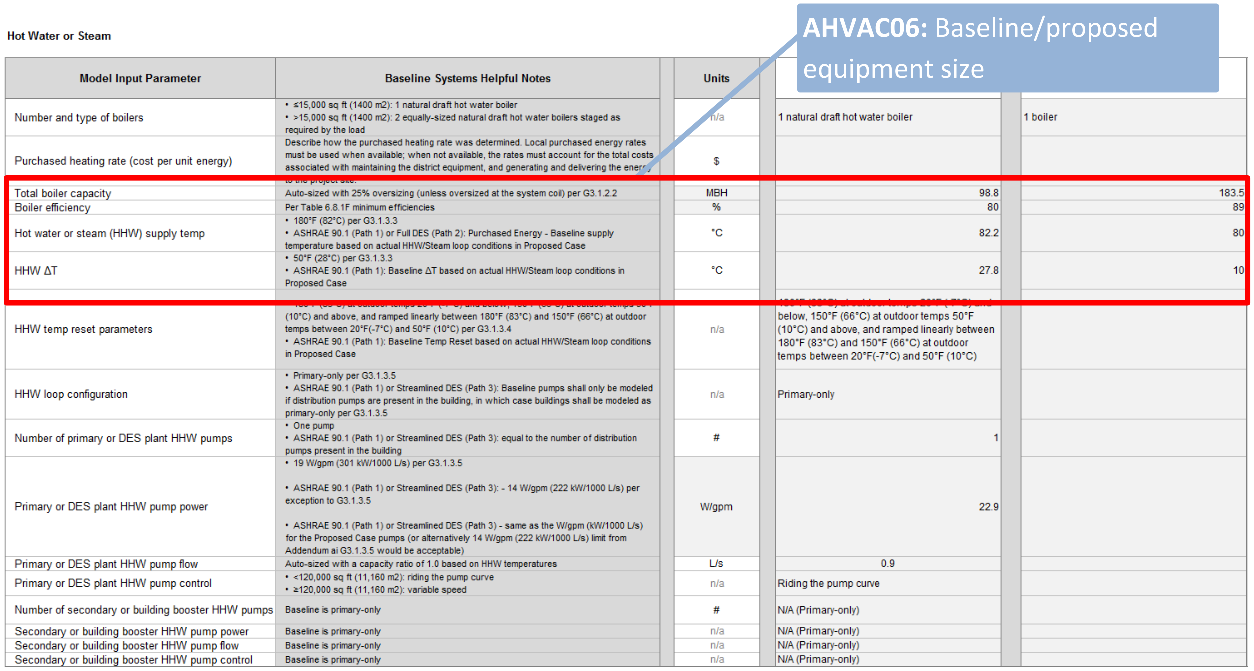
"Water-Side HVAC" sheet



Chilled Water

AHVAC06: Baseline/proposed equipment size

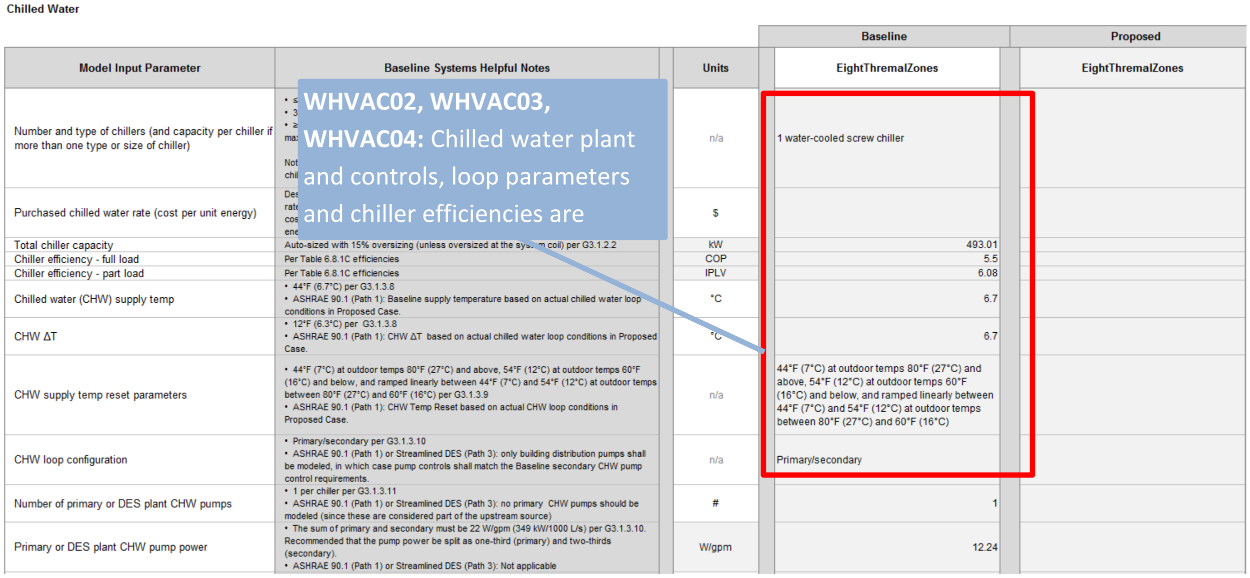
Model Input Parameter	Baseline Systems Helpful Notes	Units	Baseline	Proposed
Number and type of chillers (and capacity per chiller if more than one type or size of chiller)	• ≤300 tons (≤1055 kW) building peak: 1 water-cooled screw chiller • 300-600 tons (1055 - 2110 kW) building peak: 2 equally-sized water-cooled screw chillers • ≥600 tons (>2110 kW) building peak: At least 2 water-cooled centrifugal chillers (800 tons max per chiller) Note: Overwrite entry if more than 2 water-cooled centrifugal chillers, or N/A if purchased chilled water is modeled	n/a	1 v	
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	• 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	• 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	• 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	• 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	• 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	• 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	W/gpm	12.2	
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	Constant Flow - each primary pump interlocked to operate with associated chiller - G3.1.3.10, G3.1.3.11	n/a	Constant Flow - each primary pump interlocked with associated chiller	
Number of secondary or building booster CHW pumps	• 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)	#	1	
	• The sum of primary and secondary must be 22 W/gpm (349 kW/1000 L/s) per G3.1.3.10.			



Hot Water or Steam

AHVAC06: Baseline/proposed equipment size

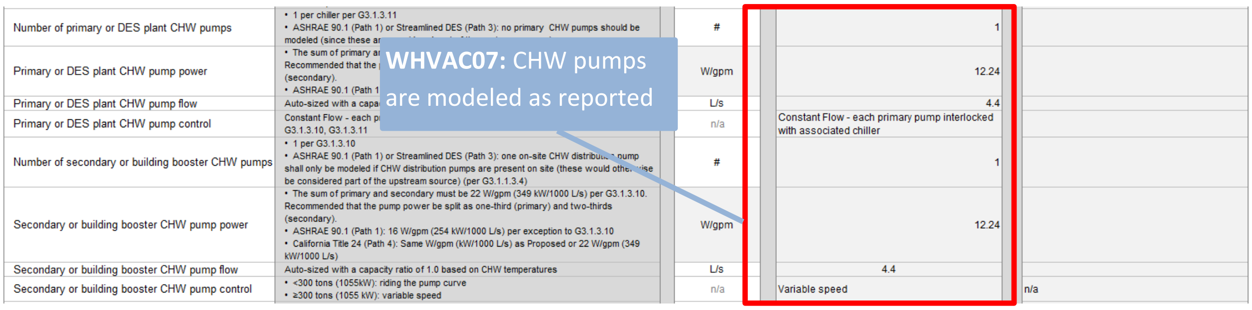
Model Input Parameter	Baseline Systems Helpful Notes	Units		
Number and type of boilers	• ≤15,000 sq ft (1400 m2): 1 natural draft hot water boiler • >15,000 sq ft (1400 m2): 2 equally-sized natural draft hot water boilers staged as required by the load	n/a	1 natural draft hot water boiler	1 boiler
Purchased 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 project 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	• 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	°C	82.2	80
HHW ΔT	• 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	• 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) 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	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	
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 • 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 ai 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	• <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

WHVAC02, WHVAC03, WHVAC04: Chilled water plant and controls, loop parameters and chiller efficiencies are

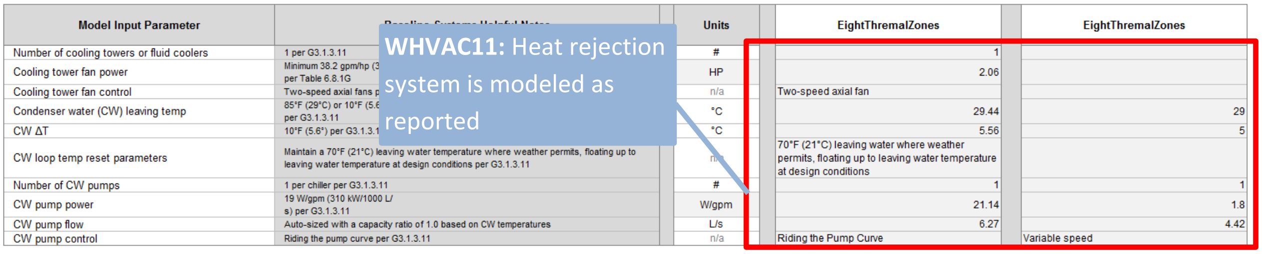
			Baseline	Proposed
Model Input Parameter	Baseline Systems Helpful Notes	Units	EightThremalZones	EightThremalZones
Number and type of chillers (and capacity per chiller if more than one type or size of chiller)	• ≤ • 3 • ≥ max Not chil	n/a	1 water-cooled screw chiller	
Purchased chilled water rate (cost per unit energy)	Des rate cos ene	$		
Total chiller capacity	Auto-sized with 15% oversizing (unless oversized at the sys… 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	• 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	• 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	• 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	• 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	• 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	• 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	W/gpm	12.24	



WHVAC07: CHW pumps are modeled as reported

Number of primary or DES plant CHW pumps	• 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 ar	#	1	
Primary or DES plant CHW pump power	• The sum of primary ar Recommended that the (secondary). • ASHRAE 90.1 (Path 1	W/gpm	12.24	
Primary or DES plant CHW pump flow	Auto-sized with a capa	L/s	4.4	
Primary or DES plant CHW pump control	Constant Flow - each p G3.1.3.10, G3.1.3.11	n/a	Constant Flow - each primary pump interlocked with associated chiller	
Number of secondary or building booster CHW pumps	• 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)	#	1	
Secondary or building booster CHW pump power	• 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)	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	• <300 tons (1055kW): riding the pump curve • ≥300 tons (1055 kW): variable speed	n/a	Variable speed	n/a

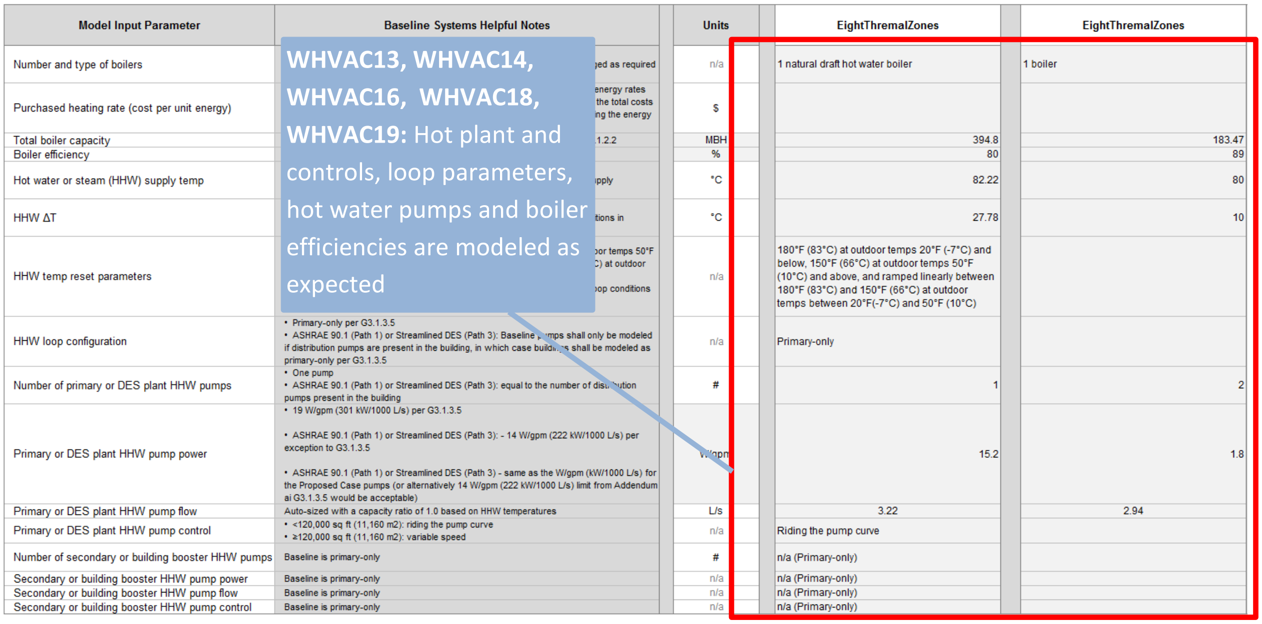
Cooling Tower and Condenser Water



WHVAC11: Heat rejection system is modeled as reported

Model Input Parameter	Baseline Systems Helpful Notes	Units	EightThremalZones	EightThremalZones
Number of cooling towers or fluid coolers	1 per G3.1.3.11	#	1	
Cooling tower fan power	Minimum 38.2 gpm/hp (3 per Table 6.8.1G	HP	2.06	
Cooling tower fan control	Two-speed axial fans p	n/a	Two-speed axial fan	
Condenser water (CW) leaving temp	85°F (29°C) or 10°F (5.6 per G3.1.3.11	°C	29.44	29
CW ΔT	10°F (5.6°) per G3.1.3.1	°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

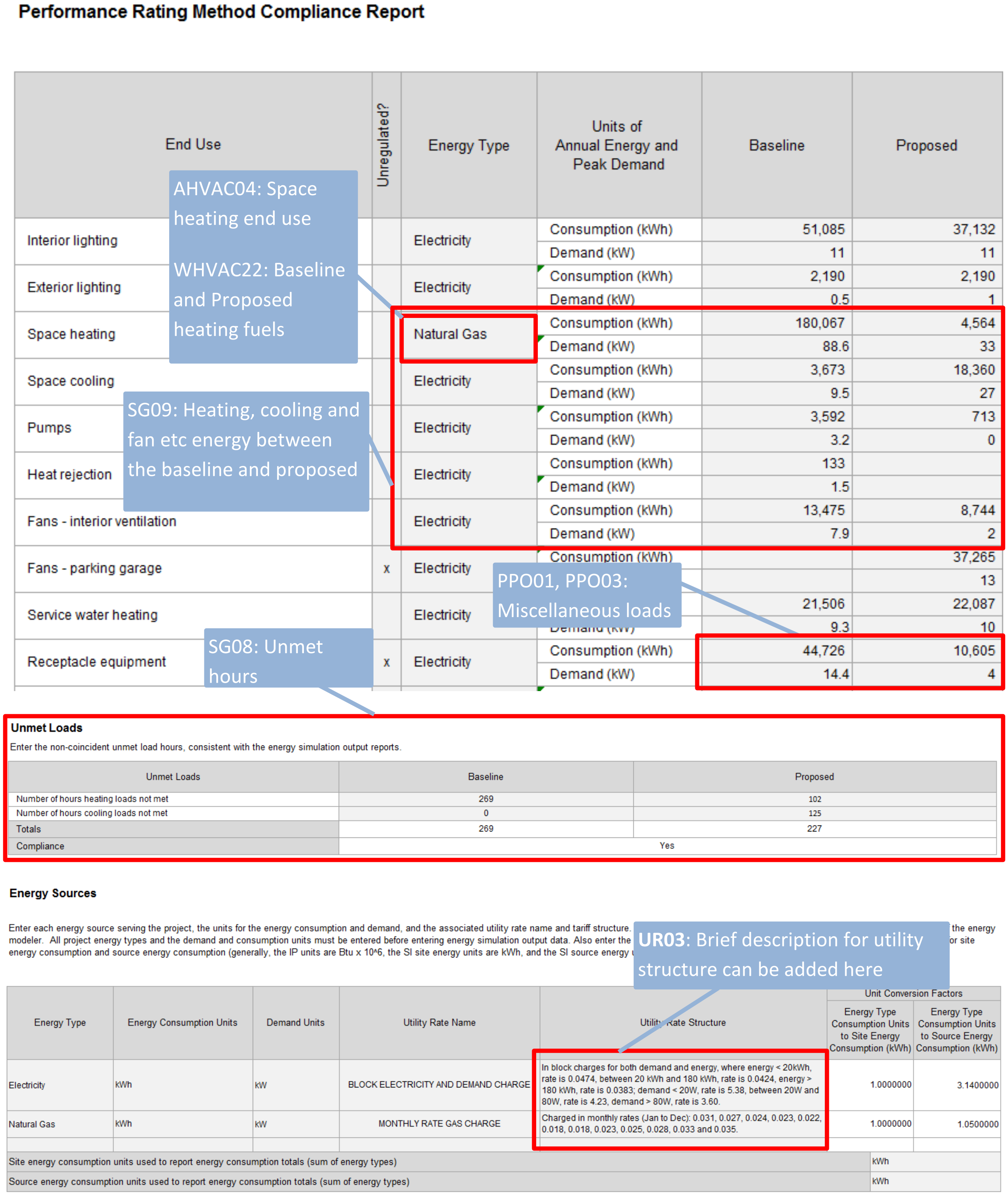
Hot Water or Steam



WHVAC13, WHVAC14, WHVAC16, WHVAC18, WHVAC19: Hot plant and controls, loop parameters, hot water pumps and boiler efficiencies are modeled as expected

Model Input Parameter	Baseline Systems Helpful Notes	Units	EightThremalZones	EightThremalZones
Number and type of boilers	ged as required	n/a	1 natural draft hot water boiler	1 boiler
Purchased heating rate (cost per unit energy)	energy rates the total costs ing the energy	$		
Total boiler capacity	1.2.2	MBH	394.8	183.47
Boiler efficiency		%	80	89
Hot water or steam (HHW) supply temp	pply	°C	82.22	80
HHW ΔT	tions in	°C	27.78	10
HHW temp reset parameters	or temps 50°F C) at outdoor op conditions	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 • 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 ai G3.1.3.5 would be acceptable)	W/gpm	15.2	1.8
Primary or DES plant HHW pump flow	Auto-sized with a capacity ratio of 1.0 based on HHW temperatures	L/s	3.22	2.94
Primary or DES plant HHW pump control	• <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)	

"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
					13
Service water heating		Electricity		21,506	22,087
			Demand (kW)	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

PPO01, PPO03: Miscellaneous loads

SG08: Unmet hours

Unmet Loads

Enter the non-coincident unmet load hours, consistent with the energy simulation output reports.

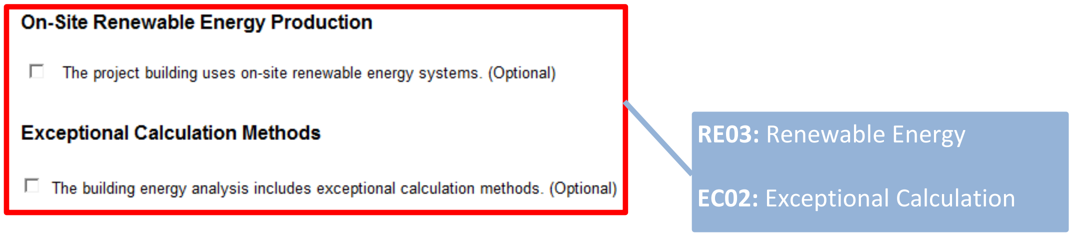
Unmet Loads	Baseline	Proposed
Number of hours heating loads not met	269	102
Number of hours cooling loads not met	0	125
Totals	269	227
Compliance	Yes	

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. the energy modeler. All project energy types and the demand and consumption units must be entered before entering energy simulation output data. Also enter the or site energy consumption and source energy consumption (generally, the IP units are Btu x 10^6, the SI site energy units are kWh, and the SI source energy

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 5.38, 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

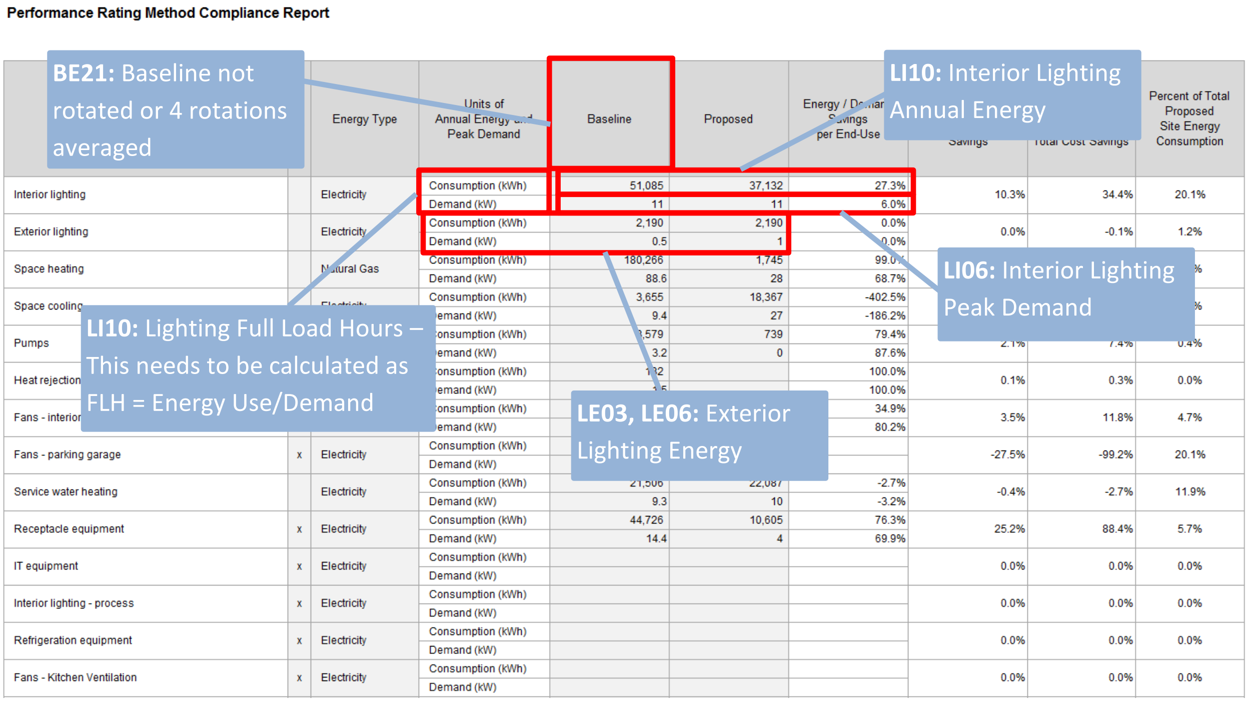
☐ The project building uses on-site renewable energy systems. (Optional)

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 / D[illegible] Savings per End-Use	Savings	Total Cost Savings	Percent of Total Proposed Site Energy Consumption
Interior lighting		Electricity	Consumption (kWh)	51,085	37,132	27.3%	10.3%	34.4%	20.1%
			Demand (kW)	11	11	6.0%			
Exterior lighting		Electricity	Consumption (kWh)	2,190	2,190	0.0%	0.0%	-0.1%	1.2%
			Demand (kW)	0.5	1	0.0%			
Space heating		Natural Gas	Consumption (kWh)	180,266	1,745	99.0	[illegible]	[illegible]	[illegible]%
			Demand (kW)	88.6	28	68.7%			
Space cooling		Electricity	Consumption (kWh)	3,655	18,367	-402.5%	[illegible]	[illegible]	[illegible]%
			emand (kW)	9.4	27	-186.2%			
Pumps		[illegible]	onsumption (kWh)	,579	739	79.4%	2.1%	7.4%	0.4%
			emand (kW)	3.2	0	87.6%			
Heat rejection		[illegible]	onsumption (kWh)	1[illegible]2		100.0%	0.1%	0.3%	0.0%
			emand (kW)	[illegible]		100.0%			
Fans - interior		[illegible]	onsumption (kWh)	[illegible]	[illegible]	34.9%	3.5%	11.8%	4.7%
			emand (kW)	[illegible]	[illegible]	80.2%			
Fans - parking garage	x	Electricity	Consumption (kWh)	[illegible]	[illegible]		-27.5%	-99.2%	20.1%
			Demand (kW)	[illegible]	[illegible]				
Service water heating		Electricity	Consumption (kWh)	21,506	22,087	-2.7%	-0.4%	-2.7%	11.9%
			Demand (kW)	9.3	10	-3.2%			
Receptacle equipment	x	Electricity	Consumption (kWh)	44,726	10,605	76.3%	25.2%	88.4%	5.7%
			Demand (kW)	14.4	4	69.9%			
IT equipment	x	Electricity	Consumption (kWh)				0.0%	0.0%	0.0%
			Demand (kW)						
Interior lighting - process	x	Electricity	Consumption (kWh)				0.0%	0.0%	0.0%
			Demand (kW)						
Refrigeration equipment	x	Electricity	Consumption (kWh)				0.0%	0.0%	0.0%
			Demand (kW)						
Fans - Kitchen Ventilation	x	Electricity	Consumption (kWh)				0.0%	0.0%	0.0%
			Demand (kW)						

BE21: Baseline not rotated or 4 rotations averaged

LI10: Interior Lighting Annual Energy

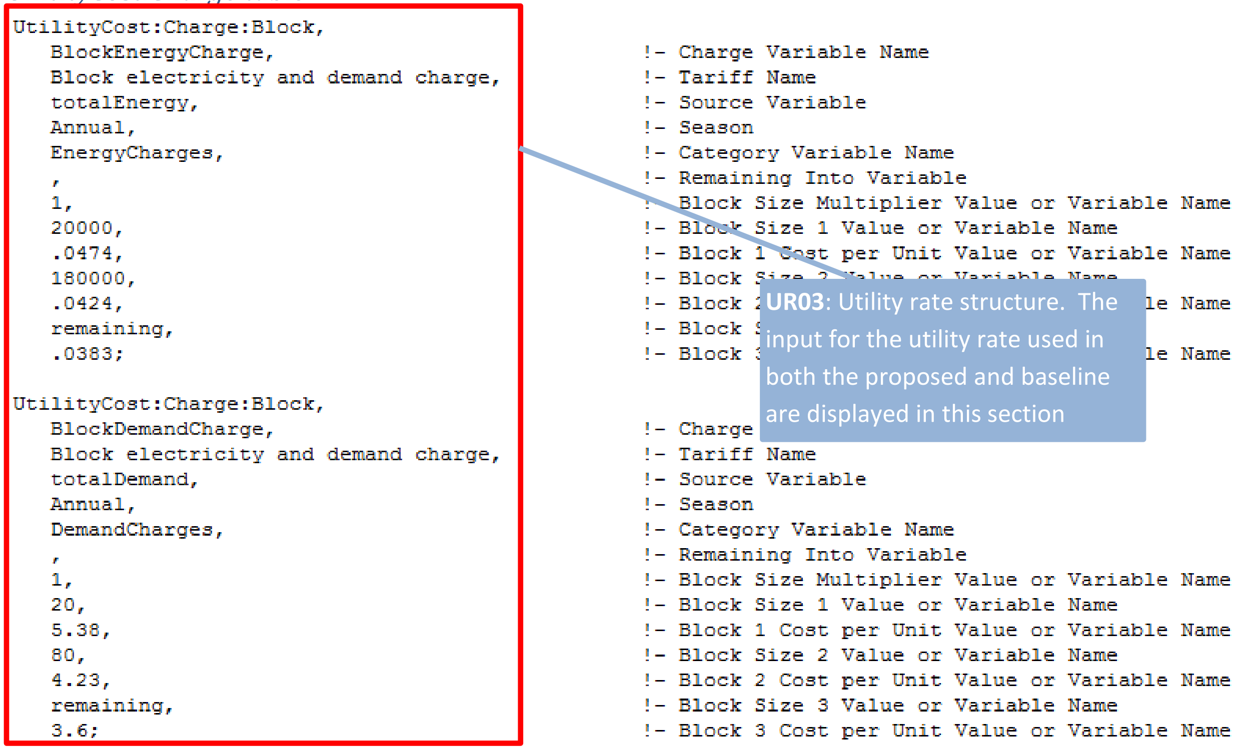
LI06: Interior Lighting Peak Demand

LI10: Lighting Full Load Hours – This needs to be calculated as FLH = Energy Use/Demand

LE03, LE06: Exterior Lighting Energy

EnergyPlus Input Data idf file

UnitityCost:Charge table



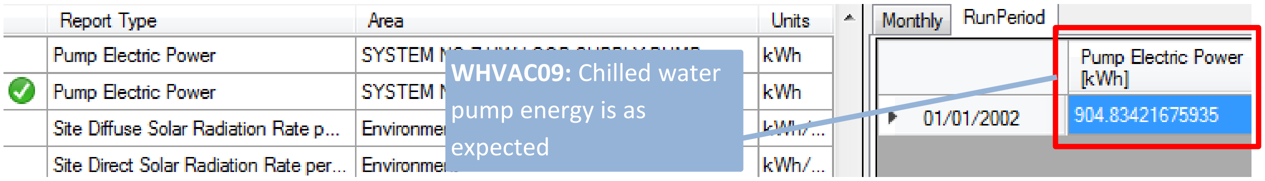
```
UtilityCost:Charge:Block,
   BlockEnergyCharge,                                 !- Charge Variable Name
   Block electricity and demand charge,               !- Tariff Name
   totalEnergy,                                       !- Source Variable
   Annual,                                            !- Season
   EnergyCharges,                                     !- Category Variable Name
   ,                                                  !- Remaining Into Variable
   1,                                                 !- Block Size Multiplier Value or Variable Name
   20000,                                             !- Block Size 1 Value or Variable Name
   .0474,                                             !- Block 1 Cost per Unit Value or Variable Name
   180000,                                            !- Block Size 2 Value or Variable Name
   .0424,                                             !- Block 2                         le Name
   remaining,                                         !- Block S
   .0383;                                             !- Block 3                         le Name

UtilityCost:Charge:Block,
   BlockDemandCharge,                                 !- Charge
   Block electricity and demand charge,               !- Tariff Name
   totalDemand,                                       !- Source Variable
   Annual,                                            !- Season
   DemandCharges,                                     !- Category Variable Name
   ,                                                  !- Remaining Into Variable
   1,                                                 !- Block Size Multiplier Value or Variable Name
   20,                                                !- Block Size 1 Value or Variable Name
   5.38,                                              !- Block 1 Cost per Unit Value or Variable Name
   80,                                                !- Block Size 2 Value or Variable Name
   4.23,                                              !- Block 2 Cost per Unit Value or Variable Name
   remaining,                                         !- Block Size 3 Value or Variable Name
   3.6;                                               !- 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

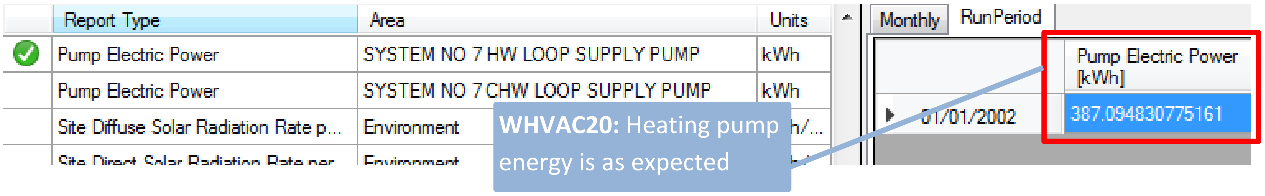


	Report Type	Area	Units
	Pump Electric Power	SYSTEM N	kWh
✓	Pump Electric Power	SYSTEM N	kWh
	Site Diffuse Solar Radiation Rate p...	Environme	kWh/...
	Site Direct Solar Radiation Rate per...	Environme	kWh/...

	Pump Electric Power [kWh]
01/01/2002	904.83421675935

WHVAC09: Chilled water pump energy is as expected

Heating Pump Energy

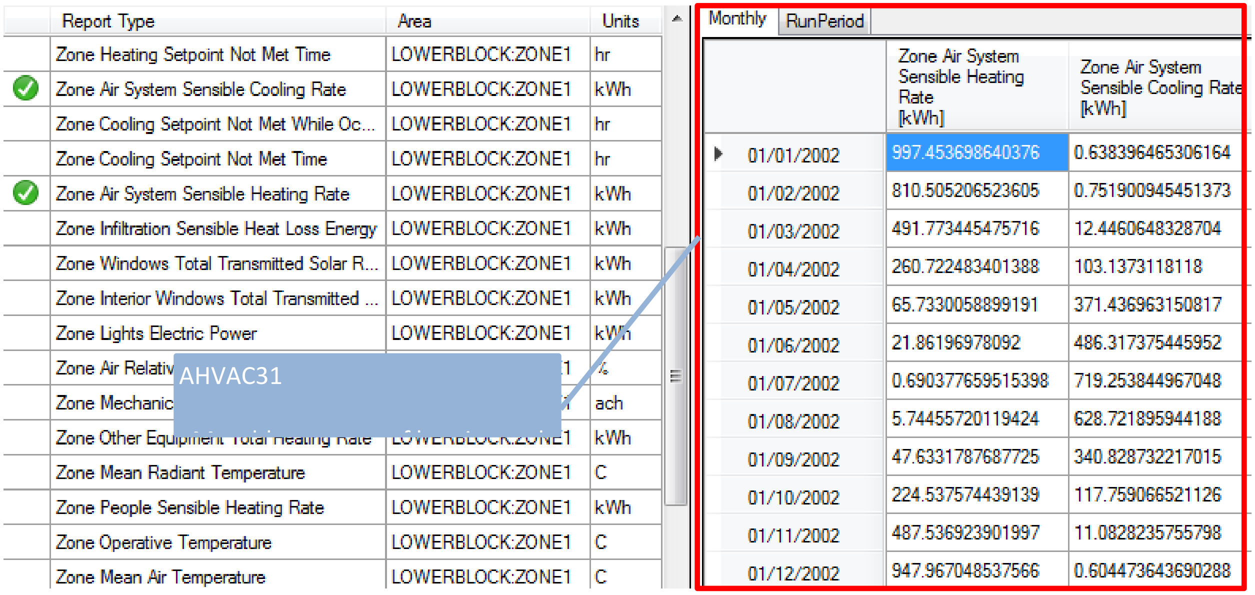


	Report Type	Area	Units
✓	Pump Electric Power	SYSTEM NO 7 HW LOOP SUPPLY PUMP	kWh
	Pump Electric Power	SYSTEM NO 7 CHW LOOP SUPPLY PUMP	kWh
	Site Diffuse Solar Radiation Rate p...	Environment	h/...
	Site Direct Solar Radiation Rate per	Environment	

	Pump Electric Power [kWh]
01/01/2002	387.094830775161

WHVAC20: Heating pump energy is as expected

Monthly heating and cooling loads - simultaneous heating and cooling check

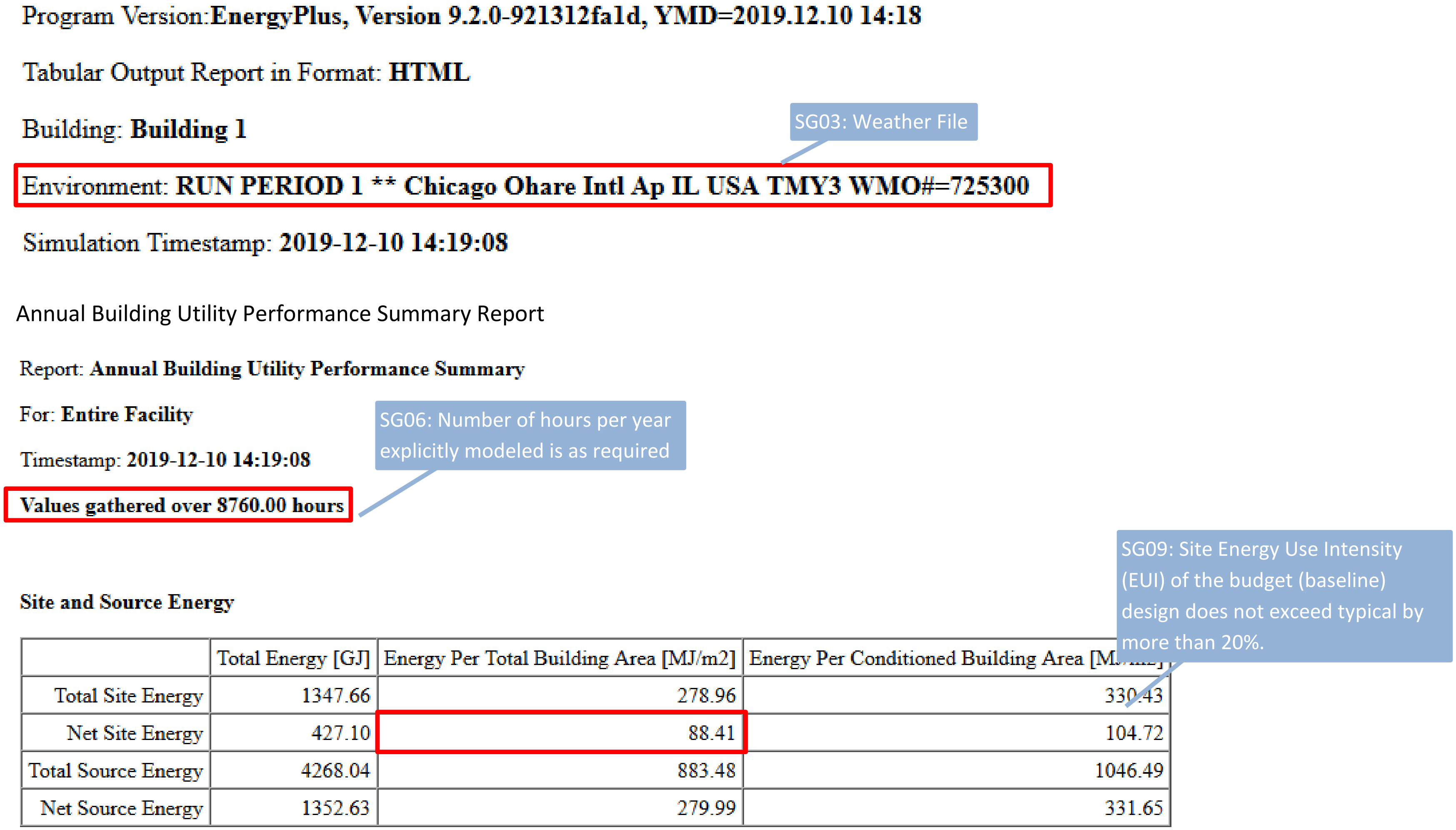


AHVAC31

	Report Type	Area	Units
	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 Relativ	1	%
	Zone Mechanic		ach
	Zone Other 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

	Zone Air System Sensible Heating Rate [kWh]	Zone Air System Sensible Cooling Rate [kWh]
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 9.2.0-921312fa1d, YMD=2019.12.10 14:18**

Tabular Output Report in Format: **HTML**

Building: **Building 1**

Environment: **RUN PERIOD 1 ** Chicago Ohare Intl Ap IL USA TMY3 WMO#=725300**

SG03: Weather File

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**

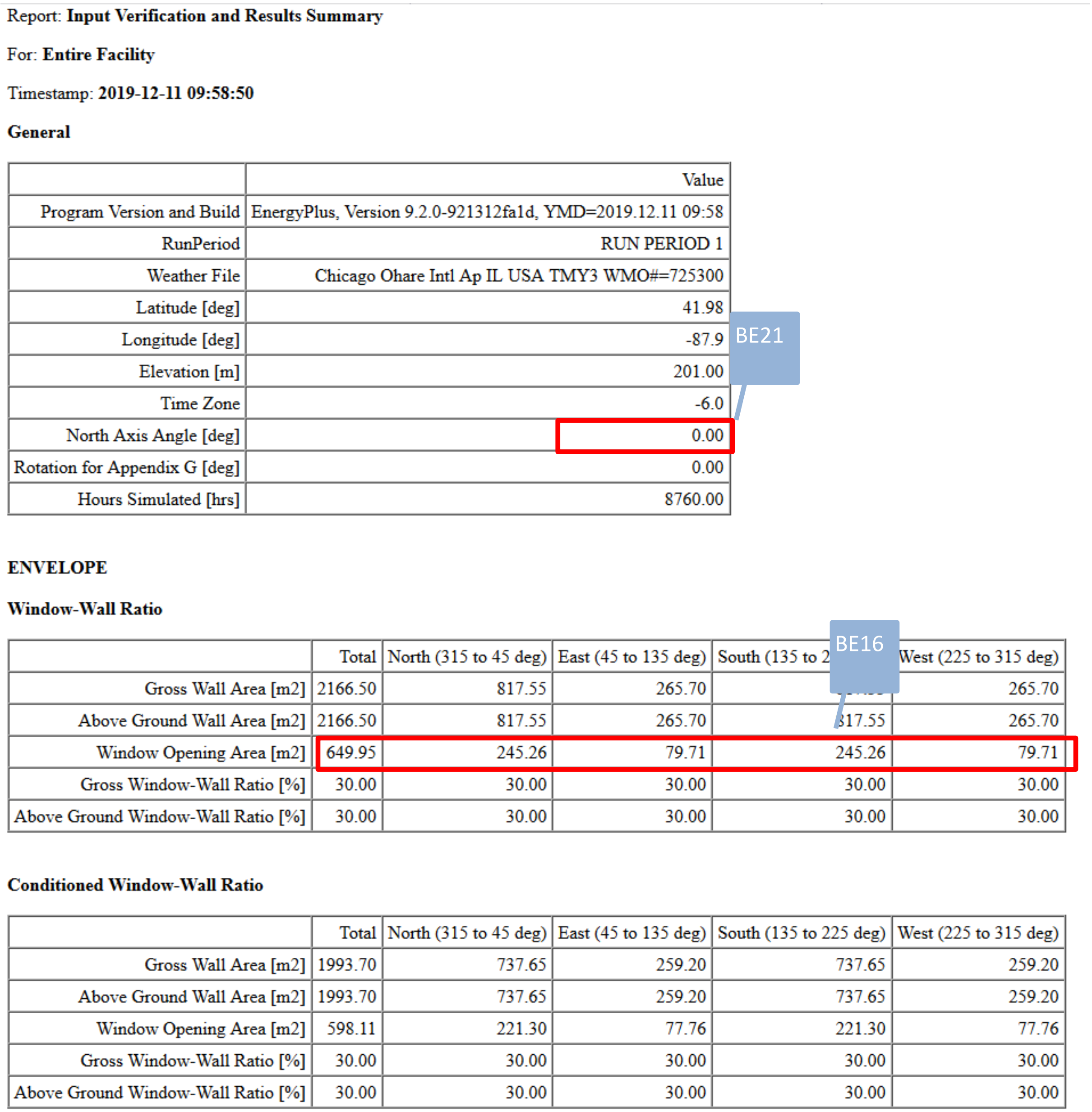
Values gathered over 8760.00 hours

SG06: Number of hours per year explicitly modeled is as required

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [M
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

SG09: Site Energy Use Intensity (EUI) of the budget (baseline) design does not exceed typical by more than 20%.



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

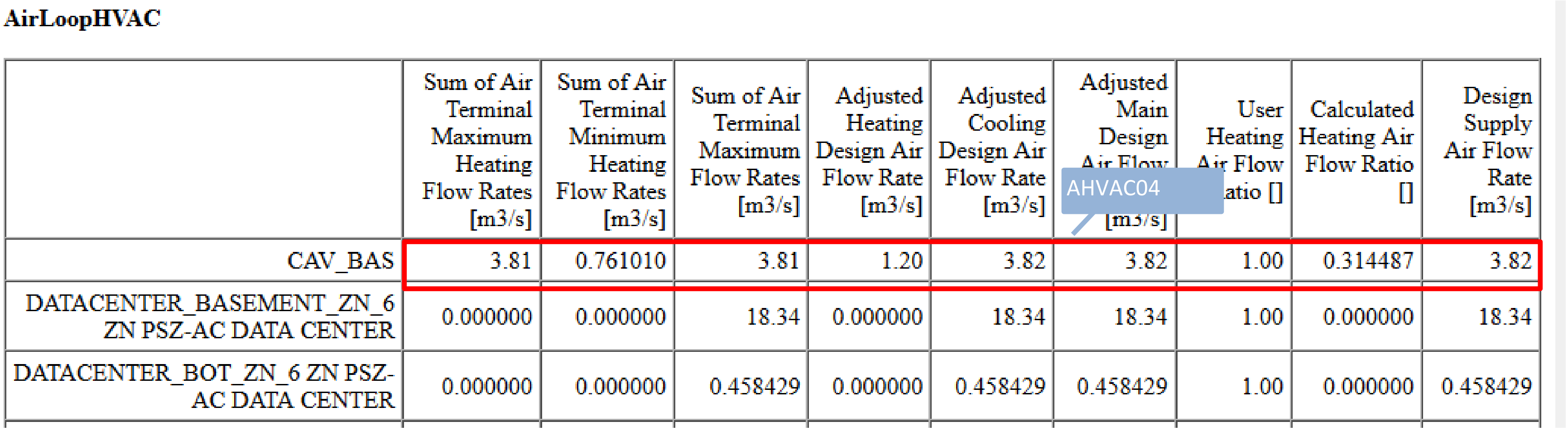
	Total	North (315 to 45 deg)	East (45 to 135 deg)	South (135 to 2	West (225 to 315 deg)
Gross Wall Area [m2]	2166.50	817.55	265.70	[illegible]	265.70
Above Ground Wall Area [m2]	2166.50	817.55	265.70	817.55	265.70
Window Opening Area [m2]	649.95	245.26	79.71	245.26	79.71
Gross Window-Wall Ratio [%]	30.00	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

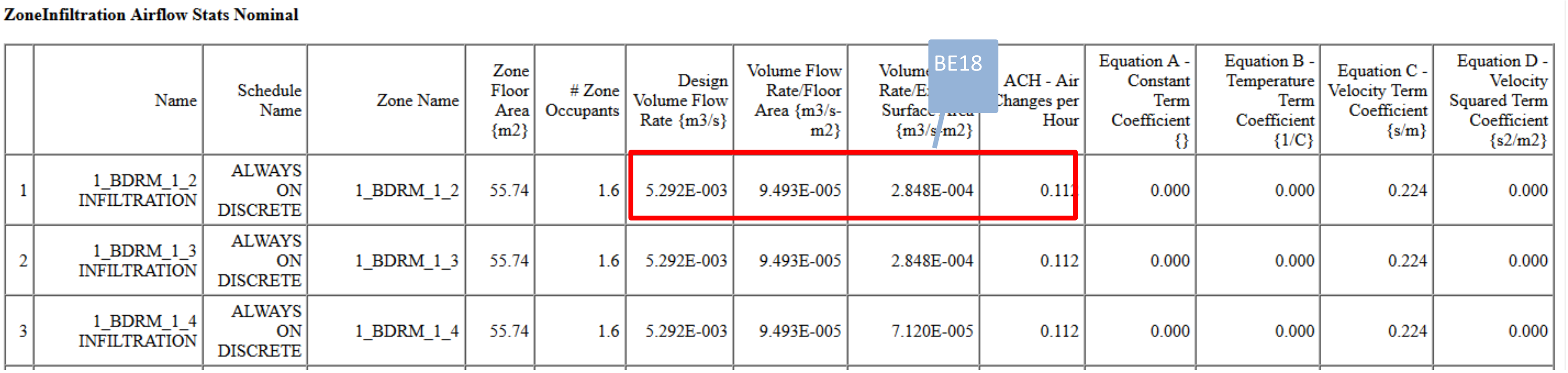
Component Sizing Summary Report



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 atio []	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

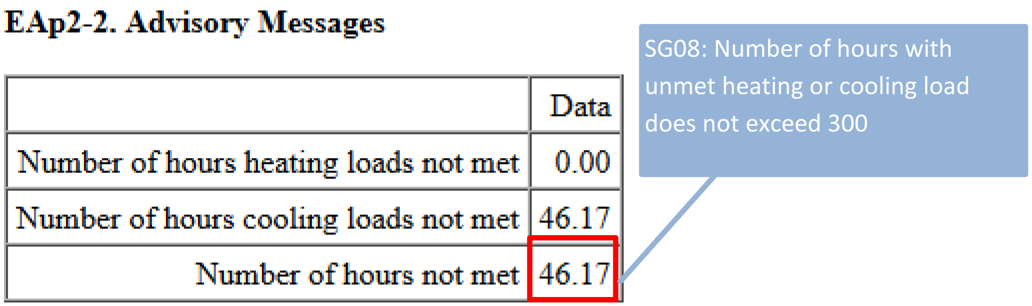
Initialization Summary Report



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}	Volum Rate/E Surfac {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	0.11	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

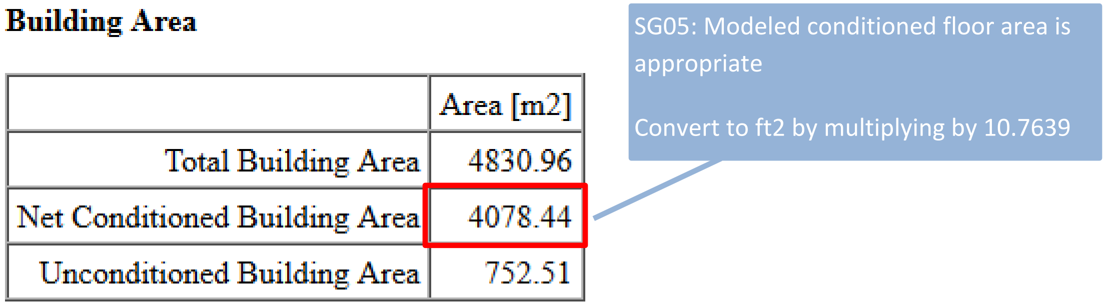
LEED Summary Report



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

	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.

L-1. Renewable Energy Source Summary

	Rated Capacity [kW]	Annual Energy Generated [GJ]
Photovoltaic	0.00	959.08
Wind	0.00	0.00

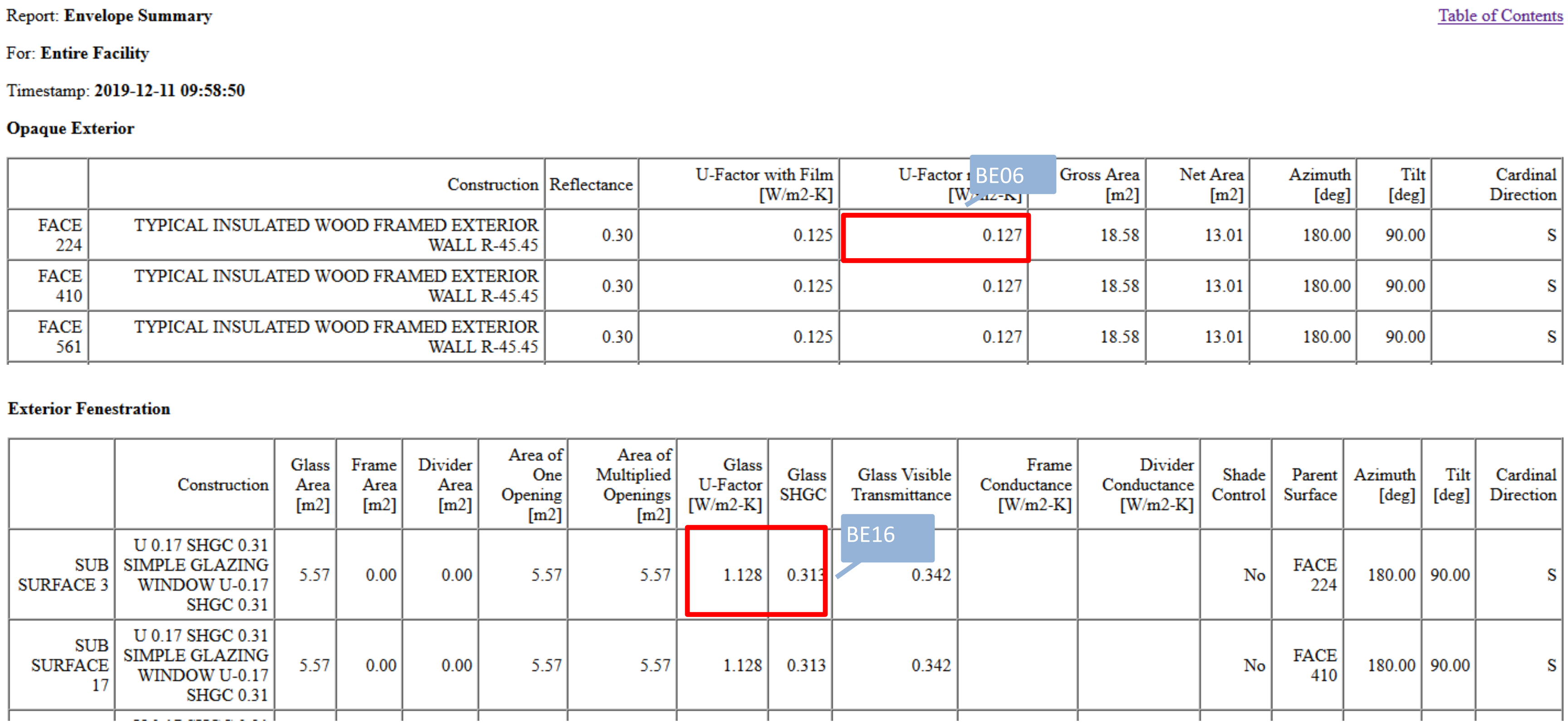
EAp2-17a. Energy Use Intensity - Electricity

	Electricty [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**

Table of Contents

For: **Entire Facility**

Timestamp: **2019-12-11 09:58:50**

Opaque Exterior

	Construction	Reflectance	U-Factor with Film [W/m2-K]	U-Factor no Film [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

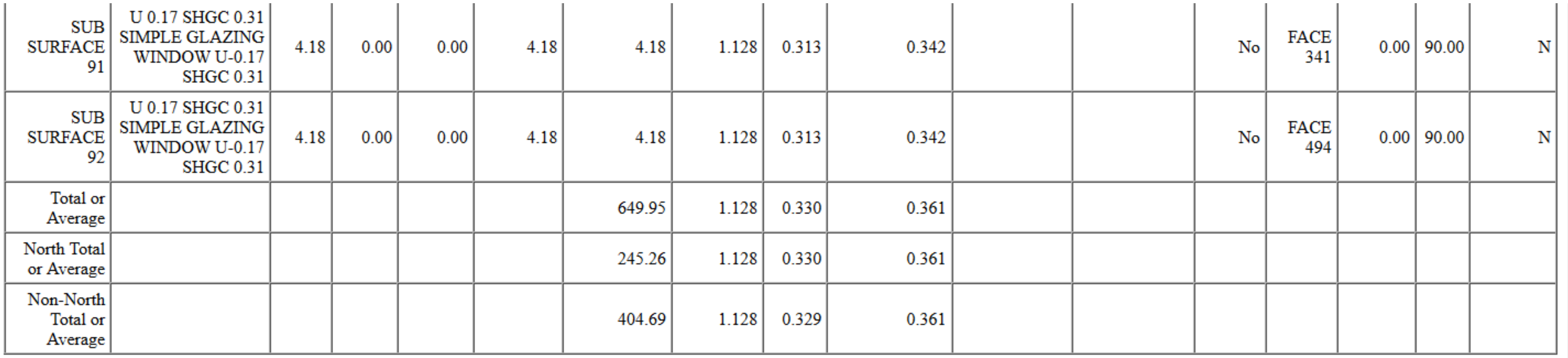
BE06

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

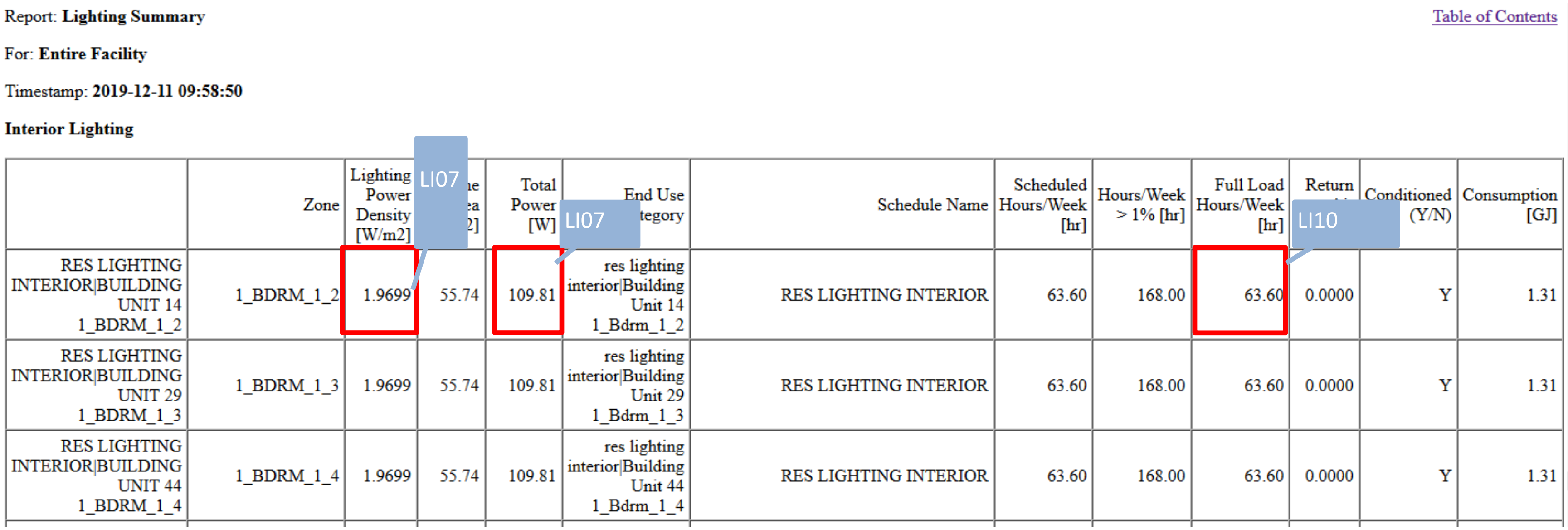
BE16

…



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**

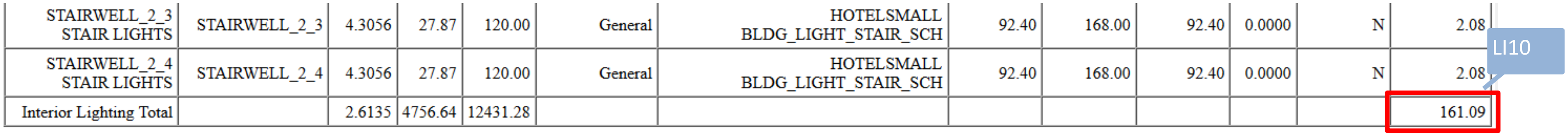
For: **Entire Facility**

Timestamp: **2019-12-11 09:58:50**

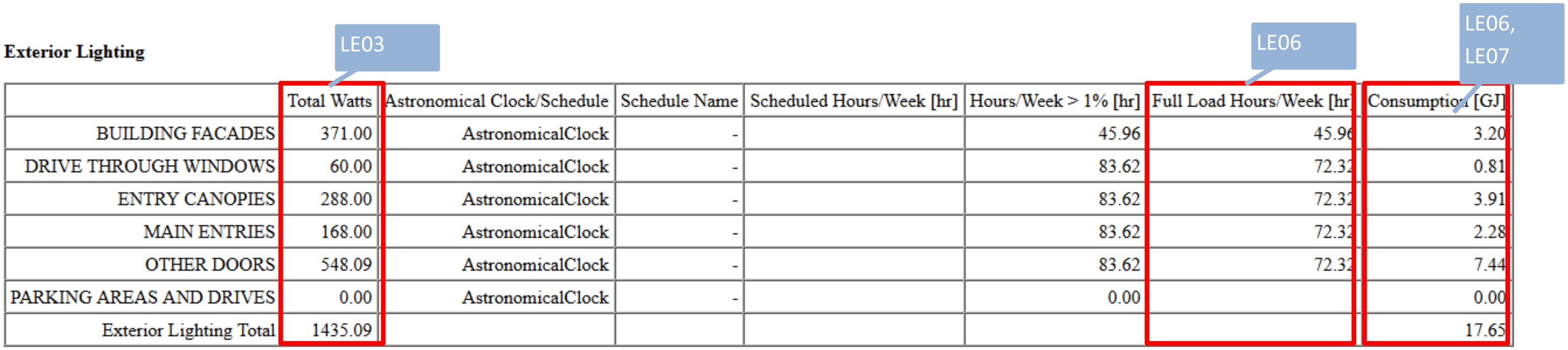
Interior Lighting

	Zone	Lighting Power Density [W/m2]	ne ea 2]	Total Power [W]	End Use tegory	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

…



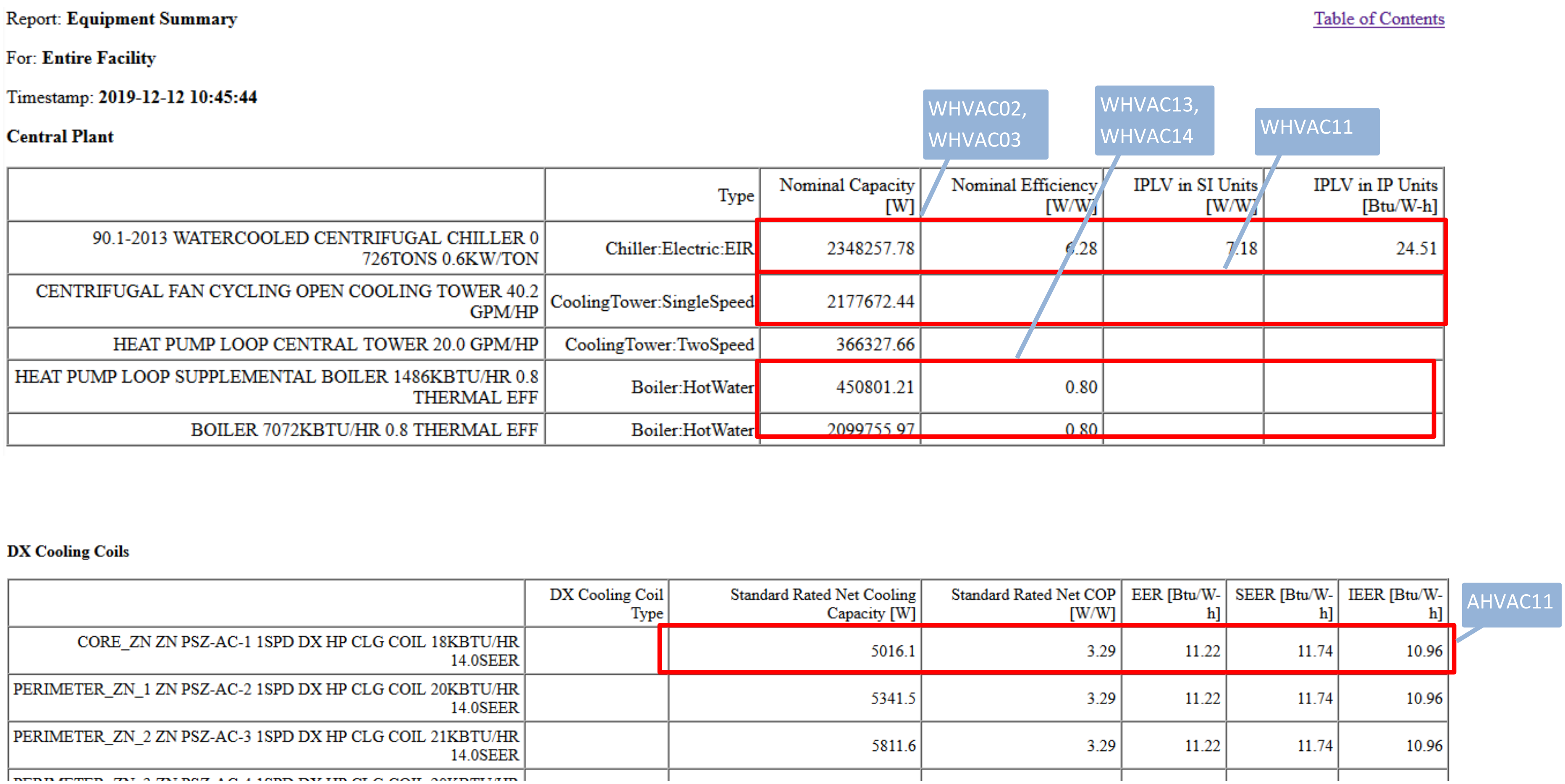
STAIRWELL_2_3 STAIR LIGHTS	STAIRWELL_2_3	4.3056	27.87	120.00	General	HOTELSMALL BLDG_LIGHT_STAIR_SCH	92.40	168.00	92.40	0.0000	N	2.08
STAIRWELL_2_4 STAIR LIGHTS	STAIRWELL_2_4	4.3056	27.87	120.00	General	HOTELSMALL BLDG_LIGHT_STAIR_SCH	92.40	168.00	92.40	0.0000	N	2.08
Interior Lighting Total		2.6135	4756.64	12431.28								161.09



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

Equipment Summary Report



Report: **Equipment Summary**

Table of Contents

For: **Entire Facility**

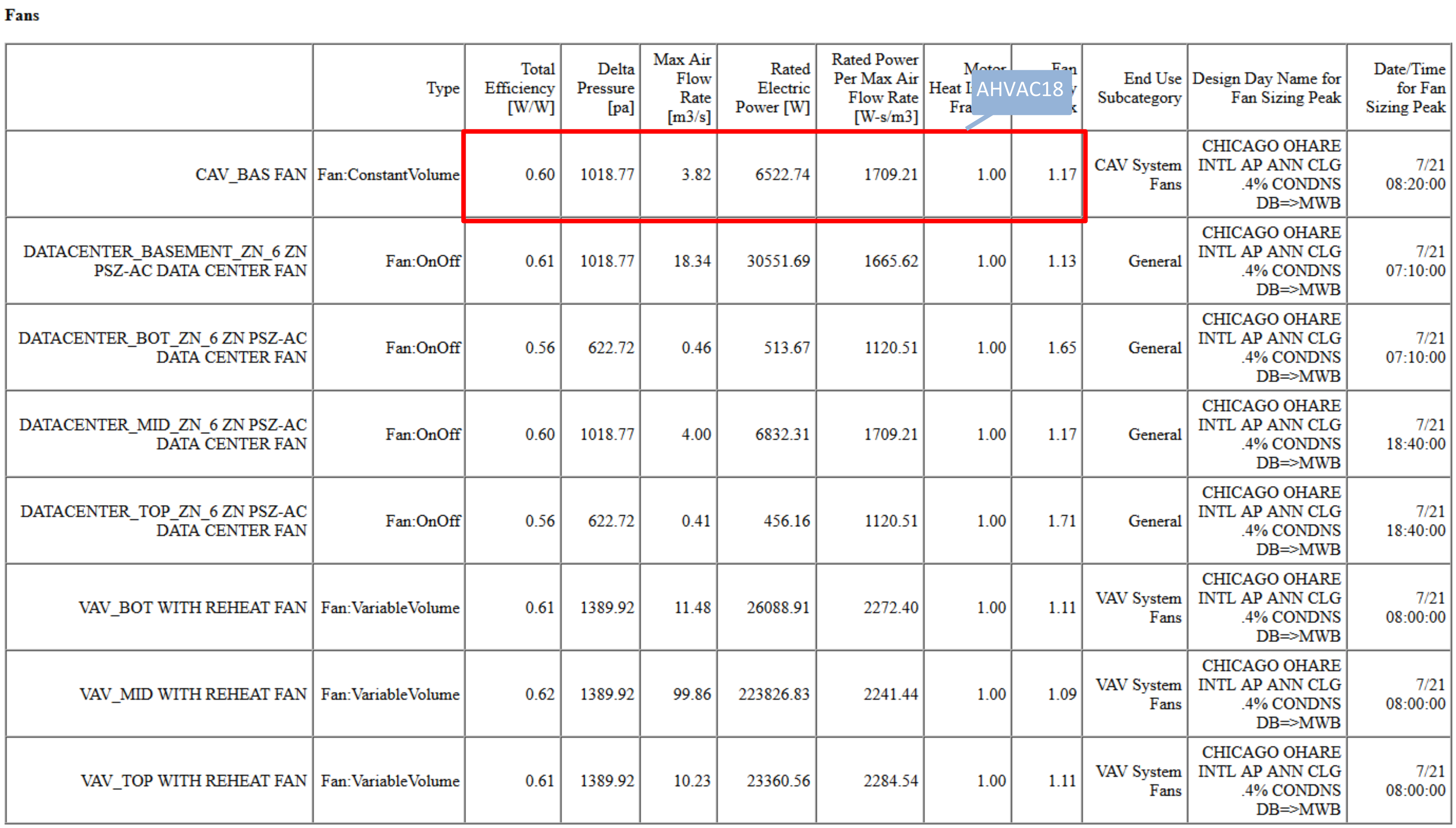
Timestamp: **2019-12-12 10:45:44**

Central Plant

	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		

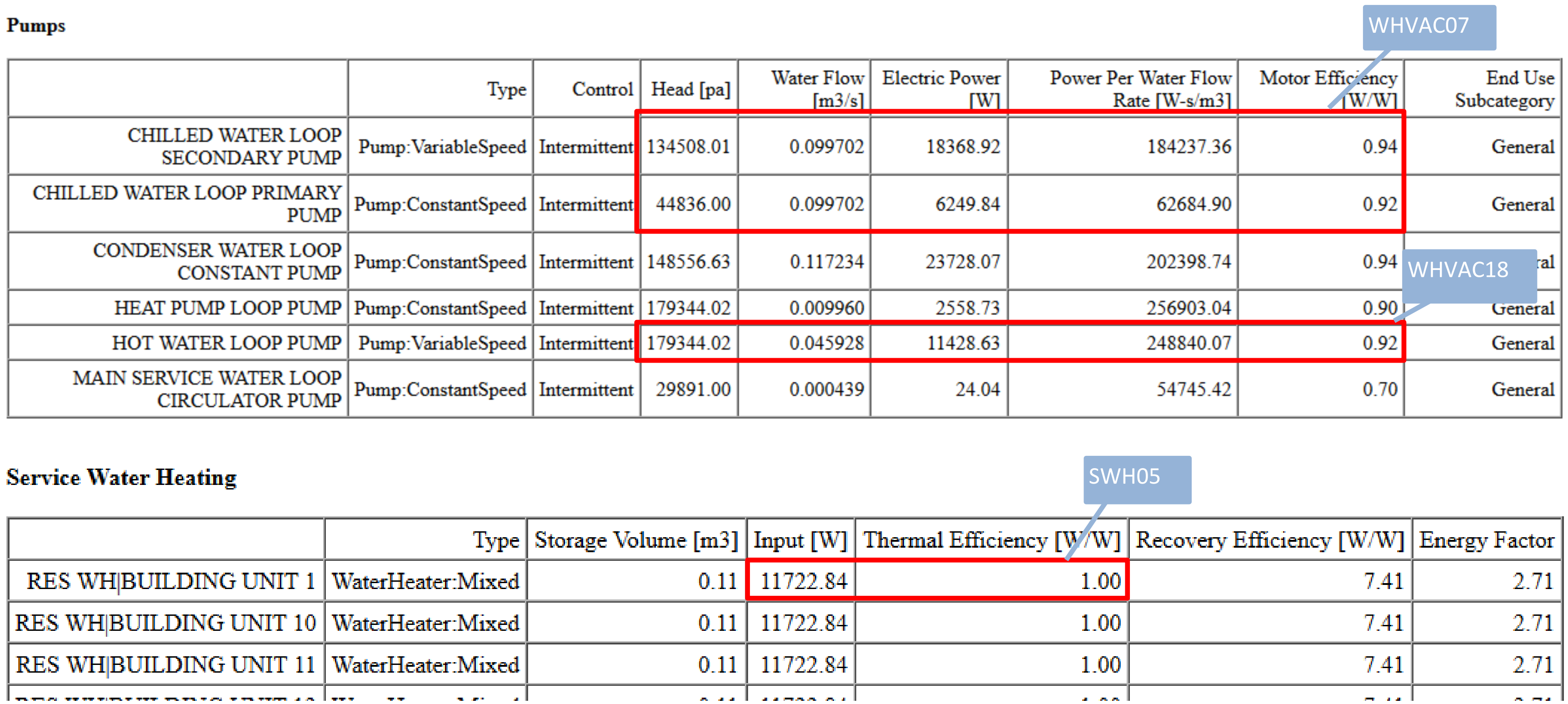
DX Cooling Coils

	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



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 Fra	Fan y k	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

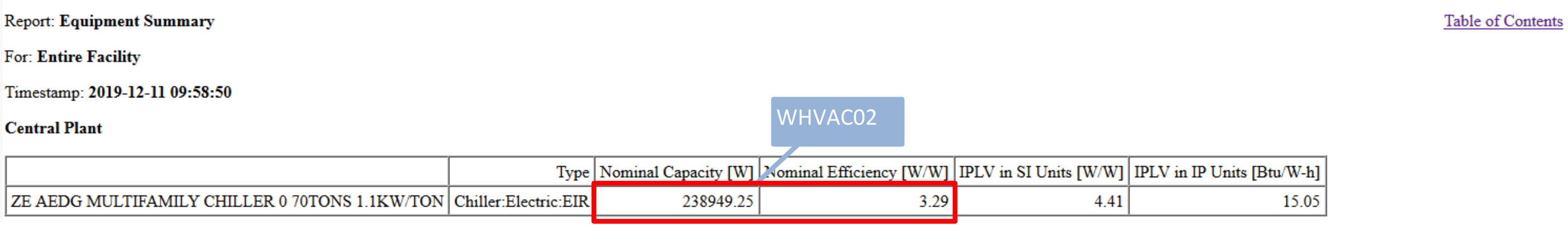


Pumps

	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	al
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

Service Water Heating

	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**

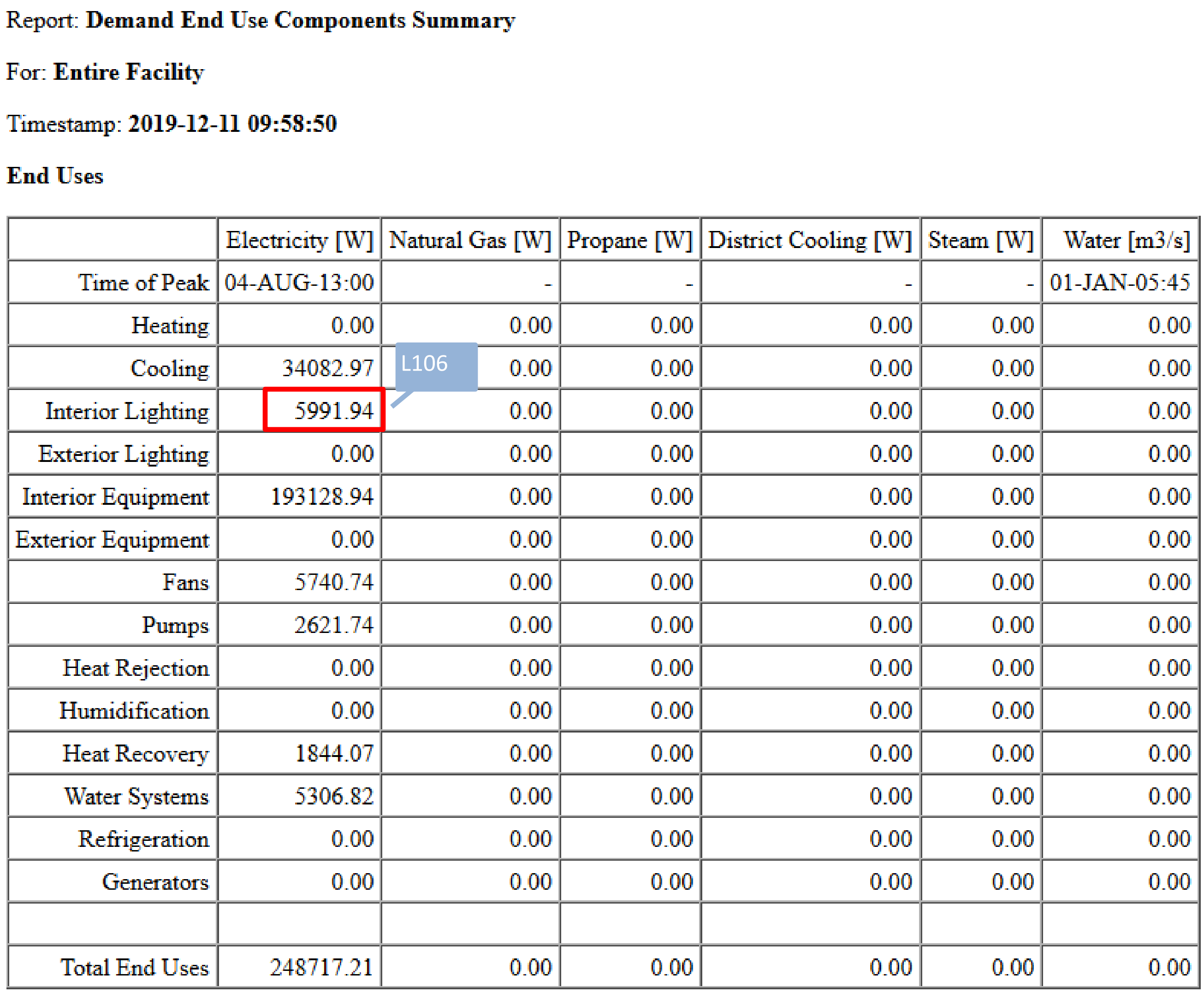
For: **Entire Facility**

Timestamp: **2019-12-11 09:58:50**

Central Plant

	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	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

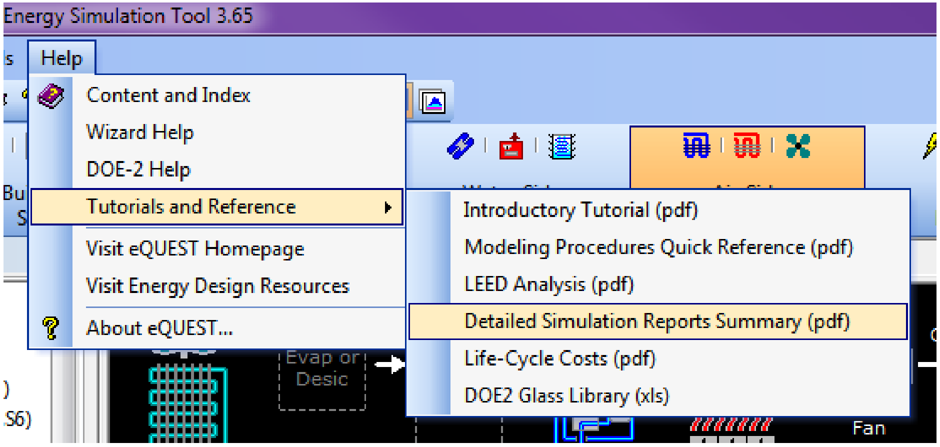
eQUEST

Resources

eQUEST Resources

1. eQUEST is free and can be downloaded from DOE2 website[25].
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

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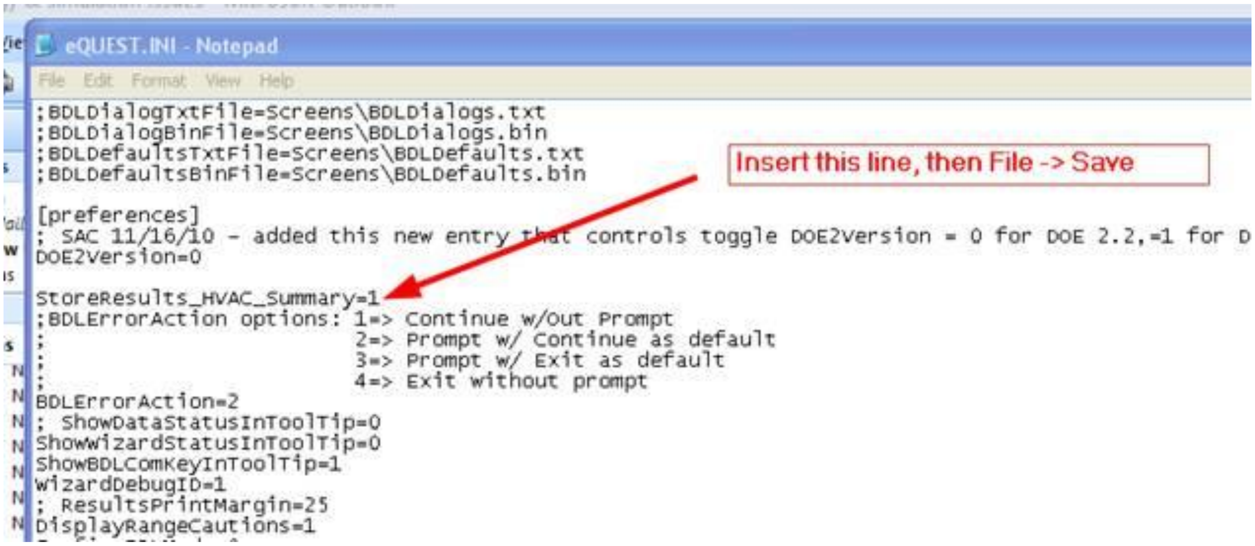
[25] http://www.doe2.com/equest/

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.



```
;BDLDialogTxtFile=Screens\BDLDialogs.txt
;BDLDialogBinFile=Screens\BDLDialogs.bin
;BDLDefaultsTxtFile=Screens\BDLDefaults.txt
;BDLDefaultsBinFile=Screens\BDLDefaults.bin

[preferences]
; SAC 11/16/10 - added this new entry that controls toggle DOE2Version = 0 for DOE 2.2,=1 for D
DOE2Version=0

StoreResults_HVAC_Summary=1
;BDLErrorAction options: 1=> Continue w/out Prompt
;                        2=> Prompt w/ Continue as default
;                        3=> Prompt w/ Exit as default
;                        4=> Exit without prompt
BDLErrorAction=2
; ShowDataStatusInToolTip=0
ShowWizardStatusInToolTip=0
ShowBDLComKeyInToolTip=1
WizardDebugID=1
; ResultsPrintMargin=25
DisplayRangeCautions=1
```

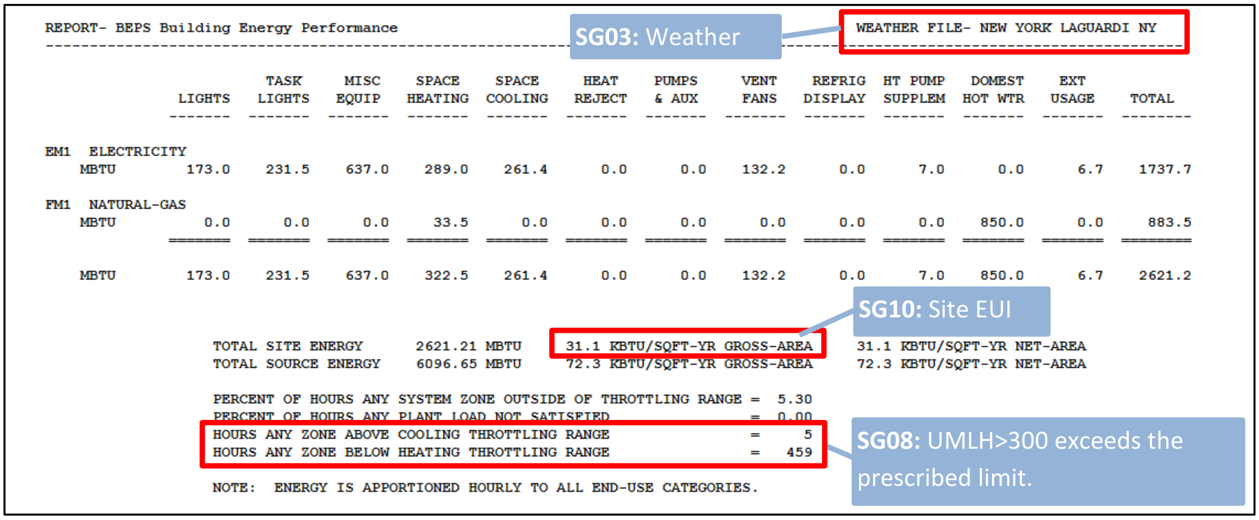
Simulation Reports to Be Submitted

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                          WEATHER FILE- NEW YORK LAGUARDI NY
---------------------------------------------------------------------------------------------------

                    TASK     MISC     SPACE    SPACE    HEAT     PUMPS    VENT     REFRIG   HT PUMP  DOMEST   EXT
          LIGHTS    LIGHTS   EQUIP    HEATING  COOLING  REJECT   & AUX    FANS     DISPLAY  SUPPLEM  HOT WTR  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

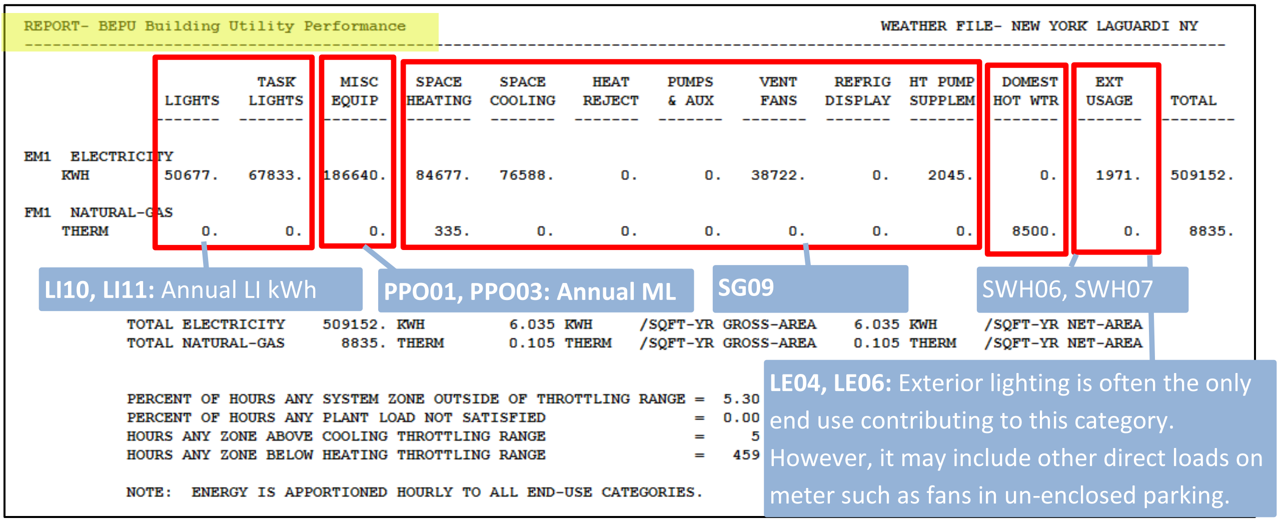


              TOTAL SITE ENERGY      2621.21 MBTU      31.1 KBTU/SQFT-YR GROSS-AREA     31.1 KBTU/SQFT-YR NET-AREA
              TOTAL SOURCE ENERGY    6096.65 MBTU      72.3 KBTU/SQFT-YR GROSS-AREA     72.3 KBTU/SQFT-YR NET-AREA

              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
---------------------------------------------------------------------------------------------------------------------

                    TASK      MISC     SPACE     SPACE      HEAT     PUMPS      VENT    REFRIG   HT PUMP    DOMEST       EXT
          LIGHTS    LIGHTS    EQUIP    HEATING   COOLING    REJECT   & AUX      FANS    DISPLAY  SUPPLEM   HOT WTR     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.

          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.
```

LI10, LI11: Annual LI kWh

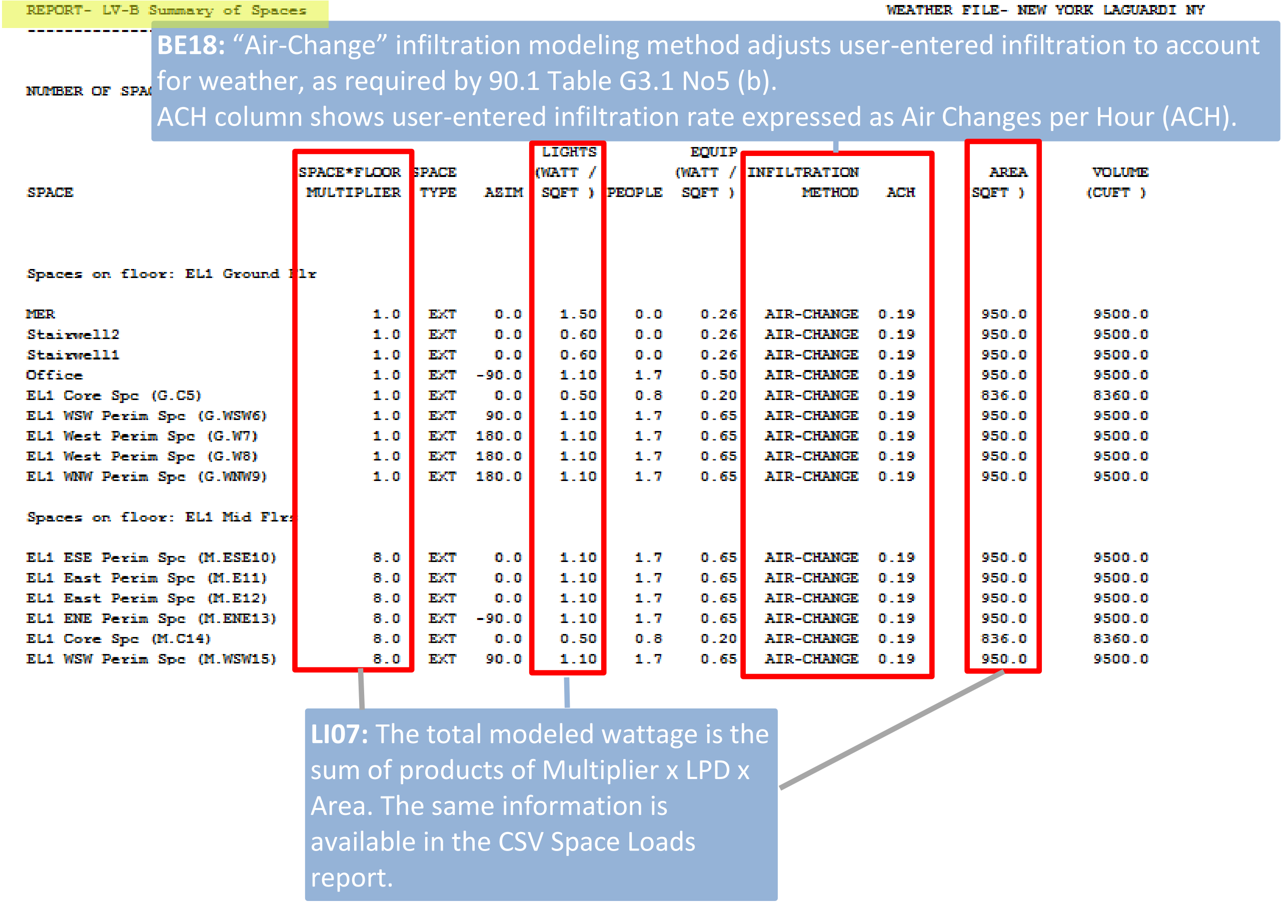
PPO01, PPO03: Annual ML

SG09

SWH06, SWH07

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



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REPORT- LV-B Summary of Spaces                                                        WEATHER FILE- NEW YORK LAGUARDI NY
--------------


NUMBER OF SPA


                                                          LIGHTS            EQUIP
                              SPACE*FLOOR  SPACE          (WATT /           (WATT /  INFILTRATION            AREA        VOLUME
SPACE                          MULTIPLIER   TYPE   AZIM    SQFT )  PEOPLE    SQFT )        METHOD    ACH     SQFT )      (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

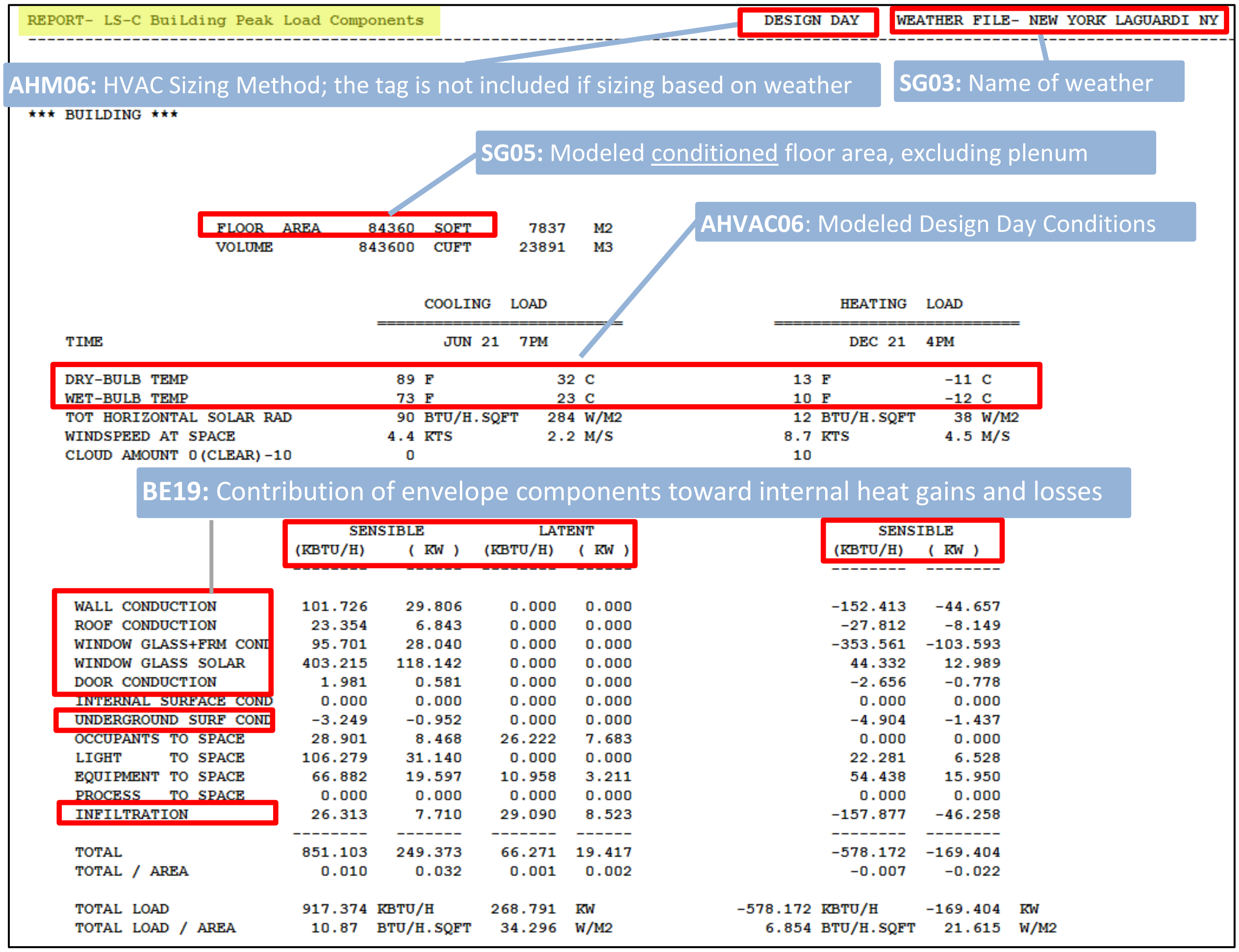
Spaces on floor: EL1 Mid Flr

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
```

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).

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



AHM06: HVAC Sizing Method; the tag is not included if sizing based on weather

SG03: Name of weather

SG05: Modeled conditioned floor area, excluding plenum

AHVAC06: Modeled Design Day Conditions

BE19: Contribution of envelope components toward internal heat gains and losses

```
REPORT- LS-C Building Peak Load Components                                    DESIGN DAY    WEATHER FILE- NEW YORK LAGUARDI NY
--------------------------------------------------------------------------------------------------------------------------------

*** BUILDING ***



                    FLOOR  AREA     84360  SQFT      7837   M2
                    VOLUME         843600  CUFT     23891   M3


                                          COOLING  LOAD                               HEATING  LOAD
                                     ==========================                ==========================
    TIME                                    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

                                  SENSIBLE            LATENT                              SENSIBLE
                            (KBTU/H)    ( KW )  (KBTU/H)  ( KW )                     (KBTU/H)  ( KW )
                            --------   -------  --------  ------                     --------  --------

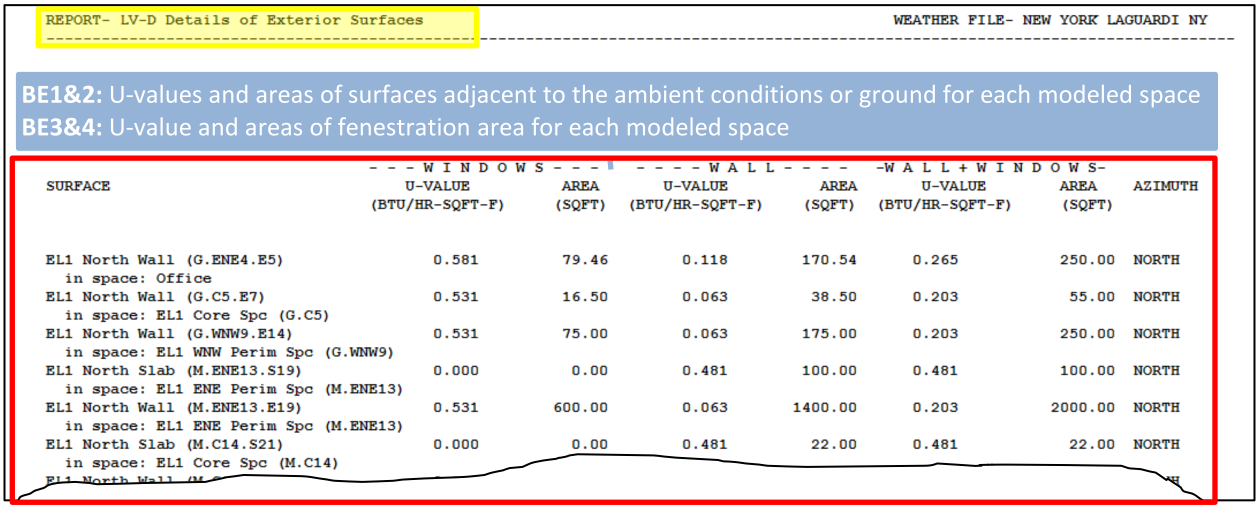
     WALL CONDUCTION         101.726    29.806     0.000   0.000                     -152.413   -44.657
     ROOF CONDUCTION          23.354     6.843     0.000   0.000                      -27.812    -8.149
     WINDOW GLASS+FRM CONI    95.701    28.040     0.000   0.000                     -353.561  -103.593
     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 CONI    -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  KW
     TOTAL LOAD / AREA        10.87  BTU/H.SQFT   34.296  W/M2                6.854 BTU/H.SQFT   21.615  W/M2
```

Notes:

1. 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



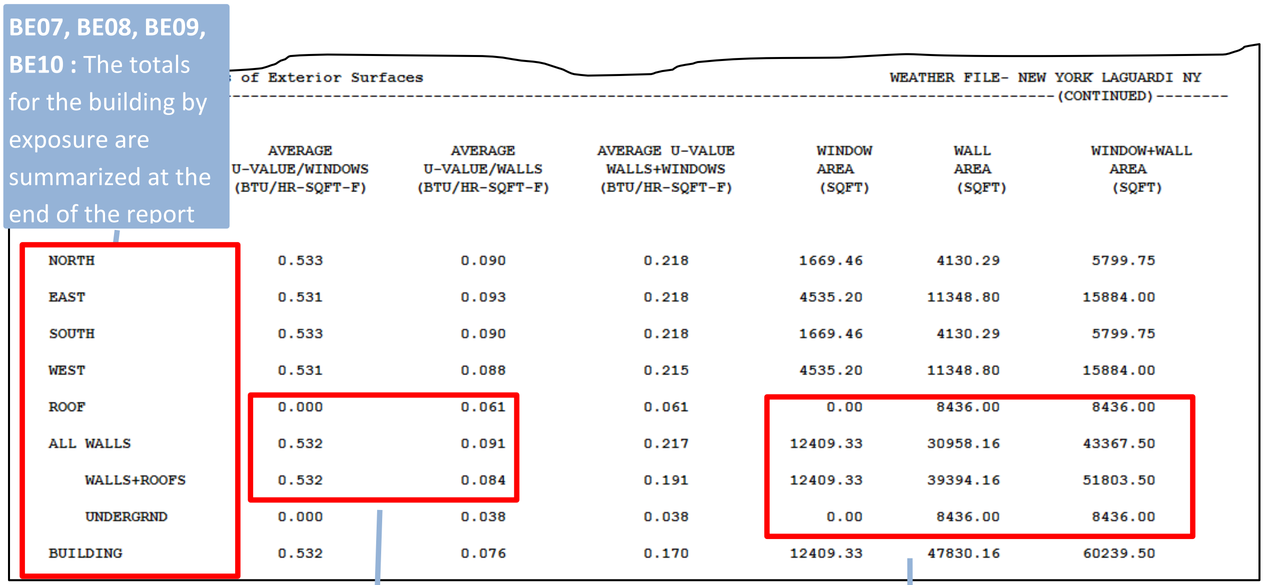
```
REPORT- LV-D Details of Exterior Surfaces                                WEATHER FILE- NEW YORK LAGUARDI NY
```

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

```
                                   - - - W I N D O W S - - -   - - - - W A L L - - - -   -W A L L + W I N D O W S-
SURFACE                                U-VALUE        AREA      U-VALUE        AREA      U-VALUE        AREA   AZIMUTH
                                   (BTU/HR-SQFT-F)   (SQFT)  (BTU/HR-SQFT-F)  (SQFT)  (BTU/HR-SQFT-F)  (SQFT)


EL1 North Wall (G.ENE4.E5)             0.581         79.46      0.118        170.54      0.265        250.00  NORTH
  in space: Office
EL1 North Wall (G.C5.E7)               0.531         16.50      0.063         38.50      0.203         55.00  NORTH
  in space: EL1 Core Spc (G.C5)
EL1 North Wall (G.WNW9.E14)            0.531         75.00      0.063        175.00      0.203        250.00  NORTH
  in space: EL1 WNW Perim Spc (G.WNW9)
EL1 North Slab (M.ENE13.S19)           0.000          0.00      0.481        100.00      0.481        100.00  NORTH
  in space: EL1 ENE Perim Spc (M.ENE13)
EL1 North Wall (M.ENE13.E19)           0.531        600.00      0.063       1400.00      0.203       2000.00  NORTH
  in space: EL1 ENE Perim Spc (M.ENE13)
EL1 North Slab (M.C14.S21)             0.000          0.00      0.481         22.00      0.481         22.00  NORTH
  in space: EL1 Core Spc (M.C14)
EL1 North Wall
```

BE07, BE08, BE09, BE10 : The totals for the building by exposure are summarized at the end of the report



```
of Exterior Surfaces                                                   WEATHER FILE- NEW YORK LAGUARDI NY
------------------------------------------------------------------------------------------(CONTINUED)--------

                  AVERAGE            AVERAGE        AVERAGE U-VALUE     WINDOW       WALL      WINDOW+WALL
              U-VALUE/WINDOWS     U-VALUE/WALLS     WALLS+WINDOWS        AREA        AREA         AREA
              (BTU/HR-SQFT-F)    (BTU/HR-SQFT-F)   (BTU/HR-SQFT-F)      (SQFT)      (SQFT)       (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

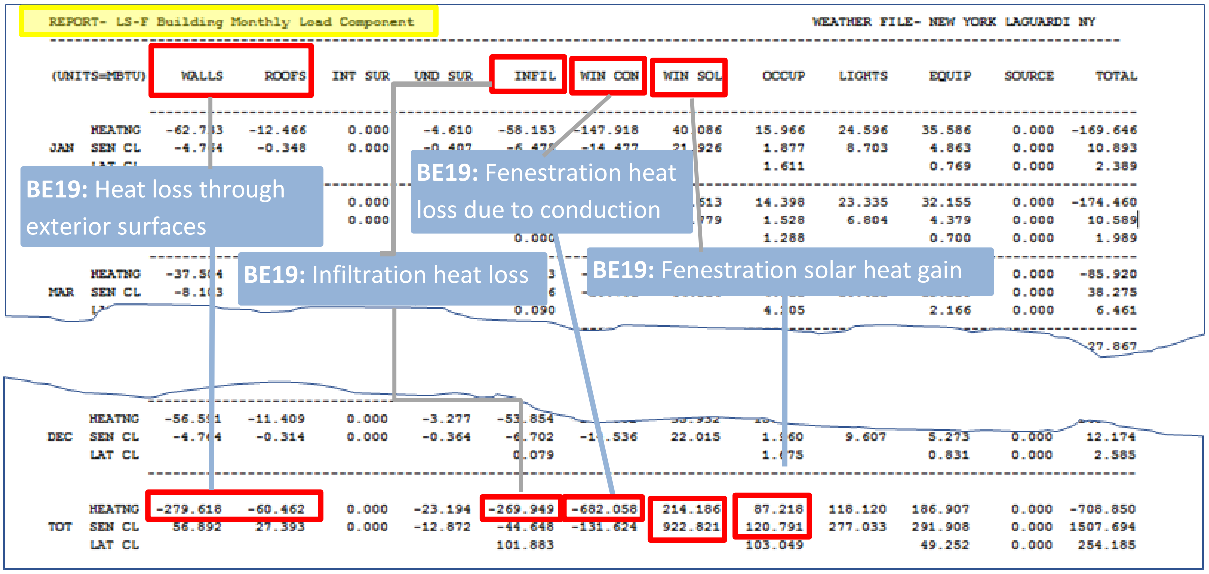
BE06, BE07: The model has the following total surface areas: 12,409 ft^2 windows; 51,804 ft^2 gross exterior wall including windows; 8,436 ft^2 roof area; 8,436 ft^2 below grade walls, floor and slab-on-grade.

BE14: Modeled WWR is 12409/43368=28.6%

Notes:

1. 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
              ----------------------------------------------------------------------------------------------------------------------
     HEATNG    -62.7 3   -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     -4.7 4    -0.348     0.000                                  21 926     1.877     8.703     4.863     0.000    10.893
                                                                                       1.611               0.769     0.000     2.389
                                  --------                                           ----------------------------------------------
                                     0.000                                     513    14.398    23.335    32.155     0.000  -174.460
                                     0.000                                     779     1.528     6.804     4.379     0.000    10.589
                                                                 0.000                 1.288               0.700     0.000     1.989
              --------                                                                                 -----------------------------
     HEATNG    -37.5 4                                                 3                                             0.000   -85.920
MAR  SEN CL     -8.1 3                                                 6                                             0.000    38.275
                                                                 0.090                 4. 05               2.166     0.000     6.461
                                                                                                                             27.867

              ----------------------------------------------------------------------------------------------------------------------
     HEATNG    -56.5 1   -11.409     0.000    -3.277   -53.854
DEC  SEN CL     -4.7 4    -0.314     0.000    -0.364    -6.702   -1 .536    22.015     1. 60     9.607     5.273     0.000    12.174
     LAT CL                                              0.079                         1. 75               0.831     0.000     2.585
              ----------------------------------------------------------------------------------------------------------------------

     HEATNG   -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
```

BE19: Heat loss through exterior surfaces

BE19: Fenestration heat loss due to conduction

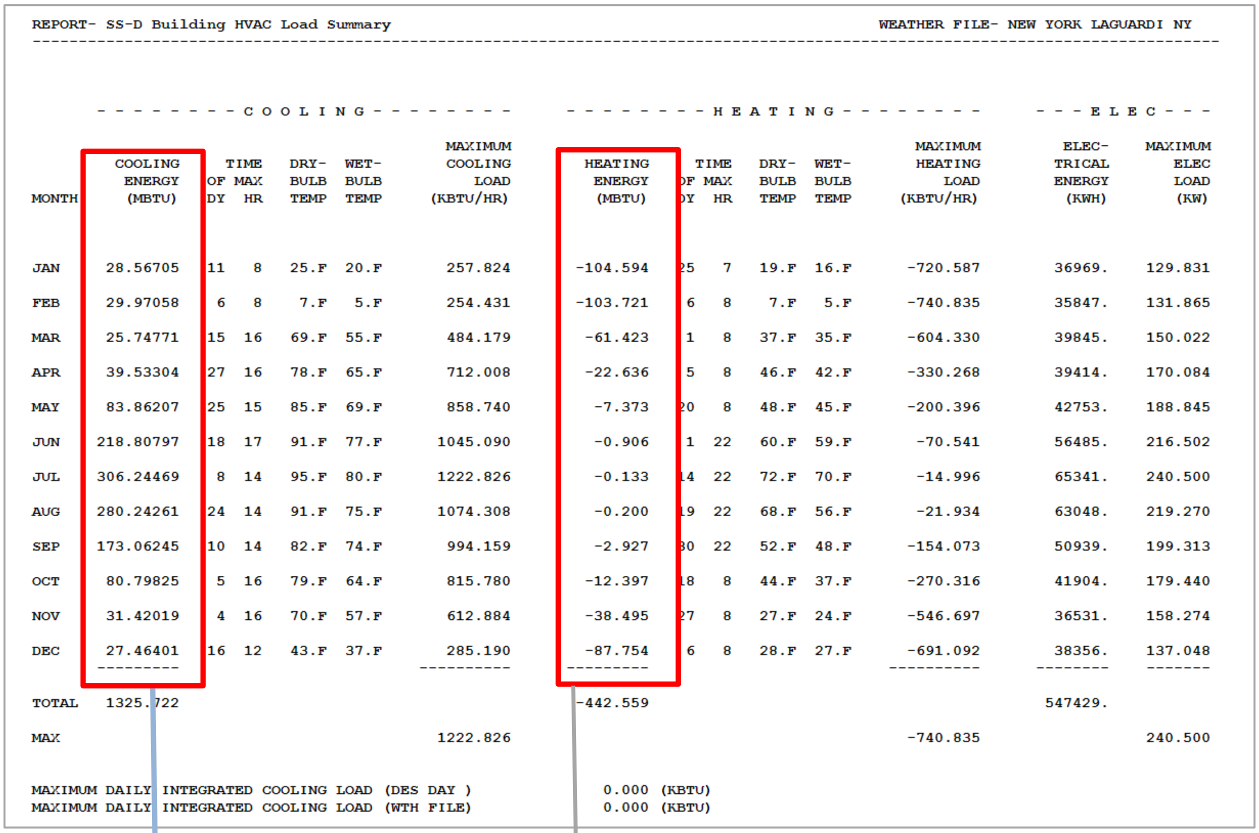
BE19: Infiltration heat loss

BE19: Fenestration solar heat gain

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



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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 - - -

                                             MAXIMUM                                             MAXIMUM      ELEC-    MAXIMUM
          COOLING    TIME    DRY-  WET-      COOLING     HEATING    TIME    DRY-  WET-      HEATING     TRICAL      ELEC
           ENERGY  OF MAX    BULB  BULB         LOAD      ENERGY  OF MAX    BULB  BULB         LOAD     ENERGY      LOAD
MONTH      (MBTU)  DY  HR    TEMP  TEMP    (KBTU/HR)      (MBTU)  DY  HR    TEMP  TEMP    (KBTU/HR)      (KWH)      (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
        ---------                         ----------   ---------                        ----------   --------   -------

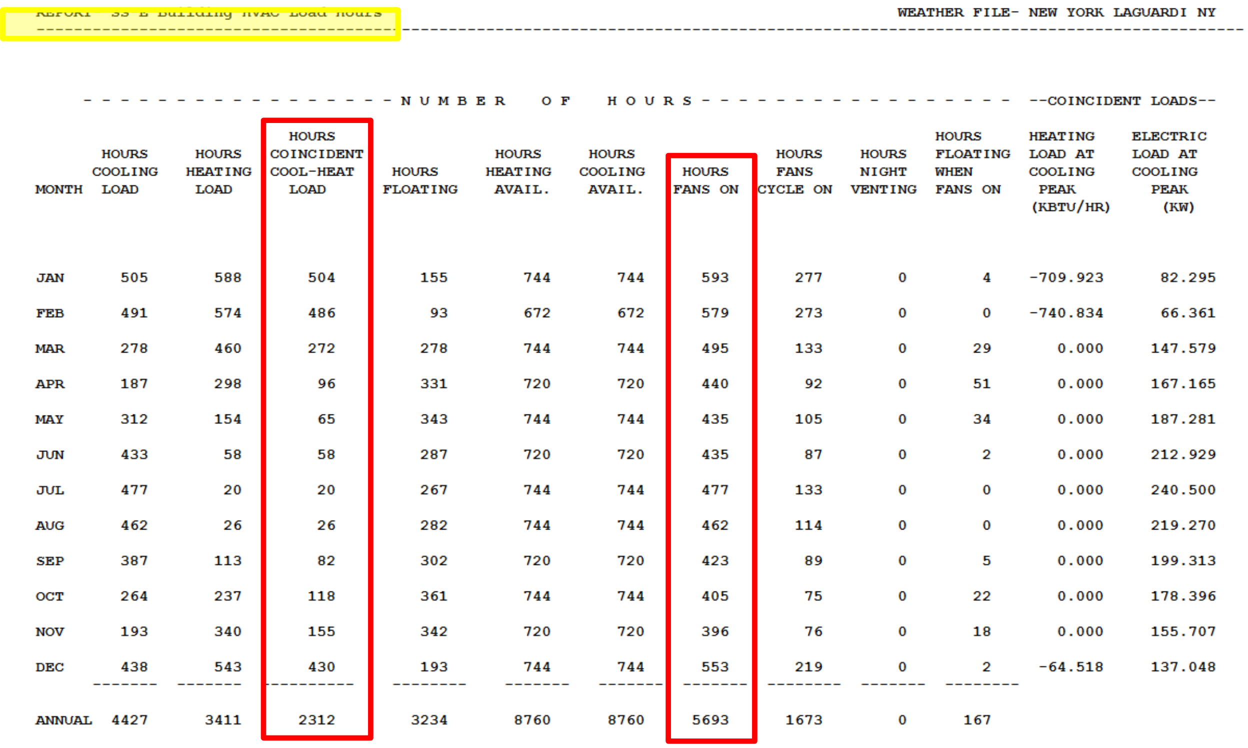
TOTAL    1325.722                                       -442.559                                       547429.

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
 ----------------------------------------------------------------------------------------------------------------------


     - - - - - - - - - - - - - - - - - - N U M B E R   O F   H O U R S - - - - - - - - - - - - - - - -  --COINCIDENT LOADS--

                               HOURS                                                          HOURS   HEATING   ELECTRIC
          HOURS     HOURS   COINCIDENT              HOURS     HOURS               HOURS   HOURS   FLOATING  LOAD AT   LOAD AT
         COOLING   HEATING  COOL-HEAT     HOURS    HEATING   COOLING    HOURS     FANS    NIGHT    WHEN    COOLING   COOLING
 MONTH    LOAD      LOAD      LOAD      FLOATING    AVAIL.    AVAIL.   FANS ON  CYCLE ON VENTING  FANS ON    PEAK      PEAK
                                                                                                          (KBTU/HR)    (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

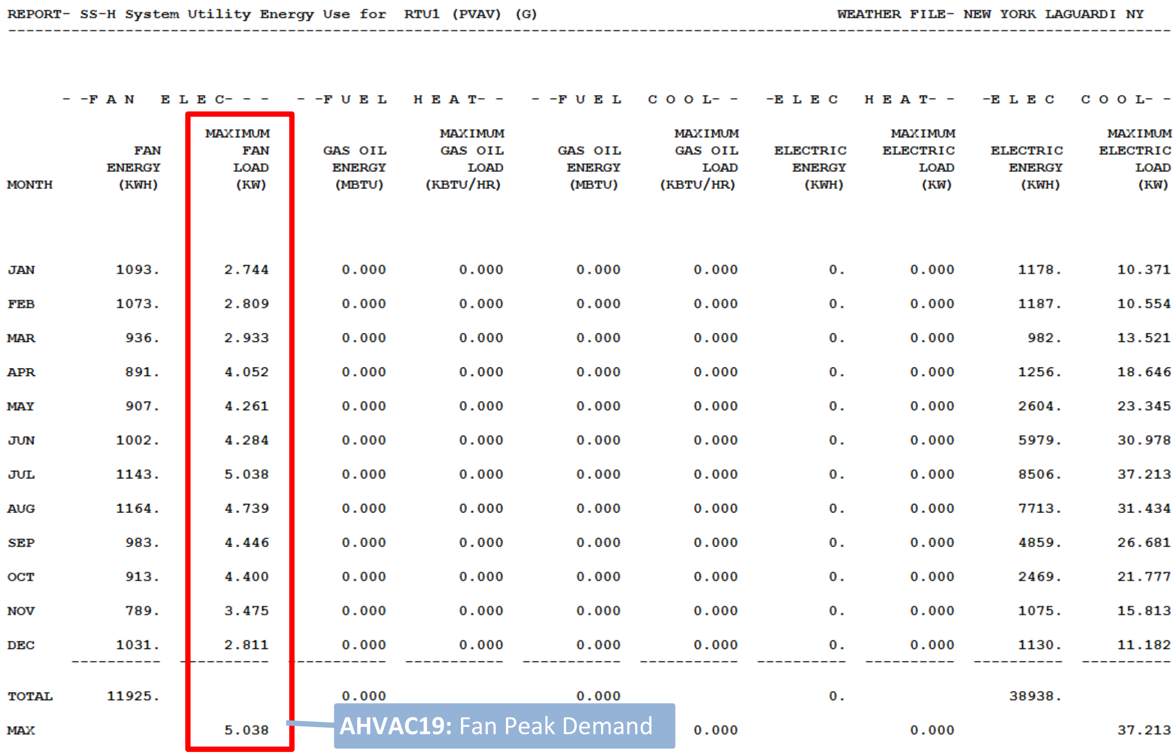
 DEC       438       543       430        193       744       744       553       219       0        2    -64.518   137.048
         -------   ------- ----------  --------   -------   -------   -------  --------  -------  --------

 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



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REPORT- SS-H System Utility Energy Use for  RTU1 (PVAV) (G)                                    WEATHER FILE- NEW YORK LAGUARDI NY
---------------------------------------------------------------------------------------------------------------------------------


      - -F A N   E L E C- - -   - -F U E L   H E A T- -   - -F U E L   C O O L- -   -E L E C   H E A T- -   -E L E C   C O O L- -

                    MAXIMUM                  MAXIMUM                  MAXIMUM                  MAXIMUM                  MAXIMUM
             FAN        FAN     GAS OIL     GAS OIL     GAS OIL     GAS OIL   ELECTRIC    ELECTRIC    ELECTRIC    ELECTRIC
          ENERGY       LOAD      ENERGY        LOAD      ENERGY        LOAD     ENERGY        LOAD      ENERGY        LOAD
MONTH      (KWH)       (KW)      (MBTU)   (KBTU/HR)      (MBTU)   (KBTU/HR)      (KWH)        (KW)       (KWH)        (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

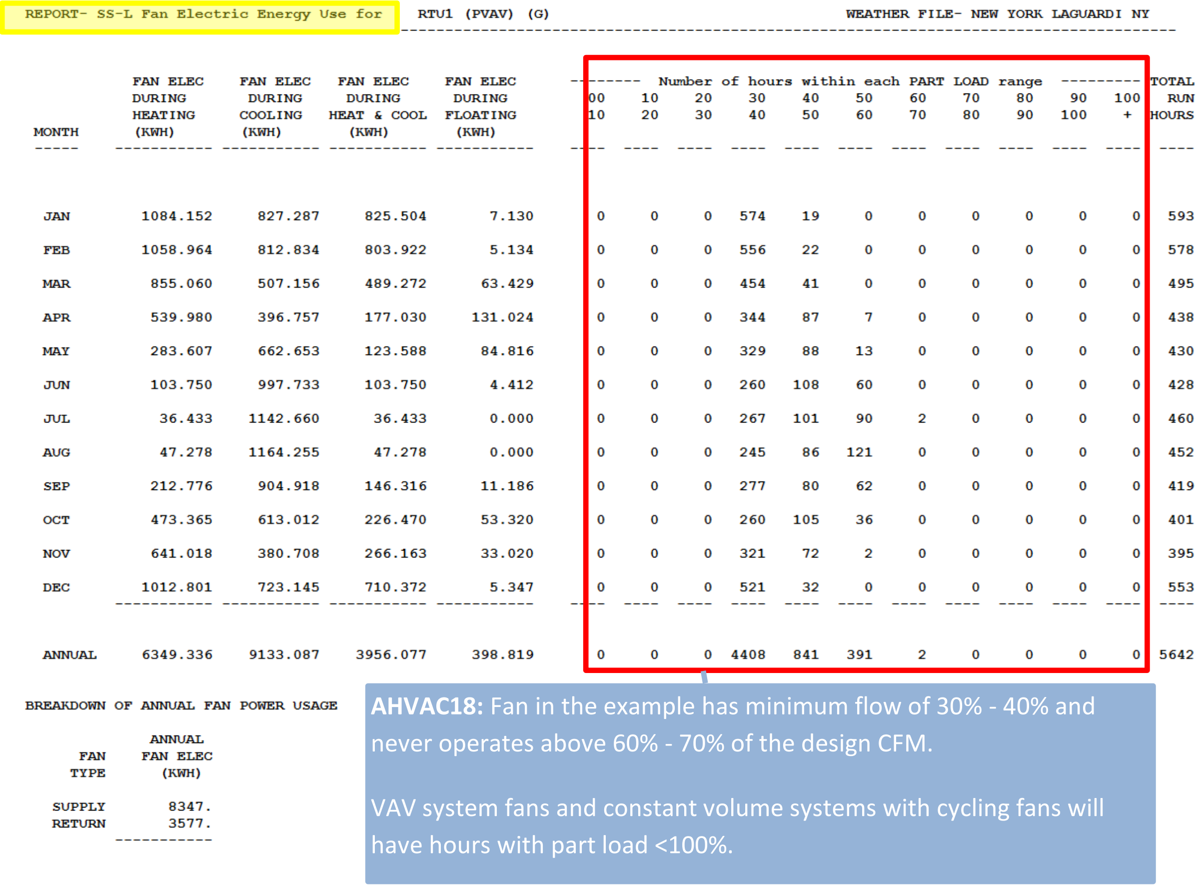
NOV         789.      3.475       0.000       0.000       0.000       0.000         0.       0.000       1075.      15.813

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                   0.000                   37.213
```

SS-L Fan Electric Energy Use



```
REPORT- SS-L Fan Electric Energy Use for   RTU1  (PVAV)  (G)                          WEATHER FILE- NEW YORK LAGUARDI NY
---------------------------------------------------------------------------------------------------------------------


                FAN ELEC   FAN ELEC   FAN ELEC   FAN ELEC     --------  Number of hours within each PART LOAD range   ---------TOTAL
                 DURING     DURING     DURING     DURING        00   10   20   30   40   50   60   70   80   90  100   RUN
                 HEATING    COOLING  HEAT & COOL FLOATING       10   20   30   40   50   60   70   80   90  100   +   HOURS
  MONTH          (KWH)      (KWH)      (KWH)      (KWH)
  -----        ---------- ---------- ---------- ----------     ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ----


   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

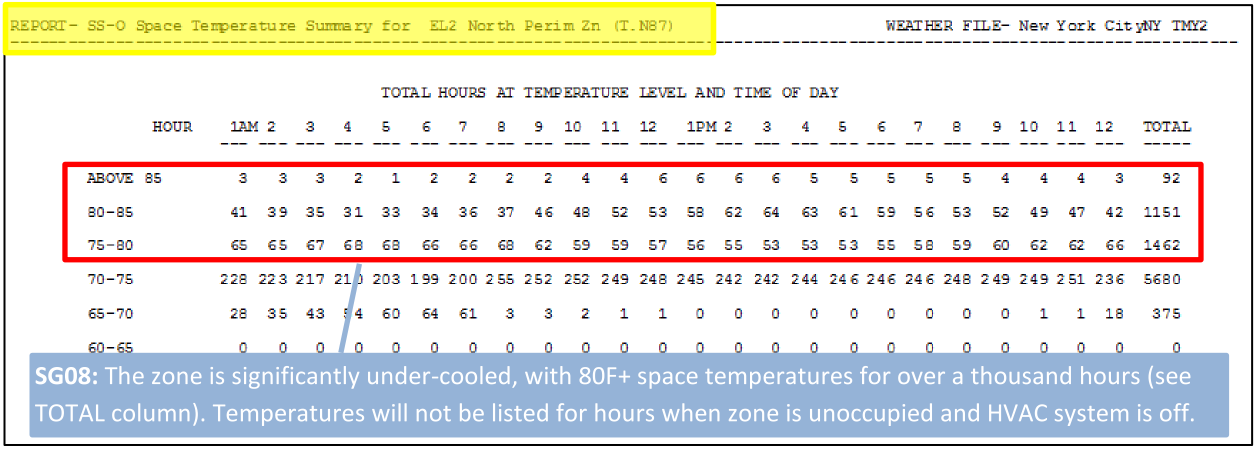
                 ANNUAL
        FAN     FAN ELEC
       TYPE      (KWH)

     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
------------------------------------------------------------------------------------------------------------------------------


                                    TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY

           HOUR      1AM 2   3   4   5   6   7   8   9  10  11  12   1PM 2   3   4   5   6   7   8   9  10  11  12    TOTAL
                     --- --- --- --- --- --- --- --- --- --- --- ---  --- --- --- --- --- --- --- --- --- --- --- ---   -----

      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

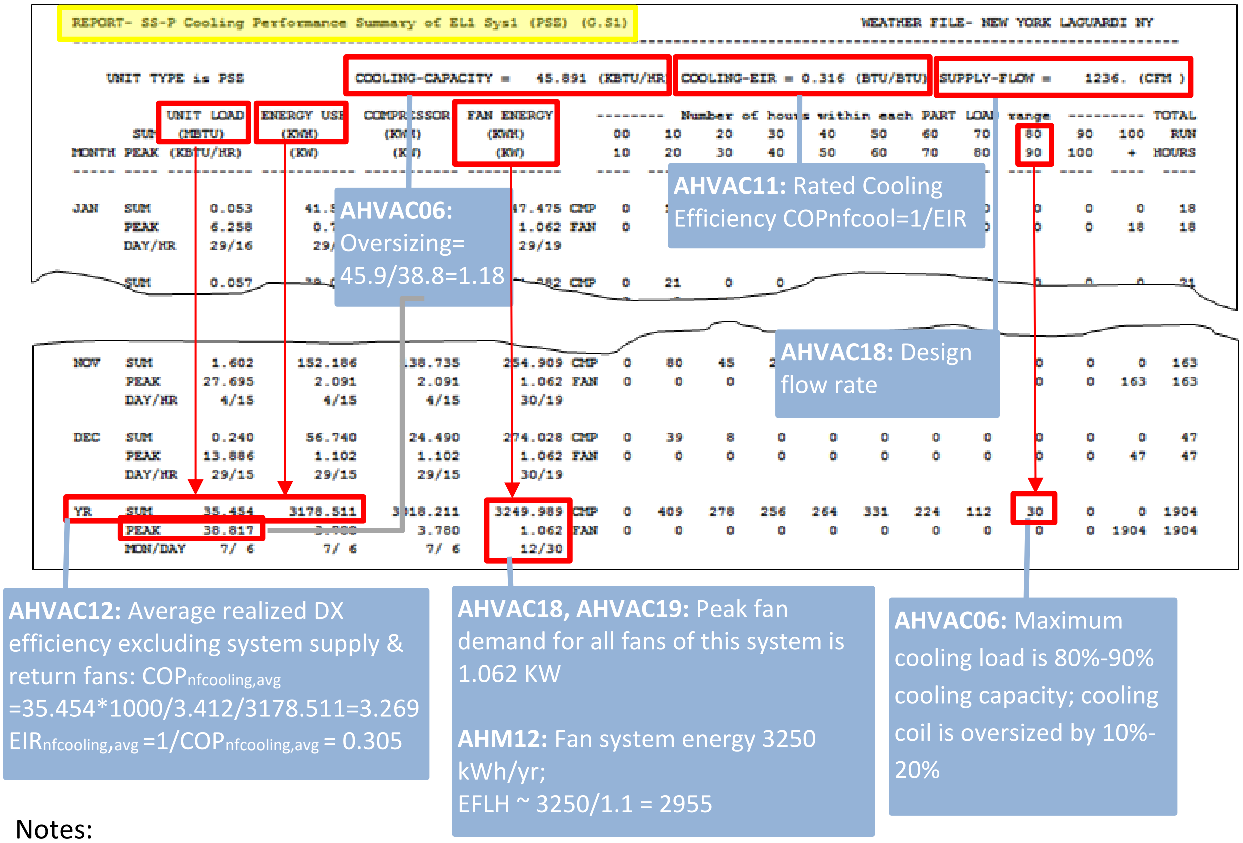
      65-70           28  35  43  54  60  64  61   3   3   2   1   1   0   0   0   0   0   0   0   0   0   1   1  18    375

      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 Sys1 (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 )

                 UNIT  LOAD   ENERGY USE   COMPRESSOR   FAN ENERGY     --------  Number of hours within each PART LOAD range  --------- TOTAL
           SUM     (MBTU)       (KWH)        (KWH)        (KWH)          00    10    20    30    40    50    60    70    80    90   100   RUN
MONTH PEAK  (KBTU/HR)           (KW)         (KW)         (KW)           10    20    30    40    50    60    70    80    90   100     +  HOURS
----- ----  -----------  -----------  -----------  -----------         ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----

JAN   SUM        0.053         41.5                     7.475 CMP      0                                               0     0     0    18
      PEAK       6.258          0.7                     1.062 FAN      0                                               0     0    18    18
      DAY/HR     29/16         29/                      29/19

      SUM        0.057                                    282 CMP      0    21     0     0                             0     0     0    21

NOV   SUM        1.602       152.186       38.735     254.909 CMP      0    80    45     2                             0     0     0   163
      PEAK      27.695         2.091        2.091       1.062 FAN      0     0     0                                   0     0   163   163
      DAY/HR      4/15          4/15         4/15       30/19

DEC   SUM        0.240        56.740       24.490     274.028 CMP      0    39     8     0     0     0     0     0     0     0     0    47
      PEAK      13.886         1.102        1.102       1.062 FAN      0     0     0     0     0     0     0     0     0     0    47    47
      DAY/HR     29/15         29/15        29/15       30/19

YR    SUM       35.454      3178.511     3018.211    3249.989 CMP      0   409   278   256   264   331   224   112    30     0     0  1904
      PEAK      38.817         3.780        3.780       1.062 FAN      0     0     0     0     0     0     0     0     0     0  1904  1904
      MON/DAY    7/ 6          7/ 6         7/ 6        12/30
```

AHVAC06: Oversizing= 45.9/38.8=1.18

AHVAC11: Rated Cooling Efficiency COPnfcool=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

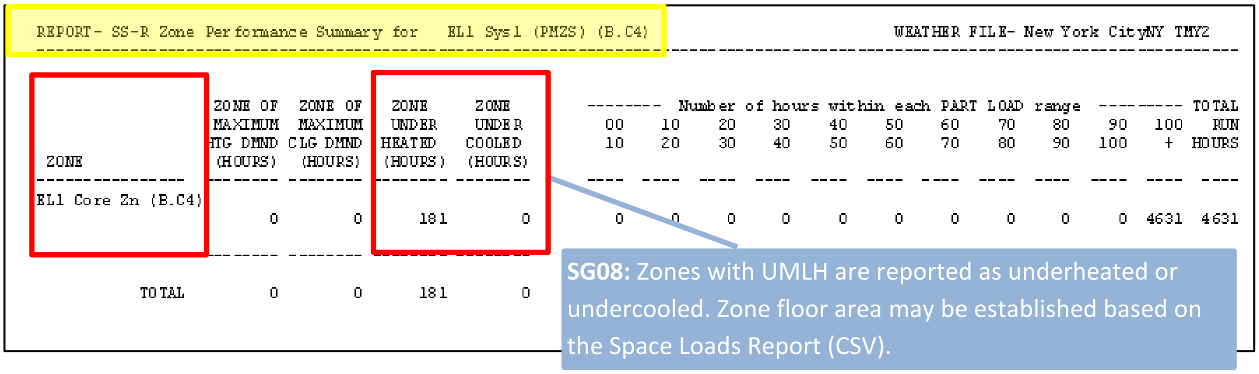
AHVAC18, AHVAC19: Peak fan demand for all fans of this system is 1.062 KW

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



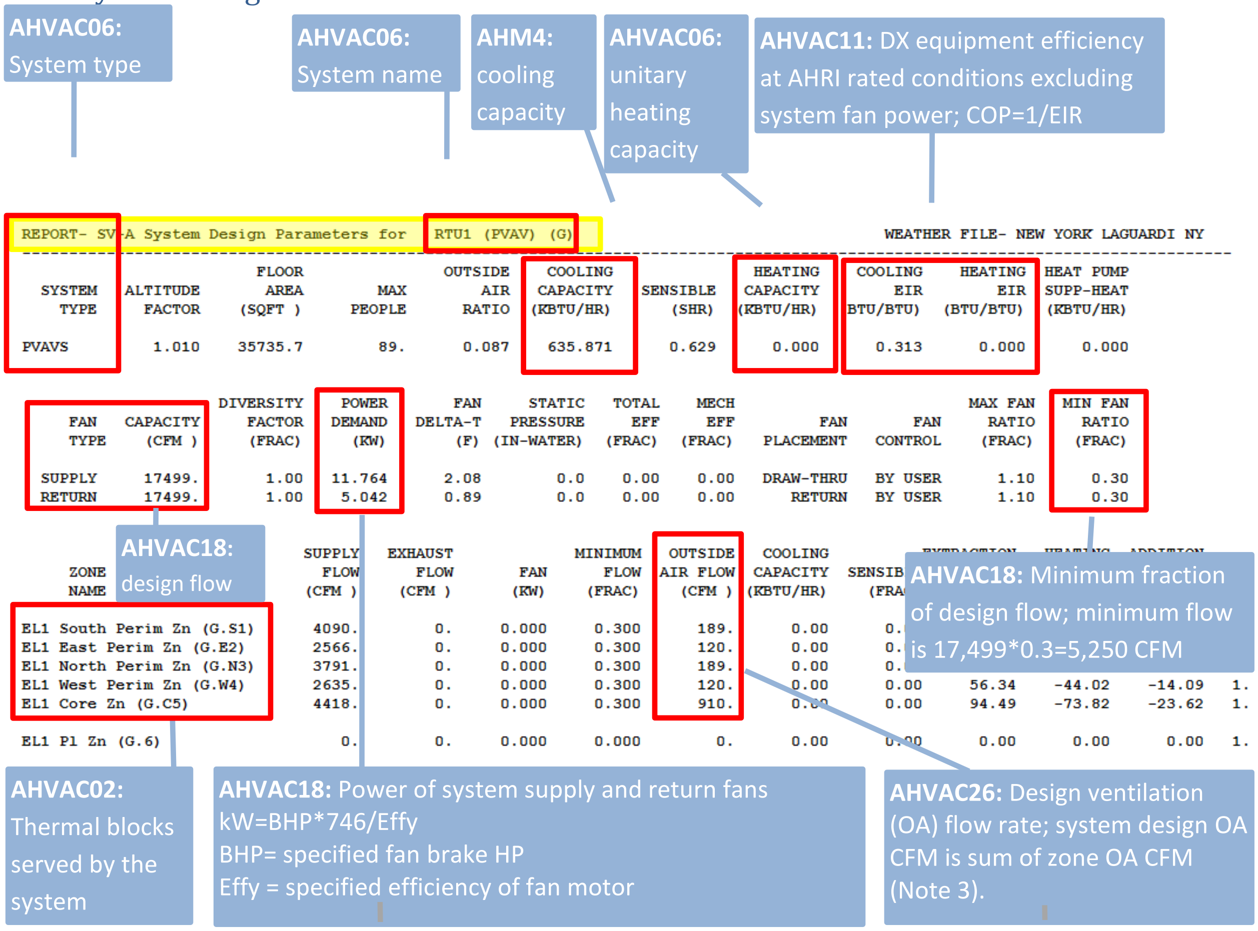
```
REPORT- SS-R Zone Performance Summary for   EL1 Sys1 (PMZS) (B.C4)                          WEATHER FILE- New York CityNY TMY2
----------------------------------------------------------------------------------------------------------------------------------

                  ZONE OF  ZONE OF   ZONE     ZONE      --------  Number of hours within each PART LOAD range  --------- TOTAL
                  MAXIMUM  MAXIMUM   UNDER    UNDER        00    10    20    30    40    50    60    70    80    90   100   RUN
                  HTG DMND CLG DMND  HEATED   COOLED       10    20    30    40    50    60    70    80    90   100    +  HOURS
 ZONE             (HOURS)  (HOURS)  (HOURS)  (HOURS)
----------------  -------- -------- -------- --------     ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----
EL1 Core Zn (B.C4)
                         0        0      181        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



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

```
REPORT- SV-A System Design Parameters for  RTU1 (PVAV) (G)                              WEATHER FILE- NEW YORK LAGUARDI NY
-------------------------------------------------------------------------------------------------------------------------------

                         FLOOR                OUTSIDE   COOLING              HEATING   COOLING     HEATING   HEAT PUMP
  SYSTEM  ALTITUDE        AREA        MAX        AIR   CAPACITY  SENSIBLE   CAPACITY      EIR         EIR   SUPP-HEAT
    TYPE    FACTOR      (SQFT )    PEOPLE      RATIO   (KBTU/HR)    (SHR)  (KBTU/HR)  BTU/BTU)   (BTU/BTU)  (KBTU/HR)

PVAVS        1.010     35735.7       89.       0.087    635.871     0.629      0.000     0.313       0.000      0.000

                    DIVERSITY    POWER      FAN     STATIC    TOTAL     MECH                             MAX FAN   MIN FAN
    FAN  CAPACITY      FACTOR   DEMAND  DELTA-T   PRESSURE      EFF      EFF        FAN         FAN       RATIO     RATIO
   TYPE    (CFM )      (FRAC)     (KW)      (F) (IN-WATER)   (FRAC)   (FRAC)  PLACEMENT     CONTROL      (FRAC)    (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

                           SUPPLY   EXHAUST                MINIMUM   OUTSIDE   COOLING
    ZONE                     FLOW      FLOW        FAN        FLOW  AIR FLOW  CAPACITY  SENSIB
    NAME                    (CFM )    (CFM )       (KW)     (FRAC)     (CFM )  (KBTU/HR)   (FRA

EL1 South Perim Zn (G.S1)    4090.        0.     0.000      0.300       189.      0.00      0.
EL1 East Perim Zn (G.E2)     2566.        0.     0.000      0.300       120.      0.00      0.
EL1 North Perim Zn (G.N3)    3791.        0.     0.000      0.300       189.      0.00      0.
EL1 West Perim Zn (G.W4)     2635.        0.     0.000      0.300       120.      0.00      0.00     56.34    -44.02    -14.09   1.
EL1 Core Zn (G.C5)           4418.        0.     0.000      0.300       910.      0.        0.00     94.49    -73.82    -23.62   1.

EL1 Pl Zn (G.6)                 0.        0.     0.000      0.000         0.      0.00      0.00      0.00      0.00      0.00   1.
```

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

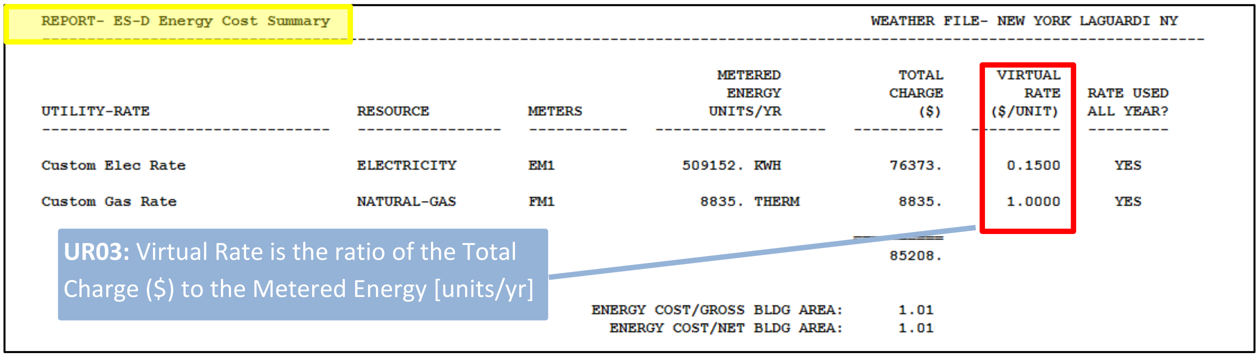
AHVAC18: Power of system supply and return fans
kW=BHP*746/Effy
BHP= specified fan brake HP
Effy = specified efficiency of fan motor

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



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REPORT- ES-D Energy Cost Summary                                              WEATHER FILE- NEW YORK LAGUARDI NY
-------------------------------------------------------------------------------------------------------------------

                                                                 METERED            TOTAL     VIRTUAL
                                                                 ENERGY             CHARGE       RATE   RATE USED
UTILITY-RATE                     RESOURCE         METERS         UNITS/YR           ($)      ($/UNIT)   ALL YEAR?
-------------------------------- ---------------- ----------- ------------------- ---------- ---------- ---------

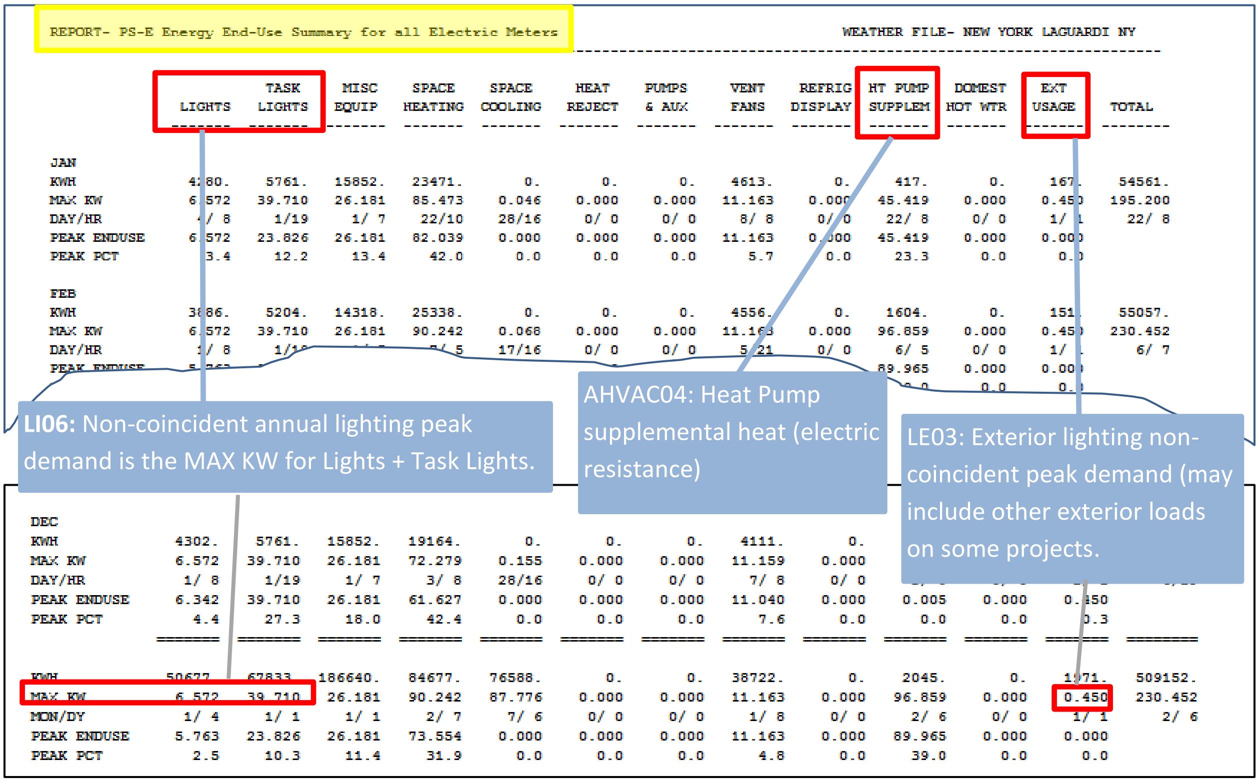
Custom Elec Rate                 ELECTRICITY      EM1          509152. KWH          76373.     0.1500      YES

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
-------------------------------------------------------------------------------------------------------------------

                        TASK      MISC     SPACE    SPACE     HEAT     PUMPS     VENT    REFRIG   HT PUMP   DOMEST     EXT
              LIGHTS    LIGHTS    EQUIP   HEATING  COOLING   REJECT    & AUX     FANS   DISPLAY   SUPPLEM  HOT WTR   USAGE     TOTAL
              -------   -------  -------  -------  -------  -------  -------  -------  -------   -------  -------  -------  --------

JAN
KWH           4 80.     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    0.45    195.200
DAY/HR         / 8       1/19      1/ 7    22/10    28/16     0/ 0     0/ 0     8/ 8     0/ 0     22/ 8     0/ 0     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    0.00
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.

FEB
KWH           3 86.     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    0.45    230.452
DAY/HR         / 8       1/1                        17/16     0/ 0     0/ 0     5/21     0/ 0      6/ 5     0/ 0     1/         6/ 7
PEAK ENDUSE                                                                                      89.965    0.000    0.00
PEAK PCT                                                                                                     0.0     0.

DEC
KWH           4302.     5761.    15852.   19164.       0.       0.       0.    4111.       0.
MAX KW        6.572    39.710    26.181   72.279    0.155    0.000    0.000   11.159    0.000
DAY/HR         1/ 8      1/19      1/ 7     3/ 8    28/16     0/ 0     0/ 0     7/ 8     0/ 0
PEAK ENDUSE   6.342    39.710    26.181   61.627    0.000    0.000    0.000   11.040    0.000     0.005    0.000    0.450
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
            ======= ======= ======= ======= ======= ======= ======= ======= ======= ======= ======= ======= ========

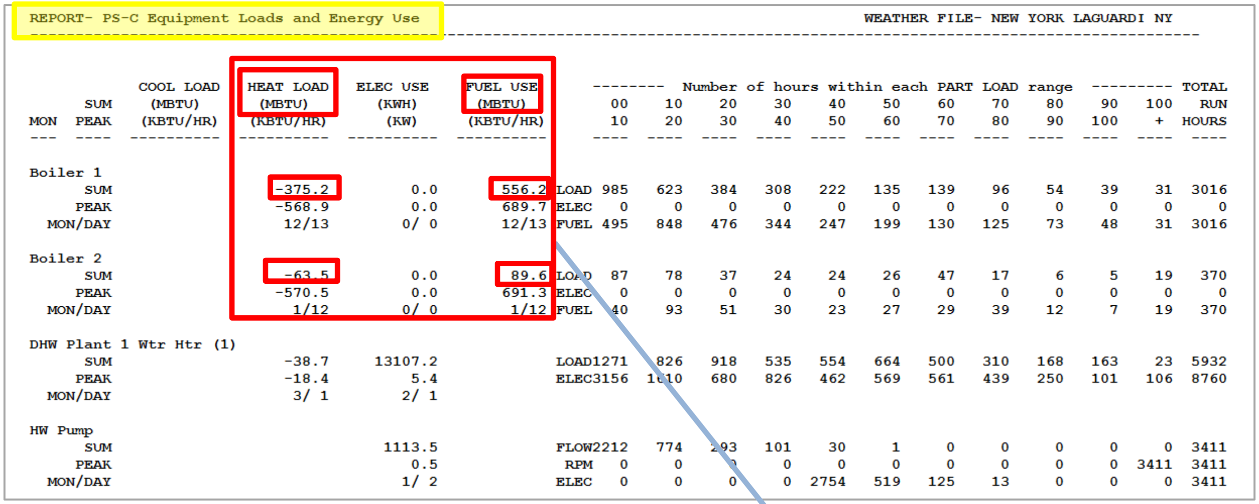
KWH          50677.    67833.   186640.   84677.   76588.       0.       0.   38722.       0.     2045.       0.    1971.   509152.
MAX KW        6.572    39.710    26.181   90.242   87.776    0.000    0.000   11.163    0.000    96.859    0.000    0.450   230.452
MON/DY         1/ 4      1/ 1      1/ 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
          SUM    (MBTU)      (MBTU)      (KWH)      (MBTU)        00    10    20    30    40    50    60    70    80    90   100   RUN
 MON   PEAK  (KBTU/HR)   (KBTU/HR)     (KW)     (KBTU/HR)        10    20    30    40    50    60    70    80    90   100     + HOURS
 ---   ----  ----------  ----------  ----------  ----------      ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----  ----

 Boiler 1
          SUM                -375.2         0.0       556.2LOAD 985   623   384   308   222   135   139    96    54    39    31  3016
         PEAK                -568.9         0.0       689.7ELEC   0     0     0     0     0     0     0     0     0     0     0     0
      MON/DAY                 12/13        0/ 0       12/13FUEL 495   848   476   344   247   199   130   125    73    48    31  3016

 Boiler 2
          SUM                 -63.5         0.0        89.6LOAD  87    78    37    24    24    26    47    17     6     5    19   370
         PEAK                -570.5         0.0       691.3ELEC   0     0     0     0     0     0     0     0     0     0     0     0
      MON/DAY                  1/12        0/ 0        1/12FUEL  40    93    51    30    23    27    29    39    12     7    19   370

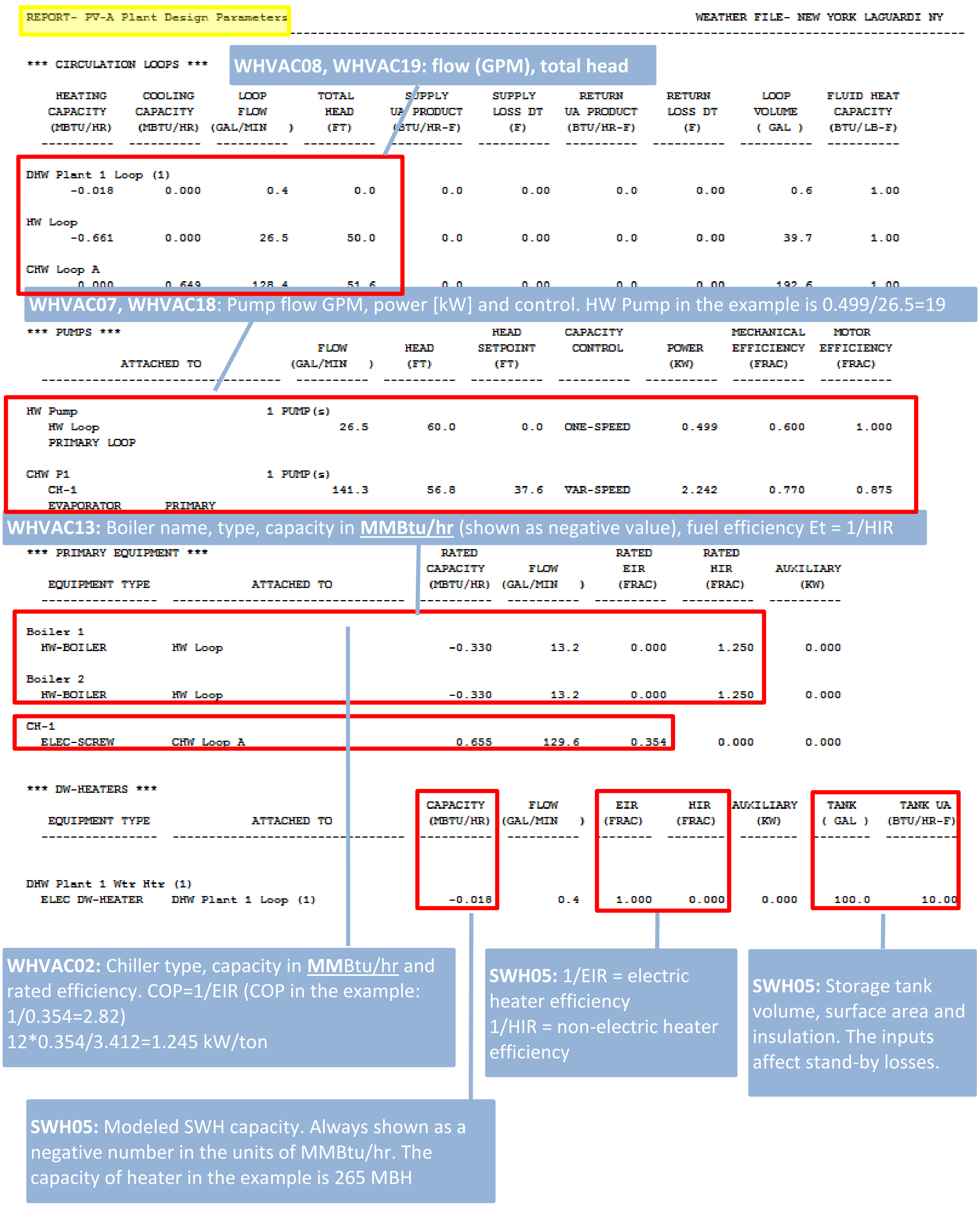
 DHW Plant 1 Wtr Htr (1)
          SUM                 -38.7     13107.2            LOAD1271   826   918   535   554   664   500   310   168   163    23  5932
         PEAK                 -18.4         5.4            ELEC3156  1610   680   826   462   569   561   439   250   101   106  8760
      MON/DAY                  3/ 1        2/ 1

 HW Pump
          SUM                            1113.5            FLOW2212   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  3411  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%.

Heat Load =375.2+63.5= 438.7 MMBtu
Fuel Use = 556.2+89.6=645.8
Effy_{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 ***

    HEATING    COOLING       LOOP      TOTAL     SUPPLY     SUPPLY     RETURN     RETURN       LOOP  FLUID HEAT
   CAPACITY   CAPACITY       FLOW       HEAD UA PRODUCT    LOSS DT UA PRODUCT    LOSS DT     VOLUME    CAPACITY
   (MBTU/HR)  (MBTU/HR) (GAL/MIN  )     (FT) (BTU/HR-F)        (F) (BTU/HR-F)        (F)    ( GAL )  (BTU/LB-F)
 ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------

DHW Plant 1 Loop (1)
     -0.018      0.000        0.4        0.0        0.0       0.00        0.0       0.00        0.6       1.00

HW Loop
     -0.661      0.000       26.5       50.0        0.0       0.00        0.0       0.00       39.7       1.00

CHW Loop A
      0.000      0.649      128.4       51.6        0.0       0.00        0.0       0.00      192.6       1.00

*** PUMPS ***                                                 HEAD   CAPACITY               MECHANICAL      MOTOR
                                        FLOW        HEAD   SETPOINT    CONTROL      POWER   EFFICIENCY EFFICIENCY
           ATTACHED TO             (GAL/MIN  )      (FT)       (FT)                  (KW)       (FRAC)     (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

*** PRIMARY EQUIPMENT ***                                          RATED                 RATED      RATED
                                                                CAPACITY       FLOW        EIR        HIR  AUXILIARY
   EQUIPMENT TYPE                 ATTACHED TO                   (MBTU/HR) (GAL/MIN  )     (FRAC)     (FRAC)       (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 ***
                                                                CAPACITY       FLOW       EIR      HIR  AUXILIARY     TANK    TANK UA
   EQUIPMENT TYPE                 ATTACHED TO                   (MBTU/HR) (GAL/MIN  )   (FRAC)   (FRAC)       (KW)  ( GAL )  (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
```

WHVAC08, WHVAC19: flow (GPM), total head

WHVAC07, WHVAC18: Pump flow GPM, power [kW] and control. HW Pump in the example is 0.499/26.5=19

WHVAC13: Boiler name, type, capacity in **MMBtu/hr** (shown as negative value), fuel efficiency Et = 1/HIR

WHVAC02: Chiller type, capacity in **MM**Btu/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

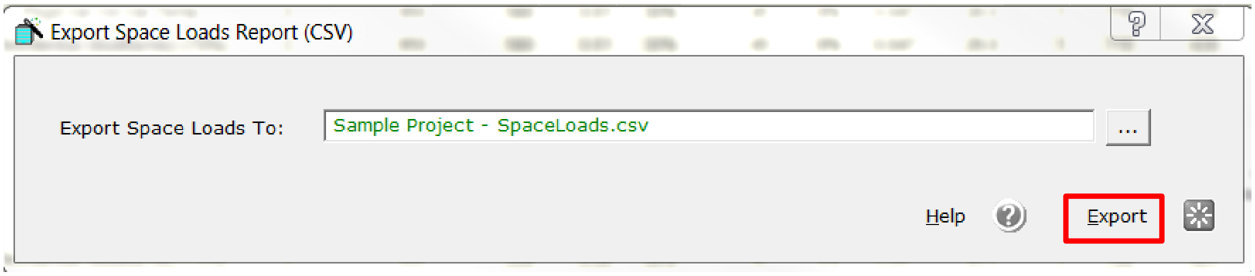
SWH05: 1/EIR = electric heater efficiency
1/HIR = non-electric heater efficiency

SWH05: Storage tank volume, surface area and insulation. The inputs affect stand-by losses.

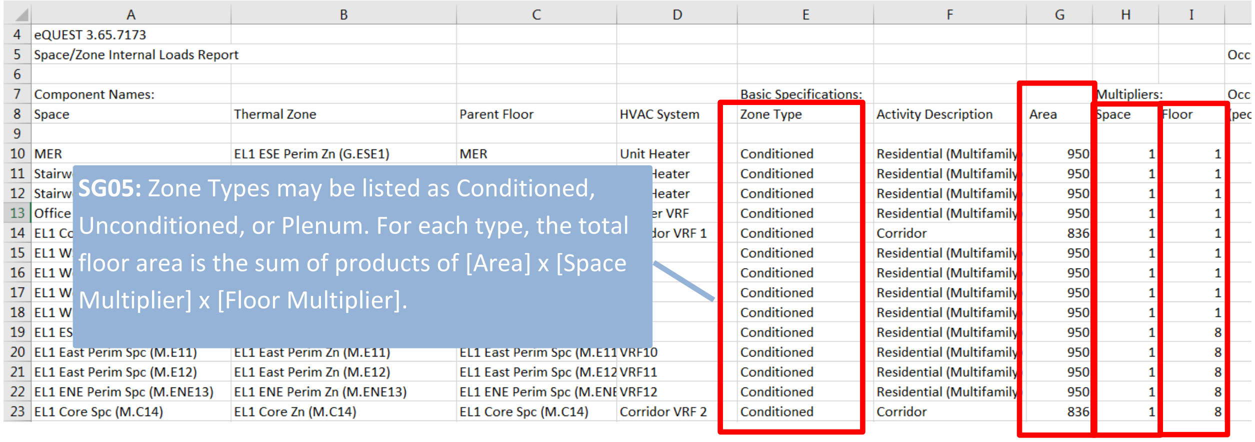
SWH05: Modeled SWH capacity. Always shown as a negative number in the units of MMBtu/hr. The capacity of heater in the example is 265 MBH

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.



Export Space Loads To: Sample Project - SpaceLoads.csv



	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 Co			dor 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].

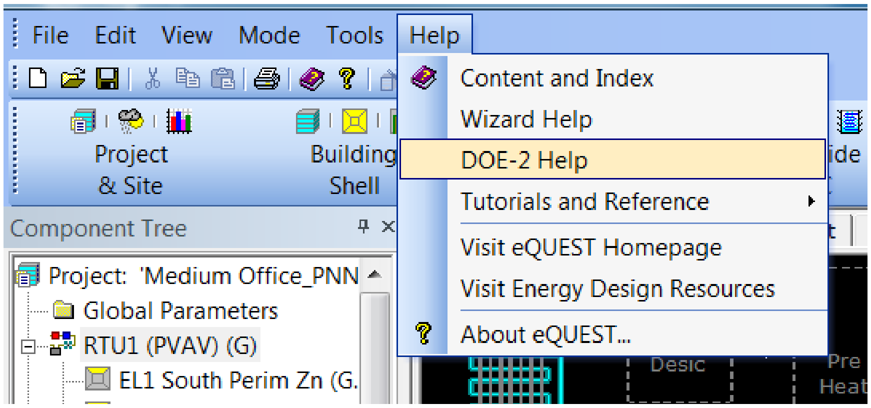
The report includes a detailed list of modeling inputs by space, including but not limited to lighting and equipment power density and full load hours. CSV (Excel) format easily supports data analysis.

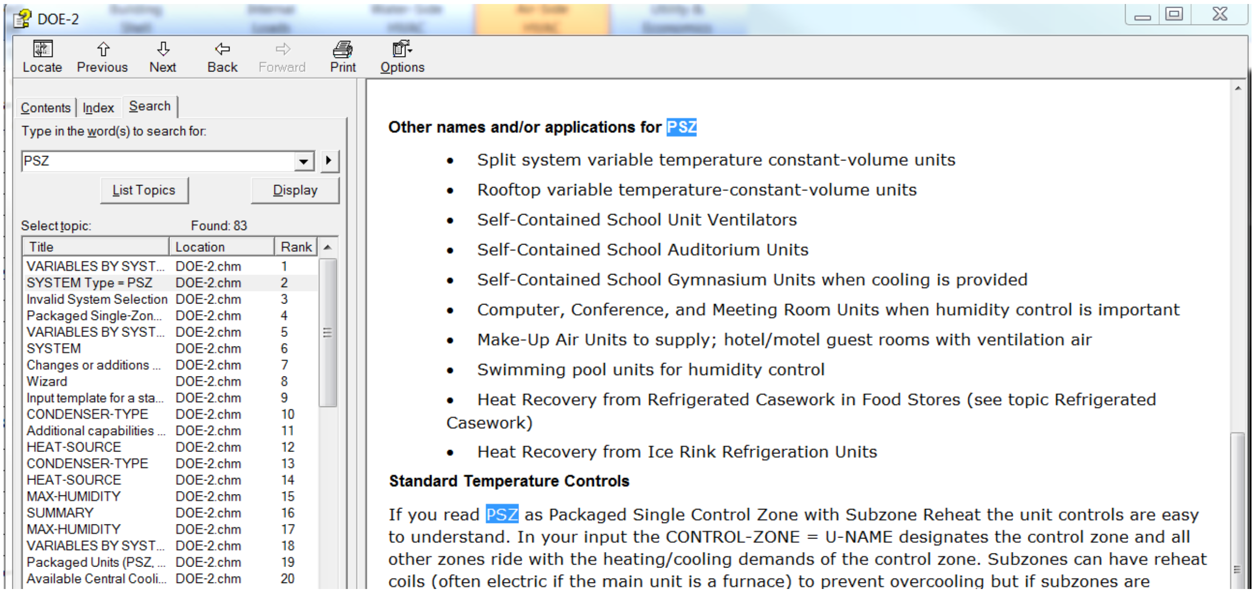
Hourly Results (CSV)

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.





Type in the word(s) to search for: PSZ

Select topic: Found: 83

Title	Location	Rank
VARIABLES BY SYST...	DOE-2.chm	1
SYSTEM Type = PSZ	DOE-2.chm	2
Invalid System Selection	DOE-2.chm	3
Packaged Single-Zon...	DOE-2.chm	4
VARIABLES BY SYST...	DOE-2.chm	5
SYSTEM	DOE-2.chm	6
Changes or additions ...	DOE-2.chm	7
Wizard	DOE-2.chm	8
Input template for a sta...	DOE-2.chm	9
CONDENSER-TYPE	DOE-2.chm	10
Additional capabilities ...	DOE-2.chm	11
HEAT-SOURCE	DOE-2.chm	12
CONDENSER-TYPE	DOE-2.chm	13
HEAT-SOURCE	DOE-2.chm	14
MAX-HUMIDITY	DOE-2.chm	15
SUMMARY	DOE-2.chm	16
MAX-HUMIDITY	DOE-2.chm	17
VARIABLES BY SYST...	DOE-2.chm	18
Packaged Units (PSZ, ...	DOE-2.chm	19
Available Central Cooli...	DOE-2.chm	20

Other names and/or applications for PSZ

- Split system variable temperature constant-volume units
- Rooftop variable temperature-constant-volume units
- Self-Contained School Unit Ventilators
- Self-Contained School Auditorium Units
- Self-Contained School Gymnasium Units when cooling is provided
- Computer, Conference, and Meeting Room Units when humidity control is important
- Make-Up Air Units to supply; hotel/motel guest rooms with ventilation air
- Swimming pool units for humidity control
- Heat Recovery from Refrigerated Casework in Food Stores (see topic Refrigerated Casework)
- Heat Recovery from Ice Rink Refrigeration Units

Standard Temperature Controls

If you read PSZ as Packaged Single Control Zone with Subzone Reheat the unit controls are easy to understand. In your input the CONTROL-ZONE = U-NAME designates the control zone and all other zones ride with the heating/cooling demands of the control zone. Subzones can have reheat coils (often electric if the main unit is a furnace) to prevent overcooling but if subzones are

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

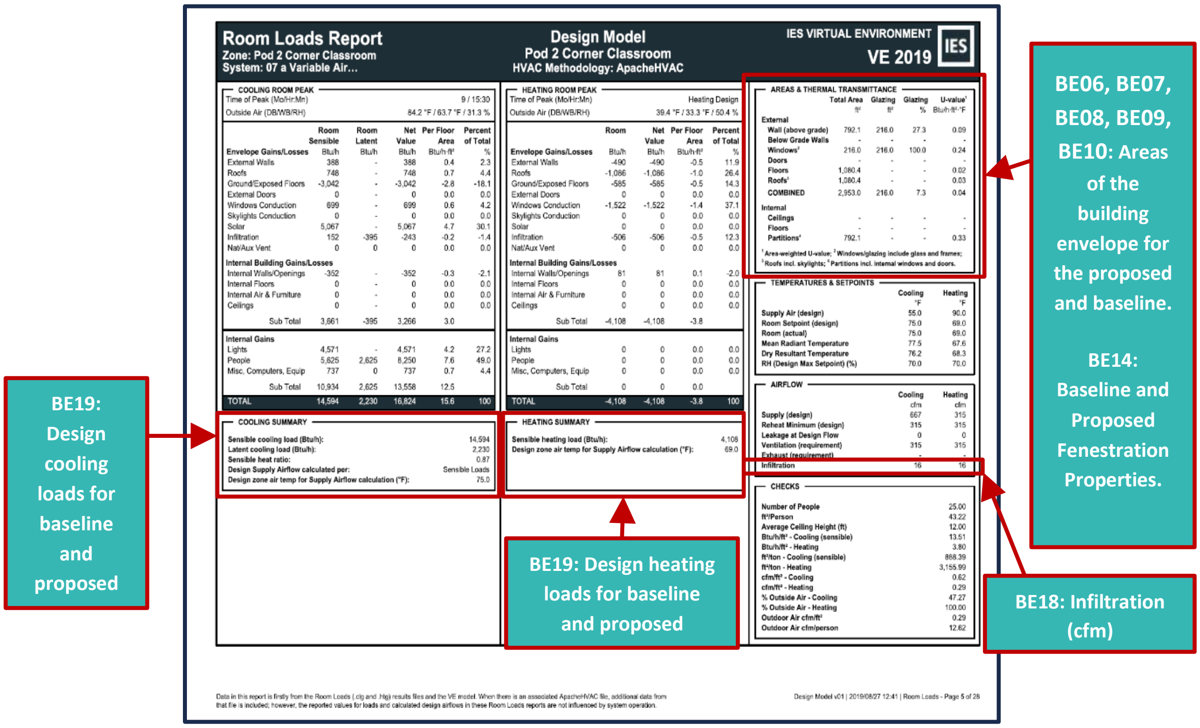
6. The reports below are both entered values reports and simulation reports. All reports can be found by going to the Tools Menu in IESVE Software > Content Manager.
7. The reports can be viewed in the Content Manager as a report viewer or exported/opened independently as PDF/DOC/XLS etc. Most commonly, 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
Zone: Pod 2 Corner Classroom
System: 07 a Variable Air...

Design Model
Pod 2 Corner Classroom
HVAC Methodology: ApacheHVAC

IES VIRTUAL ENVIRONMENT
VE 2019

COOLING ROOM PEAK

Time of Peak (Mo/Hr:Mn)	9 / 15:30
Outside Air (DB/WB/RH)	84.2 °F / 63.7 °F / 31.3 %

Envelope Gains/Losses	**Room Sensible** Btu/h	**Room Latent** Btu/h	**Net Value** Btu/h	**Per Floor Area** Btu/h·ft^2	**Percent of Total** %
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	699	-	699	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	5,625	2,625	8,250	7.6	49.0
Misc, Computers, Equip	737	0	737	0.7	4.4
Sub Total	10,934	2,625	13,558	12.5	
TOTAL	14,594	2,230	16,824	15.6	100

COOLING SUMMARY

Sensible cooling load (Btu/h):	14,594
Latent cooling load (Btu/h):	2,230
Sensible heat ratio:	0.87
Design Supply Airflow calculated per:	Sensible Loads
Design zone air temp for Supply Airflow calculation (°F):	75.0

HEATING ROOM PEAK

Time of Peak (Mo/Hr:Mn)	Heating Design
Outside Air (DB/WB/RH)	39.4 °F / 33.3 °F / 50.4 %

Envelope Gains/Losses	**Room** Btu/h	**Net Value** Btu/h	**Per Floor Area** Btu/h·ft^2	**Percent of Total** %
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	-0.5	12.3
Nat/Aux Vent	0	0	0.0	0.0
Internal Building Gains/Losses				
Internal Walls/Openings	81	81	0.1	-2.0
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	-4,108	-4,108	-3.8	
Internal Gains				
Lights	0	0	0.0	0.0
People	0	0	0.0	0.0
Misc, Computers, Equip	0	0	0.0	0.0
Sub Total	0	0	0.0	
TOTAL	-4,108	-4,108	-3.8	100

HEATING SUMMARY

Sensible heating load (Btu/h):	4,108
Design zone air temp for Supply Airflow calculation (°F):	69.0

AREAS & THERMAL TRANSMITTANCE

	Total Area ft^2	**Glazing** ft^2	**Glazing** %	**U-value**[1] Btu/h·ft^2·°F
External				
Wall (above grade)	792.1	216.0	27.3	0.09
Below Grade Walls	-	-	-	-
Windows[2]	216.0	216.0	100.0	0.24
Doors	-	-	-	-
Floors	1,080.4	-	-	0.02
Roofs[3]	1,080.4	-	-	0.03
COMBINED	2,953.0	216.0	7.3	0.04
Internal				
Ceilings	-	-	-	-
Floors	-	-	-	-
Partitions[4]	792.1	-	-	0.33

[1] Area-weighted U-value; [2] Windows/glazing include glass and frames; [3] Roofs incl. skylights; [4] Partitions incl. internal windows and doors.

TEMPERATURES & SETPOINTS

	Cooling °F	**Heating** °F
Supply Air (design)	55.0	90.0
Room Setpoint (design)	75.0	69.0
Room (actual)	75.0	69.0
Mean Radiant Temperature	77.5	67.6
Dry Resultant Temperature	76.2	68.3
RH (Design Max Setpoint) (%)	70.0	70.0

AIRFLOW

	Cooling cfm	**Heating** cfm
Supply (design)	667	315
Reheat Minimum (design)	315	315
Leakage at Design Flow	0	0
Ventilation (requirement)	315	315
Exhaust (requirement)	-	-
Infiltration	16	16

CHECKS

Number of People	25.00
ft^2/Person	43.22
Average Ceiling Height (ft)	12.00
Btu/h/ft^2 - Cooling (sensible)	13.51
Btu/h/ft^2 - Heating	3.80
ft^2/ton - Cooling (sensible)	888.39
ft^2/ton - Heating	3,155.99
cfm/ft^2 - Cooling	0.62
cfm/ft^2 - Heating	0.29
% Outside Air - Cooling	47.27
% Outside Air - Heating	100.00
Outdoor Air cfm/ft^2	0.29
Outdoor Air cfm/person	12.62

Data in this report is firstly from the Room Loads (.clg and .htg) results files and the VE model. When there is an associated ApacheHVAC file, additional data from that file is included; however, the reported values for loads and calculated design airflows in these Room Loads reports are not influenced by system operation.

Design Model v01 | 2019/08/27 12:41 | Room Loads - Page 5 of 28

BE06, BE07, BE08, BE09, BE10: Areas of the building envelope for the proposed and baseline.

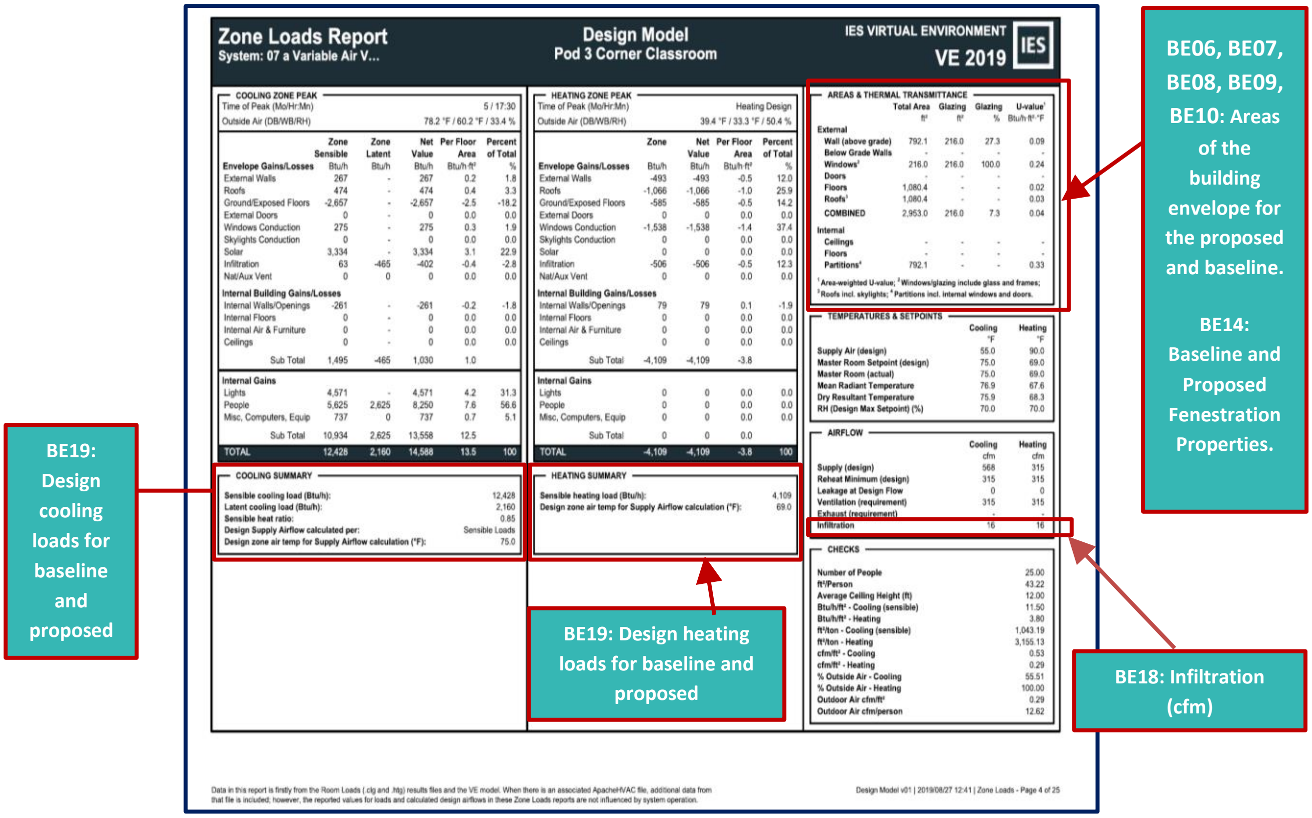
BE14: Baseline and Proposed Fenestration Properties.

BE19: Design cooling loads for baseline and proposed

BE19: Design heating loads for baseline and proposed

BE18: Infiltration (cfm)

Zone Loads Report



Zone Loads Report
System: 07 a Variable Air V...

Design Model
Pod 3 Corner Classroom

IES VIRTUAL ENVIRONMENT
VE 2019

COOLING ZONE PEAK

Time of Peak (Mo/Hr:Mn)	5 / 17:30
Outside Air (DB/WB/RH)	78.2 °F / 60.2 °F / 33.4 %

Envelope Gains/Losses	**Zone Sensible** Btu/h	**Zone Latent** Btu/h	**Net Value** Btu/h	**Per Floor Area** Btu/h·ft^2	**Percent of Total** %
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	5,625	2,625	8,250	7.6	56.6
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

COOLING SUMMARY

Sensible cooling load (Btu/h):	12,428
Latent cooling load (Btu/h):	2,160
Sensible heat ratio:	0.85
Design Supply Airflow calculated per:	Sensible Loads
Design zone air temp for Supply Airflow calculation (°F):	75.0

HEATING ZONE PEAK

Time of Peak (Mo/Hr:Mn)	Heating Design
Outside Air (DB/WB/RH)	39.4 °F / 33.3 °F / 50.4 %

Envelope Gains/Losses	**Zone** Btu/h	**Net Value** Btu/h	**Per Floor Area** Btu/h·ft^2	**Percent of Total** %
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	-0.5	12.3
Nat/Aux Vent	0	0	0.0	0.0
Internal Building Gains/Losses				
Internal Walls/Openings	79	79	0.1	-1.9
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	-4,109	-4,109	-3.8	
Internal Gains				
Lights	0	0	0.0	0.0
People	0	0	0.0	0.0
Misc, Computers, Equip	0	0	0.0	0.0
Sub Total	0	0	0.0	
TOTAL	-4,109	-4,109	-3.8	100

HEATING SUMMARY

Sensible heating load (Btu/h):	4,109
Design zone air temp for Supply Airflow calculation (°F):	69.0

AREAS & THERMAL TRANSMITTANCE

	Total Area ft^2	**Glazing** ft^2	**Glazing** %	**U-value**[1] Btu/h·ft^2·°F
External				
Wall (above grade)	792.1	216.0	27.3	0.09
Below Grade Walls	-	-	-	-
Windows[2]	216.0	216.0	100.0	0.24
Doors	-	-	-	-
Floors	1,080.4	-	-	0.02
Roofs[3]	1,080.4	-	-	0.03
COMBINED	2,953.0	216.0	7.3	0.04
Internal				
Ceilings	-	-	-	-
Floors	-	-	-	-
Partitions[4]	792.1	-	-	0.33

[1] Area-weighted U-value; [2] Windows/glazing include glass and frames; [3] Roofs incl. skylights; [4] Partitions incl. internal windows and doors.

TEMPERATURES & SETPOINTS

	Cooling °F	**Heating** °F
Supply Air (design)	55.0	90.0
Master Room Setpoint (design)	75.0	69.0
Master Room (actual)	75.0	69.0
Mean Radiant Temperature	76.9	67.6
Dry Resultant Temperature	75.9	68.3
RH (Design Max Setpoint) (%)	70.0	70.0

AIRFLOW

	Cooling cfm	**Heating** cfm
Supply (design)	568	315
Reheat Minimum (design)	315	315
Leakage at Design Flow	0	0
Ventilation (requirement)	315	315
Exhaust (requirement)	-	-
Infiltration	16	16

CHECKS

Number of People	25.00
ft^2/Person	43.22
Average Ceiling Height (ft)	12.00
Btu/h/ft^2 - Cooling (sensible)	11.50
Btu/h/ft^2 - Heating	3.80
ft^2/ton - Cooling (sensible)	1,043.19
ft^2/ton - Heating	3,155.13
cfm/ft^2 - Cooling	0.53
cfm/ft^2 - Heating	0.29
% Outside Air - Cooling	55.51
% Outside Air - Heating	100.00
Outdoor Air cfm/ft^2	0.29
Outdoor Air cfm/person	12.62

Data in this report is firstly from the Room Loads (.clg and .htg) results files and the VE model. When there is an associated ApacheHVAC file, additional data from that file is included; however, the reported values for loads and calculated design airflows in these Zone Loads reports are not influenced by system operation.

Design Model v01 | 2019/08/27 12:41 | Zone Loads - Page 4 of 25

BE06, BE07, BE08, BE09, BE10: Areas of the building envelope for the proposed and baseline.

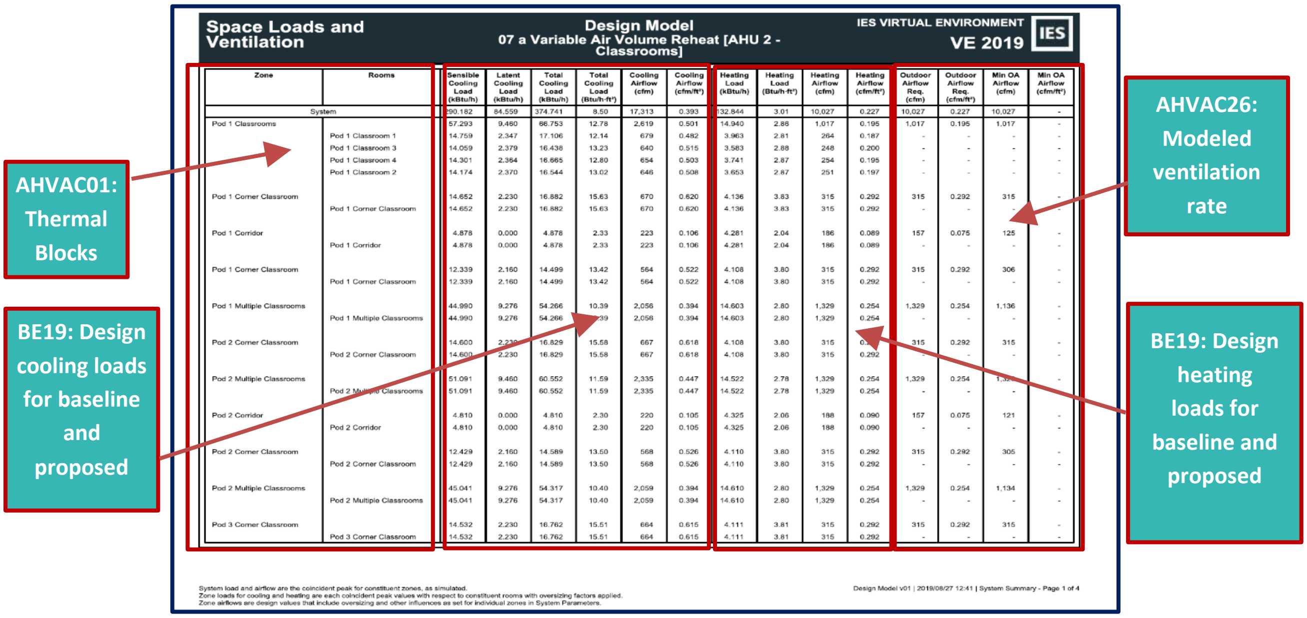
BE14: Baseline and Proposed Fenestration Properties.

BE19: Design cooling loads for baseline and proposed

BE19: Design heating loads for baseline and proposed

BE18: Infiltration (cfm)

Space Loads & Ventilation Report



AHVAC01: Thermal Blocks

BE19: Design cooling loads for baseline and proposed

AHVAC26: Modeled ventilation rate

BE19: Design heating loads for baseline and proposed

Space Loads and Ventilation

Design Model
07 a Variable Air Volume Reheat [AHU 2 - Classrooms]

IES VIRTUAL ENVIRONMENT
VE 2019

Zone	Rooms	Sensible Cooling Load (kBtu/h)	Latent Cooling Load (kBtu/h)	Total Cooling Load (kBtu/h)	Total Cooling Load (Btu/h-ft²)	Cooling Airflow (cfm)	Cooling Airflow (cfm/ft²)	Heating Load (kBtu/h)	Heating Load (Btu/h-ft²)	Heating Airflow (cfm)	Heating Airflow (cfm/ft²)	Outdoor Airflow Req. (cfm)	Outdoor Airflow Req. (cfm/ft²)	Min OA Airflow (cfm)	Min OA Airflow (cfm/ft²)
System		290.182	84.559	374.741	8.50	17,313	0.393	132.844	3.01	10,027	0.227	10,027	0.227	10,027	-
Pod 1 Classrooms		57.293	9.460	66.753	12.78	2,619	0.501	14.940	2.86	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	264	0.187	-	-	-	-
	Pod 1 Classroom 3	14.059	2.379	16.438	13.23	640	0.515	3.583	2.88	248	0.200	-	-	-	-
	Pod 1 Classroom 4	14.301	2.364	16.665	12.80	654	0.503	3.741	2.87	254	0.195	-	-	-	-
	Pod 1 Classroom 2	14.174	2.370	16.544	13.02	646	0.508	3.653	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	186	0.089	157	0.075	125	-
	Pod 1 Corridor	4.878	0.000	4.878	2.33	223	0.106	4.281	2.04	186	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	[illegible]	2,056	0.394	14.603	2.80	1,329	0.254	-	-	-	-
Pod 2 Corner Classroom		14.600	[illegible]	16.829	15.58	667	0.618	4.108	3.80	315	[illegible]	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	[illegible]	-
	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	13.50	568	0.526	4.110	3.80	315	0.292	315	0.292	305	-
	Pod 2 Corner Classroom	12.429	2.160	14.589	13.50	568	0.526	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	-	-	-	-

System load and airflow are the coincident peak for constituent zones, as simulated.
Zone loads for cooling and heating are each coincident peak values with respect to constituent rooms with oversizing factors applied.
Zone airflows are design values that include oversizing and other influences as set for individual zones in System Parameters.

Design Model v01 | 2019/08/27 12:41 | System Summary - Page 1 of 4

Thermal Template Report

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

BE18: Infiltration

INTEGRATED ENVIRONMENTAL SOLUTIONS

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 (ft²/person)	200.0
Sensible Gain (W/person)	73.3
Latent Gain (W/person)	58.6

SPACE: Office - Open plan - Equipment	
Power Consumption (W/ft²)	1.5
Sensible Gain (W/ft²)	1.5
Latent Gain (W/ft²)	0
Radiant Fraction	0.2

SPACE: Office - Open plan - Lighting	
Lighting Power Consumption (W/ft²)	0.98
Lighting Heat Gain (W/ft²)	0.98
Radiant Fraction	0.4

1

INTEGRATED ENVIRONMENTAL SOLUTIONS

Thermal Templates Data

Heating

Heating profile is set to 'on continuously'. Heating set point is defined as an absolute profile:

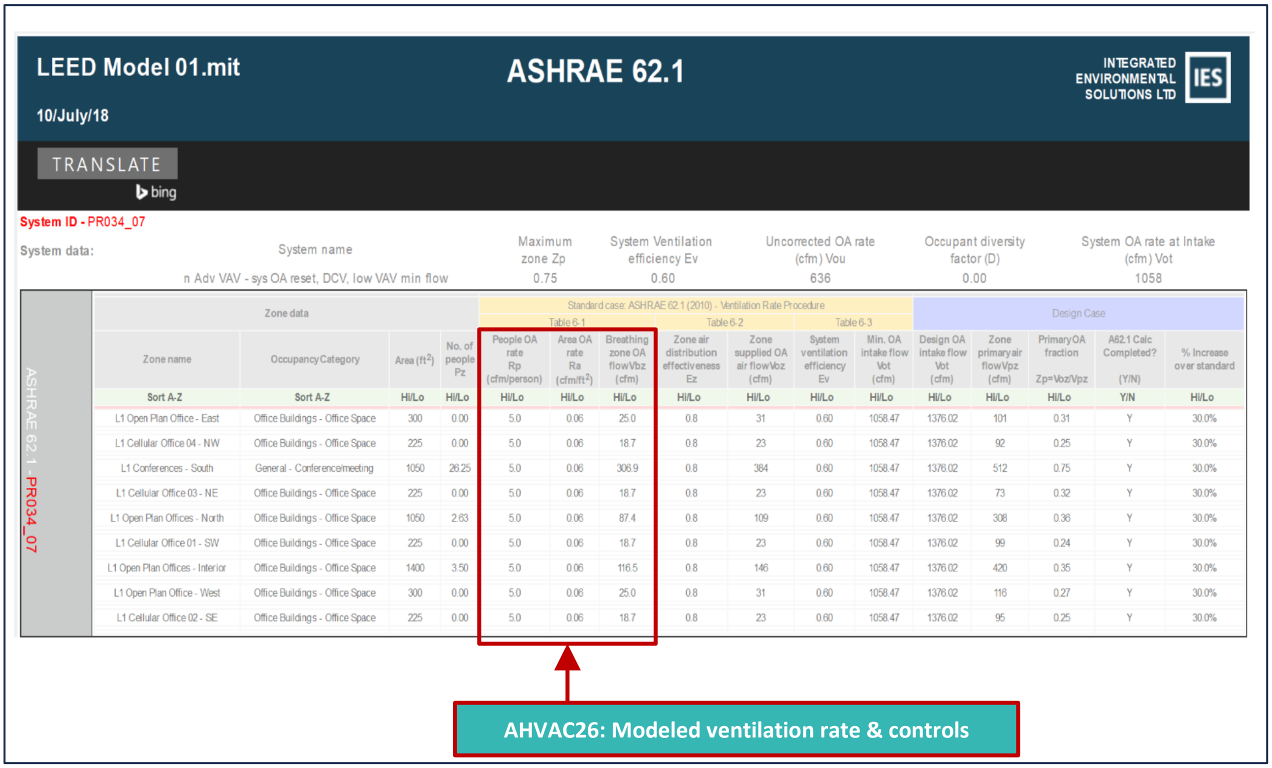
Cooling

Cooling profile is set to 'on continuously'. Cooling set point is defined as an absolute profile:

Infiltration	
Infiltration Rate (ach)	0.1

2

ASHRAE 62.1 Report



LEED Model 01.mit

ASHRAE 62.1

10/July/18

System ID - PR034_07

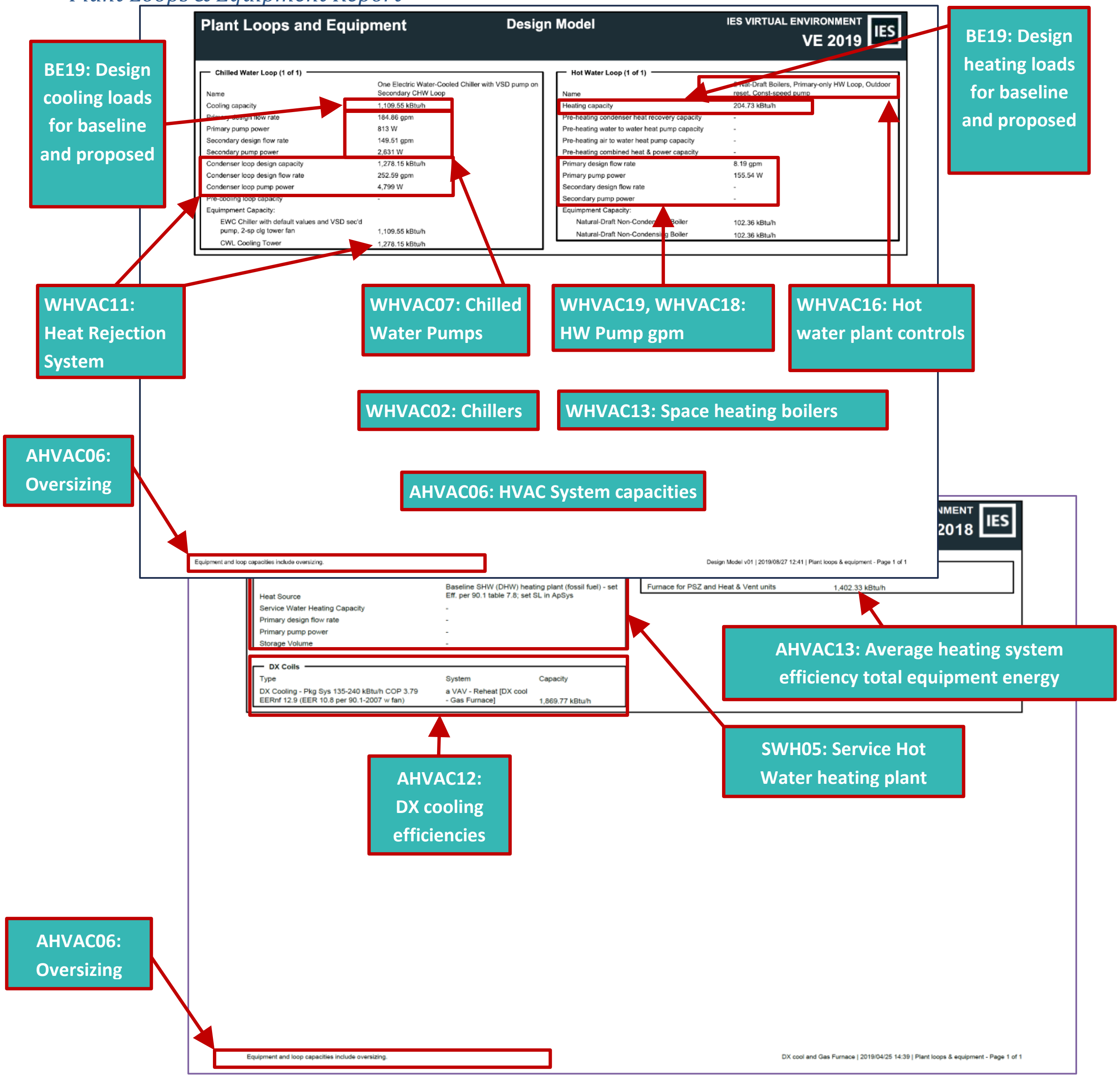
System data:

System name	Maximum zone Zp	System Ventilation efficiency Ev	Uncorrected OA rate (cfm) Vou	Occupant diversity factor (D)	System OA rate at Intake (cfm) Vot
n Adv VAV - sys OA reset, DCV, low VAV min flow	0.75	0.60	636	0.00	1058

Zone data				Standard case: ASHRAE 62.1 (2010) - Ventilation Rate Procedure							Design Case				
				Table 6-1			Table 6-2		Table 6-3						
Zone name	Occupancy Category	Area (ft²)	No. of people Pz	People OA rate Rp (cfm/person)	Area OA rate Ra (cfm/ft²)	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)	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
Sort A-Z	**Sort A-Z**	**Hi/Lo**	**Hi/Lo**	**Hi/Lo**	**Hi/Lo**	**Hi/Lo**	**Hi/Lo**	**Hi/Lo**	**Hi/Lo**	**Hi/Lo**	**Hi/Lo**	**Hi/Lo**	**Hi/Lo**	**Y/N**	**Hi/Lo**
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 - Conference/meeting	1050	26.25	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	308	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



Plant Loops and Equipment Design Model

IES VIRTUAL ENVIRONMENT VE 2019

Chilled Water Loop (1 of 1)

Name	One Electric Water-Cooled Chiller with VSD pump on Secondary CHW Loop
Cooling capacity	1,109.55 kBtu/h
Primary design flow rate	184.86 gpm
Primary pump power	813 W
Secondary design flow rate	149.51 gpm
Secondary pump power	2,631 W
Condenser loop design capacity	1,278.15 kBtu/h
Condenser loop design flow rate	252.59 gpm
Condenser loop pump power	4,799 W
Pre-cooling loop capacity	-
Equipmpent Capacity:	
EWC Chiller with default values and VSD sec'd pump, 2-sp clg tower fan	1,109.55 kBtu/h
CWL Cooling Tower	1,278.15 kBtu/h

Hot Water Loop (1 of 1)

Name	2 Nat-Draft Boilers, Primary-only HW Loop, Outdoor reset, Const-speed pump
Heating capacity	204.73 kBtu/h
Pre-heating condenser heat recovery capacity	-
Pre-heating water to water heat pump capacity	-
Pre-heating air to water heat pump capacity	-
Pre-heating combined heat & power capacity	-
Primary design flow rate	8.19 gpm
Primary pump power	155.54 W
Secondary design flow rate	-
Secondary pump power	-
Equipmpent Capacity:	
Natural-Draft Non-Condensing Boiler	102.36 kBtu/h
Natural-Draft Non-Condensing Boiler	102.36 kBtu/h

Equipment and loop capacities include oversizing.

Design Model v01 | 2019/08/27 12:41 | Plant loops & equipment - Page 1 of 1

NMENT 2018

Heat Source	Baseline SHW (DHW) heating plant (fossil fuel) - set Eff. per 90.1 table 7.8; set SL in ApSys
Service Water Heating Capacity	-
Primary design flow rate	-
Primary pump power	-
Storage Volume	-

Furnace for PSZ and Heat & Vent units	1,402.33 kBtu/h

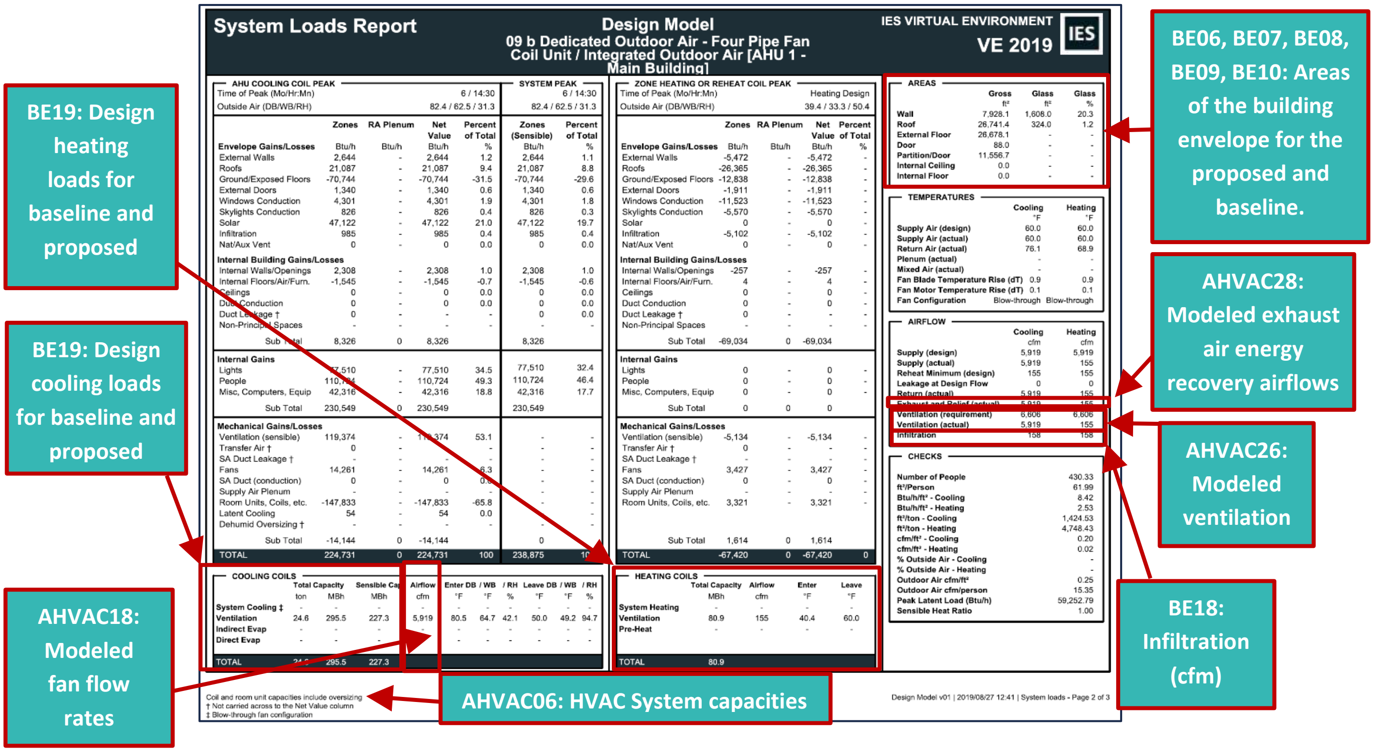
DX Coils

Type	System	Capacity
DX Cooling - Pkg Sys 135-240 kBtu/h COP 3.79 EERnf 12.9 (EER 10.8 per 90.1-2007 w fan)	a VAV - Reheat [DX cool - Gas Furnace]	1,869.77 kBtu/h

Equipment and loop capacities include oversizing.

DX cool and Gas Furnace | 2019/04/25 14:39 | Plant loops & equipment - Page 1 of 1

System Loads Report (examples: DOAS, VAV)



System Loads Report

Design Model
09 b Dedicated Outdoor Air - Four Pipe Fan Coil Unit / Integrated Outdoor Air [AHU 1 - Main Building]

IES VIRTUAL ENVIRONMENT
VE 2019

AHU COOLING COIL PEAK / **SYSTEM PEAK**

	AHU Cooling Coil Peak	System Peak
Time of Peak (Mo/Hr:Mn)	6 / 14:30	6 / 14:30
Outside Air (DB/WB/RH)	82.4 / 62.5 / 31.3	82.4 / 62.5 / 31.3

	Zones	RA Plenum	Net Value	Percent of Total	Zones (Sensible)	Percent of Total
Envelope Gains/Losses	Btu/h	Btu/h	Btu/h	%	Btu/h	%
External Walls	2,644	-	2,644	1.2	2,644	1.1
Roofs	21,087	-	21,087	9.4	21,087	8.8
Ground/Exposed Floors	-70,744	-	-70,744	-31.5	-70,744	-29.6
External Doors	1,340	-	1,340	0.6	1,340	0.6
Windows Conduction	4,301	-	4,301	1.9	4,301	1.8
Skylights Conduction	826	-	826	0.4	826	0.3
Solar	47,122	-	47,122	21.0	47,122	19.7
Infiltration	985	-	985	0.4	985	0.4
Nat/Aux Vent	0	-	0	0.0	0	0.0
Internal Building Gains/Losses						
Internal Walls/Openings	2,308	-	2,308	1.0	2,308	1.0
Internal Floors/Air/Furn.	-1,545	-	-1,545	-0.7	-1,545	-0.6
Ceilings	0	-	0	0.0	0	0.0
Duct Conduction	0	-	0	0.0	0	0.0
Duct Leakage †	0	-	-	-	0	0.0
Non-Principal Spaces	-	-	-	-	-	-
Sub Total	8,326	0	8,326		8,326	
Internal Gains						
Lights	77,510	-	77,510	34.5	77,510	32.4
People	110,724	-	110,724	49.3	110,724	46.4
Misc, Computers, Equip	42,316	-	42,316	18.8	42,316	17.7
Sub Total	230,549	0	230,549		230,549	
Mechanical Gains/Losses						
Ventilation (sensible)	119,374	-	119,374	53.1	-	-
Transfer Air †	0	-	-	-	-	-
SA Duct Leakage †	-	-	-	-	-	-
Fans	14,261	-	14,261	6.3	-	-
SA Duct (conduction)	0	-	0	0.0	-	-
Supply Air Plenum	-	-	-	-	-	-
Room Units, Coils, etc.	-147,833	-	-147,833	-65.8	-	-
Latent Cooling	54	-	54	0.0	-	-
Dehumid Oversizing †	-	-	-	-	-	-
Sub Total	-14,144	0	-14,144		0	
TOTAL	224,731	0	224,731	100	238,875	100

ZONE HEATING OR REHEAT COIL PEAK

Time of Peak (Mo/Hr:Mn)	Heating Design
Outside Air (DB/WB/RH)	39.4 / 33.3 / 50.4

	Zones	RA Plenum	Net Value	Percent of Total
Envelope Gains/Losses	Btu/h	Btu/h	Btu/h	%
External Walls	-5,472	-	-5,472	-
Roofs	-26,365	-	-26,365	-
Ground/Exposed Floors	-12,838	-	-12,838	-
External Doors	-1,911	-	-1,911	-
Windows Conduction	-11,523	-	-11,523	-
Skylights Conduction	-5,570	-	-5,570	-
Solar	0	-	0	-
Infiltration	-5,102	-	-5,102	-
Nat/Aux Vent	0	-	0	-
Internal Building Gains/Losses				
Internal Walls/Openings	-257	-	-257	-
Internal Floors/Air/Furn.	4	-	4	-
Ceilings	0	-	0	-
Duct Conduction	0	-	0	-
Duct Leakage †	0	-	-	-
Non-Principal Spaces	-	-	-	-
Sub Total	-69,034	0	-69,034	
Internal Gains				
Lights	0	-	0	-
People	0	-	0	-
Misc, Computers, Equip	0	-	0	-
Sub Total	0	0	0	
Mechanical Gains/Losses				
Ventilation (sensible)	-5,134	-	-5,134	-
Transfer Air †	0	-	-	-
SA Duct Leakage †	-	-	-	-
Fans	3,427	-	3,427	-
SA Duct (conduction)	0	-	0	-
Supply Air Plenum	-	-	-	-
Room Units, Coils, etc.	3,321	-	3,321	-
Sub Total	1,614	0	1,614	
TOTAL	-67,420	0	-67,420	0

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	11,556.7	-	-
Internal Ceiling	0.0	-	-
Internal Floor	0.0	-	-

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

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
Exhaust and Relief (actual)	5,919	155
Ventilation (requirement)	6,606	6,606
Ventilation (actual)	5,919	155
Infiltration	158	158

CHECKS

Number of People	430.33
ft²/Person	61.99
Btu/h/ft² - Cooling	8.42
Btu/h/ft² - Heating	2.53
ft²/ton - Cooling	1,424.53
ft²/ton - Heating	4,748.43
cfm/ft² - Cooling	0.20
cfm/ft² - Heating	0.02
% Outside Air - Cooling	-
% Outside Air - Heating	-
Outdoor Air cfm/ft²	0.25
Outdoor Air cfm/person	15.35
Peak Latent Load (Btu/h)	59,252.79
Sensible Heat Ratio	1.00

COOLING COILS

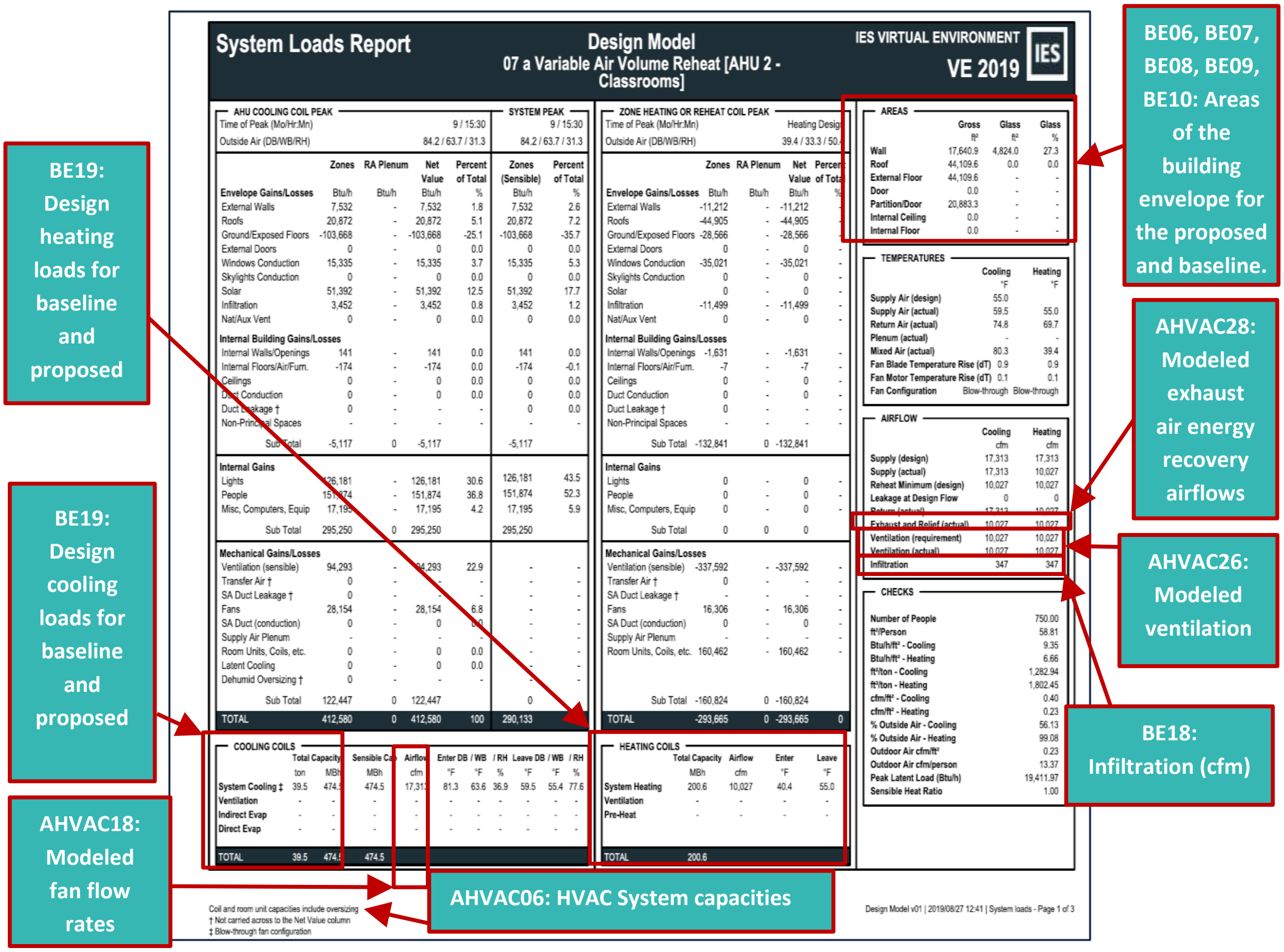
	Total Capacity		Sensible Cap	Airflow	Enter DB	/ WB	/ RH	Leave DB	/ WB	/ RH
	ton	MBh	MBh	cfm	°F	°F	%	°F	°F	%
System Cooling ‡	-	-	-	-	-	-	-	-	-	-
Ventilation	24.6	295.5	227.3	5,919	80.5	64.7	42.1	50.0	49.2	94.7
Indirect Evap	-	-	-	-	-	-	-	-	-	-
Direct Evap	-	-	-	-	-	-	-	-	-	-
TOTAL	24.6	295.5	227.3							

HEATING COILS

	Total Capacity	Airflow	Enter	Leave
	MBh	cfm	°F	°F
System Heating	-	-	-	-
Ventilation	80.9	155	40.4	60.0
Pre-Heat	-	-	-	-
TOTAL	80.9			

Coil and room unit capacities include oversizing
† Not carried across to the Net Value column
‡ Blow-through fan configuration

Design Model v01 | 2019/08/27 12:41 | System loads - Page 2 of 3



System Loads Report

Design Model
07 a Variable Air Volume Reheat [AHU 2 - Classrooms]

IES VIRTUAL ENVIRONMENT
VE 2019

AHU COOLING COIL PEAK / **SYSTEM PEAK**

Time of Peak (Mo/Hr:Mn)				9 / 15:30		9 / 15:30
Outside Air (DB/WB/RH)				84.2 / 63.7 / 31.3		84.2 / 63.7 / 31.3

	Zones	RA Plenum	Net Value	Percent of Total	Zones (Sensible)	Percent of Total
Envelope Gains/Losses	Btu/h	Btu/h	Btu/h	%	Btu/h	%
External Walls	7,532	-	7,532	1.8	7,532	2.6
Roofs	20,872	-	20,872	5.1	20,872	7.2
Ground/Exposed Floors	-103,668	-	-103,668	-25.1	-103,668	-35.7
External Doors	0	-	0	0.0	0	0.0
Windows Conduction	15,335	-	15,335	3.7	15,335	5.3
Skylights Conduction	0	-	0	0.0	0	0.0
Solar	51,392	-	51,392	12.5	51,392	17.7
Infiltration	3,452	-	3,452	0.8	3,452	1.2
Nat/Aux Vent	0	-	0	0.0	0	0.0
Internal Building Gains/Losses						
Internal Walls/Openings	141	-	141	0.0	141	0.0
Internal Floors/Air/Furn.	-174	-	-174	0.0	-174	-0.1
Ceilings	0	-	0	0.0	0	0.0
Duct Conduction	0	-	0	0.0	0	0.0
Duct Leakage †	0	-	-	-	0	0.0
Non-Principal Spaces	-	-	-	-	-	-
Sub Total	-5,117	0	-5,117		-5,117	
Internal Gains						
Lights	126,181	-	126,181	30.6	126,181	43.5
People	151,874	-	151,874	36.8	151,874	52.3
Misc, Computers, Equip	17,195	-	17,195	4.2	17,195	5.9
Sub Total	295,250	0	295,250		295,250	
Mechanical Gains/Losses						
Ventilation (sensible)	94,293	-	94,293	22.9	-	-
Transfer Air †	0	-	-	-	-	-
SA Duct Leakage †	0	-	-	-	-	-
Fans	28,154	-	28,154	6.8	-	-
SA Duct (conduction)	0	-	0	0.0	-	-
Supply Air Plenum	-	-	-	-	-	-
Room Units, Coils, etc.	0	-	0	0.0	-	-
Latent Cooling	0	-	0	0.0	-	-
Dehumid Oversizing †	0	-	-	-	-	-
Sub Total	122,447	0	122,447		0	
TOTAL	412,580	0	412,580	100	290,133	

COOLING COILS

	Total Capacity		Sensible Cap	Airflow	Enter DB	/ WB	/ RH	Leave DB	/ WB	/ RH
	ton	MBh	MBh	cfm	°F	°F	%	°F	°F	%
System Cooling ‡	39.5	474.5	474.5	17,313	81.3	63.6	36.9	59.5	55.4	77.6
Ventilation	-	-	-	-	-	-	-	-	-	-
Indirect Evap	-	-	-	-	-	-	-	-	-	-
Direct Evap	-	-	-	-	-	-	-	-	-	-
TOTAL	39.5	474.5	474.5							

ZONE HEATING OR REHEAT COIL PEAK

Time of Peak (Mo/Hr:Mn)			Heating Desig	
Outside Air (DB/WB/RH)			39.4 / 33.3 / 50.	

	Zones	RA Plenum	Net Value	Percen of Tota
Envelope Gains/Losses	Btu/h	Btu/h	Btu/h	%
External Walls	-11,212	-	-11,212	-
Roofs	-44,905	-	-44,905	-
Ground/Exposed Floors	-28,566	-	-28,566	-
External Doors	0	-	0	-
Windows Conduction	-35,021	-	-35,021	-
Skylights Conduction	0	-	0	-
Solar	0	-	0	-
Infiltration	-11,499	-	-11,499	-
Nat/Aux Vent	0	-	0	-
Internal Building Gains/Losses				
Internal Walls/Openings	-1,631	-	-1,631	-
Internal Floors/Air/Furn.	-7	-	-7	-
Ceilings	0	-	0	-
Duct Conduction	0	-	0	-
Duct Leakage †	0	-	-	-
Non-Principal Spaces	-	-	-	-
Sub Total	-132,841	0	-132,841	
Internal Gains				
Lights	0	-	0	-
People	0	-	0	-
Misc, Computers, Equip	0	-	0	-
Sub Total	0	0	0	
Mechanical Gains/Losses				
Ventilation (sensible)	-337,592	-	-337,592	-
Transfer Air †	0	-	-	-
SA Duct Leakage †	-	-	-	-
Fans	16,306	-	16,306	-
SA Duct (conduction)	0	-	0	-
Supply Air Plenum	-	-	-	-
Room Units, Coils, etc.	160,462	-	160,462	-
Sub Total	-160,824	0	-160,824	
TOTAL	-293,665	0	-293,665	0

HEATING COILS

	Total Capacity	Airflow	Enter	Leave
	MBh	cfm	°F	°F
System Heating	200.6	10,027	40.4	55.0
Ventilation	-	-	-	-
Pre-Heat	-	-	-	-
TOTAL	200.6			

AREAS

	Gross	Glass	Glass
	ft²	ft²	%
Wall	17,640.9	4,824.0	27.3
Roof	44,109.6	0.0	0.0
External Floor	44,109.6	-	-
Door	0.0	-	-
Partition/Door	20,883.3	-	-
Internal Ceiling	0.0	-	-
Internal Floor	0.0	-	-

TEMPERATURES

	Cooling	Heating
	°F	°F
Supply Air (design)	55.0	
Supply Air (actual)	59.5	55.0
Return Air (actual)	74.8	69.7
Plenum (actual)	-	-
Mixed Air (actual)	80.3	39.4
Fan Blade Temperature Rise (dT)	0.9	0.9
Fan Motor Temperature Rise (dT)	0.1	0.1
Fan Configuration	Blow-through	Blow-through

AIRFLOW

	Cooling	Heating
	cfm	cfm
Supply (design)	17,313	17,313
Supply (actual)	17,313	10,027
Reheat Minimum (design)	10,027	10,027
Leakage at Design Flow	0	0
Return (actual)	17,313	10,027
Exhaust and Relief (actual)	10,027	10,027
Ventilation (requirement)	10,027	10,027
Ventilation (actual)	10,027	10,027
Infiltration	347	347

CHECKS

Number of People	750.00
ft²/Person	58.81
Btu/h/ft² - Cooling	9.35
Btu/h/ft² - Heating	6.66
ft²/ton - Cooling	1,282.94
ft²/ton - Heating	1,802.45
cfm/ft² - Cooling	0.40
cfm/ft² - Heating	0.23
% Outside Air - Cooling	56.13
% Outside Air - Heating	99.08
Outdoor Air cfm/ft²	0.23
Outdoor Air cfm/person	13.37
Peak Latent Load (Btu/h)	19,411.97
Sensible Heat Ratio	1.00

Coil and room unit capacities include oversizing
† Not carried across to the Net Value column
‡ Blow-through fan configuration

Design Model v01 | 2019/08/27 12:41 | System loads - Page 1 of 3

BE06, BE07, BE08, BE09, BE10: Areas of the building envelope for the proposed and baseline.

BE19: Design heating loads for baseline and proposed

AHVAC28: Modeled exhaust air energy recovery airflows

BE19: Design cooling loads for baseline and proposed

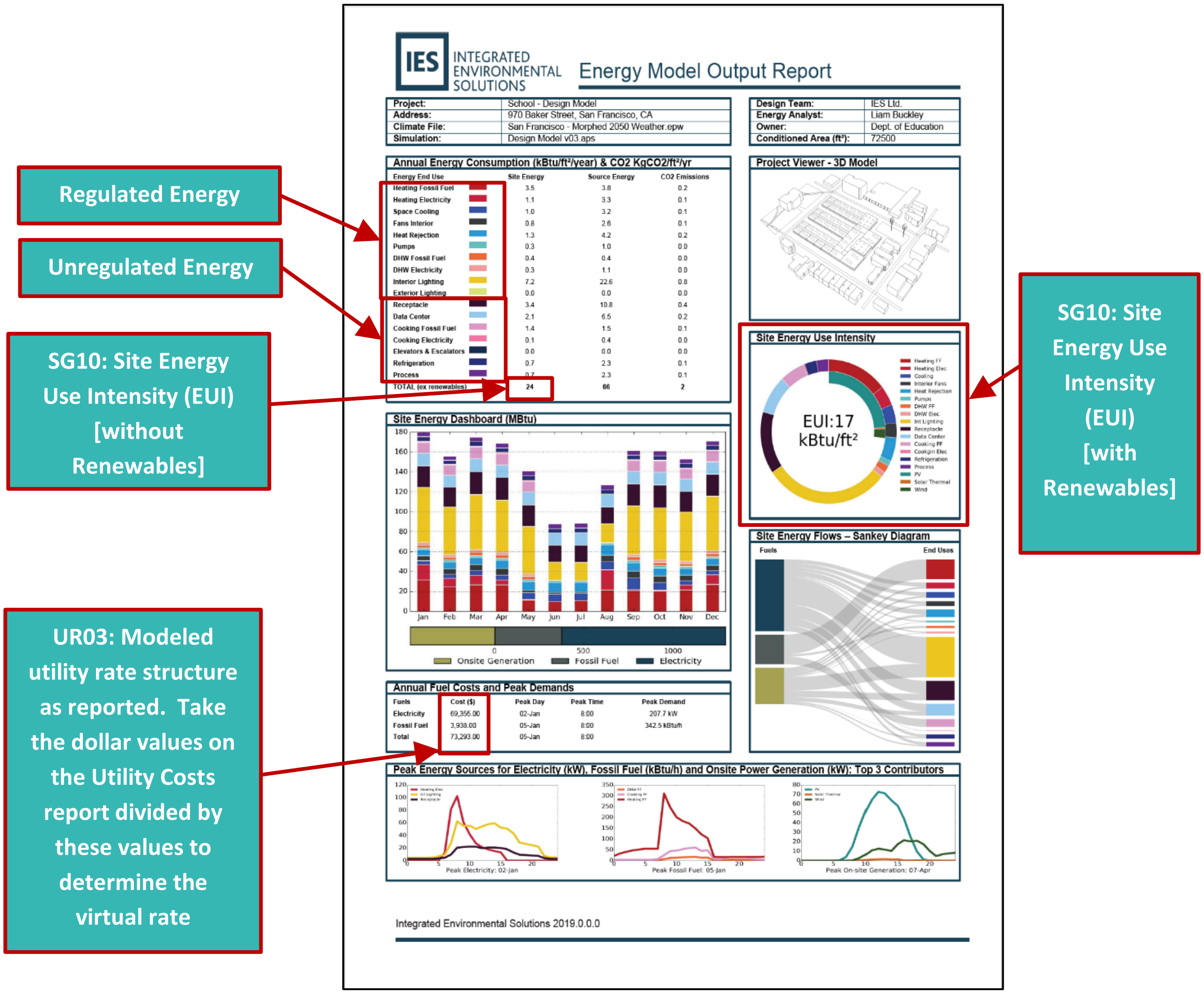
AHVAC26: Modeled ventilation

BE18: Infiltration (cfm)

AHVAC18: Modeled fan flow rates

AHVAC06: HVAC System capacities

Energy Model Output Report



INTEGRATED ENVIRONMENTAL SOLUTIONS

Energy Model Output Report

Project:	School - Design Model
Address:	970 Baker Street, San Francisco, CA
Climate File:	San Francisco - Morphed 2050 Weather.epw
Simulation:	Design Model v03.aps

Design Team:	IES Ltd.
Energy Analyst:	Liam Buckley
Owner:	Dept. of Education
Conditioned Area (ft²):	72500

Annual Energy Consumption (kBtu/ft²/year) & CO2 KgCO2/ft²/yr

Energy End Use		Site Energy	Source Energy	CO2 Emissions
Heating Fossil Fuel	🟥	3.5	3.8	0.2
Heating Electricity	🟥	1.1	3.3	0.1
Space Cooling	🟦	1.0	3.2	0.1
Fans Interior	⬛	0.8	2.6	0.1
Heat Rejection	🟦	1.3	4.2	0.2
Pumps	🟩	0.3	1.0	0.0
DHW Fossil Fuel	🟧	0.4	0.4	0.0
DHW Electricity	🟥	0.3	1.1	0.0
Interior Lighting	🟨	7.2	22.6	0.8
Exterior Lighting	🟨	0.0	0.0	0.0
Receptacle	🟪	3.4	10.8	0.4
Data Center	🟦	2.1	6.5	0.2
Cooking Fossil Fuel	🟪	1.4	1.5	0.1
Cooking Electricity	🟥	0.1	0.4	0.0
Elevators & Escalators	⬛	0.0	0.0	0.0
Refrigeration	🟦	0.7	2.3	0.1
Process	🟪	0.7	2.3	0.1
TOTAL (ex renewables)		24	66	2

Project Viewer - 3D Model

Site Energy Use Intensity

Site Energy Dashboard (MBtu)

Site Energy Flows – Sankey Diagram

Annual Fuel Costs and Peak Demands

Fuels	Cost ($)	Peak Day	Peak Time	Peak Demand
Electricity	69,355.00	02-Jan	8:00	207.7 kW
Fossil Fuel	3,938.00	05-Jan	8:00	342.5 kBtu/h
Total	73,293.00	05-Jan	8:00	

Peak Energy Sources for Electricity (kW), Fossil Fuel (kBtu/h) and Onsite Power Generation (kW): Top 3 Contributors

Integrated Environmental Solutions 2019.0.0.0

Regulated Energy

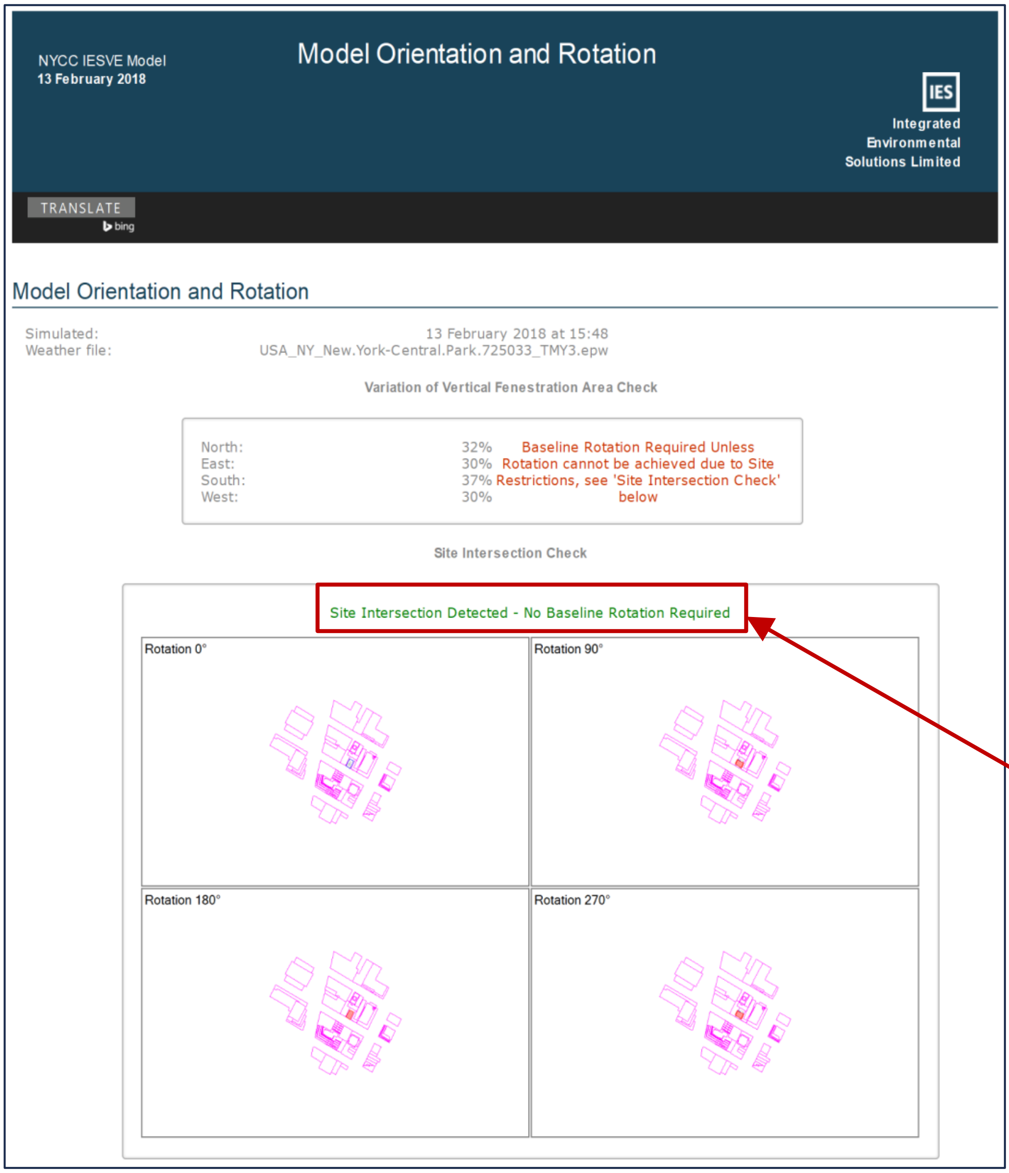
Unregulated Energy

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



NYCC IESVE Model
13 February 2018

Model Orientation and Rotation

Model Orientation and Rotation

Simulated: 13 February 2018 at 15:48
Weather file: USA_NY_New.York-Central.Park.725033_TMY3.epw

Variation of Vertical Fenestration Area Check

North: 32%
East: 30%
South: 37%
West: 30%

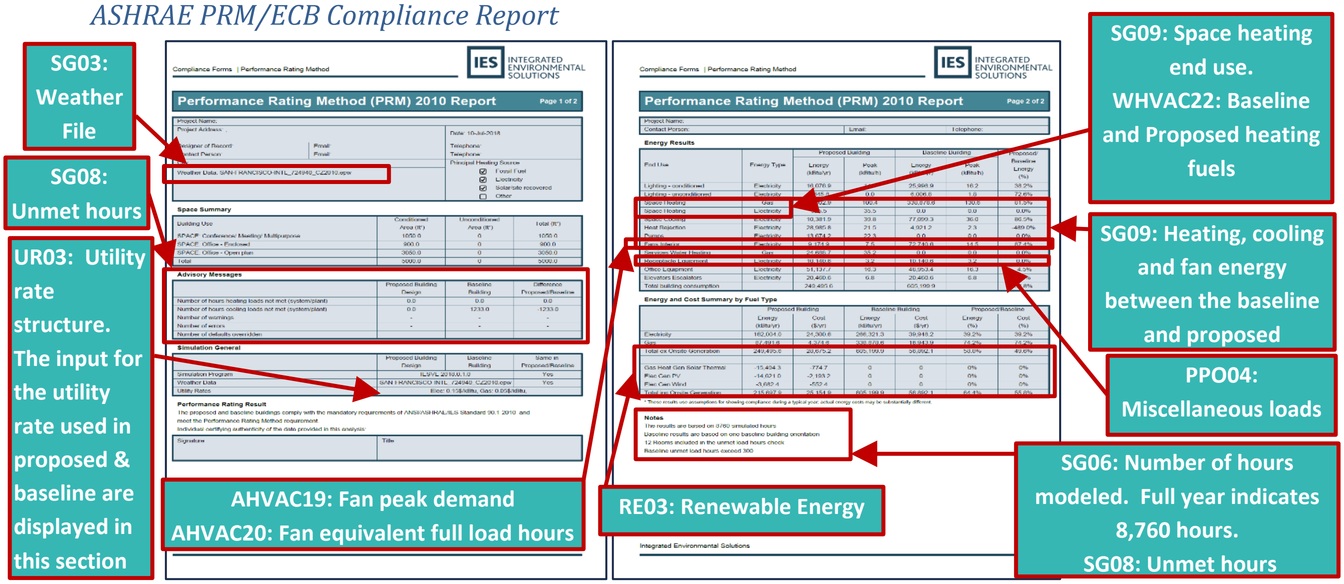
Baseline Rotation Required Unless Rotation cannot be achieved due to Site Restrictions, see 'Site Intersection Check' below

Site Intersection Check

Site Intersection Detected - No Baseline Rotation Required

BE21: Baseline 4 rotations checked for any site restrictions to determine if 1 or 4 baseline models are required

ASHRAE PRM/ECB Compliance Report



Compliance Forms | Performance Rating Method

Performance Rating Method (PRM) 2010 Report Page 1 of 2

Project Name:
Project Address: ,
Designer of Record: Email:
Contact Person: Email:
City:
Weather Data: SAN-FRANCISCO-INTL_724940_CZ2010.epw

Date: 10-Jul-2018
Telephone:
Telephone:
Principal Heating Source
☑ Fossil Fuel
☑ Electricity
☑ Solar/site recovered
☐ Other

Space Summary

Building Use	Conditioned Area (ft²)	Unconditioned Area (ft²)	Total (ft²)
SPACE: Conference/ Meeting/ Multipurpose	1050.0	0	1050.0
SPACE: Office - Enclosed	900.0	0	900.0
SPACE: Office - Open plan	3050.0	0	3050.0
Total	5000.0	0	5000.0

Advisory Messages

	Proposed Building Design	Baseline Building	Difference Proposed/Baseline
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	1233.0	-1233.0
Number of warnings	-	-	-
Number of errors	-	-	-
Number of defaults overridden			

Simulation General

	Proposed Building Design	Baseline Building	Same in Proposed/Baseline
Simulation Program	ILSVL 2018.0.1.0		Yes
Weather Data	SAN FRANCISCO INTL_724940_CZ2010.epw		Yes
Utility Rates	Elec: 0.15$/kBtu, Gas: 0.05$/kBtu,		

Performance Rating Result

The proposed and baseline buildings comply with the mandatory requirements of ANSI/ASHRAE/IES Standard 90.1 2010 and meet the Performance Rating Method requirement.

Individual certifying authenticity of the data provided in this analysis:

Signature	Title

Compliance Forms | Performance Rating Method

Performance Rating Method (PRM) 2010 Report Page 2 of 2

Project Name:
Contact Person: Email: Telephone:

Energy Results

End Use	Energy Type	Proposed Building		Baseline Building		Proposed/ Baseline Energy (%)
		Energy (kBtu/yr)	Peak (kBtu/h)	Energy (kBtu/yr)	Peak (kBtu/h)	
Lighting - conditioned	Electricity	16,076.9	[illegible]	25,998.9	16.2	38.2%
Lighting - unconditioned	Electricity	[illegible]	0.0	6,006.6	1.8	72.6%
Space Heating	Gas	[illegible]	100.4	330,078.6	130.6	61.5%
Space Heating	Electricity	[illegible]	35.5	0.0	0.0	0.0%
Space Cooling	Electricity	10,381.9	39.8	77,099.3	36.0	86.5%
Heat Rejection	Electricity	28,985.8	21.5	4,921.2	2.3	-489.0%
Pumps	Electricity	13,674.2	22.3	0.0	0.0	0.0%
Fans Interior	Electricity	9,174.9	7.5	72,740.6	14.5	87.4%
Services Water Heating	Gas	24,686.7	35.2	0.0	0.0	0.0%
Receptacle Equipment	Electricity	10,140.6	3.2	10,140.6	3.2	0.0%
Office Equipment	Electricity	51,137.7	16.3	48,953.4	16.3	4.5%
Elevators Escalators	Electricity	20,460.6	6.8	20,460.6	6.8	[illegible]
Total building consumption		249,495.6		605,199.9		[illegible]

Energy and Cost Summary by Fuel Type

	Proposed Building		Baseline Building		Proposed/Baseline	
	Energy (kBtu/yr)	Cost ($/yr)	Energy (kBtu/yr)	Cost ($/yr)	Energy (%)	Cost (%)
Electricity	162,004.0	24,300.6	266,321.3	39,948.2	39.2%	39.2%
Gas	87,491.6	4,374.6	338,878.6	18,943.9	74.2%	74.2%
Total ex Onsite Generation	249,495.6	20,675.2	605,199.9	58,892.1	58.8%	49.6%
Gas Heat Gen Solar Thermal	-15,494.3	-774.7	0	0	0%	0%
Elec Gen PV	-14,621.0	-2,193.2	0	0	0%	0%
Elec Gen Wind	-3,682.4	-552.4	0	0	0%	0%
Total inc Onsite Generation	215,697.9	25,154.9	605,199.9	58,892.1	64.4%	55.8%

* These results use assumptions for showing compliance during a typical year; actual energy costs may be substantially different.

Notes
The results are based on 8760 simulated hours
Baseline results are based on one baseline building orientation
12 Rooms included in the unmet load hours check
Baseline unmet load hours exceed 300

Integrated Environmental Solutions

SG03: Weather File

SG08: Unmet hours

UR03: Utility rate structure. The input for the utility rate used in proposed & baseline are displayed in this section

AHVAC19: Fan peak demand
AHVAC20: Fan equivalent full load hours

RE03: Renewable Energy

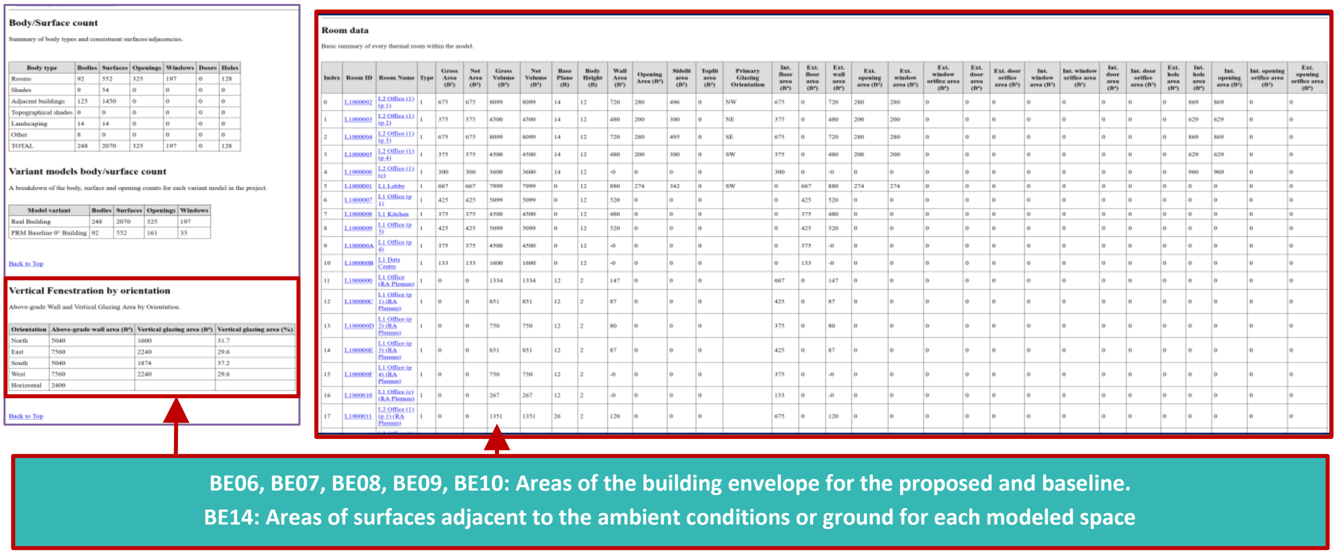
SG09: Space heating end use.
WHVAC22: Baseline and Proposed heating fuels

SG09: Heating, cooling and fan energy between the baseline and proposed

PPO04: Miscellaneous loads

SG06: Number of hours modeled. Full year indicates 8,760 hours.
SG08: Unmet hours

ModelIT Model Report



Body/Surface count

Summary of body types and consituent surfaces/adjacencies.

Body type	Bodies	Surfaces	Openings	Windows	Doors	Holes
Rooms	92	552	325	197	0	128
Shades	9	54	0	0	0	0
Adjacent buildings	125	1450	0	0	0	0
Topographical shades	0	0	0	0	0	0
Landscaping	14	14	0	0	0	0
Other	8	0	0	0	0	0
TOTAL	248	2070	325	197	0	128

Variant models body/surface count

A breakdown of the body, surface and opening counts for each variant model in the project.

Model variant	Bodies	Surfaces	Openings	Windows
Real Building	248	2070	325	197
PRM Baseline 0° Building	92	552	161	33

Back to Top

Vertical Fenestration by orientation

Above-grade Wall and Vertical Glazing Area by Orientation.

Orientation	Above-grade wall area (ft²)	Vertical glazing area (ft²)	Vertical glazing area (%)
North	5040	1600	31.7
East	7560	2240	29.6
South	5040	1874	37.2
West	7560	2240	29.6
Horizontal	2400		

Back to Top

Room data

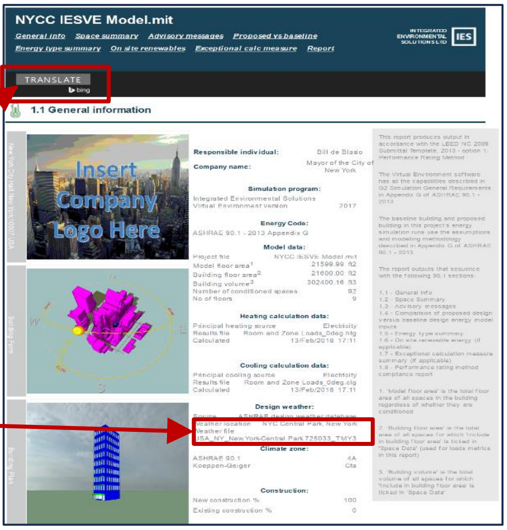
Basic summary of every thermal room within the model.

Index	Room ID	Room Name	Type	Gross Area (ft²)	Net Area (ft²)	Gross Volume (ft³)	Net Volume (ft³)	Base Plane (ft)	Body Height (ft)	Wall Area (ft²)	Opening Area (ft²)	Sidelit area (ft²)	Toplit area (ft²)	Primary Glazing Orientation	Int. floor area (ft²)	Ext. floor area (ft²)	Ext. wall area (ft²)	Ext. opening area (ft²)	Ext. window area (ft²)	Ext. window orifice area (ft²)	Ext. door area (ft²)	Ext. door orifice area (ft²)	Int. window area (ft²)	Int. window orifice area (ft²)	Int. door area (ft²)	Int. door orifice area (ft²)	Ext. hole area (ft²)	Int. hole area (ft²)	Int. opening area (ft²)	Int. opening orifice area (ft²)	Ext. opening orifice area (ft²)
0	L1000002	L2 Office (1) (p 1)	1	675	675	8099	8099	14	12	720	280	496	0	NW	675	0	720	280	280	0	0	0	0	0	0	0	0	869	869	0	0
1	L1000003	L2 Office (1) (p 2)	1	375	375	4500	4500	14	12	480	200	300	0	NE	375	0	480	200	200	0	0	0	0	0	0	0	0	629	629	0	0
2	L1000004	L2 Office (1) (p 3)	1	675	675	8099	8099	14	12	720	280	495	0	SE	675	0	720	280	280	0	0	0	0	0	0	0	0	869	869	0	0
3	L1000005	L2 Office (1) (p 4)	1	375	375	4500	4500	14	12	480	200	300	0	SW	375	0	480	200	200	0	0	0	0	0	0	0	0	629	629	0	0
4	L1000006	L2 Office (1) (c)	1	300	300	3600	3600	14	12	-0	0	0	0		300	0	-0	0	0	0	0	0	0	0	0	0	0	960	960	0	0
5	L1000001	L1 Lobby	1	667	667	7999	7999	0	12	880	274	342	0	SW	0	667	880	274	274	0	0	0	0	0	0	0	0	0	0	0	0
6	L1000007	L1 Office (p 1)	1	425	425	5099	5099	0	12	520	0	0	0		0	425	520	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	L1000008	L1 Kitchen	1	375	375	4500	4500	0	12	480	0	0	0		0	375	480	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	L1000009	L1 Office (p 3)	1	425	425	5099	5099	0	12	520	0	0	0		0	425	520	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	L100000A	L1 Office (p 4)	1	375	375	4500	4500	0	12	-0	0	0	0		0	375	-0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	L100000B	L1 Data Center	1	133	133	1600	1600	0	12	-0	0	0	0		0	133	-0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	L1000000	L1 Office (RA Plenum)	1	0	0	1334	1334	12	2	147	0	0	0		667	0	147	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	L100000C	L1 Office (p 1) (RA Plenum)	1	0	0	851	851	12	2	87	0	0	0		425	0	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	L100000D	L1 Office (p 2) (RA Plenum)	1	0	0	750	750	12	2	80	0	0	0		375	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	L100000E	L1 Office (p 3) (RA Plenum)	1	0	0	851	851	12	2	87	0	0	0		425	0	87	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	L100000F	L1 Office (p 4) (RA Plenum)	1	0	0	750	750	12	2	-0	0	0	0		375	0	-0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	L1000010	L1 Office (c) (RA Plenum)	1	0	0	267	267	12	2	-0	0	0	0		133	0	-0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	L1000011	L2 Office (1) (p 1) (RA Plenum)	1	0	0	1351	1351	26	2	120	0	0	0		675	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0

BE06, BE07, BE08, BE09, BE10: Areas of the building envelope for the proposed and baseline.
BE14: Areas of surfaces adjacent to the ambient conditions or ground for each modeled space

BPRM Report

Translate Report Language



1.1 General information

Responsible individual: Bill de Blasio
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.mit
Model floor area^1	21599.99 ft2
Building floor area^2	21600.00 ft2
Building volume^3	302400.16 ft3
Number of conditioned spaces	92
No of floors	9

Heating calculation data:

Principal heating source	Electricity
Results file	Room and Zone Loads_0deg.htg
Calculated	13/Feb/2018 17:11

Cooling calculation data:

Principal cooling source	Electricity
Results file	Room and Zone Loads_0deg.clg
Calculated	13/Feb/2018 17:11

Design weather:

Source	ASHRAE design weather database
Weather location	NYC Central Park, New York
Weather file	USA_NY_New.York-Central.Park.725033_TMY3

Climate zone:

ASHRAE 90.1	4A
Koeppen-Geiger	Cfa

Construction:

New construction %	100
Existing construction %	0

This report produces output in accordance with the LEED NC 2009 Submittal Template, 2013 - option 1: Performance Rating Method

The Virtual Environment software has all the capabilities described in G2 Simulation General Requirements in Appendix G of ASHRAE 90.1 - 2013

The baseline building and proposed building in this project's energy simulation runs use the assumptions and modelling methodology described in Appendix G of ASHRAE 90.1 - 2013

The report outputs that sequence with the following 90.1 sections:

1.1 - General info
1.2 - Space Summary
1.3 - Advisory messages
1.4 - Comparison of proposed design versus baseline design energy model inputs
1.5 - Energy type summary
1.6 - On site renewable energy (if applicable)
1.7 - Exceptional calculation measure summary (if applicable)
1.8 - Performance rating method compliance report

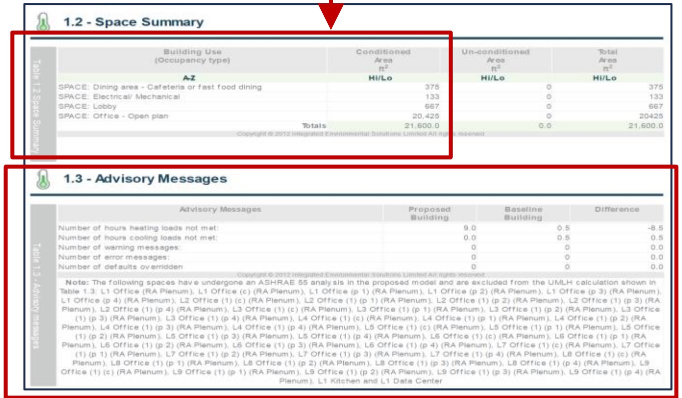
1. 'Model floor area' is the total floor area of all spaces in the building regardless of whether they are conditioned

2. 'Building floor area' is the total area of all spaces for which 'Include in building floor area' is ticked in 'Space Data' (used for loads metrics in this report)

3. 'Building volume' is the total volume of all spaces for which 'Include in building floor area' is ticked in 'Space Data'

SG03: Weather File

SG05: Conditioned Floor Area



1.2 - Space Summary

Building Use (Occupancy type)	Conditioned Area ft^2	Un-conditioned Area ft^2	Total Area ft^2
A-Z	Hi/Lo	Hi/Lo	Hi/Lo
SPACE: Dining area - Cafeteria or fast food dining	375	0	375
SPACE: Electrical/ Mechanical	133	0	133
SPACE: Lobby	667	0	667
SPACE: Office - Open plan	20,425	0	20425
Totals	21,600.0	0.0	21,600.0

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1.3 - Advisory Messages

Advisory Messages	Proposed Building	Baseline Building	Difference
Number of hours heating loads not met:	9.0	0.5	-8.5
Number of hours cooling loads not met:	0.0	0.5	0.5
Number of warning messages:	0	0	0.0
Number of error messages:	0	0	0.0
Number of defaults overridden	0	0	0.0

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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 (RA Plenum), L1 Office (c) (RA Plenum), L1 Office (p 1) (RA Plenum), L1 Office (p 2) (RA Plenum), L1 Office (p 3) (RA Plenum), L1 Office (p 4) (RA Plenum), L2 Office (1) (c) (RA Plenum), L2 Office (1) (p 1) (RA Plenum), L2 Office (1) (p 2) (RA Plenum), L2 Office (1) (p 3) (RA Plenum), L2 Office (1) (p 4) (RA Plenum), L3 Office (1) (c) (RA Plenum), L3 Office (1) (p 1) (RA Plenum), L3 Office (1) (p 2) (RA Plenum), L3 Office (1) (p 3) (RA Plenum), L3 Office (1) (p 4) (RA Plenum), L4 Office (1) (c) (RA Plenum), L4 Office (1) (p 1) (RA Plenum), L4 Office (1) (p 2) (RA Plenum), L4 Office (1) (p 3) (RA Plenum), L4 Office (1) (p 4) (RA Plenum), L5 Office (1) (c) (RA Plenum), L5 Office (1) (p 1) (RA Plenum), L5 Office (1) (p 2) (RA Plenum), L5 Office (1) (p 3) (RA Plenum), L5 Office (1) (p 4) (RA Plenum), L6 Office (1) (c) (RA Plenum), L6 Office (1) (p 1) (RA Plenum), L6 Office (1) (p 2) (RA Plenum), L6 Office (1) (p 3) (RA Plenum), L6 Office (1) (p 4) (RA Plenum), L7 Office (1) (c) (RA Plenum), L7 Office (1) (p 1) (RA Plenum), L7 Office (1) (p 2) (RA Plenum), L7 Office (1) (p 3) (RA Plenum), L7 Office (1) (p 4) (RA Plenum), L8 Office (1) (c) (RA Plenum), L8 Office (1) (p 1) (RA Plenum), L8 Office (1) (p 2) (RA Plenum), L8 Office (1) (p 3) (RA Plenum), L8 Office (1) (p 4) (RA Plenum), L9 Office (1) (c) (RA Plenum), L9 Office (1) (p 1) (RA Plenum), L9 Office (1) (p 2) (RA Plenum), L9 Office (1) (p 3) (RA Plenum), L9 Office (1) (p 4) (RA Plenum), L1 Kitchen and L1 Data Center

SG08: Unmet hours

BE06, BE07, BE08, BE09, BE10: Thermal properties of the building envelope for the proposed and baseline

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	CZ4 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 Insulation Entirely Above Deck (R-30 Ins.)	0.03	CZ4 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: U=F(0.73)*Floor perim.(200ft)/Floor area(2400ft^2)	0.06
Floor/slab construction			CZ4 Floor (Non-Res) - Steel Joist; R-30.0; U=0.038 (0.218)	0.04
Window to gross wall ratio	Overall	32%	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	CZ4 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	CZ4 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	CZ4 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	CZ4 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	CZ4 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	CZ4 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

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BE14: Baseline and Proposed Fenestration Areas

BE16: Baseline and Proposed Fenestration Properties

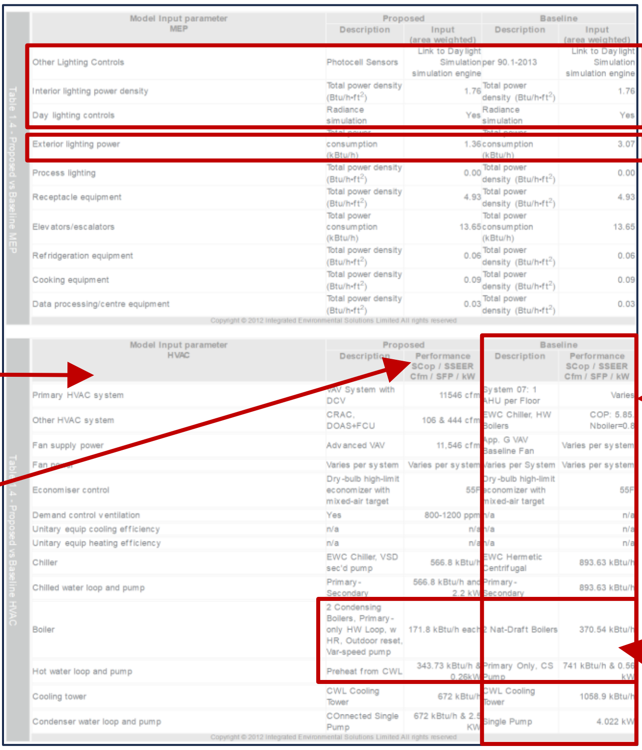


Table 1.4 - Proposed vs Baseline MEP

Model Input parameter MEP	Proposed		Baseline	
	Description	Input (area weighted)	Description	Input (area weighted)
Other Lighting Controls	Photocell Sensors	Link to Daylight Simulation simulation engine	per 90.1-2013	Link to Daylight Simulation simulation engine
Interior lighting power density	Total power density (Btu/h-ft^2)	1.76	Total power density (Btu/h-ft^2)	1.76
Day lighting controls	Radiance simulation	Yes	Radiance simulation	Yes
Exterior lighting power	Total power consumption (kBtu/h)	1.36	Total power consumption (kBtu/h)	3.07
Process lighting	Total power density (Btu/h-ft^2)	0.00	Total power density (Btu/h-ft^2)	0.00
Receptacle equipment	Total power density (Btu/h-ft^2)	4.93	Total power density (Btu/h-ft^2)	4.93
Elevators/escalators	Total power consumption (kBtu/h)	13.65	Total power consumption (kBtu/h)	13.65
Refridgeration equipment	Total power density (Btu/h-ft^2)	0.06	Total power density (Btu/h-ft^2)	0.06
Cooking equipment	Total power density (Btu/h-ft^2)	0.09	Total power density (Btu/h-ft^2)	0.09
Data processing/centre equipment	Total power density (Btu/h-ft^2)	0.03	Total power density (Btu/h-ft^2)	0.03

Table 1.4 - Proposed vs Baseline HVAC

Model Input parameter HVAC	Proposed		Baseline	
	Description	Performance SCop / SSEER Cfm / SFP / kW	Description	Performance SCop / SSEER Cfm / SFP / kW
Primary HVAC system	VAV System with DCV	11546 cfm	System 07: 1 AHU per Floor	Varies
Other HVAC system	CRAC, DOAS+FCU	106 & 444 cfm	EWC Chiller, HW Boilers	COP: 5.85, Nboiler=0.8
Fan supply power	Advanced VAV	11,546 cfm	App. G VAV Baseline Fan	Varies per system
Fan po[illegible]	Varies per system	Varies per system	Varies per System	Varies per system
Economiser control	Dry-bulb high-limit economizer with mixed-air target	55F	Dry-bulb high-limit economizer with mixed-air target	55F
Demand control ventilation	Yes	800-1200 ppm	n/a	n/a
Unitary equip cooling efficiency	n/a	n/a	n/a	n/a
Unitary equip heating efficiency	n/a	n/a	n/a	n/a
Chiller	EWC Chiller, VSD sec'd pump	566.8 kBtu/h	EWC Hermetic Centrifugal	893.63 kBtu/h
Chilled water loop and pump	Primary-Secondary	566.8 kBtu/h and 2.2 kW	Primary-Secondary	893.63 kBtu/h
Boiler	2 Condensing Boilers, Primary-only HW Loop, w HR, Outdoor reset, Var-speed pump	171.8 kBtu/h each	2 Nat-Draft Boilers	370.54 kBtu/h
Hot water loop and pump	Preheat from CWL	343.73 kBtu/h & 0.26kW	Primary Only, CS Pump	741 kBtu/h & 0.56 kW
Cooling tower	CWL Cooling Tower	672 kBtu/h	CWL Cooling Tower	1058.9 kBtu/h
Condenser water loop and pump	COnnected Single Pump	672 kBtu/h & 2.5 KW	Single Pump	4.022 kW

LI07: Lighting Power Densities for the Space-By-Space Method

LE03: Baseline & Proposed Exterior Lighting Power

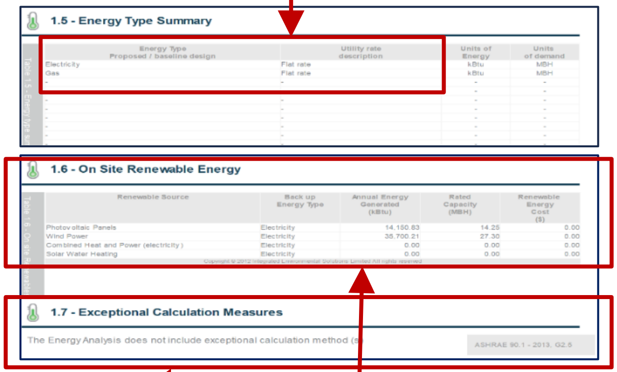
AHVAC04: HVAC System type and system type information

AHVAC06: Baseline Equipment Size

AHVAC06: HVAC System capacities

WHVAC16: Hot water plant controls

SG09: Space heating end use.
WHVAC22: Baseline and Proposed heating fuels



1.5 - Energy Type Summary

Table 1.5 - Energy type sum

Energy Type Proposed / baseline design	Utility rate description	Units of Energy	Units of demand
Electricity	Flat rate	kBtu	MBH
Gas	Flat rate	kBtu	MBH
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

1.6 - On Site Renewable Energy

Table 1.6 - On site Renewable

Renewable Source	Back up Energy Type	Annual Energy Generated (kBtu)	Rated Capacity (MBH)	Renewable Energy Cost ($)
Photovoltaic Panels	Electricity	14,150.83	14.25	0.00
Wind Power	Electricity	35,700.21	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

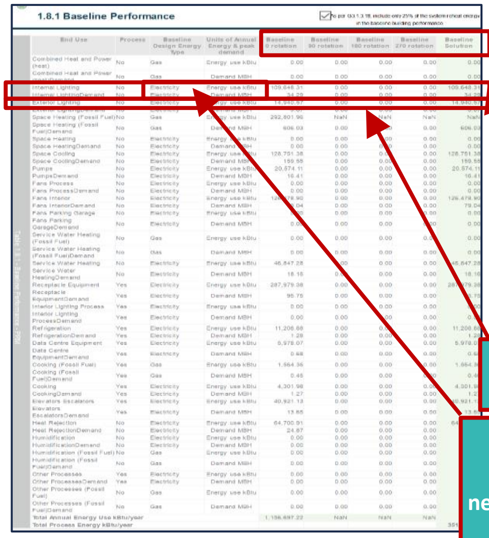
1.7 - Exceptional Calculation Measures

The Energy Analysis does not include exceptional calculation method (s

ASHRAE 90.1 - 2013, G2.5

EC03: Exceptional Calculations

RE03: Renewable Energy



1.8.1 Baseline Performance

☑ As per G3.1.3.10, include only 25% of the system reheat energ in the baseline building performance

Table 1.8.1 - Baseline Performance - PRM

End Use	Process	Baseline Design Energy Type	Units of Annual Energy & peak demand	Baseline 0 rotation	Baseline 90 rotation	Baseline 180 rotation	Baseline 270 rotation	Baseline Solution
Combined Heat and Power (heat)	No	Gas	Energy use kBtu	0.00	0.00	0.00	0.00	0.00
Combined Heat and Power (heat)Demand	No	Gas	Demand MBH	0.00	0.00	0.00	0.00	0.00
Internal Lighting	No	Electricity	Energy use kBtu	109,648.31	0.00	0.00	0.00	109,648.31
Internal LightingDemand	No	Electricity	Demand MBH	34.29	0.00	0.00	0.00	34.29
Exterior Lighting	No	Electricity	Energy use kBtu	14,940.57	0.00	0.00	0.00	14,940.57
Exterior LightingDemand	No	Electricity	Demand MBH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Space Heating (Fossil Fuel)	No	Gas	Energy use kBtu	292,801.96	NaN	NaN	NaN	NaN
Space Heating (Fossil Fuel)Demand	No	Gas	Demand MBH	606.03	0.00	[illegible]	0.00	606.03
Space Heating	No	Electricity	Energy use kBtu	0.00	0.00	0.00	0.00	0.00
Space HeatingDemand	No	Electricity	Demand MBH	0.00	0.00	0.00	0.00	0.00
Space Cooling	No	Electricity	Energy use kBtu	128,751.38	0.00	0.00	0.00	128,751.38
Space CoolingDemand	No	Electricity	Demand MBH	159.55	0.00	0.00	0.00	159.55
Pumps	No	Electricity	Energy use kBtu	20,574.11	0.00	0.00	0.00	20,574.11
PumpsDemand	No	Electricity	Demand MBH	16.41	0.00	0.00	0.00	16.41
Fans Process	No	Electricity	Energy use kBtu	0.00	0.00	0.00	0.00	0.00
Fans ProcessDemand	No	Electricity	Demand MBH	0.00	0.00	0.00	0.00	0.00
Fans Interior	No	Electricity	Energy use kBtu	[illegible]	0.00	0.00	0.00	126,478.90
Fans InteriorDemand	No	Electricity	Demand MBH	[illegible]	0.00	0.00	0.00	79.04
Fans Parking Garage	No	Electricity	Energy use kBtu	[illegible]	0.00	0.00	0.00	0.00
Fans Parking GarageDemand	No	Electricity	Demand MBH	[illegible]	0.00	0.00	[illegible]	0.00
Service Water Heating (Fossil Fuel)	No	Gas	Energy use kBtu	0.00	0.00	0.00	[illegible]	0.00
Service Water Heating (Fossil Fuel)Demand	No	Gas	Demand MBH	0.00	0.00	0.00	0.00	0.00
Service Water Heating	No	Electricity	Energy use kBtu	46,847.28	[illegible]	0.00	0.00	46,847.28
Service Water HeatingDemand	No	Electricity	Demand MBH	18.16	[illegible]	0.00	0.00	18.16
Receptacle Equipment	Yes	Electricity	Energy use kBtu	287,979.38	0.00	0.00	0.00	[illegible]
Receptacle EquipmentDemand	Yes	Electricity	Demand MBH	95.75	0.00	0.00	0.00	[illegible]
Interior Lighting Process	Yes	Electricity	Energy use kBtu	0.00	0.00	0.00	0.00	[illegible]
Interior Lighting ProcessDemand	Yes	Electricity	Demand MBH	0.00	0.00	[illegible]	0.00	[illegible]
Refrigeration	Yes	Electricity	Energy use kBtu	11,206.68	0.00	[illegible]	0.00	11,206.68
RefrigerationDemand	Yes	Electricity	Demand MBH	1.28	0.00	0.00	0.00	1.28
Data Centre Equipment	Yes	Electricity	Energy use kBtu	5,978.07	0.00	0.00	0.00	5,978.07
Data Centre EquipmentDemand	Yes	Electricity	Demand MBH	0.68	0.00	0.00	0.00	[illegible]
Cooking (Fossil Fuel)	Yes	Gas	Energy use kBtu	1,664.36	0.00	0.00	0.00	[illegible]
Cooking (Fossil Fuel)Demand	Yes	Gas	Demand MBH	0.46	0.00	0.00	[illegible]	[illegible]
Cooking	Yes	Electricity	Energy use kBtu	4,301.98	0.00	0.00	[illegible]	[illegible]
CookingDemand	Yes	Electricity	Demand MBH	1.27	0.00	0.00	0.00	[illegible]
Elevators Escalators	Yes	Electricity	Energy use kBtu	40,921.13	0.00	0.00	0.00	[illegible]
Elevators EscalatorsDemand	Yes	Electricity	Demand MBH	13.65	0.00	0.00	0.00	[illegible]
Heat Rejection	No	Electricity	Energy use kBtu	64,700.91	0.00	0.00	0.00	[illegible]
Heat RejectionDemand	No	Electricity	Demand MBH	24.87	0.00	0.00	0.00	[illegible]
Humidification	No	Electricity	Energy use kBtu	0.00	0.00	0.00	0.00	[illegible]
HumidificationDemand	No	Electricity	Demand MBH	0.00	0.00	0.00	0.00	[illegible]
Humidification (Fossil Fuel)	No	Gas	Energy use kBtu	0.00	0.00	0.00	0.00	[illegible]
Humidification (Fossil Fuel)Demand	No	Gas	Demand MBH	0.00	0.00	0.00	0.00	[illegible]
Other Processes	Yes	Electricity	Energy use kBtu	0.00	0.00	0.00	0.00	[illegible]
Other ProcessesDemand	Yes	Electricity	Demand MBH	0.00	0.00	0.00	0.00	[illegible]
Other Processes (Fossil Fuel)	No	Gas	Energy use kBtu	0.00	0.00	0.00	0.00	[illegible]
Other Processes (Fossil Fuel)Demand	No	Gas	Demand MBH	0.00	0.00	0.00	0.00	[illegible]
Total Annual Energy Use kBtu/year				1,156,697.22	NaN	NaN	NaN	[illegible]
Total Process Energy kBtu/year								[illegible]

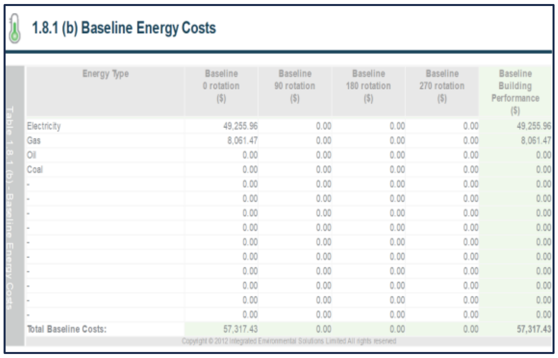
BE21: Baseline 4 rotations and average

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

AHVAC13: Average heating system efficiency total equipment energy consumption



1.8.1 (b) Baseline Energy Costs

Energy Type	Baseline 0 rotation ($)	Baseline 90 rotation ($)	Baseline 180 rotation ($)	Baseline 270 rotation ($)	Baseline Building Performance ($)
Electricity	49,255.96	0.00	0.00	0.00	49,255.96
Gas	8,061.47	0.00	0.00	0.00	8,061.47
Oil	0.00	0.00	0.00	0.00	0.00
Coal	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	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	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	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
Total Baseline Costs:	57,317.43	0.00	0.00	0.00	57,317.43

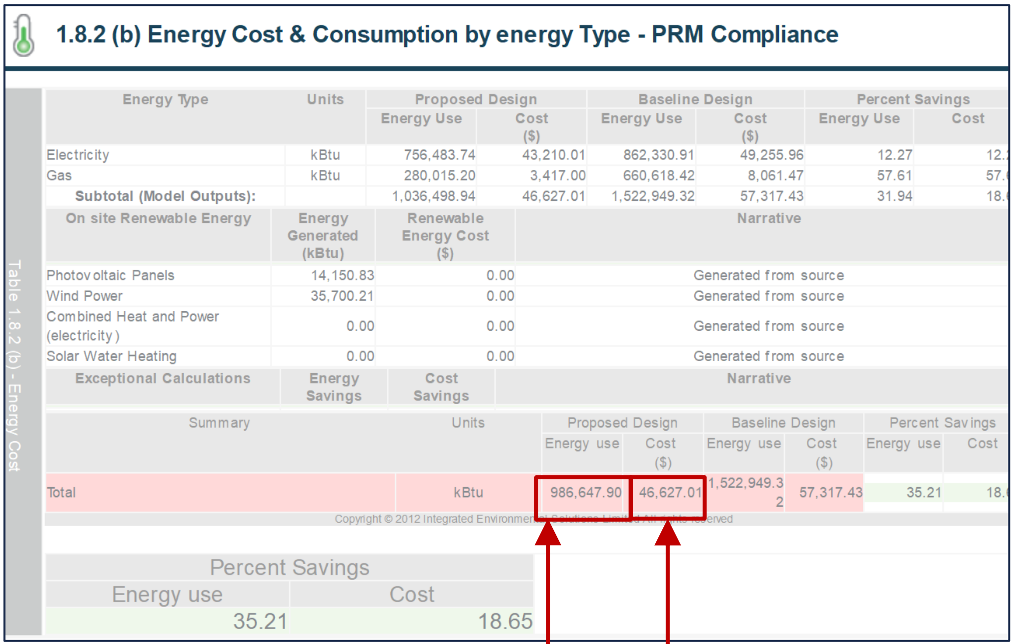
Table 1.8.1 (b) - Baseline Energy Costs

AHVAC19: Fan peak demand
AHVAC20: Fan equivalent full load hours

1.8.2 Performance Rating Table - PRM Compliance

End Use	Process	Proposed Design Energy Type	Proposed Design Units	Proposed Building Results	Baseline Design Units	Baseline Building Results	Percent Savings %
Combined Heat and Power (heat)	No	Gas	Energy use kBtu	0.00	Energy use kBtu	0.00	0.0
Combined Heat and Power (heat)	No	Gas	Demand MBH	0.00	Demand MBH	0.00	0.0
Internal Lighting	No	Electricity	Energy use kBtu	90,795.72	Energy use kBtu	109,648.31	17.2
Internal Lighting	No	Electricity	Demand MBH	34.29	Demand MBH	34.29	0.0
Exterior Lighting	No	Electricity	Energy use kBtu	6,640.26	Energy use kBtu	14,940.57	55.6
Exterior Lighting	No	Electricity	Demand MBH	1.36	Demand MBH	3.07	55.6
Space Heating (Fossil Fuel)	No	Gas	Energy use kBtu	278,450.84	Energy use kBtu	659,054.06	57.7
Space Heating (Fossil Fuel)	No	Gas	Demand MBH	358.34	Demand MBH	606.03	40.9
Space Heating	No	Electricity	Energy use kBtu	25,482.93	Energy use kBtu	0.00	0.0
Space Heating	No	Electricity	Demand MBH	36.02	Demand MBH	0.00	0.0
Space Cooling	No	Electricity	Energy use kBtu	79,785.99	Energy use kBtu	128,751.38	38.0
Space Cooling	No	Electricity	Demand MBH	104.38	Demand MBH	159.55	34.6
Pumps	No	Electricity	Energy use kBtu	24,324.31	Energy use kBtu	20,574.11	-18.2
Pumps	No	Electricity	Demand MBH	[illegible]	Demand MBH	[illegible]	[illegible]
Fans Process	No	Electricity	Energy use kBtu	0.00	Energy use kBtu	0.00	0.0
Fans Process	No	Electricity	Demand MBH	0.00	Demand MBH	0.00	0.0
Fans Interior	No	Electricity	Energy use kBtu	52,309.78	Energy use kBtu	126,478.90	58.6
Fans Interior	No	Electricity	Demand MBH	21.56	Demand MBH	79.04	72.7
Fans Parking Garage	No	Electricity	Energy use kBtu	0.00	Energy use kBtu	0.00	0.0
Fans Parking Garage	No	Electricity	Demand MBH	0.00	Demand MBH	0.00	0.0
Service Water Heating (Fossil Fuel)	No	Gas	Energy use kBtu	0.00	Energy use kBtu	0.00	0.0
Service Water Heating (Fossil Fuel)	No	Gas	Demand MBH	0.00	Demand MBH	0.00	0.0
Service Water Heating	No	Electricity	Energy use kBtu	46,847.28	Energy use kBtu	46,847.28	0.0
Service Water Heating	No	Electricity	Demand MBH	18.16	Demand MBH	18.16	0.0
Receptacle Equipment	Yes	Electricity	Energy use kBtu	302,607.06	Energy use kBtu	287,979.38	-5.1
Receptacle Equipment	Yes	Electricity	Demand MBH	95.75	Demand MBH	95.75	0.0
Interior Lighting Process	Yes	Electricity	Energy use kBtu	0.00	Energy use kBtu	0.00	0.0
Interior Lighting Process	Yes	Electricity	Demand MBH	0.00	Demand MBH	0.00	0.0
Refrigeration	Yes	Electricity	Energy use kBtu	11,208.88	Energy use kBtu	11,208.88	0.0
Refrigeration	Yes	Electricity	Demand MBH	1.28	Demand MBH	1.28	0.0
Data Centre Equipment	Yes	Electricity	Energy use kBtu	5,978.07	Energy use kBtu	5,978.07	0.0
Data Centre Equipment	Yes	Electricity	Demand MBH	0.68	Demand MBH	0.68	0.0
Cooking (Fossil Fuel)	Yes	Gas	Energy use kBtu	1,564.36	Energy use kBtu	1,564.36	0.0
Cooking (Fossil Fuel)	Yes	Gas	Demand MBH	0.46	Demand MBH	0.46	0.0
Cooking	Yes	Electricity	Energy use kBtu	4,301.98	Energy use kBtu	4,301.98	0.0
Cooking	Yes	Electricity	Demand MBH	1.27	Demand MBH	1.27	0.0
Elevators Escalators	Yes	Electricity	Energy use kBtu	40,921.13	Energy use kBtu	40,921.13	0.0
Elevators Escalators	Yes	Electricity	Demand MBH	13.65	Demand MBH	13.65	0.0
Heat Rejection	No	Electricity	Energy use kBtu	65,280.35	Energy use kBtu	64,700.91	-0.9
Heat Rejection	No	Electricity	Demand MBH	15.78	Demand MBH	24.87	36.5
Humidification	No	Electricity	Energy use kBtu	0.00	Energy use kBtu	0.00	0.0
Humidification	No	Electricity	Demand MBH	0.00	Demand MBH	0.00	0.0
Humidification (Fossil Fuel)	No	Gas	Energy use kBtu	0.00	Energy use kBtu	0.00	0.0
Humidification (Fossil Fuel)	No	Gas	Demand MBH	0.00	Demand MBH	0.00	0.0
Other Processes	Yes	Electricity	Energy use kBtu	0.00	Energy use kBtu	0.00	0.0
Other Processes	Yes	Electricity	Demand MBH	0.00	Demand MBH	0.00	0.0
Other Processes (Fossil Fuel)	No	Gas	Energy use kBtu	0.00	Energy use kBtu	0.00	0.0
Other Processes (Fossil Fuel)	No	Gas	Demand MBH	0.00	Demand MBH	0.00	0.0
Total Annual Energy Use kBtu/year				1,036,498.94		1,522,949.32	31.9
Total Process Energy kBtu/year				366,581.48		351,953.79	-4.2

Table 1.8.2 - Performance Rating



1.8.2 (b) Energy Cost & Consumption by energy Type - PRM Compliance

Energy Type	Units	Proposed Design		Baseline Design		Percent Savings	
		Energy Use	Cost ($)	Energy Use	Cost ($)	Energy Use	Cost
Electricity	kBtu	756,483.74	43,210.01	862,330.91	49,255.96	12.27	12.
Gas	kBtu	280,015.20	3,417.00	660,618.42	8,061.47	57.61	57.
Subtotal (Model Outputs):		1,036,498.94	46,627.01	1,522,949.32	57,317.43	31.94	18.

On site Renewable Energy	Energy Generated (kBtu)	Renewable Energy Cost ($)	Narrative
Photovoltaic Panels	14,150.83	0.00	Generated from source
Wind Power	35,700.21	0.00	Generated from source
Combined Heat and Power (electricity)	0.00	0.00	Generated from source
Solar Water Heating	0.00	0.00	Generated from source

Exceptional Calculations	Energy Savings	Cost Savings	Narrative

Summary	Units	Proposed Design		Baseline Design		Percent Savings	
		Energy use	Cost ($)	Energy use	Cost ($)	Energy use	Cost
Total	kBtu	986,647.90	46,627.01	1,522,949.32	57,317.43	35.21	18.

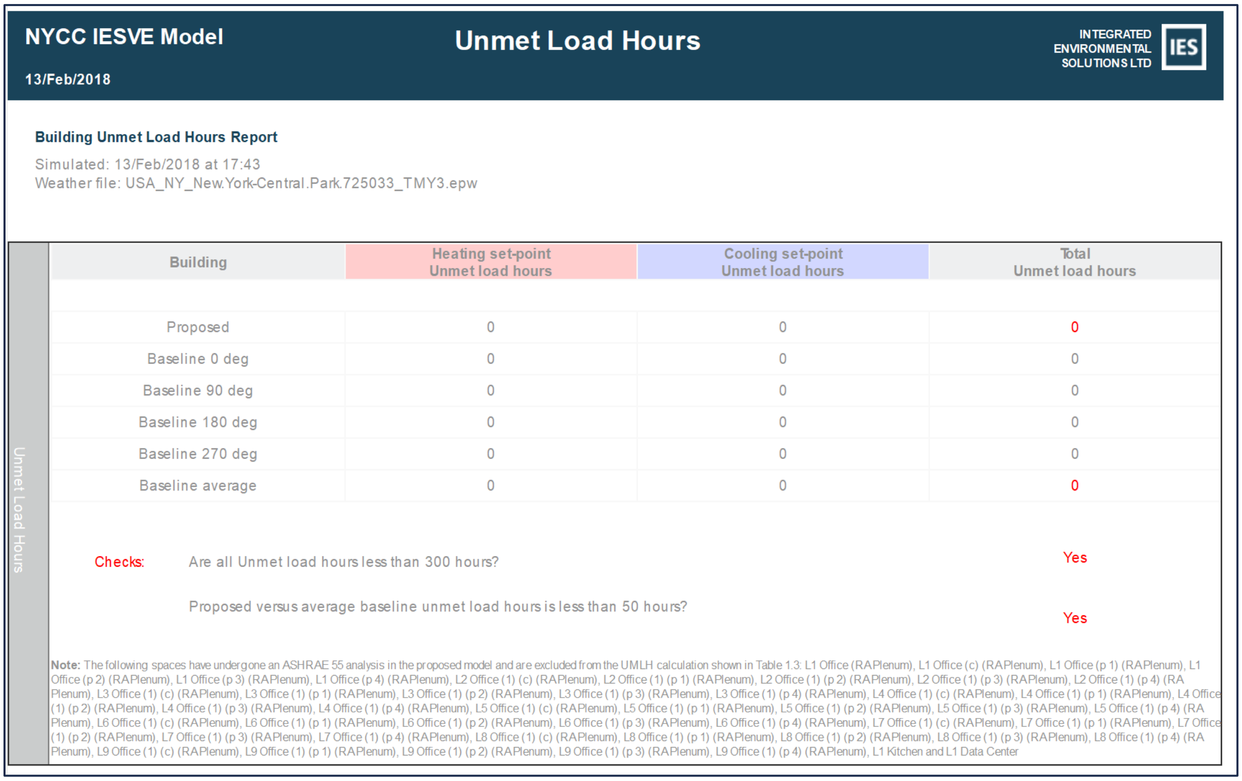
Percent Savings	
Energy use	Cost
35.21	18.65

Table 1.8.2 (b) - Energy Cost

SG10: Site Energy Use Intensity (EUI) must be calculated from the building energy consumption and floor area reported here.

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

Unmet Hours Report



NYCC IESVE Model

13/Feb/2018

Unmet Load Hours

Building Unmet Load Hours Report

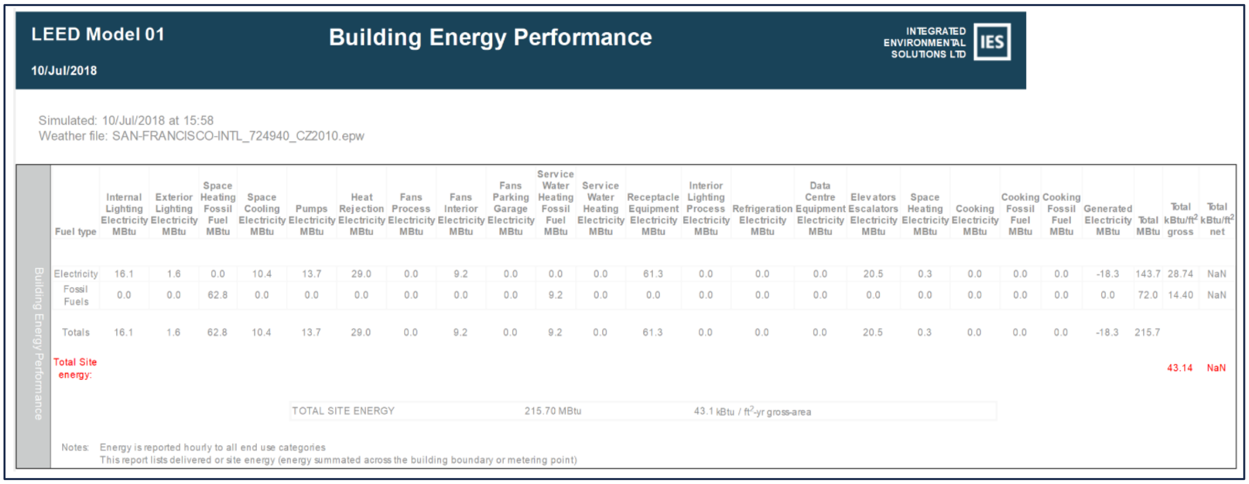
Simulated: 13/Feb/2018 at 17:43
Weather file: USA_NY_New.York-Central.Park.725033_TMY3.epw

Building	Heating set-point Unmet load hours	Cooling set-point Unmet load hours	Total Unmet load hours
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:		
Checks:	Are all Unmet load hours less than 300 hours?	Yes
	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 (RAPlenum), L1 Office (c) (RAPlenum), L1 Office (p 1) (RAPlenum), L1 Office (p 2) (RAPlenum), L1 Office (p 3) (RAPlenum), L1 Office (p 4) (RAPlenum), L2 Office (1) (c) (RAPlenum), L2 Office (1) (p 1) (RAPlenum), L2 Office (1) (p 2) (RAPlenum), L2 Office (1) (p 3) (RAPlenum), L2 Office (1) (p 4) (RAPlenum), L3 Office (1) (c) (RAPlenum), L3 Office (1) (p 1) (RAPlenum), L3 Office (1) (p 2) (RAPlenum), L3 Office (1) (p 3) (RAPlenum), L3 Office (1) (p 4) (RAPlenum), L4 Office (1) (c) (RAPlenum), L4 Office (1) (p 1) (RAPlenum), L4 Office (1) (p 2) (RAPlenum), L4 Office (1) (p 3) (RAPlenum), L4 Office (1) (p 4) (RAPlenum), L5 Office (1) (c) (RAPlenum), L5 Office (1) (p 1) (RAPlenum), L5 Office (1) (p 2) (RAPlenum), L5 Office (1) (p 3) (RAPlenum), L5 Office (1) (p 4) (RAPlenum), L6 Office (1) (c) (RAPlenum), L6 Office (1) (p 1) (RAPlenum), L6 Office (1) (p 2) (RAPlenum), L6 Office (1) (p 3) (RAPlenum), L6 Office (1) (p 4) (RAPlenum), L7 Office (1) (c) (RAPlenum), L7 Office (1) (p 1) (RAPlenum), L7 Office (1) (p 2) (RAPlenum), L7 Office (1) (p 3) (RAPlenum), L7 Office (1) (p 4) (RAPlenum), L8 Office (1) (c) (RAPlenum), L8 Office (1) (p 1) (RAPlenum), L8 Office (1) (p 2) (RAPlenum), L8 Office (1) (p 3) (RAPlenum), L8 Office (1) (p 4) (RAPlenum), L9 Office (1) (c) (RAPlenum), L9 Office (1) (p 1) (RAPlenum), L9 Office (1) (p 2) (RAPlenum), L9 Office (1) (p 3) (RAPlenum), L9 Office (1) (p 4) (RAPlenum), L1 Kitchen and L1 Data Center

Detailed Simulation Report



LEED Model 01

Building Energy Performance

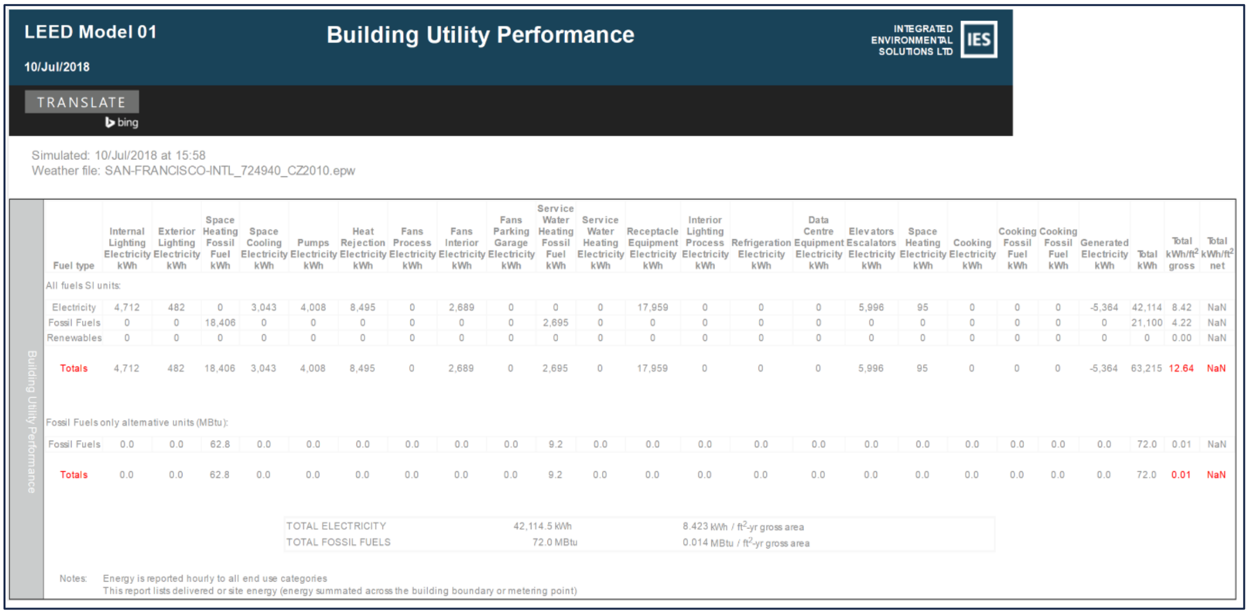
10/Jul/2018

Simulated: 10/Jul/2018 at 15:58
Weather file: SAN-FRANCISCO-INTL_724940_CZ2010.epw

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 MBtu	Total kBtu/ft^2 gross	Total kBtu/ft^2 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	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	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

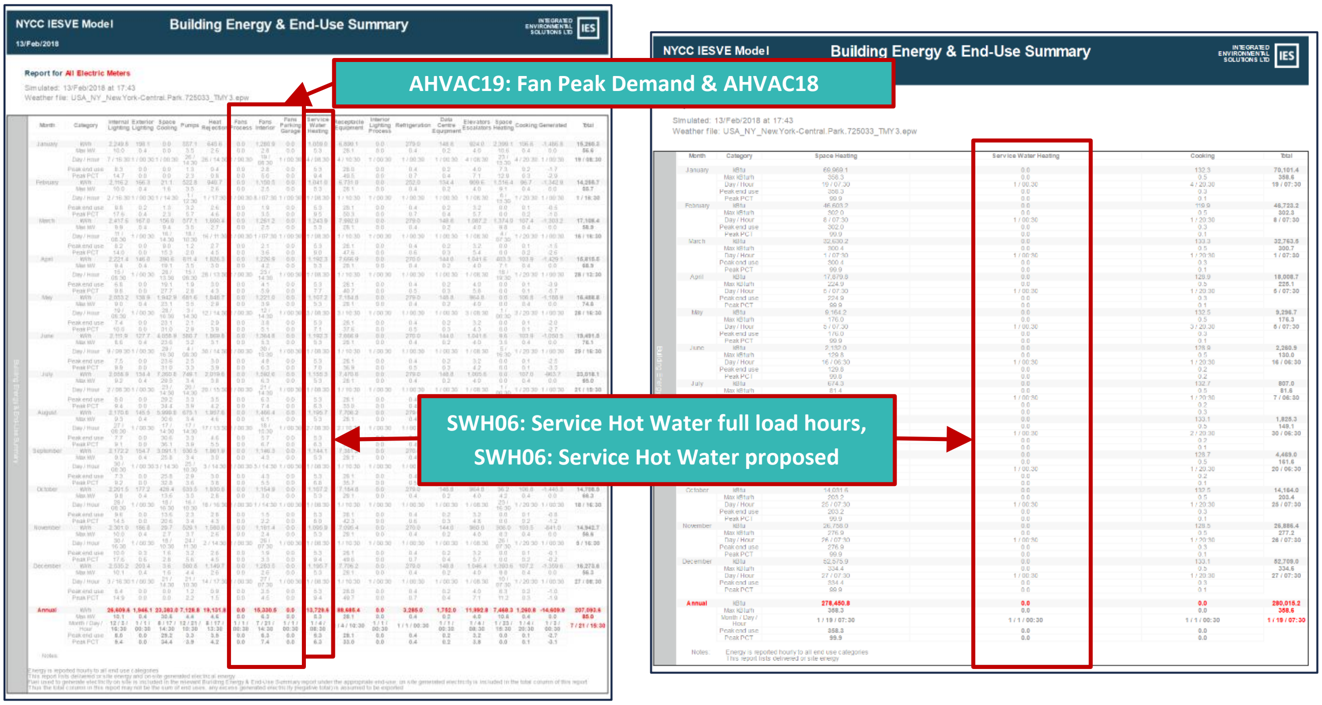
10/Jul/2018

Simulated: 10/Jul/2018 at 15:58
Weather file: SAN-FRANCISCO-INTL_724940_CZ2010.epw

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 kWh	Total kWh/ft^2 gross	Total kWh/ft^2 net
All fuels SI units:																								
Electricity	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	2,695	0	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	0.00	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	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
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)



NYCC IESVE Model
13/Feb/2018
Building Energy & End-Use Summary

Report for All Electric Meters

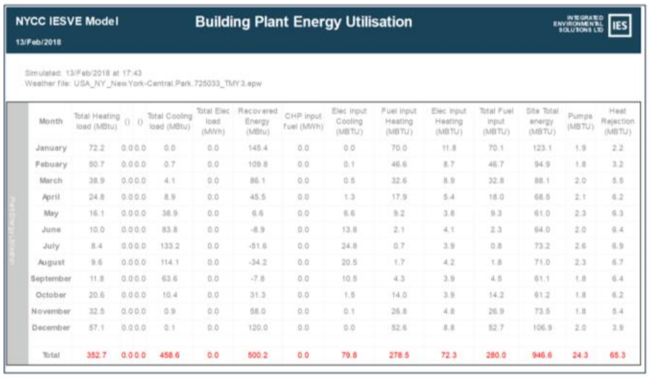
Simulated: 13/Feb/2018 at 17:43
Weather file: USA_NY_New York-Central.Park.725033_TMY3.epw

NYCC IESVE Model
Building Energy & End-Use Summary

Simulated: 13/Feb/2018 at 17:43
Weather file: USA_NY_New York-Central.Park.725033_TMY3.epw

AHVAC19: Fan Peak Demand & AHVAC18

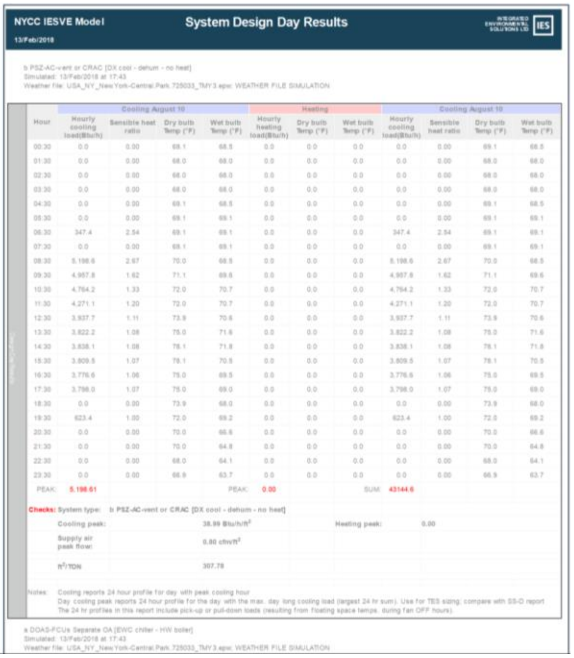
SWH06: Service Hot Water full load hours, SWH06: Service Hot Water proposed



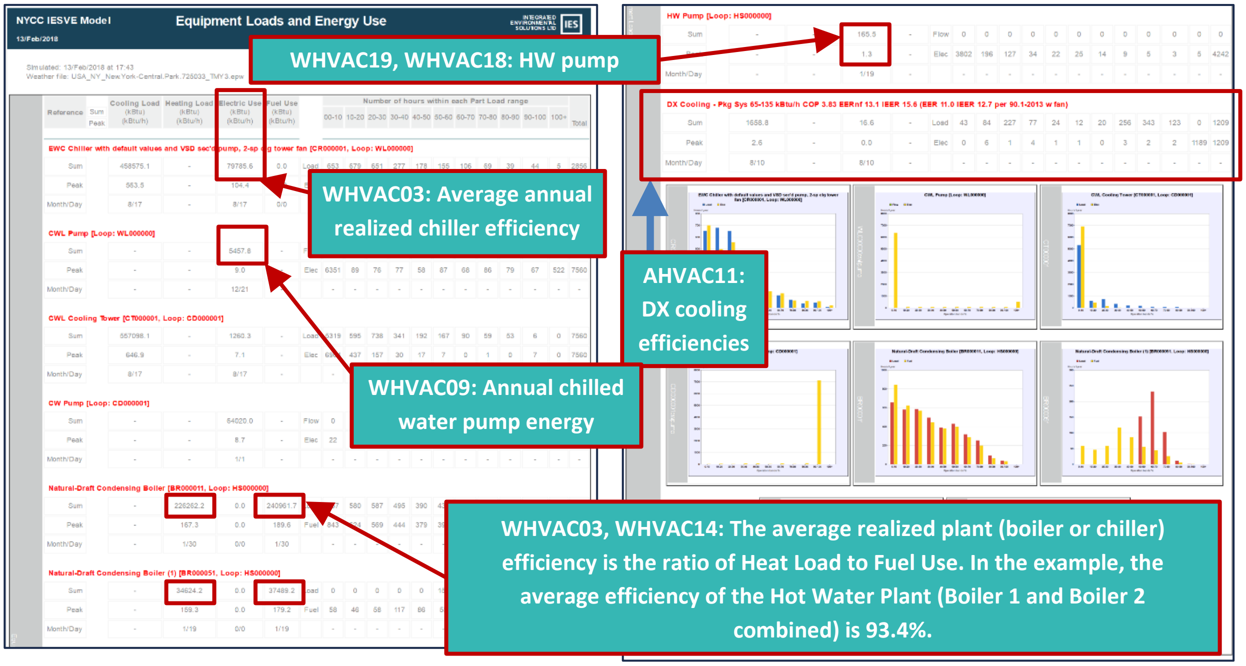
NYCC IESVE Model
13/Feb/2018
Building Plant Energy Utilisation

Simulated: 13/Feb/2018 at 17:43
Weather file: USA_NY_New York-Central.Park.725033_TMY3.epw

Month	Total Heating load (MBtu)	()	()	Total Cooling load (MBtu)	Total Elec load (MWh)	Recovered Energy (MBtu)	CHP input fuel (MWh)	Elec input Cooling (MBTU)	Fuel input Heating (MBTU)	Elec input Heating (MBTU)	Total Fuel input (MBTU)	Site Total energy (MBTU)	Pumps (MBTU)	Heat Rejection (MBTU)
January	72.2	0.0	0.0	0.0	0.0	145.4	0.0	0.0	70.0	11.8	70.1	123.1	1.9	2.2
Febuary	50.7	0.0	0.0	0.7	0.0	109.8	0.0	0.1	46.6	8.7	46.7	94.9	1.8	3.2
March	38.9	0.0	0.0	4.1	0.0	86.1	0.0	0.5	32.6	8.9	32.8	88.1	2.0	5.5
April	24.8	0.0	0.0	8.9	0.0	45.5	0.0	1.3	17.9	5.4	18.0	68.5	2.1	6.2
May	16.1	0.0	0.0	38.9	0.0	6.6	0.0	6.6	9.2	3.8	9.3	61.0	2.3	6.3
June	10.0	0.0	0.0	83.8	0.0	-8.9	0.0	13.8	2.1	4.1	2.3	64.0	2.0	6.4
July	8.4	0.0	0.0	133.2	0.0	-51.6	0.0	24.8	0.7	3.9	0.8	73.2	2.6	6.9
August	9.6	0.0	0.0	114.1	0.0	-34.2	0.0	20.5	1.7	4.2	1.8	71.0	2.3	6.7
September	11.8	0.0	0.0	63.6	0.0	-7.8	0.0	10.5	4.3	3.9	4.5	61.1	1.8	6.4
October	20.6	0.0	0.0	10.4	0.0	31.3	0.0	1.5	14.0	3.9	14.2	61.2	1.8	6.2
November	32.5	0.0	0.0	0.9	0.0	58.0	0.0	0.1	26.8	4.8	26.9	73.5	1.8	5.4
December	57.1	0.0	0.0	0.1	0.0	120.0	0.0	0.0	52.6	8.8	52.7	106.9	2.0	3.9
Total	352.7	0.0	0.0	458.6	0.0	500.2	0.0	79.8	278.5	72.3	280.0	946.6	24.3	65.3



NYCC IESVE Model
13/Feb/2018
System Design Day Results



NYCC IESVE Model — **Equipment Loads and Energy Use**

13/Feb/2018

Simulated: 13/Feb/2018 at 17:43
Weather file: USA_NY_NewYork-Central.Park.725033_TMY3.epw

Reference Sum Peak	Cooling Load (kBtu) (kBtu/h)	Heating Load (kBtu) (kBtu/h)	Electric Use (kBtu) (kBtu/h)	Fuel Use (kBtu) (kBtu/h)		00-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100+	Total
EWC Chiller with default values and VSD sec'd pump, 2-sp clg tower fan [CR000001, Loop: WL000000]																	
Sum	458575.1	-	79785.6	0.0	Load	653	679	651	277	178	155	106	69	39	44	5	2856
Peak	563.5	-	104.4														
Month/Day	8/17	-	8/17	0/0													
CWL Pump [Loop: WL000000]																	
Sum	-	-	5457.8	-													
Peak	-	-	9.0		Elec	6351	89	76	77	58	87	68	86	79	67	522	7560
Month/Day	-	-	12/21			-	-	-	-	-	-	-	-	-	-	-	-
CWL Cooling Tower [CT000001, Loop: CD000001]																	
Sum	557098.1	-	1260.3	-	Load	6319	595	738	341	192	167	90	59	53	6	0	7560
Peak	646.9	-	7.1	-	Elec	[illegible]	437	157	30	17	7	0	1	0	7	0	7560
Month/Day	8/17	-	8/17	-		-											
CW Pump [Loop: CD000001]																	
Sum	-	-	64020.0	-	Flow	0											
Peak	-	-	8.7	-	Elec	22											
Month/Day	-	-	1/1	-		-	-	-	-	-	-	-	-	-	-	-	-
Natural-Draft Condensing Boiler [BR000011, Loop: HS000000]																	
Sum	-	226262.2	0.0	240961.7			580	587	495	390							
Peak	-	167.3	0.0	189.6	Fuel	843		569	444	379							
Month/Day	-	1/30	0/0	1/30		-	-	-	-	-							
Natural-Draft Condensing Boiler (1) [BR000051, Loop: HS000000]																	
Sum	-	34624.2	0.0	37489.2	Load	0	0	0	0	0							
Peak	-	159.3	0.0	179.2	Fuel	58	46	58	117	86							
Month/Day	-	1/19	0/0	1/19		-	-	-	-	-							
HW Pump [Loop: HS000000]																	
Sum	-	-	165.5	-	Flow	0	0	0	0	0	0	0	0	0	0	0	0
Peak	-	-	1.3	-	Elec	3802	196	127	34	22	25	14	9	5	3	5	4242
Month/Day	-	-	1/19	-		-	-	-	-	-	-	-	-	-	-	-	-
DX Cooling - Pkg Sys 65-135 kBtu/h COP 3.83 EERnf 13.1 IEER 15.6 (EER 11.0 IEER 12.7 per 90.1-2013 w fan)																	
Sum	1658.8	-	16.6	-	Load	43	84	227	77	24	12	20	256	343	123	0	1209
Peak	2.6	-	0.0	-	Elec	0	6	1	4	1	1	0	3	2	2	1189	1209
Month/Day	8/10	-	8/10	-		-	-	-	-	-	-	-	-	-	-	-	-

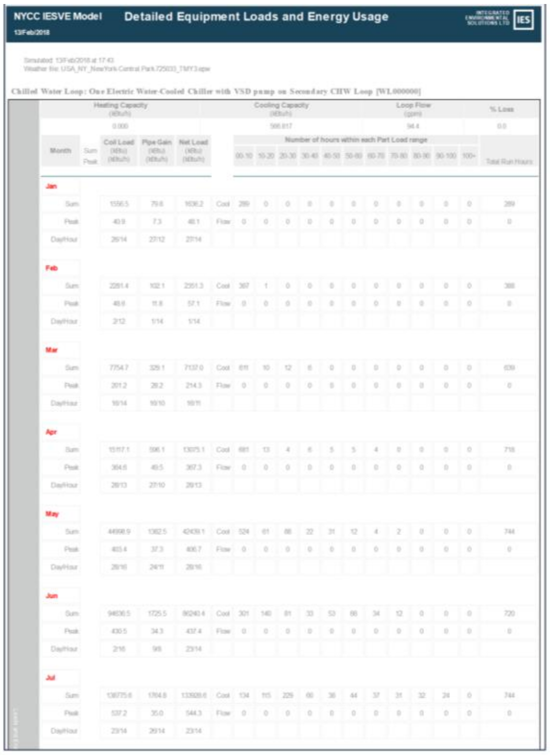
WHVAC19, WHVAC18: HW pump

WHVAC03: Average annual realized chiller efficiency

AHVAC11: DX cooling efficiencies

WHVAC09: Annual chilled water pump energy

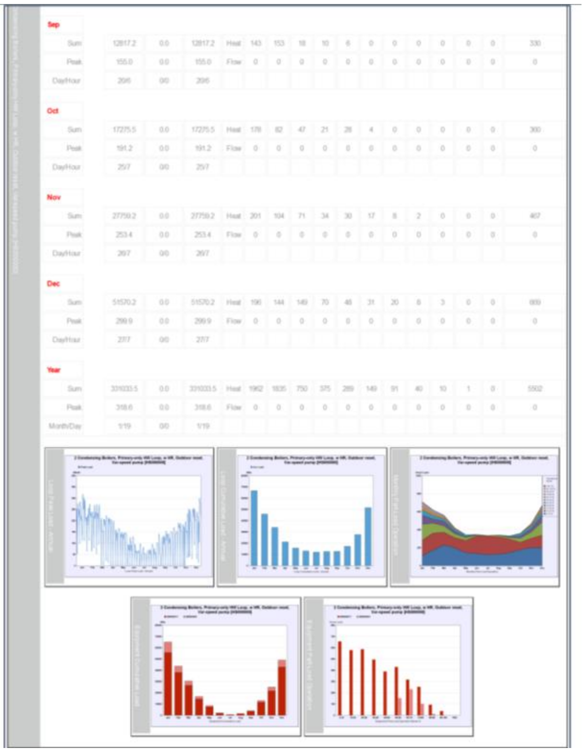
WHVAC03, WHVAC14: The average realized plant (boiler or chiller) efficiency is the ratio of Heat Load to Fuel Use. In the example, the average efficiency of the Hot Water Plant (Boiler 1 and Boiler 2 combined) is 93.4%.



NYCC IESVE Model — **Detailed Equipment Loads and Energy Usage**

13/Feb/2018

Chilled Water Loop: One Electric Water-Cooled Chiller with VSD pump on Secondary CHW Loop [WL000000]

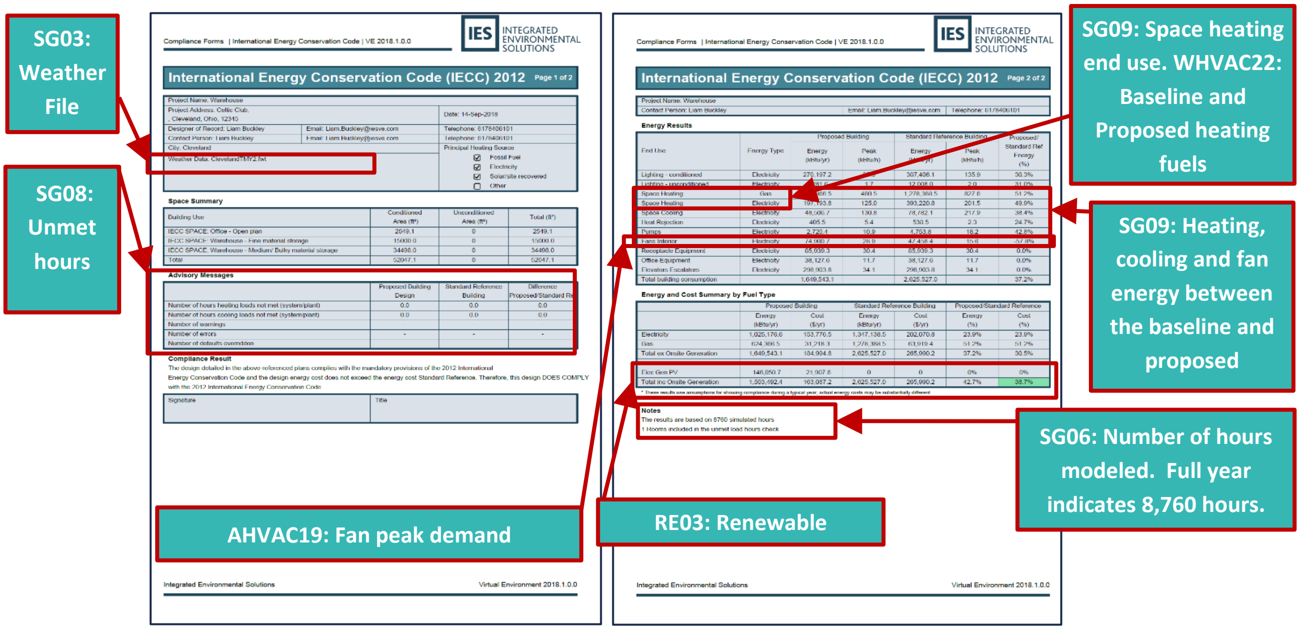


HW Loop: 2 Condensing Boilers, Primary-only HW Loop, w HR, Outdoor reset, Var-speed pump [HS000000]

Heating Capacity (kBtuh)	Cooling Capacity (kBtuh)	Loop Flow (gpm)	% Loss
343.726	0.000	13.7	0.0

Month	Sum Peak	Coil Load (kBtu) (kBtuh)	Pipe Gain (kBtu) (kBtuh)	Net Load (kBtu) (kBtuh)		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																	
	Sum	66657.3	0.0	66657.3	Heat	109	177	173	102	62	36	22	22	7	1	0	711
	Peak	318.6	0.0	318.6	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Day/Hour	19/7	0/0	19/7													
Feb																	
	Sum	45920.0	0.0	45920.0	Heat	175	186	110	47	41	28	24	8	0	0	0	619
	Peak	274.0	0.0	274.0	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Day/Hour	8/7	0/0	8/7													
Mar																	
	Sum	34125.6	0.0	34125.6	Heat	230	142	71	51	28	20	15	2	0	0	0	559
	Peak	272.7	0.0	272.7	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Day/Hour	1/7	0/0	1/7													
Apr																	
	Sum	21146.3	0.0	21146.3	Heat	200	112	43	26	24	13	2	0	0	0	0	420
	Peak	213.0	0.0	213.0	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Day/Hour	5/7	0/0	5/7													
May																	
	Sum	15789.2	0.0	15789.2	Heat	143	137	35	8	21	0	0	0	0	0	0	344
	Peak	167.1	0.0	167.1	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Day/Hour	5/7	0/0	5/7													
Jun																	
	Sum	13173.9	0.0	13173.9	Heat	136	195	11	5	0	0	0	0	0	0	0	347
	Peak	129.9	0.0	129.9	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Day/Hour	15/6	0/0	15/6													
Jul																	
	Sum	12116.4	0.0	12116.4	Heat	122	208	5	0	0	0	0	0	0	0	0	335
	Peak	97.9	0.0	97.9	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Day/Hour	6/6	0/0	6/6													
Aug																	
	Sum	12682.7	0.0	12682.7	Heat	129	193	17	1	1	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
	Day/Hour	30/6	0/0	30/6													
Sep																	
	Sum	12817.2	0.0	12817.2	Heat	143	153	18	10	6	0	0	0	0	0	0	330
	Peak	155.0	0.0	155.0	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Day/Hour	29/6	0/0	29/6													
Oct																	
	Sum	17275.5	0.0	17275.5	Heat	178	82	47	21	28	4	0	0	0	0	0	360
	Peak	191.2	0.0	191.2	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Day/Hour	25/7	0/0	25/7													
Nov																	
	Sum	27759.2	0.0	27759.2	Heat	201	104	71	34	30	17	8	2	0	0	0	467
	Peak	253.4	0.0	253.4	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Day/Hour	29/7	0/0	29/7													
Dec																	
	Sum	51570.2	0.0	51570.2	Heat	196	144	149	70	48	31	20	8	3	0	0	669
	Peak	299.9	0.0	299.9	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Day/Hour	27/7	0/0	27/7													
Year																	
	Sum	331033.5	0.0	331033.5	Heat	1962	1835	750	375	289	149	91	40	10	1	0	5502
	Peak	318.6	0.0	318.6	Flow	0	0	0	0	0	0	0	0	0	0	0	0
	Month/Day	1/19	0/0	1/19													

IECC Compliance Report



SG03: Weather File

SG08: Unmet hours

AHVAC19: Fan peak demand

RE03: Renewable

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.

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IES INTEGRATED ENVIRONMENTAL SOLUTIONS

International Energy Conservation Code (IECC) 2012 Page 1 of 2

Project Name: Warehouse		
Project Address: Celtic Club, , Cleveland, Ohio, 12345		Date: 14-Sep-2018
Designer of Record: Liam Buckley	Email: Liam.Buckley@iesve.com	Telephone: 6178406101
Contact Person: Liam Buckley	Email: Liam.Buckley@iesve.com	Telephone: 6178406101
City: Cleveland		Principal Heating Source ☑ Fossil Fuel ☑ Electricity ☑ Solar/site recovered ☐ Other
Weather Data: ClevelandTMY2.fwt		

Space Summary

Building Use	Conditioned Area (ft²)	Unconditioned Area (ft²)	Total (ft²)
IECC SPACE: Office - Open plan	2549.1	0	2549.1
IECC SPACE: Warehouse - Fine material storage	15000.0	0	15000.0
IECC SPACE: Warehouse - Medium/ Bulky material storage	34498.0	0	34498.0
Total	52047.1	0	52047.1

Advisory Messages

	Proposed Building Design	Standard Reference Building	Difference Proposed/Standard Re
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 warnings			
Number of errors	-	-	-
Number of defaults overridden			

Compliance Result

The design detailed 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

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IES INTEGRATED ENVIRONMENTAL SOLUTIONS

International Energy Conservation Code (IECC) 2012 Page 2 of 2

Project Name: Warehouse		
Contact Person: Liam Buckley	Email: Liam.Buckley@iesve.com	Telephone: 6178406101

Energy Results

End Use	Energy Type	Proposed Building		Standard Reference Building		Proposed/ Standard Ref Energy (%)
		Energy (kBtu/yr)	Peak (kBtu/h)	Energy (kBtu/yr)	Peak (kBtu/h)	
Lighting - conditioned	Electricity	270,197.2	[illegible]	387,406.1	135.9	30.3%
Lighting - unconditioned	Electricity	[illegible]	1.7	12,008.0	2.0	31.0%
Space Heating	Gas	[illegible]	480.5	1,278,388.5	827.8	51.2%
Space Heating	Electricity	197,193.8	125.0	393,220.8	201.5	49.9%
Space Cooling	Electricity	48,506.7	130.8	78,782.1	217.9	38.4%
Heat Rejection	Electricity	405.5	5.4	538.5	2.3	24.7%
Pumps	Electricity	2,720.4	10.9	4,753.8	18.2	42.8%
Fans Interior	Electricity	74,900.7	28.9	47,458.4	15.6	-57.8%
Receptacle Equipment	Electricity	85,939.3	30.4	85,939.3	30.4	0.0%
Office Equipment	Electricity	38,127.6	11.7	38,127.6	11.7	0.0%
Elevators Escalators	Electricity	298,903.8	34.1	298,903.8	34.1	0.0%
Total building consumption		1,649,543.1		2,625,527.0		37.2%

Energy and Cost Summary by Fuel Type

	Proposed Building		Standard Reference Building		Proposed/Standard Reference	
	Energy (kBtu/yr)	Cost ($/yr)	Energy (kBtu/yr)	Cost ($/yr)	Energy (%)	Cost (%)
Electricity	1,025,176.6	153,776.5	1,347,138.5	202,070.8	23.9%	23.9%
Gas	624,366.5	31,218.3	1,278,388.5	63,919.4	51.2%	51.2%
Total ex Onsite Generation	1,649,543.1	184,994.8	2,625,527.0	265,990.2	37.2%	30.5%
Elec Gen PV	146,050.7	21,907.8	0	0	0%	0%
Total inc Onsite Generation	1,503,492.4	163,087.2	2,625,527.0	265,990.2	42.7%	38.7%

* These results use assumptions for showing compliance during a typical year; actual energy costs may be substantially different

Notes

The results are based on 8760 simulated hours

1 Rooms included in the unmet load hours check

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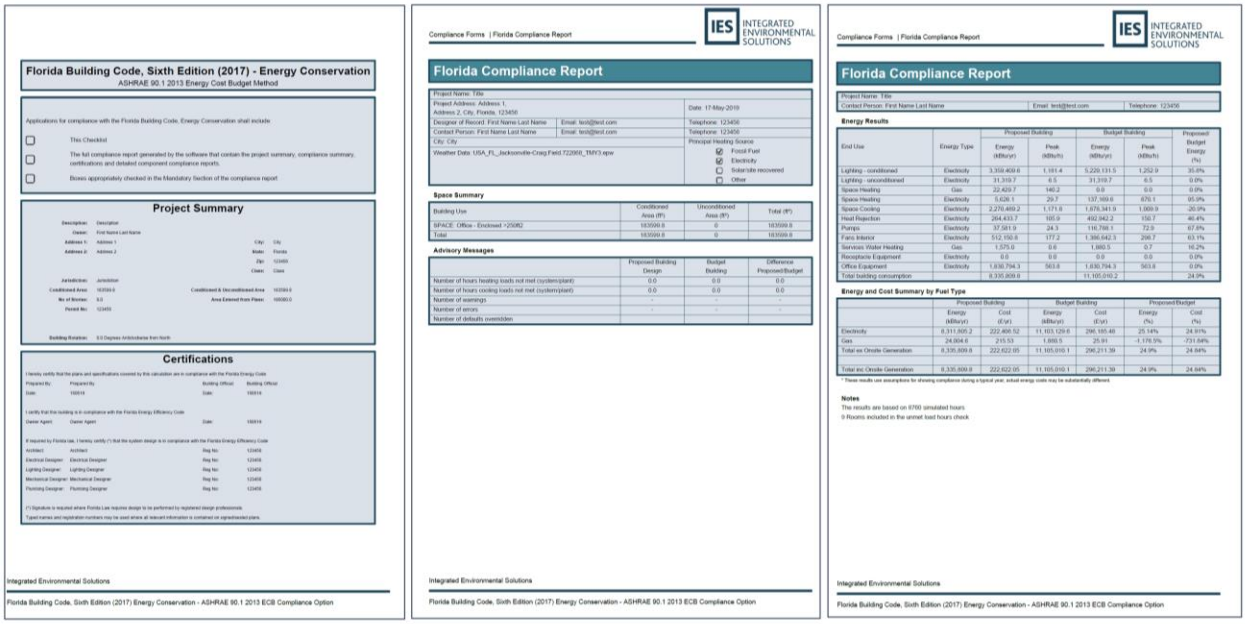
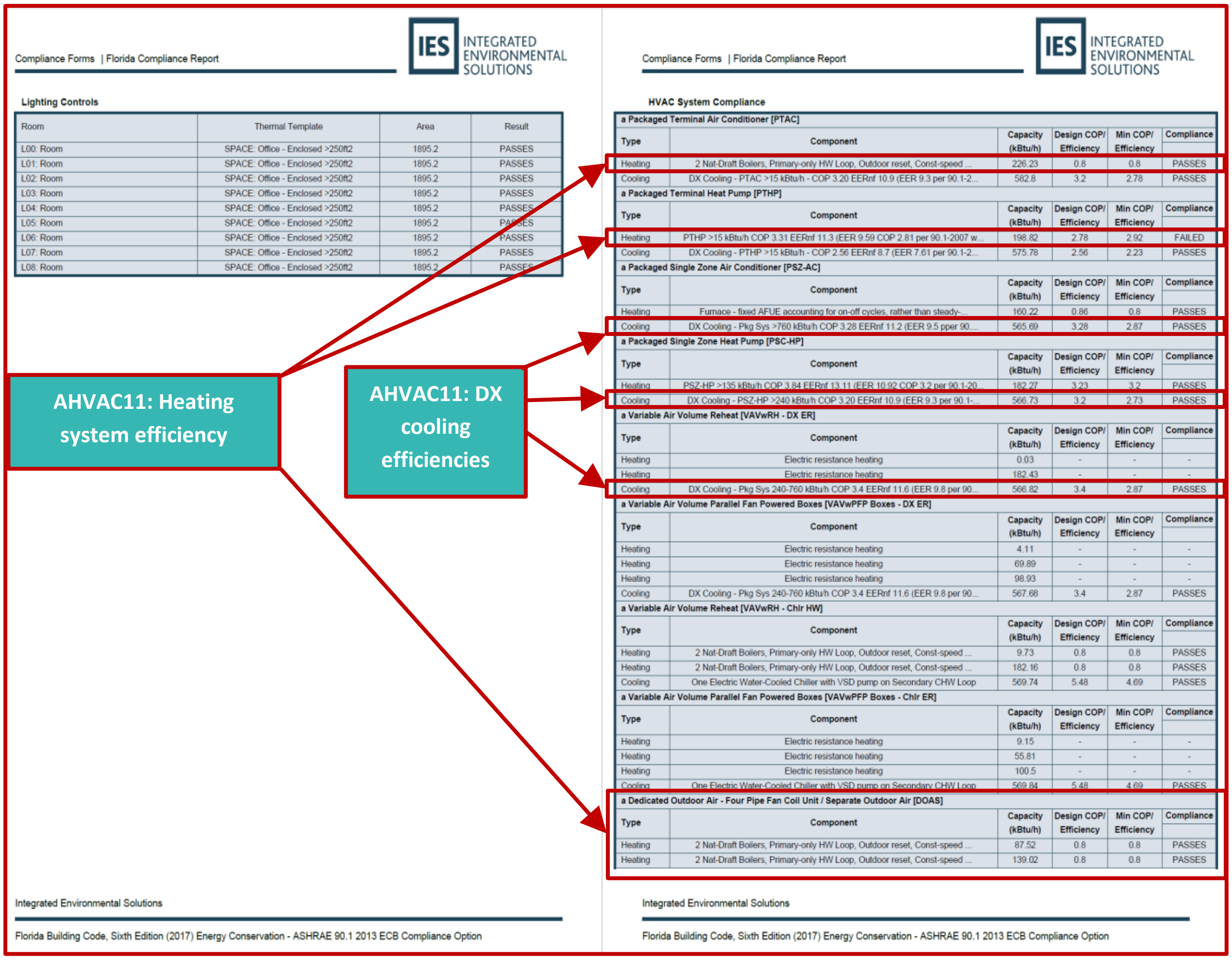
Florida Energy Code Compliance Report





AHVAC11: Heating system efficiency

AHVAC11: DX cooling efficiencies

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Lighting Controls

Room	Thermal Template	Area	Result
L00: Room	SPACE: Office - Enclosed >250ft2	1895.2	PASSES
L01: Room	SPACE: Office - Enclosed >250ft2	1895.2	PASSES
L02: Room	SPACE: Office - Enclosed >250ft2	1895.2	PASSES
L03: Room	SPACE: Office - Enclosed >250ft2	1895.2	PASSES
L04: Room	SPACE: Office - Enclosed >250ft2	1895.2	PASSES
L05: Room	SPACE: Office - Enclosed >250ft2	1895.2	PASSES
L06: Room	SPACE: Office - Enclosed >250ft2	1895.2	PASSES
L07: Room	SPACE: Office - Enclosed >250ft2	1895.2	PASSES
L08: Room	SPACE: Office - Enclosed >250ft2	1895.2	PASSES

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HVAC System Compliance

a Packaged Terminal Air Conditioner [PTAC]

Type	Component	Capacity (kBtu/h)	Design COP/ Efficiency	Min COP/ Efficiency	Compliance
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 kBtu/h - COP 3.20 EERnf 10.9 (EER 9.3 per 90.1-2...	582.8	3.2	2.78	PASSES

a Packaged Terminal Heat Pump [PTHP]

Type	Component	Capacity (kBtu/h)	Design COP/ Efficiency	Min COP/ Efficiency	Compliance
Heating	PTHP >15 kBtu/h COP 3.31 EERnf 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 kBtu/h - COP 2.56 EERnf 8.7 (EER 7.61 per 90.1-2...	575.78	2.56	2.23	PASSES

a Packaged Single Zone Air Conditioner [PSZ-AC]

Type	Component	Capacity (kBtu/h)	Design COP/ Efficiency	Min COP/ Efficiency	Compliance
Heating	Furnace - fixed AFUE accounting for on-off cycles, rather than steady-...	160.22	0.86	0.8	PASSES
Cooling	DX Cooling - Pkg Sys >760 kBtu/h COP 3.28 EERnf 11.2 (EER 9.5 pper 90....	565.69	3.28	2.87	PASSES

a Packaged Single Zone Heat Pump [PSC-HP]

Type	Component	Capacity (kBtu/h)	Design COP/ Efficiency	Min COP/ Efficiency	Compliance
Heating	PSZ-HP >135 kBtu/h COP 3.84 EERnf 13.11 (EER 10.92 COP 3.2 per 90.1-20...	182.27	3.23	3.2	PASSES
Cooling	DX Cooling - PSZ-HP >240 kBtu/h COP 3.20 EERnf 10.9 (EER 9.3 per 90.1-...	566.73	3.2	2.73	PASSES

a Variable Air Volume Reheat [VAVwRH - DX ER]

Type	Component	Capacity (kBtu/h)	Design COP/ Efficiency	Min COP/ Efficiency	Compliance
Heating	Electric resistance heating	0.03	-	-	-
Heating	Electric resistance heating	182.43	-	-	-
Cooling	DX Cooling - Pkg Sys 240-760 kBtu/h COP 3.4 EERnf 11.6 (EER 9.8 per 90...	566.82	3.4	2.87	PASSES

a Variable Air Volume Parallel Fan Powered Boxes [VAVwPFP Boxes - DX ER]

Type	Component	Capacity (kBtu/h)	Design COP/ Efficiency	Min COP/ Efficiency	Compliance
Heating	Electric resistance heating	4.11	-	-	-
Heating	Electric resistance heating	69.89	-	-	-
Heating	Electric resistance heating	98.93	-	-	-
Cooling	DX Cooling - Pkg Sys 240-760 kBtu/h COP 3.4 EERnf 11.6 (EER 9.8 per 90...	567.68	3.4	2.87	PASSES

a Variable Air Volume Reheat [VAVwRH - Chlr HW]

Type	Component	Capacity (kBtu/h)	Design COP/ Efficiency	Min COP/ Efficiency	Compliance
Heating	2 Nat-Draft Boilers, Primary-only HW Loop, Outdoor reset, Const-speed ...	9.73	0.8	0.8	PASSES
Heating	2 Nat-Draft Boilers, Primary-only HW Loop, Outdoor reset, Const-speed ...	182.16	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 [VAVwPFP Boxes - Chlr ER]

Type	Component	Capacity (kBtu/h)	Design COP/ Efficiency	Min COP/ Efficiency	Compliance
Heating	Electric resistance heating	9.15	-	-	-
Heating	Electric resistance heating	55.81	-	-	-
Heating	Electric resistance heating	100.5	-	-	-
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]

Type	Component	Capacity (kBtu/h)	Design COP/ Efficiency	Min COP/ Efficiency	Compliance
Heating	2 Nat-Draft Boilers, Primary-only HW Loop, Outdoor reset, Const-speed ...	87.52	0.8	0.8	PASSES
Heating	2 Nat-Draft Boilers, Primary-only HW Loop, Outdoor reset, Const-speed ...	139.02	0.8	0.8	PASSES

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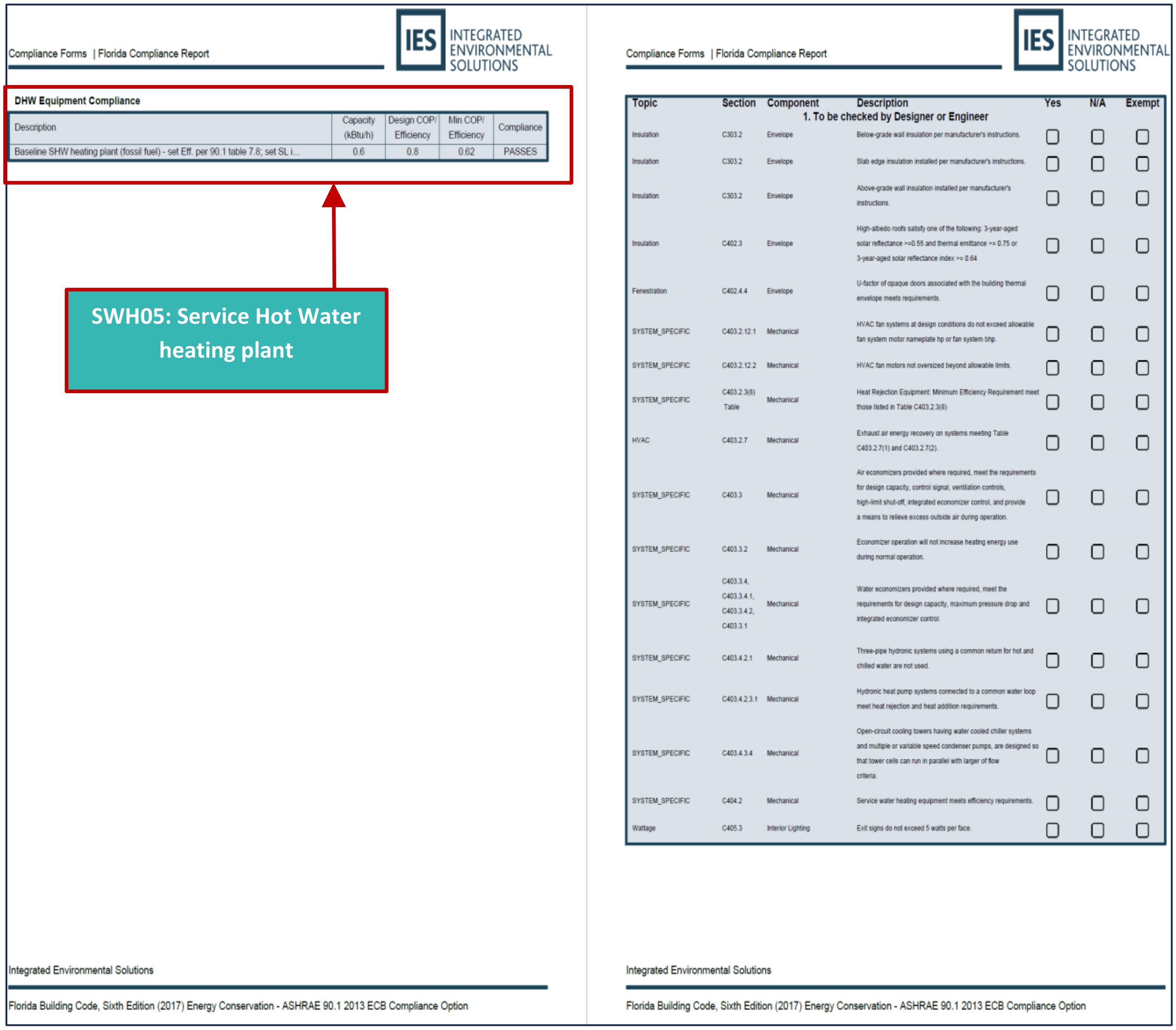

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INTEGRATED ENVIRONMENTAL SOLUTIONS

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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INTEGRATED ENVIRONMENTAL SOLUTIONS

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.	☐	☐	☐
Insulation	C303.2	Envelope	Slab edge insulation installed per manufacturer's instructions.	☐	☐	☐
Insulation	C303.2	Envelope	Above-grade wall insulation installed per manufacturer's instructions.	☐	☐	☐
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	☐	☐	☐
Fenestration	C402.4.4	Envelope	U-factor of opaque doors associated with the building thermal envelope meets requirements.	☐	☐	☐
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.	☐	☐	☐
SYSTEM_SPECIFIC	C403.2.12.2	Mechanical	HVAC fan motors not oversized beyond allowable limits.	☐	☐	☐
SYSTEM_SPECIFIC	C403.2.3(8) Table	Mechanical	Heat Rejection Equipment: Minimum Efficiency Requirement meet those listed in Table C403.2.3(8)	☐	☐	☐
HVAC	C403.2.7	Mechanical	Exhaust air energy recovery on systems meeting Table C403.2.7(1) and C403.2.7(2).	☐	☐	☐
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.	☐	☐	☐
SYSTEM_SPECIFIC	C403.3.2	Mechanical	Economizer operation will not increase heating energy use during normal operation.	☐	☐	☐
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, maximum pressure drop and integrated economizer control.	☐	☐	☐
SYSTEM_SPECIFIC	C403.4.2.1	Mechanical	Three-pipe hydronic systems using a common return for hot and chilled water are not used.	☐	☐	☐
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.	☐	☐	☐
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.	☐	☐	☐
SYSTEM_SPECIFIC	C404.2	Mechanical	Service water heating equipment meets efficiency requirements.	☐	☐	☐
Wattage	C405.3	Interior Lighting	Exit signs do not exceed 5 watts per face.	☐	☐	☐

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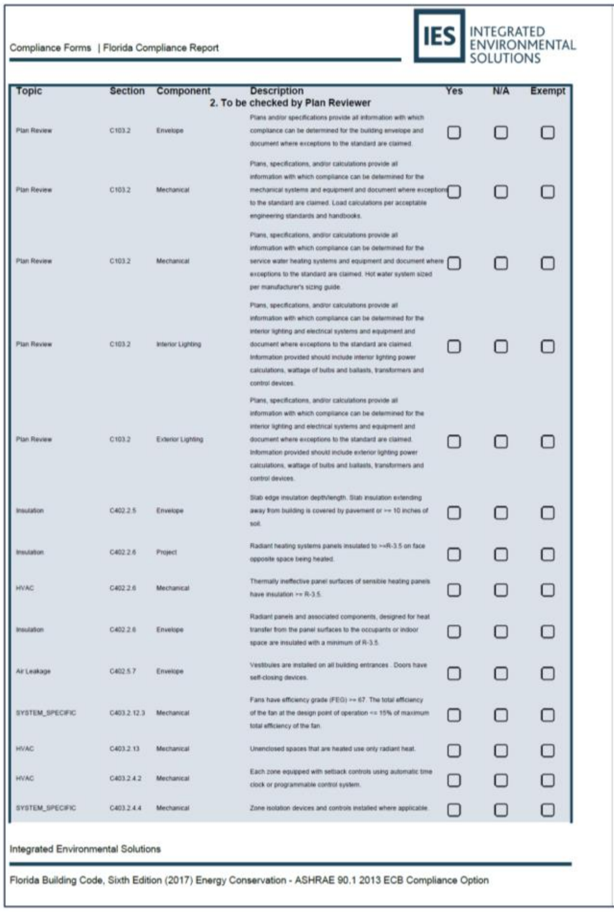

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Topic	Section	Component	Description	Yes	N/A	Exempt
			2. To be checked by Plan Reviewer			
Plan Review	C103.2	Envelope	Plans and/or specifications provide all information with which compliance can be determined for the building envelope and document where exceptions to the standard are claimed.	☐	☐	☐
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 acceptable engineering standards and handbooks.	☐	☐	☐
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.	☐	☐	☐
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.	☐	☐	☐
Plan Review	C103.2	Exterior 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 exterior lighting power calculations, wattage of bulbs and ballasts, transformers and control devices.	☐	☐	☐
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.	☐	☐	☐
Insulation	C402.2.6	Project	Radiant heating systems panels insulated to >=R-3.5 on face opposite space being heated.	☐	☐	☐
HVAC	C402.2.6	Mechanical	Thermally ineffective panel surfaces of sensible heating panels have insulation >= R-3.5.	☐	☐	☐
Insulation	C402.2.6	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.	☐	☐	☐
Air Leakage	C402.5.7	Envelope	Vestibules are installed on all building entrances . Doors have self-closing devices.	☐	☐	☐
SYSTEM_SPECIFIC	C403.2.12.3	Mechanical	Fans have efficiency grade (FEG) >= 67. The total efficiency of the fan at the design point of operation <= 15% of maximum total efficiency of the fan.	☐	☐	☐
HVAC	C403.2.13	Mechanical	Unenclosed spaces that are heated use only radiant heat.	☐	☐	☐
HVAC	C403.2.4.2	Mechanical	Each zone equipped with setback controls using automatic time clock or programmable control system.	☐	☐	☐
SYSTEM_SPECIFIC	C403.2.4.4	Mechanical	Zone isolation devices and controls installed where applicable.	☐	☐	☐

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SYSTEM_SPECIFIC	C403.2.4.7	Mechanical	Fault detection and diagnostics installed with air-cooled unitary DX units having economizers.	☐	☐	☐
SYSTEM_SPECIFIC	C403.2.5	Mechanical	Hot water boilers supplying heat via one- or two-pipe systems include outdoor setback control.	☐	☐	☐
HVAC	C403.2.6.1	Mechanical	Demand control ventilation provided for spaces >500 ft2 and >25 people/1000 ft2 occupant density and served by systems with air side economizer, auto modulating outside air damper control, or design airflow >3,000 cfm.	☐	☐	☐
SYSTEM_SPECIFIC	C403.4.1.1	Mechanical	Hydronic and multizone HVAC system controls areVAV fans driven by mechanical or electrical variable speed drive per Table C403.4.1.1.	☐	☐	☐
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.	☐	☐	☐
SYSTEM_SPECIFIC	C403.4.2	Mechanical	Temperature reset by representative building loads in pumping systems for chiller and boiler systems >500,000 Btu/h.	☐	☐	☐
SYSTEM_SPECIFIC	C403.4.2.3.2.1	Mechanical	Closed-circuit cooling tower within heat pump loop have either automatic bypass valve or lower leakage positive closure dampers. Open-circuit tower within heat pump loop have automatic valve to bypass all heat pump water flow around the tower.	☐	☐	☐
SYSTEM_SPECIFIC	C403.4.2.4	Mechanical	Hydronic systems greater than 500,000 Btu/h designed for variable fluid flow.	☐	☐	☐
SYSTEM_SPECIFIC	C403.4.2.5	Mechanical	System turndown 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	☐	☐	☐
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.	☐	☐	☐
SYSTEM_SPECIFIC	C403.4.3 C403.4.3.2	Mechanical	Fan systems with motors >=7.5 hp associated with heat rejection equipment to have capability to operate at 2/3 of full-speed and auto speed controls to control the leaving fluid temperature or condensing temp/pressure of heat rejection device.	☐	☐	☐
SYSTEM_SPECIFIC	C403.4.4.5	Mechanical	Multiple zone HVAC systems have supply air temperature reset controls.	☐	☐	☐
SYSTEM_SPECIFIC	C403.4.4.6	Mechanical	Multiple zone VAV systems with DDC of individual zone boxes have static pressure setpoint reset controls.	☐	☐	☐

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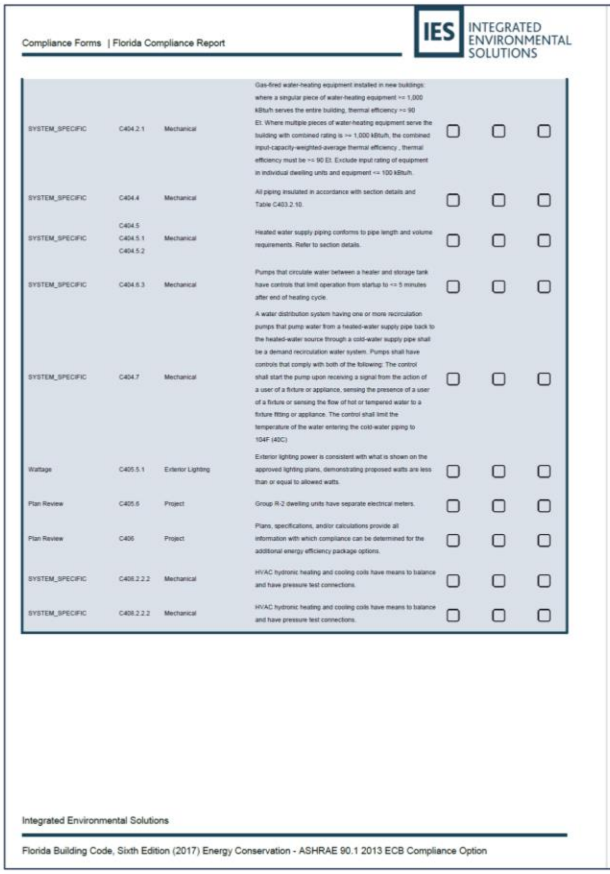

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SYSTEM_SPECIFIC	C404.2.1	Mechanical	Gas-fired water-heating equipment installed in new buildings: where a singular piece of water-heating equipment >= 1,000 kBtu/h serves the entire building, thermal efficiency >= 90 Et. Where multiple pieces of water-heating equipment serve the building with combined rating is >= 1,000 kBtu/h, the combined input-capacity-weighted-average thermal efficiency , thermal efficiency must be >= 90 Et. Exclude input rating of equipment in individual dwelling units and equipment <= 100 kBtu/h.	☐	☐	☐
SYSTEM_SPECIFIC	C404.4	Mechanical	All piping insulated in accordance with section details and Table C403.2.10.	☐	☐	☐
SYSTEM_SPECIFIC	C404.5 C404.5.1 C404.5.2	Mechanical	Heated water supply piping conforms to pipe length and volume requirements. Refer to section details.	☐	☐	☐
SYSTEM_SPECIFIC	C404.6.3	Mechanical	Pumps that circulate water between a heater and storage tank have controls that limit operation from startup to <= 5 minutes after end of heating cycle.	☐	☐	☐
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 control 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)	☐	☐	☐
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.	☐	☐	☐
Plan Review	C405.6	Project	Group R-2 dwelling units have separate electrical meters.	☐	☐	☐
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.	☐	☐	☐
SYSTEM_SPECIFIC	C408.2.2.2	Mechanical	HVAC hydronic heating and cooling coils have means to balance and have pressure test connections.	☐	☐	☐
SYSTEM_SPECIFIC	C408.2.2.2	Mechanical	HVAC hydronic heating and cooling coils have means to balance and have pressure test connections.	☐	☐	☐

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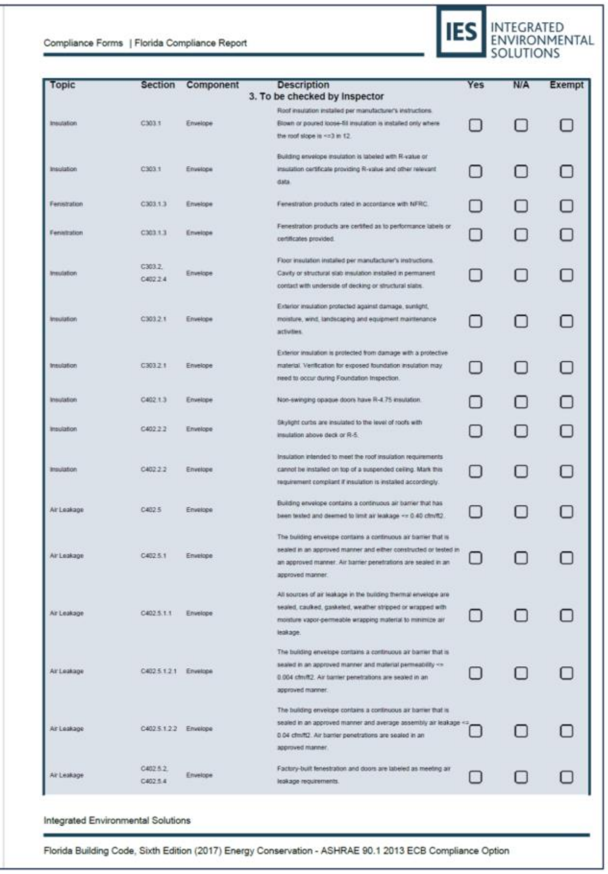

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Topic	Section	Component	Description	Yes	N/A	Exempt
			3. To be checked by Inspector			
Insulation	C303.1	Envelope	Roof insulation installed per manufacturer's instructions. Blown or poured loose-fill insulation is installed only where the roof slope is <=3 in 12.	☐	☐	☐
Insulation	C303.1	Envelope	Building envelope insulation is labeled with R-value or insulation certificate providing R-value and other relevant data.	☐	☐	☐
Fenistration	C303.1.3	Envelope	Fenestration products rated in accordance with NFRC.	☐	☐	☐
Fenistration	C303.1.3	Envelope	Fenestration products are certified as to performance labels or certificates provided.	☐	☐	☐
Insulation	C303.2, C402.2.4	Envelope	Floor insulation installed per manufacturer's instructions. Cavity or structural slab insulation installed in permanent contact with underside of decking or structural slabs.	☐	☐	☐
Insulation	C303.2.1	Envelope	Exterior insulation protected against damage, sunlight, moisture, wind, landscaping and equipment maintenance activities.	☐	☐	☐
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.	☐	☐	☐
Insulation	C402.1.3	Envelope	Non-swinging opaque doors have R-4.75 insulation.	☐	☐	☐
Insulation	C402.2.2	Envelope	Skylight curbs are insulated to the level of roofs with insulation above deck or R-5.	☐	☐	☐
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.	☐	☐	☐
Air Leakage	C402.5	Envelope	Building envelope contains a continuous air barrier that has been tested and deemed to limit air leakage <= 0.40 cfm/ft2.	☐	☐	☐
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.	☐	☐	☐
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.	☐	☐	☐
Air Leakage	C402.5.1.2.1	Envelope	The building envelope contains a continuous air barrier that is sealed in an approved manner and material permeability <= 0.004 cfm/ft2. Air barrier penetrations are sealed in an approved manner.	☐	☐	☐
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 <= 0.04 cfm/ft2. Air barrier penetrations are sealed in an approved manner.	☐	☐	☐
Air Leakage	C402.5.2, C402.5.4	Envelope	Factory-built fenestration and doors are labeled as meeting air leakage requirements.	☐	☐	☐

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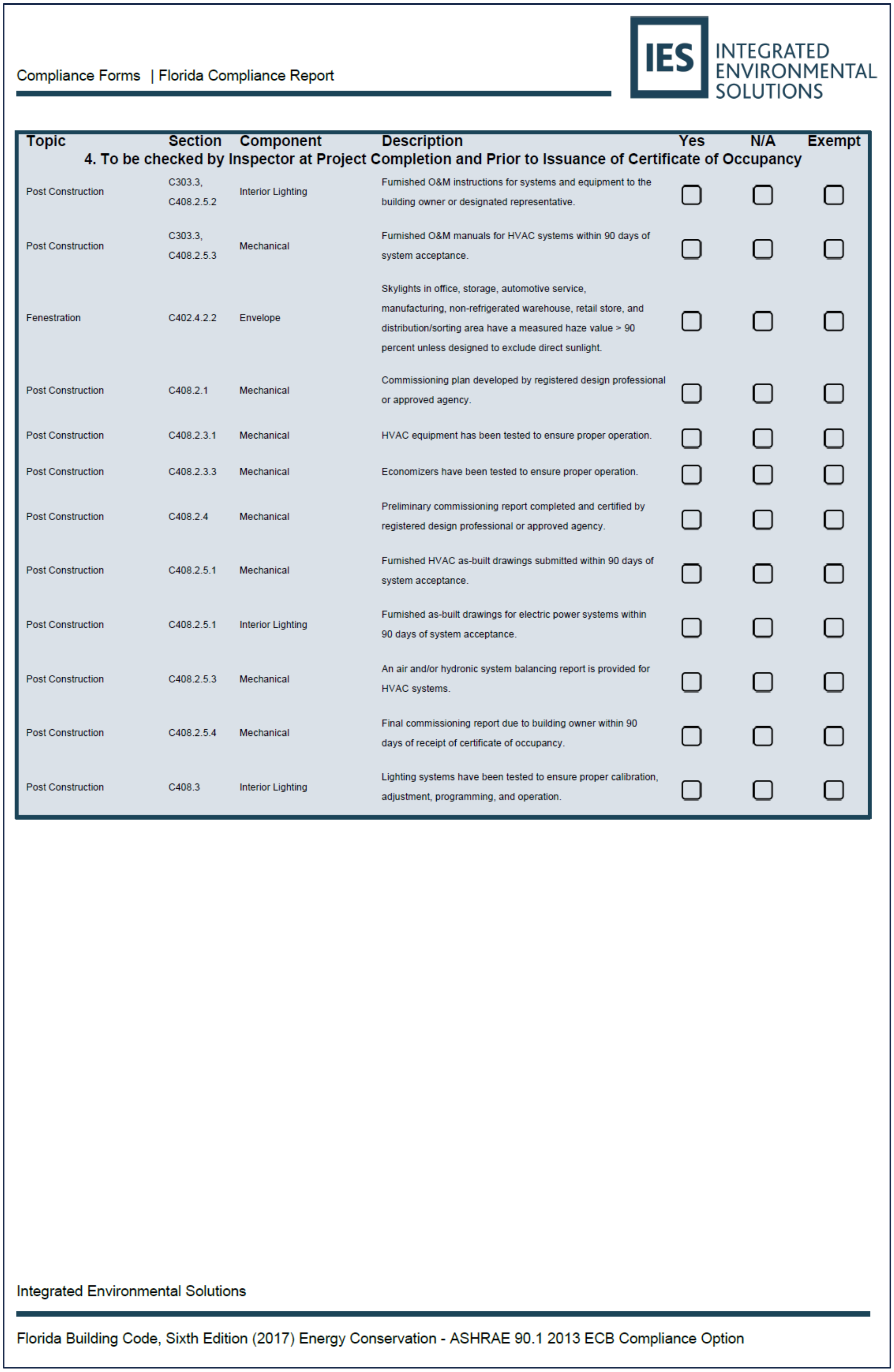

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INTEGRATED ENVIRONMENTAL SOLUTIONS

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.	☐	☐	☐
Post Construction	C303.3, C408.2.5.3	Mechanical	Furnished O&M manuals for HVAC systems within 90 days of system acceptance.	☐	☐	☐
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.	☐	☐	☐
Post Construction	C408.2.1	Mechanical	Commissioning plan developed by registered design professional or approved agency.	☐	☐	☐
Post Construction	C408.2.3.1	Mechanical	HVAC equipment has been tested to ensure proper operation.	☐	☐	☐
Post Construction	C408.2.3.3	Mechanical	Economizers have been tested to ensure proper operation.	☐	☐	☐
Post Construction	C408.2.4	Mechanical	Preliminary commissioning report completed and certified by registered design professional or approved agency.	☐	☐	☐
Post Construction	C408.2.5.1	Mechanical	Furnished HVAC as-built drawings submitted within 90 days of system acceptance.	☐	☐	☐
Post Construction	C408.2.5.1	Interior Lighting	Furnished as-built drawings for electric power systems within 90 days of system acceptance.	☐	☐	☐
Post Construction	C408.2.5.3	Mechanical	An air and/or hydronic system balancing report is provided for HVAC systems.	☐	☐	☐
Post Construction	C408.2.5.4	Mechanical	Final commissioning report due to building owner within 90 days of receipt of certificate of occupancy.	☐	☐	☐
Post Construction	C408.3	Interior Lighting	Lighting systems have been tested to ensure proper calibration, adjustment, programming, and operation.	☐	☐	☐

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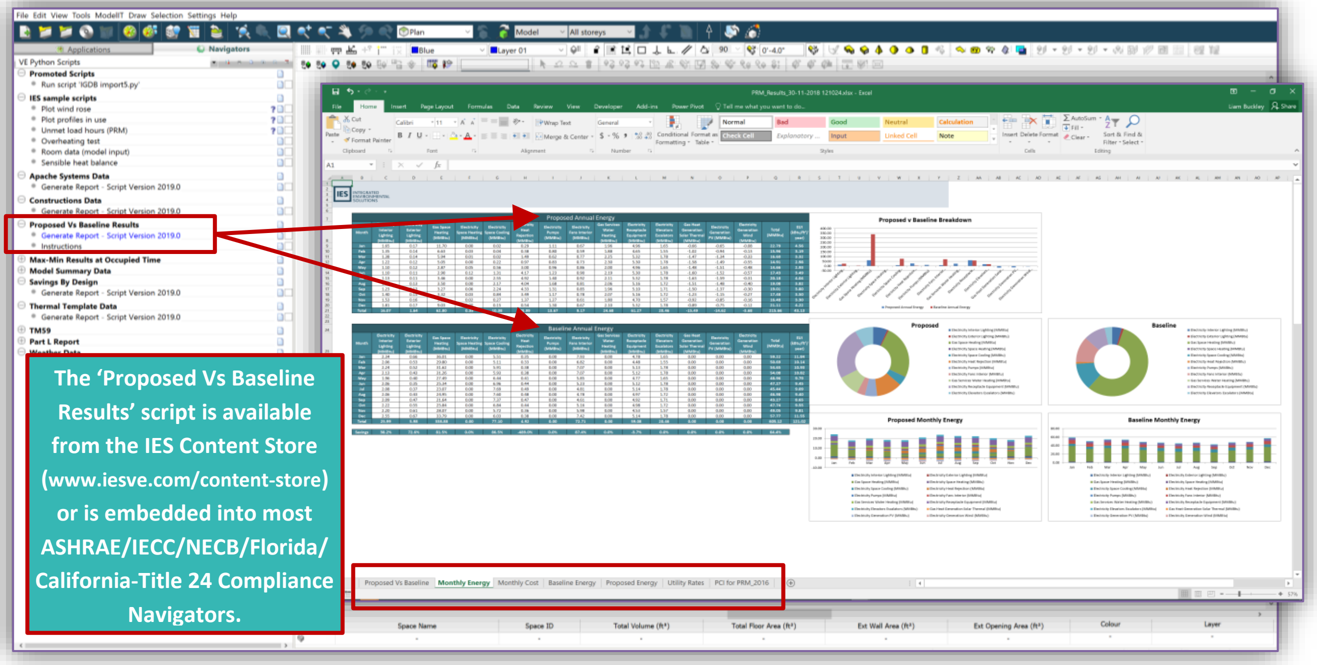
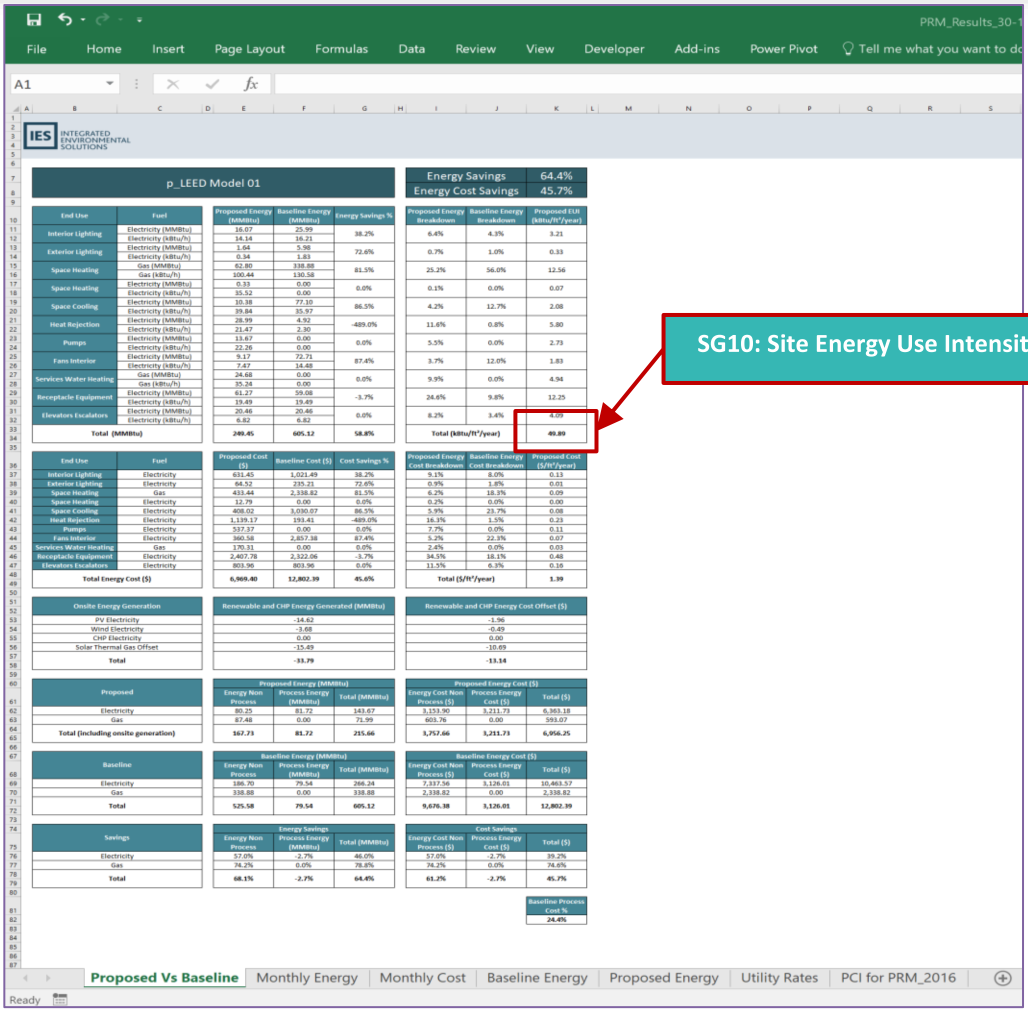
ASHRAE 90.1-2016 PCI Report (Performance Cost Index - Proposed vs Baseline)



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.



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 Breakdown	Baseline Energy Breakdown	Proposed EUI (kBtu/ft²/year)
Interior Lighting	Electricity (MMBtu)	16.07	25.99	38.2%	6.4%	4.3%	3.21
	Electricity (kBtu/h)	14.14	16.21				
Exterior Lighting	Electricity (MMBtu)	1.64	5.98	72.6%	0.7%	1.0%	0.33
	Electricity (kBtu/h)	0.34	1.83				
Space Heating	Gas (MMBtu)	62.80	338.88	81.5%	25.2%	56.0%	12.56
	Gas (kBtu/h)	100.44	130.58				
Space Heating	Electricity (MMBtu)	0.33	0.00	0.0%	0.1%	0.0%	0.07
	Electricity (kBtu/h)	35.52	0.00				
Space Cooling	Electricity (MMBtu)	10.38	77.10	86.5%	4.2%	12.7%	2.08
	Electricity (kBtu/h)	39.84	35.97				
Heat Rejection	Electricity (MMBtu)	28.99	4.92	-489.0%	11.6%	0.8%	5.80
	Electricity (kBtu/h)	21.47	2.30				
Pumps	Electricity (MMBtu)	13.67	0.00	0.0%	5.5%	0.0%	2.73
	Electricity (kBtu/h)	22.26	0.00				
Fans Interior	Electricity (MMBtu)	9.17	72.71	87.4%	3.7%	12.0%	1.83
	Electricity (kBtu/h)	7.47	14.48				
Services Water Heating	Gas (MMBtu)	24.68	0.00	0.0%	9.9%	0.0%	4.94
	Gas (kBtu/h)	35.24	0.00				
Receptacle Equipment	Electricity (MMBtu)	61.27	59.08	-3.7%	24.6%	9.8%	12.25
	Electricity (kBtu/h)	19.49	19.49				
Elevators Escalators	Electricity (MMBtu)	20.46	20.46	0.0%	8.2%	3.4%	4.09
	Electricity (kBtu/h)	6.82	6.82				
Total (MMBtu)		249.45	605.12	58.8%	Total (kBtu/ft²/year)		49.89

End Use	Fuel	Proposed Cost ($)	Baseline Cost ($)	Cost Savings %	Proposed Energy Cost Breakdown	Baseline Energy Cost Breakdown	Proposed Cost ($/ft²/year)
Interior Lighting	Electricity	631.45	1,021.49	38.2%	9.1%	8.0%	0.13
Exterior Lighting	Electricity	64.52	235.21	72.6%	0.9%	1.8%	0.01
Space Heating	Gas	433.44	2,338.82	81.5%	6.2%	18.3%	0.09
Space Heating	Electricity	12.79	0.00	0.0%	0.2%	0.0%	0.00
Space Cooling	Electricity	408.02	3,030.07	86.5%	5.9%	23.7%	0.08
Heat Rejection	Electricity	1,139.17	193.41	-489.0%	16.3%	1.5%	0.23
Pumps	Electricity	537.37	0.00	0.0%	7.7%	0.0%	0.11
Fans Interior	Electricity	360.58	2,857.38	87.4%	5.2%	22.3%	0.07
Services Water Heating	Gas	170.31	0.00	0.0%	2.4%	0.0%	0.03
Receptacle Equipment	Electricity	2,407.78	2,322.06	-3.7%	34.5%	18.1%	0.48
Elevators Escalators	Electricity	803.96	803.96	0.0%	11.5%	6.3%	0.16
Total Energy Cost ($)		6,969.40	12,802.39	45.6%	Total ($/ft²/year)		1.39

Onsite Energy Generation	Renewable and CHP Energy Generated (MMBtu)	Renewable and CHP Energy Cost Offset ($)
PV Electricity	-14.62	-1.96
Wind Electricity	-3.68	-0.49
CHP Electricity	0.00	0.00
Solar Thermal Gas Offset	-15.49	-10.69
Total	-33.79	-13.14

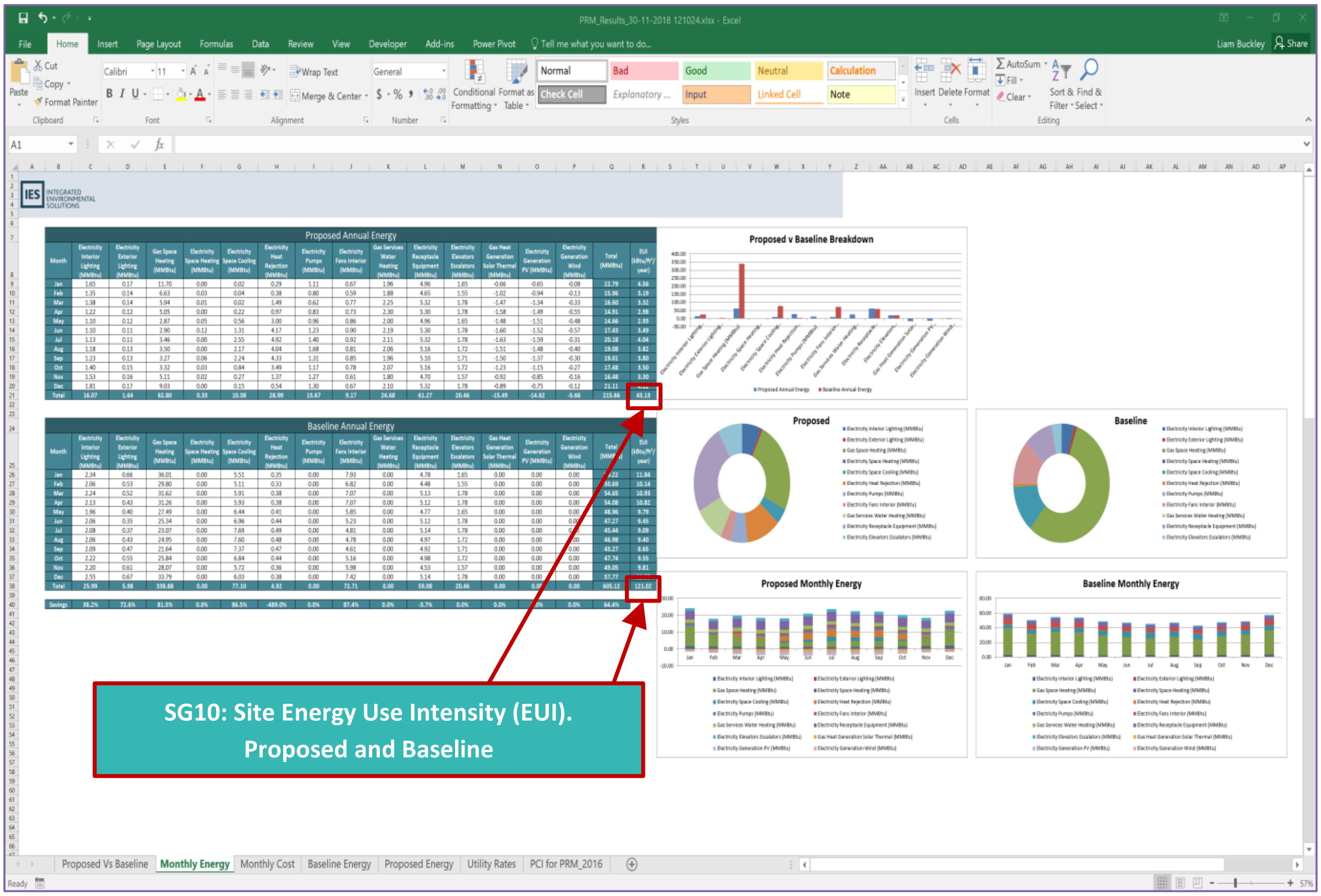
Proposed	Proposed Energy (MMBtu)			Proposed Energy Cost ($)		
	Energy Non Process	Process Energy (MMBtu)	Total (MMBtu)	Energy Cost Non Process ($)	Process Energy Cost ($)	Total ($)
Electricity	80.25	81.72	143.67	3,153.90	3,211.73	6,363.18
Gas	87.48	0.00	71.99	603.76	0.00	593.07
Total (including onsite generation)	167.73	81.72	215.66	3,757.66	3,211.73	6,956.25

Baseline	Baseline Energy (MMBtu)			Baseline Energy Cost ($)		
	Energy Non Process	Process Energy (MMBtu)	Total (MMBtu)	Energy Cost Non Process ($)	Process Energy Cost ($)	Total ($)
Electricity	186.70	79.54	266.24	7,337.56	3,126.01	10,463.57
Gas	338.88	0.00	338.88	2,338.82	0.00	2,338.82
Total	525.58	79.54	605.12	9,676.38	3,126.01	12,802.39

Savings	Energy Savings			Cost Savings		
	Energy Non Process	Process Energy (MMBtu)	Total (MMBtu)	Energy Cost Non Process ($)	Process Energy Cost ($)	Total ($)
Electricity	57.0%	-2.7%	46.0%	57.0%	-2.7%	39.2%
Gas	74.2%	0.0%	78.8%	74.2%	0.0%	74.6%
Total	68.1%	-2.7%	64.4%	61.2%	-2.7%	45.7%

Baseline Process Cost %
24.4%

SG10: Site Energy Use Intensity (EUI).



Proposed Annual Energy

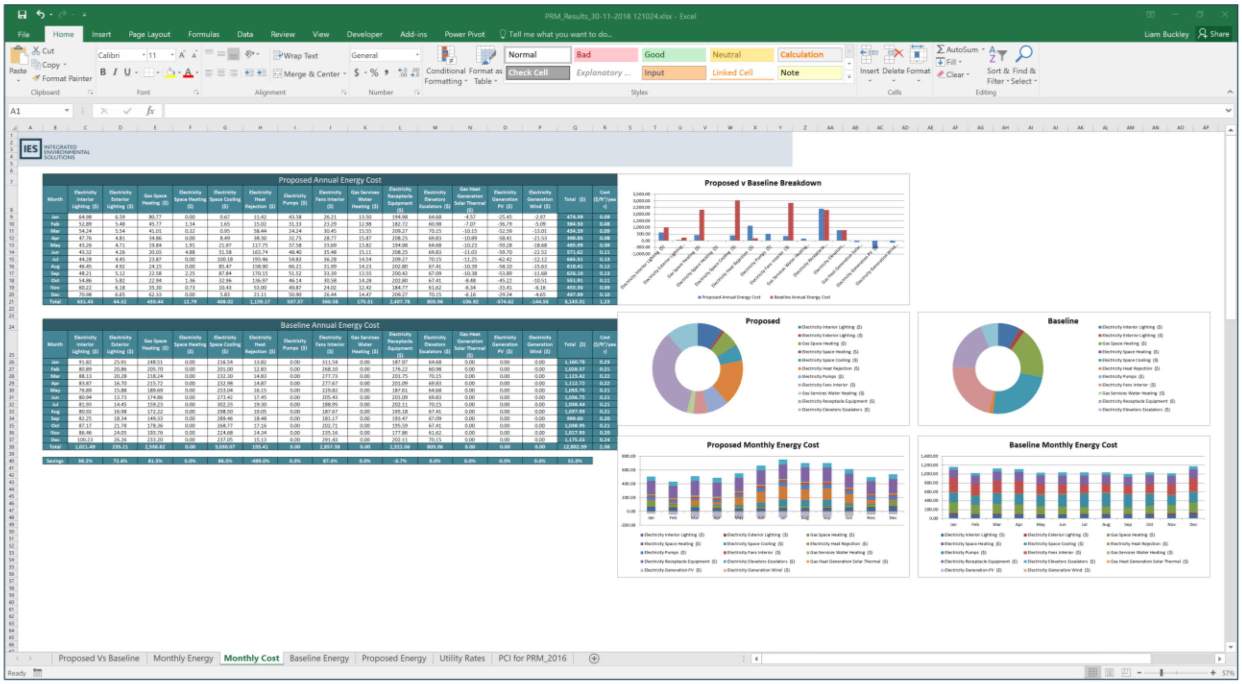
Month	Electricity Interior Lighting (MMBtu)	Electricity Exterior Lighting (MMBtu)	Gas Space Heating (MMBtu)	Electricity Space Heating (MMBtu)	Electricity Space Cooling (MMBtu)	Electricity Heat Rejection (MMBtu)	Electricity Pumps (MMBtu)	Electricity Fans Interior (MMBtu)	Gas Services Water Heating (MMBtu)	Electricity Receptacle Equipment (MMBtu)	Electricity Elevators Escalators (MMBtu)	Gas Heat Generation Solar Thermal (MMBtu)	Electricity Generation PV (MMBtu)	Electricity Generation Wind (MMBtu)	Total (MMBtu)	EUI (kBtu/ft^2/ year)
Jan	1.65	0.17	11.70	0.00	0.02	0.29	1.11	0.67	1.96	4.96	1.65	-0.66	-0.65	-0.08	22.79	4.56
Feb	1.35	0.14	6.63	0.03	0.04	0.38	0.80	0.59	1.88	4.65	1.55	-1.02	-0.94	-0.13	15.96	3.19
Mar	1.38	0.14	5.94	0.01	0.02	1.49	0.62	0.77	2.25	5.32	1.78	-1.47	-1.34	-0.33	16.60	3.32
Apr	1.22	0.12	5.05	0.00	0.22	0.97	0.83	0.73	2.30	5.30	1.78	-1.58	-1.49	-0.55	14.91	2.98
May	1.10	0.12	2.87	0.05	0.56	3.00	0.96	0.86	2.00	4.96	1.65	-1.48	-1.51	-0.48	14.66	2.93
Jun	1.10	0.11	2.90	0.12	1.31	4.17	1.23	0.90	2.19	5.30	1.78	-1.60	-1.52	-0.57	17.43	3.49
Jul	1.13	0.11	3.46	0.00	2.55	4.92	1.40	0.92	2.11	5.32	1.78	-1.63	-1.59	-0.31	20.18	4.04
Aug	1.18	0.13	3.50	0.00	2.17	4.04	1.68	0.81	2.06	5.16	1.72	-1.51	-1.48	-0.40	19.08	3.82
Sep	1.23	0.13	3.27	0.06	2.24	4.33	1.31	0.85	1.96	5.10	1.71	-1.50	-1.37	-0.30	19.01	3.80
Oct	1.40	0.15	3.32	0.03	0.84	3.49	1.17	0.78	2.07	5.16	1.72	-1.23	-1.15	-0.27	17.48	3.50
Nov	1.53	0.16	5.11	0.02	0.27	1.37	1.27	0.61	1.80	4.70	1.57	-0.92	-0.85	-0.16	16.48	3.30
Dec	1.81	0.17	9.03	0.00	0.15	0.54	1.30	0.67	2.10	5.32	1.78	-0.89	-0.75	-0.12	21.11	[illegible]
Total	16.07	1.64	62.80	0.33	10.38	28.99	13.67	9.17	24.68	61.27	20.46	-15.49	-14.62	-3.68	215.66	43.13

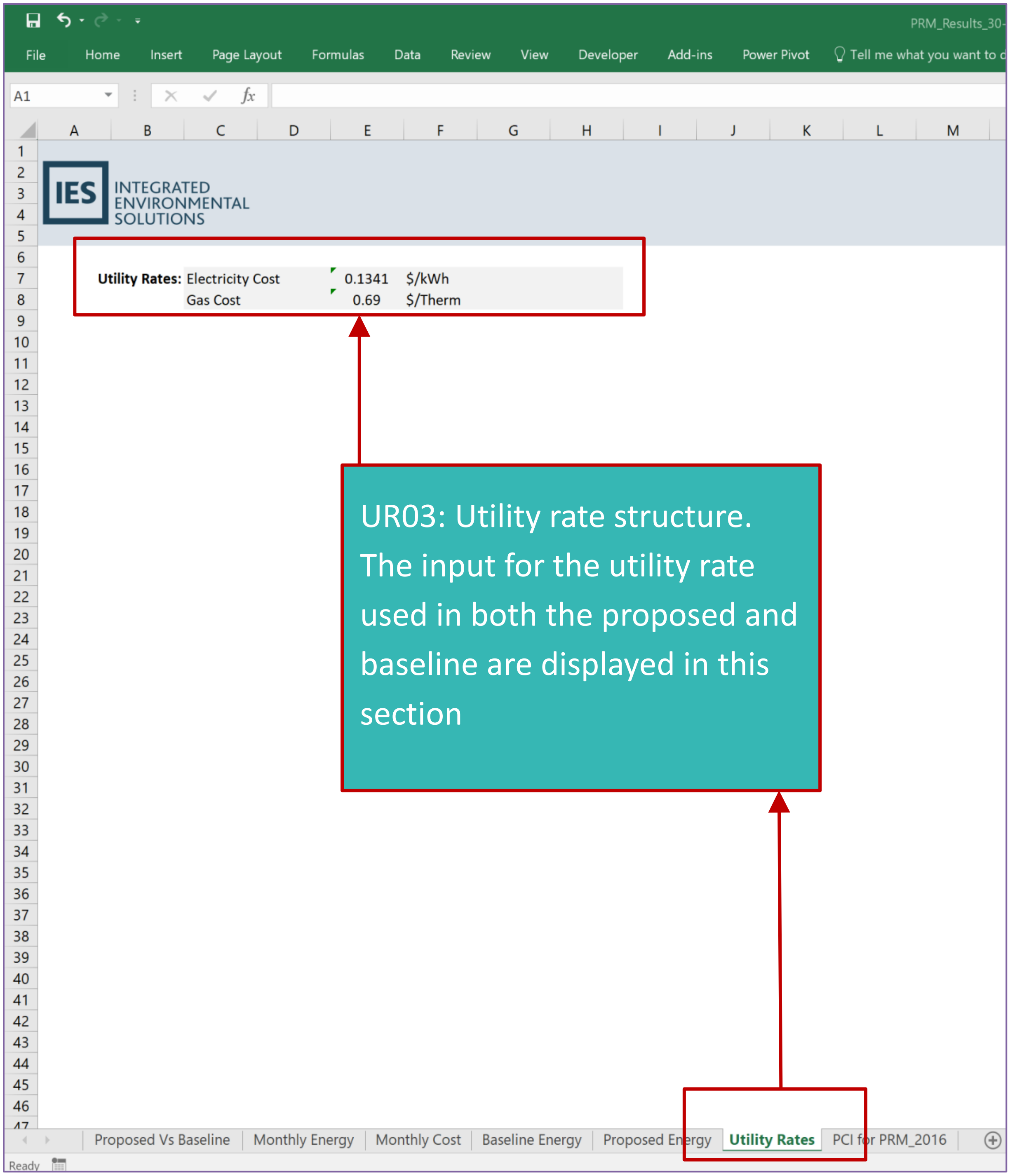
Baseline Annual Energy

Month	Electricity Interior Lighting (MMBtu)	Electricity Exterior Lighting (MMBtu)	Gas Space Heating (MMBtu)	Electricity Space Heating (MMBtu)	Electricity Space Cooling (MMBtu)	Electricity Heat Rejection (MMBtu)	Electricity Pumps (MMBtu)	Electricity Fans Interior (MMBtu)	Gas Services Water Heating (MMBtu)	Electricity Receptacle Equipment (MMBtu)	Electricity Elevators Escalators (MMBtu)	Gas Heat Generation Solar Thermal (MMBtu)	Electricity Generation PV (MMBtu)	Electricity Generation Wind (MMBtu)	Total (MMBtu)	EUI (kBtu/ft^2/ year)
Jan	2.34	0.66	36.01	0.00	5.51	0.35	0.00	7.93	0.00	4.78	1.65	0.00	0.00	0.00	[illegible]	11.84
Feb	2.06	0.53	29.80	0.00	5.11	0.33	0.00	6.82	0.00	4.48	1.55	0.00	0.00	0.00	50.69	10.14
Mar	2.24	0.52	31.62	0.00	5.91	0.38	0.00	7.07	0.00	5.13	1.78	0.00	0.00	0.00	54.65	10.93
Apr	2.13	0.43	31.26	0.00	5.93	0.38	0.00	7.07	0.00	5.12	1.78	0.00	0.00	0.00	54.08	10.82
May	1.96	0.40	27.49	0.00	6.44	0.41	0.00	5.85	0.00	4.77	1.65	0.00	0.00	0.00	48.96	9.79
Jun	2.06	0.35	25.34	0.00	6.96	0.44	0.00	5.23	0.00	5.12	1.78	0.00	0.00	[illegible]	47.27	9.45
Jul	2.08	0.37	23.07	0.00	7.69	0.49	0.00	4.81	0.00	5.14	1.78	0.00	0.00	[illegible]	45.44	9.09
Aug	2.06	0.43	24.95	0.00	7.60	0.48	0.00	4.78	0.00	4.97	1.72	0.00	0.00	[illegible]	46.98	9.40
Sep	2.09	0.47	21.64	0.00	7.37	0.47	0.00	4.61	0.00	4.92	1.71	0.00	0.00	0.00	43.27	8.65
Oct	2.22	0.55	25.84	0.00	6.84	0.44	0.00	5.16	0.00	4.98	1.72	0.00	0.00	0.00	47.74	9.55
Nov	2.20	0.61	28.07	0.00	5.72	0.36	0.00	5.98	0.00	4.53	1.57	0.00	0.00	0.00	49.05	9.81
Dec	2.55	0.67	33.79	0.00	6.03	0.38	0.00	7.42	0.00	5.14	1.78	0.00	0.00	0.00	57.77	[illegible]
Total	25.99	5.98	338.88	0.00	77.10	4.92	0.00	72.71	0.00	59.08	20.46	0.00	[illegible]	0.00	605.12	121.02

Savings	38.2%	72.6%	81.5%	0.0%	86.5%	-489.0%	0.0%	87.4%	0.0%	-3.7%	0.0%	0.0%	[illegible]	0.0%	64.4%

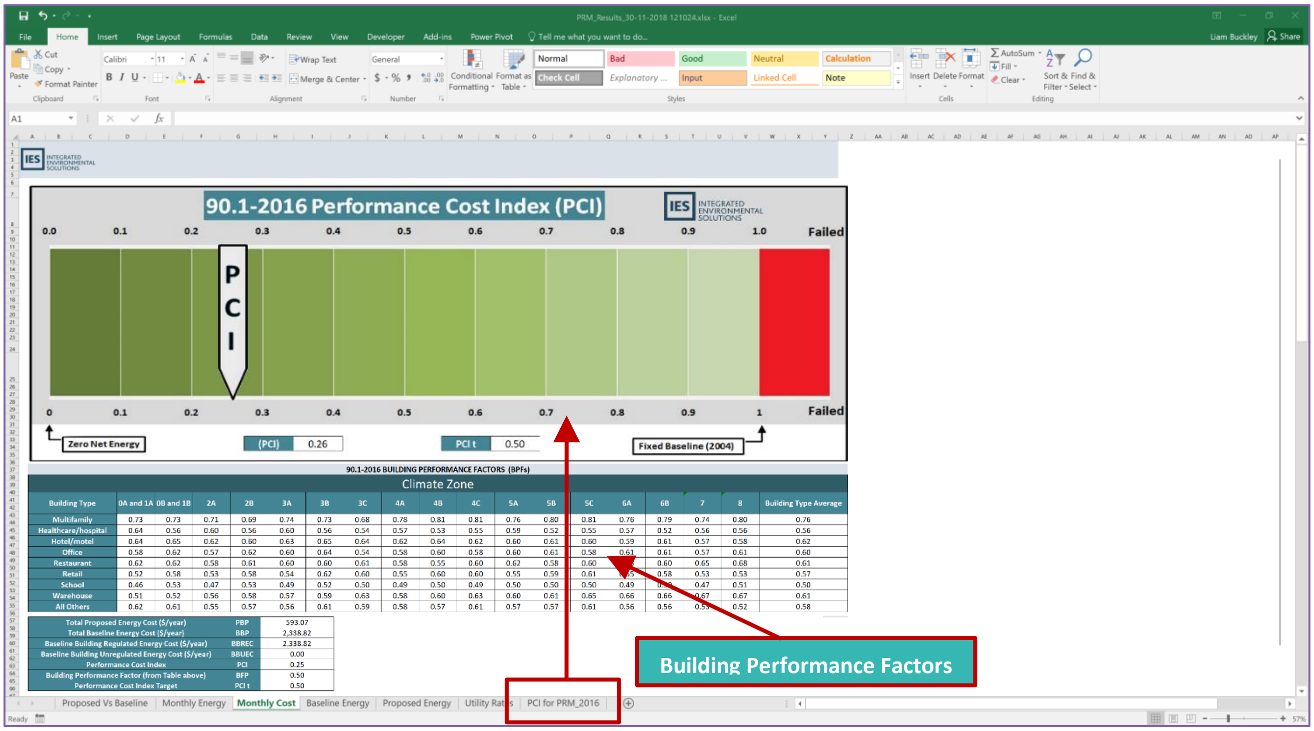
SG10: Site Energy Use Intensity (EUI). Proposed and Baseline





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

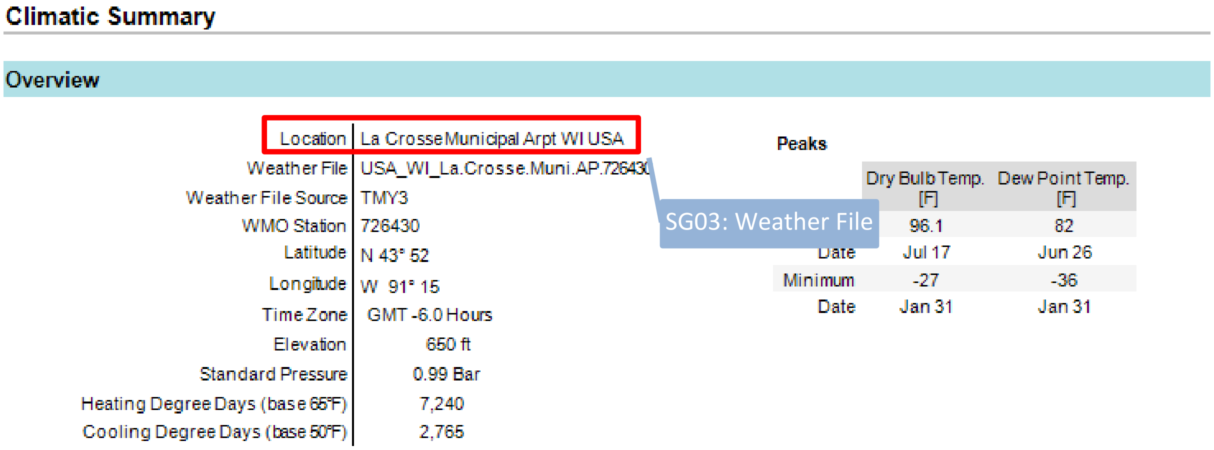


90.1-2016 BUILDING PERFORMANCE FACTORS (BPFs)

	Climate Zone																	
Building Type	0A and 1A	0B and 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8	Building Type Average
Multifamily	0.73	0.73	0.71	0.69	0.74	0.73	0.68	0.78	0.81	0.81	0.76	0.80	0.81	0.76	0.79	0.74	0.80	0.76
Healthcare/hospital	0.64	0.56	0.60	0.56	0.60	0.56	0.54	0.57	0.53	0.55	0.59	0.52	0.55	0.57	0.52	0.56	0.56	0.56
Hotel/motel	0.64	0.65	0.62	0.60	0.63	0.65	0.64	0.62	0.64	0.62	0.60	0.61	0.60	0.59	0.61	0.57	0.58	0.62
Office	0.58	0.62	0.57	0.62	0.60	0.64	0.54	0.58	0.60	0.58	0.60	0.61	0.58	0.61	0.61	0.57	0.61	0.60
Restaurant	0.62	0.62	0.58	0.61	0.60	0.60	0.61	0.58	0.55	0.60	0.62	0.58	0.60	[illegible]	0.60	0.65	0.68	0.61
Retail	0.52	0.58	0.53	0.58	0.54	0.62	0.60	0.55	0.60	0.60	0.55	0.59	0.61	[illegible]	0.58	0.53	0.53	0.57
School	0.46	0.53	0.47	0.53	0.49	0.52	0.50	0.49	0.50	0.49	0.50	0.50	0.50	0.49	[illegible]	0.47	0.51	0.50
Warehouse	0.51	0.52	0.56	0.58	0.57	0.59	0.63	0.58	0.60	0.63	0.60	0.61	0.65	0.66	0.66	0.67	0.67	0.61
All Others	0.62	0.61	0.55	0.57	0.56	0.61	0.59	0.58	0.57	0.61	0.57	0.57	0.61	0.56	0.56	[illegible]	0.52	0.58

Total Proposed Energy Cost ($/year)	PBP	593.07
Total Baseline Energy Cost ($/year)	BBP	2,338.82
Baseline Building Regulated Energy Cost ($/year)	BBREC	2,338.82
Baseline Building Unregulated Energy Cost ($/year)	BBUEC	0.00
Performance Cost Index	PCI	0.25
Building Performance Factor (from Table above)	BFP	0.50
Performance Cost Index Target	PCI t	0.50

Trane TRACE 3D Plus



Climatic Summary

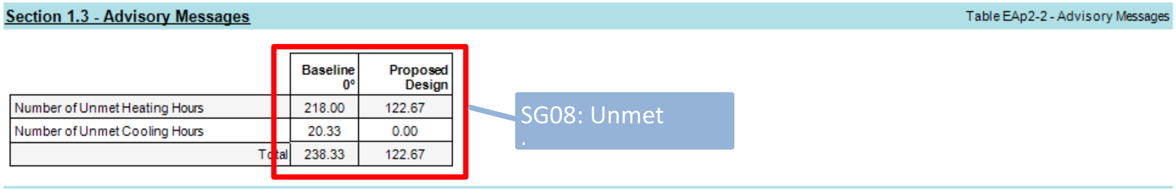
Overview

Location	La Crosse Municipal Arpt WI USA
Weather File	USA_WI_La.Crosse.Muni.AP.72643
Weather File Source	TMY3
WMO Station	726430
Latitude	N 43° 52
Longitude	W 91° 15
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

Peaks

	Dry Bulb Temp. [F]	Dew Point Temp. [F]
	96.1	82
Date	Jul 17	Jun 26
Minimum	-27	-36
Date	Jan 31	Jan 31

SG03: Weather File



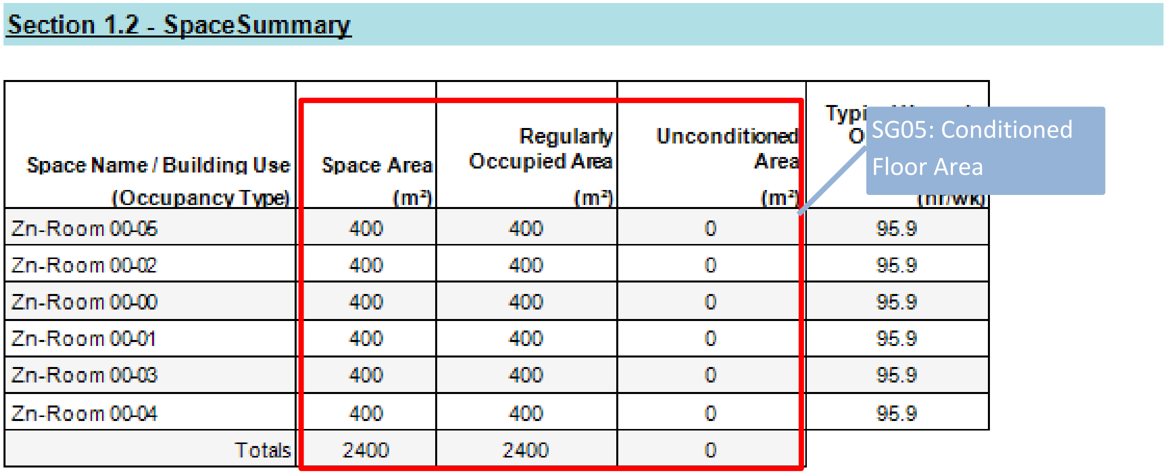
Section 1.3 - Advisory Messages

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

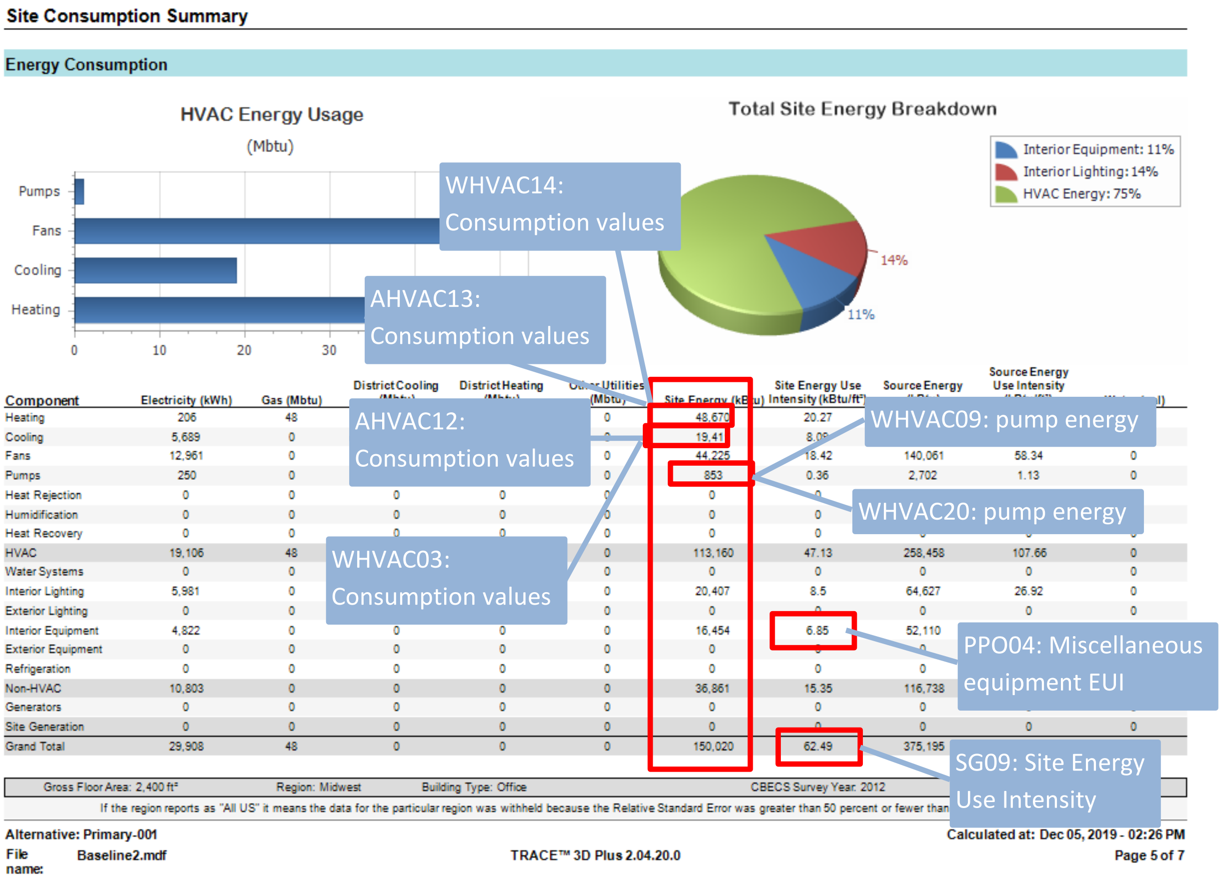
.



Section 1.2 - Space Summary

Space Name / Building Use (Occupancy Type)	Space Area (m²)	Regularly Occupied Area (m²)	Unconditioned Area (m²)	Typi O (hr/wk)
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

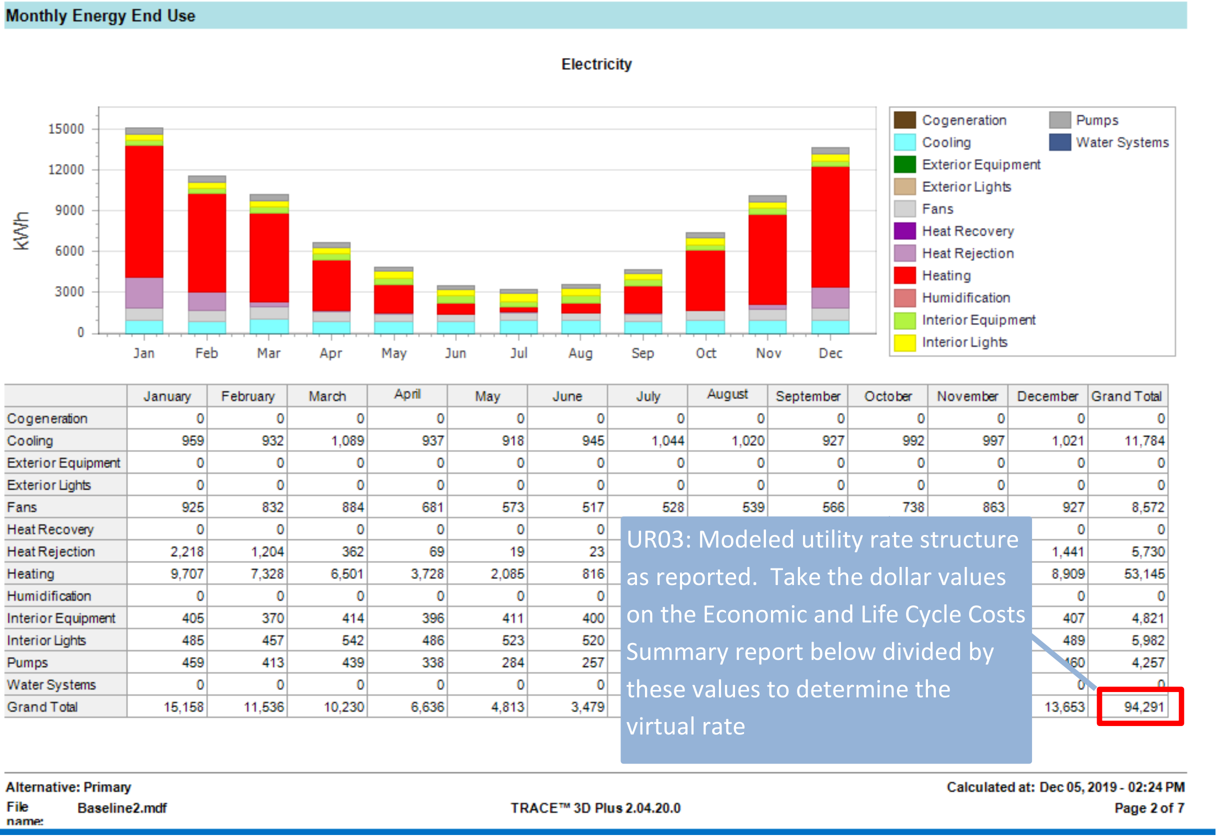
Component	Electricity (kWh)	Gas (Mbtu)	District Cooling (Mbtu)	District Heating (Mbtu)	Other Utilities (Mbtu)	Site Energy (kBtu)	Site Energy Use Intensity (kBtu/ft²)	Source Energy (kBtu)	Source Energy Use Intensity (kBtu/ft²)	[illegible]
Heating	206	48	[illegible]	[illegible]	0	48,670	20.27	[illegible]	[illegible]	[illegible]
Cooling	5,689	0	[illegible]	[illegible]	0	19,41	8.09	[illegible]	[illegible]	[illegible]
Fans	12,961	0	[illegible]	[illegible]	0	44,225	18.42	140,061	58.34	0
Pumps	250	0	[illegible]	[illegible]	0	853	0.36	2,702	1.13	0
Heat Rejection	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]
Humidification	0	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]
Heat Recovery	0	0	0	0	0	0	0	[illegible]	[illegible]	0
HVAC	19,106	48	[illegible]	[illegible]	0	113,160	47.13	258,458	107.66	0
Water Systems	0	0	[illegible]	[illegible]	0	0	0	0	0	0
Interior Lighting	5,981	0	[illegible]	[illegible]	0	20,407	8.5	64,627	26.92	0
Exterior Lighting	0	0	[illegible]	[illegible]	0	0	0	0	0	0
Interior Equipment	4,822	0	0	0	0	16,454	6.85	52,110	[illegible]	[illegible]
Exterior Equipment	0	0	0	0	0	0	0	0	[illegible]	[illegible]
Refrigeration	0	0	0	0	0	0	0	0	[illegible]	[illegible]
Non-HVAC	10,803	0	0	0	0	36,861	15.35	116,738	[illegible]	[illegible]
Generators	0	0	0	0	0	0	0	0	[illegible]	[illegible]
Site Generation	0	0	0	0	0	0	0	0	0	0
Grand Total	29,908	48	0	0	0	150,020	62.49	375,195	[illegible]	[illegible]

Gross Floor Area: 2,400 ft² Region: Midwest Building Type: Office CBECS Survey Year: 2012

If the region reports as "All US" it means the data for the particular region was withheld because the Relative Standard Error was greater than 50 percent or fewer than

Alternative: Primary-001 **Calculated at: Dec 05, 2019 - 02:26 PM**

File name: **Baseline2.mdf** **TRACE™ 3D Plus 2.04.20.0** **Page 5 of 7**



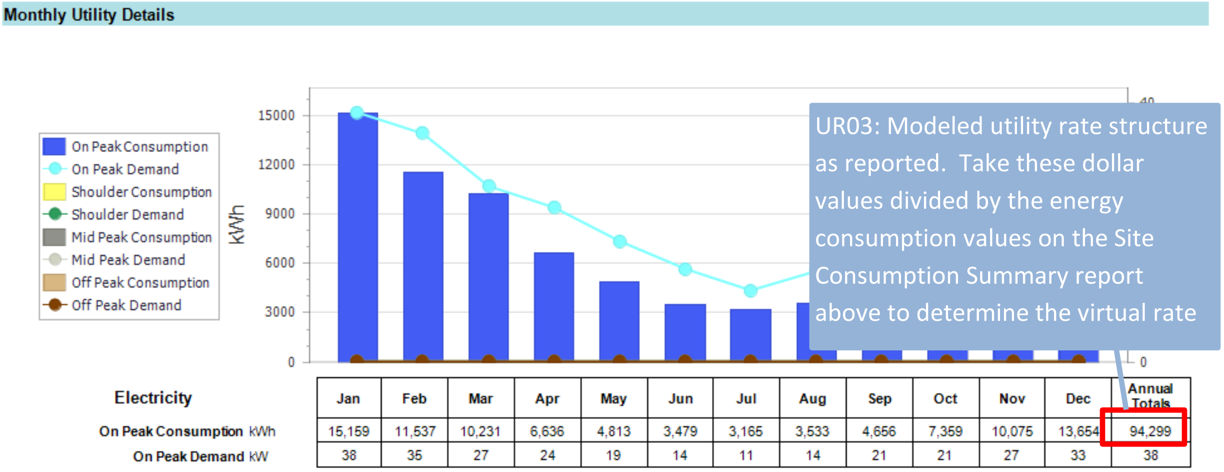
Monthly Energy End Use

	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0
Heat Rejection	2,218	1,204	362	69	19	23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,441	5,730
Heating	9,707	7,328	6,501	3,728	2,085	816	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8,909	53,145
Humidification	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0
Interior Equipment	405	370	414	396	411	400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	407	4,821
Interior Lights	485	457	542	486	523	520	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	489	5,982
Pumps	459	413	439	338	284	257	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	460	4,257
Water Systems	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0
Grand Total	15,158	11,536	10,230	6,636	4,813	3,479	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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 **Calculated at: Dec 05, 2019 - 02:24 PM**

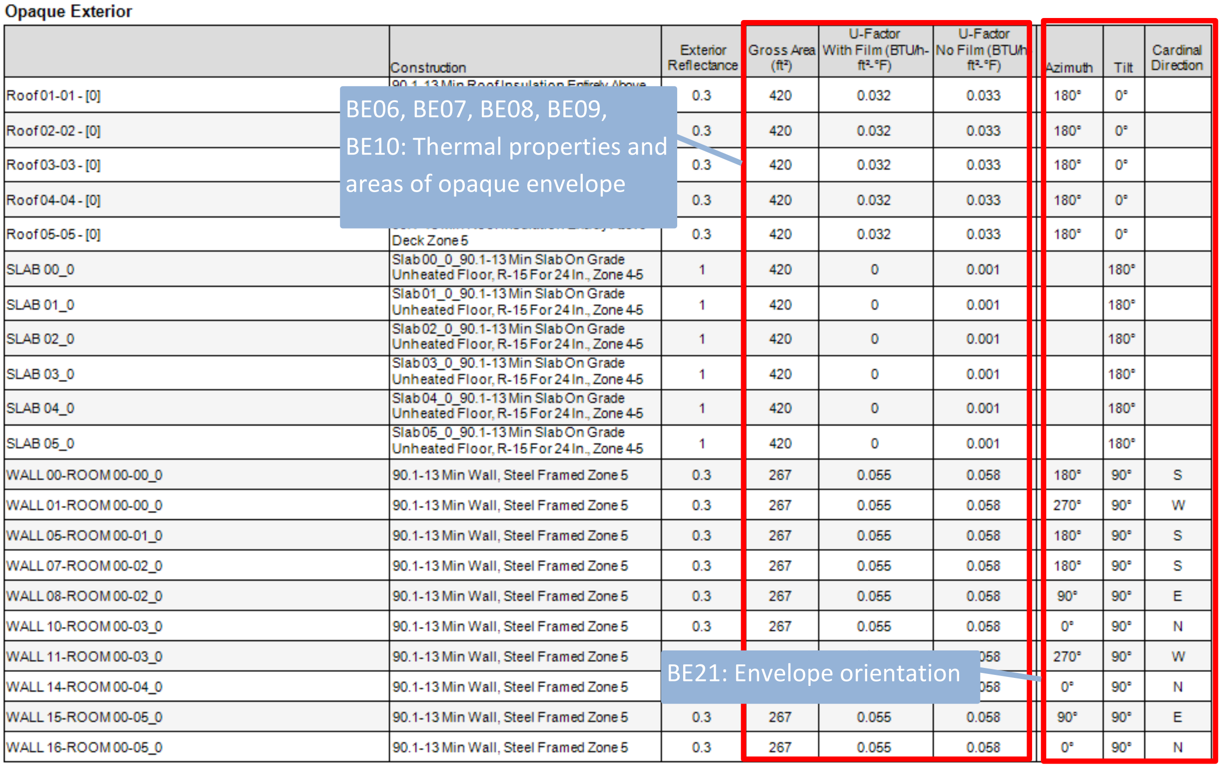
File name: **Baseline2.mdf** **TRACE™ 3D Plus 2.04.20.0** **Page 2 of 7**



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

Electricity	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Totals**
On Peak Consumption kWh	15,159	11,537	10,231	6,636	4,813	3,479	3,165	3,533	4,656	7,359	10,075	13,654	94,299
On Peak Demand kW	38	35	27	24	19	14	11	14	21	21	27	33	38



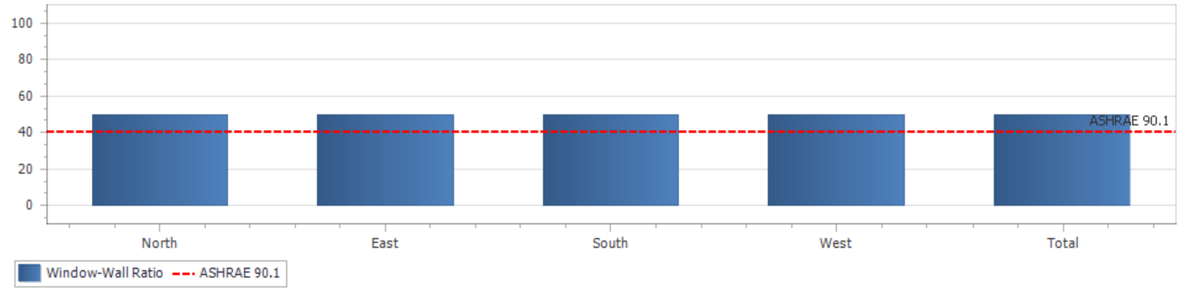
Opaque Exterior

	Construction	Exterior Reflectance	Gross Area (ft²)	U-Factor With Film (BTU/h-ft²-°F)	U-Factor No Film (BTU/h ft²-°F)	Azimuth	Tilt	Cardinal Direction
Roof 01-01 - [0]	90.1-13 Min Roof Insulation Entirely Above	0.3	420	0.032	0.033	180°	0°	
Roof 02-02 - [0]		0.3	420	0.032	0.033	180°	0°	
Roof 03-03 - [0]		0.3	420	0.032	0.033	180°	0°	
Roof 04-04 - [0]		0.3	420	0.032	0.033	180°	0°	
Roof 05-05 - [0]	Deck Zone 5	0.3	420	0.032	0.033	180°	0°	
SLAB 00_0	Slab 00_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	Slab 01_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	Slab 02_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	Slab 03_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	Slab 04_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	Slab 05_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				058	270°	90°	W
WALL 14-ROOM 00-04_0	90.1-13 Min Wall, Steel Framed Zone 5				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

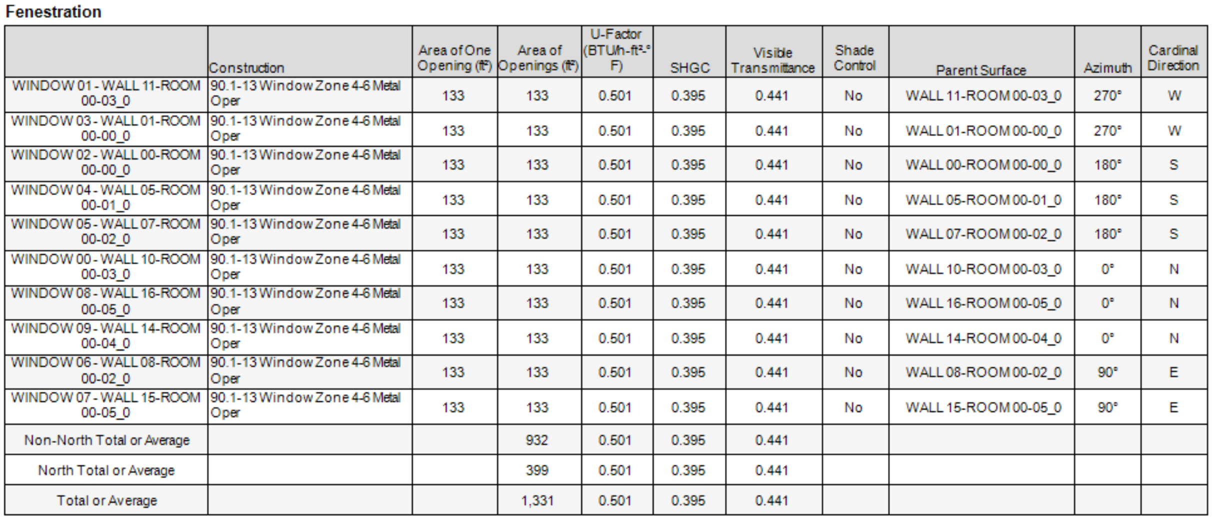
BE06, BE07, BE08, BE09, BE10: Thermal properties and areas of opaque envelope

BE21: Envelope orientation

Envelope Summary

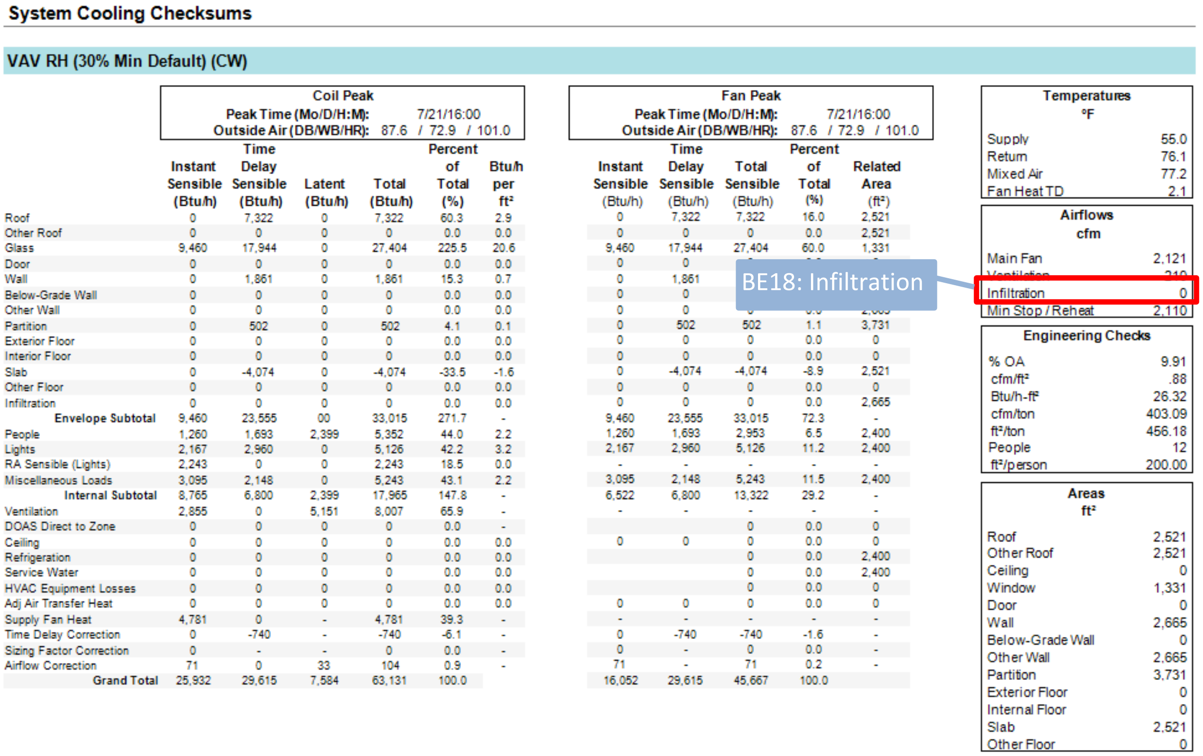


	North	East	South	West	Total
Gross Window-Wall Ratio	49.93	49.93	49.93	49.93	49.93



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

Peak Time (Mo/D/H:M): 7/21/16:00

Outside Air (DB/WB/HR): 87.6 / 72.9 / 101.0

	Instant Sensible (Btu/h)	Time Delay Sensible (Btu/h)	Latent (Btu/h)	Total (Btu/h)	Percent of Total (%)	Btu/h per ft²
Roof	0	7,322	0	7,322	60.3	2.9
Other Roof	0	0	0	0	0.0	0.0
Glass	9,460	17,944	0	27,404	225.5	20.6
Door	0	0	0	0	0.0	0.0
Wall	0	1,861	0	1,861	15.3	0.7
Below-Grade Wall	0	0	0	0	0.0	0.0
Other Wall	0	0	0	0	0.0	0.0
Partition	0	502	0	502	4.1	0.1
Exterior Floor	0	0	0	0	0.0	0.0
Interior Floor	0	0	0	0	0.0	0.0
Slab	0	-4,074	0	-4,074	-33.5	-1.6
Other Floor	0	0	0	0	0.0	0.0
Infiltration	0	0	0	0	0.0	0.0
Envelope Subtotal	9,460	23,555	00	33,015	271.7	-
People	1,260	1,693	2,399	5,352	44.0	2.2
Lights	2,167	2,960	0	5,126	42.2	3.2
RA Sensible (Lights)	2,243	0	0	2,243	18.5	0.0
Miscellaneous Loads	3,095	2,148	0	5,243	43.1	2.2
Internal Subtotal	8,765	6,800	2,399	17,965	147.8	-
Ventilation	2,855	0	5,151	8,007	65.9	-
DOAS Direct to Zone	0	0	0	0	0.0	-
Ceiling	0	0	0	0	0.0	0.0
Refrigeration	0	0	0	0	0.0	0.0
Service Water	0	0	0	0	0.0	0.0
HVAC Equipment Losses	0	0	0	0	0.0	0.0
Adj Air Transfer Heat	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	-
Sizing Factor Correction	0	-	-	0	0.0	-
Airflow Correction	71	0	33	104	0.9	-
Grand Total	25,932	29,615	7,584	63,131	100.0	

Fan Peak

Peak Time (Mo/D/H:M): 7/21/16:00

Outside Air (DB/WB/HR): 87.6 / 72.9 / 101.0

	Instant Sensible (Btu/h)	Time Delay Sensible (Btu/h)	Total Sensible (Btu/h)	Percent of Total (%)	Related Area (ft²)
Roof	0	7,322	7,322	16.0	2,521
Other Roof	0	0	0	0.0	2,521
Glass	9,460	17,944	27,404	60.0	1,331
Door	0	0	[illegible]	[illegible]	[illegible]
Wall	0	1,861	[illegible]	[illegible]	[illegible]
Below-Grade Wall	0	0	[illegible]	[illegible]	[illegible]
Other Wall	0	0	[illegible]	[illegible]	[illegible]
Partition	0	502	502	1.1	3,731
Exterior Floor	0	0	0	0.0	0
Interior Floor	0	0	0	0.0	0
Slab	0	-4,074	-4,074	-8.9	2,521
Other Floor	0	0	0	0.0	0
Infiltration	0	0	0	0.0	2,665
Envelope Subtotal	9,460	23,555	33,015	72.3	-
People	1,260	1,693	2,953	6.5	2,400
Lights	2,167	2,960	5,126	11.2	2,400
RA Sensible (Lights)	-	-	-	-	-
Miscellaneous Loads	3,095	2,148	5,243	11.5	2,400
Internal Subtotal	6,522	6,800	13,322	29.2	-
Ventilation	-	-	-	-	-
DOAS Direct to Zone			0	0.0	0
Ceiling	0	0	0	0.0	0
Refrigeration			0	0.0	2,400
Service Water			0	0.0	2,400
HVAC Equipment Losses			0	0.0	0
Adj Air Transfer Heat	0	0	0	0.0	0
Supply Fan Heat	-	-	-	-	-
Time Delay Correction	0	-740	-740	-1.6	-
Sizing Factor Correction	0	-	0	0.0	-
Airflow Correction	71	-	71	0.2	-
Grand Total	16,052	29,615	45,667	100.0	

Temperatures
°F

Supply	55.0
Return	76.1
Mixed Air	77.2
Fan Heat TD	2.1

Airflows
cfm

Main Fan	2,121
Ventilation	210
Infiltration	0
Min Stop / Reheat	2,110

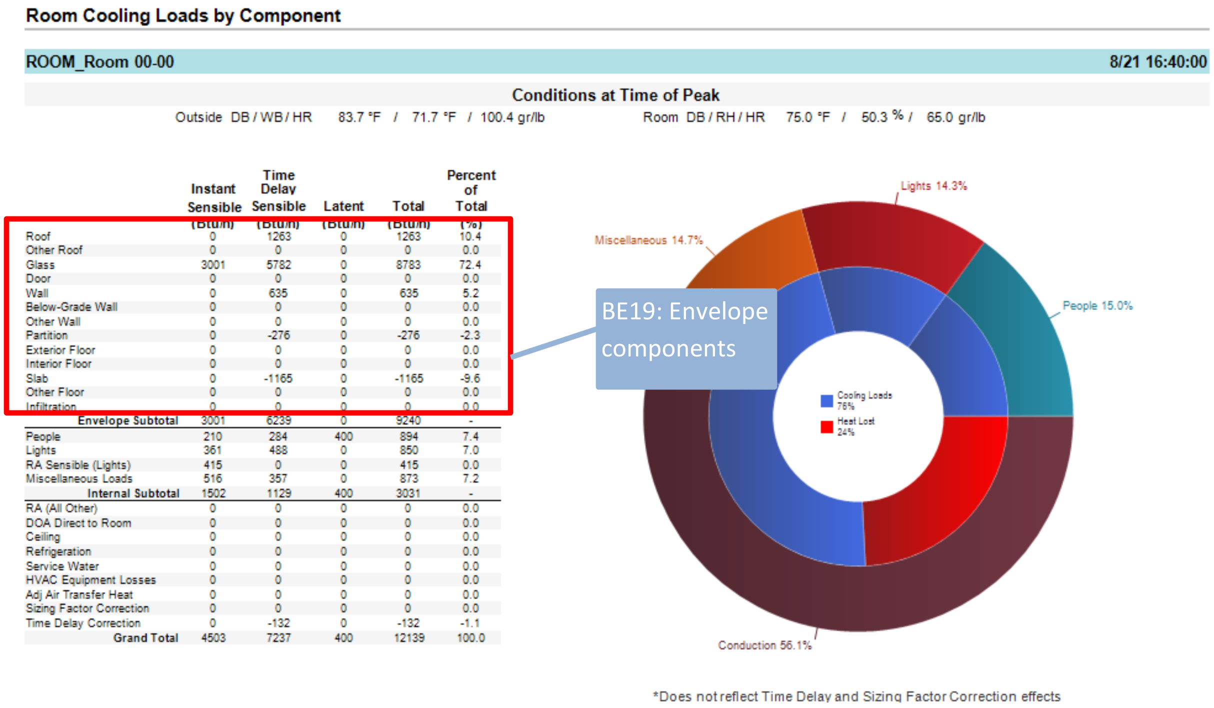
Engineering Checks

% 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
Internal Floor	0
Slab	2,521
Other Floor	0

BE18: Infiltration



Room Cooling Loads by Component

ROOM_Room 00-00 **8/21 16:40:00**

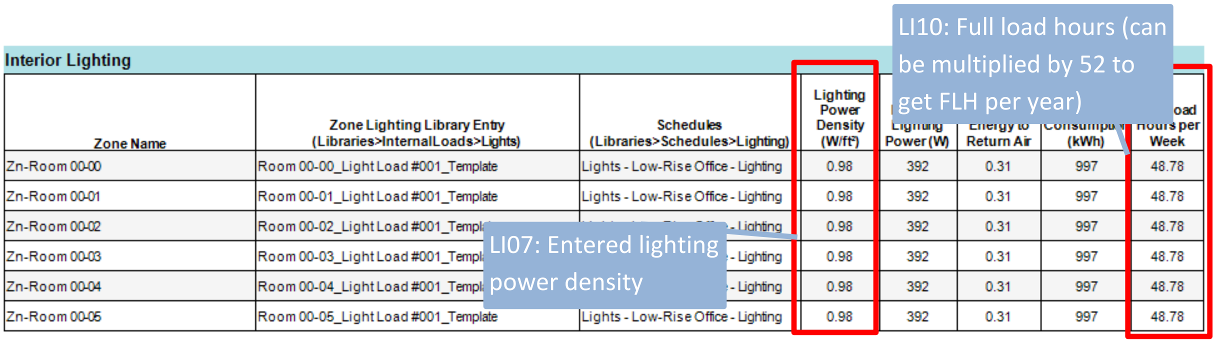
Conditions at Time of Peak

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	5782	0	8783	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	488	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

BE19: Envelope components

*Does not reflect Time Delay and Sizing Factor Correction effects

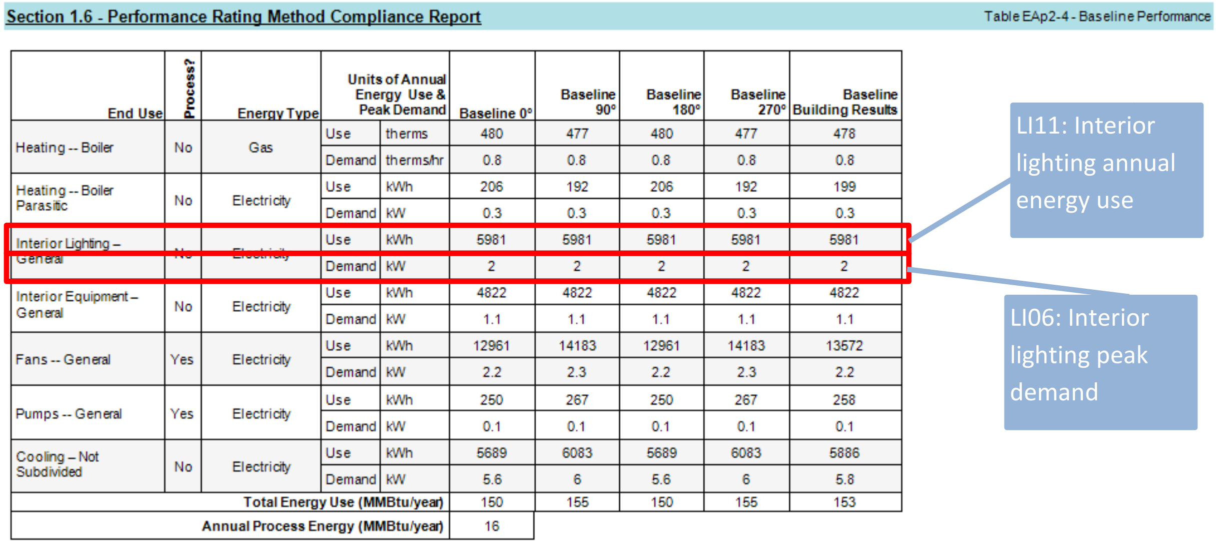


Interior Lighting

LI10: Full load hours (can be multiplied by 52 to get FLH per year)

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	Consumpti (kWh)	oad 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_Templ	- Lighting	0.98	392	0.31	997	48.78
Zn-Room 00-03	Room 00-03_Light Load #001_Templ	- Lighting	0.98	392	0.31	997	48.78
Zn-Room 00-04	Room 00-04_Light Load #001_Templ	- 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

LI07: Entered lighting power density



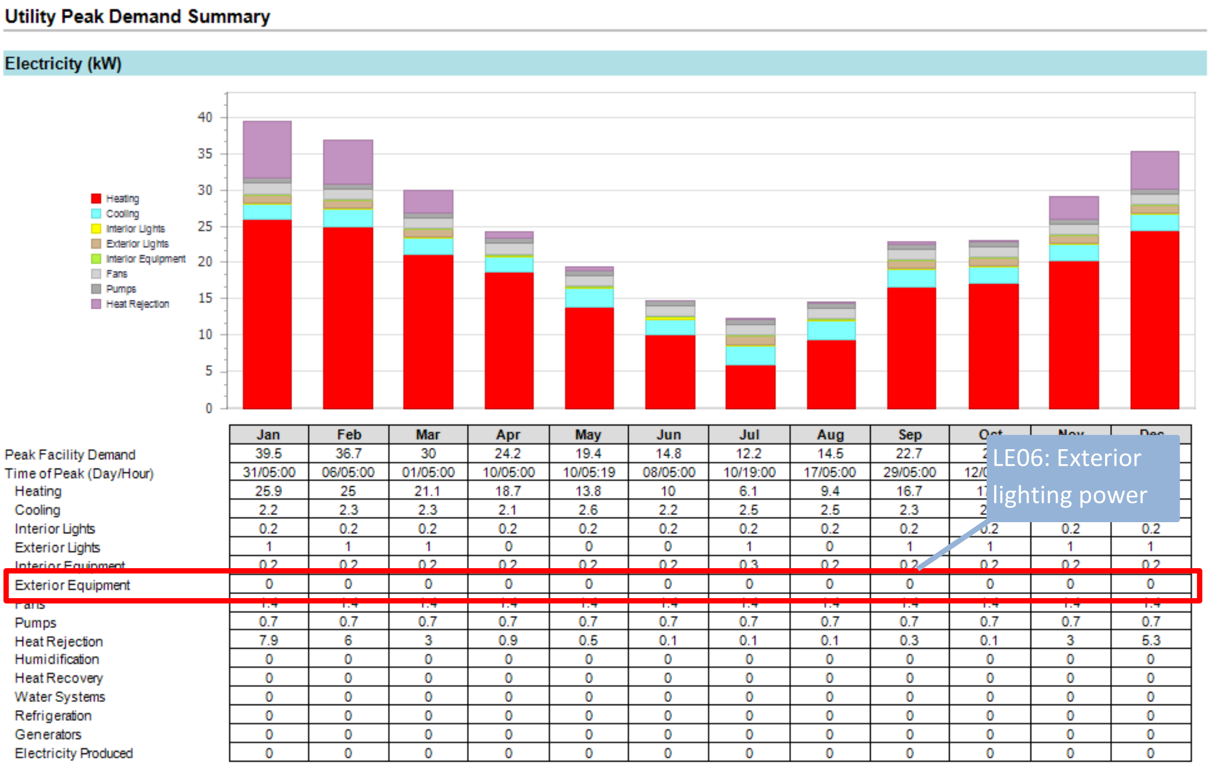
Section 1.6 - Performance Rating Method Compliance Report

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
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	2	[illegible]	[illegible]
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	12/0	[illegible]	[illegible]
Heating	25.9	25	21.1	18.7	13.8	10	6.1	9.4	16.7	17	[illegible]	[illegible]
Cooling	2.2	2.3	2.3	2.1	2.6	2.2	2.5	2.5	2.3	2	[illegible]	[illegible]
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	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
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

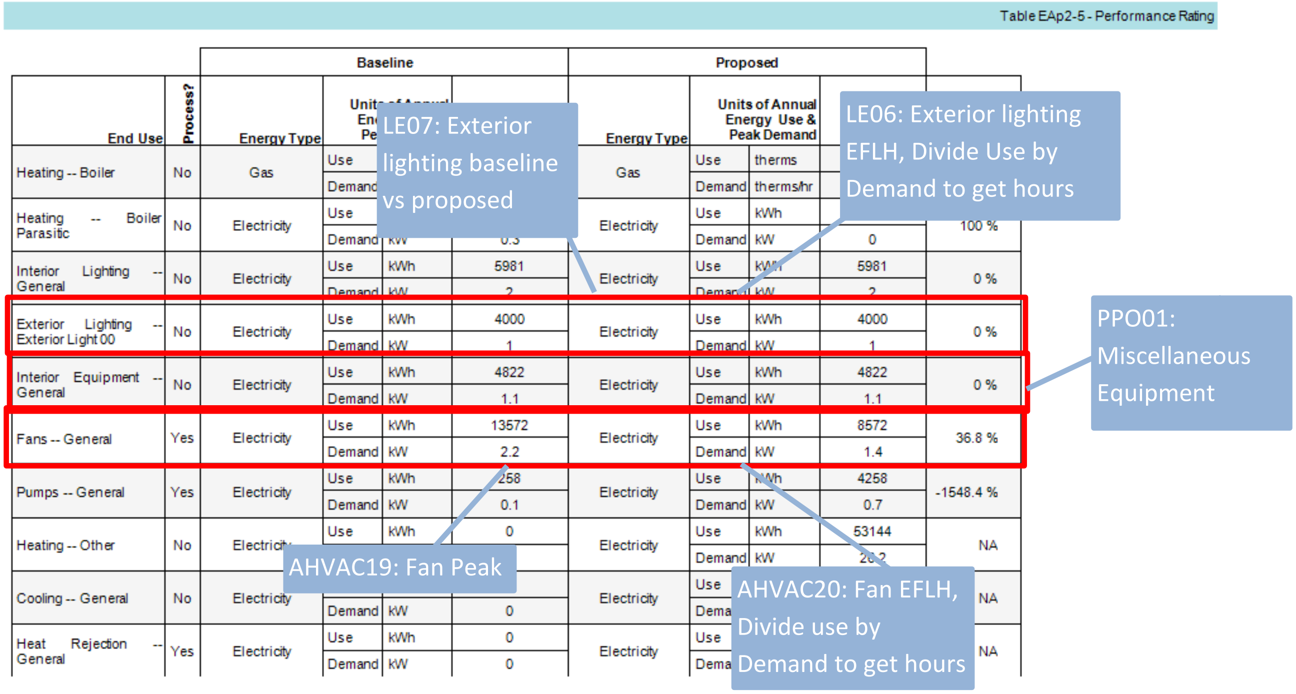
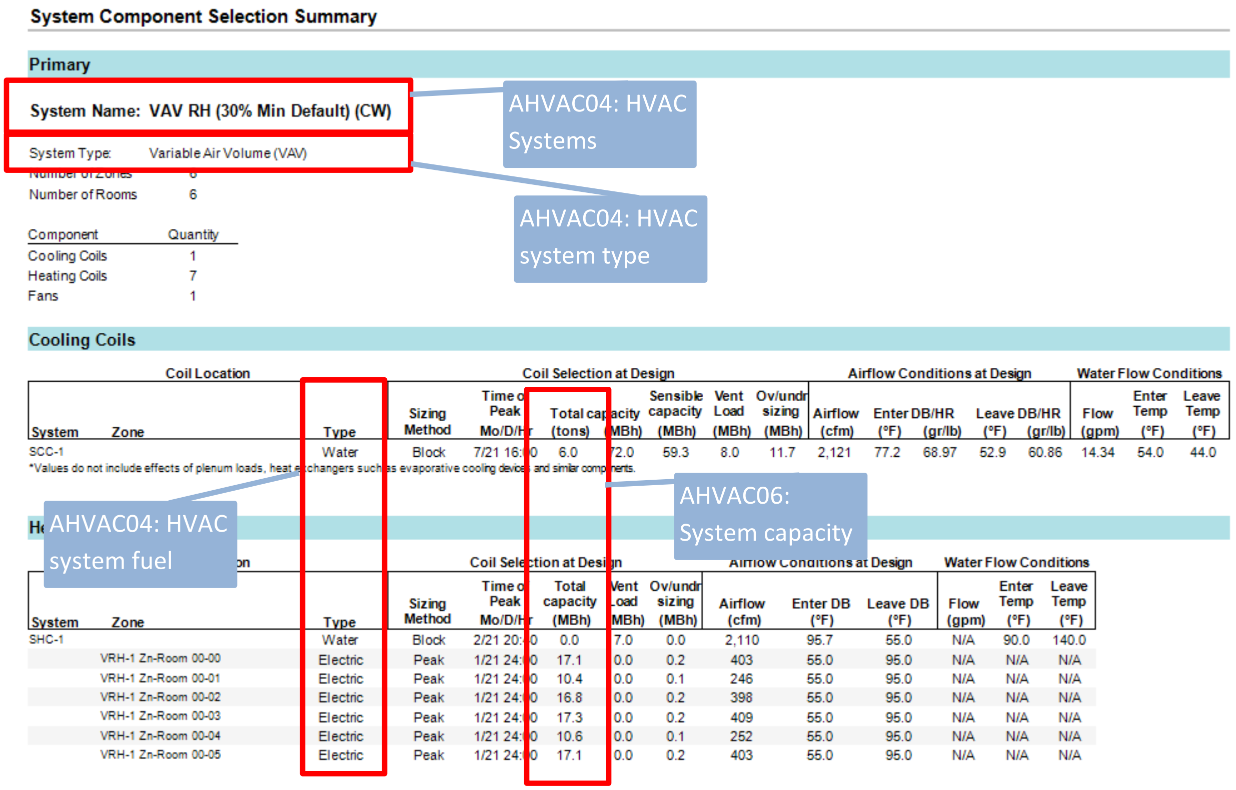


Table EAp2-5 - Performance Rating

End Use	Process?	Baseline Energy Type	Baseline Units of Annual En[illegible] Pe[illegible]			Proposed Energy Type	Proposed Units of Annual Energy Use & Peak Demand			
Heating -- Boiler	No	Gas	Use	[illegible]	[illegible]	Gas	Use	therms	[illegible]	[illegible]
			Demand	[illegible]	[illegible]		Demand	therms/hr	[illegible]	
Heating -- Boiler Parasitic	No	Electricity	Use	[illegible]	[illegible]	Electricity	Use	kWh	[illegible]	100 %
			Demand	kW	0.3		Demand	kW	0	
Interior Lighting -- General	No	Electricity	Use	kWh	5981	Electricity	Use	kWh	5981	0 %
			Demand	kW	2		Demand	kW	2	
Exterior Lighting -- Exterior Light 00	No	Electricity	Use	kWh	4000	Electricity	Use	kWh	4000	0 %
			Demand	kW	1		Demand	kW	1	
Interior Equipment -- General	No	Electricity	Use	kWh	4822	Electricity	Use	kWh	4822	0 %
			Demand	kW	1.1		Demand	kW	1.1	
Fans -- General	Yes	Electricity	Use	kWh	13572	Electricity	Use	kWh	8572	36.8 %
			Demand	kW	2.2		Demand	kW	1.4	
Pumps -- General	Yes	Electricity	Use	kWh	258	Electricity	Use	kWh	4258	-1548.4 %
			Demand	kW	0.1		Demand	kW	0.7	
Heating -- Other	No	Electricity	Use	kWh	0	Electricity	Use	kWh	53144	NA
			[illegible]	[illegible]	[illegible]		Demand	kW	[illegible]	
Cooling -- General	No	Electricity	[illegible]	[illegible]	[illegible]	Electricity	Use	[illegible]	[illegible]	NA
			Demand	kW	0		Dema	[illegible]	[illegible]	
Heat Rejection -- General	Yes	Electricity	Use	kWh	0	Electricity	Use	[illegible]	[illegible]	NA
			Demand	kW	0		Dema	[illegible]	[illegible]	



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

Cooling Coils

Coil Location			Coil Selection at Design						Airflow Conditions at Design					Water Flow Conditions		
System	Zone	Type	Sizing Method	Time o Peak Mo/D/Hr	Total capacity (tons)	(MBh)	Sensible capacity (MBh)	Vent Load (MBh)	Ov/undr sizing (MBh)	Airflow (cfm)	Enter DB/HR (°F)	(gr/lb)	Leave DB/HR (°F)	(gr/lb)	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.

He

Coil Location			Coil Selection at Design					Airflow Conditions at Design			Water Flow Conditions		
System	Zone	Type	Sizing Method	Time o Peak Mo/D/Hr	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

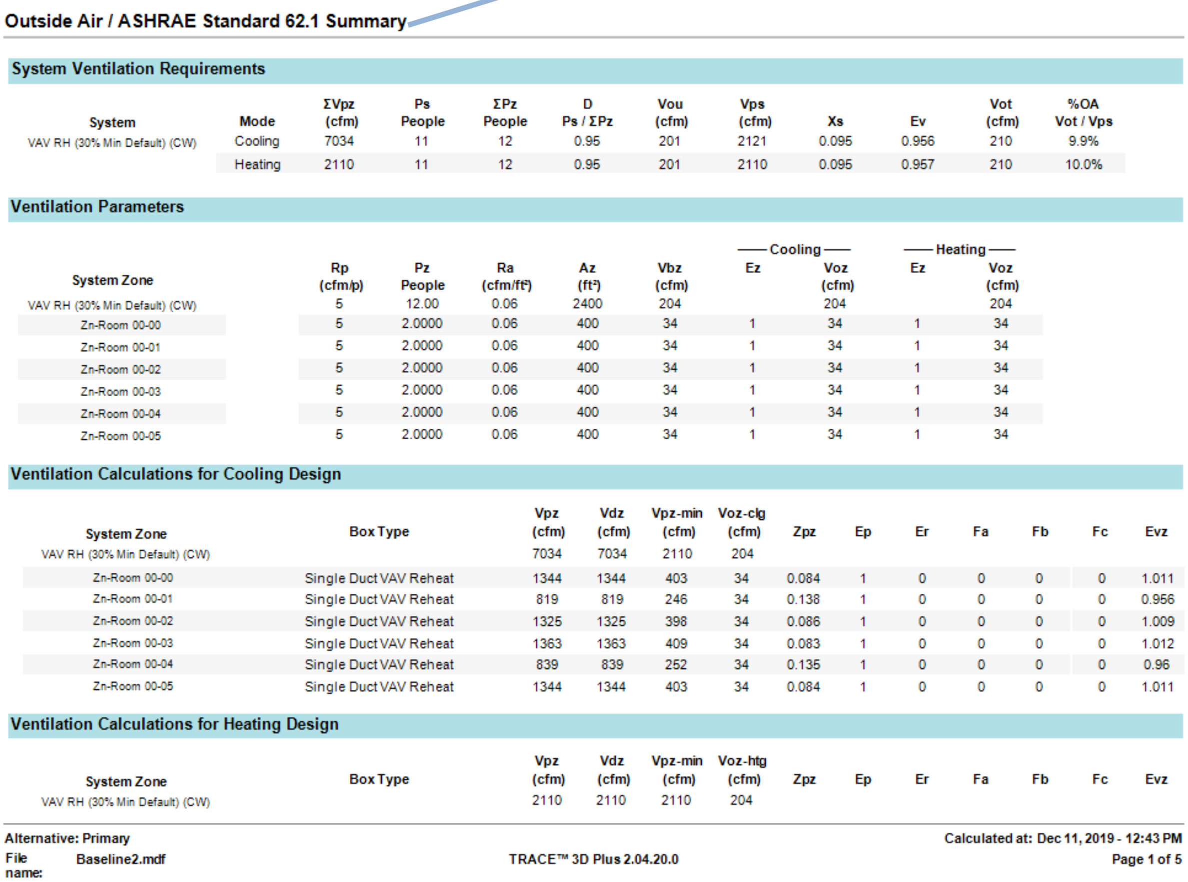
Plant Equipment

Name	Type	Nominal Capacity (MBh)	Efficiency (%)
Single Boiler CV BO-1	Boiler:HotWater	0.00	82.0

Site Load Profile

	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

AHVAC26



Outside Air / ASHRAE Standard 62.1 Summary

System Ventilation Requirements

System	Mode	ΣVpz (cfm)	Ps People	ΣPz People	D Ps / ΣPz	Vou (cfm)	Vps (cfm)	Xs	Ev	Vot (cfm)	%OA Vot / Vps
VAV RH (30% Min Default) (CW)	Cooling	7034	11	12	0.95	201	2121	0.095	0.956	210	9.9%
	Heating	2110	11	12	0.95	201	2110	0.095	0.957	210	10.0%

Ventilation Parameters

System Zone	Rp (cfm/p)	Pz People	Ra (cfm/ft²)	Az (ft²)	Vbz (cfm)	Cooling Ez	Cooling Voz (cfm)	Heating Ez	Heating Voz (cfm)
VAV RH (30% Min Default) (CW)	5	12.00	0.06	2400	204		204		204
Zn-Room 00-00	5	2.0000	0.06	400	34	1	34	1	34
Zn-Room 00-01	5	2.0000	0.06	400	34	1	34	1	34
Zn-Room 00-02	5	2.0000	0.06	400	34	1	34	1	34
Zn-Room 00-03	5	2.0000	0.06	400	34	1	34	1	34
Zn-Room 00-04	5	2.0000	0.06	400	34	1	34	1	34
Zn-Room 00-05	5	2.0000	0.06	400	34	1	34	1	34

Ventilation Calculations for Cooling Design

System Zone	Box Type	Vpz (cfm)	Vdz (cfm)	Vpz-min (cfm)	Voz-clg (cfm)	Zpz	Ep	Er	Fa	Fb	Fc	Evz
VAV RH (30% Min Default) (CW)		7034	7034	2110	204							
Zn-Room 00-00	Single Duct VAV Reheat	1344	1344	403	34	0.084	1	0	0	0	0	1.011
Zn-Room 00-01	Single Duct VAV Reheat	819	819	246	34	0.138	1	0	0	0	0	0.956
Zn-Room 00-02	Single Duct VAV Reheat	1325	1325	398	34	0.086	1	0	0	0	0	1.009
Zn-Room 00-03	Single Duct VAV Reheat	1363	1363	409	34	0.083	1	0	0	0	0	1.012
Zn-Room 00-04	Single Duct VAV Reheat	839	839	252	34	0.135	1	0	0	0	0	0.96
Zn-Room 00-05	Single Duct VAV Reheat	1344	1344	403	34	0.084	1	0	0	0	0	1.011

Ventilation Calculations for Heating Design

System Zone	Box Type	Vpz (cfm)	Vdz (cfm)	Vpz-min (cfm)	Voz-htg (cfm)	Zpz	Ep	Er	Fa	Fb	Fc	Evz
VAV RH (30% Min Default) (CW)		2110	2110	2110	204							

Alternative: Primary

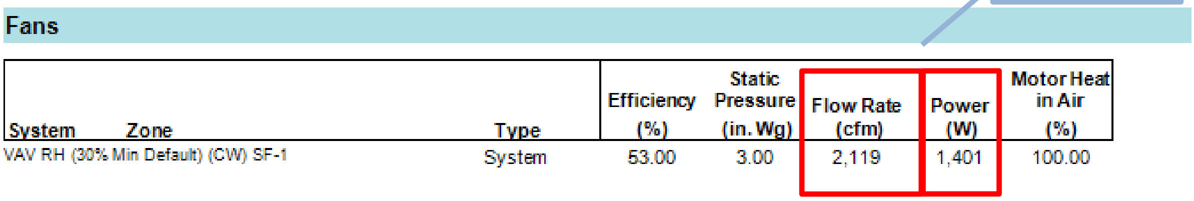
Calculated at: Dec 11, 2019 - 12:43 PM

File name: Baseline2.mdf

TRACE™ 3D Plus 2.04.20.0

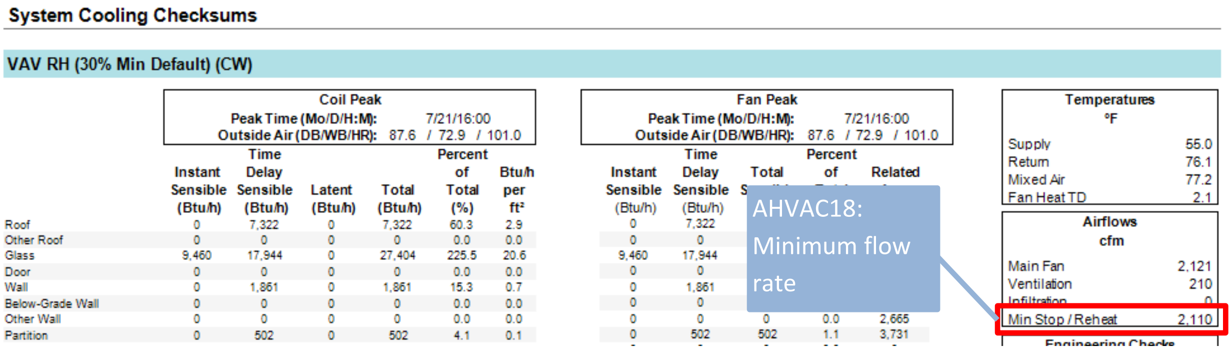
Page 1 of 5

AHVAC18: Fan power and full load rate



Fans

System	Zone	Type	Efficiency (%)	Static Pressure (in. Wg)	Flow Rate (cfm)	Power (W)	Motor Heat in Air (%)
VAV RH (30% Min Default) (CW)	SF-1	System	53.00	3.00	2,119	1,401	100.00



System Cooling Checksums

VAV RH (30% Min Default) (CW)

Coil Peak

Peak Time (Mo/D/H:M): 7/21/16:00

Outside Air (DB/WB/HR): 87.6 / 72.9 / 101.0

	Instant Sensible (Btu/h)	Time Delay Sensible (Btu/h)	Latent (Btu/h)	Total (Btu/h)	Percent of Total (%)	Btu/h per ft²
Roof	0	7,322	0	7,322	60.3	2.9
Other Roof	0	0	0	0	0.0	0.0
Glass	9,460	17,944	0	27,404	225.5	20.6
Door	0	0	0	0	0.0	0.0
Wall	0	1,861	0	1,861	15.3	0.7
Below-Grade Wall	0	0	0	0	0.0	0.0
Other Wall	0	0	0	0	0.0	0.0
Partition	0	502	0	502	4.1	0.1

Fan Peak

Peak Time (Mo/D/H:M): 7/21/16:00

Outside Air (DB/WB/HR): 87.6 / 72.9 / 101.0

Instant Sensible (Btu/h)	Time Delay Sensible (Btu/h)	Total S	Percent of	Related
0	7,322	[illegible]	[illegible]	[illegible]
0	0	[illegible]	[illegible]	[illegible]
9,460	17,944	[illegible]	[illegible]	[illegible]
0	0	[illegible]	[illegible]	[illegible]
0	1,861	[illegible]	[illegible]	[illegible]
0	0	[illegible]	[illegible]	[illegible]
0	0	0	0.0	2,665
0	502	502	1.1	3,731

AHVAC18: Minimum flow rate

Temperatures °F

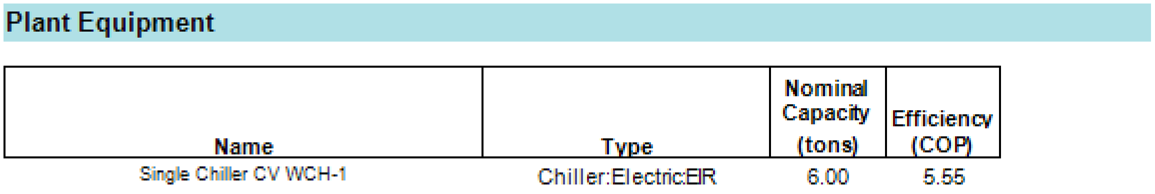
Supply	55.0
Return	76.1
Mixed Air	77.2
Fan Heat TD	2.1

Airflows cfm

Main Fan	2,121
Ventilation	210
Infiltration	0
Min Stop / Reheat	2,110

Engineering Checks

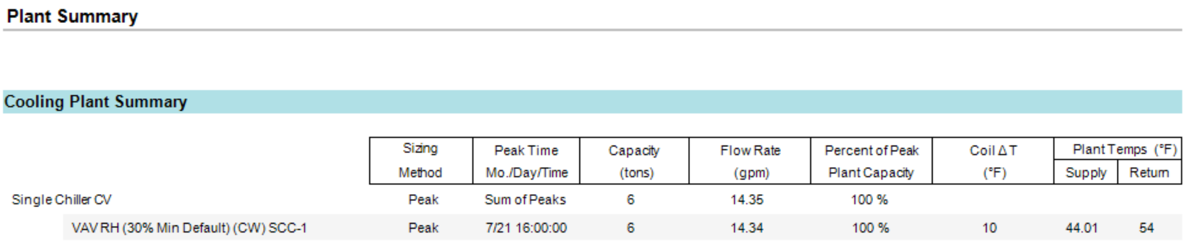
WHVAC02



Plant Equipment

Name	Type	Nominal Capacity (tons)	Efficiency (COP)
Single Chiller CV WCH-1	Chiller:Electric:EIR	6.00	5.55

WHVAC05, WHVAC08

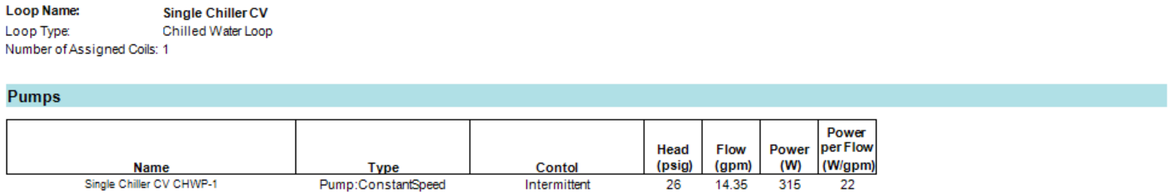


Plant Summary

Cooling Plant Summary

	Sizing Method	Peak Time Mo./Day/Time	Capacity (tons)	Flow Rate (gpm)	Percent of Peak Plant Capacity	Coil Δ T (°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

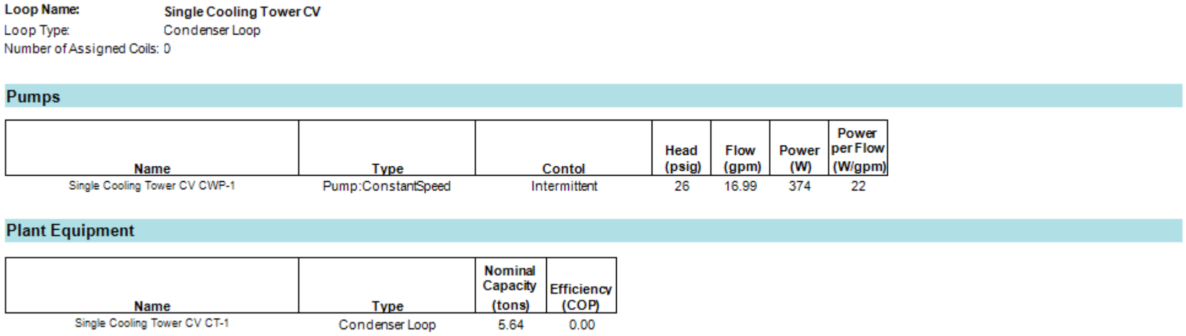


Loop Name: **Single Chiller CV**
Loop Type: Chilled Water Loop
Number of Assigned Coils: 1

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

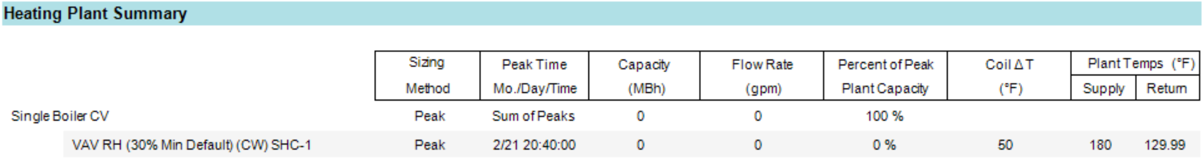
Name	Type	Contol	Head (psig)	Flow (gpm)	Power (W)	Power per Flow (W/gpm)
Single Cooling Tower CV CWP-1	Pump:ConstantSpeed	Intermittent	26	16.99	374	22

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

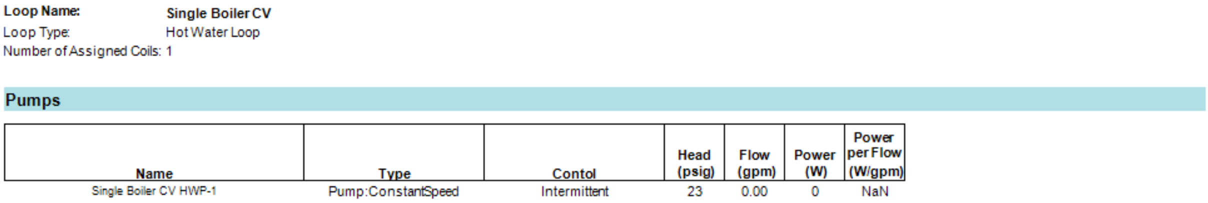


Heating Plant Summary

	Sizing Method	Peak Time Mo./Day/Time	Capacity (MBh)	Flow Rate (gpm)	Percent of Peak Plant Capacity	Coil ΔT (°F)	Plant Temps (°F) Supply	Plant Temps (°F) 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	Contol	Head (psig)	Flow (gpm)	Power (W)	Power per Flow (W/gpm)
Single Boiler CV HWP-1	Pump:ConstantSpeed	Intermittent	23	0.00	0	NaN

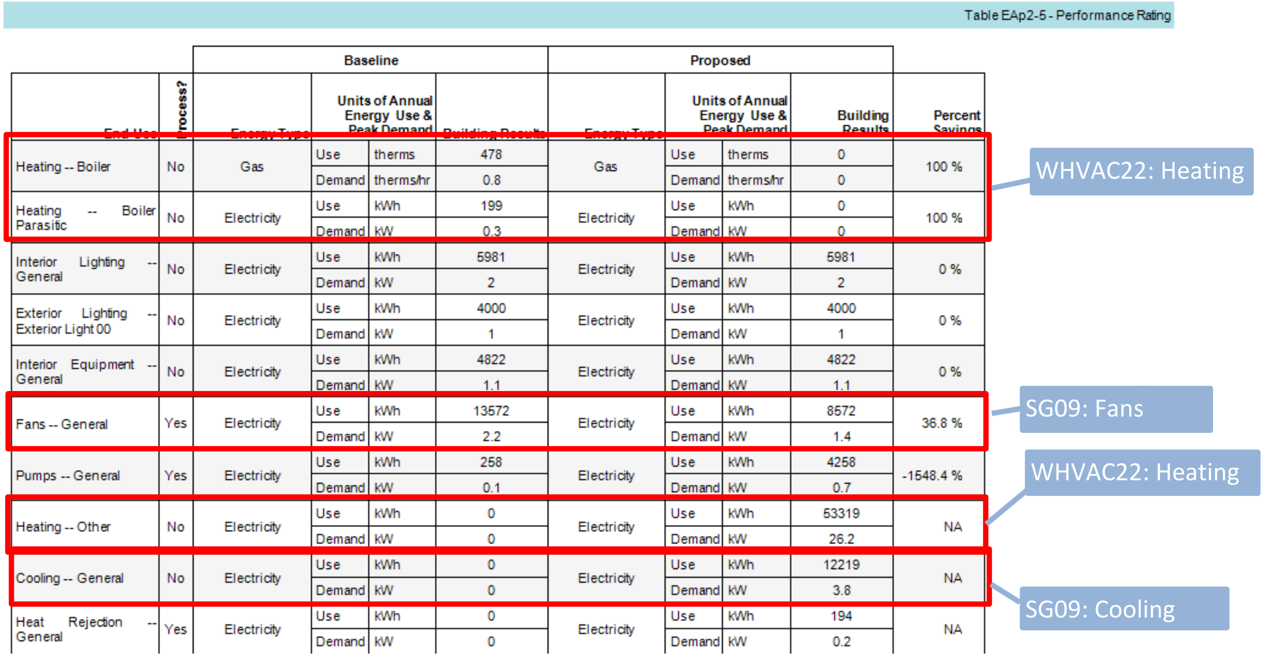


Table EAp2-5 - Performance Rating

		Baseline				Proposed				
End Use	Process?	Energy Type	Units of Annual Energy Use & Peak Demand		Building Results	Energy Type	Units of Annual Energy Use & Peak Demand		Building Results	Percent Savings
Heating -- Boiler	No	Gas	Use	therms	478	Gas	Use	therms	0	100 %
			Demand	therms/hr	0.8		Demand	therms/hr	0	
Heating -- Boiler Parasitic	No	Electricity	Use	kWh	199	Electricity	Use	kWh	0	100 %
			Demand	kW	0.3		Demand	kW	0	
Interior Lighting -- General	No	Electricity	Use	kWh	5981	Electricity	Use	kWh	5981	0 %
			Demand	kW	2		Demand	kW	2	
Exterior Lighting -- Exterior Light 00	No	Electricity	Use	kWh	4000	Electricity	Use	kWh	4000	0 %
			Demand	kW	1		Demand	kW	1	
Interior Equipment -- General	No	Electricity	Use	kWh	4822	Electricity	Use	kWh	4822	0 %
			Demand	kW	1.1		Demand	kW	1.1	
Fans -- General	Yes	Electricity	Use	kWh	13572	Electricity	Use	kWh	8572	36.8 %
			Demand	kW	2.2		Demand	kW	1.4	
Pumps -- General	Yes	Electricity	Use	kWh	258	Electricity	Use	kWh	4258	-1548.4 %
			Demand	kW	0.1		Demand	kW	0.7	
Heating -- Other	No	Electricity	Use	kWh	0	Electricity	Use	kWh	53319	NA
			Demand	kW	0		Demand	kW	26.2	
Cooling -- General	No	Electricity	Use	kWh	0	Electricity	Use	kWh	12219	NA
			Demand	kW	0		Demand	kW	3.8	
Heat Rejection -- General	Yes	Electricity	Use	kWh	0	Electricity	Use	kWh	194	NA
			Demand	kW	0		Demand	kW	0.2	

Trane TRACE 700

Resources

4. Searchable database of documentation on various topics[26]: 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 topics [27], 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

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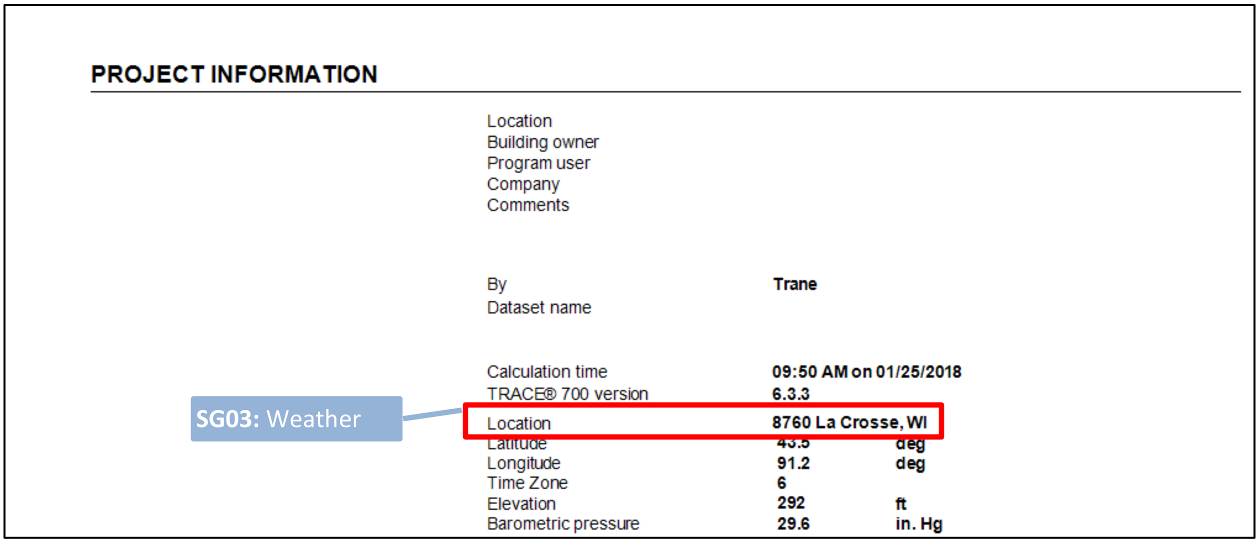
[26] https://irtranecds.custhelp.com/app/answers/list

[27] https://irtranecds.custhelp.com/app/e_learning

Annotated Reports

Title Page Report



PROJECT INFORMATION

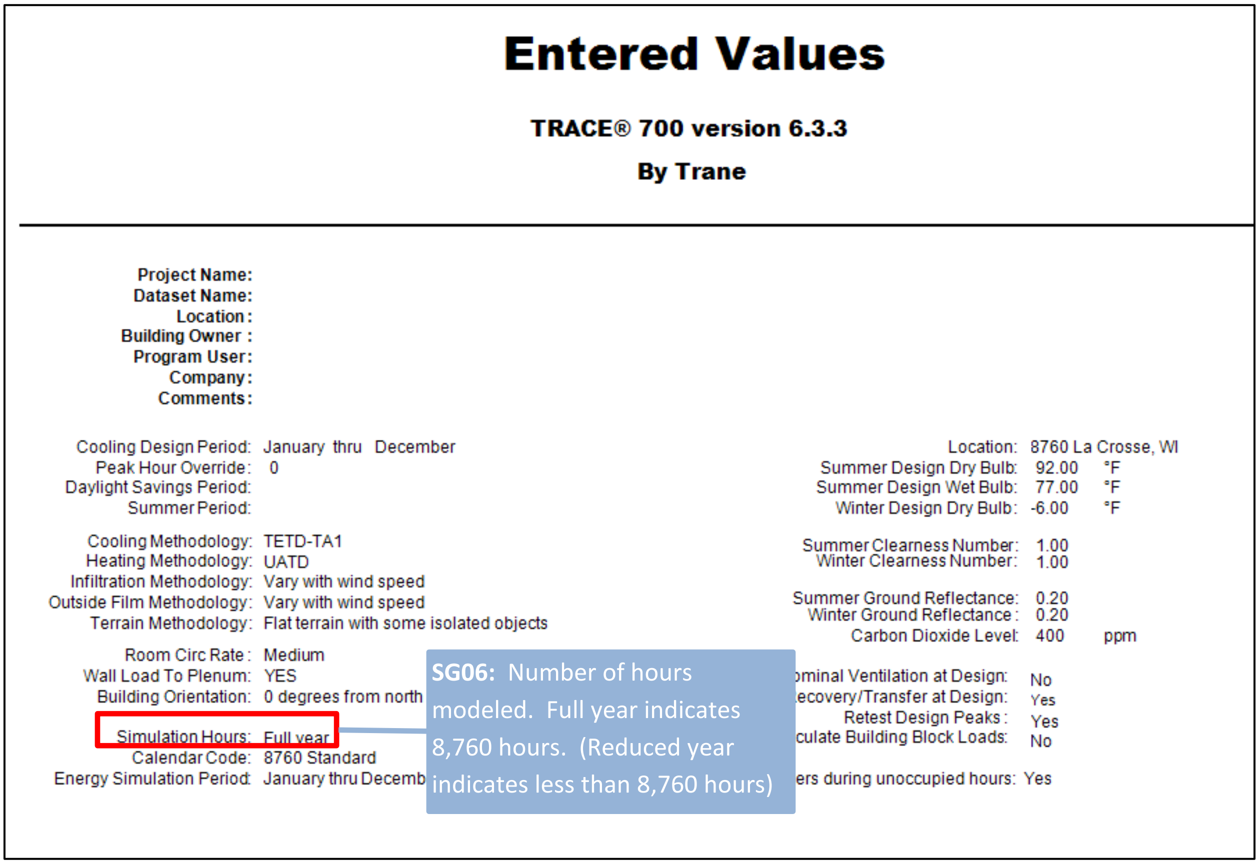
Location
Building owner
Program user
Company
Comments

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 Decemb

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

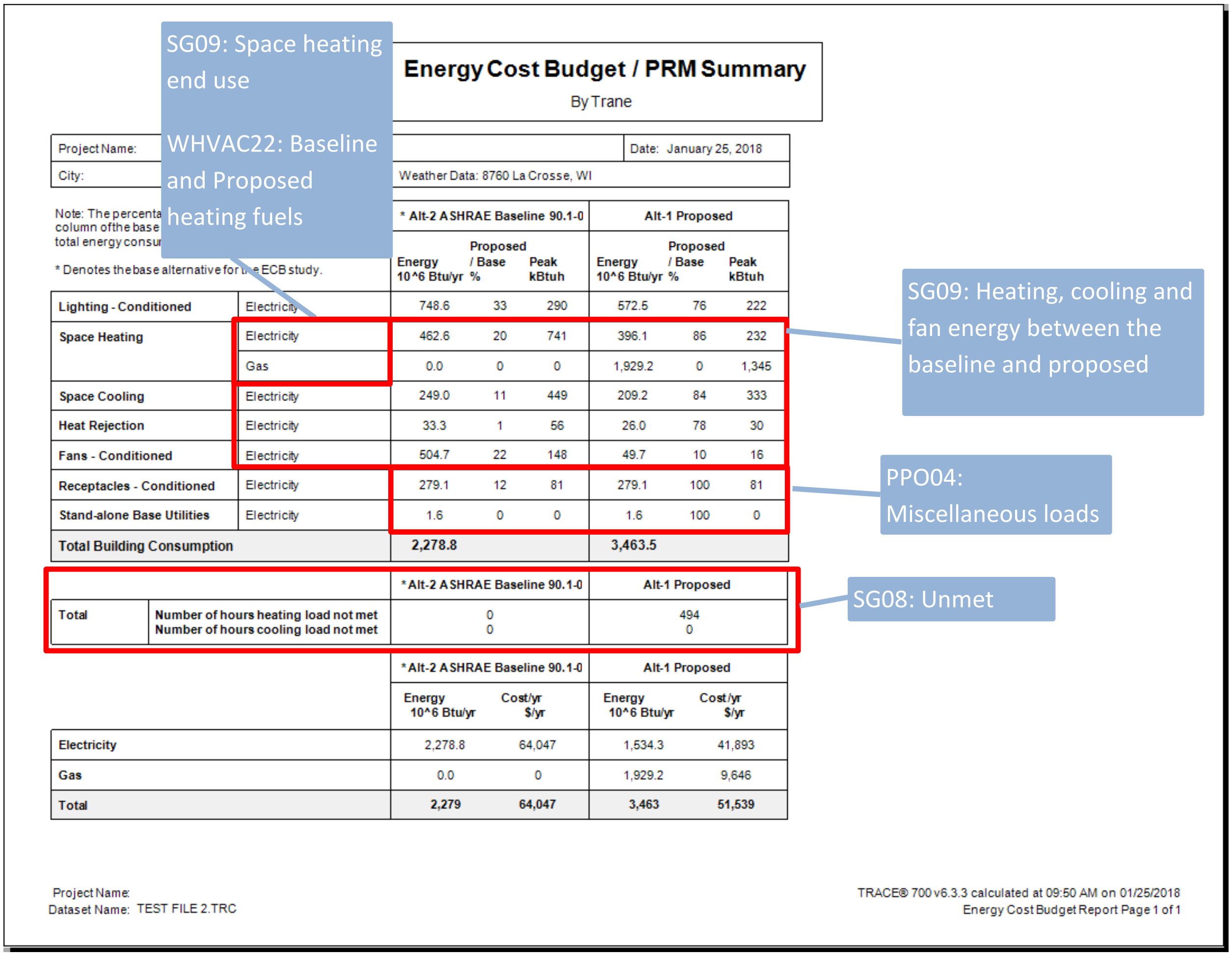
Summer Ground Reflectance: 0.20
Winter Ground Reflectance : 0.20
Carbon Dioxide Level: 400 ppm

ominal Ventilation at Design: No
ecovery/Transfer at Design: Yes
Retest Design Peaks : Yes
culate Building Block Loads: No

ers 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



SG09: Space heating end use

WHVAC22: Baseline and Proposed heating fuels

SG09: Heating, cooling and fan energy between the baseline and proposed

PPO04: Miscellaneous loads

SG08: Unmet

Energy Cost Budget / PRM Summary

By Trane

Project Name:

Date: January 25, 2018

City:

Weather Data: 8760 La Crosse, WI

Note: The percenta
column of the base
total energy consu

* Denotes the base alternative for the ECB study.

		* Alt-2 ASHRAE Baseline 90.1-0			Alt-1 Proposed		
		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**		

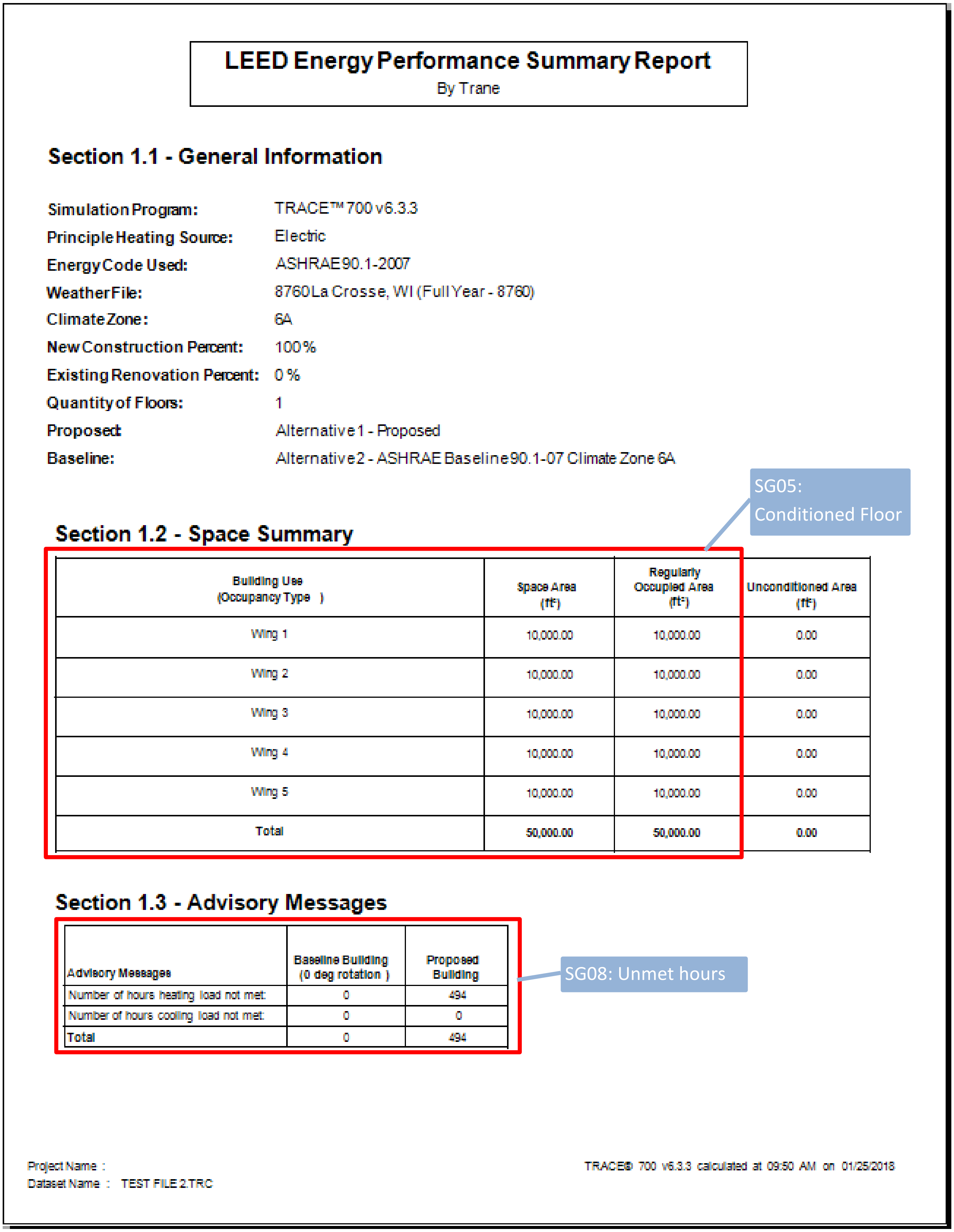
		* Alt-2 ASHRAE Baseline 90.1-0	Alt-1 Proposed
Total	**Number of hours heating load not met**	0	494
	Number of hours cooling load not met	0	0

	* 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**

Project Name:
Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
Energy Cost Budget Report Page 1 of 1

LEED Summary report



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

Section 1.2 - Space Summary

SG05: Conditioned Floor

Building Use (Occupancy Type)	Space Area (ft²)	Regularly Occupied Area (ft²)	Unconditioned Area (ft²)
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**

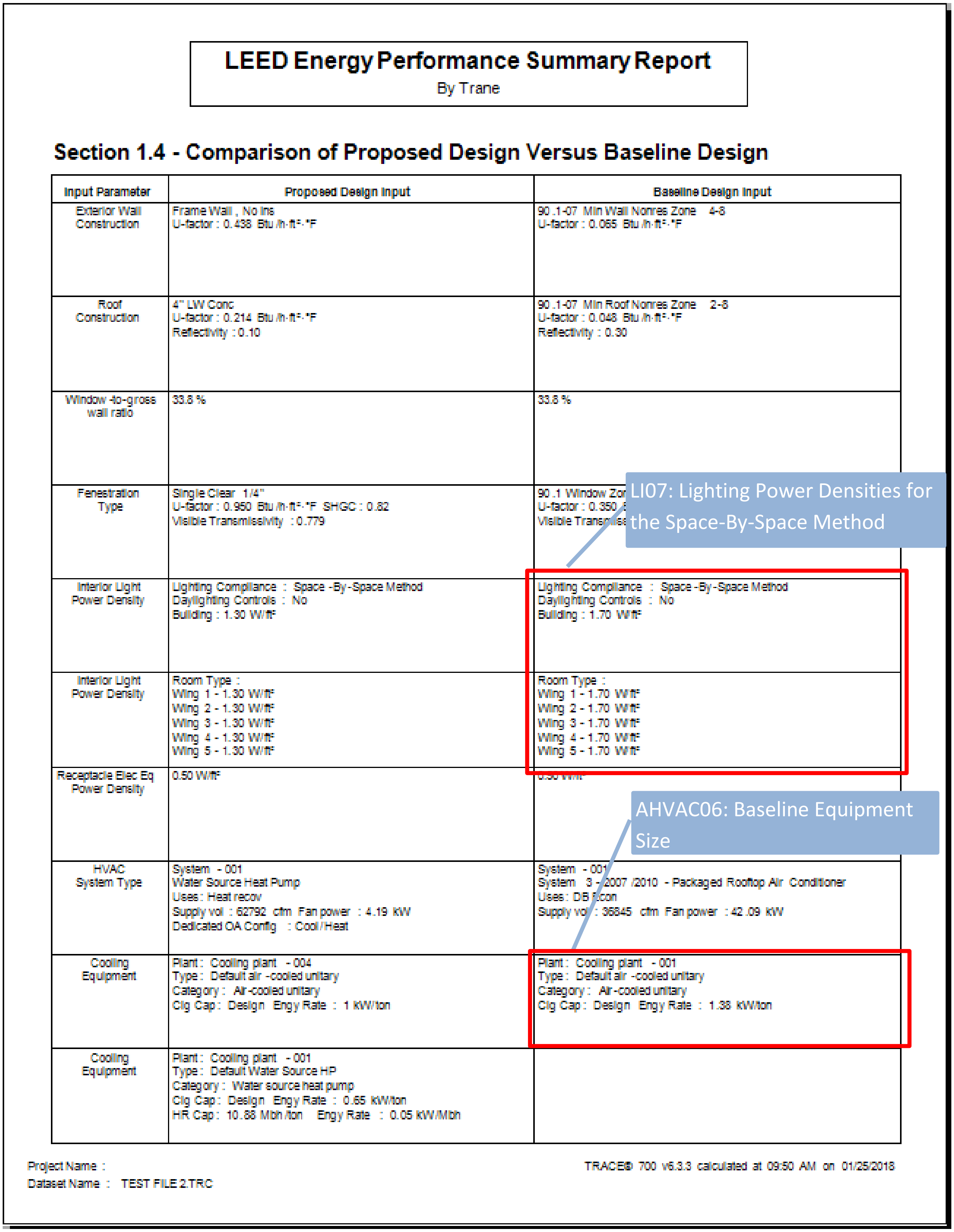
Section 1.3 - Advisory Messages

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

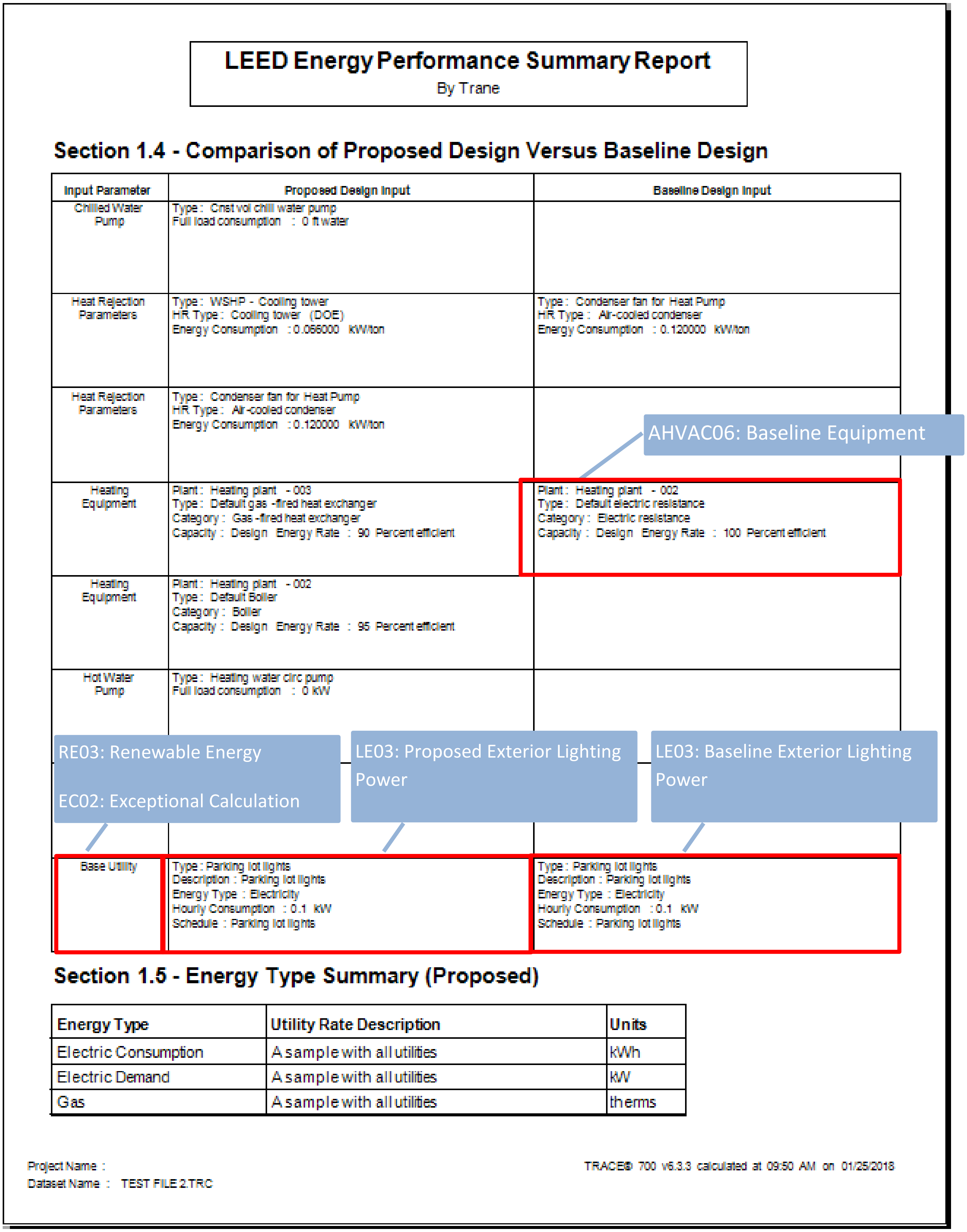
Input Parameter	Proposed Design Input	Baseline Design Input
Exterior Wall Construction	Frame Wall , No Ins U-factor : 0.438 Btu /h·ft²·°F	90 .1-07 Min Wall Nonres Zone 4-8 U-factor : 0.065 Btu /h·ft²·°F
Roof Construction	4" LW Conc U-factor : 0.214 Btu /h·ft²·°F Reflectivity : 0.10	90 .1-07 Min Roof Nonres Zone 2-8 U-factor : 0.048 Btu /h·ft²·°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·ft²·°F SHGC : 0.82 Visible Transmissivity : 0.779	90 .1 Window Zor U-factor : 0.350 Visible Transmiss
Interior Light Power Density	Lighting Compliance : Space -By-Space Method Daylighting Controls : No Building : 1.30 W/ft²	Lighting Compliance : Space -By-Space Method Daylighting Controls : No Building : 1.70 W/ft²
Interior Light Power Density	Room Type : Wing 1 - 1.30 W/ft² Wing 2 - 1.30 W/ft² Wing 3 - 1.30 W/ft² Wing 4 - 1.30 W/ft² Wing 5 - 1.30 W/ft²	Room Type : Wing 1 - 1.70 W/ft² Wing 2 - 1.70 W/ft² Wing 3 - 1.70 W/ft² Wing 4 - 1.70 W/ft² Wing 5 - 1.70 W/ft²
Receptacle Elec Eq Power Density	0.50 W/ft²	0.50 W/ft²
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 Econ 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 Mbh /ton Engy Rate : 0.05 kW/Mbh	

Project Name :
Dataset Name : TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018

LI07: Lighting Power Densities for the Space-By-Space Method

AHVAC06: Baseline Equipment Size



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 : Cnst 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

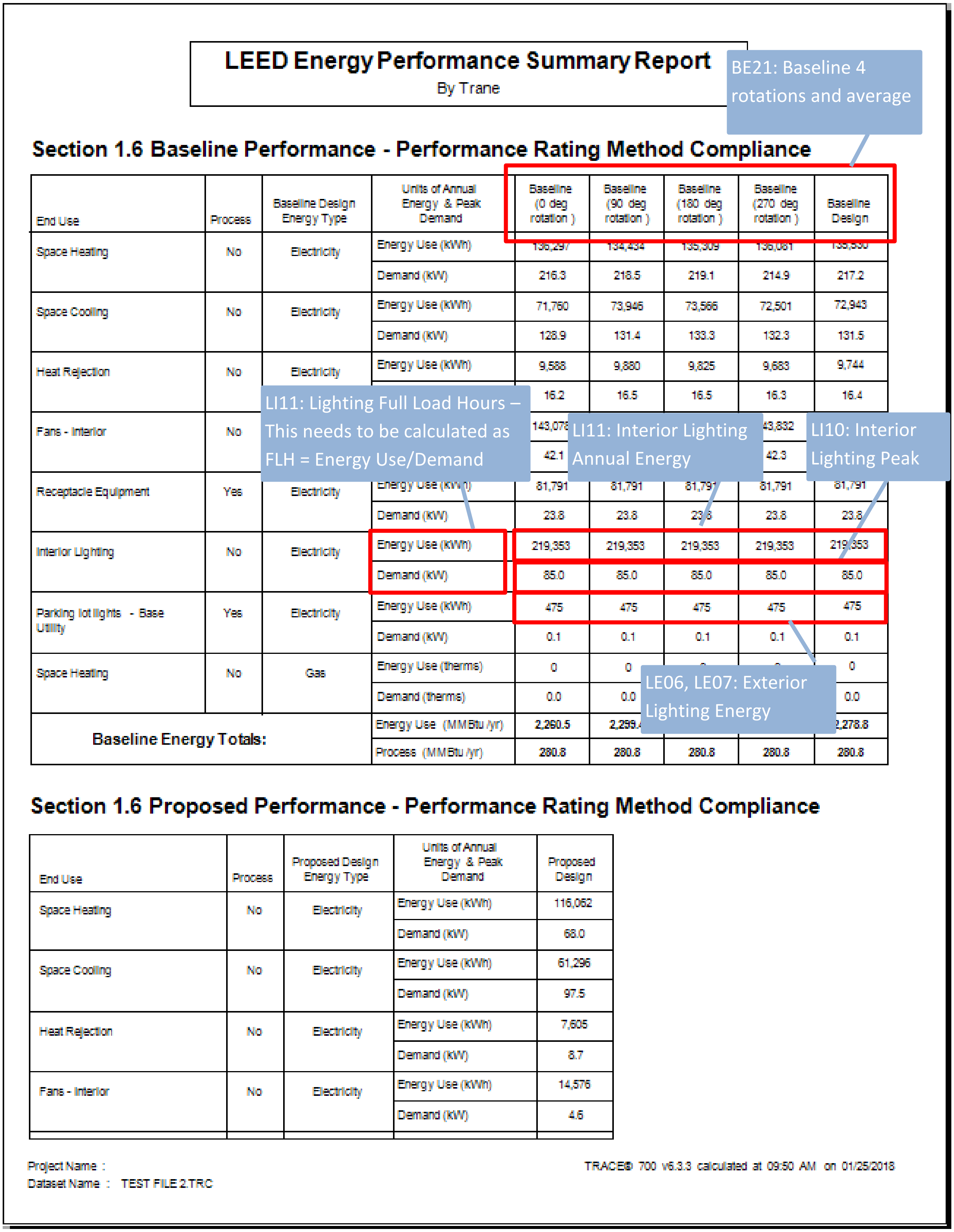
Section 1.5 - Energy Type Summary (Proposed)

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	135,530
			Demand (kW)	216.3	218.5	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
			[illegible]	16.2	16.5	16.5	16.3	16.4
Fans - Interior	No	[illegible]	[illegible]	143,078	[illegible]	[illegible]	143,832	[illegible]
			[illegible]	42.1	[illegible]	[illegible]	42.3	[illegible]
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)	85.0	85.0	85.0	85.0	85.0
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	[illegible]	[illegible]	0
			Demand (therms)	0.0	0.0	[illegible]	[illegible]	0.0
Baseline Energy Totals:			Energy Use (MMBtu /yr)	2,260.5	[illegible]	[illegible]	[illegible]	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

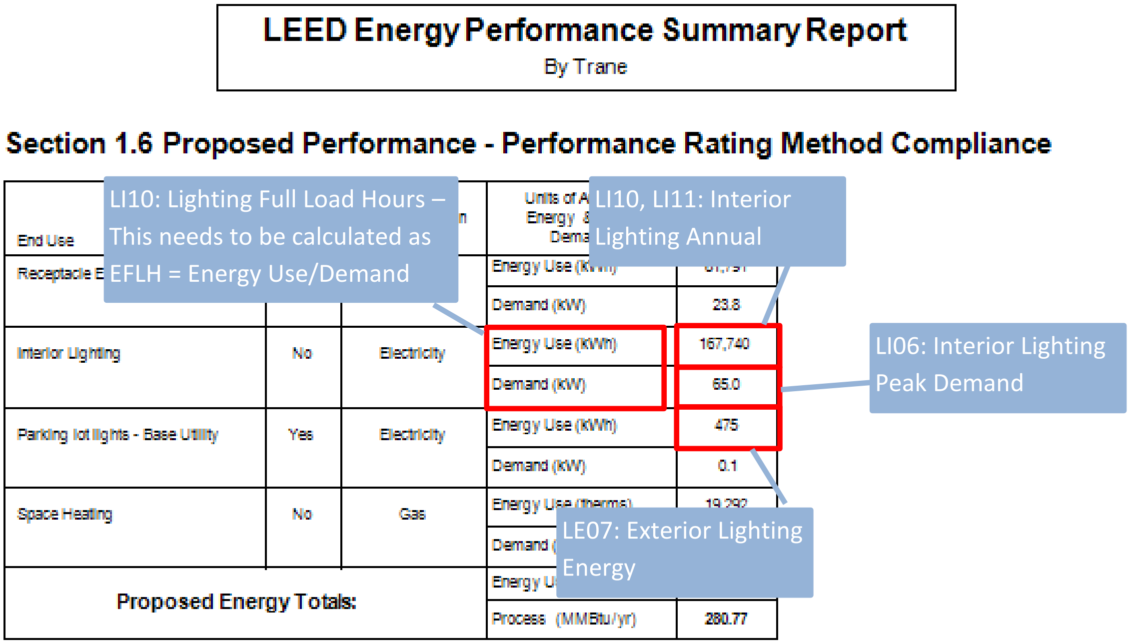
LE06, LE07: Exterior Lighting Energy

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)	7,605
			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		n	Units of A Energy & Dema	
Receptacle E			Energy Use (K	[illegible]
			Demand (kW)	23.8
Interior Lighting	No	Electricity	Energy Use (kWh)	167,740
			Demand (kW)	65.0
Parking lot lights - Base Utility	Yes	Electricity	Energy Use (kWh)	475
			Demand (kW)	0.1
Space Heating	No	Gas	Energy Use (therms)	19,292
			Demand (	
Proposed Energy Totals:			Energy U	
			Process (MMBtu/yr)	280.77

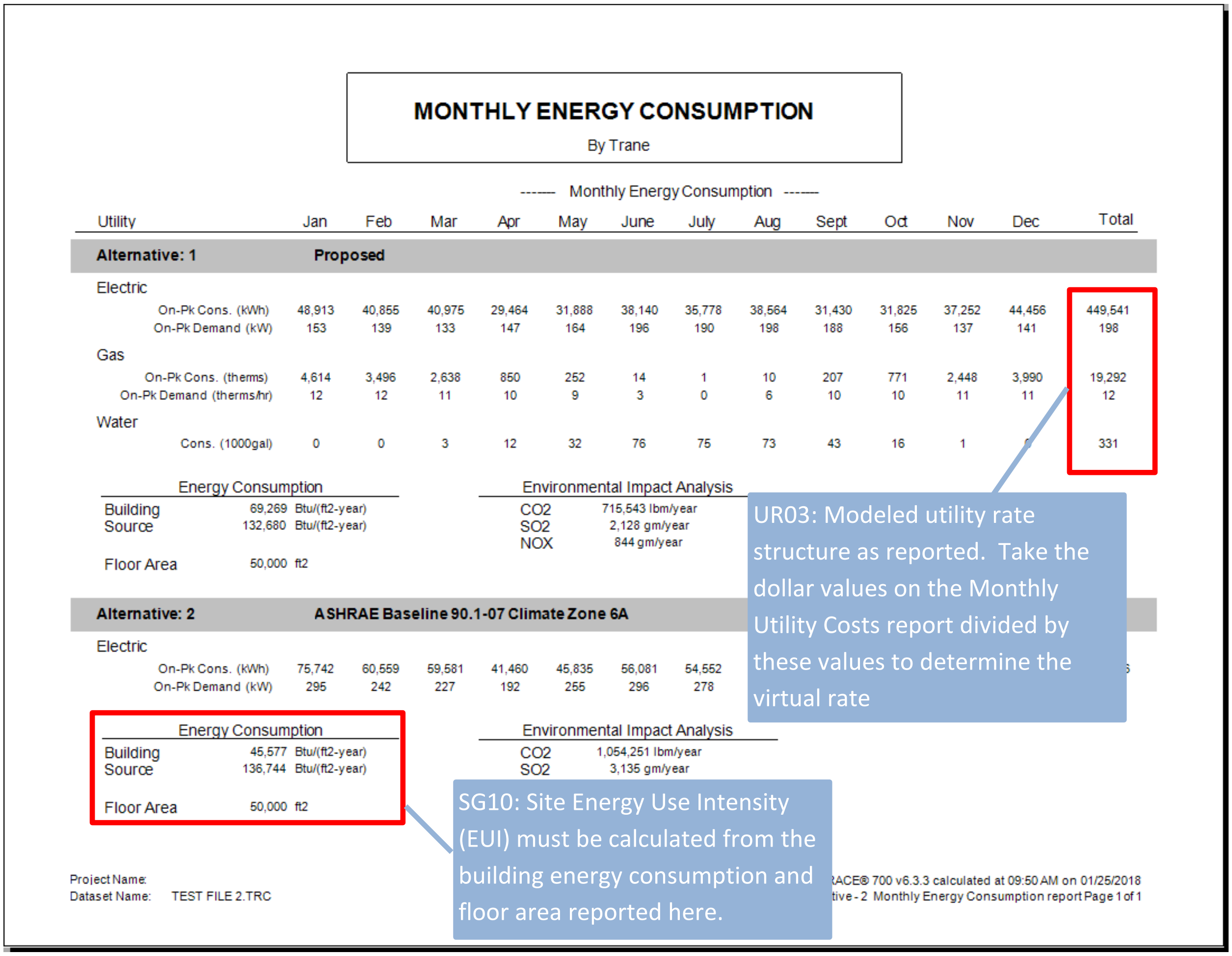
LI10: Lighting Full Load Hours – This needs to be calculated as EFLH = Energy Use/Demand

LI10, LI11: Interior Lighting Annual

LI06: Interior Lighting Peak Demand

LE07: Exterior Lighting Energy

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	0	331

Energy Consumption		
Building	69,269	Btu/(ft2-year)
Source	132,680	Btu/(ft2-year)
Floor Area	50,000	ft2

Environmental Impact Analysis	
CO2	715,543 lbm/year
SO2	2,128 gm/year
NOX	844 gm/year

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

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
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		
Building	45,577	Btu/(ft2-year)
Source	136,744	Btu/(ft2-year)
Floor Area	50,000	ft2

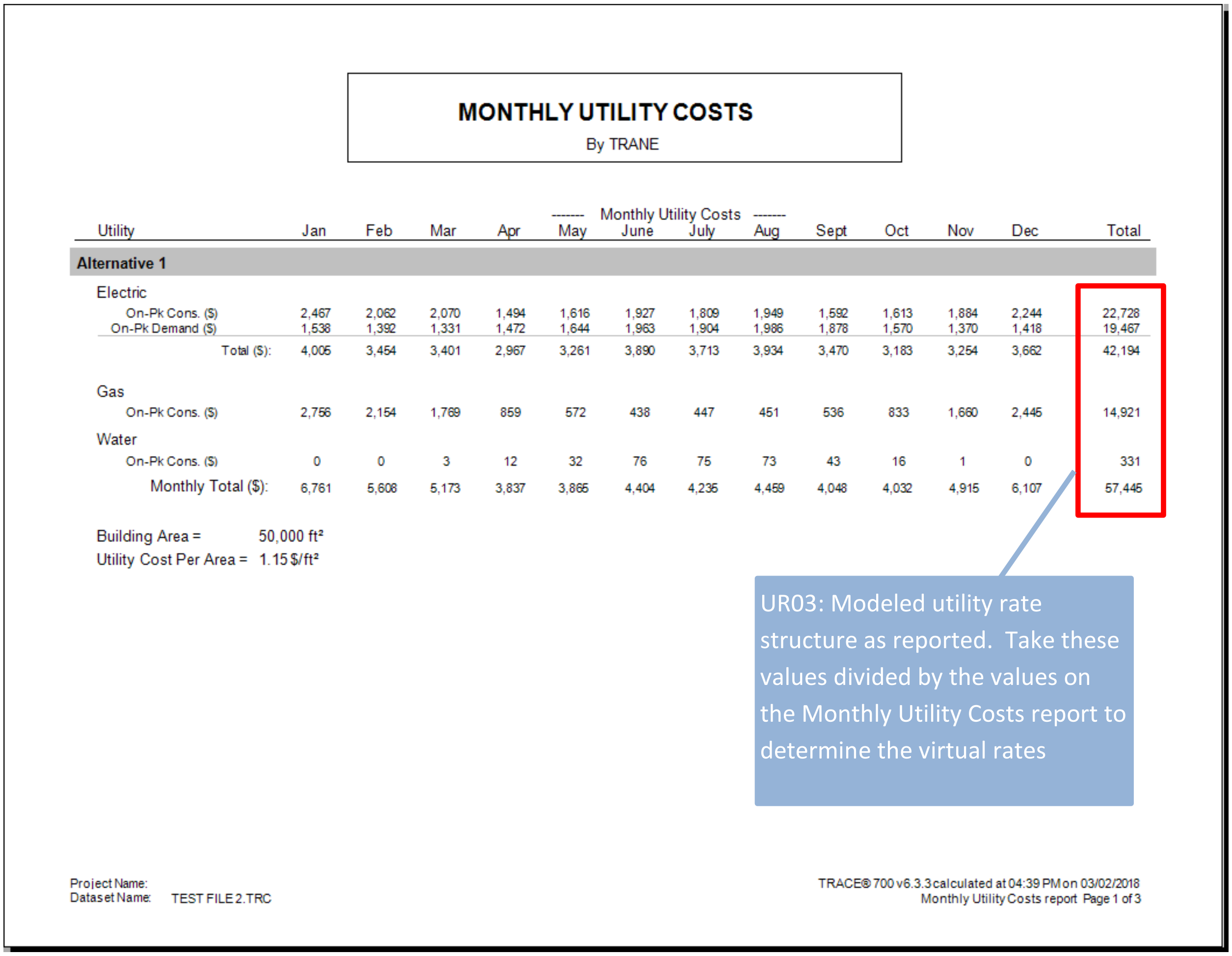
Environmental Impact Analysis	
CO2	1,054,251 lbm/year
SO2	3,135 gm/year

SG10: Site Energy Use Intensity (EUI) must be calculated from the building energy consumption and floor area reported here.

Project Name:
Dataset Name: TEST FILE 2.TRC

ACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
tive - 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	2,445	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	4,235	4,459	4,048	4,032	4,915	6,107	57,445

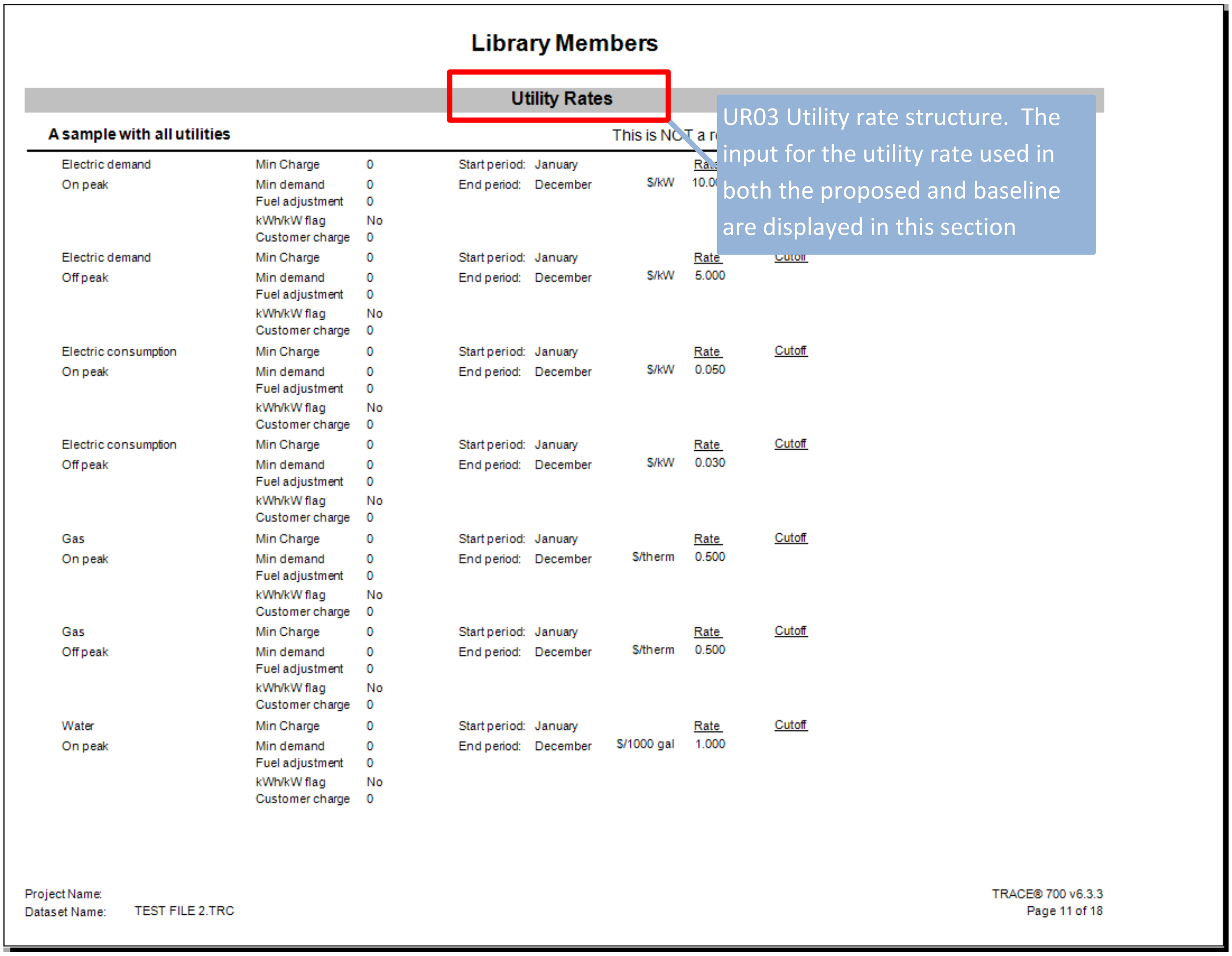
Building Area =	50,000 ft²
Utility Cost Per Area =	1.15 $/ft²

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

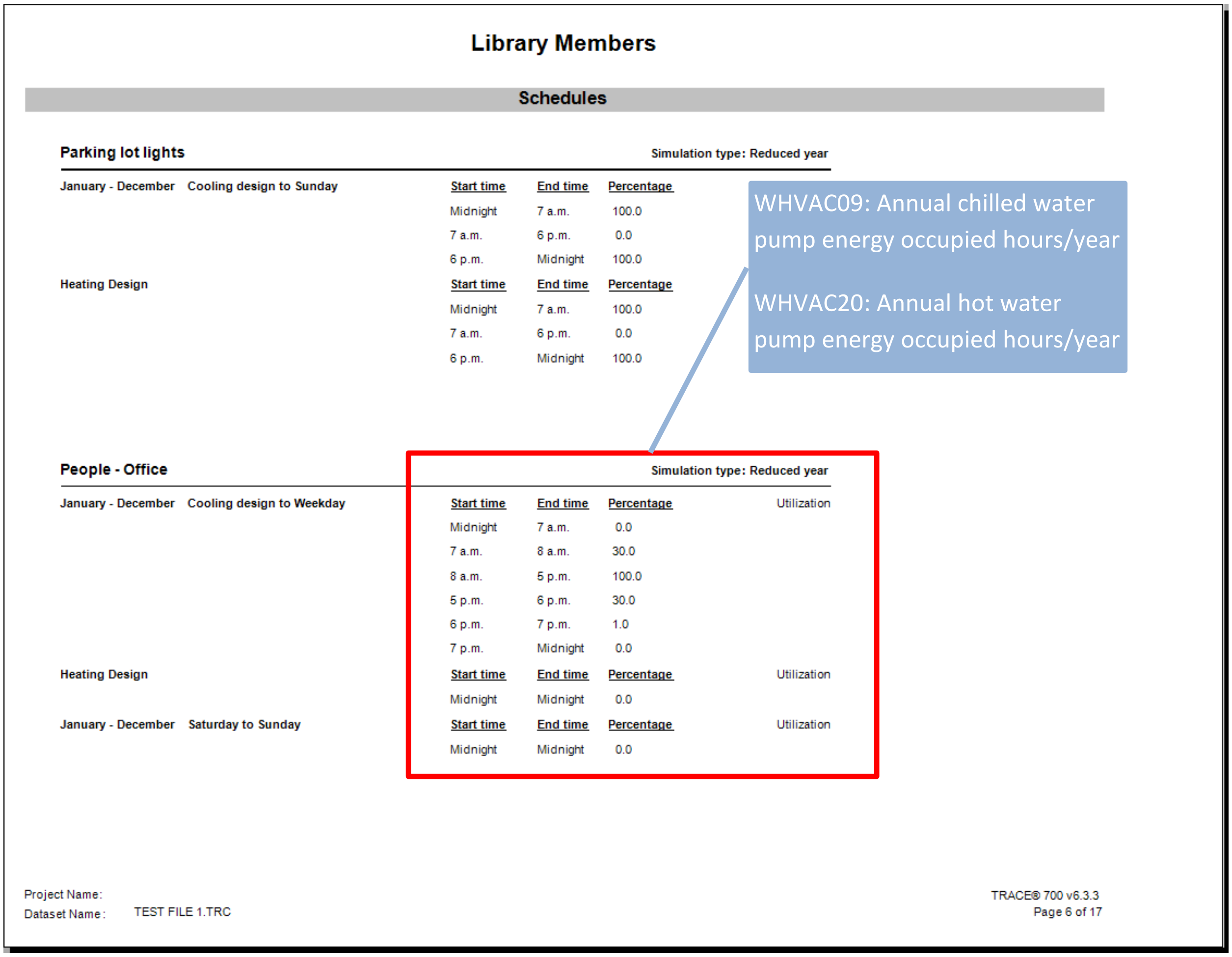
This is NO T a r

Electric demand	Min Charge	0	Start period:	January		Ra	
On peak	Min demand	0	End period:	December	$/kW	10.0	
	Fuel adjustment	0					
	kWh/kW flag	No					
	Customer charge	0					
Electric demand	Min Charge	0	Start period:	January		Rate	Cutoff
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	Cutoff
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	Cutoff
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	Cutoff
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	Cutoff
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	Cutoff
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:
Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3
Page 11 of 18



Library Members

Schedules

Parking lot lights — **Simulation type: Reduced year**

		Start time	End time	Percentage	
January - December	**Cooling design to Sunday**	Midnight	7 a.m.	100.0	
		7 a.m.	6 p.m.	0.0	
		6 p.m.	Midnight	100.0	
Heating Design		**Start time**	**End time**	**Percentage**	
		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

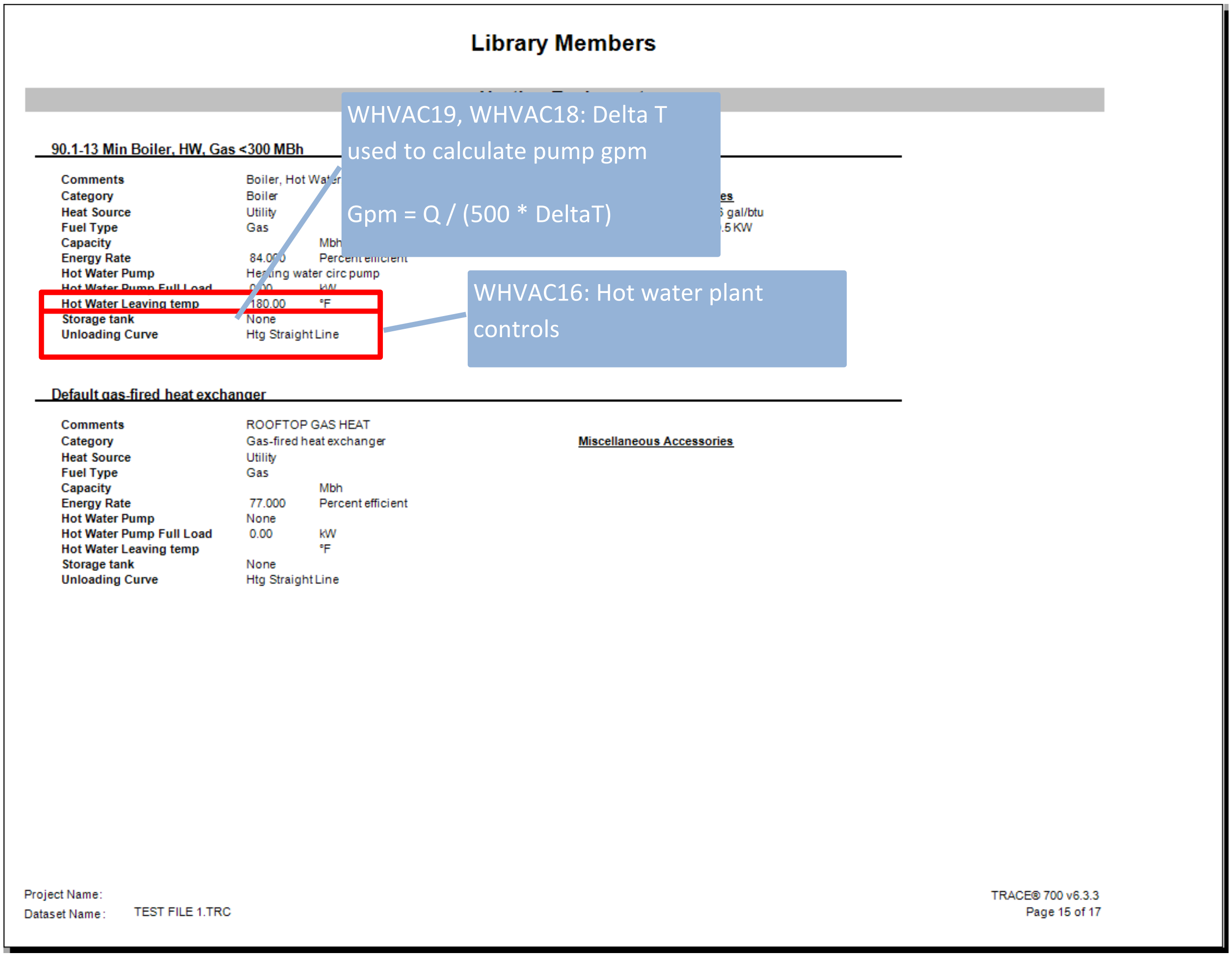
WHVAC20: Annual hot water pump energy occupied hours/year

People - Office — **Simulation type: Reduced year**

		Start time	End time	Percentage	Utilization
January - December	**Cooling design to Weekday**	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		**Start time**	**End time**	**Percentage**	Utilization
		Midnight	Midnight	0.0	
January - December	**Saturday to Sunday**	**Start time**	**End time**	**Percentage**	Utilization
		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	
Fuel Type	Gas	
Capacity		Mbh
Energy Rate	84.000	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	

es

gal/btu

.5 KW

WHVAC19, WHVAC18: Delta T used to calculate pump gpm

Gpm = Q / (500 * DeltaT)

WHVAC16: Hot water plant controls

Default gas-fired heat exchanger

Comments	ROOFTOP GAS HEAT	
Category	Gas-fired heat exchanger	
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	

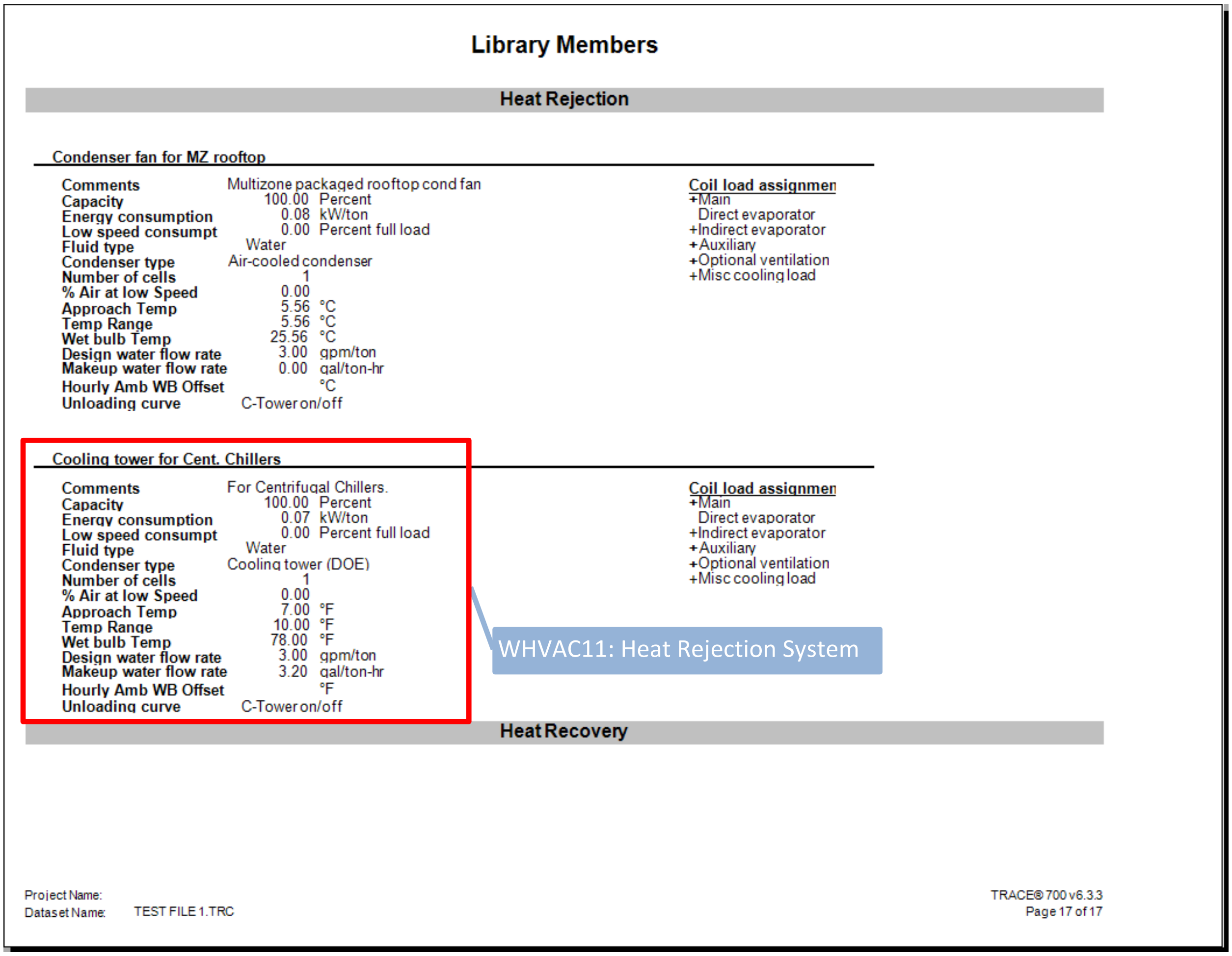
Miscellaneous Accessories

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	
Capacity	100.00	Percent
Energy consumption	0.08	kW/ton
Low speed consumpt	0.00	Percent full load
Fluid type	Water	
Condenser type	Air-cooled condenser	
Number of cells	1	
% 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	

Coil load assignmen
+Main
Direct evaporator
+Indirect evaporator
+Auxiliary
+Optional ventilation
+Misc cooling load

Cooling tower for Cent. Chillers

Comments	For Centrifugal Chillers.	
Capacity	100.00	Percent
Energy consumption	0.07	kW/ton
Low speed consumpt	0.00	Percent full load
Fluid type	Water	
Condenser type	Cooling tower (DOE)	
Number of cells	1	
% 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	

Coil load assignmen
+Main
Direct evaporator
+Indirect evaporator
+Auxiliary
+Optional ventilation
+Misc cooling load

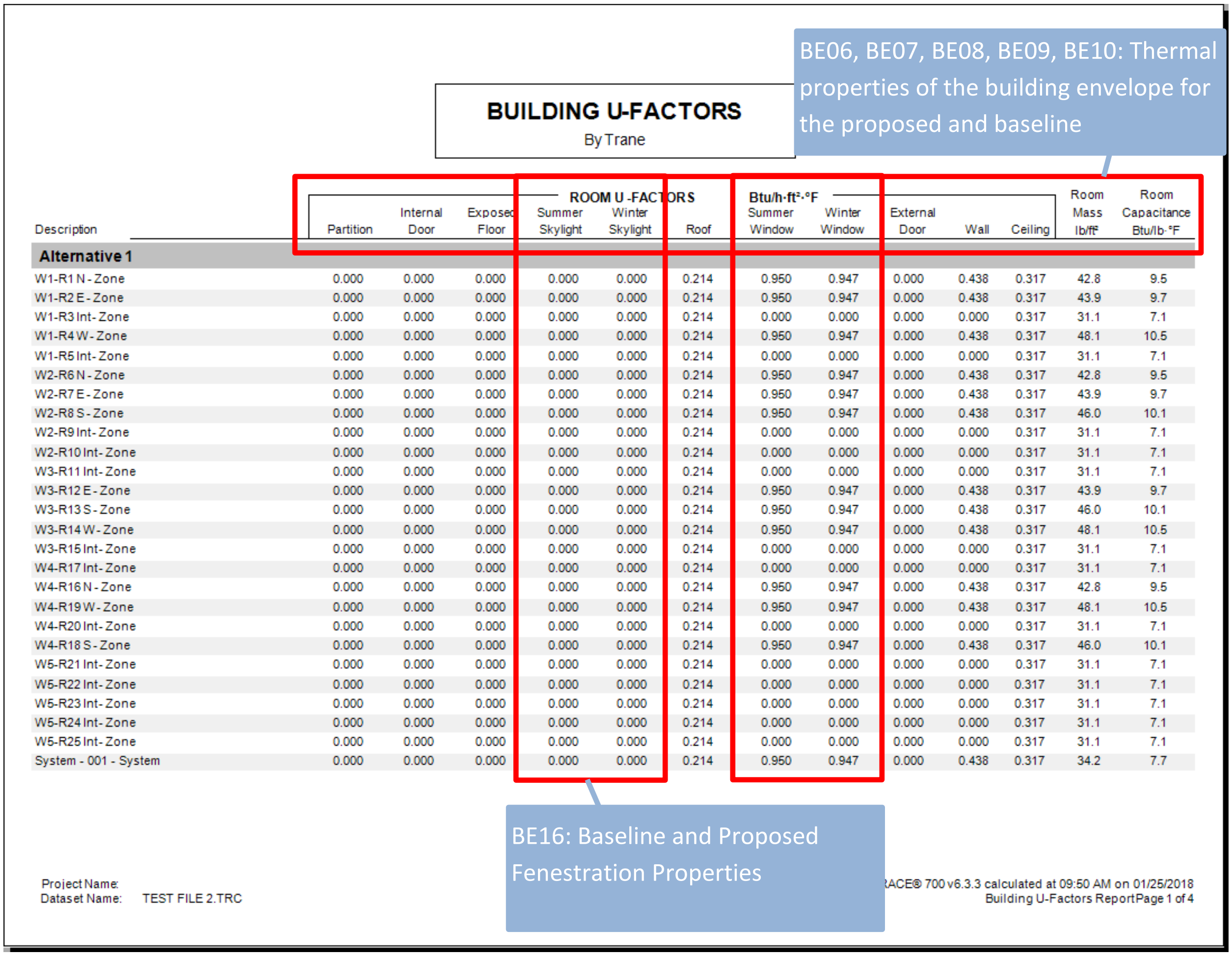
WHVAC11: Heat Rejection System

Heat Recovery

Project Name:
Dataset Name: TEST FILE 1.TRC

TRACE® 700 v6.3.3
Page 17 of 17

Building U-Values report



BE06, BE07, BE08, BE09, BE10: Thermal properties of the building envelope for the proposed and baseline

BUILDING U-FACTORS

By Trane

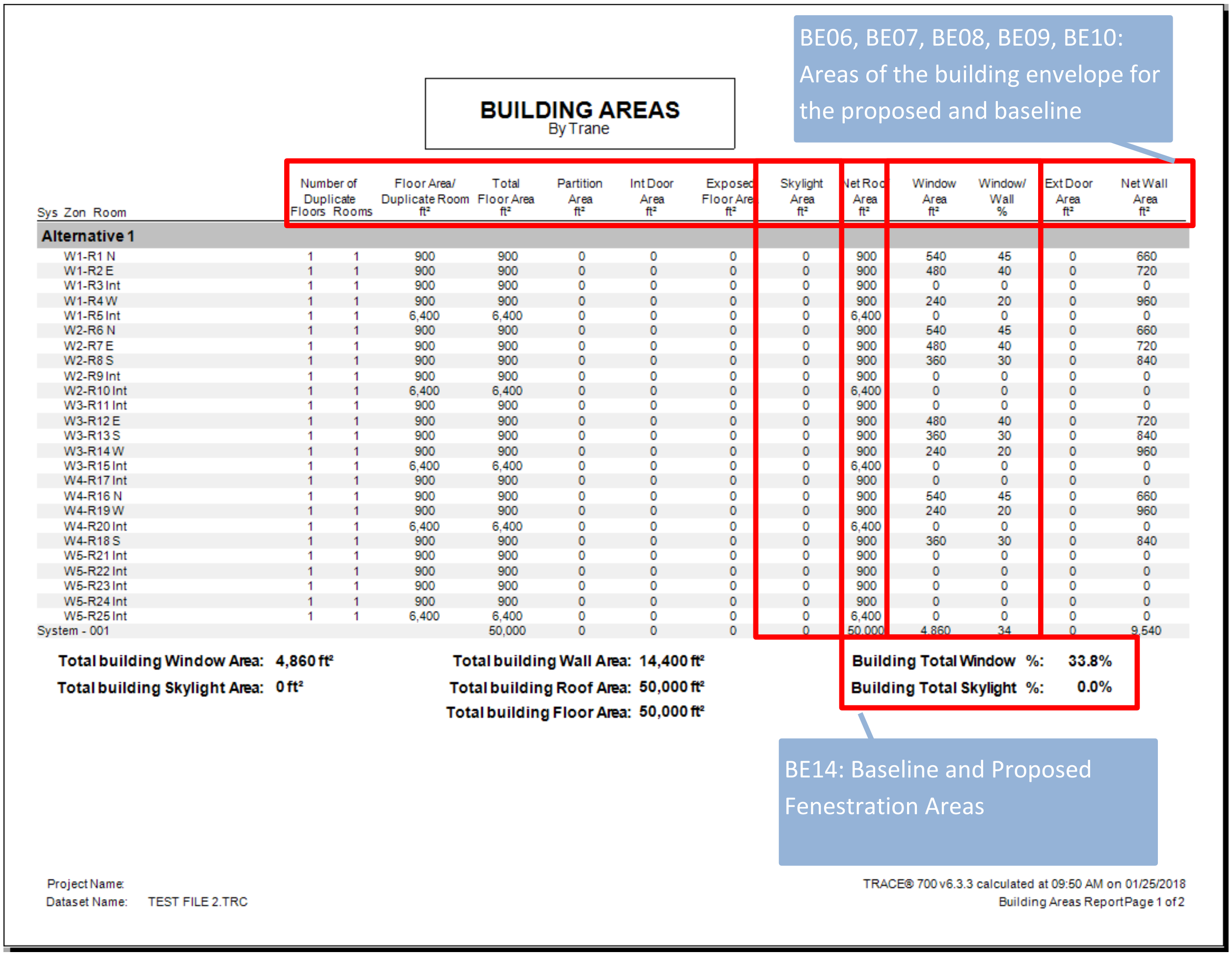
	ROOM U-FACTORS Btu/h·ft²·°F											Room	Room
Description	Partition	Internal Door	Exposed Floor	Summer Skylight	Winter Skylight	Roof	Summer Window	Winter Window	External Door	Wall	Ceiling	Mass lb/ft²	Capacitance Btu/lb·°F
Alternative 1													
W1-R1 N - Zone	0.000	0.000	0.000	0.000	0.000	0.214	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

ACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
Building U-Factors ReportPage 1 of 4

Building Areas report



BE06, BE07, BE08, BE09, BE10: Areas of the building envelope for the proposed and baseline

BUILDING AREAS
By Trane

Sys Zon Room	Number of Duplicate Floors	Rooms	Floor Area/ Duplicate Room ft²	Total Floor Area ft²	Partition Area ft²	Int Door Area ft²	Exposed Floor Are ft²	Skylight Area ft²	Net Roo 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

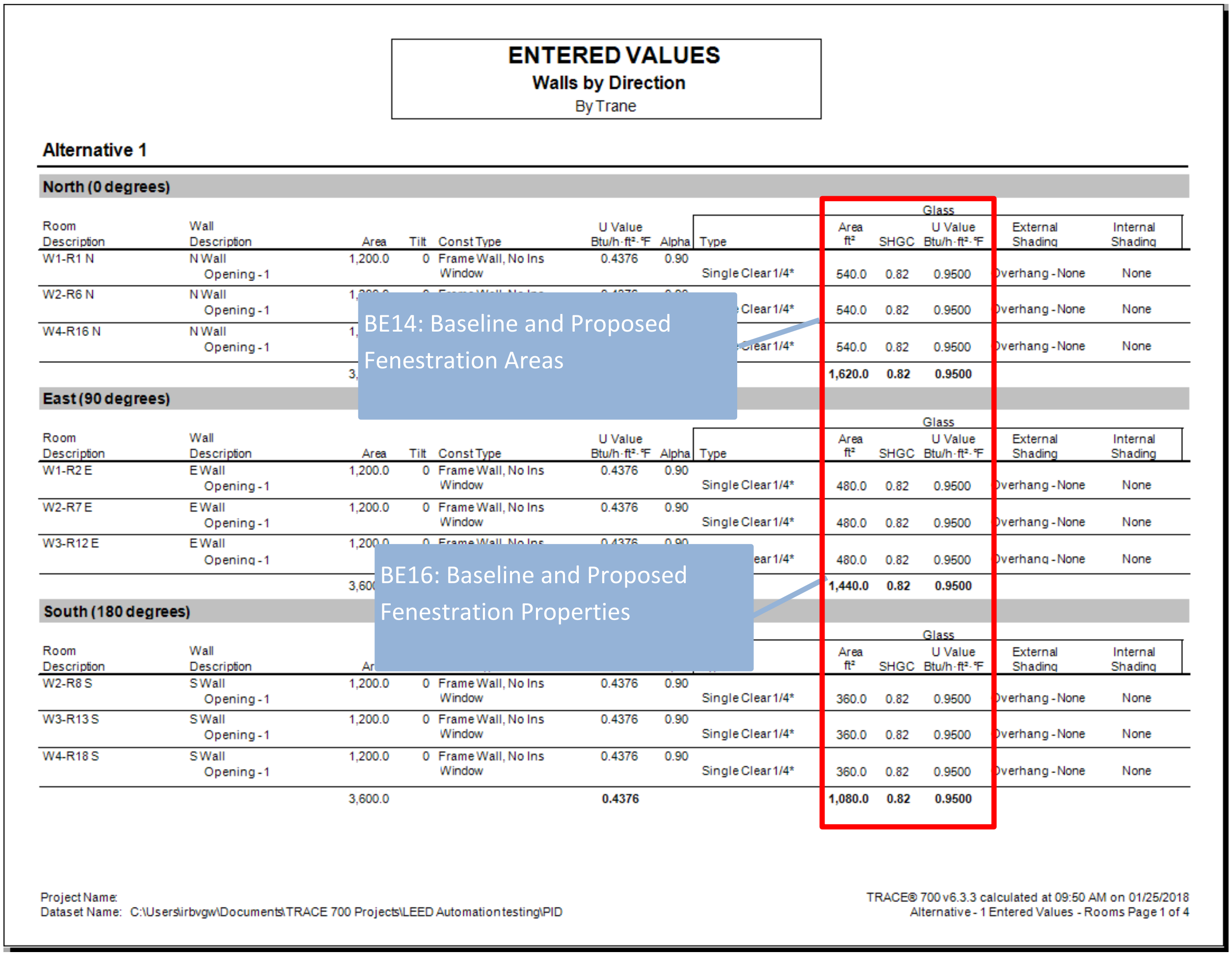
Total building Window Area:	**4,860 ft²**	**Total building Wall Area:**	**14,400 ft²**	**Building Total Window %:**	**33.8%**
Total building Skylight Area:	**0 ft²**	**Total building Roof Area:**	**50,000 ft²**	**Building Total Skylight %:**	**0.0%**
		Total building Floor Area:	**50,000 ft²**		

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·ft²·°F	Alpha	Type	Glass Area ft²	Glass SHGC	Glass U Value Btu/h·ft²·°F	External Shading	Internal Shading
W1-R1 N	N Wall	1,200.0	0	Frame Wall, No Ins	0.4376	0.90						
	Opening - 1			Window			Single Clear 1/4*	540.0	0.82	0.9500	Overhang - None	None
W2-R6 N	N Wall	1,										
	Opening - 1						Clear 1/4*	540.0	0.82	0.9500	Overhang - None	None
W4-R16 N	N Wall	1,										
	Opening - 1						Clear 1/4*	540.0	0.82	0.9500	Overhang - None	None
		3,						**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·ft²·°F	Alpha	Type	Glass Area ft²	Glass SHGC	Glass U Value Btu/h·ft²·°F	External Shading	Internal Shading
W1-R2 E	E Wall	1,200.0	0	Frame Wall, No Ins	0.4376	0.90						
	Opening - 1			Window			Single Clear 1/4*	480.0	0.82	0.9500	Overhang - None	None
W2-R7 E	E Wall	1,200.0	0	Frame Wall, No Ins	0.4376	0.90						
	Opening - 1			Window			Single Clear 1/4*	480.0	0.82	0.9500	Overhang - None	None
W3-R12 E	E Wall	1,200.0										
	Opening - 1						ear 1/4*	480.0	0.82	0.9500	Overhang - None	None
		3,60						**1,440.0**	**0.82**	**0.9500**		

BE16: Baseline and Proposed Fenestration Properties

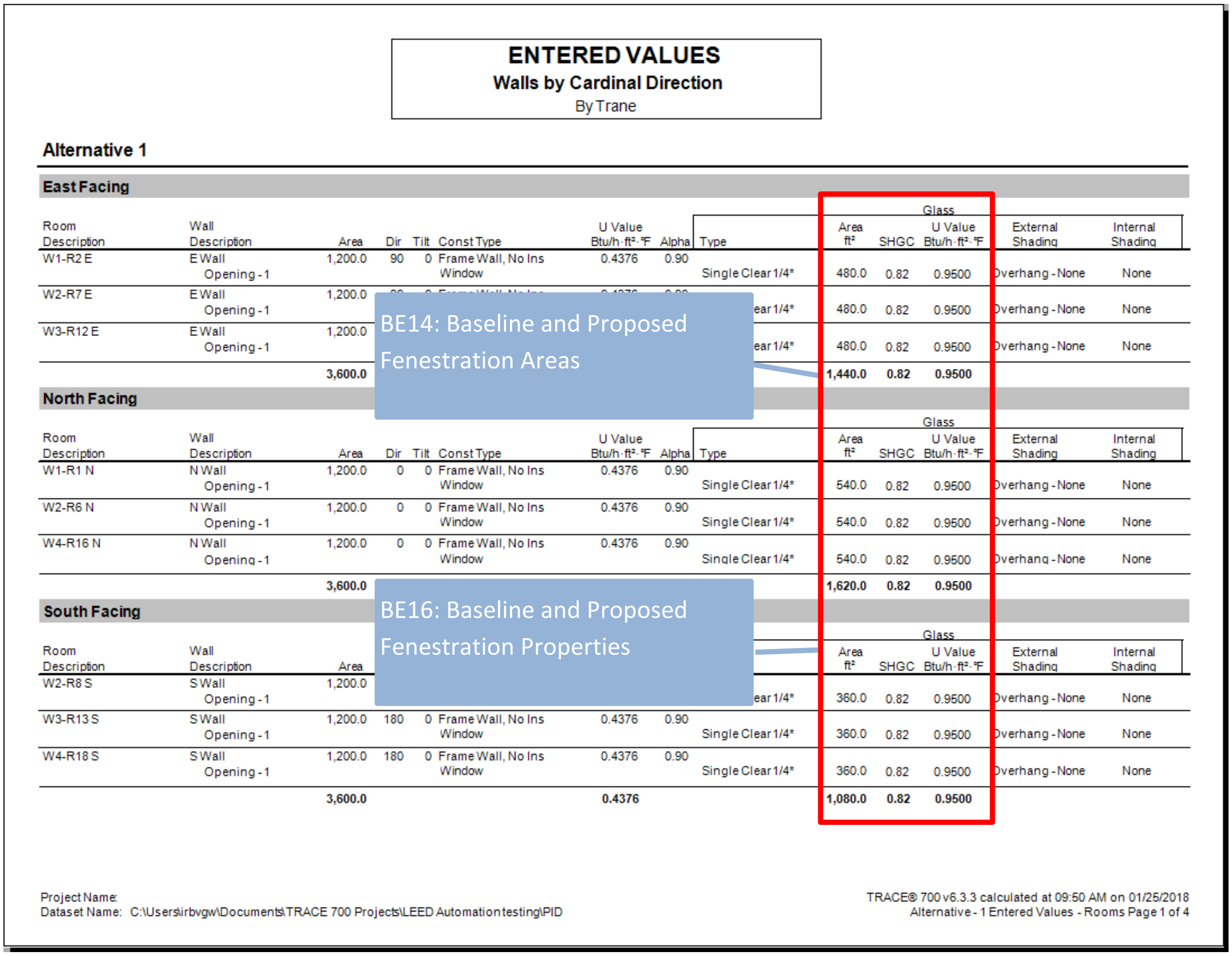
South (180 degrees)

Room Description	Wall Description	Ar						Glass Area ft²	Glass SHGC	Glass U Value Btu/h·ft²·°F	External Shading	Internal Shading
W2-R8 S	S Wall	1,200.0	0	Frame Wall, No Ins	0.4376	0.90						
	Opening - 1			Window			Single Clear 1/4*	360.0	0.82	0.9500	Overhang - None	None
W3-R13 S	S Wall	1,200.0	0	Frame Wall, No Ins	0.4376	0.90						
	Opening - 1			Window			Single Clear 1/4*	360.0	0.82	0.9500	Overhang - None	None
W4-R18 S	S Wall	1,200.0	0	Frame Wall, No Ins	0.4376	0.90						
	Opening - 1			Window			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\irbvgw\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·ft²·°F	Alpha	Type	Glass Area ft²	SHGC	U Value Btu/h·ft²·°F	External Shading	Internal Shading
W1-R2 E	E Wall 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	E Wall Opening - 1	1,200.0						ear 1/4*	480.0	0.82	0.9500	Overhang - None	None
W3-R12 E	E Wall Opening - 1	1,200.0						ear 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·ft²·°F	Alpha	Type	Glass Area ft²	SHGC	U Value Btu/h·ft²·°F	External Shading	Internal Shading
W1-R1 N	N Wall 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	N Wall 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	N Wall 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

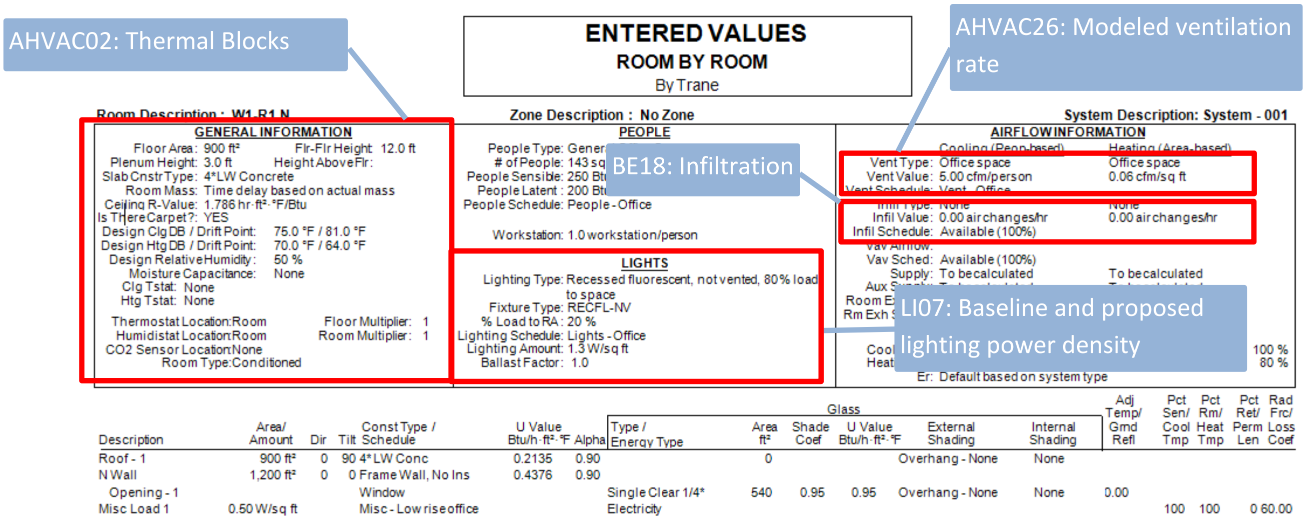
South Facing

Room Description	Wall Description	Area							Glass Area ft²	SHGC	U Value Btu/h·ft²·°F	External Shading	Internal Shading
W2-R8 S	S Wall Opening - 1	1,200.0						ear 1/4*	360.0	0.82	0.9500	Overhang - None	None
W3-R13 S	S Wall 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	S Wall 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\irbvgw\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

AHVAC26: Modeled ventilation rate

BE18: Infiltration

LI07: Baseline and proposed lighting power density

ENTERED VALUES
ROOM BY ROOM
By Trane

Room Description : W1-R1 N
Zone Description : No Zone
System Description: System - 001

GENERAL INFORMATION
Floor Area: 900 ft² Flr-Flr Height 12.0 ft
Plenum Height: 3.0 ft Height Above Flr:
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

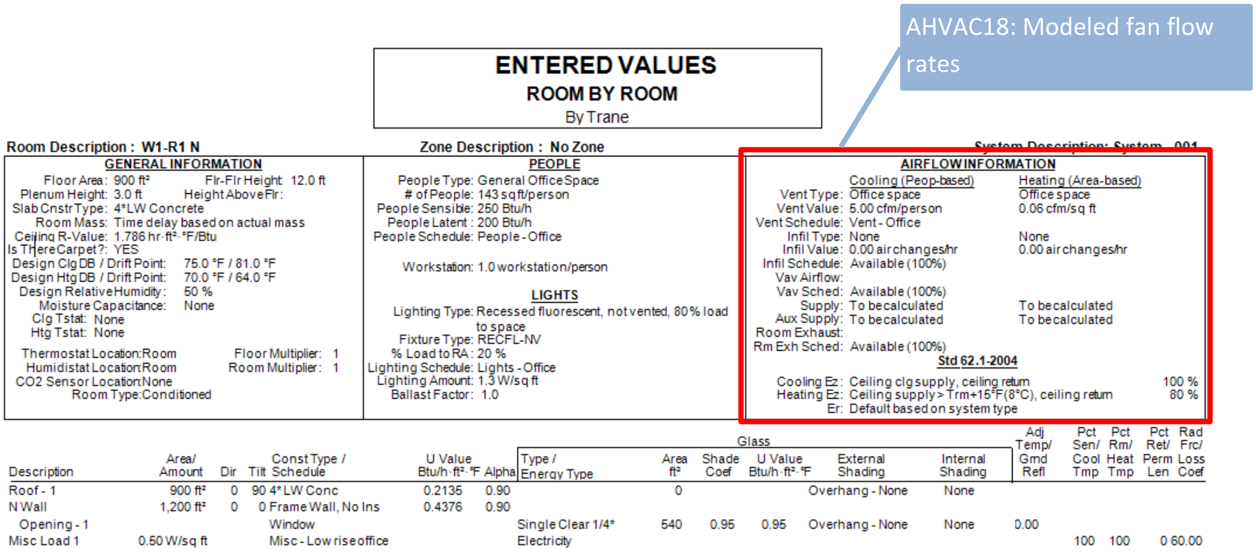
PEOPLE
People Type: Gener
# of People: 143 sq
People Sensible: 250 Bt
People Latent : 200 Bt
People Schedule: People - Office
Workstation: 1.0 workstation/person

LIGHTS
Lighting Type: Recessed fluorescent, not vented, 80% load to space
Fixture Type: RECFL-NV
% Load to RA: 20 %
Lighting Schedule: Lights - Office
Lighting Amount: 1.3 W/sq ft
Ballast Factor: 1.0

AIRFLOW INFORMATION
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%)
Supply: To be calculated To be calculated
Aux S
Room E
Rm Exh S
Cool 100 %
Heat 80 %
Er: Default based on system type

							Glass						Adj Temp/ Grnd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
Description	Area/ Amount	Dir	Tilt	Const Type / Schedule	U Value Btu/h·ft²·°F	Alpha	Type / Energy Type	Area ft²	Shade Coef	U Value Btu/h·ft²·°F	External Shading	Internal 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.



AHVAC18: Modeled fan flow rates

ENTERED VALUES
ROOM BY ROOM
By Trane

Room Description : W1-R1 N
Zone Description : No Zone
System Description: System - 001

GENERAL INFORMATION
Floor Area: 900 ft² Flr-Flr Height 12.0 ft
Plenum Height: 3.0 ft Height Above Flr:
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

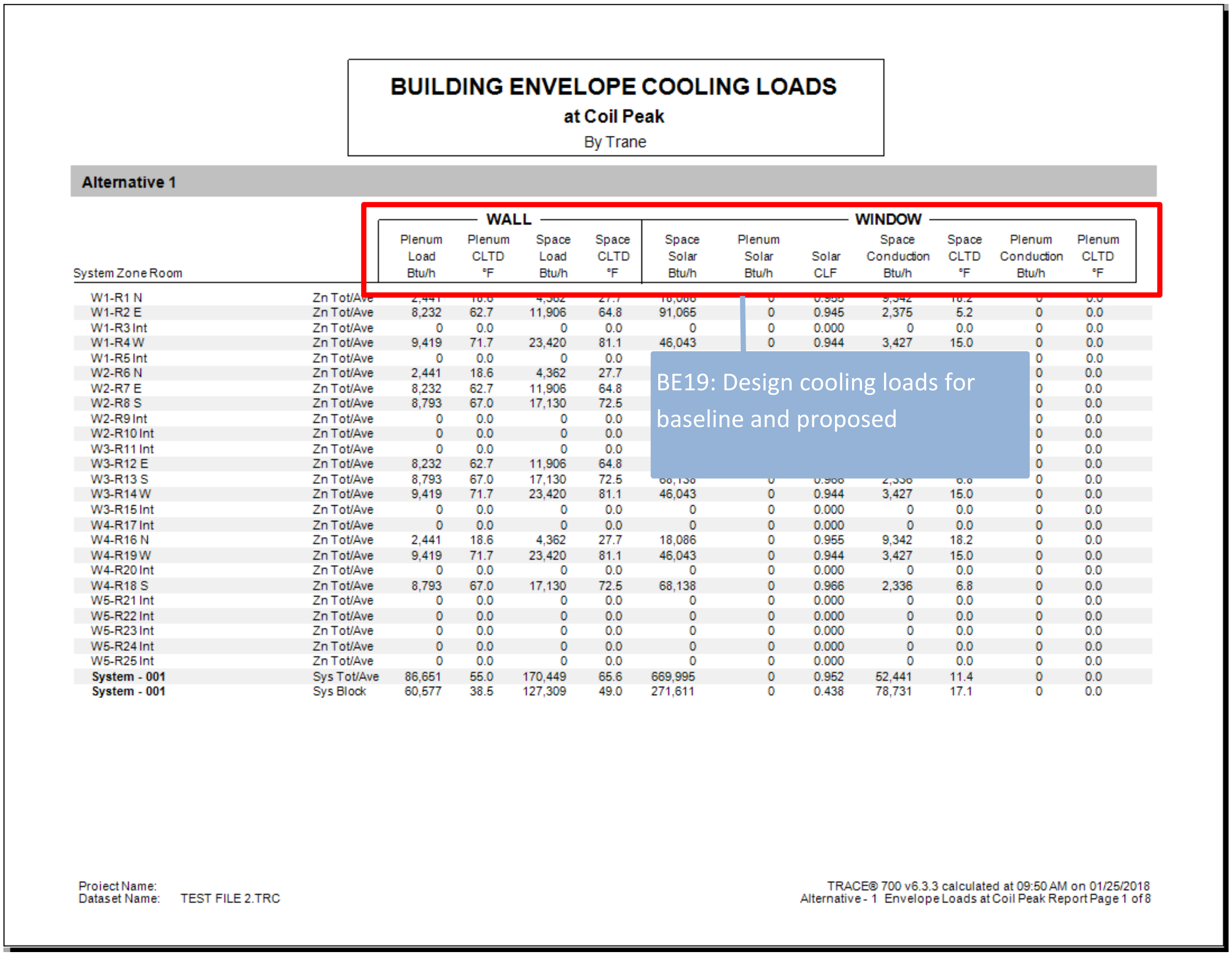
PEOPLE
People Type: General Office Space
# of People: 143 sq ft/person
People Sensible: 250 Btu/h
People Latent : 200 Btu/h
People Schedule: People - Office
Workstation: 1.0 workstation/person

LIGHTS
Lighting Type: Recessed fluorescent, not vented, 80% load to space
Fixture Type: RECFL-NV
% Load to RA: 20 %
Lighting Schedule: Lights - Office
Lighting Amount: 1.3 W/sq ft
Ballast Factor: 1.0

AIRFLOW INFORMATION
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%)
Supply: To be calculated To be calculated
Aux Supply: To be calculated To be calculated
Room Exhaust:
Rm Exh Sched: Available (100%)
Std 62.1-2004
Cooling Ez: Ceiling clg supply, ceiling return 100 %
Heating Ez: Ceiling supply > Trm+15°F(8°C), ceiling return 80 %
Er: Default based on system type

							Glass						Adj Temp/ Grnd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
Description	Area/ Amount	Dir	Tilt	Const Type / Schedule	U Value Btu/h·ft²·°F	Alpha	Type / Energy Type	Area ft²	Shade Coef	U Value Btu/h·ft²·°F	External Shading	Internal 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 Plenum Load Btu/h	WALL Plenum CLTD °F	WALL Space Load Btu/h	WALL Space CLTD °F	WINDOW Space Solar Btu/h	WINDOW Plenum Solar Btu/h	WINDOW Solar CLF	WINDOW Space Conduction Btu/h	WINDOW Space CLTD °F	WINDOW Plenum Conduction Btu/h	WINDOW 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	91,065	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0.0
W2-R6 N	Zn Tot/Ave	2,441	18.6	4,362	27.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0.0
W2-R7 E	Zn Tot/Ave	8,232	62.7	11,906	64.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0.0
W2-R8 S	Zn Tot/Ave	8,793	67.0	17,130	72.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0.0
W2-R9 Int	Zn Tot/Ave	0	0.0	0	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0.0
W2-R10 Int	Zn Tot/Ave	0	0.0	0	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0.0
W3-R11 Int	Zn Tot/Ave	0	0.0	0	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0.0
W3-R12 E	Zn Tot/Ave	8,232	62.7	11,906	64.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

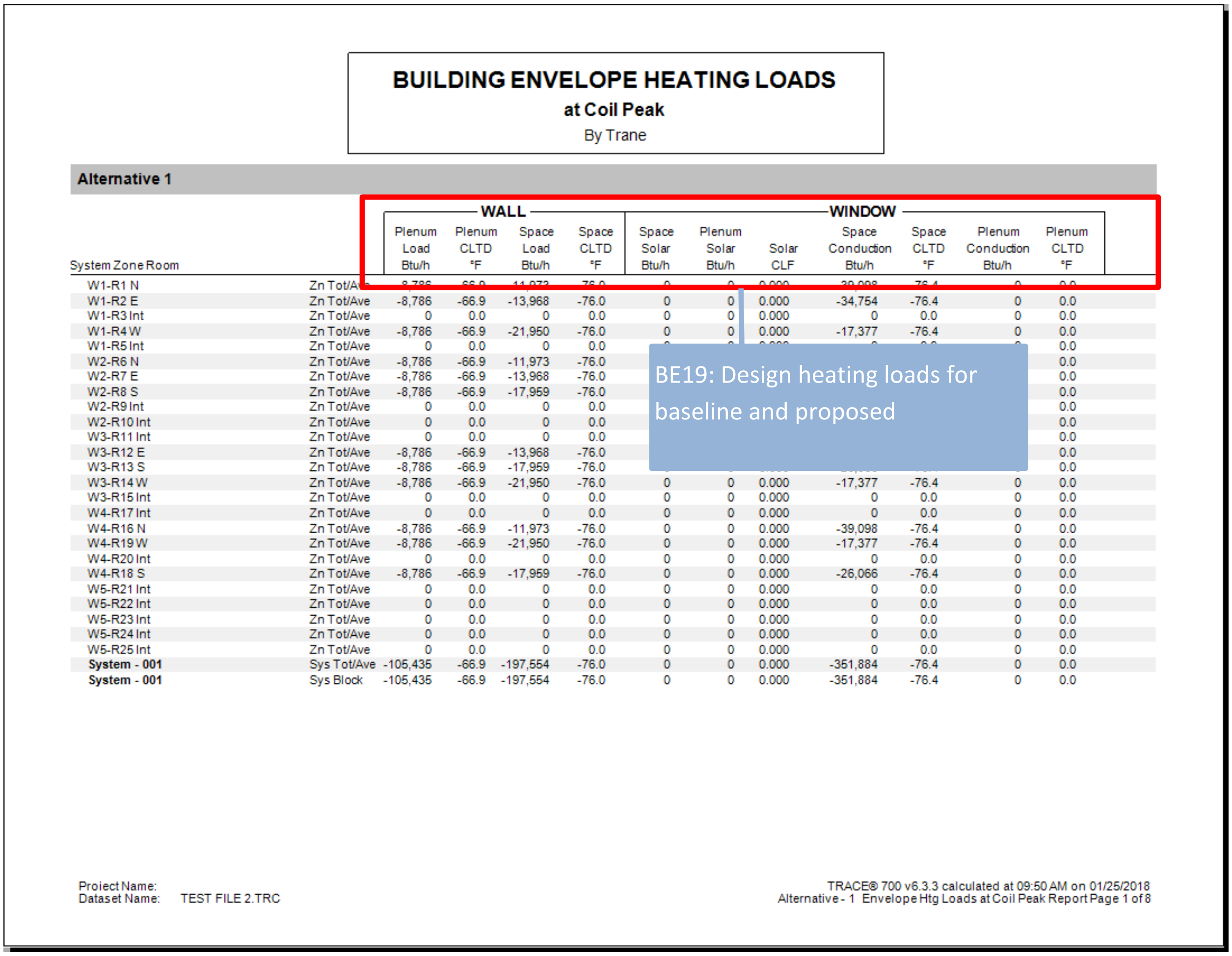
BE19: Design cooling loads for baseline and proposed

Project Name:
Dataset 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		WALL Plenum Load Btu/h	WALL Plenum CLTD °F	WALL Space Load Btu/h	WALL Space CLTD °F	WINDOW Space Solar Btu/h	WINDOW Plenum Solar Btu/h	WINDOW Solar CLF	WINDOW Space Conduction Btu/h	WINDOW Space CLTD °F	WINDOW Plenum Conduction Btu/h	WINDOW Plenum CLTD °F
W1-R1 N	Zn Tot/Ave	-8,786	-66.9	-11,973	-76.0	0	0	0.000	-39,098	-76.4	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0
W2-R7 E	Zn Tot/Ave	-8,786	-66.9	-13,968	-76.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0
W2-R8 S	Zn Tot/Ave	-8,786	-66.9	-17,959	-76.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0
W2-R9 Int	Zn Tot/Ave	0	0.0	0	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0
W2-R10 Int	Zn Tot/Ave	0	0.0	0	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0
W3-R11 Int	Zn Tot/Ave	0	0.0	0	0.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0
W3-R12 E	Zn Tot/Ave	-8,786	-66.9	-13,968	-76.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

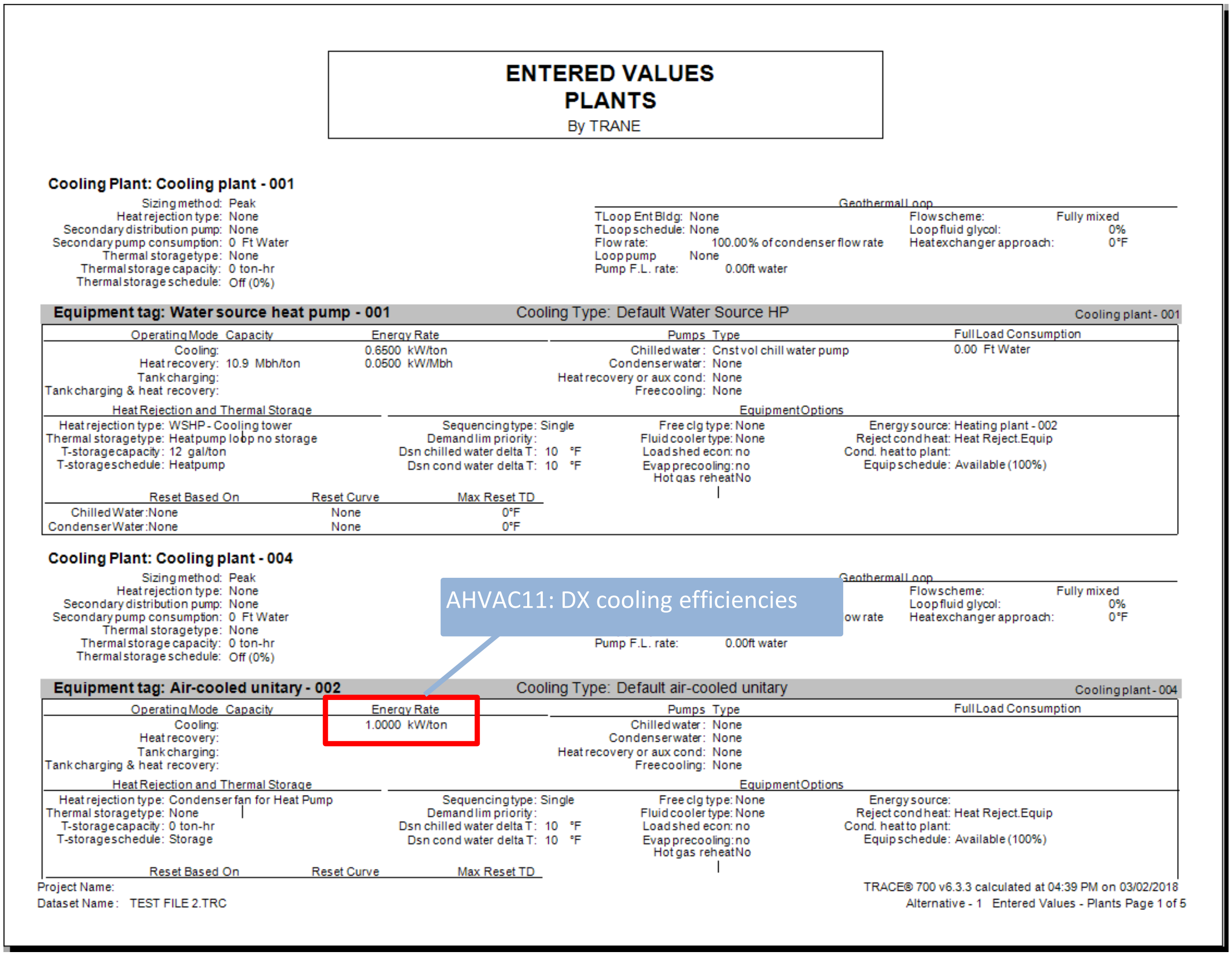
BE19: Design heating loads for baseline and proposed

Project Name:
Dataset Name: TEST FILE 2.TRC

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                                    Geothermal Loop
           Heat rejection type:  None              TLoop Ent Bldg:  None                       Flow scheme:            Fully mixed
  Secondary distribution pump:  None              TLoop schedule:  None                       Loop fluid glycol:             0%
 Secondary pump consumption:  0  Ft Water          Flow rate:        100.00% of condenser flow rate  Heat exchanger approach:  0°F
          Thermal storage type:  None              Loop pump         None
      Thermal storage capacity:  0 ton-hr          Pump F.L. rate:     0.00ft water
      Thermal storage schedule:  Off (0%)

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  Mbh/ton     0.0500  kW/Mbh             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       Energy source:  Heating plant - 002
Thermal storage type:  Heatpump loop no storage     Demand lim priority:                Fluid cooler type: None   Reject cond heat:  Heat Reject.Equip
   T-storage capacity:  12  gal/ton          Dsn chilled water delta T:  10   °F      Load shed econ: no        Cond. heat to plant:
   T-storage schedule:  Heatpump                Dsn cond water delta T:  10   °F      Evap precooling: no       Equip schedule:  Available (100%)
                                                                                       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                                    Geothermal Loop
           Heat rejection type:  None                                                          Flow scheme:            Fully mixed
  Secondary distribution pump:  None                                                          Loop fluid glycol:             0%
 Secondary pump consumption:  0  Ft Water                                        ow rate       Heat exchanger approach:      0°F
          Thermal storage type:  None
      Thermal storage capacity:  0 ton-hr          Pump F.L. rate:     0.00ft water
      Thermal storage schedule:  Off (0%)

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       Energy source:
Thermal storage type:  None                         Demand lim priority:                Fluid cooler type: None   Reject cond heat:  Heat Reject.Equip
   T-storage capacity:  0 ton-hr             Dsn chilled water delta T:  10   °F      Load shed econ: no        Cond. heat to plant:
   T-storage schedule:  Storage                 Dsn cond water delta T:  10   °F      Evap precooling: no       Equip schedule:  Available (100%)
                                                                                       Hot gas reheat No
           Reset Based On            Reset Curve          Max Reset TD
Project Name:                                                                  TRACE® 700 v6.3.3 calculated at 04:39 PM on 03/02/2018
Dataset Name:   TEST FILE 2.TRC                                            Alternative - 1   Entered Values - Plants Page 1 of 5
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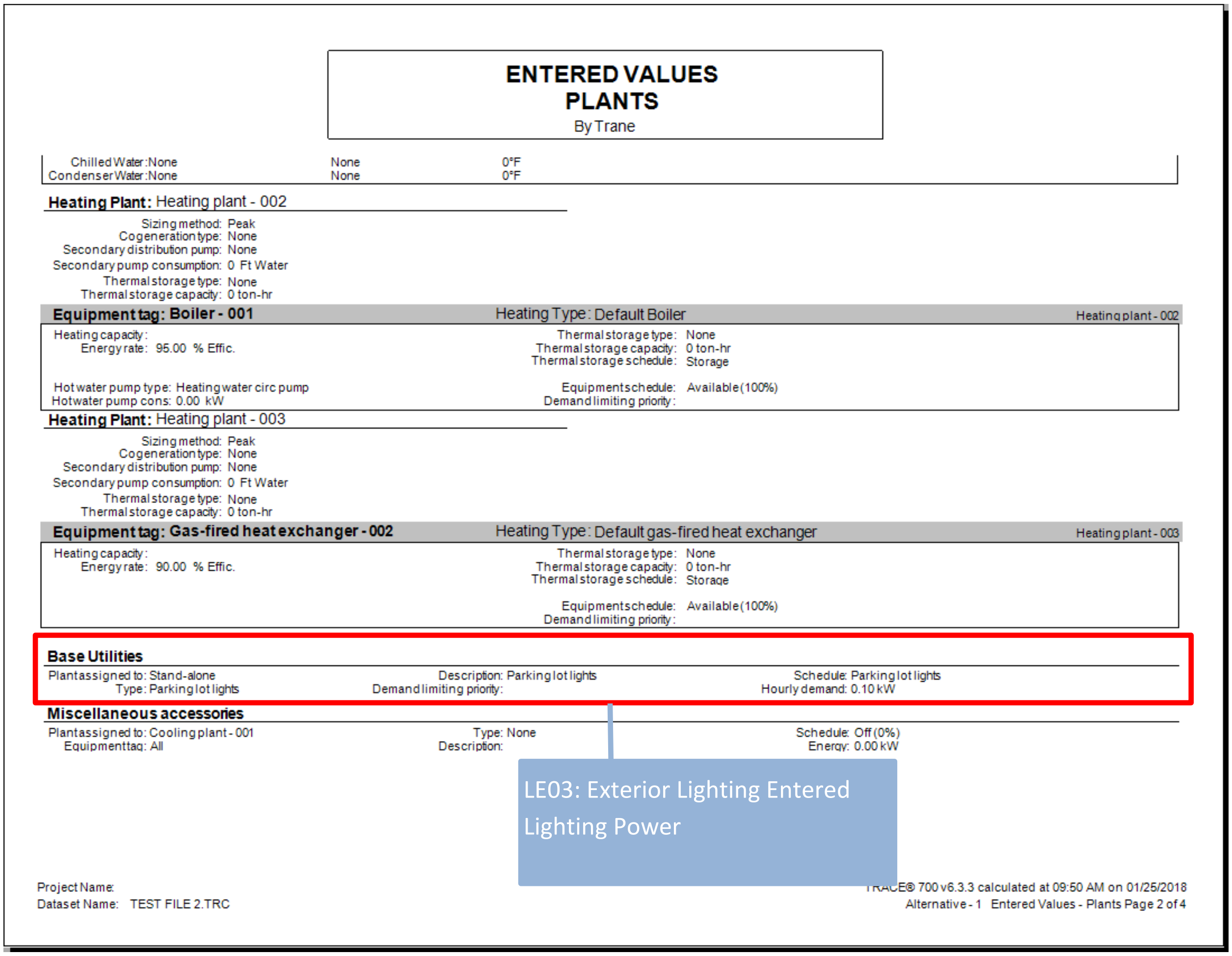
AHVAC11: DX cooling efficiencies



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:
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
Hot water pump cons: 0.00 kW
Equipment schedule: Available (100%)
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:
Energy rate: 90.00 % Effic.
Thermal storage type: None
Thermal storage capacity: 0 ton-hr
Thermal storage schedule: Storage
Equipment schedule: Available (100%)
Demand limiting priority:

Base Utilities

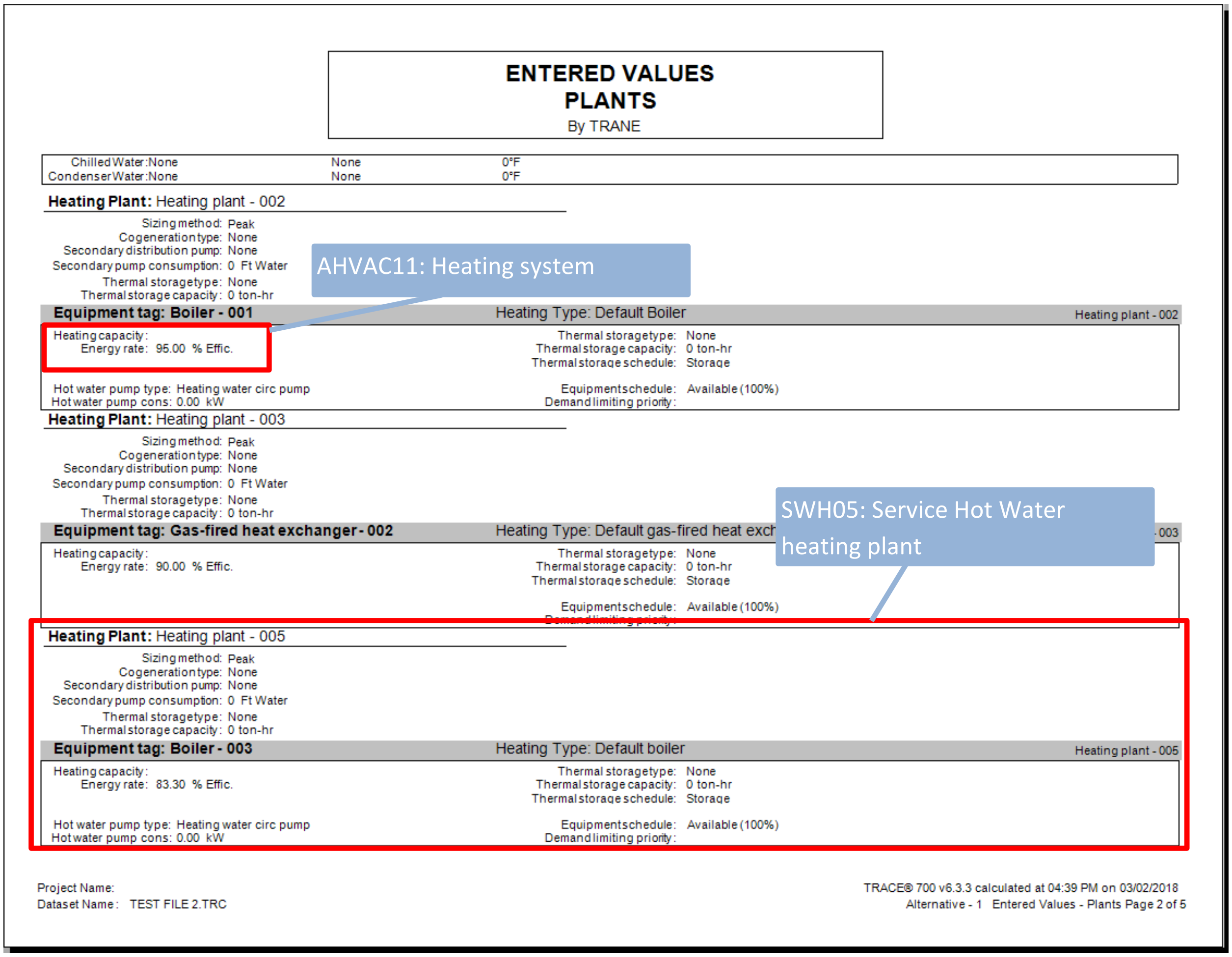
Plant assigned to: Stand-alone
Type: Parking lot lights
Description: Parking lot lights
Demand limiting priority:
Schedule: Parking lot lights
Hourly demand: 0.10 kW

Miscellaneous accessories

Plant assigned to: Cooling plant - 001
Equipment tag: All
Type: None
Description:
Schedule: Off (0%)
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

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:
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
Hot water pump cons: 0.00 kW
Equipment schedule: Available (100%)
Demand limiting priority:

AHVAC11: Heating system

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 exch 003

Heating capacity:
Energy rate: 90.00 % Effic.
Thermal storage type: None
Thermal storage capacity: 0 ton-hr
Thermal storage schedule: Storage
Equipment schedule: Available (100%)
Demand limiting priority:

SWH05: Service Hot Water heating plant

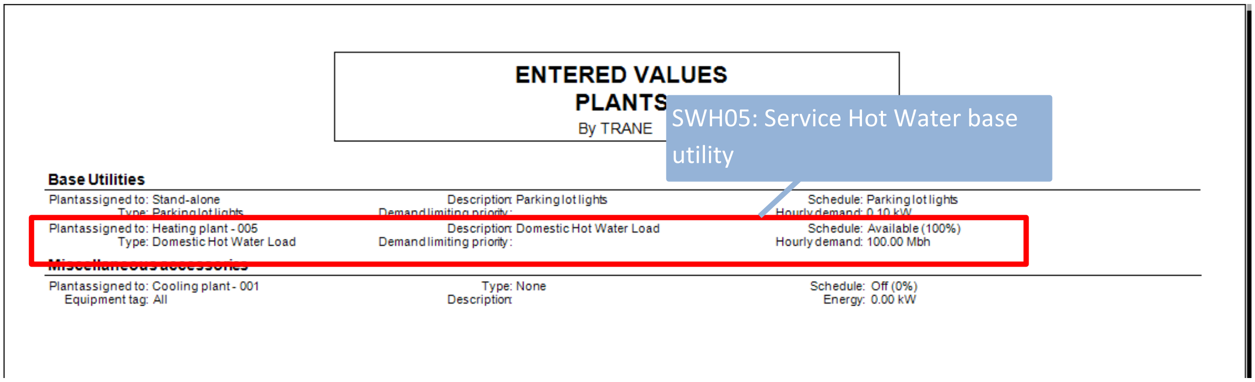
Heating Plant: Heating plant - 005

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

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
Hot water pump cons: 0.00 kW
Equipment schedule: Available (100%)
Demand limiting 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

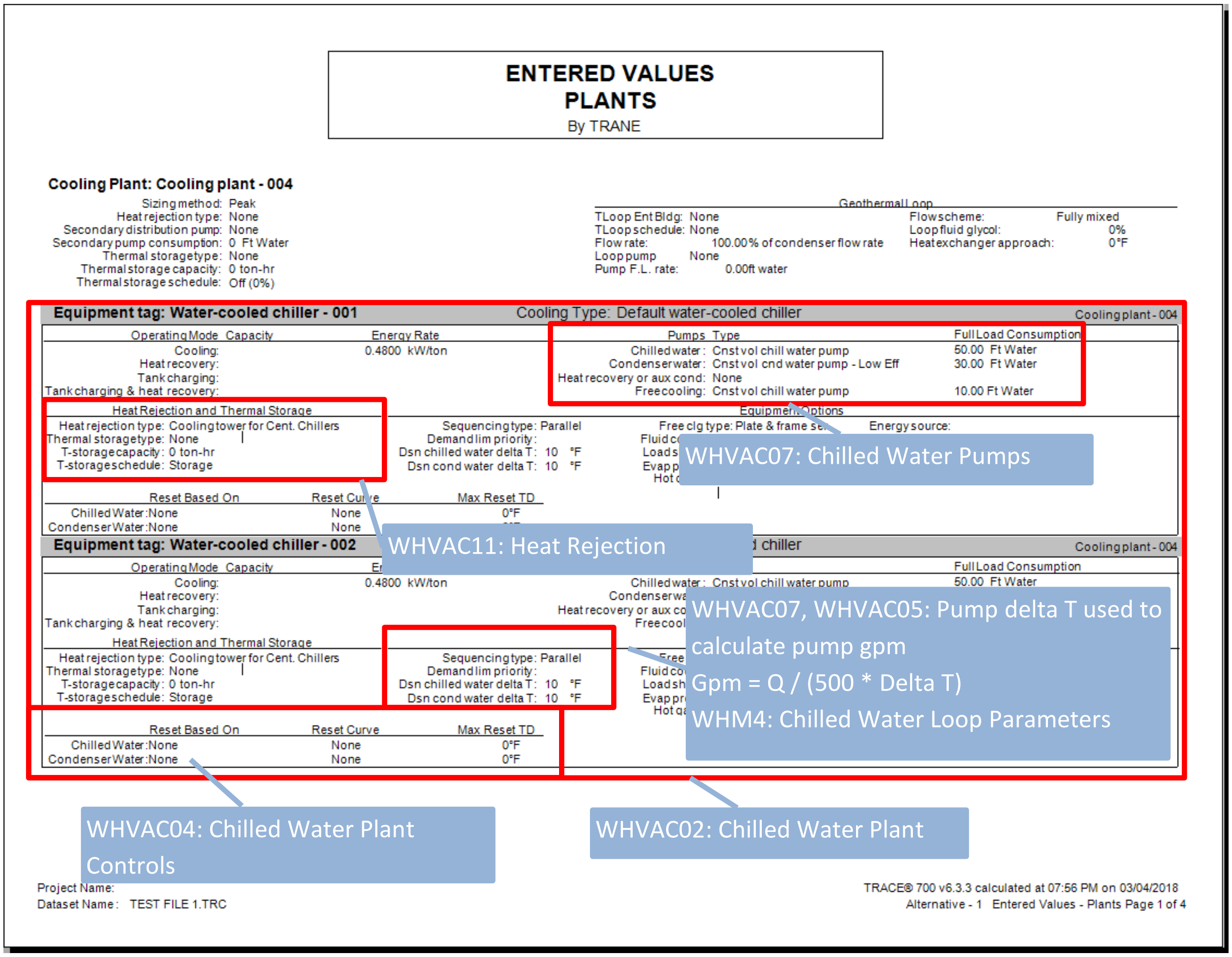
SWH05: Service Hot Water base utility

Base Utilities

Plant assigned to: Stand-alone Description: Parking lot lights Schedule: Parking lot lights
Type: Parking lot lights Demand limiting priority: Hourly demand: 0.10 kW
Plant assigned to: Heating plant - 005 Description: Domestic Hot Water Load Schedule: Available (100%)
Type: Domestic Hot Water Load Demand limiting priority: Hourly demand: 100.00 Mbh

Miscellaneous accessories

Plant assigned to: Cooling plant - 001 Type: None Schedule: Off (0%)
Equipment tag: All Description: 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	Flow scheme:	Fully mixed
TLoop schedule:	None	Loop fluid glycol:	0%
Flow rate:	100.00% of condenser flow rate	Heat exchanger approach:	0°F
Loop pump	None		
Pump F.L. rate:	0.00ft water		

Equipment tag: Water-cooled chiller - 001 Cooling Type: Default water-cooled chiller Cooling plant - 004

Operating Mode	Capacity	Energy Rate
Cooling:		0.4800 kW/ton
Heat recovery:		
Tank charging:		
Tank charging & heat recovery:		

Pumps	Type	Full Load Consumption
Chilled water:	Cnst vol chill water pump	50.00 Ft Water
Condenser water:	Cnst vol cnd water pump - Low Eff	30.00 Ft Water
Heat recovery or aux cond:	None	
Free cooling:	Cnst vol chill water pump	10.00 Ft Water

Heat Rejection and Thermal Storage
Heat rejection type: Cooling tower for Cent. Chillers
Thermal storage type: None
T-storage capacity: 0 ton-hr
T-storage schedule: Storage

Sequencing type: Parallel
Demand lim priority:
Dsn chilled water delta T: 10 °F
Dsn cond water delta T: 10 °F

Equipment Options
Free clg type: Plate & frame se
Fluid c
Load s
Evap p
Hot c
Energy source:

Reset Based On	Reset Curve	Max Reset TD
Chilled Water: None	None	0°F
Condenser Water: None	None	

Equipment tag: Water-cooled chiller - 002 chiller Cooling plant - 004

Operating Mode	Capacity	Er
Cooling:		0.4800 kW/ton
Heat recovery:		
Tank charging:		
Tank charging & heat recovery:		

		Full Load Consumption
Chilled water:	Cnst vol chill water pump	50.00 Ft Water
Condenserwa		
Heat recovery or aux co		
Freecool		

Heat Rejection and Thermal Storage
Heat rejection type: Cooling tower for Cent. Chillers
Thermal storage type: None
T-storage capacity: 0 ton-hr
T-storage schedule: Storage

Sequencing type: Parallel
Demand lim priority:
Dsn chilled water delta T: 10 °F
Dsn cond water delta T: 10 °F

Free
Fluid co
Load sh
Evap pr
Hot ga

Reset Based On	Reset Curve	Max Reset TD
Chilled Water: None	None	0°F
Condenser Water: None	None	0°F

WHVAC07: Chilled Water Pumps

WHVAC11: Heat Rejection

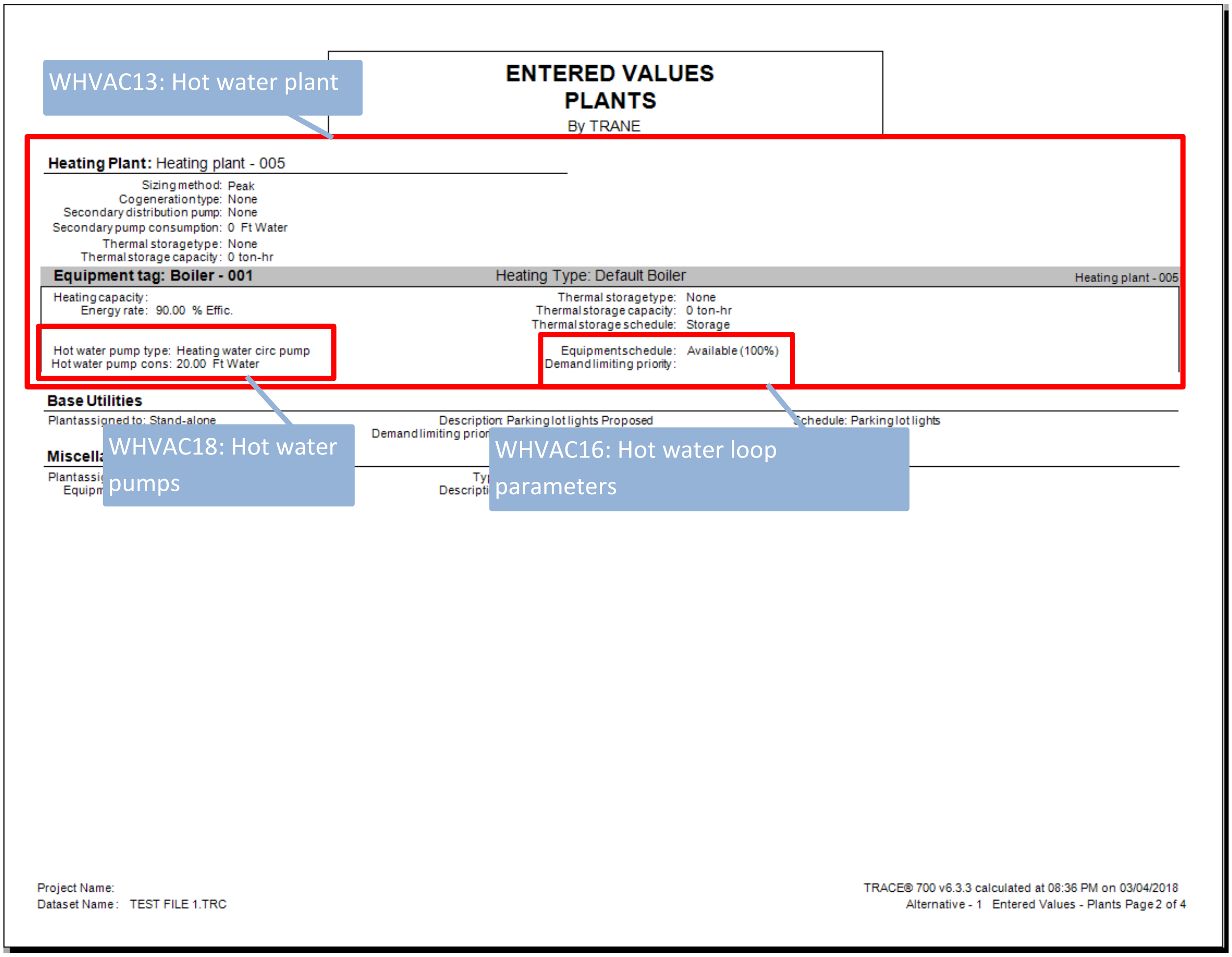
WHVAC07, WHVAC05: Pump delta T used to calculate pump gpm
Gpm = Q / (500 * Delta T)
WHM4: Chilled Water Loop Parameters

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



WHVAC13: Hot water plant

WHVAC18: Hot water pumps

WHVAC16: Hot water loop parameters

ENTERED VALUES
PLANTS
By TRANE

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

Equipment tag: Boiler - 001 Heating Type: Default Boiler Heating plant - 005

Heating capacity:
Energy rate: 90.00 % Effic.
Thermal storage type: None
Thermal storage capacity: 0 ton-hr
Thermal storage schedule: Storage

Hot water pump type: Heating water circ pump
Hot water pump cons: 20.00 Ft Water
Equipment schedule: Available (100%)
Demand limiting priority:

Base Utilities

Plant assigned to: Stand-alone
Description: Parking lot lights Proposed
Demand limiting prior
chedule: Parking lot lights

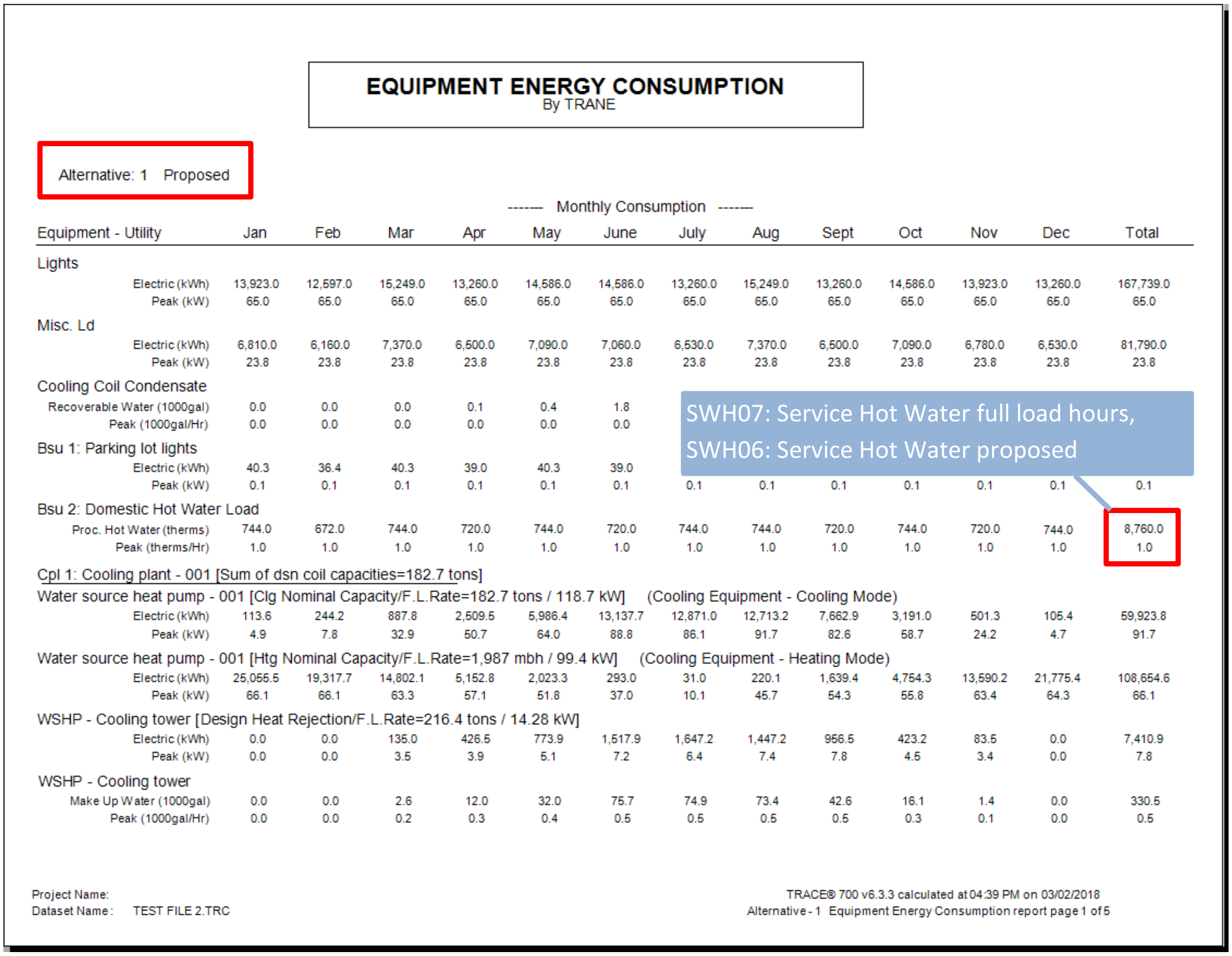
Miscella

Plantassi
Equipm
Ty
Descripti

Project Name:
Dataset Name: TEST FILE 1.TRC

TRACE® 700 v6.3.3 calculated at 08:36 PM on 03/04/2018
Alternative - 1 Entered Values - Plants Page 2 of 4

Equipment Energy Consumption Report



EQUIPMENT ENERGY CONSUMPTION
By TRANE

Alternative: 1 Proposed

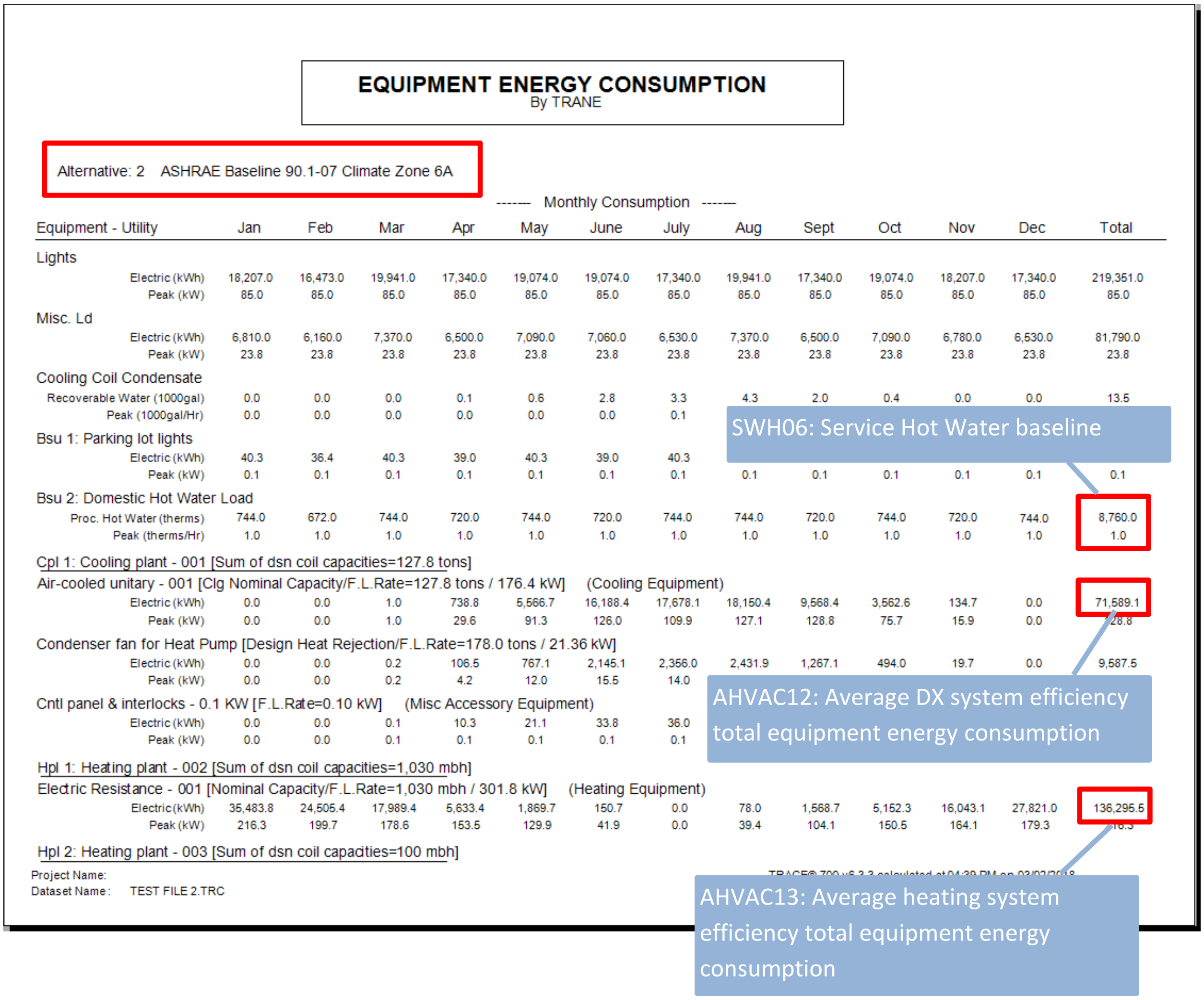
------- Monthly Consumption -------

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Lights													
Electric (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)	25,055.5	19,317.7	14,802.1	5,152.8	2,023.3	293.0	31.0	220.1	1,639.4	4,754.3	13,590.2	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bsu 1: Parking lot lights													
Electric (kWh)	40.3	36.4	40.3	39.0	40.3	39.0	40.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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=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	[illegible]
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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Peak (kW)	0.0	0.0	0.1	0.1	0.1	0.1	0.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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	[illegible]
Hpl 2: Heating plant - 003 [Sum of dsn coil capacities=100 mbh]													

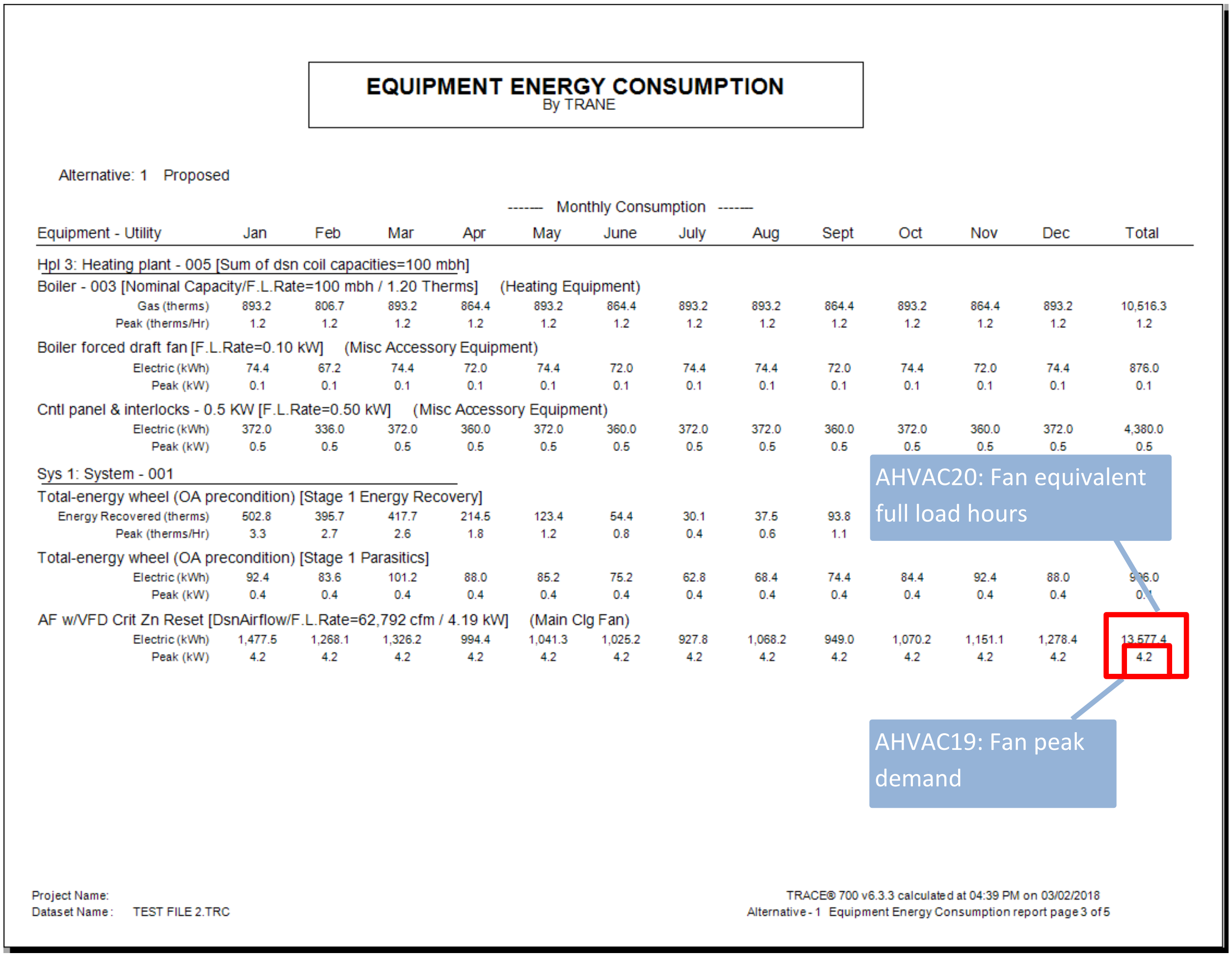
Project Name:
Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 04:39 PM on 03/02/2018

SWH06: Service Hot Water baseline

AHVAC12: Average DX system efficiency total equipment energy consumption

AHVAC13: Average heating system efficiency total equipment energy consumption



EQUIPMENT ENERGY CONSUMPTION

By TRANE

Alternative: 1 Proposed

------ Monthly Consumption ------

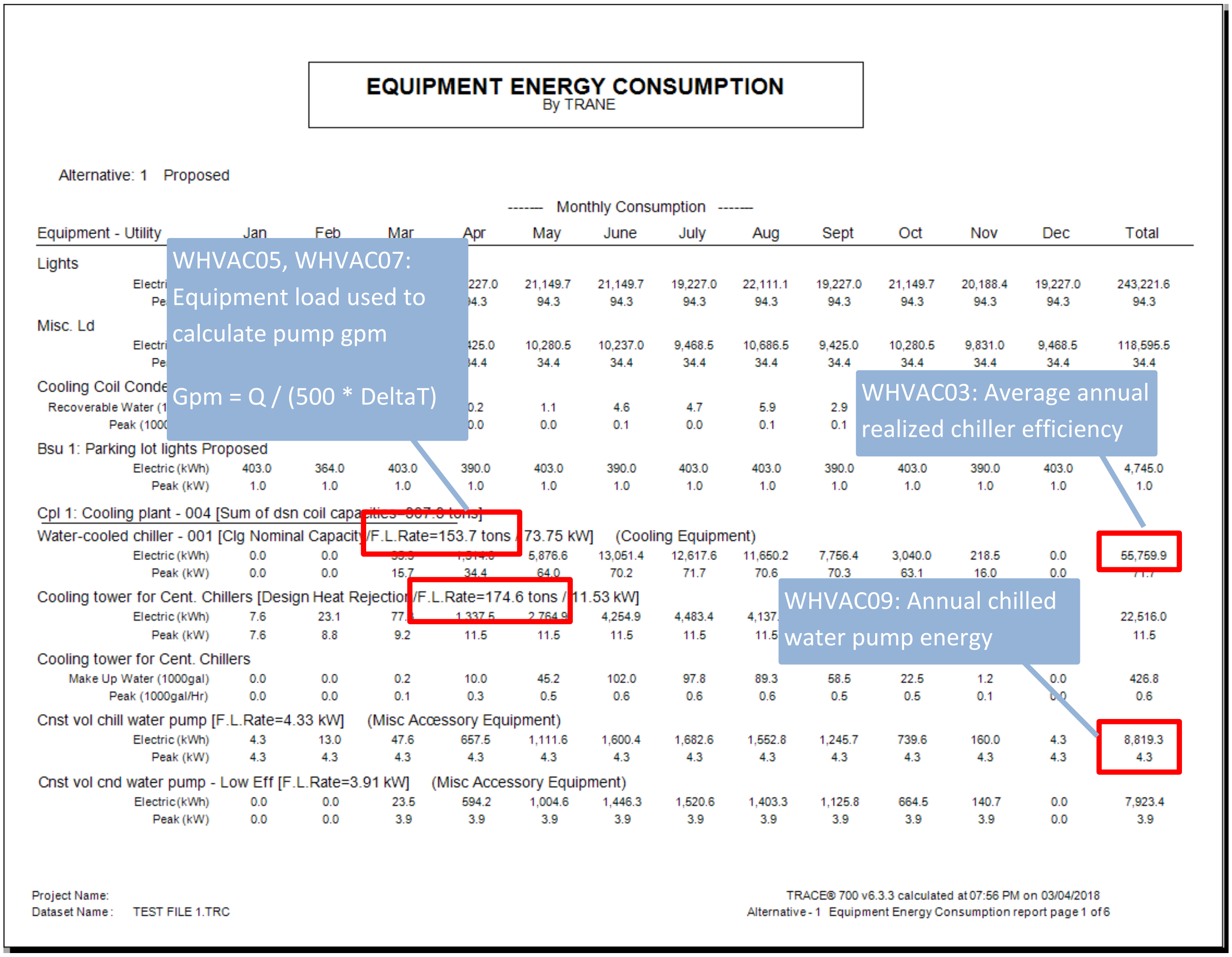
Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Hpl 3: Heating plant - 005 [Sum of dsn coil capacities=100 mbh]													
Boiler - 003 [Nominal Capacity/F.L.Rate=100 mbh / 1.20 Therms] (Heating Equipment)													
Gas (therms)	893.2	806.7	893.2	864.4	893.2	864.4	893.2	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	9[illegible]6.0
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.[illegible]
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													
Electri	[illegible]	[illegible]	[illegible]	[illegible]	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
Pe	[illegible]	[illegible]	[illegible]	[illegible]	94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.3
Misc. Ld													
Electri	[illegible]	[illegible]	[illegible]	[illegible]	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
Pe	[illegible]	[illegible]	[illegible]	[illegible]	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4
Cooling Coil Conde													
Recoverable Water (1	[illegible]	[illegible]	[illegible]	[illegible]	1.1	4.6	4.7	5.9	2.9	[illegible]	[illegible]	[illegible]	[illegible]
Peak (100	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.1	0.0	0.1	0.1	[illegible]	[illegible]	[illegible]	[illegible]
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 capa[illegible]													
Water-cooled chiller - 001 [Clg Nominal Capacity/F.L.Rate=153.7 tons / 73.75 kW] (Cooling Equipment)													
Electric (kWh)	0.0	0.0	[illegible]	[illegible]	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	64.0	70.2	71.7	70.6	70.3	63.1	16.0	0.0	71.7
Cooling tower for Cent. Chillers [Design Heat Rejection/F.L.Rate=174.6 tons / 11.53 kW]													
Electric (kWh)	7.6	23.1	[illegible]	1,337.5	2,764.9	4,254.9	4,483.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22,516.0
Peak (kW)	7.6	8.8	9.2	11.5	11.5	11.5	11.5	11.5	[illegible]	[illegible]	[illegible]	[illegible]	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

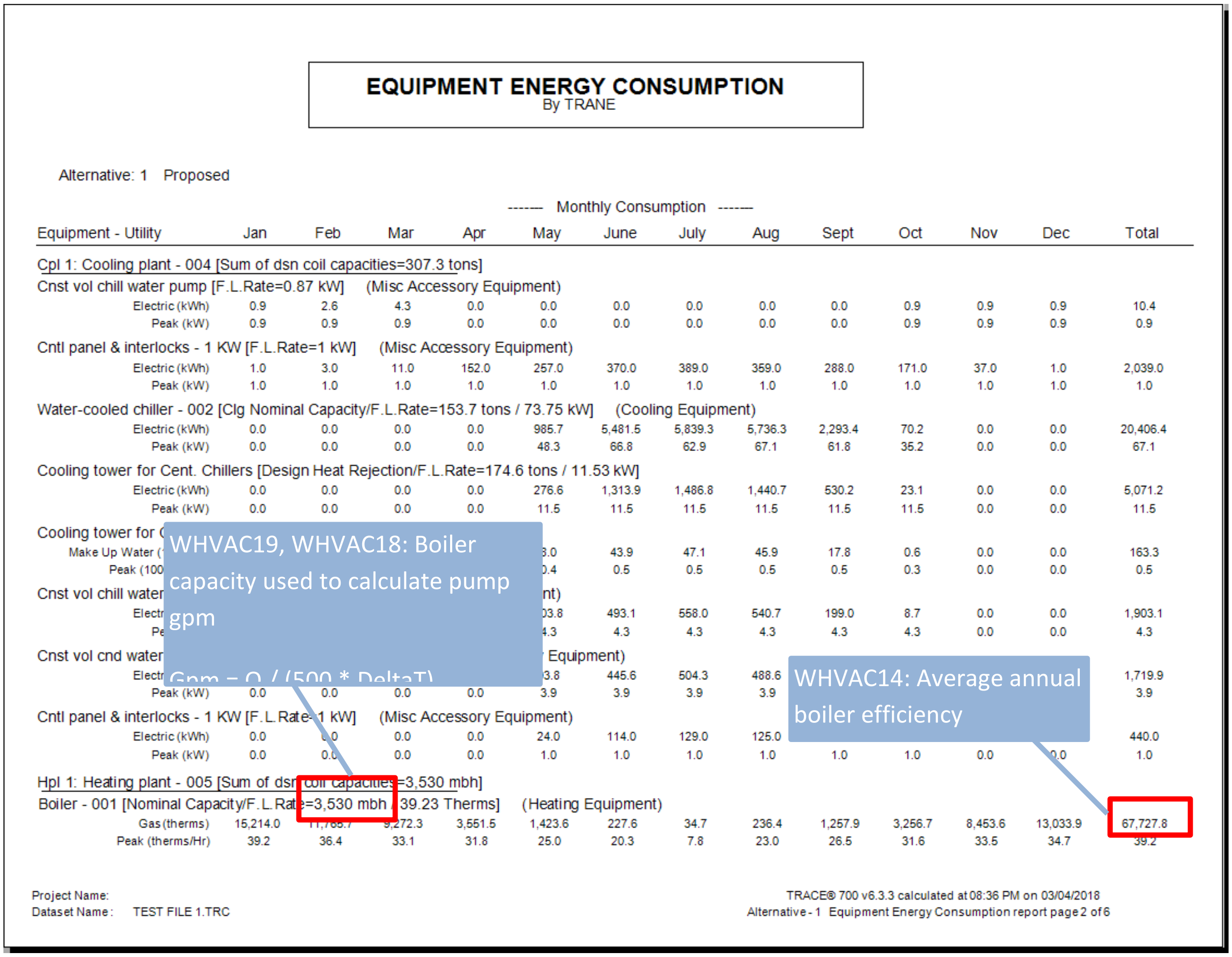
Gpm = Q / (500 * DeltaT)

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	35.2	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 (													
Make Up Water (					3.0	43.9	47.1	45.9	17.8	0.6	0.0	0.0	163.3
Peak (100					0.4	0.5	0.5	0.5	0.5	0.3	0.0	0.0	0.5
Cnst vol chill water nt)													
Electr					03.8	493.1	558.0	540.7	199.0	8.7	0.0	0.0	1,903.1
Pe					4.3	4.3	4.3	4.3	4.3	4.3	0.0	0.0	4.3
Cnst vol cnd water Equipment)													
Electr					3.8	445.6	504.3	488.6					1,719.9
Peak (kW)	0.0	0.0	0.0	0.0	3.9	3.9	3.9	3.9					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					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	11,765.7	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

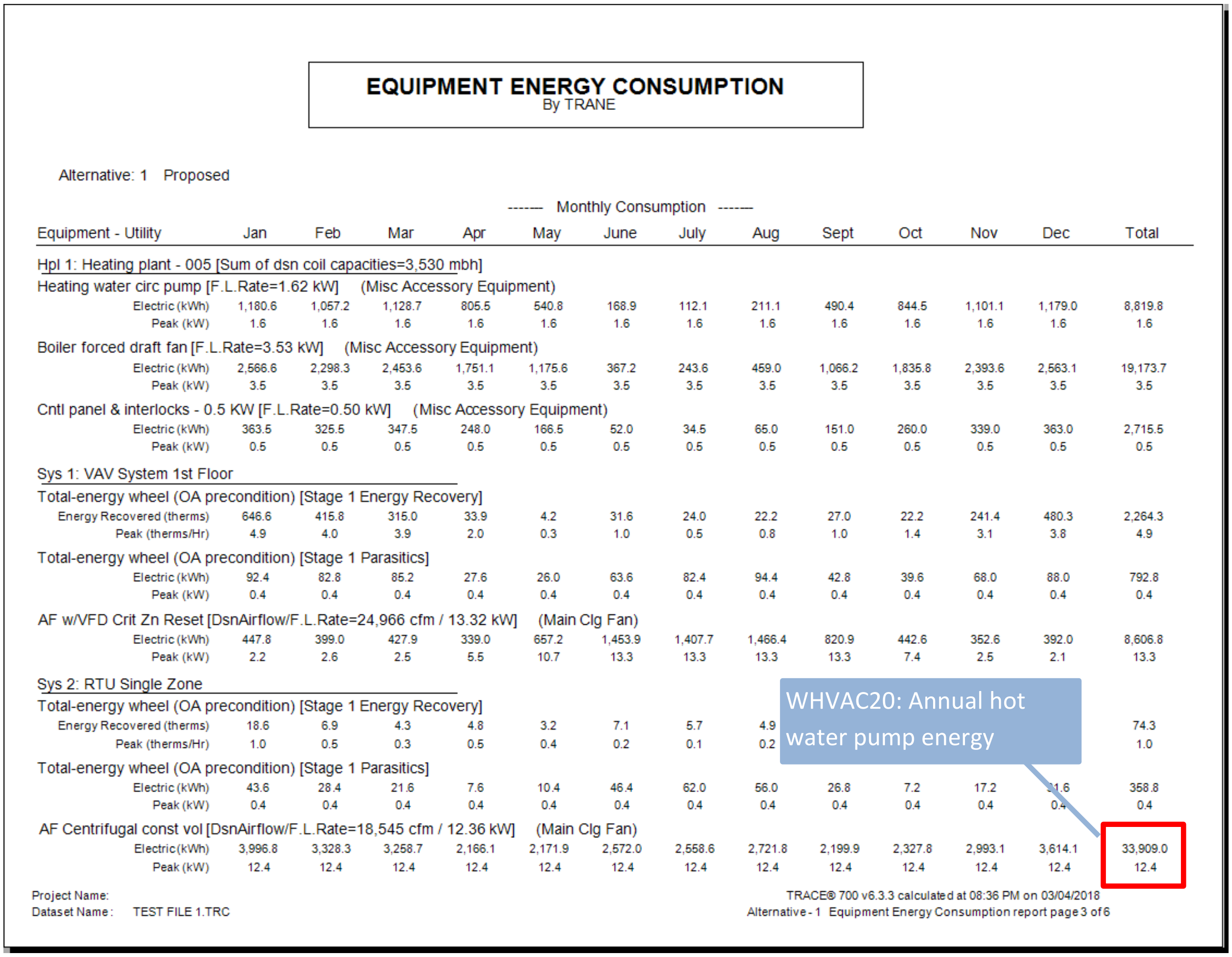
WHVAC19, WHVAC18: Boiler capacity used to calculate pump gpm

Gpm = Q / (500 * DeltaT)

WHVAC14: Average annual boiler efficiency

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 ------

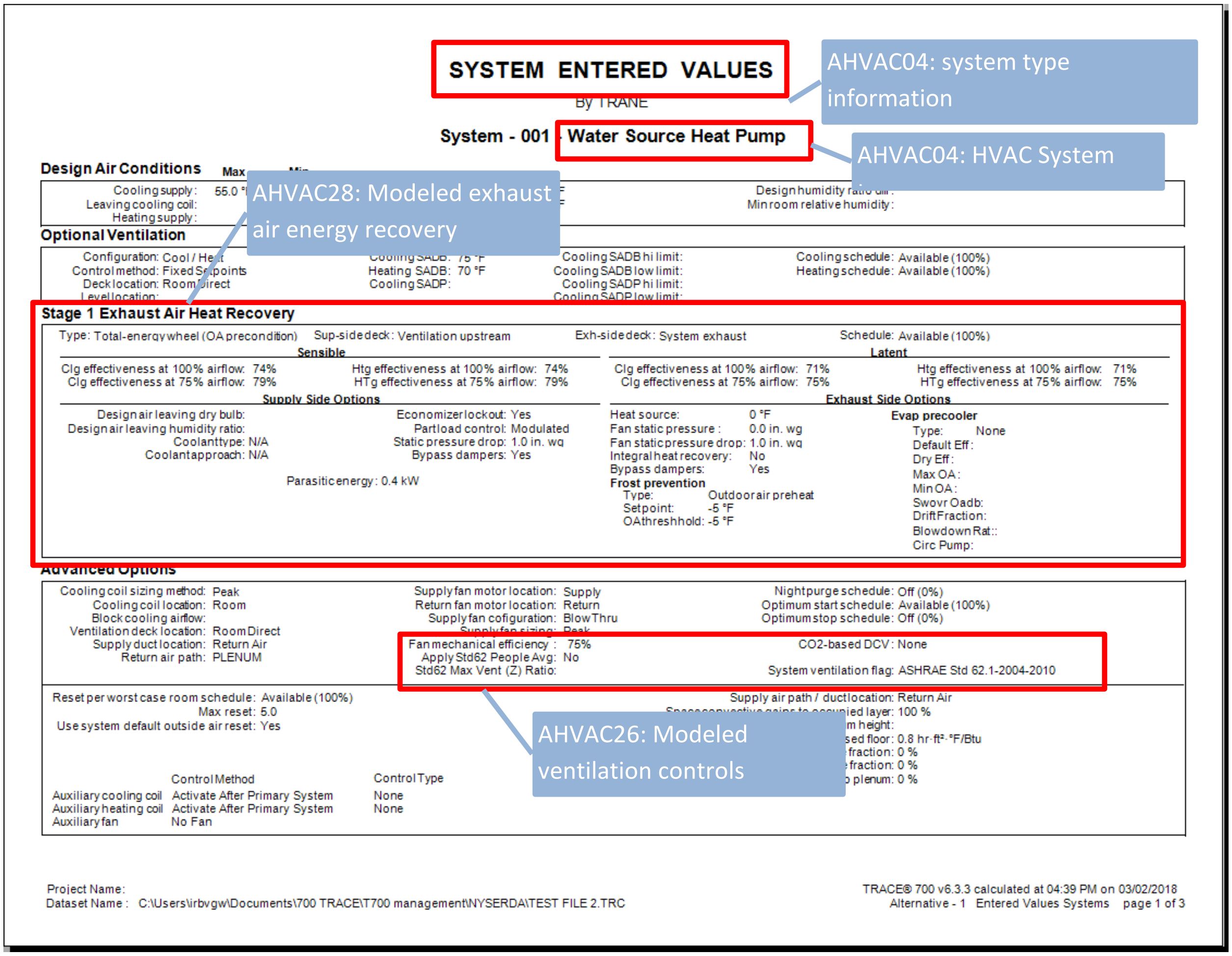
Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Hpl 1: Heating plant - 005 [Sum of dsn coil capacities=3,530 mbh]													
Heating water circ pump [F.L.Rate=1.62 kW] (Misc Accessory Equipment)													
Electric (kWh)	1,180.6	1,057.2	1,128.7	805.5	540.8	168.9	112.1	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	2,453.6	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	260.0	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	[illegible]	[illegible]	[illegible]	[illegible]	74.3
Peak (therms/Hr)	1.0	0.5	0.3	0.5	0.4	0.2	0.1	0.2	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]1.6	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

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 Entered Values Report



AHVAC04: system type information

AHVAC04: HVAC System

AHVAC28: Modeled exhaust air energy recovery

AHVAC26: Modeled ventilation controls

SYSTEM ENTERED VALUES

By TRANE

System - 001 - Water Source Heat Pump

Design Air Conditions Max Min

Cooling supply: 55.0 °

Leaving cooling coil:

Heating supply:

Design humidity ratio diff:

Min room relative humidity:

Optional Ventilation

Configuration: Cool / He t

Control method: Fixed S tpoints

Deck location: Room irect

Level location:

Cooling SADB: 75 °F

Heating SADB: 70 °F

Cooling SADP:

Cooling SADB hi limit:

Cooling SADB low limit:

Cooling SADP hi limit:

Cooling SADP low limit:

Cooling schedule: Available (100%)

Heating schedule: Available (100%)

Stage 1 Exhaust Air Heat Recovery

Type: Total-energy wheel (OA precondition) Sup-side deck: Ventilation upstream Exh-side deck: System exhaust Schedule: Available (100%)

Sensible

Clg effectiveness at 100% airflow: 74%

Clg effectiveness at 75% airflow: 79%

Htg effectiveness at 100% airflow: 74%

HTg effectiveness at 75% airflow: 79%

Latent

Clg effectiveness at 100% airflow: 71%

Clg effectiveness at 75% airflow: 75%

Htg effectiveness at 100% airflow: 71%

HTg effectiveness at 75% airflow: 75%

Supply Side Options

Design air leaving dry bulb:

Design air leaving humidity ratio:

Coolant type: N/A

Coolant approach: N/A

Economizer lockout: Yes

Partload control: Modulated

Static pressure drop: 1.0 in. wg

Bypass dampers: Yes

Parasitic energy: 0.4 kW

Exhaust Side Options

Heat source: 0 °F

Fan static pressure : 0.0 in. wg

Fan static pressure drop: 1.0 in. wg

Integral heat recovery: No

Bypass dampers: Yes

Frost prevention

Type: Outdoor air preheat

Setpoint: -5 °F

OA threshhold: -5 °F

Evap precooler

Type: None

Default Eff:

Dry Eff:

Max OA:

Min OA:

Swovr Oadb:

Drift Fraction:

Blowdown Rat::

Circ Pump:

Advanced Options

Cooling coil sizing method: Peak

Cooling coil location: Room

Block cooling airflow:

Ventilation deck location: Room Direct

Supply duct location: Return Air

Return air path: PLENUM

Supply fan motor location: Supply

Return fan motor location: Return

Supply fan cofiguration: Blow Thru

Supply fan sizing: Peak

Fan mechanical efficiency : 75%

Apply Std62 People Avg: No

Std62 Max Vent (Z) Ratio:

Night purge schedule: Off (0%)

Optimum start schedule: Available (100%)

Optimum stop schedule: Off (0%)

CO2-based DCV: None

System ventilation flag: ASHRAE Std 62.1-2004-2010

Reset per worst case room schedule: Available (100%)

Max reset: 5.0

Use system default outside air reset: Yes

Supply air path / duct location: Return Air

Space convective gains to occupied layer: 100 %

m height:

sed floor: 0.8 hr·ft²·°F/Btu

fraction: 0 %

fraction: 0 %

plenum: 0 %

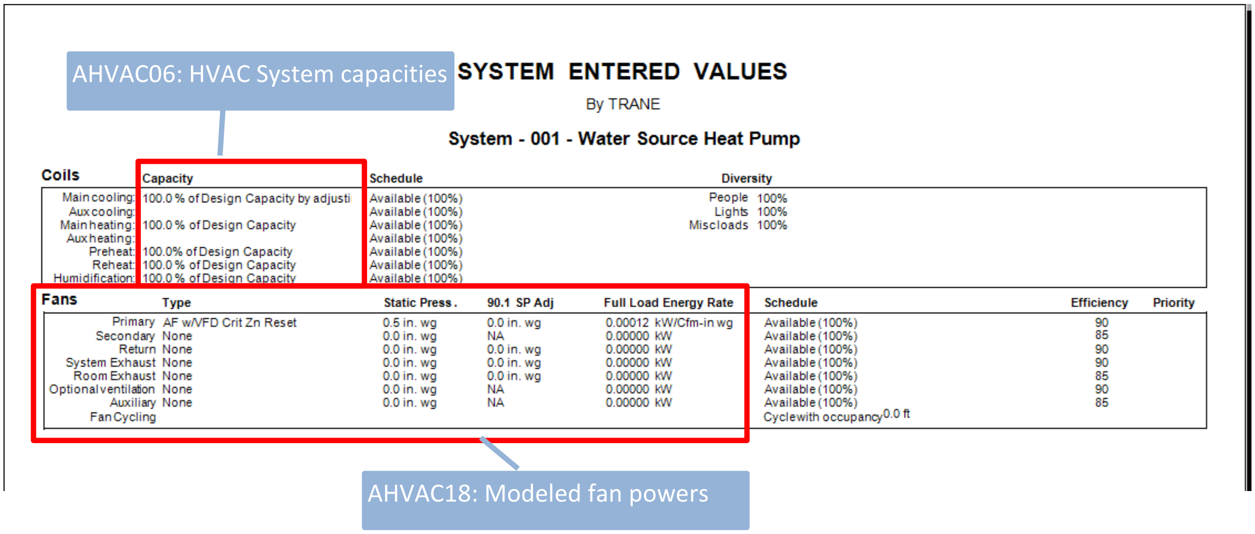
	Control Method	Control Type
Auxiliary cooling coil	Activate After Primary System	None
Auxiliary heating coil	Activate After Primary System	None
Auxiliary fan	No Fan	

Project Name:

Dataset Name : C:\Users\irbvgw\Documents\700 TRACE\T700 management\NYSERDA\TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 04:39 PM on 03/02/2018

Alternative - 1 Entered Values Systems page 1 of 3



AHVAC06: HVAC System capacities

AHVAC18: Modeled fan powers

SYSTEM ENTERED VALUES

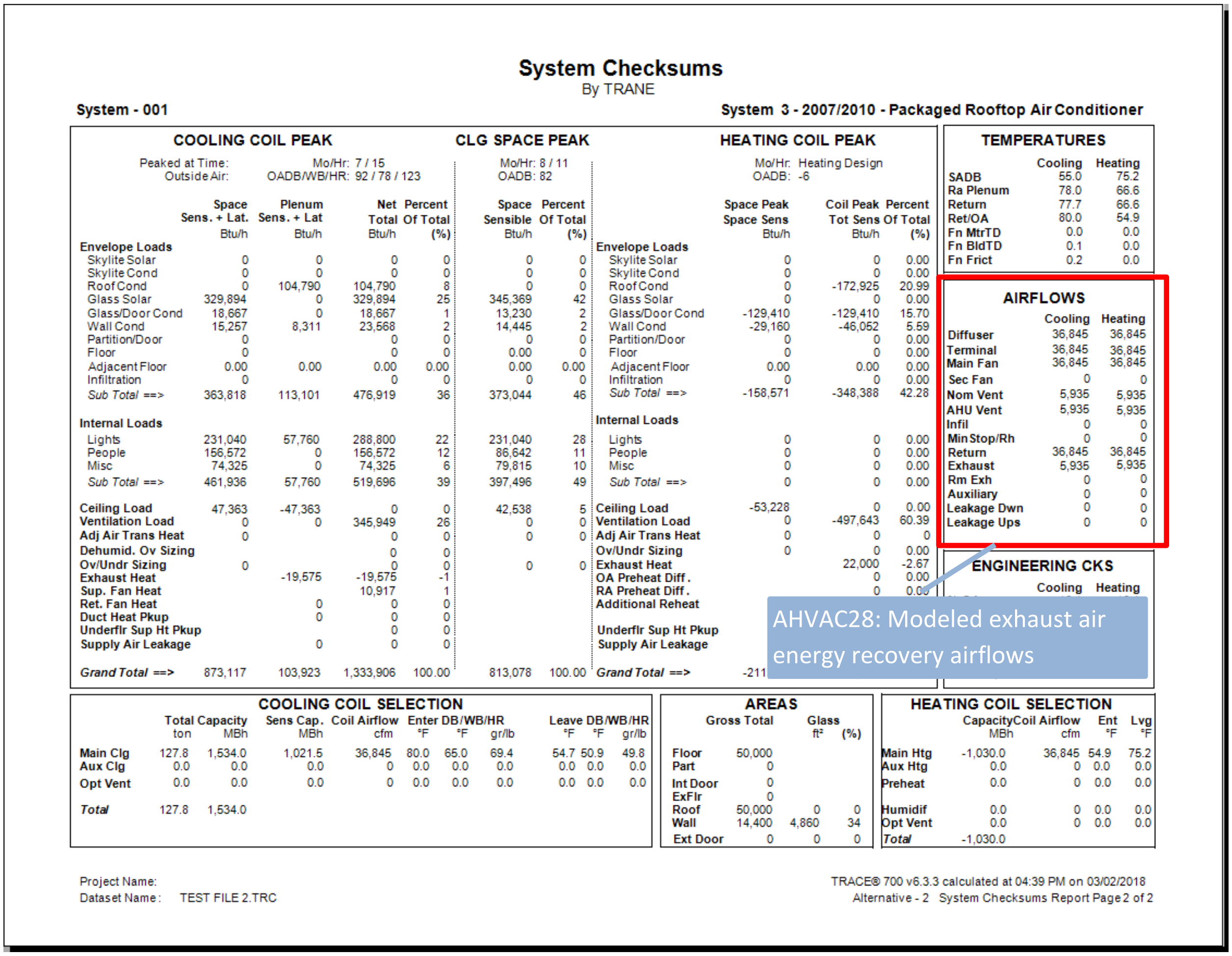
By TRANE

System - 001 - Water Source Heat Pump

Coils	Capacity	Schedule	Diversity	
Main cooling:	100.0 % of Design Capacity by adjusti	Available (100%)	People	100%
Aux cooling:		Available (100%)	Lights	100%
Main heating:	100.0 % of Design Capacity	Available (100%)	Miscloads	100%
Aux heating:		Available (100%)		
Preheat:	100.0% of Design Capacity	Available (100%)		
Reheat:	100.0 % of Design Capacity	Available (100%)		
Humidification:	100.0 % of Design Capacity	Available (100%)		

Fans	Type	Static Press.	90.1 SP Adj	Full Load Energy Rate	Schedule	Efficiency	Priority
Primary	AF w/VFD Crit Zn Reset	0.5 in. wg	0.0 in. wg	0.00012 kW/Cfm-in wg	Available (100%)	90	
Secondary	None	0.0 in. wg	NA	0.00000 kW	Available (100%)	85	
Return	None	0.0 in. wg	0.0 in. wg	0.00000 kW	Available (100%)	90	
System Exhaust	None	0.0 in. wg	0.0 in. wg	0.00000 kW	Available (100%)	90	
Room Exhaust	None	0.0 in. wg	0.0 in. wg	0.00000 kW	Available (100%)	85	
Optional ventilation	None	0.0 in. wg	NA	0.00000 kW	Available (100%)	90	
Auxiliary	None	0.0 in. wg	NA	0.00000 kW	Available (100%)	85	
Fan Cycling					Cycle with occupancy 0.0 ft		

System Checksums Report



System Checksums

By TRANE

System - 001

System 3 - 2007/2010 - Packaged Rooftop Air Conditioner

COOLING COIL PEAK / CLG SPACE PEAK

Peaked at Time: Mo/Hr: 7 / 15
Outside Air: OADB/WB/HR: 92 / 78 / 123

CLG SPACE PEAK: Mo/Hr: 8 / 11
OADB: 82

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads						
Skylite Solar	0	0	0	0	0	0
Skylite Cond	0	0	0	0	0	0
Roof Cond	0	104,790	104,790	8	0	0
Glass Solar	329,894	0	329,894	25	345,369	42
Glass/Door Cond	18,667	0	18,667	1	13,230	2
Wall Cond	15,257	8,311	23,568	2	14,445	2
Partition/Door	0		0	0	0	0
Floor	0		0	0	0.00	0
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00
Infiltration	0		0	0	0	0
Sub Total ==>	363,818	113,101	476,919	36	373,044	46
Internal Loads						
Lights	231,040	57,760	288,800	22	231,040	28
People	156,572	0	156,572	12	86,642	11
Misc	74,325	0	74,325	6	79,815	10
Sub Total ==>	461,936	57,760	519,696	39	397,496	49
Ceiling Load	47,363	-47,363	0	0	42,538	5
Ventilation Load	0	0	345,949	26	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			0	0		
Ov/Undr Sizing	0		0	0	0	0
Exhaust Heat		-19,575	-19,575	-1		
Sup. Fan Heat			10,917	1		
Ret. Fan Heat		0	0	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	873,117	103,923	1,333,906	100.00	813,078	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: -6

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	-172,925	20.99
Glass Solar	0	0	0.00
Glass/Door Cond	-129,410	-129,410	15.70
Wall Cond	-29,160	-46,052	5.59
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0.00	0.00	0.00
Infiltration	0	0	0.00
Sub Total ==>	-158,571	-348,388	42.28
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	-53,228	0	0.00
Ventilation Load	0	-497,643	60.39
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		22,000	-2.67
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.0
Additional Reheat			
Underflr Sup Ht Pkup			
Supply Air Leakage			
Grand Total ==>	-211		

TEMPERATURES

	Cooling	Heating
SADB	55.0	75.2
Ra Plenum	78.0	66.6
Return	77.7	66.6
Ret/OA	80.0	54.9
Fn MtrTD	0.0	0.0
Fn BldTD	0.1	0.0
Fn Frict	0.2	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
Min Stop/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

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR °F	Enter DB/WB/HR °F	Enter DB/WB/HR gr/lb	Leave DB/WB/HR °F	Leave DB/WB/HR °F	Leave DB/WB/HR gr/lb
Main Clg	127.8	1,534.0	1,021.5	36,845	80.0	65.0	69.4	54.7	50.9	49.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	127.8	1,534.0								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	50,000		
Part	0		
Int Door	0		
ExFlr	0		
Roof	50,000	0	0
Wall	14,400	4,860	34
Ext Door	0	0	0

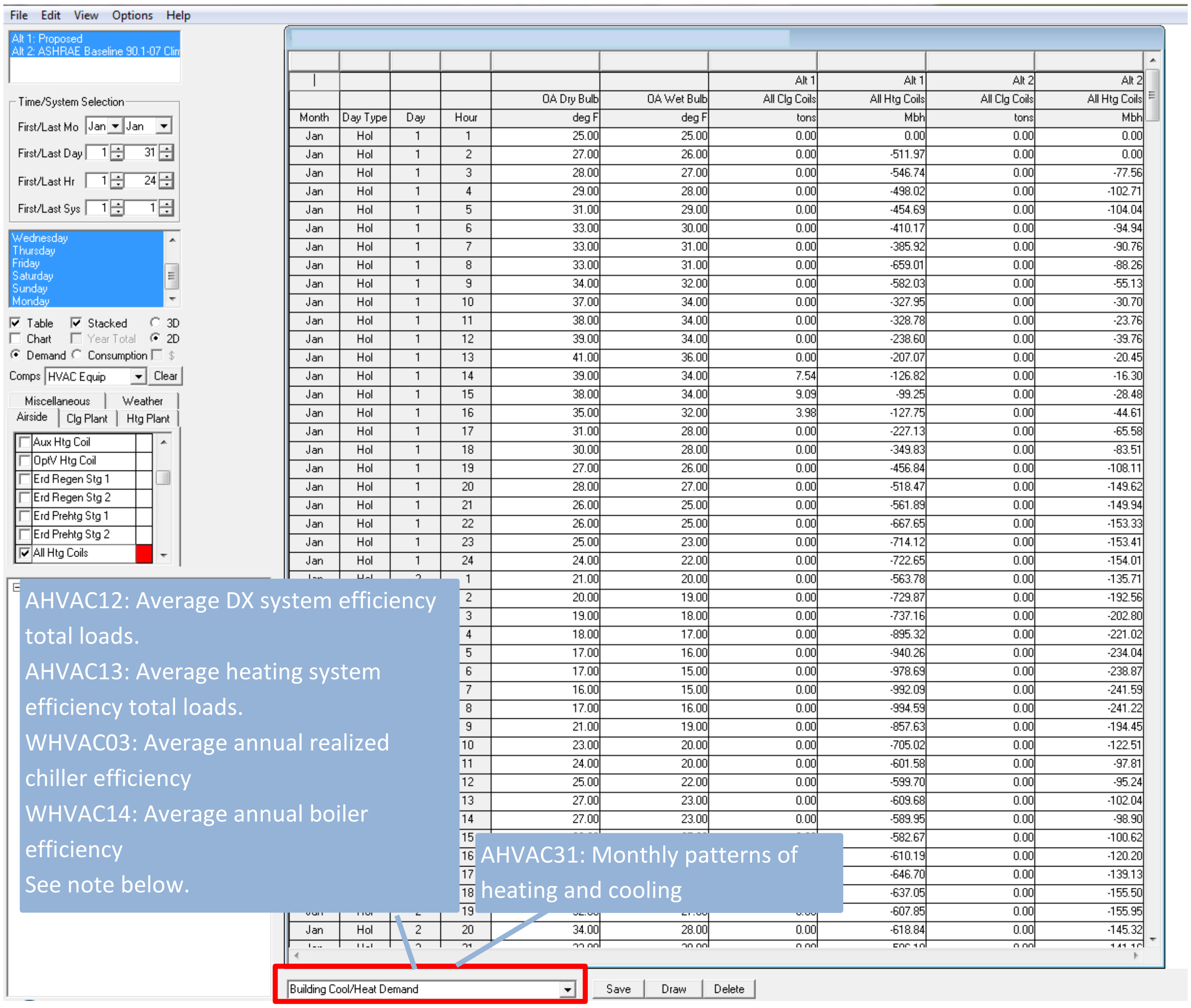
HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-1,030.0	36,845	54.9	75.2
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	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



Alt 1: Proposed
Alt 2: ASHRAE Baseline 90.1-07 Clin

Time/System Selection
First/Last Mo: Jan Jan
First/Last Day: 1 31
First/Last Hr: 1 24
First/Last Sys: 1 1

Wednesday
Thursday
Friday
Saturday
Sunday
Monday

☑ Table ☑ Stacked ○ 3D
☐ Chart ☐ Year Total ● 2D
● Demand ○ Consumption ☐ $

Comps: HVAC Equip; Clear

☐ Aux Htg Coil
☐ OptV Htg Coil
☐ Erd Regen Stg 1
☐ Erd Regen Stg 2
☐ Erd Prehtg Stg 1
☐ Erd Prehtg Stg 2
☑ All Htg Coils 🟥

						Alt 1	Alt 1	Alt 2	Alt 2
				OA Dry Bulb	OA Wet Bulb	All Clg Coils	All Htg Coils	All Clg Coils	All Htg Coils
Month	Day Type	Day	Hour	deg F	deg F	tons	Mbh	tons	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	-385.92	0.00	-90.76
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	-55.13
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
			1	21.00	20.00	0.00	-563.78	0.00	-135.71
			2	20.00	19.00	0.00	-729.87	0.00	-192.56
			3	19.00	18.00	0.00	-737.16	0.00	-202.80
			4	18.00	17.00	0.00	-895.32	0.00	-221.02
			5	17.00	16.00	0.00	-940.26	0.00	-234.04
			6	17.00	15.00	0.00	-978.69	0.00	-238.87
			7	16.00	15.00	0.00	-992.09	0.00	-241.59
			8	17.00	16.00	0.00	-994.59	0.00	-241.22
			9	21.00	19.00	0.00	-857.63	0.00	-194.45
			10	23.00	20.00	0.00	-705.02	0.00	-122.51
			11	24.00	20.00	0.00	-601.58	0.00	-97.81
			12	25.00	22.00	0.00	-599.70	0.00	-95.24
			13	27.00	23.00	0.00	-609.68	0.00	-102.04
			14	27.00	23.00	0.00	-589.95	0.00	-98.90
			15				-582.67	0.00	-100.62
			16				-610.19	0.00	-120.20
			17				-646.70	0.00	-139.13
			18				-637.05	0.00	-155.50
			19				-607.85	0.00	-155.95
Jan	Hol	2	20	34.00	28.00	0.00	-618.84	0.00	-145.32

Building Cool/Heat Demand

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
See note below.

AHVAC31: Monthly patterns of heating and cooling

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.ashraepcs.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.