Performance-Based Energy Code Enforcement

Manual

for Authorities Having Jurisdiction

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Table of Contents

Acknowledgements 3
Abbreviations and Acronyms 4
1 Scope 5
2 Submittal Review Quick Start 6
3 How to Use This Manual 7
4 Enforcement Infrastructure 10
5 Review Process 12
6 Submittal Requirements 14
7 Review Checklist 23
8 Review Checks 25
8.1 Nomenclature 25
8.2 Simulation General (SG) 26
8.3 Utility Rate (UR) 34
8.4 Compliance Calculations (CC) 36
8.5 Building Envelope (BE) 39
8.6 Lighting, Interior (LI) 50
8.7 Lighting, Exterior (LE) 59
8.8 Miscellaneous Loads (ML) 65
8.9 Service Water Heating (SWH) 66
8.10 Air-side HVAC (AHVAC) – Proposed 70
8.11 AHVAC - Baseline (Budget) 76
8.12 Air-side HVAC Model Input / Output (AHM) 82
8.13 Waterside HVAC (WHVAC) – Proposed 90
8.14 WHVAC – Baseline (budget) 93
8.15 WHVAC Model Input/Output (WHM) 96
8.16 Other Equipment (OE) 101
9 Simulation Reports 103
9.1 eQUEST Reports 103
9.2 Trane TRACE 700 Reports 118
Appendix A: Typical Building Operating Schedules 153
Appendix B: Third-Party Reviews 154
References 155

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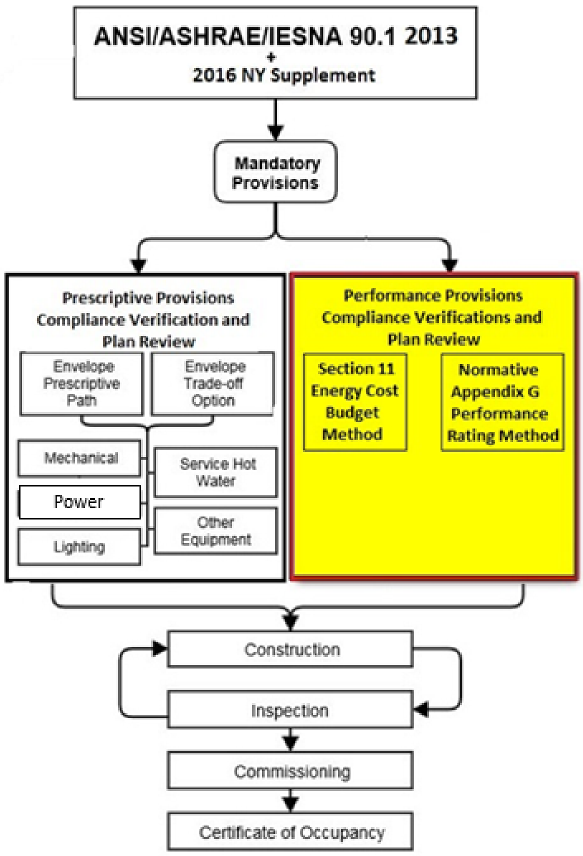
Abbreviations and Acronyms

AFUE – annual fuel utilization efficiency
AHJ – authority having jurisdiction
AHM – air-side HVAC model inputs/outputs
AHRI – American Heating and Refrigeration Institute
AHVAC – air-side HVAC
ANSI – American National Standards Institute
ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers
BHP – brake horse power
CFM – cubic feet per minute
CHP – combined heat and power
ECB – Energy Cost Budget Method described in ASHRAE Standard 90.1 Section 11
EFLH – effective full load hours
Et – thermal efficiency
LI – lighting, interior
MI – model inputs
ML – miscellaneous loads
MO – model outputs
PA – permit applicant
PCIt – performance cost index target
PRM – Performance Rating Method described in ASHRAE Standard 90.1 Appendix G
PRM RT – Performance Rating Method Reporting Template
PRM RM – Performance Rating Method Reference Manual
SWH – service water heating
UMLH – unmet load hour
VAV – variable air volume
WHVAC – water-side HVAC

1 Scope

The Performance-based Energy Code Enforcement Manual (the Manual) contains the recommended enforcement infrastructure and methodology for reviewing submittals of projects that followed ASHRAE 90.1-2013 Section 11, Energy Cost Budget Method (ECB) and Appendix G, Performance Rating Method (PRM) incorporated via 2016 New York State Supplement, for compliance with the 2016 Energy Conservation Construction Code of New York State (ECCC NYS). The Manual does not specifically address the enforcement steps that are the same for the prescriptive and performance projects, such as verifying compliance with the mandatory provisions and site inspections, focusing on the areas that are unique to the performance projects. The scope of the Manual is illustrated in Figure 1.

Figure 1. Review Manual Scope



2 Submittal Review Quick Start

The section describes how to perform submittal review using the Review Checklist spreadsheet included in the package without having to read the Manual first. The references within the Review Checklist allow easy navigation to the relevant subsections of the Manual to access examples, common mistakes, and simulation reports relevant to each review check.

1. **Open the review checklist spreadsheet and read the instructions tab.**
2. **Open the general information tab of the review checklist:**
   - If a prefilled Review Checklist is included in the submittal, confirm the tab is filled out by the permit applicant (PA).
   - If a prefilled Review Checklist is not included in the submittal, fill it out based on the information included in the submittal (e.g., project address, modeler name, etc.).
3. **Open submittal checklist tab.**
   - If a prefilled Review Checklist is included in the submittal, confirm the tab is filled out by the PA and locate the materials referenced in the Review Checklist that will be used in the review.
   - If a prefilled Review Checklist is not included in the submittal, fill out the Submittal Checklist tab and locate the materials in the submittal that are needed to support the review.
4. **Fill out the remaining tabs of the Review Checklist spreadsheet.**
   - Perform the checks in the order listed. The mandatory checks have the "Include in Review" field preset to "Yes". These checks should be performed on all projects.
   - Some of the mandatory checks, once completed, point to the additional checks that should be performed. Set "Include in Review" field for these checks to "Yes" and perform these checks.
5. **Copy the review comments from the Review Checklist into a separate document to be shared with PA, or review outcome and required corrective actions.**

Each required item is described in the Submittal Requirements section of the Manual.

Use the values in CheckID field as necessary to locate the detailed description of each check in the Review Checks section of the Manual, including the relevant requirements of Standard 90.1, examples, and common mistakes. For checks that require using simulation reports, use the names of the reports listed in the simulation reports field for each check to locate the annotated reports included in the Simulation Reports section of the Manual.

3 How to Use This Manual

The Enforcement Infrastructure section of the Manual is intended for authority having jurisdiction (AHJ) staff charged with organizing and managing submittal reviews. It covers the organizational prerequisites for effective and efficient reviews, including but not limited to reviewer qualifications, submittal requirements, and adoption of the standardized reporting template.

The Review Process section describes the review prioritization strategies and the sequence in which the review checks should be performed. It is intended for the AHJ staff charged with managing submittal reviews and the submittal reviewers.

The Review Checklist (Figure 2) is a companion spreadsheet included in the Manual package. The reviewers will use it to identify the planned review scope (i.e., the checks to be performed), document review outcome (Pass/Fail) and provide comments to the PA.

Figure 2. Companion Review Checklist

Check No			Description	Include in Review?	Review Outcome	Review Comment
ENVELOPE						
BE	CR	1	Thermal properties and areas of the proposed opaque envelope are established correctly.	Yes		
		2	Proposed fenestration areas are established correctly	Yes		
		3	Proposed fenestration properties are established correctly	Yes		
		4	Proposed orientation is established correctly	Yes		
		5	Proposed infiltration rate is established correctly	Yes		
	MI	6	Modeled thermal properties and areas of the proposed opaque envelope are as reported in the submittal.			
		7	Modeled proposed fenestration areas are as reported in the submittal			
		8	Modeled proposed fenestration properties are as reported in the submittal			
		9	Modeled proposed design orientation is as described in the submittal			
		10	Proposed infiltration modeling methodology is as required; modeled infiltration rate reflects the values reported in the submittal.			
Interior Lighting						
Check No			**Description**	**Include in Review?**	**Review Outcome**	**Review Comment**
LI	CR	1	Proposed lighting wattage is based on the total manufacturer's labeled fixture wattage	Yes		
		2	Proposed LPD is established correctly for spaces where lighting is not specified or partially specified	Yes		
		3	Proposed lighting controls are established correctly	Yes		
	MI	4	Proposed wattage entered into simulation tool reflects values reported in the submittal.			
	MO	5	Interior lighting peak demand is consistent with proposed lighting wattage reported in the submittal			
		6	Modeled lighting runtime hours are realistic			

... Submittal Checklist | Proposed Design | ECB Budget & PRM Baseline | Compliance Calculattions

The Submittal Requirements section of the Manual lists materials that must be provided to the AHJ. It should be used as a reference when completing the steps outline in the submittal checklist tab of the Review Checklist.

Each check in the Proposed Design, ECB Budget and PRM Baseline, and Compliance Calculations tab is described in the Review Checks section of the Manual. The checks that involve verifying model inputs and outputs reference simulation reports for the supported tools. The Simulation Reports section contains the annotated eQUEST and TRACE 700 reports, to help locate the necessary information.

Additional code resources related to requirements applicable to special situations and exceptions that are beyond the scope of this Manual and simulation tools are listed as follows.

Energy Code Resources

- ANSI/ASHRAE/IES Standard 90.1-2013 (available from ASHRAE Bookstore).[1]
- 90.1-2013 User's Manual; 90.1-2016 User's Manual (available from ASHRAE Bookstore). The Manual provides examples and explains requirements of the standard, including Section 11 and Appendix G.
- 2016 Supplement to the New York State Energy Conservation Construction Code (Revised August 2016).[2]
- 2016 New York City Energy Conservation Code,[3] including Appendix CA, which contains the 90.1 Appendix G, as adopted by NYC.
- ANSI/ASHRAE/IES Performance Rating Method Reference Manual.[4] The document expands on requirements of 90.1-2016 Appendix G and can be used as the source for the simulation assumptions and methodologies that are not addressed in 90.1.
- ASHRAE Interpretation Requests. Questions on applying code requirements to the specific projects may be sent to ASHRAE as an official or un-official interpretation request.[5] The official interpretations are posted on the ASHRAE website for 90.1-2013[6] and 90.1-2016[7] and are a useful resource.
- DOE Help Desk.[8]

eQUEST Resources

- eQUEST is free and can be downloaded from DOE2 website.[9]
- 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

1 www.ashrae.org/technical-resources/standards-and-guidelines

2 www.dos.ny.gov/dcea/pdf/2016%20EC%20Supp-Revised-2016-08-12-approved%20bycouncil%20V-A.pdf

3 www1.nyc.gov/site/buildings/codes/2016-energy-conservation-code.page

4 www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

5 www.ashrae.org/technical-resources/standards-and-guidelines/pcs-toolkit/standards-forms-procedures#interpretationrequest

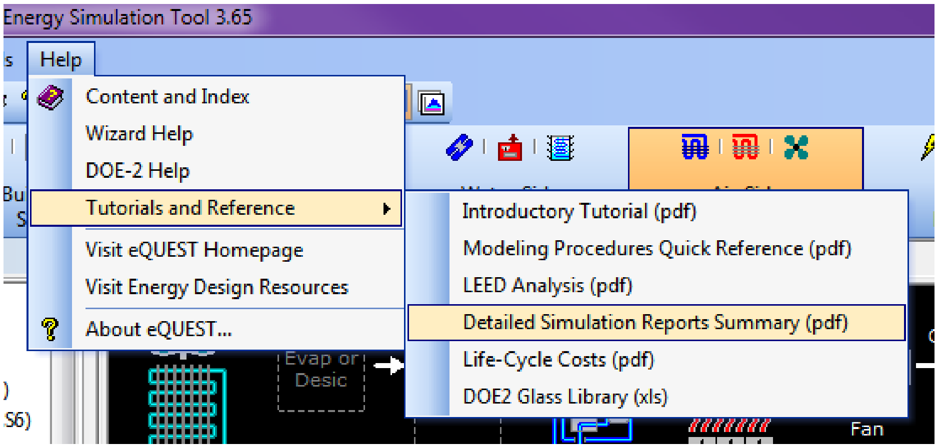
6 www.ashrae.org/standards-research--technology/standards-interpretations/interpretations-for-standard-90-1-2013

7 www.ashrae.org/technical-resources/standards-and-guidelines/standards-interpretations/interpretations-for-standard-90-1-2016

8 www.energycodes.gov/HelpDesk

9 www.doe2.com/equest/

Figure 3. Accessing eQUEST Help Menu



Trane TRACE 700 Resources

- Searchable database of documentation on various topics:[10] 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; and Common mistakes in LEED modeling.
- Free tutorial videos on specific topics,[11] such as LEED Guide video.
- If a TRACE 700 License has been purchased, a user's manual comes with the software.

10 https://irtranecds.custhelp.com/app/answers/list

11 https://irtranecds.custhelp.com/app/e_learning

4 Enforcement Infrastructure

Effective and efficient compliance enforcement of performance-based projects requires the framework described as follows.

1. Establish minimum qualification requirements for energy analysts and reviewers.

Projects that use performance-based compliance options require the services of an energy analyst and an energy model reviewer. The energy analyst is the person or persons responsible for the energy modeling and compliance documentation. The Reviewer is the who reviews compliance documentation submitted in support of a performance-based permit application on behalf of the AHJ. The energy analyst and reviewer must have the following qualifications:

- Broad experience with commercial and institutional building energy systems and operating characteristics similar to those in the permit application.
- Extensive understanding of ASHRAE Standard 90.1 and performance-based compliance options.
- Three or more years of full-time equivalent modeling experience with computerized building modeling tools used for energy analysis, or two years of modeling experience and an ASHRAE certification as a building energy modeling professional (BEMP).
- Demonstrated capability to model basic building features such as internal gains, multiple zones with central HVAC systems, envelope measures that affect thermal transmission, and architectural shading effects. Experience with complex energy conservation measures including but not limited to system heat recovery, enhanced direct digital control strategies including code required temperature and pressure resets, demand control ventilation, and daylighting.

2. Establish submittal requirements and adopt the standard reporting template.

Submittals for the performance-based projects must detail completed energy analysis, including simulation inputs and outputs, as prescribed by 90.1 Section 11 and Appendix G. The ECB compliance form included in the 90.1 2013 users' manual[12] package largely relies on the prescriptive compliance forms, making it easy to overlook the reporting requirements specific to the performance-based projects. To address the issues, some AHJs developed reporting templates, such as New York City EN-1 Form[13] for ECB projects.

The Manual package includes the performance rating method reporting template (PRM RT) that may be used by projects documenting compliance using 90.1 Appendix G. The PRM RT requires the applicant to provide a detailed list of energy modeling inputs and outputs in a standardized form, with references to drawings where the reported values such as insulation levels, lighting power density, mechanical system types, capacities and efficiencies can be verified, ensuring consistent reporting among projects. PRM RT includes numerous built-in calculators and code look-ups to simplify development of the baseline and proposed design models. Some of the review checks described in the Manual are automated in the PRM

12 https://xp20.ashrae.org/UM90.1-2013/ECB-Method-Compliance-Form-2013.pdf

13 http://www1.nyc.gov/site/buildings/codes/energy-code-forms.page

RT to flag potential inconsistences in the submittal and enable internal quality control before the project is submitted to AHJ. The PRM RT is described in more detail in the Submittal Requirements section of the Manual. The adopted submittal requirements and reporting template should be posted on the AHJ website.

3. Establish review process

Each project typically has only a handful of high-impact areas, and the review effort may be reduced by prioritizing the review to focus on these areas.[14] The Manual includes the prioritization strategies based on the project characteristics, such as contribution of different end uses (heating, cooling, lighting, etc.) toward the trade-offs and the areas where mistakes are often made. The AHJ may adjust the scope of the review based on available resources. For example, the review checks identified as impactful in the Manual may be performed on all projects; additional checks may be performed on a rotating or randomized basis, encouraging designers and contractors to focus on the most impactful requirements, while ignoring none. Alternatively, more comprehensive reviews may be performed on larger, more energy intensive projects. The AHJ that adopt the PRM RT may choose to largely rely on the built-in flags. The review checks may be shared with the PAs, to encourage internal quality control before the documents are submitted to the AHJ. The AHJ may require PAs self-check the submittal following the Review Checklist and include the filled-out Review Checklist in the submittal as proof of internal quality control.

4. Use Third-Party Reviewers

The AHJs that do not have the needed resources may engage external reviewers and charge the applicant for the review. The AHJs planning to engage third-party reviewers should establish the associated policies and maintain a pool of preapproved reviewers who are trained on performing the reviews and can be assigned to projects as needed.

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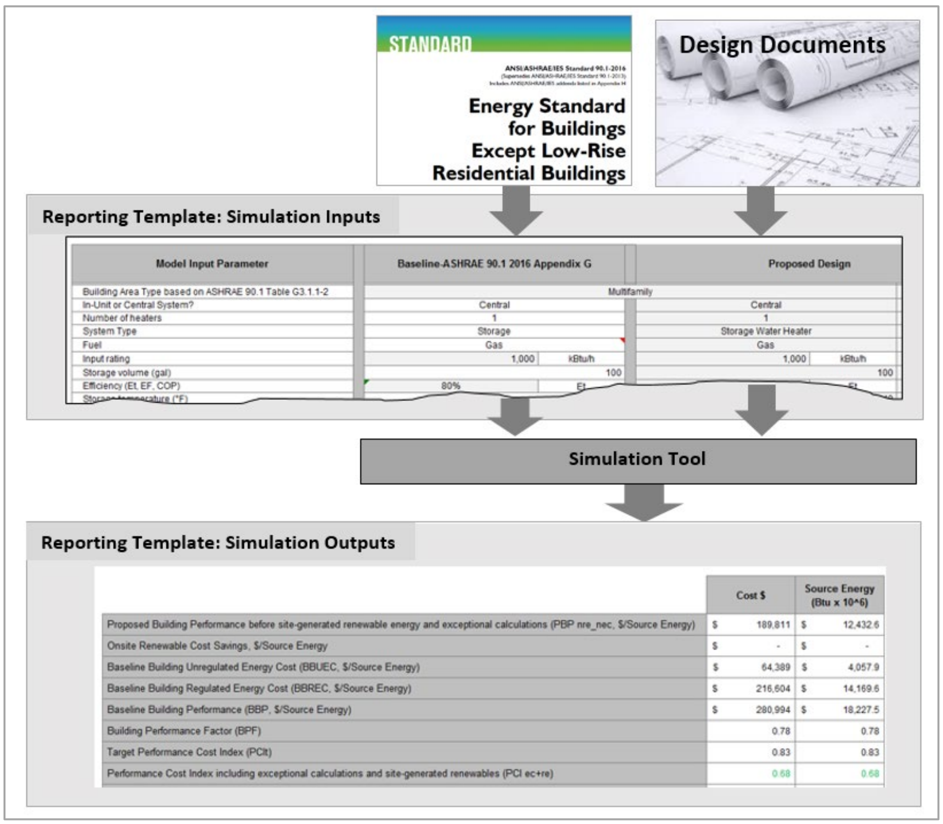
14 An Approach to Assessing Potential Energy Cost Savings from Increased Energy Code Compliance in Commercial Buildings" (M Rosenberg et al. PNNL 2016)

5 Review Process

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 window to wall ratio over 40% may demonstrate compliance by showing the energy penalty associated with the higher thermal loads is offset by savings from an efficient HVAC system and daylighting. The required analysis is illustrated in Figure 4 and involves developing two whole building energy simulation models. The first model establishes the point of reference and is referred to as budget (ECB) or baseline (PRM) building design. It is configured as prescribed in ECB or PRM respectively. The second model represents the building design based on the design documents. The compliance is established by comparing the simulated annual energy cost of the two models.

Figure 4. Establishing Performance-based Compliance



On the high level, submittal review involves the following steps:

- Review description of the proposed design in the Reporting Template to verify that it reflects design documents. (In jurisdictions that adopted PRM RTP as the required reporting format, the PRM RT is the Reporting Template.)
- Review description of the baseline (budget) design in the Reporting Template to verify that requirements of 90.1 PRM (ECB) were followed.

- Review simulation reports to verify that baseline (budget) and proposed designs were modeled as described in the reporting template.
- Review compliance calculations in the reporting template to ensure they reflect simulation outputs and comply with ASHRAE Standard 90.1.

Table 1. Submittal Review Process

Step 1: Check submittal for completeness
• Use Submittal Checklist tab of the Review Checklist to verify that all required documentation is provided. • Request additional information if submittal is incomplete.
Step 2: Review description of the proposed design in the reporting template and perform high-level proposed design simulation review
• Complete the Code Requirements (CR) checks in the Proposed Design tab of the Review Checklist, to verify that description of the energy features of the proposed design reported in the submittal is complete and reflects design documents. • Perform Modeling Output (MO) checks to verify that simulation outputs are generally consistent with the reported proposed systems and components
Step 3: Review description of the baseline (budget) design in the reporting template and perform high-level baseline (budget) design simulation review
• Complete CR review checks in the Review Checklist, ECB Budget and PRM Baseline tab to verify that the baseline (budget) design is established correctly following PRM (ECB) requirements. • Perform modeling output (MO) checks to verify that simulation outputs are generally consistent with the reported baseline (budget) systems and components
Step 4: Prioritize the remaining review to verify the key differences between the baseline (budget) and proposed design based on Steps 2 and 3 are properly reflected in the simulations.
• Based on the checks completed in Steps 2 and 3, identify the key systems and components of the proposed design that differ from the corresponding systems and components in the baseline (budget) design. These differences represent trade-off areas. • In the Review Checklist, mark the checks that verify that these systems and components are properly modeled, to be included in the review. • Complete MO checks to establish the end uses that changed the most between the baseline (budget) and proposed design based on the simulation outputs • In the Review Checklist, select the checks that verify the relevant systems and components, to be included in the review.
Step 5: Complete the remaining review checks
• Complete the check identified in Step 4. • Perform additional checks as review budget / schedule allows
Step 6: Communicate review outcome to the Permit Applicant
Provide written comments to PA to require corrective actions or approve the submittal.

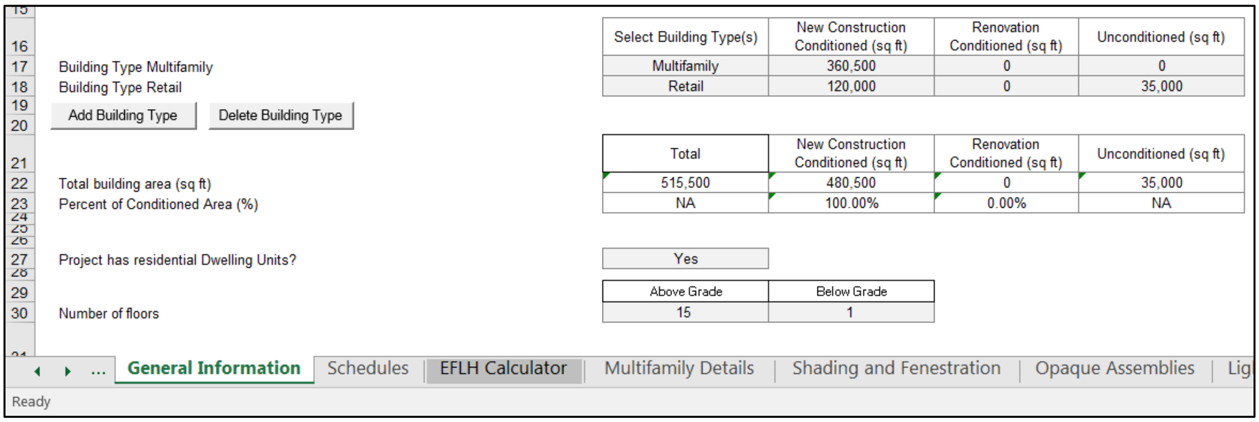
6 Submittal Requirements

Submittal requirements below are based on the Standard 90.1 and include several additional items that are instrumental to the effective review of performance-based submittals.

Project Overview

The overview must include the number of stories above and below grade, the typical floor size, the uses in the building (e.g., office, cafeteria, retail, parking, etc.), the gross area and the conditioned floor area for each use. The inputs are illustrated in Figure 6 based on the PRM RT General Information tab.

Figure 5. PRM RT Project Overview



A narrative describing the areas where trade-offs are made

The narrative provides a description of building or system elements that do not comply with the prescriptive requirements of the code, elements exceeding requirements, and building elements or systems modeled to provide additional energy savings to offset the non-complying elements.

For each element, provide the reference to the part of the submittal where it is described in the full details required by code. Projects using PRM RT must identify these systems in the “Measure #” column of the appropriate tabs.

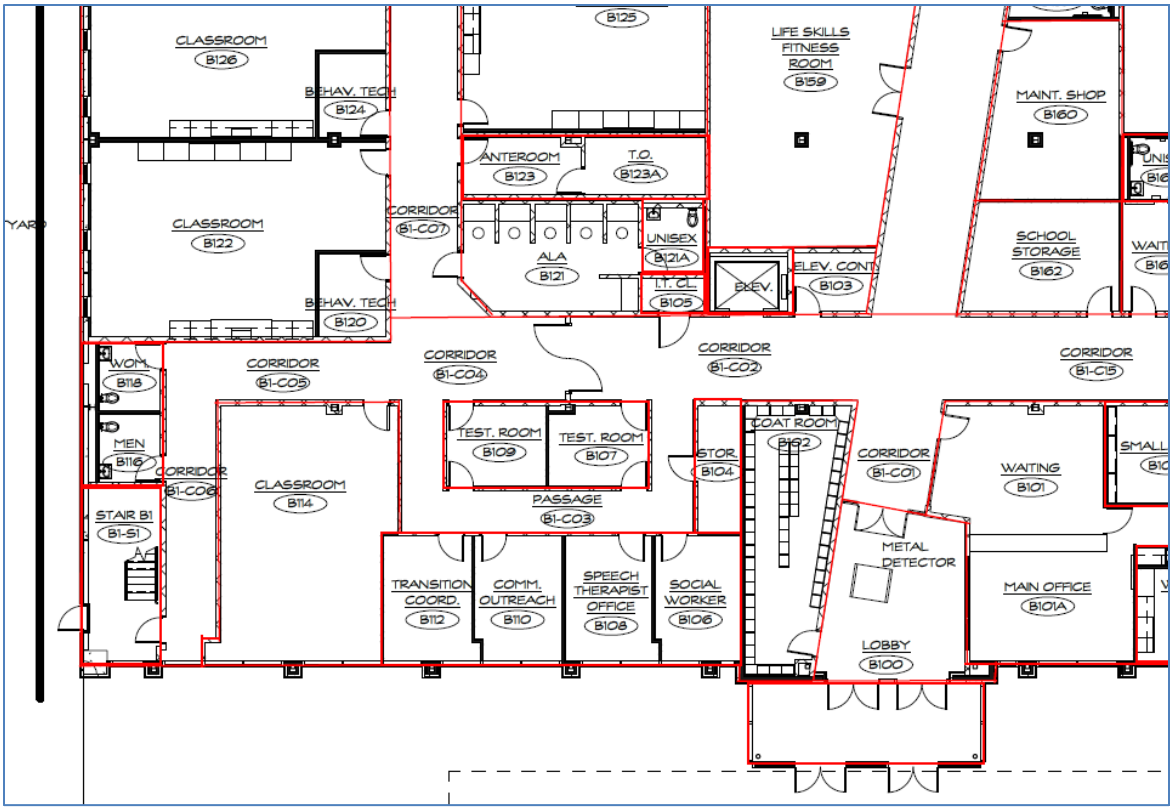
Design documents

Submittal must include the full set of construction documents including drawings and specifications.

A diagram showing the thermal blocks used in the computer simulation

The diagram should include the labels corresponding to the block names used in the simulation or description of the thermal block naming convention used. For example, the names of the thermal blocks may be based on space names shown on architectural drawings.

Figure 6. Sample Thermal Blocks Used in the Computer Simulation



Purchased energy rates used in the simulations

The scope of information related to utility rates that must be provided is illustrated in Figure 7, based on PRM RT.

Figure 7. Utility Rate Structure Used in the Simulation

Energy Type	Energy Consumption Units	Demand Units	Utility Rate Structure Type	Utility Rate Description
Electricity	kWh	kW	Time of Use Rates per unit of consumption and demand varying seasonally	Low season 1/1- 5/31 and 10/1 - 12/31: On Peak 0.230516 $/kWh, 10.77 $/kW; Off Peak 0.122130 $/kWh; 3.64 $/kW High Season 6/1- 9/30: On Peak 0.255110 $/kWh, 12.55 $/kW; Off Peak 0.102334 $/kWh, 3.64 $/kW
Natural Gas	therm	Btuh x 10^6	Fixed Rates per unit of consumption	$0.86 / Therm
District Cooling	MWh	MW		

Air-Side HVAC | Water-Side HVAC | Results from eQuest | Detailed Measures | Performance_Outputs_1 | Revision Notes | Quality

Ready

Additional documentation must be provided if project used the rate from a local utility company (Figure 8) as opposed to the averages from the Energy Information Administration (EIA).

Figure 8. Additional Documentation for Projects that Used Custom Utility Rates

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

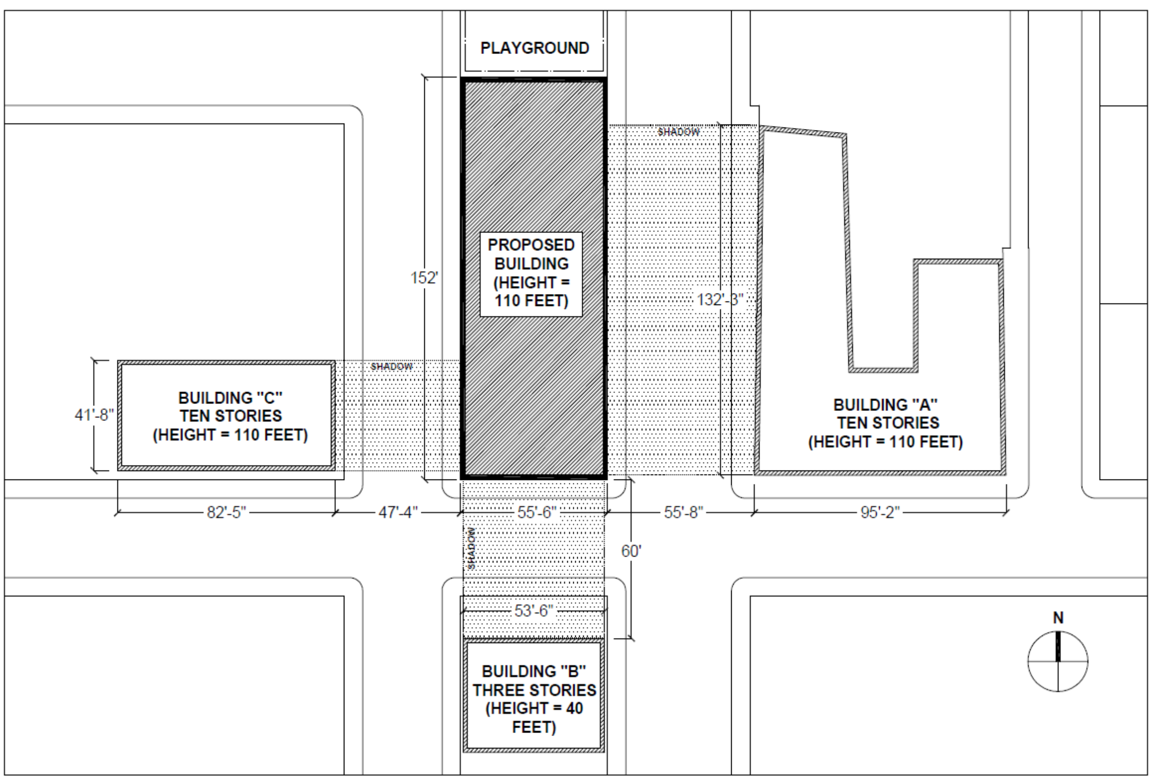
Transmission Charge (Demand)

		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:

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

Figure 9. Site Plan with Building Shading



Description of the proposed design and the baseline (budget) simulation

- A list of the energy-related features included in the design and on which the 90.1 Appendix G performance rating, or compliance with 90.1 Section 11, is based. This list must document all energy features that differ between the models used in the baseline building performance (or energy cost budget) and proposed building performance (or design energy cost) calculations.
- The key energy efficiency improvements compared with the requirements in 90.1 Sections 5 through 10.
- A list identifying the aspects of the proposed design that are less stringent than the requirements of 90.1 Sections 5.5, 6.5, 7.5,9.5 and 9.6 (prescriptive provisions).

The filled out PRM RT tabs including shading and fenestration, opaque assemblies, lighting counts, general lighting, service water heating, general HVAC, air-side HVAC and water-side HVAC meet the required level of details. Projects not using PRM RT must submit equivalently detailed information in an alternative format approved by the AHJ.

The PRM RT tabs have a consistent structure as illustrated in the following figures. Each tab includes a checklist, to be filled by the energy analyst, to confirm that code requirements are met (Figure 11) and a table with the baseline and proposed model inputs (Figure 12).

Figure 10. PRM RT Shading and Fenestration Checklist

Shading and Fenestration

Building Massing and Zoning

Instructions: Provide the following shading and orientation information. An example of the expected level of detail has been provided for each input. For any information not applicable to the project enter "N/A".

Modeled baseline vertical fenestration areas for new buildings and additions reflects Window to Wall (WWR) ratio in Table G3.1.1-1 based on the area of gross above-grade walls that separate conditioned spaces and semiheated spaces from the exterior. For building areas not shown in Table G3.1.1-1, vertical fenestration areas is equal that in the proposed design or 40% of gross above-grade wall area, whichever is smaller	Yes
Modeled baseline vertical fenestration is distributed on each face of the building in the same proportion as in the proposed design.	Yes
Modeled baseline fenestration area for an existing building is equal the existing fenestration area prior to the proposed work and distributed on each face of the building in the same proportions as the existing building.	N/A
Modeled baseline skylight area is equal to that in the proposed design or 3%, whichever is smaller. Skylight orientation and tilt is the same as in the proposed design.	N/A
Shading by adjacent structures and terrain was modeled the same in the baseline and proposed design models. 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 were accounted for in both simulations.	Yes
Manual fenestration shading devices such as blinds or shades have been modeled or not modeled, the same in the baseline and proposed design.	Yes
Automatically controlled fenestration shades or blinds have been modeled in the proposed design but not in the baseline.	Yes
Permanent shading devices such as fins, overhangs, and light shelves were modeled in the proposed design but not in the baseline.	Yes
The baseline is modeled with the same shape and orientation as the proposed.	Yes
All baseline fenestration for new buildings, existing buildings, and additions was modeled with assembly U-factor and SHGC from Tables G3.4-1 through G3.4-8	Yes
Thermal Blocks were modeled consistent with Table G3.1#7 and Table G3.1#8 as applicable, and were modeled identically in the Baseline and Proposed design models	Yes
All proposed fenestration was modeled based on the assembly U-factor and SHGC determined using the following method: (If more than one method used, list additional methods in the Note, and describe and fenestration products to which it was applied.)	NFRC testing for site-assembled fenestration

For each item entered as "No" above, describe the applicable ASHRAE 90.1 Appendix G exception(s) that apply, or the circumstances preventing the building massing modeling parameters from being modeled as required. If the energy simulation software is not capable of modeling the required parameters, describe the adjustments that were made to provide a thermodynamically similar representation or provide a narrative justifying why the predicted energy performance results will not be influenced.

Figure 11. PRM RT Shading and Fenestration Inputs

General Information		Baseline			Proposed						Prescriptive Requirements Applicable to the Baseline
New or Existing Construction	Space-Conditioning Category	Description	Assembly U-factor	SHGC	Description	Assembly U-factor	SHGC	VLT	Area, SF	Plans / Spec	
		Helpful Hints ▪ New/Existing vertical glazing: ▪ Select a description ▪ Assembly U-factor and SHGC from Table G3.4-1 through G3.4-8 per Table G3.1#5(d). ▪ (SHGC). Please note that this is not equivalent to the shading coefficient (SC).			Helpful Hints ▪ Proposed vertical glazing assembly U-factor should be as-designed and account for the impact of the frames on the whole assembly. Reference Table A8.2 of ASHRAE 90.1 as necessary. ▪ Describe the Proposed vertical glazing assembly (for example: double glazing, argon filled, low-e coating, aluminum frame with thermal break) ▪ Enter the Proposed vertical glazing assembly solar heat gain coefficient (SHGC). Please note that this is not equivalent to the shading coefficient (SC). ▪ Enter the Proposed vertical glazing assembly visual light transmittance (VLT) ▪ If the Proposed design includes building envelope assemblies of different U-values, please specify surface area, square feet, for each envelope assembly.					Show compliance by including a drawing sheet, detail number, specification section and/or subparagraph.	n accordance with Prescriptive Requirements of 90.1-2013 Table 5.5-4
New	Residential	20.1%-30.0%	0.57	0.39	High Performance Windows	0.35	0.35	0.5	560	Drawing no. A-610.00, view #3, #5; Type 1: Kawneer 1600 LR Wall(TM) Curtain Wall System, double glazed, clear, air filled, fixed	Nonmetal framing, all: U-0.35; SHGC-0.40; VT/SHGC-1.10 Metal framing, fixed: U-0.42; SHGC-0.40; VT/SHGC-1.10 Metal framing, operable: U-0.50; SHGC-0.40; VT/SHGC-1.10 Metal framing, entrance door: U-0.68; SHGC-0.40; VT/SHGC-1.10

Baseline columns list parameters of the Baseline model

Proposed columns list parameters of the Proposed Design model
"Plans / Spec" column includes references to place in the design document where the reported parameters are listed, to support verification.

On most tabs, parameters of the proposed design that improve over the applicable prescriptive requirements are automatically formatted to show in green font and those that are worse are shown in red, to highlight the areas of trade-offs.

Prescriptive Requirements column shows the prescriptive requirements of 90.1 2013 for the given component

x

The majority of the inputs in the baseline and prescriptive requirements columns of the PRM RT auto-populate based on the built-in lookups. For example, once the project's climate zone and space conditioning (i.e., residential, non-residential, semi-heated, unconditioned) are entered, the baseline fenestration U-value and SHGC that must be modeled (the Baseline column) and the prescriptive requirements of 90.1-2013 (Prescriptive Requirements column) are auto-populated.

Simulation Details

- The name and version of the simulation program used. The approved software list is published by the New York Secretary of State. The list of software tool approved for use in New York City is included in RCNY[15] 5000-01. As of the publication of this Manual, the following tools are approved:
    - DOE2.1E
    - VisualDOE
    - EnergyPlus
    - eQUEST
    - Trane TRACE 700

  In addition, IES VE is allowed in New York City.
- An explanation of any error messages noted in the simulation program output
- An explanation of any significant modeling assumptions
- Backup calculations and materials to support data inputs (e.g., U-factors for building envelope assemblies, NFRC ratings for fenestration, etc.)
- Documentation of the exceptional calculation methods
    - Where the simulation program does not specifically model the functionality of the installed system, spreadsheets, or other documentation of the assumptions must be used to generate the power demand and operating schedule of the systems and included in the submittal.
    - Submittal must include a narrative explaining the exceptional calculation method performed and theoretical or empirical information supporting the accuracy of the method. The documentation must meet 90.1 Section 11.4.5 for ECB path and 90.1 Section G2.5 for the Appendix G path.

Results of the energy analysis

- A table with a summary by end use of the budget (baseline) building performance and the proposed building performance in the units of site energy and the energy cost.
- The calculated budget (baseline) building performance and the proposed building performance
- The reduction in the proposed building performance associated with on-site renewable energy
- The reduction in the proposed building performance associated with exceptional calculation methods, if any
- The energy savings by in the units of site energy and the energy cost by energy type

The outputs are illustrated in Figure 13 and Figure 14, based on the PRM RT.

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15 https://www1.nyc.gov/assets/buildings/rules/1_RCNY_5000-01_prom_details_date.pdf

Figure 12. Baseline and Proposed Design Energy Use and Savings by End Use (PRM RT)

End Use	Unregulated?	Energy Type	Units of Annual Energy and Peak Demand	Baseline	Proposed Design	Energy / Demand Savings per End-Use	End Use Percent Contribution to Total Energy Savings	End Use Percent Contribution to Total Cost Savings	Percent of Total Proposed Site Energy Consumption
Interior lighting		Electricity	Consumption (kWh)	202,034.0	116,820.0	42.2%	12.4%	12.9%	7.0%
			Demand (kW)	42.5	28.2	33.8%			
Lighting in Apartments		Electricity	Consumption (kWh)	732,341.0	466,029.0	36.4%	38.6%	40.3%	27.9%
			Demand (kW)	83.6	53.2	36.4%			
Interior lighting - process	x	Electricity	Consumption (kWh)						
			Demand (kW)						
Exterior lighting		Electricity	Consumption (kWh)						0.0%
			Demand (kW)						
Space heating		Natural Gas	Consumption (therm)	10,490.8	10,564.0	-0.7%	-0.3%	-0.1%	18.5%
			Demand (Btuh x 10^6)						
Space heating		Electricity	Consumption (kWh)		517.0				0.0%
			Demand (kW)		0.4				
Heat Pump Supplementary		Electricity	Consumption (kWh)						0.0%
			Demand (kW)						
Space cooling		Electricity	Consumption (kWh)	312,025.8	132,462.0	57.5%	26.0%	27.2%	7.9%
			Demand (kW)	198.3	103.8	47.7%			
Space cooling		Natural Gas	Consumption (therm)						0.0%
			Demand (Btuh x 10^6)						
Pumps		Electricity	Consumption (kWh)	1,657.5	2,523.0	-52.2%	-0.1%	-0.1%	0.2%
			Demand (kW)	0.8	1.0	-14.8%			
Heat rejection		Electricity	Consumption (kWh)						0.0%
			Demand (kW)						

... Results from eQuest | Detailed Measures | 12 - Performance_Outputs_1 | Quality Assurance Checks

Figure 13. Baseline and Proposed Design Energy Use by Fuel (PRM RT)

Energy Type	Site Energy Units	Baseline			Proposed Design			Percent Savings		
		Site Energy Use (Units shown per energy type)	Source Energy Use (Btu x 10^6)	Cost	Site Energy Use (Units shown per energy type)	Source Energy Use (Btu x 10^6)	Cost	Site Energy	Source Energy	Cost
Electricity	kWh	1,909,276.3	16,611.8	$ 263,591	1,259,680.0	10,960.0	$ 173,948	34.0%	34.0%	34.0%
Natural Gas	therm	15,386.8	1,615.6	$ 17,403	14,025.0	1,472.6	$ 15,863	8.9%	8.9%	8.8%
		0.0	0.0		0.0	0.0				
		0.0	0.0		0.0	0.0				
Energy model subtotal (Btu x 10^6)		8,053.1	18,227.5	$ 280,994	5,700.5	12,432.6	$ 189,811	29.2%	31.8%	32.5%

... Results from eQuest | Detailed Measures | 12 - Performance_Outputs_1 | Quality Assurance Checks

Simulation Reports

The submitted reports must include the following information:

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

The reports required for each simulation tool are listed as follows.

eQUEST

- <project name B>.SIM and <project name P>.SIM files with the detailed simulation reports for the baseline (budget) and proposed models
- 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

Trane TRACE 700

AHJ may require that all TRACE 700 entered values and output reports are submitted. Alternatively, the individual reports may be requested. These reports are utilized in the review checks described in the Manual.

- Title page report
- Project information entered values report
- Energy Cost Budget/PRM Summary report
- LEED Summary report
- Monthly Energy Consumption report
- Monthly utility costs report
- Library members entered values report
- Building U-Values report
- Building areas report
- Walls by direction entered values report
- Walls by cardinal direction entered values report
- Room information entered values report
- Building envelope cooling loads at coil peak
- Building envelope heating loads at coil peak
- Plant information entered values report
- Equipment energy consumption report
- System entered values report
- System checksums report
- Building Cool/Heat Demand report from the Visualizer

Explanation of areas flagged by the automated quality assurance functionality (if any) incorporated into the submittal template

Figure 14. PRM RT Automated QA Checks

An example based on the PRM RT Quality Assurance Checks tab.

Interior Lighting								
	Input/Output Summary							
	Interior Lighting Power [W] (6b - General Lighting tab)	Lighting Power [W] Adjusted for OS (6b - General Lighting tab)	Non-coincident Lighting Peak Demand [W] (12 - Performance_Outputs_1 tab)	Annual Lighting Use [kWh] (12 - Performance_Outputs_1 tab)	Effective Full Load Hours	Typical EFLH (COMNET)	Diversity Factor	Effective Full Load Hours (12 - Performance_Outputs_1 tab)
	ILP	ILPwOS	NCLPD	ALU	EFLH = ALU / ILP	EFLHt	DF = NCLPD / ILP	EFLH
Baseline Design	133,020	133,020	126,120	934,375	7,024	2,884	0.95	7,409
Proposed Design	66,520	65,086	81,350	582,849	8,762	NA	1.22	7,165
Baseline / Proposed	200%	204%	155%	160%	80%	NA	78%	103%

Issue	Project Team Response
The baseline lighting non-coincident peak demand reported on the Performance Outputs tab exceeds the maximum baseline lighting power on the General Lighting tab. Please correct the lighting inputs in the baseline model, or update the inputs on the Lighting Counts tab.	
The proposed lighting non-coincident peak demand reported on the Performance Outputs tab is lower than expected, based on the Lighting Power adjusted for the Occupancy Sensors from the General Lighting tab, and the modeled lighting schedule represented by the Diversity Factor (NCPD proposed < 0.85 * MPvOS * DF). Please correct the lighting inputs in the proposed model, or update the inputs on the Lighting Counts tab.	
The difference between the proposed and baseline lighting non-coincident peak demand reported on the Performance Outputs tab is higher than expected, based on the Baseline and Proposed Lighting Power adjusted for the Occupancy Sensors from the General Lighting tab (NCPDbase / NCPD prop > 1.1 * LPwOS base / LPwOS prop). Please review and correct the lighting inputs in the proposed and / or baseline model, or update the inputs on the Lighting Counts tab.	
The effective full load hours (EFLH) exceed the typical by more than 20%. Ensure that the model reflects the mandatory lighting controls, and is based on the anticipated schedule of operation for the building. Please describe operating schedule if different than typical for the building type.	
The difference between the baseline and proposed annual lighting energy use is higher than expected (LPwOS prop / LPwOS base > 0.9*ALU prop / ALU base) based on the baseline and proposed lighting wattages and controls entered on the Lighting Counts tab. Please verify that the modeled lighting wattages and controls reflect the values reported on the Lighting Counts tab.	

Figure 15. Review Checklist, Submittal Checklist Tab (Abstract)

	PROJECT DOCUMENTS AND SUPPORTING INFORMATION	Included?
1	Project overview: Include the number of stories above and below grade, the typical floor size, the uses in the building (e.g., office, cafeteria, retail, parking, etc.), the gross area and the conditioned floor area for each use.	**YES**
2	A narrative describing the areas where trade-offs are made: Description of building or system elements that do not comply with the prescriptive requirements of the code; elements exceeding requirements; and a description of those building elements or systems modeled to provide additional energy savings to offset the non-complying elements. For each element, provide the reference to the part of the submittal where it is described.	**YES**
3	Design documents	**YES**
4	A diagram showing the thermal blocks used in the computer simulation	**YES**
5	Purchased energy rates used in the simulation with supporting documentation	**YES**
6	A site plan showing all adjacent buildings and topography that may shade the proposed building, with the estimated height or number of stories (PRM only)	**NA**
	SIMULATION DETAILS	
7	A list of the energy-related features that are included in the design and on which the Appendix G performance rating, or compliance with Section 11, is based. This list must document all energy features that differ between the models used in the baseline building performance (or energy cost budget) and proposed building performance (or design energy cost) calculations	**YES**
8	The key energy efficiency improvements compared with the requirements in Sections 5 through 10.	**YES**
9	A list identifying the aspects of the proposed design that are less stringent than the requirements of 5.5, 6.5, 7.5,9.5, and 9.6 (prescriptive provisions).	**YES**
10	The name and version of the simulation program used.	**YES**
11	An explanation of any error messages noted in the simulation program output	**YES**

Instructions | **Submittal Checklist** | Proposed Design | ECB Bud ...

7 Review Checklist

The Review Checklist is provided in Excel format as a companion to the Manual. The instructions for using the checklist, included on the Instructions tab of the checklist, are as follows:

Background

- This checklist is a companion to the Performance-based Energy Code Enforcement Manual (the Manual).
- The general information and submittal checklist tabs should be filled out by the permit applicant (PA)
- Authority Having Jurisdiction (AHJ) may request the PA to complete other checks included in the checklist, to help improve the initial quality of submittal, and to streamline the review.

Instructions for Permit Applicant

- Fill out "general information" and "submittal checklist" tabs.
- If required by AHJ, fill out "Proposed Design" and "ECB Budget and PRM Baseline" tabs to document the internal submittal quality control. Refer to "Instructions for Submittal Reviewer" section for details.

Instructions for Submittal Reviewer

1. General review process and tips

- Read the review process section of the Manual to understand the general review logic.
- Checks that must be performed on all projects (are mandatory) have the check number shown in red font, (e.g., 3). "Include in Review" column for these checks is pre-set to "Yes".
- Search the Manual using the value in "CheckID" field to locate detailed description of each check in the review checks section of the Manual, including the applicable requirements of Standard 90.1, examples, and common mistakes.
- Search the Manual using the value in "Simulation Reports" field to locate the annotated simulation reports in the simulation reports section of the Manual. eQUEST and Trane Trace 700 reports are currently included.
- (For AHJ reviewers only) Document review outcome (pass/fail/NA) and provide comments as applicable for each completed check.

A "Pass" outcome means no changes are required in the given area. Any comments provided a re informative and may apply to future projects. No response is required from PA.

A "Fail" outcome means changes must be made to the submittal before it can be approved. The issues and required changes are described in the Review Comment.

2. **Review the "General Information" and "Submittal Checklist" tabs to verify that all materials necessary to support the review are provided. Document review outcome for each check and provide review comments as necessary.**
3. **Proposed Design and ECB Budget and PRM Baseline tabs:**
   - Complete the mandatory checks in the “Proposed Design” tab.
   - Complete the mandatory checks in the “ECB Budget and PRM Baseline” tab.
   - Select additional checks to be performed based on the outcome of the completed checks by setting “include in review” column to “Yes” on the “Proposed Design” and “ECB Budget and PRM Baseline” tabs, as applicable.
   - Complete the checks on the “Proposed Design” and “ECB Budget and PRM Baseline” tabs marked in the previous step.
   - Complete additional checks for a more comprehensive review, if desired.
4. **(For AHJ reviewers only) Copy the review comments from the Review Checklist into a separate document to be shared with PA or share the completed Review Checklist with the PA to communicate the review outcome and required corrective actions.**

8 Review Checks

This section provides information on all checks included in the companion Review Checklist **s**preadsheet and should be used as a reference when performing reviews.

8.1 Nomenclature

The checks are subdivided into those that verify compliance with the code requirements, verify model inputs, or model outputs.

Code Requirements (CR) checks confirm that parameters of the baseline (budget) and proposed designs were properly established following the applicable rules of Standard 90.1, such as whether the baseline HVAC system type was properly established or the thermal properties of the exterior walls in the proposed design properly account for thermal bridging. Most CR checks cover both ECB and PRM, with the information applicable to each performance path listed separately and appropriately labeled.

Model Inputs (MI) checks verify the established baseline (budget) or proposed design parameters were properly entered into the simulation tool. For example, if the reporting template indicates that the baseline exterior lighting power is 1,700 W, confirm if it matches the exterior lighting input.

Model Outputs (MO) checks confirm simulation results are as expected based on the parameters of systems and components being modeled. Baseline (budget) and Proposed design models include numerous inputs in addition to those reported in the submittal. 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 must 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.

The review checks are further organized into the following categories based on the building system and verification type:

Simulation General (SG) checks verify the general simulation requirements are met, such as confirming that an appropriate weather file was used or verifying that the number of unmet load hours does not exceed the specified limit. SG check also establish the key end uses included in the trade-offs based on the simulation output reports.

Building Envelope (BE) checks verify that the envelope geometry, thermal, and solar properties were established and modeled correctly.

Lighting, Interior (LI) and Lighting, Exterior (LE) checks verify the interior and exterior lighting power and controls were properly established and modeled.

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

AHM and WHM checks verify that air-side and water-side systems are properly modeled.

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

Other Equipment (OE) checks cover systems and components that impact compliance but are not covered in other sections, such as combined heat and power (CHP) and photovoltaic (PV) systems.

Compliance Calculations (CC) checks confirm that compliance calculations were completed correctly, such as that contribution of renewable energy and exceptional calculations does not exceed the allowed limit.

In addition, checks are designated as applying to the baseline (budget) design, or proposed design.

- **Budget/Baseline Design (B)** checks confirm the baseline (budget) model parameters described in the submittal reflect the requirements of the selected path and were modeled as described.
- **Proposed Design (P)** checks verify the parameters of the proposed design reported in the submittal match design documents, were established correctly following the applicable code requirements and were appropriately modeled.

Checks that must be performed on all projects have the check number followed by an asterisk. For example, "BE3*(MI–B,P)" is a review check #3 related to the building envelope (BE) that verifies model inputs (MI), applies to both the baseline (budget) model proposed designs (B,P) and must be performed on all projects ("*").

8.2 Simulation General (SG)

SG1*(MI-B,P) The same approved weather file used in the baseline (budget) and proposed simulation

As of the date of the publication of this Manual, there are no preapproved weather files in New York, thus projects must use one of the typical meteorological year (TMY) files based on the proximity to the project site. The same weather file must be used for the budget (baseline) and proposed design simulations.

TMY2[16] files are available for Albany, Binghamton, Buffalo, Massena, NYC (Central Park), Rochester, and Syracuse. TMY3[17] data is available for additional locations within the State and reflect more recent weather patterns.

eQUEST Reports	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)

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

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

SG2*(MI-B,P) Number of hours per year explicitly modeled is as required

ECB: At least 1,400 hour per year representing the full range of conditions must be explicitly simulated (90.1 Section 11.4.1.1); the same number of hours must be explicitly simulated for the budget and proposed design.

PRM: 8,760 hours (full year) must be explicitly simulated (90.1 Section G2.2.1)

eQUEST Reports	8,760 simulated by default; CSV Hourly Results, LS-F and other monthly reports
Trane TRACE 700	Project Information entered values report

SG3*(MO-B,P) Number of hours with unmet heating or cooling load does not exceed 300

Background: An unmet load hour (UMLH) 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 when one or more zones has an unmet cooling load or unmet heating load, is defined as an UMLH (90.1 Section 3). If UMLH in the submittal exceed the prescribed limits, it is the modeler's responsibility to diagnose and resolve the issues.

ECB (90.1 Section 11.5.2 i): UMLH for the proposed design or baseline designs shall not exceed 300 hours. In addition, the UMLH for the proposed design shall not exceed the unmet load hours for the budget building design.

PRM (90.1 Section G3.1.2.3): UMLH for the proposed design or baseline building design shall not exceed 300 out of the 8,760 hours simulated.

Both PRM and ECB allow the building official to accept submittals where UMLH limit is exceeded if sufficient justification is provided indicating the accuracy of the simulation is not significantly compromised.

Listed are several common reasons for a high UMLH.[18]

- The thermostat schedules should agree with schedules of 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.
- The inputs for internal gains, occupants, and outside air ventilation should be reasonable and consistent with the intended operation of the building.
- The simulated operation of controls can be examined to determine if primary or secondary heating or cooling equipment (pumps, coils, boilers, etc.) is activated.
- Inadequate equipment capacity in the proposed design.

18 PNNL-26917, ANSI/ASHRAE/IES Standard 90.1-2016 Performance Rating Method Reference Manual, Richland, WA https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26917.pdf

The prescribed limits should be enforced for majority of projects because the high UMLH is often due to simulation errors that may have a high impact on the compliance outcome. The higher UMLH 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 heating season and/or higher during cooling season. This will reduce energy use of the proposed design, but it is not an allowed trade-off opportunity. Some examples of extenuating circumstances that can be considered for accepting submittals where the UMLH limit is exceeded are as follows:

- Number of UMLH beyond the allowed limit. AHJ may judge submittal with 350 UMLH (that exceed the 300 limit by 50 hours) to be acceptable, but reject submittal with 800 UMLH (that exceed the 300 limit by 500 hours).
- Floor area of the thermal blocks where UMLH occur. AHJ may choose to accept submittal with high UMLH in a 100 ft^2 thermal block (e.g., a stairwell), but reject submittal with high UMLH in the zones that account for a notable fraction (e.g., exceeding 5%) of the overall conditioned floor area.
- How far indoor temperatures drop or rise outside of the acceptable range. For example, AHJ may accept submittal if the actual zone temperatures during UMLH is one or two degrees outside of the throttling range, but may reject submittals with larger discrepancies; for example, if during the UMLH the temperature in the thermal block is 60°F compared to a 70°F heating setpoint.

eQUEST Reports	BEPU, SS-R, SS-O, LS-C, CSV Space Loads Report
Trane TRACE 700	Energy Cost Budget/PRM Summary, LEED Summary Section 1.3

SG4*(MI-B,P) Modeled conditioned floor area is appropriate

The modeled conditioned floor area must be the same for the baseline (budget) and proposed design and align with the floor area reported in the design documents. Small deviations between the modeled area and the area specified in the design documents are common and may be acceptable. Some common reasons for the mismatch are listed as follows.

- Gross floor area reported in the design documents is based on the definition in the 2015 IBC,[19] which differs from the 90.1 – 2013 definition (both are quoted in the following section). ECB and PRM do not specify how building area should be inputted into the model; for example, 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.

19 International Code Council, 2015 International Building Code (3rd Printing as adopted by New York State), Washington, DC.

- **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 excluding covered walkways, open roofed-over areas, porches and similar spaces, pipe trenches, exterior terraces or steps, chimneys, roof overhangs, and similar features.

- 90.1 distinguishes between the enclosed spaces, which include directly or indirectly conditioned, semi-heated, or unconditioned spaces and unenclosed spaces, such as crawlspaces, attics, and parking garages with natural or mechanical ventilation (see 90.1 definition of unconditioned space). Unenclosed spaces may be modeled as ambient conditions, thus not contributing to the modeled floor area.
- 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).
- 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.

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

eQUEST Reports	Conditioned area: LS-C, CSV Space Loads Report
Trane TRACE 700	LEED Summary Section 1.2

SG5*(MO,B) Site Energy Use Intensity (EUI) of the budget (baseline) design does not exceed typical by more than 20%.

ECB: The budget building design is a virtual building similar to the proposed design, but with all systems and components minimally compliant with the prescriptive requirements of 90.1 2013. Thus, the site EUI of the ECB budget design is expected to be similar to the EUIs of the common designs compliant with 90.1 2013 in Table 1 of the Manual.

PRM: The baseline building minimally complies with 90.1 2004 and is expected to have a similar EUI as designs prescriptively compliant with 90.1 2004, as shown in Table 1.

Baseline (budget) site EUI exceeding the values in Table 1 by more than 20% should be flagged. Such deviations may indicate inappropriate simulation assumptions or modeling mistakes. Deviations may be justified by project-specific conditions, such as EUI of miscellaneous equipment (Misc. Equipment column in Table 1) higher than the typical shown in the table.

Table 2. Site EUI kBtu/SF

YR of Common Commercial Building Designs[20]

	90.1 2004 Site EUI (PRM)			90.1 2013 Site EUI (ECB)			Misc. Equipment
	4A	5A	6A	4A	5A	6A	
Multifamily NYStretch							
Multifamily High-rise	54	63	65	46	52	53	13
Hospital	172	174	182	124	127	128	50
Large Hotel	118	132	134	86	90	90	37
Large Office	83	87	87	70	74	75	42
Medium Office	45	50	51	32	35	36	16
Primary School	79	86	89	55	57	58	25
Secondary School	73	74	74	39	40	40	15

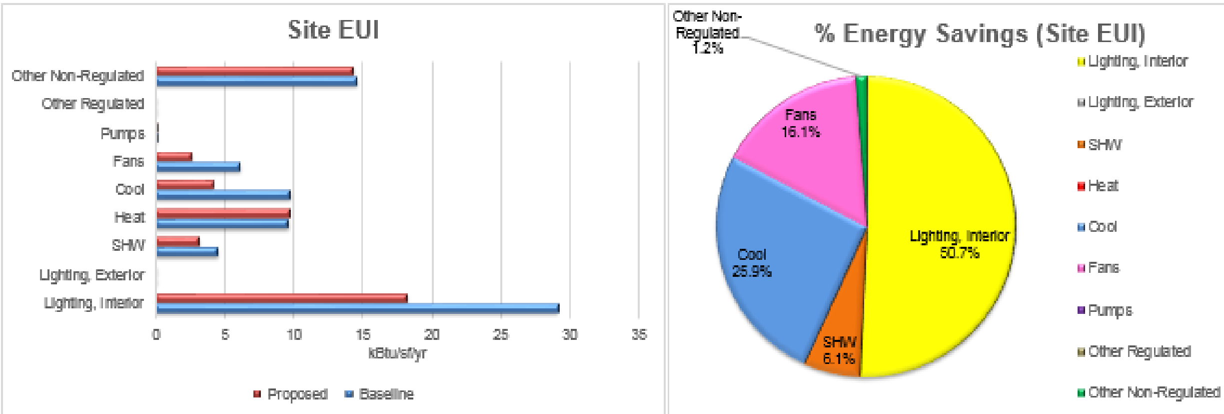
eQUEST Reports	BEPS
Trane TRACE 700	Monthly Energy Consumption report

SG6*(MO) Identify the key end uses contributing to the site energy trade-offs based on the simulation outputs; mark the high priority checks to be completed in the Review Checklist.

The check identifies the end uses that contribute the most to the difference between the baseline (budget) and proposed design energy use based on the simulation outputs. The comparison is illustrated in Figure 18, based on the PRM RT quality assurance checks tab.

20 Based on PNNL 2013EndUseTables_2014jun20.xls derived from DOE building prototypes http://www.energycodes.gov/commercial-prototype-building-models and related analysis http://www.energycodes.gov/development/commercial/cost_effectiveness

Figure 16. Site EUI by End Use Comparison (PRM RT Quality Assurance Checks tab)



<u>PRM:</u> The PRM baseline is compliant with 90.1 2004, thus most end uses in the proposed design may show improvement over the corresponding end uses in the baseline. In the Review Checklist, mark the checks that must be performed to verify systems and components contributing to the three or more most impactful end uses based on site EUI, as identified in Table 2.

<u>ECB:</u> The ECB budget design is compliant with the prescriptive requirements of 90.1 2013, so the comparison will show savings for some end uses and penalty for the others. In the Review Checklist, mark the checks that must be performed to verify systems and components contributing to the three or more most impactful end uses based on site EUI, as identified in Table 2.

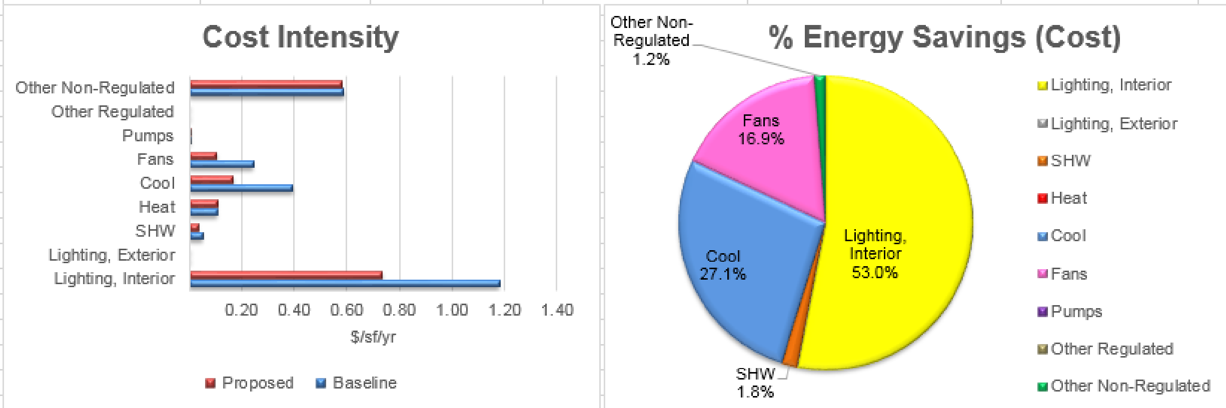
Once the most impactful end uses are identified, the reviewer should select the relevant checks in the Review Checklist that confirm that the baseline value is not inflated and that the proposed value is not under-estimated. Common reasons for high/low end uses are included in Table 2.

SG7*(MO) Identify the key end uses contributing to the energy cost trade-offs based on the simulation outputs; mark the high priority checks to be completed in the Review Checklist.

Compliance for ECB and PRM is based on the energy cost, thus the end uses with the highest contribution to energy cost savings must be verified.

<u>ECB, PRM:</u> In the Review Checklist, mark the checks that must be performed to verify systems and components contributing to the three or more most impactful end uses based on cost EUI (if different from site EUI). Common patterns are shown in Table 2, while Figure 19 illustrates the check implemented in the PRM RT. AHJs may require that PA justifies savings of the key end uses contributing to the savings by describing the associated features of the baseline and proposed design, as shown at the bottom of Figure 18.

Figure 17. Cost EUI by End Use Comparison (PRM RT Quality Assurance Checks tab)



Issue	Project Team Response
The three largest end use contributors to the cost savings are Interior Lighting, Cooling, and Fans (as reported in the 12 - Performance_Outputs_1 tab). Please provide a narrative to justify the savings of these end uses, such as the energy conservation measures which contribute to the savings claimed.	

Once the most impactful end uses based on the energy cost are identified, the reviewer should select the relevant checks in the Review Checklist that confirm the baseline value is not inflated and the proposed value is not underestimated, based on Table 2. Many of the high priority checks may already be selected after the SG6 check.

Table 3. Simulation Output Patterns and Review Priorities

Heating Use Too High/Low
■ Thermal properties of the envelope are not established or modeled correctly ■ Infiltration rate is too high/low ■ Window to wall ratio (WWR) is higher (lower) than typical for the building type ■ Internal heat gains from lighting, appliances, or plug loads are too low/high ■ Excessive simultaneous heating/cooling (simulation outputs show high heating use during summer months, leading to high heating EUI) ■ Modeled ventilation rate is too high/low ■ Heating efficiency is too low/high ■ Heating thermostat setpoints are too high/low
Cooling Use Too High/Low
■ Fenestration SHGC is too high/low ■ Baseline (budget) WWR significantly higher (lower) than typical for the building type ■ Internal heat gains from lighting, appliances, or plug loads are too high/low ■ Excessive simultaneous heating/cooling (simulation outputs show high cooling use during winter months, leading to high cooling EUI) ■ Modeled ventilation rate is too high/low ■ Baseline cooling efficiency is too low/high ■ Modeled heating thermostat setpoints are too low/high ■ Economizer not modeled or modeled incorrectly
Service Water Heating Too High/Low
■ Hot water demand too high/low
■ Water heater efficiency too low/high
Fan Energy Use Too High/Low
■ Fans are not modeled explicitly (low EUI)
■ Fans modeled as process load (low EUI)
■ Exhaust or DOAS fans are modeled in addition to the baseline allowance (high baseline EUI)
■ Project includes parking garage with exhaust fans (high EUI)
■ Flow controls are not properly modeled (e.g., high EUI if Constant Volume (CV) instead of Variable Air Volume (VAV) control was modeled)
Interior Lighting Energy Use Too High/Low
■ Modeled lighting wattage is too high/low

■ Lighting runtime hours are too high/low, or not equal between the baseline and proposed
■ Savings from occupancy sensors and daylighting are too low/high
Exterior Lighting Energy Use Too High/Low
■ Lighting wattage is too high/low
■ Lighting runtime hours are too high/low, or not equal between the baseline and proposed
■ Credit claimed for non-tradeable lighting
Exterior Lighting Energy Use Too High/Low
■ Unregulated loads are not modeled the same in the baseline (budget) and proposed design.
Significant Difference Between Cost vs Side EUI End Use Savings for the Impactful End Uses
■ Significant difference in $/BTU cost of fuels (e.g., electricity versus gas); inappropriate utility rates used, or utility rates not modeled correctly

8.3 Utility Rate (UR)

UR1*(CR-B,P) The utility rate structure based on the approved source and the same for the baseline (budget) and proposed design

ECB (90.1 Section 11.4.3.2): The rates for purchased energy (such as electricity, gas, oil, propane, steam and chilled water) must be approved by the AHJ.

PRM (90.1 Section G2.4.2): Either the actual rates for purchased energy or State average energy prices published by DOE'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.

As of the date of the Manual publication, New York does not have preapproved purchased energy rates for ECB, thus AHJ may select to use PRM rules for all projects. The most recent New York annual average costs from EIA website are 0.1528 $/kWh for electricity[21] (2015) and $ 6.18 per thousand cubic feet of natural gas[22] (2016). The actual utility rates, if used, may include time of use charges, block charges, etc.

21 https://www.eia.gov/electricity/state/newyork/

22 https://www.eia.gov/dnav/ng/ng_pri_sum_dcu_SNY_a.htm

UR2*(MI,MO-B,P) The modeled utility rate structure is as reported and the difference between the baseline and proposed virtual rate is as expected.

Simulation input and output reports should be reviewed to confirm that the utility rate structure described in the submittal was properly modeled.

When using the simulation output reports, 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 in the submittal. 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 proposed design reduces the peak demand and the modeled electricity rates include demand charges.

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.

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

Quality Assurance Checks in the PRM RT

PRM RT automates some of the checks related to utility rates, as illustrated in Figure 19.

Figure 18. Service Water Heating Checks

Incorporated into PRM RT Quality Assurance Check Tab

Service Water Heating							
Input/Output Summary							
	Annual Service Water Heating Use MMBtu/Yr (12 - Performance_Outputs_1)	Heater Capacity [kBtu/Hr] (8 - Service Water Heating)	Annual Effective Full Load Hours	Typical Effective Full Load Hours	Heater Efficiency	Annual Service Water Heating Load MMBtu/Yr (12 - Performance Outputs 1 tab)	Annual Service Water Heatin [kBtu/SF] (12 - Performance Outputs
	SHWE	Cap	EFLH = SHWU / Cap x 1000	EFLH_typ	Effy	SWHE x Effy	SWH_E
Baseline Design	490	1,017	481	2,555	80%	393	4.5
Proposed Design	346	1,017	NA	NA	95%	329	3.2
Proposed/Baseline	71%	100%	NA	NA	118%	84%	71%

	Issue	Project Team Response
Pass	Effective full load hours exceed typical by more than 25%, which may indicate that the modeled demand is high relative to the specified service water heater capacity. Please review the service water heater capacity and hot water demand (e.g. flow rate and schedule) to justify the result. The modeled service water heater energy use may be exaggerated.	
Pass	The baseline site EUI differs from typical by more than 25%. Please review the inputs related to service water heating use, such as the amount of hot water used in the building (the design flow rate and schedule), temperature of water entering water heater, water heater efficiency, and stand-by losses.	
Please Explain	Annual Service Water Heating Load differs between baseline and proposed design. Please explain what factors other than heater efficiency affected SWH energy use in the baseline and proposed design.	

8.4 Compliance Calculations (CC)

CC1*(MO-B,P) Baseline(budget) and proposed energy cost used in the compliance calculations match simulation output reports

PRM and ECB compliance is established based on the simulation outputs for the baseline (budget) and proposed design. Some simulation tools perform compliance calculations automatically, while others require exporting simulation outputs into an external spreadsheet where compliance calculations are performed by the PA. It is not uncommon for the simulation outputs used in such external calculations to not match the values shown in the simulation outputs reports included in the submittal.

PRM RT allows the PA to copy results from the standard simulation output reports into the designated areas to auto-populate the template with the simulation results, to avoid mistakes from manual data transfer.

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

CC2*(CR-P) Contribution of the renewable energy toward compliance does not exceed the allowed limit

ECB (Section 11.4.3.1): The reduction in design energy cost associated with on-site renewable energy shall be no more than 5% of the calculated energy cost budget.

PRM: PRM does not limit contribution of the renewable energy toward compliance. However, such contribution should be verified to ensure that it is not overly optimistic.

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 preheat, 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.

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 the renewable energy toward savings is 5% x 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.

If project uses renewable energy to document compliance, add the OE1 review check to the scope of the review.

eQUEST Reports	NA
Trane TRACE 700	LEED Summary Section 1.4

CC3*(CR-P) Contribution of the exceptional calculations toward compliance does not exceed the allowed limits

ECB: ECB does not limit contribution of savings documented via the exceptional calculations toward compliance. However, since exceptional calculations often involve spreadsheets developed by the permit applicant and are not peer-reviewed, AHJ may choose to use a similar approach as described for PRM.

PRM (90.1 Section G2.5): When the simulation program does not model a design, material, or device of 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. The calculation must be done using energy cost units.

Example
Q: The modeled baseline energy cost is $100,000 and the modeled proposed energy cost is $92,000. In addition, the submittal includes $7,000 savings from a ventilated façade which could not be modeled in the simulation tool. The savings were determined using the 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 the exceptional calculations is $100,000 − $92,000 = $8,000. The savings from the exceptional calculations are greater than $8,000 x 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.

If project uses exceptional calculations to document compliance, add OE3 review check to the scope of the review.

eQUEST Reports	NA
Trane TRACE 700	LEED Summary Section 1.4

CC4*(CR-B,P) Combined Heat and Power (CHP) systems are modeled energy neutral, with performance credit limited to recovered heat

ECB: Based on 90.1 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 90.1 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 specified for the proposed design. Following 90.1 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.

PRM: Based on 90.1 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 specified for the proposed design. The recovered waste heat of the specified CHP system is not considered purchased energy and must be subtracted from the proposed design energy consumption following 90.1 Section G2.4.1, thus contributing to the performance credit.

If the CHP system is modeled using exceptional calculation methods, the amount of electricity generated by the 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. Similar patterns should be verified in the simulation output reports if CHP is incorporated in the simulation. If the proposed design includes CHP system(s), add an OE2 review check to the scope of the review.

CC5*(CR) Compliance calculations are performed as required

ECB: The energy cost of the proposed design (design energy cost) must not exceed the energy cost budget (90.1 Section 11.2). Both the design energy cost and the energy cost budget must be based on the completed simulations and may include adjustments based on the exceptional calculation methods.

PRM: PRM compliance calculations require separating the baseline energy cost into the baseline building regulated energy cost (BBREC) and baseline building unregulated energy cost (BBUEC). Regulated energy use is the energy used by building systems and components with requirements prescribed in 90.1 Sections 5 through 10, including but not limited to interior and exterior lighting, service water heating, space heating, humidification, dehumidification, mechanical cooling, heat rejection, cooling towers, HVAC supply, return and exhaust fans, heat recovery fans and wheel energy, hydronic pumps, elevators, and in-building transformers.

Unregulated energy use is the energy used by unregulated systems and components, such as energy used by household appliances, plug loads, custom refrigeration systems, and other systems not covered in 90.1 Sections 5 through 10.

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.

The reviewer must verify that the baseline energy cost is properly separated into BBREC and BBUEC and that the project's performance cost index (PCI) is less than or equal to the performance cost index target (PCIt) calculated as described in 90.1 Section 4.2.1.1.

The calculation is automated in the performance output tab of PRM RT (Figure 20), based on the simulation results for the baseline and proposed design.

Figure 19. PRM RT Compliance Calculation

	Cost $	Source Energy (Btu x 10^6)
Proposed Building Performance before site-generated renewable energy and exceptional calculations (PBP nre_nec, $/Source Energy)	$ 70,832	5,336.90
Onsite Renewable Cost Savings, $/Source Energy	$ -	-
Exceptional Calculations Cost Savings, $/Source Energy	$ -	-
Proposed Building Performance including site-generated renewable energy and exceptional calculations (PBP, $/Source Energy)	$ 70,832	5,336.90
Baseline Building Unregulated Energy Cost (BBUEC, $/Source Energy)	$ 28,759	2,054.11
Baseline Building Regulated Energy Cost (BBREC, $/Source Energy)	$ 79,946	6,411.44
Baseline Building Performance (BBP, $/Source Energy)	$ 108,705	8,465.55
Building Performance Factor (BPF)	0.78	0.78
Target Performance Cost Index (PCIt)	0.84	0.83
Performance Cost Index without site-generated renewables and exceptional calculations (PCI nre_nec)	0.65	0.63
Performance Cost Index including exceptional calculations (PCI ec)	0.65	0.63
Performance Cost Index including exceptional calculations and site-generated renewables (PCI ec+re)	0.65	0.63
% Improvement Beyond ASHRAE 90.1-2013, excluding site-generated renewable and exceptional calculations	22.3%	24.4%
% Improvement Beyond ASHRAE 90.1-2013, all included	22.3%	24.4%

8.5 Building Envelope (BE)

BE1*(CR-B) Thermal properties and areas of the baseline (budget) opaque envelope are established correctly.

The submittal must include a description of the baseline (budget) and proposed design for each opaque envelope assembly. In addition, PRM submittals must show the applicable prescriptive requirements of 90.1 2013. Information that must be provided is illustrated in Figure 21, based on the PRM RT opaque assembly tab.

Figure 20. PRM RT Opaque Assembly Tab (Abstract)

Table 5.3: Above-Grade Exterior Wall Constructions

General Information			Baseline-ASHRAE 90.1 2016 Appendix G		Proposed Design					Prescriptive Requirement of ASHRAE 90.1-2013 Applicable to App. G Baseline	Measure #
Building ID	New or Existing Construction	Space-Conditioning Category	Description	Assembly U-factor	Type	Description	Assembly U-factor	Area (sf)	Plans / Specs		
			Helpful Hints ▪ Describe the Baseline above-grade exterior wall construction (for example: steel-framed with R-13.0 (R-2.3) cavity insulation and R-7.5 (R-1.3)continuous insulation). ▪ New/Existing/Addition above-grade walls: steel-framed with U-factor from Table G3.4-1 through G3.4-8 per Table G3.1#5(b).			Helpful Hints ▪ Describe the Proposed above-grade exterior wall construction and Appendix A Table referenced (for example: 6" (150mm) steel frames spaced 24" (610mm) on center with R-21 cavity insulation and R-10 (R3.7)continuous insulation per Table A3.3.3.1). ▪ Proposed construction assembly U-factor should be as-designed and consistent with Appendix A of ASHRAE 90.1. ▪ If the Proposed design includes building envelope assemblies of different U-values, please specify surface area, square feet, for each envelope assembly. ▪Reference specific place in the submitted design documents (e.g. drawing & detail number) where relevant parameters are listed to support review.				In accordance with Prescriptive Requirements of 90.1-2013 Table 5.5-4	
425 Main Street	New	Residential	steel-framed with a U-factor of 0.064	0.064	Steel Framed	3 5/8" Brick; 2 1/4" air space; 3" rigid insulation R-15; 1/2" Gypsum sheathing; 6" metal framing; R-11 batt insulation in steel frame cavity; 5/8" gypsum board	0.042	14,550	A105	U-0.064	5

This input affects the baseline (budget) envelope requirements.

Baseline surface type and construction based on the ECB/PRM rules. Auto-populated in the PRM RT

Proposed assembly description, thermal properties, gross area and drawling reference. In PRM RT, U-value is shown in green if it improves over the prescriptive requirements of 90.1 2013

(PRM only) 90.1 prescriptive requirements. Auto-populated in PRM RT

Row is marked as "measure" in PRM RT if it's an area of trade-off

ECB (90.1 Table 11.5.1 #5, 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 for alterations. When trade-offs are made between an addition and an existing building as described in the exception to 90.1 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.

PRM (90.1 Table G3.1 #5): 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).

Description and assembly U-factor are auto-populated with the appropriate values for projects using the PRM RT. Unconditioned envelope components must be modeled in the baseline with the same properties as specified in the proposed design.

- Floors of conditioned spaces adjacent to garages must be treated as exterior surfaces when establishing the baseline floor U-value.

BE1*(CR-P) Thermal properties and areas of the proposed opaque envelope are established correctly.

For the opaque envelope components, assembly description, area, and U-factors must be provided in the submittal as illustrated in Figure 21 and reflect design documents. The existing envelope assemblies of the renovation projects must be reflected in the submittal and based on the actual properties.

Any insulated building envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) may be added to the area of the adjacent assembly of that same type and the thermal properties of the aggregated surface must reflect area-weighted average (ECB 90.1 Table 11.5.1 #5; PRM 90.1 Table G3.1 #5).

All uninsulated assemblies (e.g., projecting balconies, perimeter edges of intermediate floor stabs, concrete floor beams over parking garages, and roof parapets must be separately reported and either modeled as a separate surface, or by calculating the U-factor for each of these assemblies and averaging it with the larger adjacent surfaces using an area-weighted average method.

- The overall U-value insulation is established without accounting for 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 (Figure 22).
- For tapered roof insulation, the U-value should be based on the average insulation thickness.

Figure 21. Proposed Envelope Properties with 90.1

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

Framing Type and Spacing Width (Actual Depth)	Cavity Insulation R-Value: Rated (Effective Installed [see Table A9.2B])	Overall U-Factor for Entire Base Wall Assembly	Overall U-Factor for Assembly of Base Wall Plus Continuous Insulation (Uninterrupted by Framing) — Rated R-Value of Continuous Insulation: R-1.00	R-2.00	R-3.00	R-4.00	R-5.00	R-6.00	R-7.00	R-8.00	R-9.00	R-10.00	R-11.00	R-12.00	R-13.00	R-14.00
Steel Framing at 16 in. on Center																
3.5 in. depth	None (0.0)	0.352	0.260	0.207	0.171	0.146	0.128	0.113	0.102	0.092	0.084	0.078	0.072	0.067	0.063	[illegible]
	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	[illegible]
	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	[illegible]				
	[illegible]	0.109	0.099	[illegible]	[illegible]	[illegible]	0.071	0.066	0.062	[illegible]						

BE2*(CR-B) Baseline (budget) fenestration areas are established correctly

The submittal must list fenestration areas in the baseline and proposed design for each building area type and orientation. In addition, PRM submittals must show the applicable prescriptive requirements of 90.1 2013. The level of detail that must be included in the submittal is illustrated in Figure 23, based on the PRM RT.

ECB (90.1 Table 11.5.1 #5 c): 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 the exception to Section 4.2.1.2, the budget building design shall reflect existing conditions, such as fenestration area, prior to any revisions that are part of this permit.

PRM (90.1 Table G3.1 Baseline Building Performance column (c) and 90.1 Table G3.1.1-1): The baseline fenestration area depends on the building area type in Table G3.1.1-1. For example, a 40,000 ft2 office building is modeled with the baseline vertical fenestration area equal to 31% of the gross above-grade wall area. For building types not specified in Table G3.1.1-1, such as multifamily, the baseline fenestration area shall be equal the proposed design or 40% of 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 be distributed on each face of the building in the same proportions as the existing building.

Figure 22. PRM RT Fenestration Areas tab

Table 4.1: Envelope Area Summary

Gross Exterior Wall & Vertical Glazing Area Summary		**Baseline-ASHRAE 90.1 2016 Appendix G**			**Proposed Design**		
		Helpful Hints • All vertical glazing flush with exterior wall and no shading projections per Table G3.1#5(d) • Manual shading devices such as blinds or shades may be modeled per Table G3.1#5(d) • No self-shading per Table G3.1#5 • Total vertical fenestration areas for new construction and additions shall equal that in Table G3.1.1-1 based on gross above-grade exterior wall area. For buildings areas not shown in Table G3.1.1-1, vertical fenestration shall equal that in the proposed design or the maximum allowed in Tables G3.4-1 through G3.4-8 for the applicable glazing percentage for U-fixed, whichever is smaller, per Table G3.1#5(c) • Total vertical fenestration areas for existing construction 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 per Table G3.1#5(c)			Helpful Hints • Manual shading devices such as blinds or shades may be modeled and must be consistent with the baseline per Table G3.1#5(4) • Permanent shading devices (such as fins, overhangs, and light shelves) and automatically controlled shades or blinds must be modeled per Table G3.1#5(4)		
Building Area Type	Orientation	Gross Above-Grade Wall Area (sq ft)	Vertical Glazing Area		Gross Above-Grade Wall Area (sq ft)	Vertical Glazing Area	
			(sq ft)	(%)		(sq ft)	(%)
Office (5,000 to 50,000 sf)	North	Identical to Proposed	4,820	31.0%	15,549	4,943	31.8%
Office (5,000 to 50,000 sf)	East	Identical to Proposed	7,812	31.0%	25,200	11,319	44.9%
Office (5,000 to 50,000 sf)	South	Identical to Proposed	4,820	31.0%	15,549	4,943	31.8%
Office (5,000 to 50,000 sf)	West	Identical to Proposed	5,952	31.0%	19,200	11,319	59.0%
Total		75,498	23,404	31.0%	75,498	32,524	43.1%

Fenestration area must be provided for each building area type (e.g. multifamily vs. office in a mixed-use occupancy) and each exposure

Baseline (budget) fenestration area and Window to Wall ratios as prescribed. (Auto-populated in PRM RT)

Proposed gross wall and fenestration areas based on design documents. Cells with white background are auto-populated in PRM RT

Common Mistake

- Based on the 90.1 Definition section, all areas (including frame) that let in lighting, such as windows, 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)

BE2*(CR-P) Proposed fenestration areas are established correctly

ECB (90.1 Table 11.5.1 No5, Column A): Fenestration area must be as shown on architectural drawings or as installed for existing building envelopes.

PRM (90.1 Table G3.1 #5, Proposed Building Performance column)*:* Fenestration area must be as shown on architectural drawings, or as installed for existing building envelopes.

BE3*(CR-B) Baseline (budget) fenestration properties are established correctly

The submittal must include a description of the baseline and proposed design for each fenestration assembly. In addition, PRM submittals must show the applicable prescriptive requirements of 90.1 2013. The submittal requirements are illustrated in Figure 24, based on the PRM RT.

ECB (90.1 Table 11.5.1 #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, 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.

PRM (90.1 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.

Figure 23. PRM RT Fenestration Properties Tab

Table 4.2: Vertical Glazing

General Informatio			Baseline-ASHRAE 90.1 2016 Appendix G			Proposed						Prescriptive Requirement of ASHRAE 90.1-2013 Applicable to App. G Baseline
Building ID	New or Existing Constructio	Space-Conditioning Category	Description	Assembly U-factor	SHGC	Description	Assembly U-factor	SHGC	VLT	Area (sf)	Plans / Specs	
			<u>Helpful Hints</u> • New/Existing vertical glazing: • Select a description • Assembly U-factor and SHGC from Table G3.4-1 through G3.8 per Table G3.1#5(d). • (SHGC). Please note that this is not equivalent to the shading coefficient (SC).			<u>Helpful Hints</u> • Proposed vertical glazing assembly U-factor should be as-designed and account for the impact of the frames on the whole assembly. Reference Table A8.2 of ASHRAE 90.1 as necessary. • Describe the Proposed vertical glazing assembly (for example: double glazing, argon filled, low-e coating, aluminum frame with thermal break) • Enter the Proposed vertical glazing assembly solar heat gain coefficient (SHGC). Please note that this is not equivalent to the shading coefficient (SC). • Enter the Proposed vertical glazing assembly visual light transmittance (VLT) • If the Proposed design includes building envelope assemblies of different U-values, please specify surface area, square feet, for each envelope assembly.						In accordance with Prescriptive Requirements of 90.1-2013 Table 5.5-4
Sample Building	New	Nonresidential	10.1%-20.0%	0.57	0.39	Double pane, metal framing, operable windows	0.45	0.4	0.5	23,000	Dwg A205, Window Schedule	Nonmetal framing, all: U-0.35; SHGC-0.40; VT/SHGC-1.10 Metal framing, fixed: U-0.42; SHGC-0.40; VT/SHGC-1.10 Metal framing, operable: U-0.50; SHGC-0.40; VT/SHGC-1.10 Metal framing, entrance door: U-0.77; SHGC-0.40; VT/SHGC-1.10
Sample Building	New	Residential	20.1%-30.0%	0.57	0.39	Double pane, insulated storefront	0.35	0.3	0.5	2,000	Dwg A205, Window Schedule	Nonmetal framing, all: U-0.35; SHGC-0.40; VT/SHGC-1.10 Metal framing, fixed: U-0.42; SHGC-0.40; VT/SHGC-1.10 Metal framing, operable: U-0.50; SHGC-0.40; VT/SHGC-1.10 Metal framing, entrance door: U-0.68; SHGC-0.40; VT/SHGC-1.10

- Construction type and space conditioning category must be provided for each fenestration assembly, as it affects baseline (budget) fenestration properties
- Baseline (budget) U-value, SHGC and VT (for ECB) must be provided for each fenestration assembly. Auto-populated in PRM RT.
- Proposed fenestration type, properties and areas, based on design documents. Properties must be established using an approved method
- 90.1 2013 prescriptive requirements (PRM only); auto-populated in PRM RT.

BE3*(CR-P) Proposed fenestration properties are established correctly

<u>ECB, PRM:</u> 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 (ECB 90.1 Table 11.5.1 #5; PRM 90.1 Table G3.1 #5).

The fenestration description, U-value, SHGC and VT must reflect design documents, with the drawing and detail number, or specification section provided to support the review, as illustrated in Figure 24.

Common Mistakes

- 90.1 Section 5.8.2.1 requires that performance of the windows and other fenestration products including U-factor, SHGC, VT, and air leakage rate is determined by a laboratory accredited by 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 generic values in 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.
- Visible Light Transmittance (VLT) is not entered for the baseline (ECB) and proposed (ECB, PRM) glazing. 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.

BE4*(CR-B) The baseline building (budget) performance is an average of four orientations, if required

ECB (90.1 Table 11.5.1): 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.

PRM (90.1 Table G3.1 #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 the building vertical fenestration area on each orientation varies by less than 5%; or 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. For PRM projects, the averaging of four orientations is implemented in the RT.

BE4*(CR-P) Proposed building orientation is as specified

Proposed building orientation must reflect the actual building exposure.

BE5*(CR-B) Baseline (budget) infiltration rate is established correctly

PRM (90.1 Table G3.1 No 5 b): The air leakage rate of the building envelope (I75Pa) at a fixed building pressure differential of 0.3 in. of water shall be 0.4 cfm/ft2. Infiltration shall 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 shall be converted to appropriate units for the simulation program using one of the methods in 90.1 Section G3.1.1.4. The calculations to obtain simulation inputs must be documented in the reporting template as illustrated in Figure 25 based on PRM RT. The template auto-populates all baseline values and most values for the proposed design, including the conversion from tested air leakage at 75Pa or 50Pa to the simulation tool inputs.

Figure 24. PRM RT Infiltration Inputs

Table 5.1: Infiltration

	Baseline-ASHRAE 90.1 2016 Appendix G	Proposed Design
	Per Table G3.1#5, the air leakage rate at a fixed building pressure differential of 0.3 in. H20 shall be 0.4 cfm/ft2, and infiltration rates must be converted into appropriate modeling inputs using one of the two methods in G3.1.1.4	To claim performance credit for infiltration reduction, actual, measured infiltration, based on testing performed in accordance with ASTM e779, must be modeled. Otherwise, proposed infiltration must be modeled identically to the baseline.
A FLR = total gross floor area, SqFt	84,360	84,360
A EW = total above grade exterior wall area, SqFt	43,328	43,328
S = total area of the envelope air pressure boundary (expressed in ft2), including the lowest floor, any below- or above-grade walls, and roof (or ceiling) (including windows and skylights), separating the interior conditioned space from the unconditioned environment measured	60,188	60,188
Air leakage measurement type	Whole Building	Whole Building
Fixed building pressure differential	75 Pa	75 Pa
I 75Pa / I 50 Pa = air leakage rate of the building envelope expressed in cfm/ft2 at the specified	0.40	0.35
Q = Volume of air in CFM flowing through the whole building envelope when subjected to the specified fixed building pressure differential.	24,075	21,066
Building Volume (ft3)	843,600	843,600
	Simulation Inputs	
I flr = Baseline Model Infiltration as a Function of Floor Area [cfm/sf]	0.032	0.028
I ew = Baseline Model Infiltration as a Function of Exterior Wall Area [cfm/sf]	0.062	0.054
Air Changes Per Hour (ACH)	0.192	0.168

Common Mistake

- An infiltration rate of 0.4 CFM/ft^2 is entered into simulation tool without converting to normal wind conditions. This exaggerates infiltration related loads by about factor of 10, significantly increasing the heating load and any savings from air leakage reduction in the proposed design.

ECB: Air-leakage in the budget building is not prescribed, thus any reasonable rate may be modeled. It is expected to be similar to the PRM rate above. Modeling unrealistically high air leakage will exaggerate contribution of heating energy use toward budget building performance and may skew compliance outcome.

BE5*(CR-P) Proposed infiltration is established correctly.

ECB: The same envelope air leakage rate must be modeled in the budget and proposed design; no trade-offs are allowed.

PRM (90.1 Table G3.1 No 5): Infiltration rate in the proposed design must be the same as in the baseline, except when the 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.

BE6(MI-B,P) Modeled thermal properties and areas of the baseline (budget) and proposed opaque envelope are as reported in the submittal.

Compare thermal properties and areas of the opaque envelope entered into simulation to the values in the reporting template, including the following:

- Roof area and U-value
- Exterior wall area and U-value
- Exposed floor area and U-value
- Slab-on-grade, below-grade surfaces area, and U-value

eQUEST Reports	LV-D
Trane TRACE 700	Building U-Values, Building Areas

BE7(MI-B,P) Modeled fenestration areas for the baseline (budget) and proposed design are as reported in the submittal

Compare fenestration areas entered into simulation, based on the listed simulation reports, to the values reported in the submittal.

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

BE8(MI-B,P): Modeled baseline (budget) and proposed fenestration properties are as reported in the submittal.

Compare the fenestration U-values, SHGC, and VT entered into the simulation tool to the values reported in the submittal.

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

BE9(MI-B,P) Baseline (budget) and proposed building orientation is modeled as reported in the submittal.

Use the simulation reports to verify modeled exposure is as reported in the submittal.

eQUEST Reports	LV-D, results for the four baseline orientations must be averaged externally
Trane TRACE 700	LEED Summary Section 1.6

BE10(MI,MO-B,P) Baseline (budget) and proposed infiltration modeling methodology is as required; modeled infiltration rate reflects the values reported in the submittal.

Use the simulation reports to verify modeled baseline (budget) and proposed infiltration rate is as listed in the reporting template. Ensure that both the units (CFM/SF, ACH) and the value is correct.

eQUEST Reports	LV-B
Trane TRACE 700	Room Information entered values report

BE11*(MO-B,P) Change in the proposed versus baseline (budget) design total annual and design loads from envelope components is reasonable given the difference in the proposed versus baseline (budget) envelope parameters reported in the submittal

This review check verifies simulation outputs are consistent with the baseline (budget) and proposed envelope parameters. These rough checks do not consider factors such as thermal mass, exposure, and shading, so look for a general correlation and not an exact match.

- 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 ECB projects and most PRM 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 /cooling losses / gains from infiltration should be the same or very close in the baseline and proposed simulations.
- Conductive heat losses through surfaces (windows, exterior walls, roofs) should correlate to the surface U-value and area.

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

Example 2: Based on the submittal, the proposed design has 40,000 SF of vertical fenestration with U-0.5; the baseline has 30,000 SF of fenestration with U-0. 5. The heat loss through windows due to conduction should go up. $(U_{prop} \times A_{prop})/(U_{base} \times A_{base})$ =(40,000*0.5)/(30,000*0.5)~1.3)

- 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

8.6 Lighting, Interior (LI)

The reporting template may include a checklist for the modeler to confirm that the specified code requirements are met, as illustrated in Figure 26, based on the PRM RT general lighting tab.

Figure 25. PRM RT Modeler Checklist

Interior Lighting

Instructions: Confirm that the energy model complies with the Interior lighting requirements listed, and provide a narrative explaining any discrepancies. Completing the Lighting Counts tab will populate the Interior Lighting by Space Type table. Please refer to the column header notes for information about Appendix G modeling protocol. Enter "N/A" for any information not applicable to the project.

Interior Lighting Requirements

The baseline lighting schedules reflects the anticipated operating schedules, and include the occupancy sensors in employee lunch and break rooms, conference/meeting rooms, and classrooms (not including shop classrooms, laboratory classrooms, and preschool through 12th grade classrooms).	Yes
Baseline and proposed lighting schedules reflet the mandaotry shut-off lighting controls that turn off lighting during unoccupied hours	Yes
In spaces where proposed lighting is not specified or patially specified , or where the proposed lighting is specifically exempted in Section 9.1.1, 9.2.2.3, or 9.4.2, the same lighting power is modeled in the baseline and the proposed design	Yes
The proposed lighting power includes all lighting system components shown or provided for on the plans (including lamps and ballasts and task and furniture-mounted fixtures), and is based on the manufacturers' **labeled maximum wattage** of the luminaires.	Yes
The proposed building design contains the mandatory automatic lighting controls specified in Section 9.4.1 (e.g., automatic daylight responsive controls, occupancy sensors, programmable controls, etc.).	Yes
Automatic daylighting controls are modeled directly in the proposed design or through schedule adjustments determined by a separate daylighting analysis approved by the rating authority. Modeling and schedule adjustments separately account for primary side lighted areas, secondary side lighted areas, and top lighted areas.	Yes
The proposed lighting schedules are the same as the baseline, except as allowed in Table G3.7. The occupancy sensors included in the proposed design are modeled by reducing the lighting schedule each hour by the Occupancy Sensor Reduction factor in Table G3.7 for the applicable space type. This reduction is taken only for lighting controlled by the occupancy sensors. Credit for other programmable lighting control in buildings less than 5000 ft2 is taken by reducing the lighting schedule each hour by 10%.	Yes

For each item entered as "No" above, describe the applicable ASHRAE 90.1 Appendix G exception(s) that apply, or the circumstances preventing the lighting parameters from being modeled as required. If the energy simulation software is not capable of modeling the required parameters, describe the adjustments that were made to provide a similar representation or provide a narrative justifying why the predicted energy performance results will not be influenced.

... | 4 - Shading and Fenestration | 5 - Opaque Assemblies | 6a - Lighting Counts | **6b - General Lighting** | 7 - Process Loa

The reporting template that contains a description of the baseline (budget) and proposed design and simulation output allows the automation of some of the checks, as illustrated in Figure 27.

Figure 26. Interior Lighting Checks in the PRM RM Quality Assurance Tab

Input/Output Summary								
	Interior Lighting Power [W] (6b - General Lighting tab)	Lighting Power [W] Adjusted for OS (6b - General Lighting tab)	Non-coincident Lighting Peak Demand [W] (12 - Performance_Outputs_1	Annual Lighting Use [kWh] (12 - Performance_Output	Effective Full Load Hours	Typical EFLH	Diversity Factor	Effective Full Load Hours (12 - Performance_Outputs_1 tab)
	ILP	ILPwOS	NCLPD	ALU	EFLH = ALU / ILP	EFLHt	DF = NCLPD / ILP	EFLH
Baseline Design	132,473	132,473	126,120	934,375	7,053	3,036	0.95	7,409
Proposed Design	84,204	82,633	81,350	582,849	6,922	NA	0.97	7,165
Proposed/Baseline	64%	62%	65%	62%	98%	NA	101%	97%

Issue		Project Team Response
Pass	The baseline lighting non-coincident peak demand reported on the Performance Outputs tab exceeds the maximum baseline lighting power on the General Lighting tab. Please correct the lighting inputs in the baseline model, or update the inputs on the Lighting Counts tab.	
Pass	The proposed lighting non-coincident peak demand reported on the Performance Outputs tab is lower than expected, based on the Lighting Power adjusted for the Occupancy Sensors from the General Lighting tab, and the modeled lighting schedule represented by the Diversity Factor (NCPD proposed < 0.85 * MPvOS * DF). Please correct the lighting inputs in the proposed model, or update the inputs on the Lighting Counts tab.	
Pass	The difference between the proposed and baseline lighting non-coincident peak demand reported on the Performance Outputs tab is higher than expected, based on the Baseline and Proposed Lighting Power adjusted for the Occupancy Sensors from the General Lighting tab (NCPDbase / NCPD prop > 1.1 * LPwOS base / LPwOS prop). Please review and correct the lighting inputs in the proposed and / or baseline model, or update the inputs on the Lighting Counts tab.	
Please Explain	**The effective full load hours (EFLH) exceed the typical by more than 20%. Ensure that the model reflects the mandatory lighting controls, and is based on the anticipated schedule of operation for the building. Please describe operating schedule if different than typical for the building type.**	
Pass	The difference between the baseline and proposed annual lighting energy use is higher than expected (LPwOS prop *0.9 / LPwOS base > ALU prop / ALU base) based on the baseline and proposed lighting wattages and OS entered on the Lighting Counts tab, and an estimated addeitional 10% credit for daylighting controls. Please verify that the modeled lighting wattages and controls reflect the values reported on the Lighting Counts tab.	
Pass	The proposed in-unit lighting is reported as <0.6 w/sf in the General Lighting tab. For ENERGY STAR MFHR projects, if the proposed in-unit lighting is below 0.6 W/SF, the savings in excess of these limits may be modeled only if the proposed fixtures are demonstrated to meet the recommended weighted average footcandles based on the 10th edition of the Illuminating Engineering Society (IESNA) Lighting Handbook for the given space type. Please provide external calculations showing these requirements are met, and also note the modeled in-unit LPD.	
Pass	Some space types in the General Lighting tab show a LPD reduction of >30% compared to the space-by-space lighting power allowance in the reference edition of 90.1. For ENERGY STAR MFHR projects, if a proposed common space lighting power reduction is >30%, the savings in excess of these limits may be modeled only if the proposed fixtures are demonstrated to meet the recommended weighted average footcandles based on the 10th edition of the Illuminating Engineering Society (IESNA) Lighting Handbook for the given space type. Please provide external calculations showing these requirements are met, and also note the modeled common space LPDs for any spaces with >30% LPD reduction.	

The details that must be included in the submittal are illustrated in Figure 28, based on the PRM RT lighting counts tab. The inputs are summarized by space type on the general lighting tab of the PRM RT (Figure 29).

Figure 27. PRM RT Lighting Counts tab

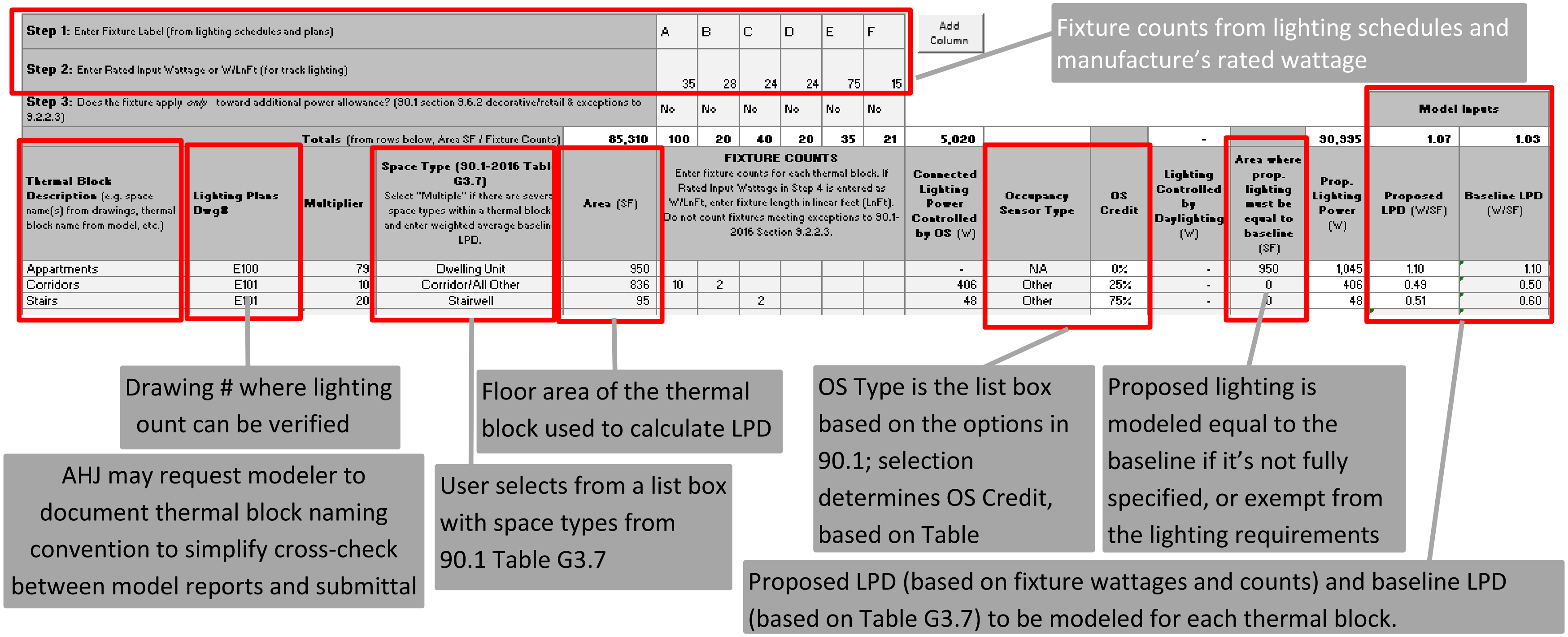


Figure 28. Lighting Summary on the General Lighting Tab of the PRM RT

Table 6.1: Interior Lighting by Space Type

				Model Inputs		Reference Values		
Space Type	**Floor Area** (SF)	**Prop. Lighting Power** (W)	**Baseline Lighting Power** (W)	**Prop. LPD** (W/SF)	**Baseline LPD** (W/SF)	**Prop. LPD x OS Credit** (W/SF)	**Prop. Lighting Power x OS Credit** (W)	**Prescriptive Requirement of ASHRAE 90.1-2013 Applicable to App. G Baseline**
Dwelling Unit	76,000	83,600	83,600	1.10	1.10	0.82	62,688	1.10
Corridor/All Other	6,528	2,612	5,418	0.40	0.83	0.30	1,960	0.66
Stairwell	1,832	916	1,099	0.50	0.60	0.12	226	0.69
Retail Facilities/Mall Concourse	24,701	0	41,991	0.00	1.70	0.00	0	1.10
Electrical/Mechanical Room	608	304	911	0.50	1.50	0.35	212	0.42
Total	**109,668**	**87,432**	**133,020**	**0.80**	**1.21**	**0.59**	**65,086**	**1.06**

LI1*(CR-B) Baseline (budget) Lighting Power Density (LPD) is established correctly for spaces where proposed lighting is fully specified.

ECB (90.1 Table 11.5.1 #6): 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, or 90.1 Section 9.4.2 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 a general lighting and is separately controlled.

PRM (90.1 Table G3.1 #6): 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, or 9.4.2 must be modeled in the baseline the same as in the proposed design.

- Baseline LPD increased to include decorative lighting allowance

PRM: the baseline LPD is always based on the values in 90.1 Table G3.7. There are no provisions for any additional allowances.

ECB: 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 this section (e.g., installed in addition to the general lighting, 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 the 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.

ECB: 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 general and decorative lighting.

PRM: the decorative lighting allowance cannot be added to the baseline. The proposed design must be modeled as specified and include both general and decorative lighting.

- Baseline (budget) LPD is based on an incorrect space type.
  Using incorrect space type in 90.1 Table G3.7 (PRM) or 90.1 Section 9.6.1 (ECB) may lead to an exaggerated baseline LPD allowance. For example, the project may include a large space (e.g., in the basement) that houses some mechanical equipment on one side, but it is mostly used for 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. If project has a significant (e.g., more than 30%) LPD reduction in the proposed design compared to the prescriptive requirements of 90.1 2013, AHJ may request more details on space use, or ask for the illuminance levels provided by specified fixtures, to be compared to the IESNA-recommended illuminance levels for the selected space type.

- The baseline (budget) LPD is used in conjunction with an exaggerated floor area.
  Floor area of each space type used in the lighting calculations must be the sum of the floor areas of the lighted 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 exterior 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.

LI1*(CR-P) Proposed LPD is established correctly for spaces where lighting is fully specified.

ECB (90.1 Table 11.5.1 #6), PRM (90.1 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.
- Lighting system power shall include all lighting system components shown or provided for on plans (including lamps, ballasts, task fixtures and furniture mounted fixtures).

Following 90.1 Section 9.1.3 and 9.1.4, 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).

Example: Wall sconces installed in the corridors of a multifamily building are specified with two 18W CFL bulbs with 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 relabeled by the manufacturer based on the CFL lamps. Thus, unless all specified fixtures reflect the maximum rated wattage, or the fixtures are relabeled by the manufacturer, the total fixture wattages specified on the lighting drawings will typically be lower than the wattages required for lighting compliance calculations.

Common Mistakes

- Fixture wattage is not based on a complete fixture, including lamp and ballast.
- Track lighting is not calculated according to the allowed methods as described in 90.1 Section 9.1.4.

LI2*(CR-B) Baseline (budget) LPD is established correctly for spaces where lighting in the proposed design is not specified or partially specified

ECB (90.1 Table 11.5.1 #6): The budget lighting power density is the same as in spaces with fully specified lighting.

PRM (90.1 Table G3.1 #6): The baseline lighting must be modeled based on 90.1 Table G3.7, same as for areas where lighting is fully specified.

LI2*(CR-P) Proposed LPD is established correctly for spaces where lighting is not specified or partially specified

Lighting is often not specified in core and shell projects. Furthermore, the specified fixtures may not be intended to provide full lighting in the space, such as in residential occupancies including hotels, dormitories, and multifamily buildings. For example, in hotel guestrooms, hard-wired fixtures may be specified in bathrooms and hallways and 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. This review check addresses such scenarios.

ECB (90.1 Table 11.5.1 #6, Column A, #c): Where no lighting exists or is specified, lighting power shall be determined in accordance with the building area method for the appropriate building type, based on the allowances in 90.1 Section 9. Areas with partial lighting are not specifically addressed in 90.1 and may be treated as areas with no specified lighting.

PRM (90.1 Table G3.1 #6, proposed Column, #c): Where lighting neither exists nor is submitted with design documents, lighting power must be modeled as meeting but not exceeding prescriptive requirements of 90.1 Section 9, building area method. Since lighting power density in dwelling units is not prescribed in 90.1 Section 9, AHJ may allow using the methodology described in the EPA Energy Star® Multifamily High-rise Simulation Guidelines[23] Section 6.3.3.1.

LI3*(CR-B) Baseline(budget) lighting controls are established correctly

ECB (90.1 Table 11.5.1 #6 e, f): Mandatory lighting controls required in 90.1 Section 9.4.1 must be included in budget design and modeled using the same methodology for both.

Daylighting controls must be modeled explicitly in the simulation tool, or as an adjustment determined by a separate approved analysis. The standard does not specify the schedule adjustments to be used for capturing occupancy sensor savings, thus the values from Table G3.7 Occupancy Sensor Reduction column should be used.

PRM (90.1 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.

LI3*(CR-P) Proposed lighting controls are reported as specified

ECB (90.1 Table 11.5.1 #6) Design documents must include lighting controls required in 90.1 Section 9.4.1, since these requirements are mandatory. Only the lighting controls in the proposed design that exceed the minimum requirements of 90.1 Section 9.4.1 may be different in the proposed design compared to the baseline. Examples of controls that exceed the minimum requirements include 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.

Daylighting controls must be modeled explicitly in the simulation tool or as an adjustment determined by a separate approved analysis. 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.

PRM (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 following the table.

[23] https://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/mfhr/ENERGY_STAR_MFHR_Simulati0n_Guidelines_AppG2016.pdf?f7f2-5989

Common Mistakes

- Mandatory lighting controls are not specified in the proposed design.
  The lighting control requirements in 90.1 2013 are significantly more comprehensive compared to 90.1 2010; for example, many spaces with windows must have daylighting controls. The lighting controls are mandatory and must be specified where required.
- Credit for daylighting and OS must only be applied to the portion of lighting in each thermal block that is under control and not to all lighting in the thermal block.

LI4(MI-B,P) Baseline (budget) and proposed wattage entered into simulation tool reflects values reported in the submittal.

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.

- Review simulation input reports to confirm total modeled baseline (budget) and proposed wattage reported in the submittal match the total modeled wattage.
- Spot-check simulation reports showing inputs for individual spaces or thermal blocks to confirm entered baseline (budget) and proposed LPDs reflect the reported values. Focus on the larger thermal blocks with high-lighting wattage, as input discrepancies for these thermal blocks may be impactful.

Some of the modeled thermal blocks may 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.

eQUEST Reports	LV-B, CSV Space Loads Report
Trane TRACE 700	Room Information entered values report

LI5(MO-B,P) Interior lighting peak demand is consistent with the baseline (budget) and proposed lighting wattage reported in the submittal

The interior lighting peak demand is the maximum modeled interior lighting load (kW) based on the simulation reports. The lighting peak demand may not coincide with the building peak demand; for example, in a multifamily building, the peak electricity demand may occur on a hot summer afternoon when the cooling load is the highest, while the maximum lighting load occurs in the evening or at night, when most of the lighting in apartments, corridors, and stairwells is on. 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 peak lighting demand (PLD) reported in the simulation output reports can be used to perform QC checks:

- $PLD_{base} > LTW_{base}$ indicates an error in the baseline model that should be flagged. The non-coincident peak demand cannot exceed the maximum wattage reported in the submittal. The model inputs or the baseline lighting wattage reported in the submittal must be corrected.

  PLD = noncoincident peak lighting demand [kW]
  LTW = total lighting wattage listed in the submittal [kW]

  - $PLD_{prop} < 0.7 \times LTW_{prop}$ should be flagged and questioned in the review comments, because it may indicate that the modeled proposed lighting energy use is underestimated. A 0.7 multiplier reflects the typical reduction in lighting demand due to modeled schedules (not all lighting fixtures are on all the time), occupancy, and daylighting controls.

eQUEST Reports	PS-E
Trane TRACE 700	LEED Summary Section 1.6

LI6(MO-B,P) Modeled lighting runtime hours are realistic

90.1 Section 9.4.1.1 requires that most non-emergency lights are turned off during unoccupied periods. Furthermore, during the hours when the building is occupied, not all lights are on all the time. The effective full load hours (EFLH) should be estimated and compared to the typical values for common building types included in Appendix A of the Manual.

$EFLH_{base} \sim LEU_{base} / LTW_{base}$

$EFLH_{budget} \sim LEU_{budget} / PLD_{budget}$

LEU = annual lighting energy use from simulation output reports[kWh]

The EFLH significantly higher (e.g., 20%) than those provided in Appendix A may be explained by nonstandard building operation (e.g., an office building occupied 16 hours a day). The contribution of lighting toward the overall building energy cost is misrepresented in projects with the standard operating conditions, but it is significantly different EFLH compared to Appendix A. Too high EFLH exaggerates lighting-related performance penalty/credit. Too low EFLH underestimates lighting penalty/credit.

eQUEST Reports	BEPU
Trane TRACE 700	LEED Summary Section 1.6

LI7*(MO-B,P) The difference in the interior lighting annual energy use of the baseline(budget) and proposed design is reasonable

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 as follows:

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

LCC = proposed design lighting controls credit

For PRM, LCC=0.6 may be assumed (i.e., ~40% reduction in lighting energy due to 90.1 2013 mandatory lighting controls and any additional controls that are specified). For ECB, LCC=1 if the proposed design does not have any lighting controls in addition to those required by 90.1 2013, or ~ 0.9 if additional lighting controls are specified. The expected change in lighting energy use may be different on projects using space-by-space method.

Example 1: 60,000 SF dormitory building includes 30,000 SF of dorm rooms (dormitory living quarters space type) with 0.3 W/SF specified lighting and 30,000 SF corridors (corridor space type) with 0.8 W/SF 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/SF (90.1 Table 9.5.1). This LPD must be modeled for all spaces in the budget model. The proposed LPD is (30,000 x 0.3+30,000 x 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 space-by-space method is used. 90.1 Table 9.6.1 has an allowance of 0.54 W/SF for dormitory living quarters and 0.66 W/SF 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 assumptions, the proposed lighting energy use is expected to be (0.3 x 30,000 x 4 + 0.8 x 30,000 x 24 x (1 − 0.25)/(0.54 x 30,000 x 4 + 0.66 x 30,000 x 24 x (1 − 0.25) ~ 110% of the budget lighting energy use.

eQUEST Reports	BEPU
Trane TRACE 700	LEED Summary Section 1.6

8.7 Lighting, Exterior (LE)

A checklist is included in the reporting template to confirm the applicable rules were followed, as illustrated in Figure 30, based on the PRM RT general lighting tab. The exterior lighting details that must be included in the submittal are illustrated in Figure 31.

Figure 29. Exterior Lighting Modeler Checklist (PRM RT General Lighting tab)

Exterior Lighting	
The same shedules reflecting the mandatory exterior lighting controls were modeled in the baseline and proposed design.	Yes
The baseline lighting power allowance is based on the portions of the site that are illuminated. (The illuminated area is any area within a square pattern around each luminaire or pole that is six times the luminaire mounting height, with the luminaire in the middle of the pattern, less any area that is within a building, under a canopy, beyond property lines, or obstructed by a sign or structure.)	Yes
Any overlapping area of another lighting application were subtracted from the area of the other lighting application, to avoid double-counting. (The allowed area of roadway, driveway, sidewalk, walkway or bikeway was 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.)	Yes
The proposed lighting power includes all lighting system components shown or provided for on the plans (including lamps and ballasts and task and furniture-mounted fixtures except where specifically exempted), manufacturers' **labeled maximum wattage** of the luminaire.	Yes
The proposed building design contains the mandatory automatic lighting controls specified in Section 9.4.1 (e.g., automatic daylight responsive controls, occupancy sensors, programmable controls, etc).	Yes
Select the appropriate Exterior Lighting Zone from ASHRAE 90.1-2016 Table 9.4.2-1	Zone 4

Figure 30. Exterior Lighting Inputs (PRM RT General Lighting tab)

General Information			**Baseline-ASHRAE 90.1 2016 Appendix G**		**Proposed**	**Prescriptive Requirement of ASHRAE 90.1-2013 Applicable to App. G Baseline**
Table G3.6 Lighting Power Densities for Building Exteriors (Tradable)	Required Input (Area or Length)	Total Area (sq ft) or Length (ft)	Allowed LPD	Lighting Power Allowance (W)	Design Lighting Power (W)	
Helpful Hints Fixtures cannot be double-counted for multiple exterior surface types	Helpful Hints	Helpful Hints Only enter area or length of illuminated surface in the design	Helpful Hints Allowance calculated using the lighting power density from Table G3.6.		Helpful Hints Lighting power should be modeled as designed (or installed)	In accordance with Prescriptive Requirements of 90.1-2013 Table 9.4.2-2
Parking lots and drives	Area	10,000	0.15	1,500	500	LPD-0.13, 1300 Watts
Main entries	Length	250	30.00	7,500	8,000	LPD-30, 7500 Watts
Other doors	Length		20.00	0		LPD-20, 0 Watts
Total tradable surface lighting allowance				9,000	8,500	8,800

Add Rows | Delete Rows

User must select tradeable application type from the drop-down list, end enter the area or length.

Baseline model inputs are auto-populated in PRM RT

Proposed lighting entered by user based on design documents, auto-formatted in red if worse than allowances in 90.1 Section 9 and in green if better

Auto-populated based on Table 9.4.2-2.

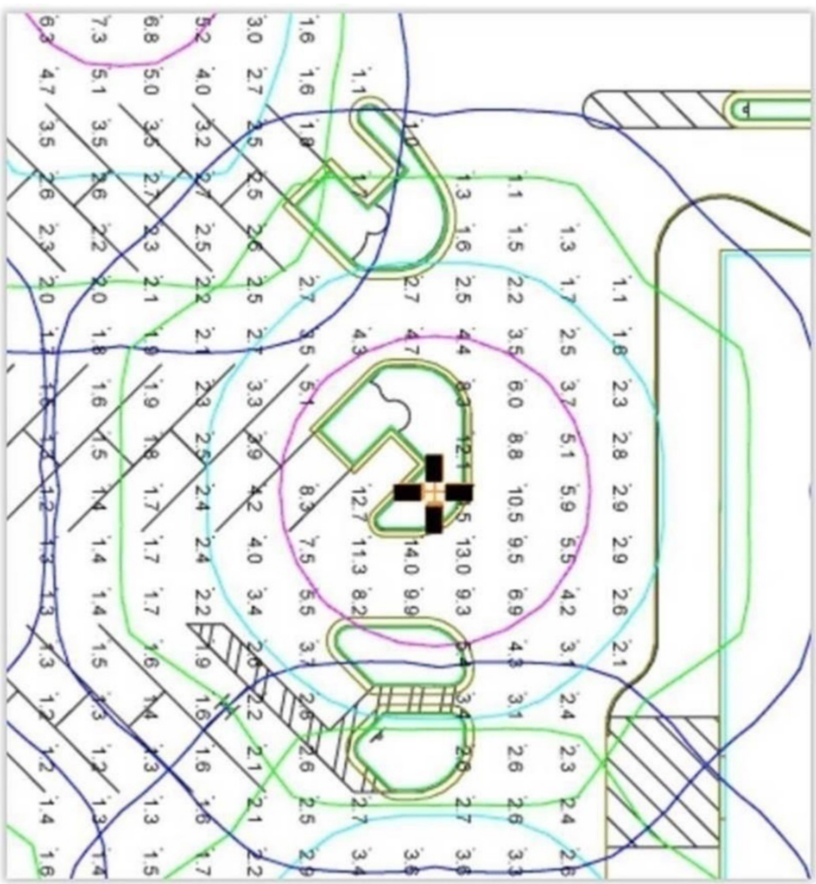
LE1*(CR-B) Baseline (budget) Exterior Lighting Power is established correctly

ECB: Exterior lighting is not a trade-off opportunity and must be modeled the same in the Budget building as specified in the proposed design.

PRM: Exterior lighting in areas identified as "Tradable Surfaces" in 90.1 Table G3.6 must be modeled with the lighting power shown in 90.1 Table G3.6. Other exterior lighting, including lighting of building facades, must be modeled the same in the baseline as specified for the proposed design.

When the proposed design includes exterior lighting serving one of the surface types included in the tradeable surfaces groups, then the baseline will include exterior lighting for those surfaces with power determined using the values in the table and the surface area designed to be illuminated. The area that should be included in the calculation of baseline lighting power is the area 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 illuminated, as shown in Figure 32.

Figure 31. Illuminated Areas in the Proposed Design



Only areas of façade that are illuminated without obstruction are included in the illuminated area. 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. The allowed area of a site roadway, driveway, sidewalk, walkway, or bikeway must be determined as either the actual paved area plus five 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.[24]

Common Mistakes

- Modeling different exterior lighting between the budget and proposed design with the ECB path.
- 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 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.
- 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 previously described, must be subtracted from the parking lot area used to calculate the parking lot baseline lighting allowance.
- 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.

LE1*(CR-P) Proposed Exterior Lighting Power is established correctly

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

[24] California Title 24

Common Mistakes

- Proposed fixture wattage is based on the specified lamps and not the manufacturer's labeled maximum wattage of the luminaire
- The total specified tradeable wattage exceeds the tradeable wattage allowance in 90.1 Table 9.4.2-2. The exterior lighting requirements are mandatory and must be met by the proposed design.
- The specified wattage for the individual applications identified in 90.1 Table 9.4.2-2 as non-tradeable, such as building facades, exceed the individual maximums prescribed in the table. By the virtue of being non-tradeable and mandatory, proposed design must meet each individual allowance to comply with the energy code.
- Exterior lighting wattage is excluded for compliance calculations. Submittals with no exterior lighting should be flagged.

LE2 (MI,MO-B,P) Baseline (budget) and Proposed Lighting Power is correctly entered into simulation tool

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

- Use simulation input reports to verify the exterior lighting wattage entered into the simulation tool matches the wattage reported in the submittal
- Use simulation output reports to verify modeled lighting peak demand is either equal to the exterior lighting wattage reported in the submittal or is slightly lower than the reported wattage if the maximum modeled schedule fraction is less than 1 (e.g., no more than 90% of the total installed lighting is ever lit). The exterior lighting peak demand occurs at night and 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

The check should be performed for both the baseline (budget) and proposed design.

eQUEST Reports	PS-E
Trane TRACE 700	LEED Summary Section 1.4, Plant Information entered values report

LE3(MI,MO-B,P) Exterior Lighting runtime hours are reasonable and the same between the baseline (budget) and proposed design

Exterior lighting must be controlled to turn off when sufficient lighting is available. In addition, following 90.1 Section 9.4.1.4, it must be turned off or operate at wattage reduced by at least 30% during non-business hours. These controls are mandatory and must be specified on all projects.

Neither PRM nor ECB allow modeling different lighting controls between the baseline (budget) and proposed design; thus, the same lighting runtime hours must be used in both models. The modeled exterior lighting runtime may be up to 12 hours per day (4,380 hours per year) for facilities opened 24/7, such as hospitals. Lower runtime (e.g., six hours per day) is expected for other building types due to lighting control requirements in 90.1 Section 9.4.1.4. Exterior lighting runtime exceeding these values should be flagged.

$EFLH = LEU / LTW < 4380$
$EFLH_{base} = EFLH_{prop}$

EFLH [hrs/yr] = exterior lighting effective full load hours
LEU [kWh] = annual exterior lighting energy use, based on the simulation output reports

eQUEST Reports	BEPU
Trane TRACE 700	LEED Summary Section 1.6

LE4*(MO-B,P) Difference between the baseline (budget) and proposed exterior lighting energy is as expected

ECB: Since exterior lighting is not a trade-off opportunity, the annual exterior lighting kWh must be the same in the budget and proposed design.

PRM: Since only the installed exterior lighting wattage and not the exterior lighting controls, are the opportunity for trade-offs, the difference in the annual exterior lighting use between the baseline and proposed design should be directly proportional to the difference in the exterior lighting wattage reported in the submittal. For example, if the proposed exterior lighting wattage reported in the submittal is 20% lower than the baseline, the proposed exterior lighting kWh is expected to be 20% lower than the baseline.

PRM: LTW prop / LTW base = LEU prop / LEU base

ECB: LEU prop = LEU budget

eQUEST Reports	BEPU
Trane TRACE 700	LEED Summary Section 1.6

8.8 Miscellaneous Loads (ML)

The ML category includes receptacle loads, non-HVAC motors, process loads, refrigeration equipment, elevators and other systems and components not covered in other sections of this Manual. Some of these systems, such as certain refrigeration equipment and elevators, are regulated by 90.1, while others are not.

ML1*(CR-B,P) Baseline (budget) and Proposed energy use associated with the miscellaneous loads is established correctly

ECB: All building systems and components within and associated with the building must be modeled (90.1 Table 11.5.1 #12), unless specifically excluded by 90.1 Table 11.5.1 Section 13 and 14 and must be the same in the budget design as specified in the proposed design (90.1 Table 11.5.1#1).

PRM: All building systems and components within, and associated with, the building must be modeled and be the same in the baseline as in the proposed design (90.1 Table G3.1#1, G3.1 #12). Motors 1 HP or larger (90.1 Table G3.1 #12), distribution transformers (90.1 Table G3.1 #15), elevators (90.1 Table G3.1 #16), and certain refrigeration systems (90.1 Table G3.1 #17) may be modeled differently between the baseline and proposed designs.

ML2(MO-B,P) Modeled baseline (budget) and proposed miscellaneous loads energy use is reasonable

Table 1, misc. equipment column shows the typical site EUI of the miscellaneous loads in common types of commercial buildings. The EUI of the project may differ from the typical due to 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 ML EUI than hotels without restaurants.

Even though ML must be the same between ECB budget and proposed designs and only the limited trade-off opportunities are available with PRM, the values which are significantly different from typical (e.g., by more than 25%) should be flagged and explanation requested, because of the impact of ML on heating and cooling use. Unreasonably high ML EUI will result in exaggerated internal heat gain, under-estimating the impact of any heating-related trade-offs (e.g., lowering the penalty from inefficient heating system type in the proposed design) and magnifying impact of cooling-related tradeoffs (e.g., exaggerating savings from specified economizer in the climate zones where it does not have to be modeled in the baseline (budget) design).

eQUEST Reports	BEPU
Trane TRACE 700	Energy Cost Budget report

ML3*(MO-B,P) The difference in the baseline (budget) and proposed ML energy use is as expected

Submittal must include an explanation if simulation outputs indicate a difference between the baseline (budget) and proposed ML energy use.

Common Mistakes

- Modeling different ML between ECB budget and proposed design
- Modeling differences in ML between the baseline and proposed design beyond those allowed in 90.1 Table G3.1 #12, #15, #16 and #17.

eQUEST Reports	BEPU
Trane TRACE 700	Energy Cost Budget report

8.9 Service Water Heating (SWH)

Submittal requires a description of the baseline (budget) and proposed SWH equipment and pumps. In addition, PRM submittals must show the applicable prescriptive requirements of 90.1 2013. Information that must be provided is illustrated in Figure 33, based on the PRM RT Service Water Heating tab.

Figure 32. Service Water Heating Details (PRM RT Service Water Heating tab)

Model Input Parameter	Baseline-ASHRAE 90.1 2016 Appendix G		Proposed			Prescriptive Requirement of ASHRAE 90.1-2013 Applicable to App. G Baseline
					Plans / Specs	
	Helpful Hints ▪ New and existing systems: as specified in Table G3.1.1-2; minimum performance requirements from Table 7.8 per Table G3.1#11(b) ▪ Capacity: for existing systems, use actual component capacities; for new systems, system shall be sized following Section 7.4.1 ▪ Condenser heat recovery (Table G3.1#11 f): 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 (example: preheats service hot water to 85°F); otherwise enter "Not required"		Helpful Hints ▪ 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 Table G3.1#11(d) ▪ For buildings where a combined system has been specified to meet both space heating and service water heating loads, the proposed design shall reflect the actual system type using actual capacities and efficiencies per Table G3.1#11(e)			In accordance with 90.1-2013 Section 7.5
Building Area Type based on ASHRAE 90.1 Table G3.1.1-2	Multifamily					
In-Unit or Central System?	Central		In-Unit			Central
System Type	Storage		Storage Water Heater			Storage
Fuel	Gas		Gas			Gas
Input rating	1500	kBtu/hr	50	kBtu/hr		1500 kBtu/hr
Efficiency	80% Et		90%	Et		80% Et
Storage volume (gal)	1000		20			1000
Storage temperature (°F)	120		120			N/A
Peak hot water demand (gpm). Refer to the Multifamily Details tab if this is a Multifamily project.	20		18			N/A
Condenser heat recovery	Not Required		Not Required			
Number of recirculation pumps	2		2			N/A
Total recirculation pump power (kW)	5		5			N/A
Recirculation pump control	Constant speed		Constant speed			N/A
Number of booster pumps	2		2			N/A
Total booster pump power (kW)	Constant speed		Variable speed			Constant Speed
Booster pump controls meet 90.1 Section 10.4.2	YES		YES			YES

Review checks may be automated in the reporting template such as PRM RT, as illustrated in Figure 34.

Figure 33. Service Water Heating QC checks in PRM RT

Service Water Heating								
Input/Output Summary								
	Annual Service Water Heating Use MMBtu/Yr (12 - Performance_Outputs_1)	Heater Capacity [kBtu/Hr] (8 - Service Water Heating)	Annual Effective Full Load Hours	Typical Effective Full Load Hours	Heater Efficiency	Annual Service Water Heating Load MMBtu/Yr (12 - Performance Outputs 1 tab)	Annual Service Water Heating Site EUI [kBtu/SF] (12 - Performance Outputs tab)	Typical SWH Site EUI
	SHWE	Cap	EFLH = SHWU / Cap x 1000	EFLH_typ	Effy	SWHE x Effy	SWH_EUI	SWH_EUI_typ
Baseline Design	490	1,017	481	2,555	80%	393	4.5	11.8
Proposed Design	346	1,017	NA	NA	95%	329	3.2	NA
Proposed/Baseline	71%	100%	NA	NA	118%	84%	71%	-

	Issue	Project Team Response
Pass	Effective full load hours exceed typical by more than 25%, which may indicate that the modeled demand is high relative to the specified service water heater capacity. Please review the service water heater capacity and hot water demand (e.g. flow rate and schedule) to justify the result. The modeled service water heater energy use may be exaggerated.	
Pass	The baseline site EUI differs from typical by more than 25%. Please review the inputs related to service water heating use, such as the amount of hot water used in the building (the design flow rate and schedule), temperature of water entering water heater, water heater efficiency, and stand-by losses.	
Please Explain	**Annual Service Water Heating Load differs between baseline and proposed design. Please explain what factors other than heater efficiency affected SWH energy use in the baseline and proposed design.**	

SWH1*(CR-B) Baseline (budget) SWH system type, efficiency and capacity is established correctly

ECB (90.1 Table 11.5.1 #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. The SWH system performance must minimally meet the criteria specified in 90.1 Table 7.8. Any 24-hour facilities that meet the prescriptive criteria in 90.1 Section 6.5.6.2 must have condenser heat recovery.

PRM (90.1 Table G3.1 #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 and all office occupancies have a central electric resistance storage water heater. In mixed use buildings, such as in a building with multifamily occupancy on the top 10 floors and office occupancy on the lower three 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. Large, non-residential 24-hour facilities may be affected by condenser heat recovery; Table G3.1 #11 (e).

SWH1*(CR-P) Proposed SWH system type, efficiency and capacity is established correctly

The proposed SWH system type, fuel, and efficiency shown in the reporting template must reflect design documents.

SWH2*(CR-B,P) Difference in the baseline (budget) and proposed hot water demand is as allowed

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.

PRM (90.1 Table G3.1 h): Service water heating load must be the same for the proposed and baseline building design, except due to use of the following technologies:

- Water conservation measures that reduce the physical volume of service water required. 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 Energy Policy Act 1992 (EPACT 1992). In residential occupancies, the reduction may be calculated as follows:[25]

  $HW\_Demand_{prop} = HW\_Demand_{baseline}*(0.36+0.54*LFS/2.5+0.1*LFF/2.5)$

  HW_Demand [Gal/day] = amount of hot water consumed daily

  0.36 = fraction of hot water consumption that is volume-dominated (e.g., filling up a bath tub) and not affected by installation of low flow fixtures

  0.54 = fraction of hot water consumption associated with showers

  0.1 = fraction of hot water consumption associated with kitchen and bathroom faucets

  LFS [GPM_{80psi}] = rated flow rate of the low-flow showerheads specified on the drawings

  LFF[GPM_{80psi}] = rated flow rate of the low-flow faucets specified on the drawings

  - Reducing the required temperature of service mixed water, such as when using alternative sanitizing technologies for dishwashing.
  - Increasing the temperature of the entering makeup water, such as when using heat recovery or thermal solar to preheat makeup water.

SWH3(MI-B,P) Modeled baseline (budget) and proposed SWH system type, efficiency and capacity match parameters reported in the submittal

Review the simulation reports to confirm that the modeled SWH system parameters are as reported in the submittal.

eQUEST	PS-A
Trane TRACE 700	Plant Information entered values report

25 Residential Appliance Data, Assumptions and Methodology for End-Use Forecasting with EPRI-REEPS 2.1, Roland J. Hwang, Francis X. Johnson, Richard E. Brown, James W. Hanford and Jonathan G. Koomey http://enduse.lbl.gov/Info/LBNL-34046.pdf

SWH4(MO-B,P) Modeled proposed SWH effective full load hours are reasonable

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

SWH5*(MO-B,P) Difference in the baseline (budget) and proposed hot water use is reasonable based on the system parameters included in the submittal

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 don't 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, or other means of service hot water preheat, such as use of condenser heat recovery, that differs between the budget and proposed design. PRM: The baseline SWH system may be a different type and use a different fuel than the proposed SWH system; thus, the annual use must be converted from the unit of fuel to MMBtu before performing the comparison. In addition to the system efficiencies, the annual use may be affected by the difference in hot water demand between the baseline and proposed design as described in SWH2 review check. Therefore, the following relationship is expected:

$$SWH\_Use_{prop} * SWH\_Eff_{prop} / HW\_Demand_{prop} = SWH\_Use_{baseline} \times SWH\_Eff_{baseline} / HW\_Demand_{baseline}$$

Projects that do not follow this pattern should be flagged and an explanation and supporting documentation should be requested. Higher savings may be demonstrated by projects using solar hot water preheat as allowed by 90.1 Section G2.4.1, or other means of service hot water preheat, such as use of condenser heat recovery that differs between the budget and proposed design and other technologies allowed in 90.1 Table G3.1 #11.

eQUEST Reports	BEPU
Trane TRACE 700	Equipment Energy Consumption report

8.10 Air-side HVAC (AHVAC) - Proposed

The review should focus on a sample of the air-side HVAC systems with the largest capacity and typical smaller systems. 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. Review scope and outcome for each reviewed system should be documented in the Review Checklist.

The submitted design documents must include the HVAC system parameters and controls required to verify compliance. Reviewer may also request product cut sheets if necessary. The level of details that must be provided in the reporting template for each proposed air-side system is illustrated in Figure 35 (PRM RT, HVAC – General) and Figure 36 (PRM RT, Air-Side HVAC – Proposed).

Figure 34. List of Proposed HVAC Systems

Table 9.1: Proposed HVAC System Type(s)

System Description	Areas Served
Helpful Hints • 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).	Helpful Hints • Described areas served by each system. • The HVAC system type and all related parameters, such as equipment capacities and efficiencies, must be modeled as designed (or installed) per Table G3.1#10(a&b) • Where no heating system exists or has been designed, the system type shall be the same as modeled in the baseline building design and shall comply with, but not exceed, the requirements of Section 6, 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.
HW Baseboards with Cycling Room Air Conditioner and Energy Recovery. Ventilation provided by passive make-up air through trickle vents from apartment exhaust system.	Apartments
RTU1: Constant Volume, DX, Gas-fired Rooftop Unit with Energy Recovery	Corridors & Office
UH 1 - 15Constant Volume Gas-fired Unit Heaters	Stairwells and MER

Figure 35. Proposed Air-Side System Information in PRM RT

	ASHRAE 90.1 2016 Appendix G – Proposed System Helpful Notes	Proposed System Description		Proposed Design	
* System type	Select from proposed systems entered on the General HVAC tab	HW Baseboard + Window AC + Continuous Exhaust		Gas-fired Packaged Single Zone	
System designation(s)	Enter designation for the system (or a group of systems) used in the model	Apt HVAC X		RTU1	
Number of similar systems	Systems that have the same parameters marked with (*) may be aggregated for reporting	80		1	
Total cooling capacity	Cooling capacity based on the design documents, or the total for a group of similar systems	1,120	kBtu/h	768	kBtu/h
Unitary cooling efficiency	Should be consistent with efficiency units used in 90.1 Section 6 tables for this system type	15.00	EER	10.10	EER
COPnfcooling	Must be calculated based on		COP		COP
Unitary cooling part-load efficiency (if applicable)	Enter the spefied unitary cooling efficiency for the proposed HVAC system (or group of similar systems) at AHRI rating conditions	NA	IEER	NA	IEER
Total heating capacity	Enter the specified heating capacity for the proposed HVAC system, or the total heating capacity for a group of similar systems.	NA	kBtu/h	3,006	kBtu/h
Unitary heating efficiency	List all relevant efficiencies (e.g. 3.2 COP at 47°F 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)	NA		80.00	kBtu/h
* Fan control	Constant or Variable Volume	Constant Volume		Constant Volume	
* Fan operation during unoccupied hours	Systems that deliver ventilation air must run continuously when zones are occupied.	Cycling with load		Running continuously	
Supply airflow	Design flow based on drawings	48,000	CFM	14,504	CFM
Outdoor airflow	Minimum outdoor flow rate, as specified	4,800	CFM	5,743	CFM
Demand control ventilation (DCV)	As specified. If DCV is required is Section 6.4.3.8, it must be specified because it is a mandatory requirement	No		No	
* Air-side Economizer type	Indicate the type of economizer specified	No		No	
* Economizer high-limit shutoff	Describe specified economizer controls	NA		NA	
* Supply air temperature reset	Describe specified supply air temperature reset (if any).	No		No	
Exhaust Air Energy Recovery	Select specified system type	No		Energy Recovery Wheel	
Recovery Effectiveness	Recovery effectiveness must be based on specified OA and exhaust flow through the recovery device, and the rated effectiveness of the specified device.	NA		65%	
Supply fan power	All fans that operate at design conditions to supply air from the heating or cooling source to the conditioned spaces and return it to the source or exhaust it to the outdoors. In multifamily buildings this includes kitchen and bathroom exhaust fans		CFM	13.6	CFM
Return or relief fan power			CFM		CFM
Exhaust fan power		1.8	CFM		CFM
Total System fan power	Auto-calculated to include all fans	1.80	CFM	13.60	CFM

AHVAC1*(CR-P) Thermal blocks are established correctly

PRM (90.1 Table G3.1 #7 - 9): Thermal blocks must be based on the HVAC zones specified in the proposed design. Where HVAC zones are defined on the 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:

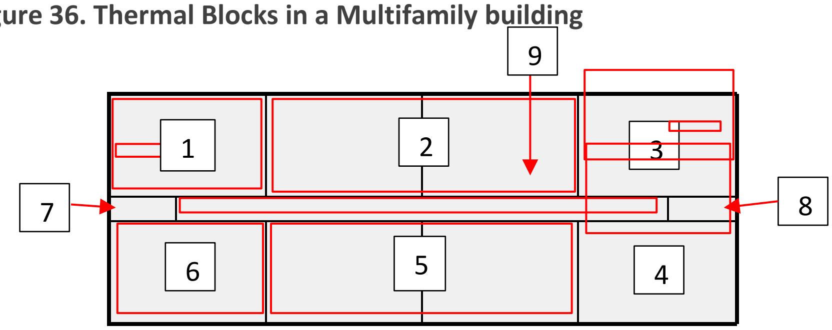
- zones have similar occupancy types (e.g., include primarily office spaces)
- have windows facing the same orientation, or their orientations vary by less than 45 degrees
- are served by the same kind of HVAC system

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. Special rules apply to projects with no HVAC zones designed (90.1 Table G3.1 #8).

The 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). The project submittal must include a diagram showing thermal blocks drawn over the HVAC plans. Projects with fewer than 15 thermal blocks should be flagged, as it may indicate that the modeled floor plan was oversimplified.

Example: A 10-story multifamily building with eight apartments, corridor, and stairwells on each floor (Figure 37) would be modeled with 27 thermal blocks (highlighted in red), including nine thermal blocks on top and bottom floors and another nine thermal blocks on a typical middle floor to which a multiplier of eight is applied to indicate that there are eight such floors in the building.

Figure 36. Thermal Blocks in a Multifamily building



ECB (90.1 Table 11.5.1): Same as for PRM.

AHVAC2*(CR-P) All specified air-side HVAC systems are reported in the submittal

Each HVAC system shown on mechanical schedules must be included in the reporting template.

Common Mistake

- Some systems shown on mechanical schedules are not reported. For example, electric resistance unit heaters and baseboards are often specified for mechanical rooms, stairwells, and bathrooms. If electric resistance heaters are shown on project's mechanical schedules, they must be included in the reporting template.

AHVAC3*(CR-P) Reported cooling system capacities are as specified

Cooling system capacities shown in the reporting template must reflect design documents and cut sheets.

AHVAC4*(CR-P) Reported heating system capacities are as specified

Heating system capacities shown in the reporting template must reflect design documents and cut sheets.

AHVAC5*(CR-P) Reported DX cooling system efficiencies are as specified, and calculations are provided to show efficiency with fan power extracted

Efficiencies shown in the reporting template for each system must match design documents or cut sheets.

For DX systems, efficiency entered into the simulation tool (COP_{nfcool}) must be based on the applicable rated efficiency (EER, SEER, HSPF, or COP) from equipment manufacturer and exclude fan power at the AHRI test conditions, as illustrated in the following example. These calculations must be included in the submittal.

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

AHVAC6*(CR-P) Reported air-side heating system efficiencies are as specified

The reporting template must list the rated system efficiency and other impactful metric pertinent to the actual system performance. For example, air-source heat pumps often operate in the heat pump mode only down to 35°F and use electric resistance heating at the lower temperatures. Reviewers should request equipment cut sheets documenting low-temperature performance of the specified equipment (Figure 38), as it has significant impact on heating energy use.

Figure 37. Sample Air-Source Heat Pump Specification – Low Temperature Operation

— *Heat Pump Reverse Cycle Heating Capacity (Btu)*

Model No.[1]												
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
[illegible]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.

AHVAC7*(CR-P) Reported design ventilation rates and controls are as specified

Ventilation rate reported in the submittal must be as specified on project drawings (Figure 39). In addition, the submittal must indicate whether the system has demand control ventilation and describe the relevant controls including the minimum system outdoor air (OA) flow rate and whether ventilation control is based on the readings of the return air sensor or critical zone method. Critical zone method results in higher minimum ventilation rate and lower savings.

AHVAC8*(CR-P) Reported design supply, return, relieve and exhaust flow rates are as specified

Design flow rates must be as shown in the design documents for each specified supply, return, relief, and exhaust fan. For example, AHU-1 in Figure 39 must be reported with 8,000 CFM supply air flow.

AHVAC9*(CR-P) Reported fan power is as specified

The power of supply, return, relief and exhaust fans must be reported in the submittal and reflect the design documents. The fan power provided on drawings may be expressed in units not supported by the simulation tool used on the project. If supporting calculations were performed to convert the available information into the simulation tool inputs, such calculations must be included in the reporting template and are subject to AHJ approval. The following conversions may be used:

Fan Power [W] = BHP*746 / Effy

BHP = TDPD / 4131

BHP [HP] = fan brake horse power

TDPD [in. wg] = total design pressure drop

Effy = fan motor efficiency

Common Mistakes

- External static pressure (ESP in Figure 39) is used in lieu of the total static pressure (TSP). This significantly under-estimates the proposed fan energy.
- Only supply fan power is entered. Other specified fans such as return, exhaust and relief omitted from the template.

Figure 38. Specified Fan System Performance

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		NORTH PENTHOUSE 318	17	8,000	PL	900	3500	2.0	4.58	2431	9.65	5.0	1800	208	3	YES
AHU-2		SOUTH PENTHOUSE 302	30	15,000	PL	930	4230	2.0	4.89	3191	19.99	7.5	1800	208	3	YES

AHVAC10*(CR-P) Reported flow controls are as specified

For each air-side system, the submittal must state whether the system is constant volume (CV) or variable air volume (VAV), and whether each of the system fans is constant speed, two-speed, or has a variable speed drive (VSD). The minimum flow rate and control must be as specified in the design documents (Figure 39 and 40).

Figure 39. Specified Flow Ranges and Controls

	GENERAL		PHYSICAL	PERFORMANCE	
SYMBOL	MANUFACTURER	MODEL	COOLING AIR DAMPER	COOLING AIR DAMPER	
				MIN. CFM	MAX. CFM
VAV-A			4"	50	225
VAV-B			5"	100	350
VAV-C			6"	100	500
VAV-D			8"	200	900
VAV-E			10"	500	1400
VAV-F			12"	800	2000
VAV-G			14"	1500	3000
VAV-H	TRANE	VCCF	16"	2000	4000

AHVAC11*(CR-P) Reported air-side system controls are as specified

Supply air temperature reset must be reported as specified.

AHVAC12*(CR-P) Air-side economizers are reported as specified

The following must be reported for each system with an air-side economizer specified in the proposed design:

- economizer type (e.g., dry bulb, enthalpy)
- economizer high-limit shutoff

Projects without economizers are expected to have higher cooling energy use in fall, winter, and spring as well as higher simultaneous heating and cooling during these months.

AHVAC13*(CR-P) Reported exhaust air energy recovery is as specified

The following must be reported for each system with exhaust-air energy recovery in the proposed design:

- System type (e.g., enthalpy wheel, runaround coil, heat exchanger)
- Supply and exhaust flows (cfm) through the energy recovery device
- Rated recovery effectiveness
- Controls (e.g., to allow economizer operation when appropriate)

8.11 AHVAC - Baseline (Budget)

The review should focus on the representative baseline air-side HVAC systems with the largest capacity and typical smaller systems. The review scope and outcome for each reviewed system should be documented in the Review Checklist.

AHVAC1*(CR-B) Thermal blocks are established correctly

ECB (90.1 Table 11.5.1), PRM (90.1 Table G3.1 #7 – 9): Thermal blocks in the baseline (budget) design must be the same as in the proposed design.

AHVAC2*(CR-B) Baseline (budget) system type(s) are established correctly

ECB: Each HVAC system specified in the proposed design must have a corresponding baseline system established following 90.1 Figure 11.5.2, Table 11.5.2-1 and accompanying notes.

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 nonresidential building types with non-predominant conditions accounting for more than 20,000 SF of conditioned floor area must have a separate baseline system type established for each set of conditions. The following baseline systems apply to New York climate zones 4a, 5a, 6a:

- All residential occupancies (dormitory, hotel, motel, and multifamily):
    - System 1 – PTAC
- All public assembly occupancies (houses of worship, auditoriums, movie theaters, performance theaters, concert halls, arenas, enclosed stadiums, ice rinks, gymnasiums, convention centers, exhibition centers, and natatoriums):
    - System 3—PSZ-AC if <120,000 ft2
    - System 12—SZ-CV-HW if >= 120,000 ft2
- Heated-only storage (e.g., warehouse) meeting the definition of non-predominant conditions, or certain heated-only spaces such as storage rooms, stairwells, electrical/mechanical rooms (90.1 Section G3.1.1 e):
    - System 9—Heating and ventilation

- All other non-residential:
    - System 3—PSZ-AC if 3 floors or fewer and <25,000 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 ft2 to 150,000 ft^2
    - System 7—VAV with reheat if more than 5 floors or >150,000 ft^2

Common Mistake

- 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.

AHVAC3*(CR-B) Baseline (budget) cooling system capacities are established correctly

<u>PRM:</u> The cooling coil capacities for the baseline systems must be based on sizing runs for each orientation (per 90.1 Table G3.1, No. 5[a]) and oversized by 15%; i.e., the ratio between the cooling capacities used in the annual simulations and the capacities determined by the sizing runs must be 1.15. 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 (Figure 40).

Figure 40. 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

The baseline cooling loads should be compared to the typical shown in Table 3. Projects with lower SF/Ton compared to the ranges in Table 3 should be flagged, as it may indicate that the baseline cooling systems are oversized beyond the allowed limit. In addition, exaggerated cooling load may be due to a higher than expected modeled peak equipment load (e.g., equipment schedule that turns an unrealistically high fraction of equipment design load during a particular hour), or a cooling thermostat schedule leading to higher than expected load when the building switches from unoccupied to occupied, or incorrect cooling system sizing.

Table 4. Cooling Capacity Rule of Thumb

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

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 (budget), this will also exaggerate the baseline (budget) fan energy use.[26] In addition, if project uses a utility rate structures with demand charges, this will exaggerate the baseline (budget) demand charges and energy cost.

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).

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.

AHVAC4*(CR-B) Baseline (budget) heating systems capacities are established correctly

PRM: The heating equipment capacities (i.e., system coil capacities) for the baseline building design must be based on sizing runs for each orientation (per 90.1 Table G3.1, No. 5[a]) and oversized by 25%; i.e., the ratio between the capacities used in the annual simulations and the capacities determined by the sizing runs must be 1.25.

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 and budget building design (90.1 Section 11.5.2 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 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.

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

AHVAC5*(CR-B) Baseline (budget) air-side system efficiencies are established correctly

PRM: Baseline system efficiencies must be based on 90.1 Tables G3.5.1 through G3.5.6.

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.

For ECB Systems 3,4,6,8,9,10,11 and PRM Systems 1 – 6, supply fan energy at AHRI test conditions must be extracted from efficiency rating. To meet this requirement, cooling efficiency must be entered into the simulation tool as COPnfcooling calculated as shown below. COPnfheating must be used to describe heating efficiency of ECB Systems 6, 8, and 9.

$$COPnfcooling = 7.84E\text{-}8 \times EER \times Q + 0.338 \times EER$$
$$COPnfcooling = -0.0076 \times SEER^2 + 0.3796 \times SEER$$
$$COPnfheating = 1.48E\text{-}7 \times COP47 \times Q + 1.062 \times COP47$$
$$COPnfheating = -0.0296 \times HSPF^2 + 0.7134 \times HSPF$$

Calculated $COP_{nfcooling}$ and $COP_{nfheating}$ must be included in the submittal.

AHVAC6*(CR-B) Baseline (budget) ventilation rate is established correctly

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.

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.

- Baseline may have higher OA flow compared to the proposed design if the following applies:
    - 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).
    - 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).
- 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).

Example: Based on the NYS Mechanical Code, minimum ventilation rate in corridors of apartment buildings is 0.06 CFM/SF. If the specified ventilation exceeds this minimum, the ventilation rate in the baseline design must be modeled as 0.06 CFM/CF. Ventilation in the proposed design must be as specified and will be higher than in the baseline.

AHVAC7*(CR-B) Baseline (budget) design flow rates are established correctly

ECB (90.1 Section 11.5.2 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.

PRM (90.1 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.

The ECB budget and PRM baseline design flow CFM may be compared to the typical shown in Table 4.[27]

Common Mistakes

- The causes for higher than expected design flow rates are similar to those that lead to exaggerated cooling loads described in AHVAC3*(CR–B).
- For PRM, exaggerated design flow rate may also be caused by applying the oversizing 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.
- Sizing flow based on supply air-to-room air temperature difference less than 20°F exaggerates the flow.

Table 5. Typical Supply Air Flow Rates

Occupancy Type	Supply Air CFM/SF
Apartment high-rise	0.5 – 0.8
Office buildings	0.8 – 1.6

AHVAC8*(CR-B) Baseline (budget) fan power W/CFM is established correctly

ECB (90.1 Section 11.5.2 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.

PRM: The total power of supply, return, exhaust and relief fans (excluding power to fan-powered *VAV* boxes) must be calculated based on 90.1 Section G3.1.2.9 quoted:

For Systems 1 and 2:	Pfan = CFMs × 0.3
For Systems 3 - 8 and 11, 12, and 13:	Pfan = bhp × 746/ effy
For Systems 9 and 10 (supply fan):	Pfan = CFMs × 0.3

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

For Systems 9 and 10 (non-mechanical cooling per Section G3.1.2.8.2): Pfan = CFMnmc × 0.054

Pfan = electric power to fan motor, W

bhp = brake horsepower of baseline fan motor from Table G3.1.2.9

effy = the efficiency from Table G3.9.1 for the next motor size greater than the bhp

CFMs = the baseline system maximum design supply fan airflow rate, cfm

CFMnmc = the baseline non-mechanical cooling fan airflow, cfm

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 when the increased pressure drop is allowed include the proposed designs with MERV 9 or higher air filters, sound attenuation devices and ducted returns (90.1 Table 6.5.3.1-2).

Common Mistakes

- Increased pressure drop allowance is erroneously claimed when there is exhaust air energy recovery in the proposed design, but there is no exhaust air energy recovery in the baseline (90.1 Table G3.1.2.9 Note 2).
- 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.

AHVAC9*(CR-B) Baseline (budget) air flow control is established correctly

PRM: 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.

ECB (90.1 Section 11.5.2): 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 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 (see Table 6). 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.

AHVAC10*(CR-B) Baseline (budget) air temperature controls are established correctly

PRM (90.1 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.

ECB (90.1 Section Table 11.5.2 – 1): 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.

AHVAC11*(CR-B) Baseline (budget) economizer is established correctly

ECB: 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. In New York climate zones 4A, 5A, and 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.

PRM: Economizers must not be included in baseline HVAC System 1,2,9 and 10. Air economizers must be included in baseline HVAC Systems 3–8 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. Following the table, 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.

AHVAC12*(CR-B) Baseline (budget) exhaust air energy recovery is established correctly

ECB (90.1 Section 11.5.2 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, all systems in New York climate zones operating 8,000 or more hours per year must have energy recovery (90.1 Section 6.5.6.1-2), unless exceptions apply.

PRM (90.1 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. A 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 don't 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.

8.12 Air-side HVAC Model Input / Output (AHM)

AHM1 (MI-B,P) Thermal blocks are modeled as reported

Thermal blocks for the baseline (budget) and proposed design must be modeled as described in the submittal.

eQUEST Reports	SV-A
Trane TRACE 700	Room Information entered values report

AHM2(MI,MO-B,P) All air-side HVAC systems reported in the submittal are modeled.

The HVAC system naming convention used in the model must allow easy mapping between the modeled systems and mechanical schedules. For example, system labeled RTU1 on the mechanical schedules should be named RTU1 in the model.

All systems shown in the reporting template for the baseline (budget) and proposed design must be included in the simulation. For example, if the reporting template shows systems that use electric resistance heat, simulation output reports must show electricity consumption under space heating end use.

eQUEST Reports	SV-A (includes all air-side systems), BEPU (check that electricity is reported under heating end use if electric resistance heaters are specified)
Trane TRACE 700	System Information entered values report for system type and Energy Cost Budget report for space heating end use

AHM3(MI-P,B) Air-side HVAC system types are modeled as described in the submittal

Each air-side HVAC system listed in the reporting template for the proposed design must be modeled and reflect the reported system type and fuel.

- Using an incorrect template within the simulation tool to model specified system type, such as a constant volume system template to model a variable volume system.

eQUEST Reports	SS-P, SV-A, DOE-2 Help (established modeled system type based on SV-A and enter it into DOE-2 Help "search" box to see typical applications). The following system types are commonly used to model PRM Baseline systems: System 1 – PTAC or PSZ-AC System 3 – PSZ – AC System 5 – PVAVS System 7 – VAVS System 9 – UHT
Trane TRACE 700	System Information entered values report

AHM4(MI,MO-B,P) Air-side HVAC system capacities are modeled correctly

Proposed Design: Heating and cooling capacities must be modeled as reported in the submittal.

Common Mistake

- Having the software auto-size the proposed systems instead of using heating and cooling capacities specified on mechanical schedules.

PRM baseline, cooling capacity: Use simulation input and output reports to verify that the ratio of the baseline cooling system capacity to the simulated peak load is close to the required 15%. The oversizing may be slightly 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.

PRM Baseline, heating capacity: Use simulation input and output reports to verify that the ratio of the baseline heating system capacities to the peak annual simulated load may exceed 25% due to the difference in the internal gains and weather used for the heating system sizing versus the annual simulation, but oversizing significantly higher than 1.25 (e.g. 1.35) should be flagged.

ECB budget: The budget equipment cooling and heating coils over-sizing (i.e., the ratio of equipment capacity to the simulated 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. The effective heating and cooling full load hours of each proposed system is expected to be similar to the corresponding values in the budget systems. The effective heating (cooling) full load hours are equal to the ration of the annual heating (cooling) load to the heating (cooling) equipment capacity.

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

AHM5(MI-B,P) Modeled DX cooling efficiencies are as listed in the submittal

The entered cooling efficiency must reflect $COP_{nfcooling}$ reported in the submittal.

eQUEST Reports	SS-P, SV-A
Trane TRACE 700	Plant Information entered values report

AHB6(MO-B,P) Average realized DX cooling system efficiencies are as expected

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) expressed as $COP_{nfcooling}$ to exclude supply fan energy at the AHRI test conditions.

$$COP_{nfcooling\ avg} \sim 7.84\text{E-}8 \times IEER \times Q + 0.338 \times IEER$$

Different than expected efficiency may be due to inappropriate performance curves, such as using the software default performance curves instead of the performance curves provided in the PRM RM.

Proposed Design: Average efficiency that exceeds the rated IEER should be flagged.

Baseline/Budget Design: Average efficiency that is below the rated IEER should be flagged.

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

AHM7(MI-B,P) Modeled air-side heating system efficiencies are as reported in the submittal

The modeled efficiency must reflect the actual system performance, such as air-side heat pump performance degradation at low ambient temperatures. Warm-air furnaces may have efficiency expressed as the annual fuel utilization efficiency (AFUE), thermal efficiency (Et) or combustion efficiency (Ec). The conversions listed (from PRM RM) 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 x AFUE + 0.3989
Et=Ec – 2%

eQUEST Reports	SS-P, PS-E (heat pump supplement)
Trane TRACE 700	Plant Information entered values report

AHM8(MO-B,P) Average realized air-side heating system efficiencies are as expected

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. The average efficiency is expected to differ from the rated efficiency due to factors such as part load performance degradation, stand-by losses, etc.

Proposed Design: For heat pumps, simulation must reflect heat pump efficiency degradation at lower ambient temperatures including the use of electric resistance heat. In New York heating-dominated climate, the average realized heat pump heating efficiency is expected to be lower 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 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 PRM RM. 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.

Baseline (Budget) Design: Where performance of fossil fuel furnace in ECB System 11 and PRM Systems 3 and 9 is given as combustion efficiency, a 2% lower thermal efficiency (i.e. 2% thermal losses) can be assumed. The baseline systems must be modeled without the pilot light. 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 4 shows efficiency degradation based on the performance curves in PRM RM. For example, a furnace operates at 74% efficiency when the heating load is equal to the half of its rated capacity.

Table 6. 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%

eQUEST Reports	SS-P, SV-A, PS-E (heat pump supplement)
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

AHM9 (MI, MO - B, P) Modeled ventilation rate and control is as reported

Verify that the minimum design ventilation rate CFM and controls, such as demand control ventilation are modeled as reported for each air-side system.

eQUEST Reports	SV-A;
Trane TRACE 700	Room Information entered values report for ventilation rate, System Information entered values report for ventilation controls

AHM10(MI - B, P) Modeled fan power, flow rate and controls are as reported

Verify that the following simulation inputs match the reporting template:

- power of supply, exhaust, return, and relief fans (Watt)
- supply, exhaust, return, and relieve flow (CFM)
- minimum flow (CFM)

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

AMH11 (MO - B, P) Fan peak demand is as expected

Proposed Design: For the constant volume systems, the peak demand is equal to the design fan kW. Variable volume system fans often have the peak load no greater than 70% of the design flow, drawing approximately 50% of the design power (Table 6). These relationships may be used to estimate the expected peak fan demand in the proposed design for the individual systems and project as a whole, to compare it to the values shown in the simulation output reports. Lower than expected proposed peak demand should be flagged.

Baseline (budget) design: For the constant volume systems including PRM System 1, 3, 9, and 12 and ECB Systems 5 - 11, peak demand is equal to the design fan kW. For the variable volume baseline systems including PRM Systems 5, 7 and ECB Systems 1-4, the peak flow usually does not exceed 70% of the design CFM, drawing approximately 50% of the design power (Table 6). These relationships may be used to estimate the expected peak fan system demand in the baseline (budget) design of the individual systems and for the project as a whole, based on the fan system peak demand in the simulation output reports. A fan peak demand that exceeds the estimated value by 15% or more should be flagged.

eQUEST Reports	SS-H, SS-P
Trane TRACE 700	Equipment Energy Consumption report

AMH12 (MO - B, P) Proposed fan equivalent full load hours are as expected.

The EFLH of the fan system is the ratio of the fan energy use to fan peak demand. If 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.

Baseline (Budget) Design: 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. The baseline fan EFLH that exceed expectation should be flagged and may indicate incorrect modeled fan system control.

Table 7. 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

Common Mistakes:

- Modeled minimum flow for VAV systems are higher than 30%
- Fans are modeled as running continuously instead of cycling with load during unoccupied hours.

Proposed design: Estimate the expected effective fan full load hours based on the fan flow control in the proposed design described in the submittal and typical part load performance from Table 6. The proposed fan system EFLH that are lower than expected should be flagged.

Common Mistake

- Modeling fans that supply ventilation air as cycling with load instead of running continuously during occupied hours results in significantly underestimated fan, heating, and cooling energy use.

eQUEST Reports	SS-P
Trane TRACE 700	Equipment Energy Consumption report

AMH13(MI,MO-B, P) Modeled exhaust air energy recovery is as reported

The exhaust energy recovery must be modeled as reported, 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

Common Mistakes

- 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.
- 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

AMH14(MO-B,P) Monthly patterns of heating and cooling loads are as expected; no excessive simultaneous heating and cooling

Typical single zone systems including but not limited to PRM Baseline System 1 – PTAC or System 3 – PSZ operate either in heating or cooling mode and no simultaneous heating and cooling is expected on system level. In models with only single-zone systems, such as in PRM baseline of a multifamily building, there may be very minimal simultaneous heating and cooling 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 including but not limited to PRM Baseline System 5 and System 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 Section 6.5.2.

Common Mistakes

The following issues with the baseline (budget) model may result in excessive simultaneous heating and cooling:

- PRM 90.1 Section G3.1.1 Exception b 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.
- Temperature reset required in 90.1 Section G3.1.3.12 (PRM) and 90.1 Table 11.5.2-1 Note b (ECB) was not properly modeled.
- Not resetting the supply temperature as required during periods of low cooling load will result in excessive reheat.
- VAV minimum flow setpoint was not modeled as required in 90.1 Section G3.1.3.13 (PRM) and 90.1 Table 11.5.2-1 Note b (ECB).
- Projects often use 0.4 CFM/SF minimum flow instead of 30% of the zone peak as required by this section.
- Economizer was not modeled where required for ECB budget design.

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

8.13 Waterside HVAC (WHVAC) - Proposed

WHVAC1*(CR-P) Proposed chilled-water plant is reported as specified

Verify that quantity, type, capacity, and rated efficiency at full and part load of the proposed chillers are described in the reporting template and reflect design documents. If chiller efficiency specified in the design documents must be converted to different units for input into simulation tool, such conversions must be documented in the reporting template. The following conversions may be used:

COP=EER/3.412
kW/ton = 12/EER

If variations in chiller performance, including but not limited to the impact of part load, are simulated using performance curves, the following options are allowed:

- Use the default curves specified in PRM RM for the specified chiller type.
- Use custom curves based on chiller performance data from the equipment manufacturer. The supporting documentation must be included in the submittal.

WHVAC2*(CR-P): Proposed chilled-water plant controls are reported as specified

Verify that reported chilled-water plant controls including design supply and return CHW temperature and reset reflect design documents.

WHVAC3*(CR-P): Proposed chilled-water pump system parameters are reported as specified

Verify that pumps included in the reporting template match design documents. If values provided on drawings (Figure 42) are converted to units acceptable by the simulation tool, the conversions must be documented in the submittal. Common conversions are included as follows.

Pump Power [W] = BHP x 746 / Effy
Effy = pump motor efficiency

Figure 41. 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.

Verify the following chilled-water loop parameters are reported as specified:

- configuration (i.e., primary/secondary)
- flow (GMP)
- flow controls (constant volume – three-way valves; variable volume – two-way valves)
- speed control (constant speed, two-speed, VSD)

WHVAC4*(CR-P) Proposed heat rejection system is reported as specified

Verify the following parameters of heat rejection system are reported and match design documents:

- cooling tower type
- fan speed control
- fan power [HP]
- design flow rate [GPM]
- design leaving water temperature
- condenser loop pump power [W]

WHVAC5*(CR-P) Proposed hot water plant is reported as specified

Verify that the proposed boiler quantity, type, capacity and efficiency is reported as specified. The full load efficiency of a boiler at rated conditions may have to be converted to different units for inputs into simulation tool. The following conversions should be used (PRM RM) as applicable and must be documented in the reporting template:

Where AFUE is provided, Et shall be calculated as follows:

75%<=AFUE<80%: Et=0.1xAFUE+72.5%; all other Et=0.875 x AFUE + 10.5%

Where Ec is provided, Et shall be calculated as follows: Et = Ec − 2%

If variations in boiler performance due to factors such as part load and return water temperature are simulated using performance curves, the following options are allowed:

- Use the default curves specified in PRM RM for the specified boiler type
- Use custom curves based on boiler performance data from the equipment manufacturer. The supporting documentation must be included in the submittal.

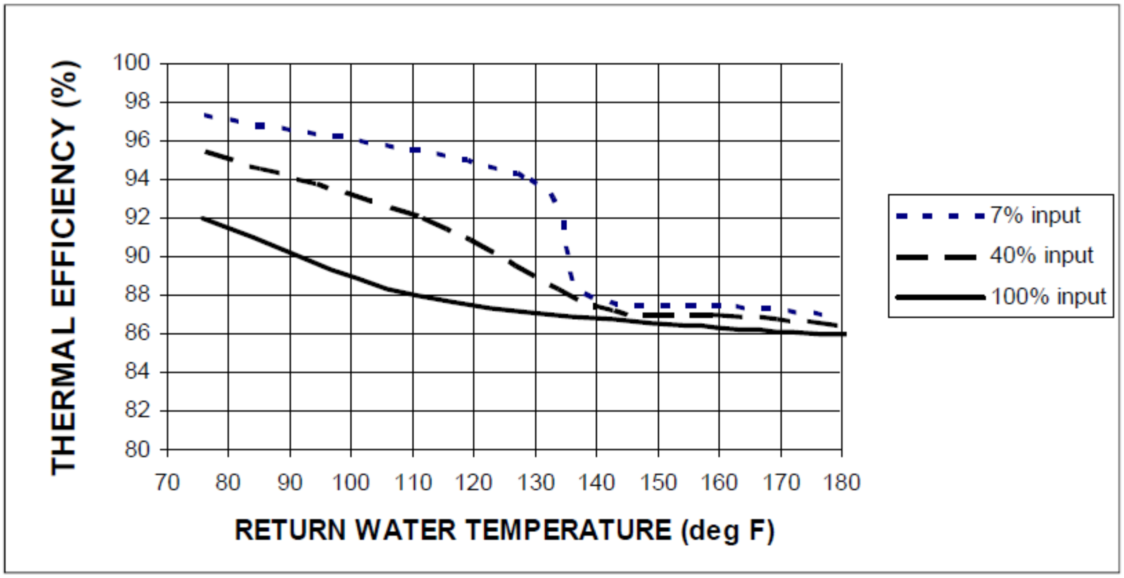
WHVAC6*(CR-P) Proposed hot water loop controls are reported as specified

Verify that hot water loop controls including design supply and return water temperature and temperature reset are reported as specified. Controls may have significant impact on the realized efficiency. For example, the rated efficiency of condensing boilers corresponds to 80°F return water temperature. A much higher design return water temperature is common, such as 160°F in Figure 43, resulting in a significantly lower realized efficiency, as illustrated in Figure 44.

Figure 42. Condensing Boiler Specification

DESIGNATION	LOCATION	SERVICE				BURNER PERFORMANCE DATA GAS				ELECTICAL BOILER POWER			HOT WATER			
			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

Figure 43. Condensing Boiler Efficiency



Cut sheets for the proposed condensing boiler with AHRI efficiency and performance characteristics at various return water temperature and loads may be requested to justify the modeled performance.

WHVAC7*(C-P) Proposed hot water pump system parameters are reported as specified

Verify that reported hot water pump power is as shown on design documents. The provided information must include pump BHP, electrical efficiency of pump motor, design flow rate GPM and speed control (single-speed, two-speed, VSD).

Verify that hot water loop configuration, design flow and flow controls are reported as specified, including the following:

- configuration (i.e., primary/secondary)
- design flow (GMP)
- flow controls (constant volume – three-way valves; variable volume – two-way valves)
- associated pumps

8.14 WHVAC - Baseline

WHVAC1*(CR-B) Baseline (budget) chilled water plant is established correctly

ECB (90.1 Table 11.5.2-1 Note e): The chiller plant of budget Systems 1, 2, 5, and 7 must be modeled with chiller quantity based on 90.1 Table 11.5.2-2 and chiller type based on 90.1 Table 11.5.2-3. If 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 90.1 Section 11.4.3. Budget chillers efficiency must be based on 90.1 Table 6.8.1-3 Path A (11.5.2 – 1 Note c).

PRM (90.1 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 (see 90.1 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 cooling load as shown in Table 8 (90.1 Tables G3.1.3.7 and G3.5.3).

Table 8. Baseline Chiller Description

Building peak cooling load	Number and type of chillers	Chiller efficiency
<=300 ton	1 water-cooled screw chiller	<150 ton: 0.790 kW/ton FL 0.676 IPLV >150 ton and < 300 ton: 0.718 FL 0.629 IPLV
>300 ton and < 600 ton	2 water-cooled screw chillers sized equally	0.639 FL 0.572 IPLV.IP
>=600 ton	2 water-cooled centrifugal chillers minimum with chillers added so that no chiller is larger than 800 tons, all sized equally	0.576 FL 0.549 IPLV.IP

WHVAC2*(CR-B) Baseline (budget) chilled water plant controls are established correctly

ECB (90.1 Table 11.5.2-1 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.

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 (90.1 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 (90.1 Section G3.1.3.9). Exceptions apply to chilled-water systems serving computer rooms or using purchased chilled water (Exception to 90.1 Section G3.1.3.9).

WHVAC3*(CR-B) Baseline (budget) chilled-water pump system parameters are established correctly

ECB (90.1 Table 11.5.2-1 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.

PRM (90.1 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 90.1 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 (90.1 Section G3.1.1.3.2 and 90.1 G3.1.1.3.3).

WHVAC4*(CR-B) Baseline (budget) heat rejection system is established correctly

ECB (90.1 Table 11.5.2-1 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 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).

PRM (90.1 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.

WHVAC5* (CR - B) Baseline (budget) hot water plant is established correctly

ECB (90.1 Table 11.5.2 – 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.

PRM (90.1 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 (90.1 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 shall be staged as required by the load.

WHVAC6*(CR-B) Baseline (budget) hot water plant controls are established correctly

ECB (90.1 Table 11.5.2 – 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.

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.

WHVAC7*(CR-B) Baseline (budget) hot water pumps are established correctly

ECB (90.1 Table 11.5.2 – 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.

PRM (90.1 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.

8.15 WHVAC Model Input/Output (WHM)

WHM1(MI-B, P): Chilled-water plant is modeled as reported

Modeled quantity, type, capacity, and efficiency of the chillers matches information in the reporting template.

eQUEST Reports	PV-A
Trane TRACE 700	Plant information entered values report

WHM2(MI, MO-B, P) Chilled-water plant controls are modeled as reported

Modeled chilled-water plant controls including design supply and return CHW temperature and reset are as reported.

eQUEST Reports	NA
Trane TRACE 700	Plant information entered values report

WHM3(MI-B, P) CHW pumps are modeled as reported

Modeled pumps are as reported, 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.

WHM4(MI,MO-B, P) CHW loop parameters are modeled as reported

CHP loop configuration (i.e., primary/secondary), design flow (GMP), and flow control (three-way or two-way valves) are modeled as reported.

eQUEST Reports	PV-A
Trane TRACE 700	Plant information entered values report. Equipment energy consumption report to calculate pump gpm.

WHM5(MI,MO-B, P) Heat rejection system is modeled as reported

Verify that cooling tower type, fan speed control, and efficiency is modeled as reported.

eQUEST Reports	PV-A
Trane TRACE 700	Plant Information entered values report, Library Members entered values report

WHM6(MO-B, P) Average annual realized chiller efficiency is as expected

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.

Proposed Design: Average annual realized chiller efficiency exceeding the rated part load efficiency of the specified chiller should be flagged. Different than expected average efficiency may be due to use of inappropriate performance curves, incorrect rated full load efficiency input, or CHW loop operation, such as design supply water temperature and temperature drop, significantly different from AHRI rated conditions.

Baseline (budget) design: Average annual realized chiller efficiency less than the rated part load efficiency should be flagged. Different than expected efficiency may be due to use of inappropriate default performance curves, such as based on the software defaults instead of PRM RM curves, incorrect loop setpoint temperatures, or incorrect rated full load efficiency input.

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

WHM7(MO-B,P) Annual chilled-water pump energy is as expected

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 9. 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

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

WHMC8(MI,MO-B,P) Hot water plant is modeled as reported

The proposed boiler quantity, type, capacity, and efficiency is modeled as reported.

eQUEST Reports	PV-A
Trane TRACE 700	Plant information entered values report

WHM (MI,MO-B,P) Hot water plant controls are modeled as reported

Verify the hot water plant controls such as supply and return hot water temperature and temperature reset are modeled as reported.

eQUEST Reports	NA
Trane TRACE 700	Library Members entered values report

WHM10 (MI,MO-B,P) Hot water loop parameters are modeled as reported

Verify the hot water loop configuration (i.e., primary/secondary), design flow (GMP) and flow control (three-way/two-way valves) are modeled as specified.

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.

WHM11 (MI,MO-B,P) Hot water pumps are modeled as reported

Verify the hot water design pump power is modeled as reported as either kW, or BHP and electrical efficiency of pump motor. Verify that the design flow rate GPM and motor speed control (single-speed/two-speed/VSD) are modeled as reported.

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.

WHM12(MI,MO-B,P) Annual hot water pump energy is as expected

Verify that the modeled annual hot water pump energy is as expected. Review steps are the same as described in WHM7 for chilled-water pumps.

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

WHM13(MO-B,P) Average annual boiler efficiency is as expected

The average annual efficiency is the ratio of the annual load on the boiler to the annual boiler energy use, as shown on simulation output reports.

Proposed Design: The average realized efficiency is expected to be lower than the rated efficiency, as discussed in WHVAC6. For example, if manufacturer's marketing materials list efficiency of the specified condensing boiler as "up to 98%" and the design documents show boiler return water temperature of 160F, the boiler would operate at ~86% efficiency at design conditions (Figure 44). The results should be flagged if the average annual boiler efficiency based on the simulation output reports is higher than expected based on this estimate.

Baseline (budget) Design: PRM and ECB baseline boilers are natural draft. The part load efficiency degradation of the boilers based on the performance curves in PRM RM results in the efficiencies shown in Table 9**.** 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 based on this estimate should be flagged.

Table 10. 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

WHM14*(MO-B,P) Difference in the baseline (budget) and proposed heating fuels is as expected

This high-level check verifies the expected trends for both air-side and water-side HVAC.

ECB: When 90.1 Section 11.5.2 j 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.

PRM: There should be no electric heating in the baseline model for projects in New York climate zones (Table G3.1.1-3).

For the proposed design, heating fuels included in the simulation reports must match the fuels used by the specified systems. For example, if electric baseboards or electric unit heaters are shown on the mechanical schedules, there should be electricity heating energy use in the simulation reports. If proposed design includes air-source heat pumps, electricity use should be shown under heating and heat pump supplement end uses.

eQUEST Reports	BEPU
Trane TRACE 700	Energy Cost Budget report

WHM15*(MO-B,P) Change in heating, cooling and fan energy between the baseline (budget) and proposed design is as expected based on the described system parameters

This high-level check verifies the expected trends for both air-side and water-side HVAC.

For some common proposed design configurations, the change in HVAC end uses between the baseline (budget) and proposed design simulation may be compared to the expectations. For example, many multifamily projects in New York City have through-the-wall air conditioners and hot water baseboards in apartments, with hot water provided by gas-fired boiler(s). There is often no outdoor air supply to apartments, with continuous or intermittent exhaust ventilation. These projects have PTAC in the baseline (budget). The following trends are expected for the PRM models:

- Lower fan energy in the proposed design, because exhaust fans are the only fans running throughout the year and the only other fans are in the through-the-wall air conditioners that are only running in summer when there is cooling load (i.e., cycle with load).
- Higher pump energy in the proposed design, since the baseboard hot water loop often has 20°F design temperature drop compared to 50°F delta T in the baseline PTACs.

Several additional examples of the high-level checks are included.

- No HVAC pump energy if no pumps are reported in the submittal (e.g., in the baseline model of projects reported to only have System 3 or System 5).
- Higher pump energy in the proposed design with ground source heat pump, chillers, and water source heat pumps compared to baseline (budget) designs that require pumps only for heating.

This review check largely relies on reviewer's experience with similar projects. If general trends are not as expected, or if the expected outcomes for the given project are difficult to establish, for example due to project size and diversity of systems, the air-side and water-side HVAC system checks should be completed.

eQUEST Reports	BEPU
Trane TRACE 700	Energy Cost Budget report

8.16 Other Equipment (OE)

OE1 Verify that reported PV systems are as specified in the design documents and that the calculated PV system electricity generation is appropriate

PV system details included in the submittal must at minimum include system type, orientation, and generation capacity (kW). If a 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 OE3 review check. See also CC2 and CC3 review checks.

To verify 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). EFLH greater than 1,500 hours/year should be flagged.

OE2 Verify that reported CHP systems are as specified in the design documents and that the CHP systems electricity generation and recovered energy reported in submittal is reasonable.

The provided information must, at minimum, include the generator 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). If a CHP system is not modeled in the whole building simulation tool, the supporting calculations must be provided as described in OR3 review check. See also CC3 and CC4 review checks.

OE3 Verify that reported systems and components included in the exceptional calculation methods reflect design documents and savings calculations follow accepted engineering practice.

All exceptional methods must include the following supporting documentation (G2.5):

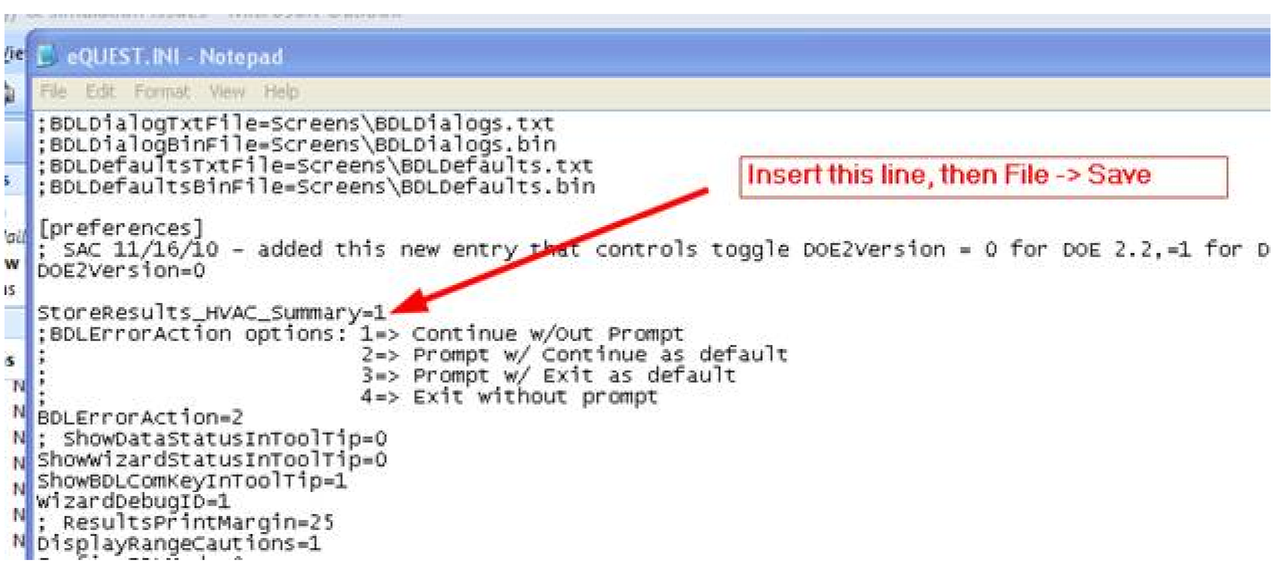
- Step-by-step documentation of the exceptional calculation method performed, detailed enough to reproduce the results.
- Copies of all spreadsheets used to perform the calculations.
- A sensitivity analysis of energy consumption when each of the input parameters is varied from half to double the value assumed.
- The calculations shall be performed on a time-step basis consistent with the simulation program used.
- The performance rating calculated with and without the exceptional calculation method.

9 Simulation Reports

9.1 eQUEST Reports

General

1. 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.
2. 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.
3. There are separate reports for the baseline (budget) and proposed design model.
4. 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.
5. 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 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.



BEPS Building Energy Performance

REPORT- BEPS Building Energy Performance

SG1: Weather File

WEATHER FILE- NEW YORK LAGUARDI NY

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY MBTU	173.0	231.5	637.0	289.0	261.4	0.0	0.0	132.2	0.0	7.0	0.0	6.7	1737.7
FM1 NATURAL-GAS MBTU	0.0	0.0	0.0	33.5	0.0	0.0	0.0	0.0	0.0	0.0	850.0	0.0	883.5
MBTU	173.0	231.5	637.0	322.5	261.4	0.0	0.0	132.2	0.0	7.0	850.0	6.7	2621.2

SG7: Site EUI

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

SG3: UMLH>300 exceeds the prescribed limit.

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

BEPU Building Utility Performance

REPORT- BEPU Building Utility Performance

WEATHER FILE- NEW YORK LAGUARDI NY

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY KWH	50677.	67833.	186640.	84677.	76588.	0.	0.	38722.	0.	2045.	0.	1971.	509152.
FM1 NATURAL-GAS THERM	0.	0.	0.	335.	0.	0.	0.	0.	0.	0.	8500.	0.	8835.

LI6, LI7: Annual LI kWh

ML2, ML3: Annual ML kWh

SG11, SG12

SWH4 & 5

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.

LE3, LE4: 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 unenclosed

LV-B Summary of Spaces

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

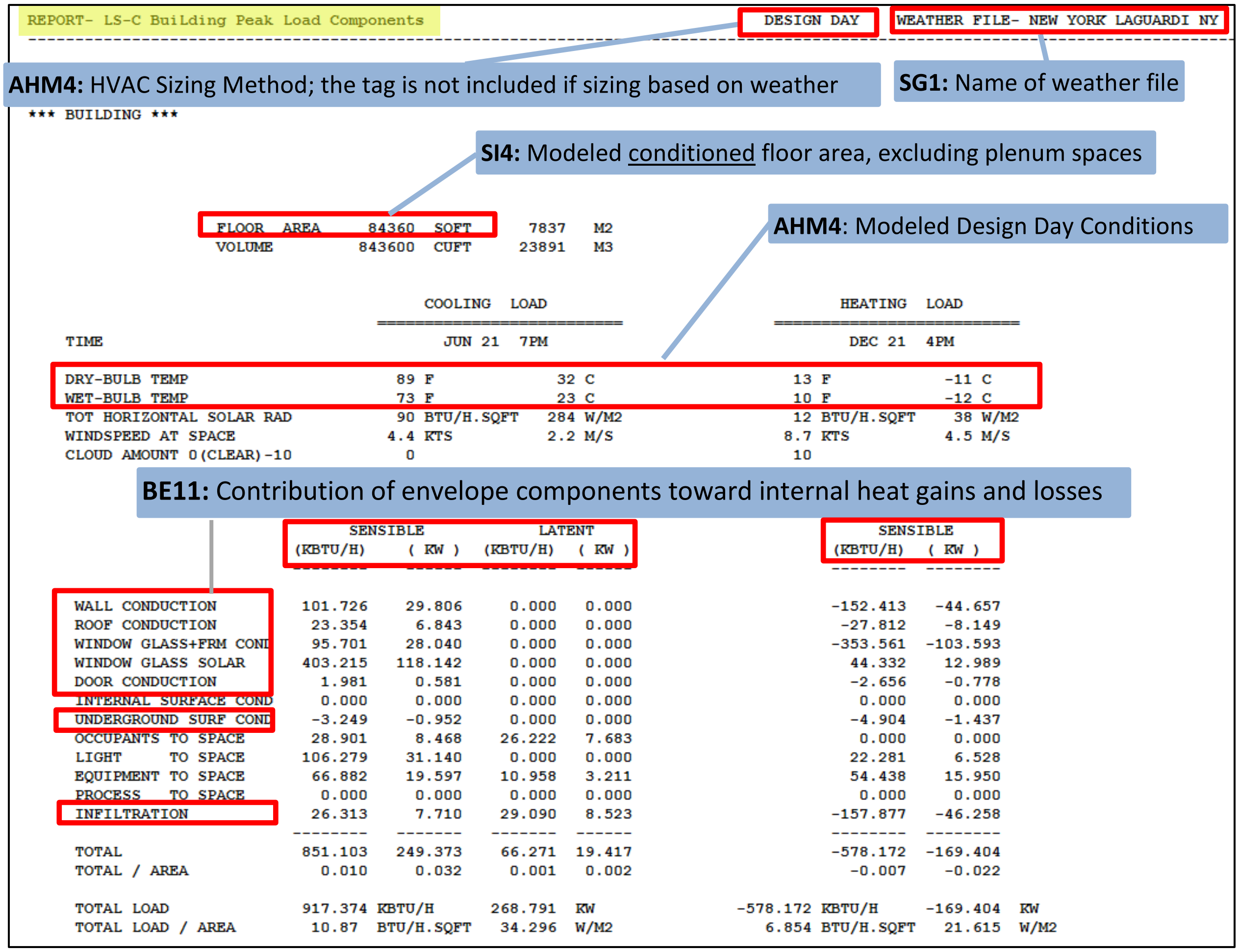
NUMBER OF SPA

BE10: "Air-Change" infiltration modeling method adjusts user-entered infiltration to account for weather, as required by 90.1 Table G3.1 No5 (b).

SPACE	SPACE*FLOOR MULTIPLIER	SPACE TYPE	AZIM	LIGHTS (WATT / SQFT)	PEOPLE	EQUIP (WATT / SQFT)	INFILTRATION METHOD	ACH	AREA SQFT)	VOLUME (CUFT)
Spaces on floor: EL1 Ground Flr										
MER	1.0	EXT	0.0	1.50	0.0	0.26	AIR-CHANGE	0.19	950.0	9500.0
Stairwell2	1.0	EXT	0.0	0.60	0.0	0.26	AIR-CHANGE	0.19	950.0	9500.0
Stairwell1	1.0	EXT	0.0	0.60	0.0	0.26	AIR-CHANGE	0.19	950.0	9500.0
Office	1.0	EXT	-90.0	1.10	1.7	0.50	AIR-CHANGE	0.19	950.0	9500.0
EL1 Core Spc (G.C5)	1.0	EXT	0.0	0.50	0.8	0.20	AIR-CHANGE	0.19	836.0	8360.0
EL1 WSW Perim Spc (G.WSW6)	1.0	EXT	90.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 West Perim Spc (G.W7)	1.0	EXT	180.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 West Perim Spc (G.W8)	1.0	EXT	180.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 WNW Perim Spc (G.WNW9)	1.0	EXT	180.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
Spaces on floor: EL1 Mid Flr:										
EL1 ESE Perim Spc (M.ESE10)	8.0	EXT	0.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 East Perim Spc (M.E11)	8.0	EXT	0.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 East Perim Spc (M.E12)	8.0	EXT	0.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 ENE Perim Spc (M.ENE13)	8.0	EXT	-90.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0
EL1 Core Spc (M.C14)	8.0	EXT	0.0	0.50	0.8	0.20	AIR-CHANGE	0.19	836.0	8360.0
EL1 WSW Perim Spc (M.WSW15)	8.0	EXT	90.0	1.10	1.7	0.65	AIR-CHANGE	0.19	950.0	9500.0

LI4: The total modeled wattage is the sum of products of Multiplier x LPD x Area. The same information is available in the CSV Space Loads report.

LS-C Building Peak Load Components



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

AHM4: HVAC Sizing Method; the tag is not included if sizing based on weather

SG1: Name of weather file

*** BUILDING ***

SI4: Modeled conditioned floor area, excluding plenum spaces

AHM4: Modeled Design Day Conditions

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	

BE11: Contribution of envelope components toward internal heat gains and losses

	SENSIBLE (KBTU/H)	SENSIBLE (KW)	LATENT (KBTU/H)	LATENT (KW)	SENSIBLE (KBTU/H)	SENSIBLE (KW)
WALL CONDUCTION	101.726	29.806	0.000	0.000	-152.413	-44.657
ROOF CONDUCTION	23.354	6.843	0.000	0.000	-27.812	-8.149
WINDOW GLASS+FRM COND	95.701	28.040	0.000	0.000	-353.561	-103.593
WINDOW GLASS SOLAR	403.215	118.142	0.000	0.000	44.332	12.989
DOOR CONDUCTION	1.981	0.581	0.000	0.000	-2.656	-0.778
INTERNAL SURFACE COND	0.000	0.000	0.000	0.000	0.000	0.000
UNDERGROUND SURF COND	-3.249	-0.952	0.000	0.000	-4.904	-1.437
OCCUPANTS TO SPACE	28.901	8.468	26.222	7.683	0.000	0.000
LIGHT TO SPACE	106.279	31.140	0.000	0.000	22.281	6.528
EQUIPMENT TO SPACE	66.882	19.597	10.958	3.211	54.438	15.950
PROCESS TO SPACE	0.000	0.000	0.000	0.000	0.000	0.000
INFILTRATION	26.313	7.710	29.090	8.523	-157.877	-46.258
TOTAL	851.103	249.373	66.271	19.417	-578.172	-169.404
TOTAL / AREA	0.010	0.032	0.001	0.002	-0.007	-0.022

TOTAL LOAD	917.374	KBTU/H	268.791	KW	-578.172	KBTU/H	-169.404	KW
TOTAL LOAD / AREA	10.87	BTU/H.SQFT	34.296	W/M2	6.854	BTU/H.SQFT	21.615	W/M2

Notes:

Heat losses are shown as negative numbers; heat gains are shown as positive numbers. For example, in the report shown above, conduction heat losses through windows contribute 353.561 kBtu/H toward the heating load; while window solar heat gains reduce peak heating load by 44.332.

LV-D Details of Exterior Surfaces

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

BE1&2: U-values and areas of surfaces adjacent to the ambient conditions or ground for each modeled space
BE3&4: U-value and areas of fenestration area for each modeled space

SURFACE	- - - W I N D O W S - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	- - - - W A L L - - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	-W A L L + W I N D O W S- U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	AZIMUTH
EL1 North Wall (G.ENE4.E5) in space: Office	0.581	79.46	0.118	170.54	0.265	250.00	NORTH
EL1 North Wall (G.C5.E7) in space: EL1 Core Spc (G.C5)	0.531	16.50	0.063	38.50	0.203	55.00	NORTH
EL1 North Wall (G.WNW9.E14) in space: EL1 WNW Perim Spc (G.WNW9)	0.531	75.00	0.063	175.00	0.203	250.00	NORTH
EL1 North Slab (M.ENE13.S19) in space: EL1 ENE Perim Spc (M.ENE13)	0.000	0.00	0.481	100.00	0.481	100.00	NORTH
EL1 North Wall (M.ENE13.E19) in space: EL1 ENE Perim Spc (M.ENE13)	0.531	600.00	0.063	1400.00	0.203	2000.00	NORTH
EL1 North Slab (M.C14.S21) in space: EL1 Core Spc (M.C14)	0.000	0.00	0.481	22.00	0.481	22.00	NORTH

BE6, 7, 8, 9: 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 U-VALUE/WINDOWS (BTU/HR-SQFT-F)	AVERAGE U-VALUE/WALLS (BTU/HR-SQFT-F)	AVERAGE U-VALUE WALLS+WINDOWS (BTU/HR-SQFT-F)	WINDOW AREA (SQFT)	WALL AREA (SQFT)	WINDOW+WALL AREA (SQFT)
NORTH	0.533	0.090	0.218	1669.46	4130.29	5799.75
EAST	0.531	0.093	0.218	4535.20	11348.80	15884.00
SOUTH	0.533	0.090	0.218	1669.46	4130.29	5799.75
WEST	0.531	0.088	0.215	4535.20	11348.80	15884.00
ROOF	0.000	0.061	0.061	0.00	8436.00	8436.00
ALL WALLS	0.532	0.091	0.217	12409.33	30958.16	43367.50
WALLS+ROOFS	0.532	0.084	0.191	12409.33	39394.16	51803.50
UNDERGRND	0.000	0.038	0.038	0.00	8436.00	8436.00
BUILDING	0.532	0.076	0.170	12409.33	47830.16	60239.50

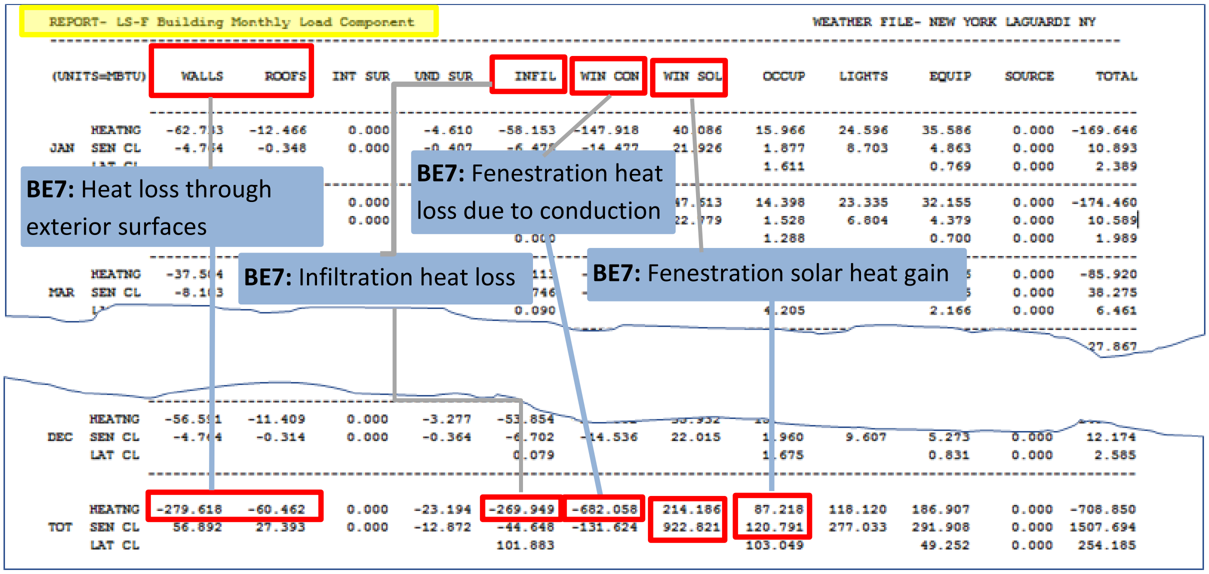
BE6, 8: The model has the following area-weighted average U-values: roof U-0.061; exterior walls U-0.091; windows U-0.532

BE6, 7: 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.
BE3: Modeled WWR is 12409/43368=28.6%

Notes:

Projects may have exaggerated area of roof or exposed and below grade floors due to common modeling mistake, when exposed horizontal surfaces are sandwiched between the floor that were modeled as different building shells when the project was created in the Wizard. If the proposed roof is better insulated than the baseline (budget) and its area is doubled, it's contribution toward the trade-offs will also be exaggerated by the factor of 2.

LS-F Building Monthly Load Components



Notes:

- Negative numbers indicate heat losses; positive numbers indicate heat gains.
- Jan – Dec values provided in the report indicate that the full annual simulation was completed for 8,760 hours/year.

SS-D Building HVAC Load Summary

REPORT- SS-D Building HVAC Load Summary WEATHER FILE- NEW YORK LAGUARDI NY

MONTH	COOLING ENERGY (MBTU)	COOLING TIME OF MAX DY	COOLING TIME OF MAX HR	COOLING DRY-BULB TEMP	COOLING WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	HEATING TIME OF MAX DY	HEATING TIME OF MAX HR	HEATING DRY-BULB TEMP	HEATING WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	28.56705	11	8	25.F	20.F	257.824	-104.594	25	7	19.F	16.F	-720.587	36969.	129.831
FEB	29.97058	6	8	7.F	5.F	254.431	-103.721	6	8	7.F	5.F	-740.835	35847.	131.865
MAR	25.74771	15	16	69.F	55.F	484.179	-61.423	1	8	37.F	35.F	-604.330	39845.	150.022
APR	39.53304	27	16	78.F	65.F	712.008	-22.636	5	8	46.F	42.F	-330.268	39414.	170.084
MAY	83.86207	25	15	85.F	69.F	858.740	-7.373	20	8	48.F	45.F	-200.396	42753.	188.845
JUN	218.80797	18	17	91.F	77.F	1045.090	-0.906	1	22	60.F	59.F	-70.541	56485.	216.502
JUL	306.24469	8	14	95.F	80.F	1222.826	-0.133	14	22	72.F	70.F	-14.996	65341.	240.500
AUG	280.24261	24	14	91.F	75.F	1074.308	-0.200	19	22	68.F	56.F	-21.934	63048.	219.270
SEP	173.06245	10	14	82.F	74.F	994.159	-2.927	30	22	52.F	48.F	-154.073	50939.	199.313
OCT	80.79825	5	16	79.F	64.F	815.780	-12.397	18	8	44.F	37.F	-270.316	41904.	179.440
NOV	31.42019	4	16	70.F	57.F	612.884	-38.495	27	8	27.F	24.F	-546.697	36531.	158.274
DEC	27.46401	16	12	43.F	37.F	285.190	-87.754	6	8	28.F	27.F	-691.092	38356.	137.048
TOTAL	1325.722						-442.559						547429.	
MAX						1222.826						-740.835		240.500

MAXIMUM DAILY INTEGRATED COOLING LOAD (DES DAY) 0.000 (KBTU)
MAXIMUM DAILY INTEGRATED COOLING LOAD (WTH FILE) 0.000 (KBTU)

AMH14: 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 Hour

REPORT- SS-E Building HVAC Load Hours WEATHER FILE- NEW YORK LAGUARDI NY

MONTH	HOURS COOLING LOAD	HOURS HEATING LOAD	HOURS COINCIDENT COOL-HEAT LOAD	HOURS FLOATING	HOURS HEATING AVAIL.	HOURS COOLING AVAIL.	HOURS FANS ON	HOURS FANS CYCLE ON	HOURS NIGHT VENTING	HOURS FLOATING WHEN FANS ON	HEATING LOAD AT COOLING PEAK (KBTU/HR)	ELECTRIC LOAD AT COOLING PEAK (KW)
	- - - - N U M B E R		O F		H O U R S - - - -						--COINCIDENT LOADS--	
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		

AMH14: Large hours of simultaneous heating/cooling, especially in summer, may indicate overcooling and excessive reheat.

AMH14: Hours when at least one air-side system is running to provide HVAC during occupied hours plus night cycling to maintain setback temperature.

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

MONTH	FAN ENERGY (KWH)	MAXIMUM FAN LOAD (KW)	GAS OIL ENERGY (MBTU)	MAXIMUM GAS OIL LOAD (KBTU/HR)	GAS OIL ENERGY (MBTU)	MAXIMUM GAS OIL LOAD (KBTU/HR)	ELECTRIC ENERGY (KWH)	MAXIMUM ELECTRIC LOAD (KW)	ELECTRIC ENERGY (KWH)	MAXIMUM ELECTRIC LOAD (KW)
	--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--	
JAN	1093.	2.744	0.000	0.000	0.000	0.000	0.	0.000	1178.	10.371
FEB	1073.	2.809	0.000	0.000	0.000	0.000	0.	0.000	1187.	10.554
MAR	936.	2.933	0.000	0.000	0.000	0.000	0.	0.000	982.	13.521
APR	891.	4.052	0.000	0.000	0.000	0.000	0.	0.000	1256.	18.646
MAY	907.	4.261	0.000	0.000	0.000	0.000	0.	0.000	2604.	23.345
JUN	1002.	4.284	0.000	0.000	0.000	0.000	0.	0.000	5979.	30.978
JUL	1143.	5.038	0.000	0.000	0.000	0.000	0.	0.000	8506.	37.213
AUG	1164.	4.739	0.000	0.000	0.000	0.000	0.	0.000	7713.	31.434
SEP	983.	4.446	0.000	0.000	0.000	0.000	0.	0.000	4859.	26.681
OCT	913.	4.400	0.000	0.000	0.000	0.000	0.	0.000	2469.	21.777
NOV	789.	3.475	0.000	0.000	0.000	0.000	0.	0.000	1075.	15.813
DEC	1031.	2.811	0.000	0.000	0.000	0.000	0.	0.000	1130.	11.182
TOTAL	11925.		0.000		0.000		0.		38938.	
MAX		5.038				0.000		0.000		37.213

AHM11: Fan Peak Demand

SS-L Fan Electric Energy Use

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

MONTH	FAN ELEC DURING HEATING (KWH)	FAN ELEC DURING COOLING (KWH)	FAN ELEC DURING HEAT & COOL (KWH)	FAN ELEC DURING FLOATING (KWH)	00 10	10 20	20 30	30 40	40 50	50 60	60 70	70 80	80 90	90 100	100 +	TOTAL RUN HOURS
					Number of hours within each PART LOAD range											
JAN	1084.152	827.287	825.504	7.130	0	0	0	574	19	0	0	0	0	0	0	593
FEB	1058.964	812.834	803.922	5.134	0	0	0	556	22	0	0	0	0	0	0	578
MAR	855.060	507.156	489.272	63.429	0	0	0	454	41	0	0	0	0	0	0	495
APR	539.980	396.757	177.030	131.024	0	0	0	344	87	7	0	0	0	0	0	438
MAY	283.607	662.653	123.588	84.816	0	0	0	329	88	13	0	0	0	0	0	430
JUN	103.750	997.733	103.750	4.412	0	0	0	260	108	60	0	0	0	0	0	428
JUL	36.433	1142.660	36.433	0.000	0	0	0	267	101	90	2	0	0	0	0	460
AUG	47.278	1164.255	47.278	0.000	0	0	0	245	86	121	0	0	0	0	0	452
SEP	212.776	904.918	146.316	11.186	0	0	0	277	80	62	0	0	0	0	0	419
OCT	473.365	613.012	226.470	53.320	0	0	0	260	105	36	0	0	0	0	0	401
NOV	641.018	380.708	266.163	33.020	0	0	0	321	72	2	0	0	0	0	0	395
DEC	1012.801	723.145	710.372	5.347	0	0	0	521	32	0	0	0	0	0	0	553
ANNUAL	6349.336	9133.087	3956.077	398.819	0	0	0	4408	841	391	2	0	0	0	0	5642

BREAKDOWN OF ANNUAL FAN POWER USAGE

FAN TYPE	ANNUAL FAN ELEC (KWH)
SUPPLY	8347.
RETURN	3577.

AHM10: 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

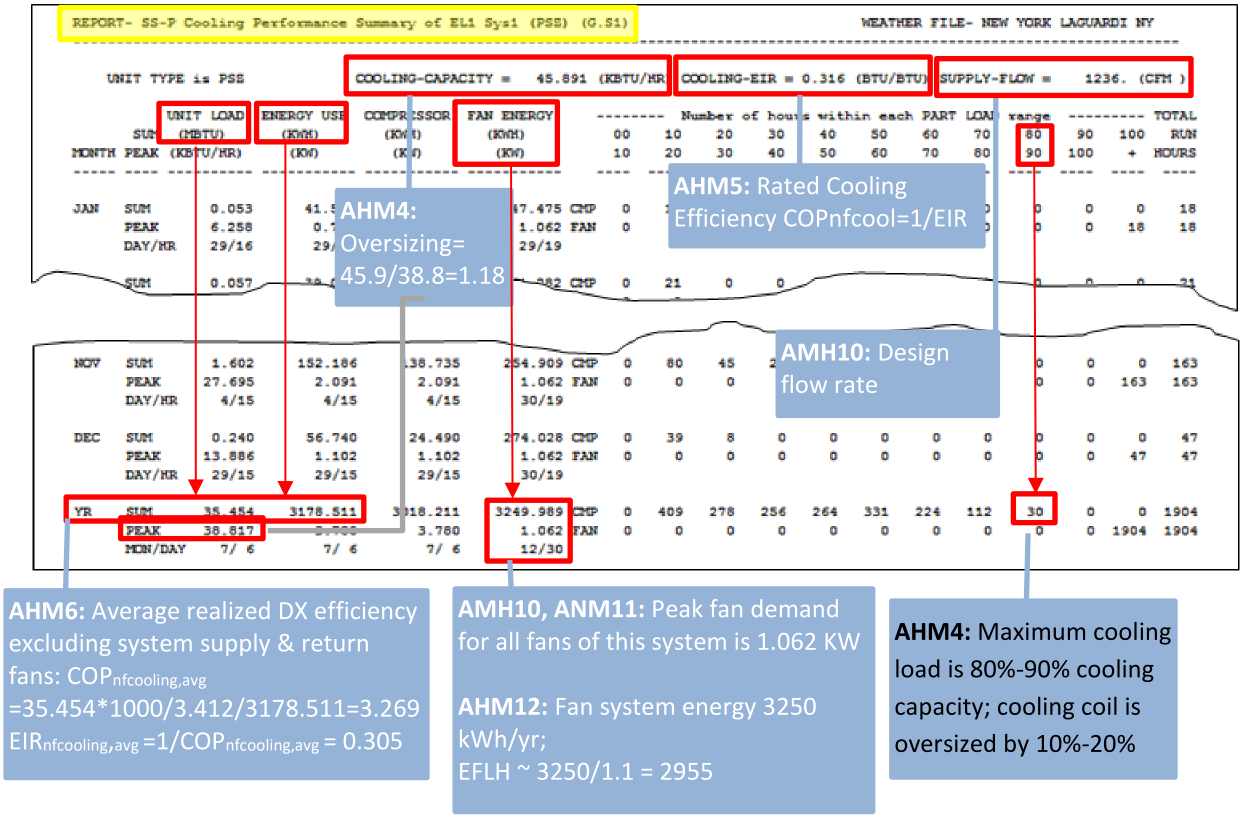
TOTAL HOURS AT TEMPERATURE LEVEL AND TIME OF DAY

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	[illegible]	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	[illegible]	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

SG3: 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.

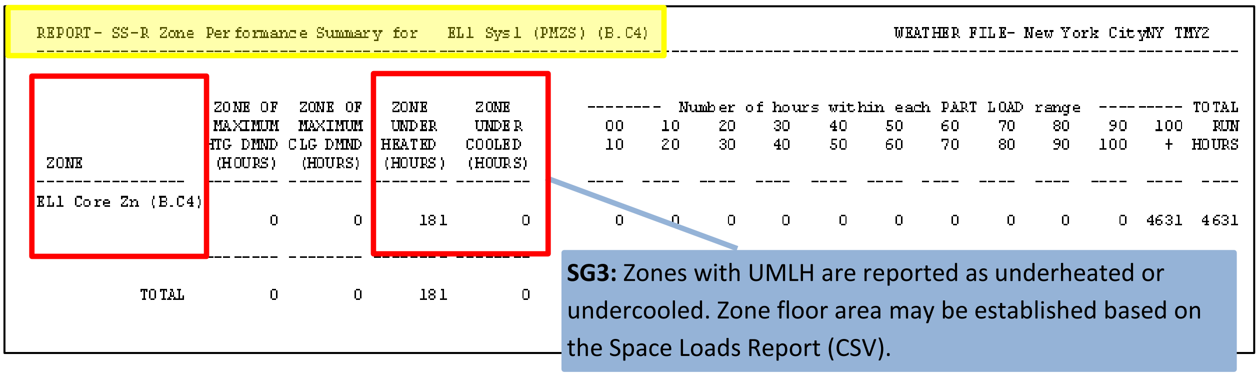
SS-P - Cooling (Heating) Performance Summary



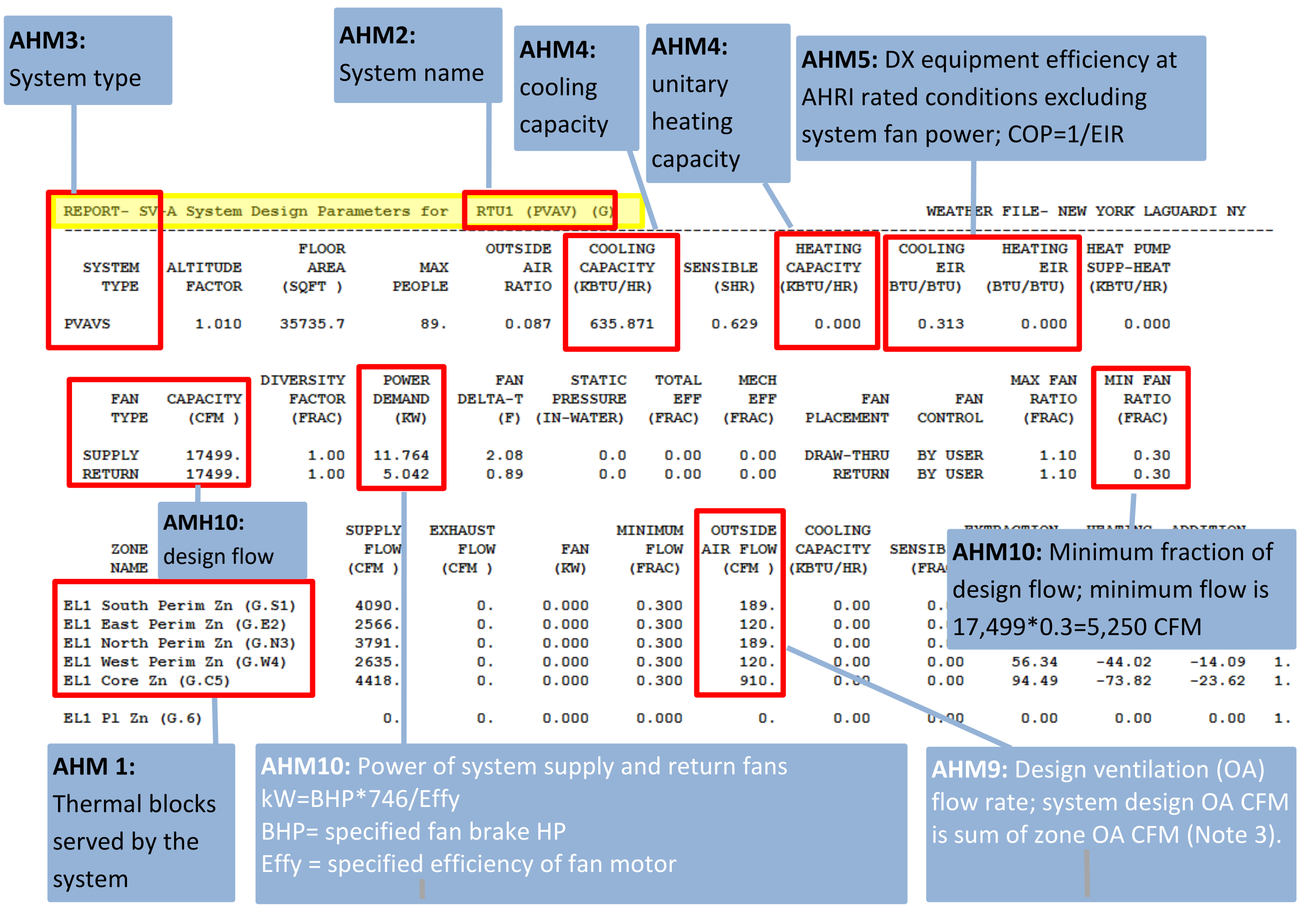
Notes:

- An SS-P report is available for each air-handler.
- An instance of SS-P report is also generated for each system with DX (heat pump) heating.

SS-R Zone Performance Summary



SV-A System Design Parameters



Notes:

- SV-A report is available for each modeled air handler.
- Refer to eQUEST "Detailed Simulation Reports Summary" p.84 of the pdf for detailed description of other values shown in the SV-A report.
- Design OA flow in the simulation may be different, based on the entered ventilation schedule.

ES-D Energy Cost Summary

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

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
Custom Elec Rate	ELECTRICITY	EM1	509152. KWH	76373.	0.1500	YES
Custom Gas Rate	NATURAL-GAS	FM1	8835. THERM	8835.	1.0000	YES
				85208.		

ENERGY COST/GROSS BLDG AREA: 1.01
ENERGY COST/NET BLDG AREA: 1.01

SI6: Virtual Rate is the ratio of the Total Charge ($) to the Metered Energy [units/yr]

PS-E Energy End Use Summary for all Electric Meters

REPORT- PS-E Energy End-Use Summary for all Electric Meters — WEATHER FILE- NEW YORK LAGUARDI NY

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
JAN													
KWH	4[illegible]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[illegible]	195.200
DAY/HR	[illegible]/ 8	1/19	1/ 7	22/10	28/16	0/ 0	0/ 0	8/ 8	0/ [illegible]	22/ 8	0/ 0	1/ [illegible]	22/ 8
PEAK ENDUSE	6.572	23.826	26.181	82.039	0.000	0.000	0.000	11.163	0.0[illegible]0	45.419	0.000	0.00[illegible]	
PEAK PCT	3.4	12.2	13.4	42.0	0.0	0.0	0.0	5.7	[illegible].0	23.3	0.0	0.[illegible]	
FEB													
KWH	3[illegible]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[illegible]	230.452
DAY/HR	1/ 8	1/1[illegible]	[illegible]	[illegible]/ 5	17/16	0/ 0	0/ 0	5/21	0/ 0	6[illegible]	[illegible]	[illegible]	[illegible]
PEAK ENDUSE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	89.[illegible]	[illegible]	[illegible]	[illegible]
DEC													
KWH	4302.	5761.	15852.	19164.	0.	0.	0.	4111.	0.	18.	0.	167.	49376.
MAX KW	6.572	39.710	26.181	72.279	0.155	0.000	0.000	11.159	0.000	2.473	0.000	0.450	145.356
DAY/HR	1/ 8	1/19	1/ 7	3/ 8	28/16	0/ 0	0/ 0	7/ 8	0/ 0	3/ 8	0/ 0	1/ 1	6/19
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	

LI5: Non-coincident annual lighting peak demand is the MAX KW for Lights + Task Lights.

SG11, AHM2: Heat Pump supplemental heat (electric resistance)

LE2: 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       556.2 LOAD [illegible]   623   384   308   222   135   139    96    54    39    31  3016
        PEAK                  -568.9         0.0       689.7 ELEC [illegible]     0     0     0     0     0     0     0     0     0     0     0
     MON/DAY                   12/13        0/ 0       12/13 FUEL  495   848   476   344   247   199   130   125    73    48    31  3016

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

DHW Plant 1 Wtr Htr (1)
         SUM                   -38.7     13107.2             LOAD1271   826 [illegible]   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 [illegible]   519   125    13     0     0     0  3411
```

WHM6, WHM13: 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                                  N          RETURN     LOOP       FLUID HEAT
  CAPACITY   CAPACITY                                 UCT        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
```

WHM4, WHM10: flow (GPM), total head

WHM3, WHM11: Pump flow GPM, power [kW] and control. HW Pump in the example is 0.499/26.5=19 W/GPM

```
          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
```

WHM8: Boiler name, type, capacity in **MMBtu/hr** (shown as negative value), fuel efficiency Et = 1/HIR

```
   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
```

WHM1: Chiller type, capacity in MMBtu/hr and rated efficiency. COP=1/EIR (COP in the example: 1/0.354=2.82)

```
*** 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
```

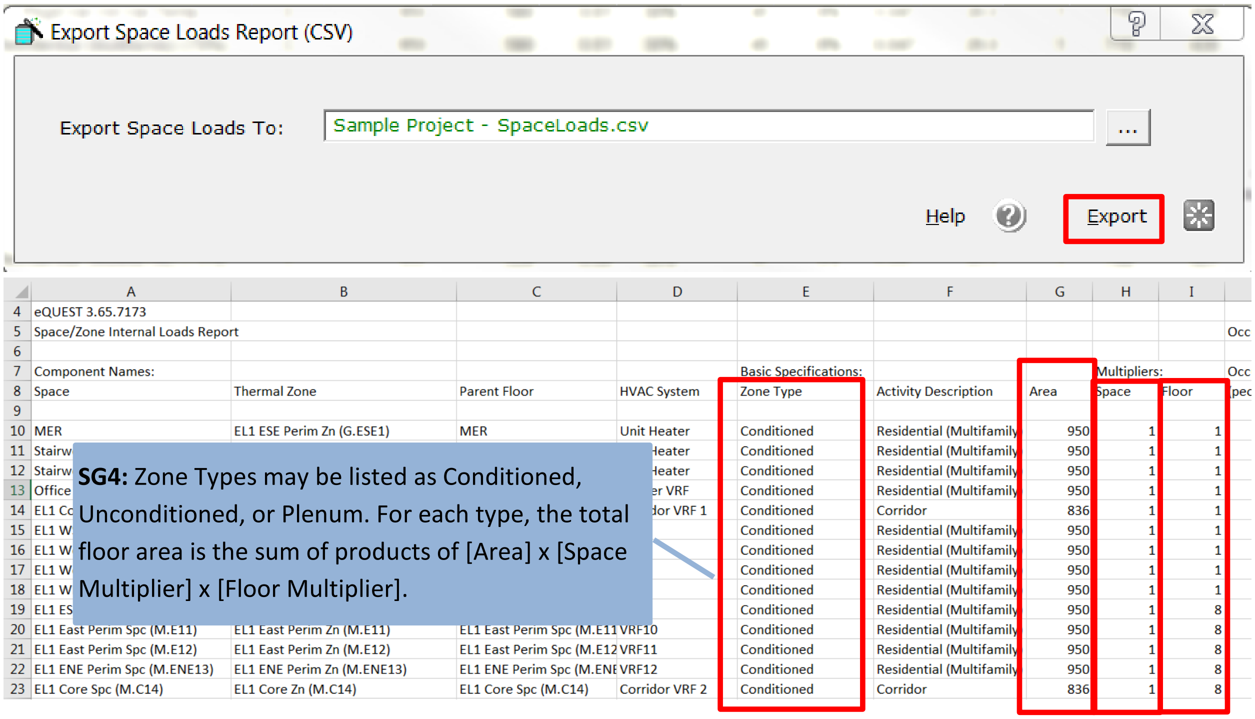
SWH3: Modeled SWH capacity. Always shown as a negative number in the units of MMBtu/hr. The capacity of heater in the example is 265 MBH

SWH3: 1/EIR = electric heater efficiency
1/HIR = non-electric heater efficiency

SWH3: Storage tank volume, surface area and insulation. The inputs affect stand-by losses.

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.



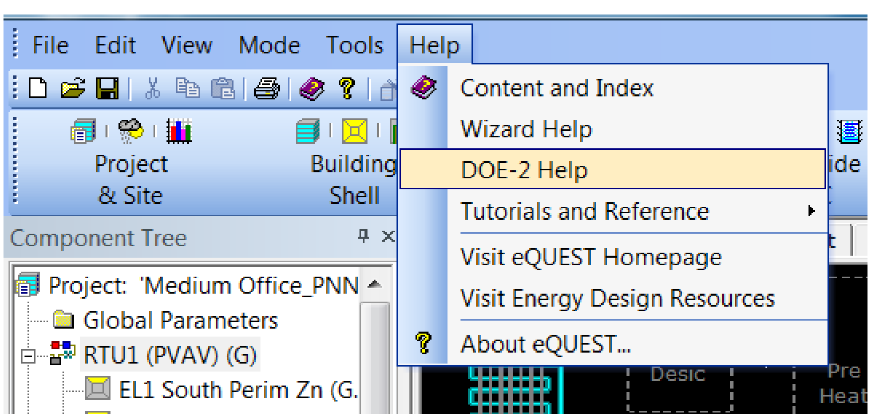
The report includes a detailed list of modeling inputs by space, including but not limited to lighting and equipment power density and full load hours. CSV (Excel) format easily supports data analysis.

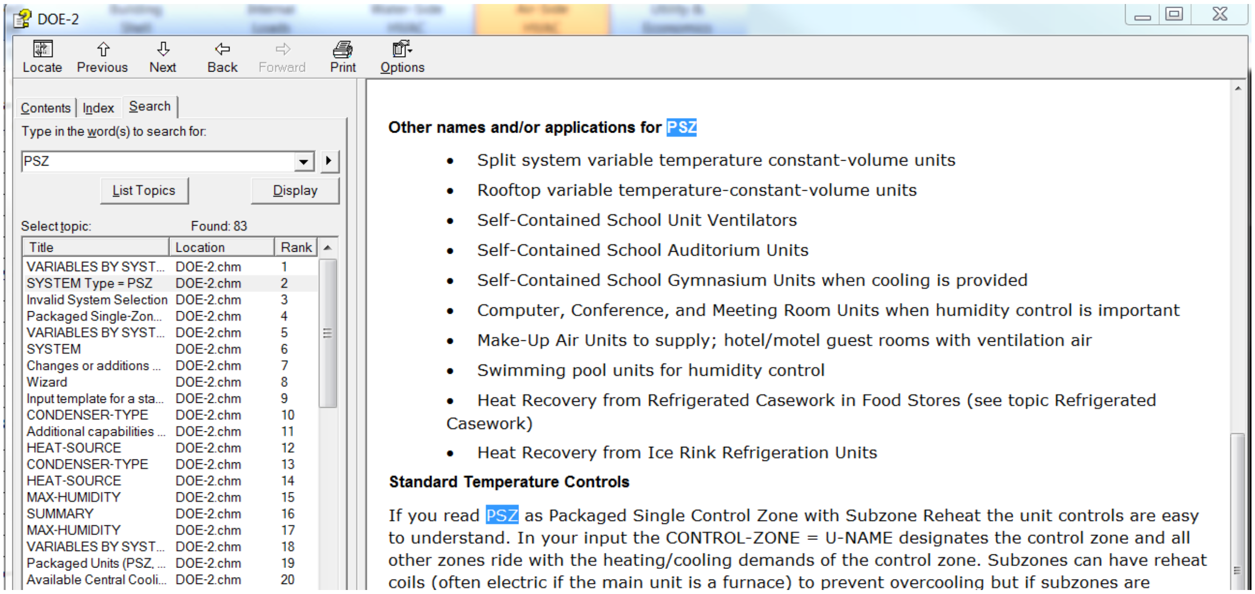
Hourly Results (CSV)

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. A total of 8,760 hours indicate that the full hourly simulation was completed.

DOE-2 Help

The help is accessible from within eQUEST interface.



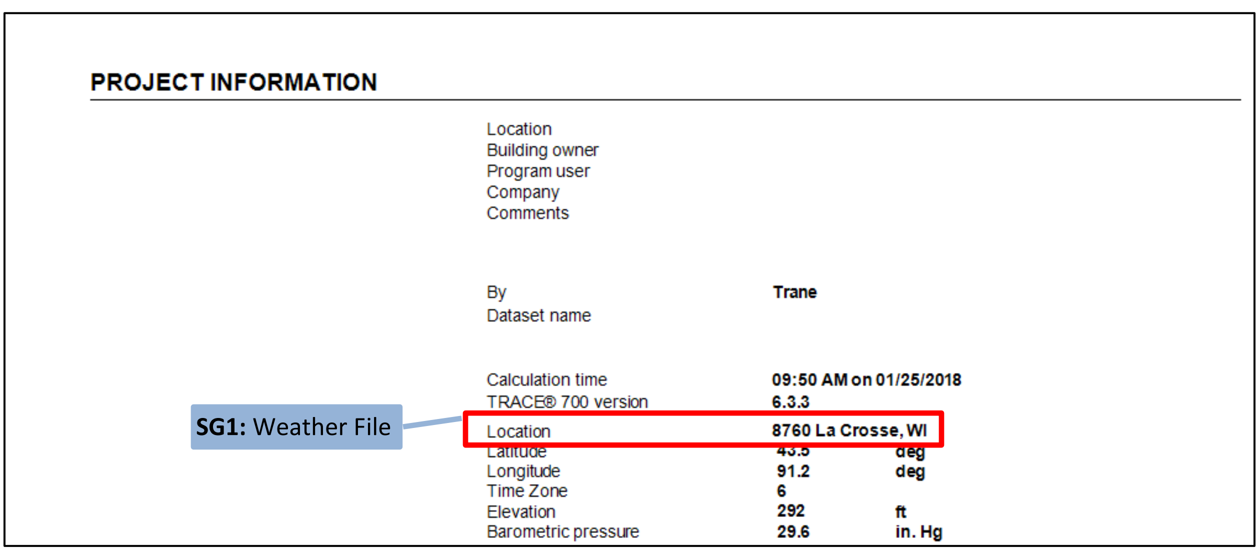


9.2 Trane TRACE 700 Reports

General

- The following reports 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.
- The reports can be viewed in the report viewer or exported. Most commonly the reports are exported to .pdf files for submittals.

Title Page Report



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	

SG2: Number of hours modeled. Full year indicates 8,760 hours. (Reduced year indicates less than 8,760 hours)

Energy Cost Budget/PRM Summary report

Energy Cost Budget / PRM Summary

By Trane

AHM2: Space heating end use
WHM14: Baseline and Proposed heating fuels

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 ...e 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		

WHM15: Heating, cooling, and fan energy between the baseline and proposed

ML2 and ML3: Miscellaneous loads

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

SG3: Unmet hours

	* 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

SG4: Conditioned Floor Area

Section 1.2 - Space Summary

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

SG3: 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 Zo 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 : 35845
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	

LI4: Lighting Power Densities for the Space-By-Space Method

AHM4: Baseline Equipment Size

Project Name :
Dataset Name : TEST FILE 2.TRC

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

LEED Energy Performance Summary Report

By Trane

Section 1.4 - Comparison of Proposed Design Versus Baseline Design

AHM4: Baseline Equipment Size

CC2: Renewable Energy
CC3: Exceptional Calculation

LE2: Proposed Exterior Lighting Power

LI1: Baseline Exterior Lighting Power

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 : 0.056000 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

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 CC2 and CC3, 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 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

BE9: 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	135,330
			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]	[illegible]43,832	[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	2,299.4	[illegible]	[illegible]	2,278.8
			Process (MMBtu /yr)	280.8	280.8	280.8	280.8	280.8

LI7: Lighting Full Load Hours – This needs to be calculated as FLH = Energy Use/Demand

LI8: Interior Lighting Annual Energy

LI6: Interior Lighting Peak Demand

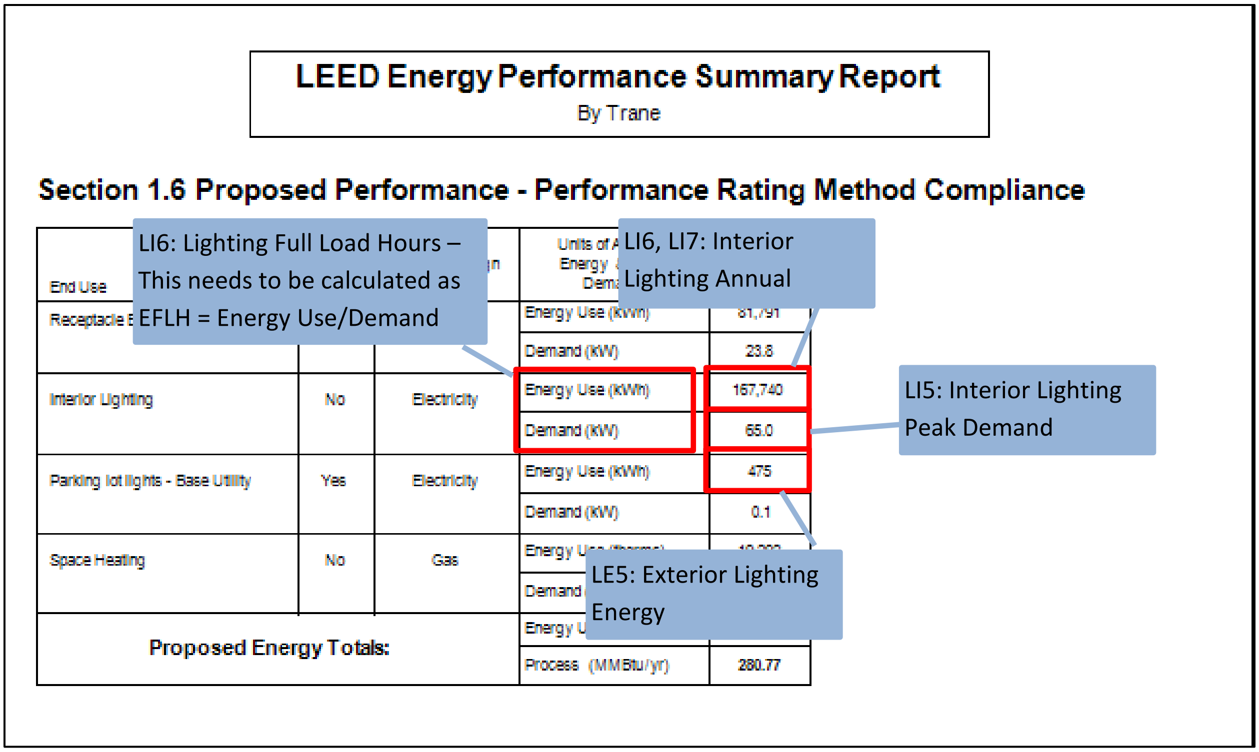
LE3, LE4: Exterior Lighting Energy

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 (kWh)	81,791
			Demand (kW)	23.8
Interior Lighting	No	Electricity	Energy Use (kWh)	157,740
			Demand (kW)	65.0
Parking lot lights - Base Utility	Yes	Electricity	Energy Use (kWh)	475
			Demand (kW)	0.1
Space Heating	No	Gas	Energy U... (therms)	[illegible]
			Demand ...	
Proposed Energy Totals:			Energy U...	
			Process (MMBtu/yr)	280.77

Monthly Energy Consumption report

MONTHLY ENERGY CONSUMPTION

By Trane

------- Monthly Energy Consumption -------

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 1	**Proposed**												
Electric													
On-Pk Cons. (kWh)	48,913	40,855	40,975	29,464	31,888	38,140	35,778	38,564	31,430	31,825	37,252	44,456	449,541
On-Pk Demand (kW)	153	139	133	147	164	196	190	198	188	156	137	141	198
Gas													
On-Pk Cons. (therms)	4,614	3,496	2,638	850	252	14	1	10	207	771	2,448	3,990	19,292
On-Pk Demand (therms/hr)	12	12	11	10	9	3	0	6	10	10	11	11	12
Water													
Cons. (1000gal)	0	0	3	12	32	76	75	73	43	16	1	[illegible]	331

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

Environmental Impact Analysis	
CO_2	715,543 lbm/year
SO_2	2,128 gm/year
NOX	844 gm/year

UR2: 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	
CO_2	1,054,251 lbm/year
SO_2	3,135 gm/year

SG5: 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

------- Monthly Utility Costs -------

Utility	Jan	Feb	Mar	Apr	May	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 ft^2

Utility Cost Per Area = 1.15 $/ft^2$

UR2: 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

UR1, UR2 Utility rate structure. The input for the utility rate used in both the proposed and baseline are displayed in this section

A sample with all utilities

This is NOT 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					

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

January - December Cooling design to Sunday

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

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

WHM7: Annual chilled-water pump energy occupied hours/year
WHM12: Annual hot water pump energy occupied hours/year

People - Office — Simulation type: Reduced year

January - December Cooling design to Weekday — Utilization

Start time	End time	Percentage
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 — Utilization

Start time	End time	Percentage
Midnight	Midnight	0.0

January - December Saturday to Sunday — Utilization

Start time	End time	Percentage
Midnight	Midnight	0.0

Project Name:
Dataset Name: TEST FILE 1.TRC

TRACE® 700 v6.3.3
Page 6 of 17

Library Members

WHM10, WHM11: Delta T used to calculate pump gpm

Gpm = Q / (500 * DeltaT)

90.1-13 Min Boiler, HW, Gas <300 MBh

Comments	Boiler, Hot Wat	
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

6 gal/btu

5 KW

WHM9: 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

WHM5: 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

BE6: Thermal properties of the building envelope for the proposed and baseline

BUILDING U-FACTORS

By Trane

Description	Partition	Internal Door	Exposed Floor	Summer Skylight	Winter Skylight	Roof	Summer Window	Winter Window	External Door	Wall	Ceiling	Room Mass lb/ft²	Room Capacitance Btu/lb·°F
	ROOM U-FACTORS						Btu/h·ft²·°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

BE8: 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 Report Page 1 of 4

Building Areas report

BE6, BE7: Areas of the building envelope for the proposed and baseline

BUILDING AREAS
By Trane

Sys Zon Room	Number of Duplicate Floors	Number of Duplicate Rooms	Floor Area/ Duplicate Room ft²	Total Floor Area ft²	Partition Area ft²	Int Door Area ft²	Exposed Floor 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 Skylight Area: 0 ft²

Total building Wall Area: 14,400 ft²
Total building Roof Area: 50,000 ft²
Total building Floor Area: 50,000 ft²

Building Total Window %: 33.8%
Building Total Skylight %: 0.0%

BE7: 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 Report Page 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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
	Opening - 1			[illegible]			[illegible] Clear 1/4*	540.0	0.82	0.9500	Overhang - None	None
W4-R16 N	N Wall	1,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]						
	Opening - 1			[illegible]			[illegible] Clear 1/4*	540.0	0.82	0.9500	Overhang - None	None
		3,[illegible]			[illegible]			**1,620.0**	**0.82**	**0.9500**		

BE7: 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	0	Frame Wall, No Ins	0.4376	0.90						
	Opening - 1			[illegible]			[illegible]ear 1/4*	480.0	0.82	0.9500	Overhang - None	None
		3,60[illegible]			[illegible]			**1,440.0**	**0.82**	**0.9500**		

BE8: Baseline and Proposed Fenestration Properties

South (180 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
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	Glass SHGC	Glass U Value Btu/h·ft²·°F	External Shading	Internal Shading
W1-R2 E	E Wall	1,200.0	90	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											
	Opening - 1							ear 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
		3,600.0							**1,440.0**	**0.82**	**0.9500**		

BE7: 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	Glass SHGC	Glass U Value Btu/h·ft²·°F	External Shading	Internal Shading
W1-R1 N	N Wall	1,200.0	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	1,200.0	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
W4-R16 N	N Wall	1,200.0	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
		3,600.0							**1,620.0**	**0.82**	**0.9500**		

BE8: Baseline and Proposed Fenestration Properties

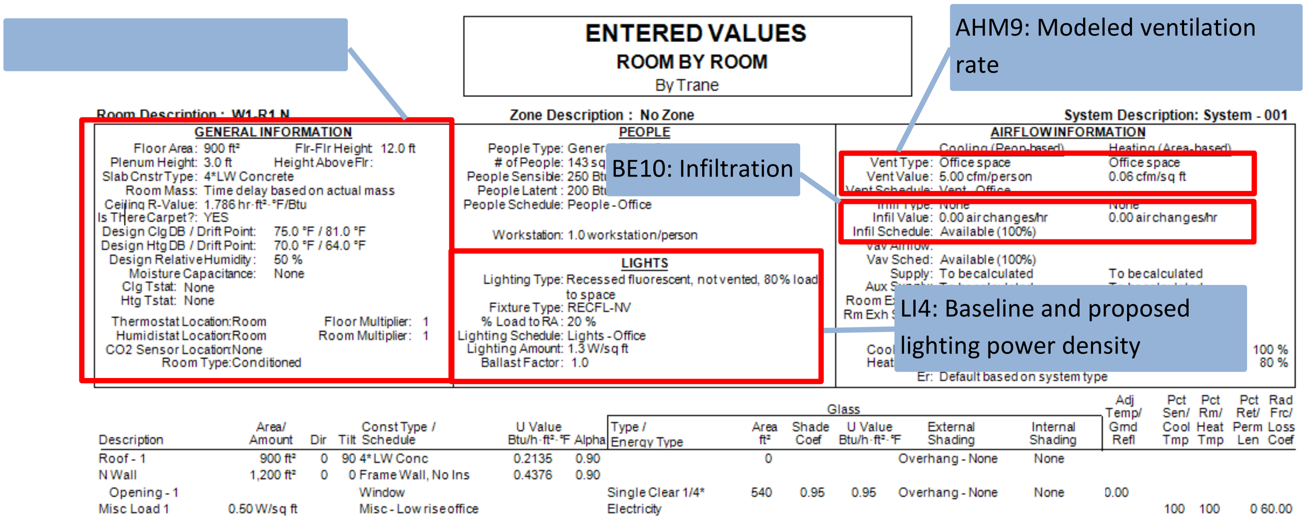
South Facing

Room Description	Wall Description	Area	Dir	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
W2-R8 S	S Wall	1,200.0											
	Opening - 1							ear 1/4"	360.0	0.82	0.9500	Overhang - None	None
W3-R13 S	S Wall	1,200.0	180	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	180	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**		

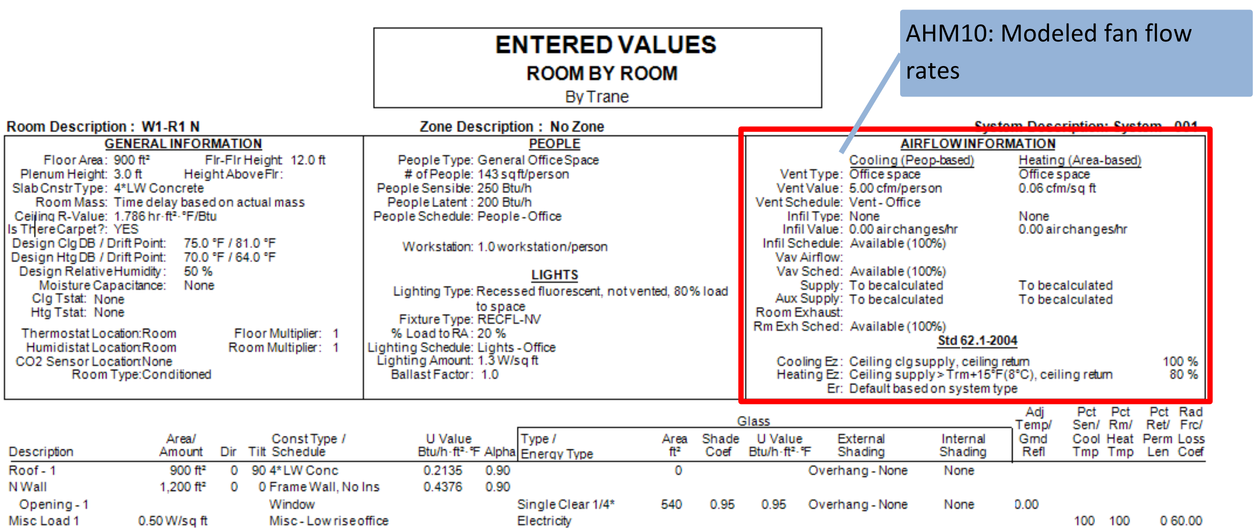
Project Name:
Dataset Name: C:\Users\irbvgw\Documents\TRACE 700 Projects\LEED Automation testing\PID

TRACE® 700 v6.3.3 calculated at 09:50 AM on 01/25/2018
Alternative - 1 Entered Values - Rooms Page 1 of 4

Room Information entered values report



Note: Alternative 1 rooms are displayed first. Alternative 2 rooms are displayed later in the report.



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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

BE11: 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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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

BE11: 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
Heat rejection type: None
Secondary distribution pump: None
Secondary pump consumption: 0 Ft Water
Thermal storage type: None
Thermal storage capacity: 0 ton-hr
Thermal storage schedule: Off (0%)

Geothermal Loop
TLoop Ent Bldg: None
TLoop schedule: None
Flow rate: 100.00% of condenser flow rate
Loop pump: None
Pump F.L. rate: 0.00ft water
Flow scheme: Fully mixed
Loop fluid glycol: 0%
Heat exchanger approach: 0°F

Equipment tag: Water source heat pump - 001 — Cooling Type: Default Water Source HP — Cooling plant - 001

Operating Mode	Capacity	Energy Rate
Cooling:		0.6500 kW/ton
Heat recovery:	10.9 Mbh/ton	0.0500 kW/Mbh
Tank charging:		
Tank charging & heat recovery:		

Pumps	Type	Full Load Consumption
Chilled water:	Cnst vol chill water pump	0.00 Ft Water
Condenser water:	None	
Heat recovery or aux cond:	None	
Free cooling:	None	

Heat Rejection and Thermal Storage
Heat rejection type: WSHP - Cooling tower
Thermal storage type: Heat pump loop no storage
T-storage capacity: 12 gal/ton
T-storage schedule: Heatpump

Equipment Options
Sequencing type: Single
Demand lim priority:
Dsn chilled water delta T: 10 °F
Dsn cond water delta T: 10 °F
Free clg type: None
Fluid cooler type: None
Load shed econ: no
Evap precooling: no
Hot gas reheat: No
Energy source: Heating plant - 002
Reject cond heat: Heat Reject.Equip
Cond. heat to plant:
Equip schedule: Available (100%)

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

Cooling Plant: Cooling plant - 004

Sizing method: Peak
Heat rejection type: None
Secondary distribution pump: None
Secondary pump consumption: 0 Ft Water
Thermal storage type: None
Thermal storage capacity: 0 ton-hr
Thermal storage schedule: Off (0%)

Geothermal Loop
...ndenser flow rate
Pump F.L. rate: 0.00ft water
Flow scheme: Fully mixed
Loop fluid glycol: 0%
Heat exchanger approach: 0°F

AHM5: DX cooling efficiencies

Equipment tag: Air-cooled unitary - 002 — Cooling Type: Default air-cooled unitary — Cooling plant - 004

Operating Mode	Capacity	Energy Rate
Cooling:		1.0000 kW/ton
Heat recovery:		
Tank charging:		
Tank charging & heat recovery:		

Pumps	Type	Full Load Consumption
Chilled water:	None	
Condenser water:	None	
Heat recovery or aux cond:	None	
Free cooling:	None	

Heat Rejection and Thermal Storage
Heat rejection type: Condenser fan for Heat Pump
Thermal storage type: None
T-storage capacity: 0 ton-hr
T-storage schedule: Storage

Equipment Options
Sequencing type: Single
Demand lim priority:
Dsn chilled water delta T: 10 °F
Dsn cond water delta T: 10 °F
Free clg type: None
Fluid cooler type: None
Load shed econ: no
Evap precooling: no
Hot gas reheat: No
Energy source:
Reject cond heat: Heat Reject.Equip
Cond. heat to plant:
Equip schedule: Available (100%)

Reset Based On	Reset Curve	Max Reset TD

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 1 of 5

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.
Hot water pump type: Heating water circ pump
Hot water pump cons: 0.00 kW

Thermal storage type: None
Thermal storage capacity: 0 ton-hr
Thermal storage schedule: Storage
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

LE2: 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

AHM7: Heating system efficiency

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

SWH3: Service Hot Water heating plant

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:

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

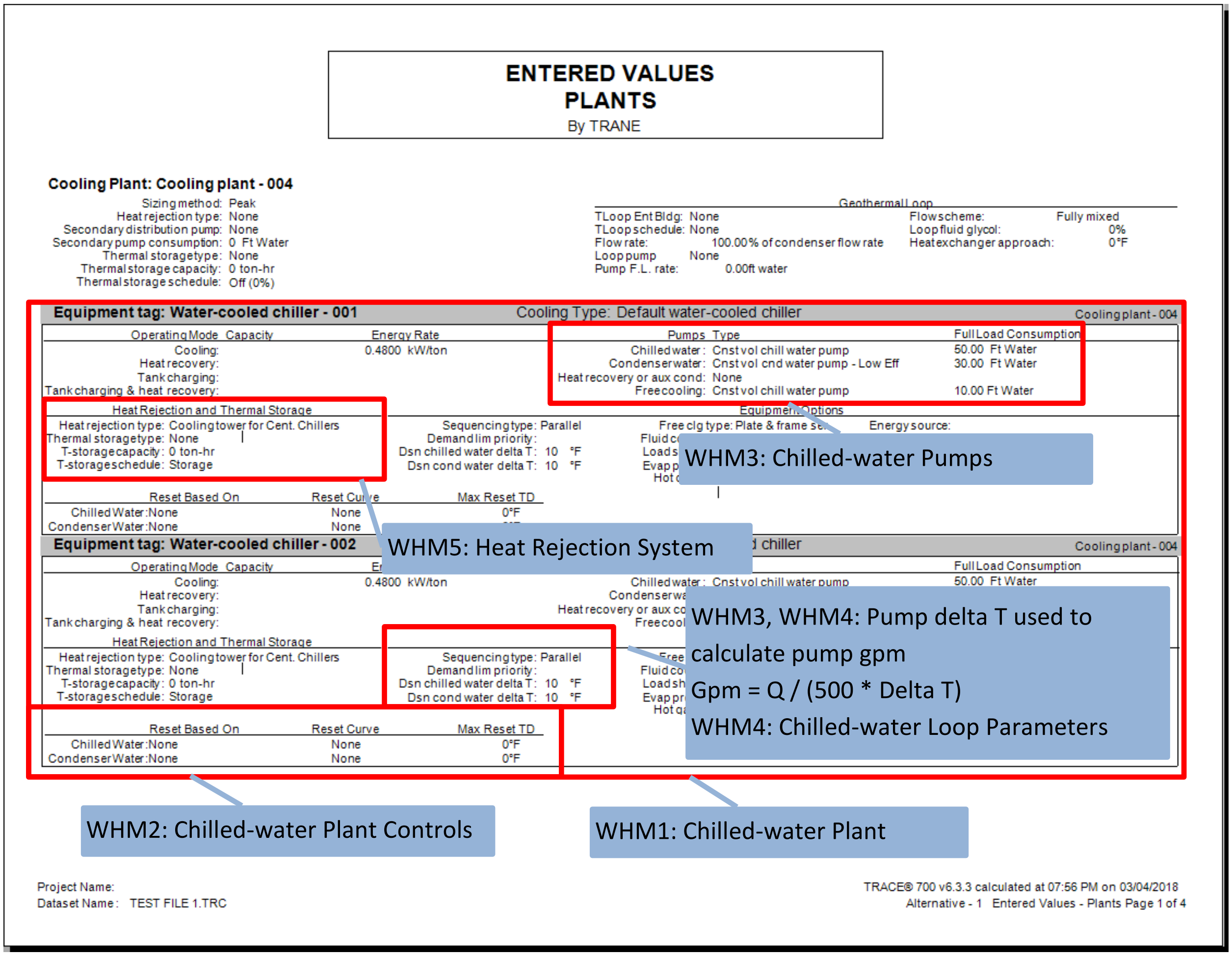
SWH3: Service Hot Water base utility

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
Plant assigned to: Heating plant - 005 Type: Domestic Hot Water Load	Description: Domestic Hot Water Load Demand limiting priority:	Schedule: Available (100%) Hourly demand: 100.00 Mbh

Miscellaneous accessories

Plant assigned to: Cooling plant - 001 Equipment tag: All	Type: None Description:	Schedule: Off (0%) Energy: 0.00 kW



ENTERED VALUES
PLANTS
By TRANE

Cooling Plant: Cooling plant - 004

Sizing method: Peak
Heat rejection type: None
Secondary distribution pump: None
Secondary pump consumption: 0 Ft Water
Thermal storage type: None
Thermal storage capacity: 0 ton-hr
Thermal storage schedule: Off (0%)

Geothermal Loop
TLoop Ent Bldg: None
TLoop schedule: None
Flow rate: 100.00% of condenser flow rate
Loop pump: None
Pump F.L. rate: 0.00ft water
Flow scheme: Fully mixed
Loop fluid glycol: 0%
Heat exchanger approach: 0°F

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

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

Pumps — Full Load Consumption
Chilled water: Cnst vol chill water pump — 50.00 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

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

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

WHM8: Hot water plant

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
Schedule: Parking lot lights
limiting prior

WHM11: Hot water pumps

WHM10: Hot water loop parameters

Miscell

Plant assig
Equipment tag: All
Ty
Description:
Energy: 0.00 kW

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	2.1						
Peak (1000gal/Hr)	0.0	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	40.3						
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Bsu 2: Domestic Hot Water Load													
Proc. Hot Water (therms)	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

SWH4: Service Hot Water full load hours,
SWH5: Service Hot Water proposed

Project Name:
Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 04:39 PM on 03/02/2018
Alternative - 1 Equipment Energy Consumption report page 1 of 5

EQUIPMENT ENERGY CONSUMPTION
By TRANE

Alternative: 2 ASHRAE Baseline 90.1-07 Climate Zone 6A

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

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Lights													
Electric (kWh)	18,207.0	16,473.0	19,941.0	17,340.0	19,074.0	19,074.0	17,340.0	19,941.0	17,340.0	19,074.0	18,207.0	17,340.0	219,351.0
Peak (kW)	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
Misc. Ld													
Electric (kWh)	6,810.0	6,160.0	7,370.0	6,500.0	7,090.0	7,060.0	6,530.0	7,370.0	6,500.0	7,090.0	6,780.0	6,530.0	81,790.0
Peak (kW)	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
Cooling Coil Condensate													
Recoverable Water (1000gal)	0.0	0.0	0.0	0.1	0.6	2.8	3.3	4.3	2.0	0.4	0.0	0.0	13.5
Peak (1000gal/Hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.1						
Bsu 1: Parking lot lights													
Electric (kWh)	40.3	36.4	40.3	39.0	40.3	39.0	40.3						
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Bsu 2: Domestic Hot Water Load													
Proc. Hot Water (therms)	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						
Cntl panel & interlocks - 0.1 KW [F.L.Rate=0.10 kW] (Misc Accessory Equipment)													
Electric (kWh)	0.0	0.0	0.1	10.3	21.1	33.8	36.0						
Peak (kW)	0.0	0.0	0.1	0.1	0.1	0.1	0.1						
Hpl 1: Heating plant - 002 [Sum of dsn coil capacities=1,030 mbh]													
Electric Resistance - 001 [Nominal Capacity/F.L.Rate=1,030 mbh / 301.8 kW] (Heating Equipment)													
Electric (kWh)	35,483.8	24,505.4	17,989.4	5,633.4	1,869.7	150.7	0.0	78.0	1,568.7	5,152.3	16,043.1	27,821.0	136,295.5
Peak (kW)	216.3	199.7	178.6	153.5	129.9	41.9	0.0	39.4	104.1	150.5	164.1	179.3	[illegible]
Hpl 2: Heating plant - 003 [Sum of dsn coil capacities=100 mbh]													

SWH5: Service Hot Water baseline

AHM6: Average DX system efficiency total equipment energy consumption

AHM8: Average heating system efficiency total equipment energy consumption

Project Name:
Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 04:39 PM on 03/02/20[illegible]8

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

AHM12: Fan equivalent full load hours

AHM11: Fan peak demand

Project Name:
Dataset Name: TEST FILE 2.TRC

TRACE® 700 v6.3.3 calculated at 04:39 PM on 03/02/2018
Alternative - 1 Equipment Energy Consumption report page 3 of 5

EQUIPMENT ENERGY CONSUMPTION
By TRANE

Alternative: 1 Proposed

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

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Lights													
Electric (kWh)	[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
Peak (kW)	[illegible]	[illegible]	[illegible]	[illegible]	94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.3
Misc. Ld													
Electric (kWh)	[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
Peak (kW)	[illegible]	[illegible]	[illegible]	[illegible]	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4
Cooling Coil Condensate													
Recoverable Water (1000gal)	[illegible]	[illegible]	[illegible]	[illegible]	1.1	4.6	4.7	5.9	2.9	[illegible]	[illegible]	[illegible]	[illegible]
Peak (1000gal/Hr)	[illegible]	[illegible]	[illegible]	[illegible]	0.0	0.1	0.0	0.1	0.1	[illegible]	[illegible]	[illegible]	[illegible]
Bsu 1: Parking lot lights Pr[illegible]													
Electric (kWh)	403.0	364.0	403.0	[illegible]	403.0	390.0	403.0	403.0	390.0	[illegible]	[illegible]	[illegible]	[illegible]
Peak (kW)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cpl 1: Cooling plant - 004 [Sum of dsn coil capacities=307.3 tons]													
Water-cooled chiller - 001 [Clg Nominal Capacity/F.L.Rate=153.7 tons / 73.75 kW] (Cooling Equipment)													
Electric (kWh)	0.0	0.0	35.3	1,514.0	5,876.6	13,051.4	12,617.6	11,650.2	7,756.4	3,040.0	218.5	0.0	[illegible]
Peak (kW)	0.0	0.0	15.7	[illegible]	[illegible]	70.2	71.7	70.6	70.3	63.1	16.0	0.0	[illegible]
Cooling tower for Cent. Chillers [Design Heat Rejection/F.L.Rate=174.6 tons / 11.53 kW]													
Electric (kWh)	7.6	23.1	77.3	1,337.5	2,764.9	[illegible]	4,483.4	4,137.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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	[illegible]
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	[illegible]
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

WHM3, WHM4:
Equipment load used to calculate pump gpm
Gpm = Q / (500 * DeltaT)

WHM6: Average annual realized chiller efficiency

WHM7: 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 (	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	43.9	47.1	45.9	17.8	0.6	0.0	0.0	163.3
Peak (100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.5	0.5	0.5	0.5	0.3	0.0	0.0	0.5
Cnst vol chill water ... nt)													
Electr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	493.1	558.0	540.7	199.0	8.7	0.0	0.0	1,903.1
Pe	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.3	4.3	4.3	4.3	4.3	0.0	0.0	4.3
Cnst vol cnd water ... Equipment)													
Electr	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	445.6	504.3	488.6	[illegible]	[illegible]	[illegible]	[illegible]	1,719.9
Peak (kW)	0.0	0.0	0.0	0.0	3.9	3.9	3.9	3.9	[illegible]	[illegible]	[illegible]	[illegible]	3.9
Cntl panel & interlocks - 1 KW [F.L.Rate=1 kW] (Misc Accessory Equipment)													
Electric (kWh)	0.0	[illegible]	0.0	0.0	24.0	114.0	129.0	125.0	[illegible]	[illegible]	[illegible]	[illegible]	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	[illegible]	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

WHM10, WHM11: Boiler capacity used to calculate pump gpm
Gpm = Q / (500 * DeltaT)

WHM13: 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 ------

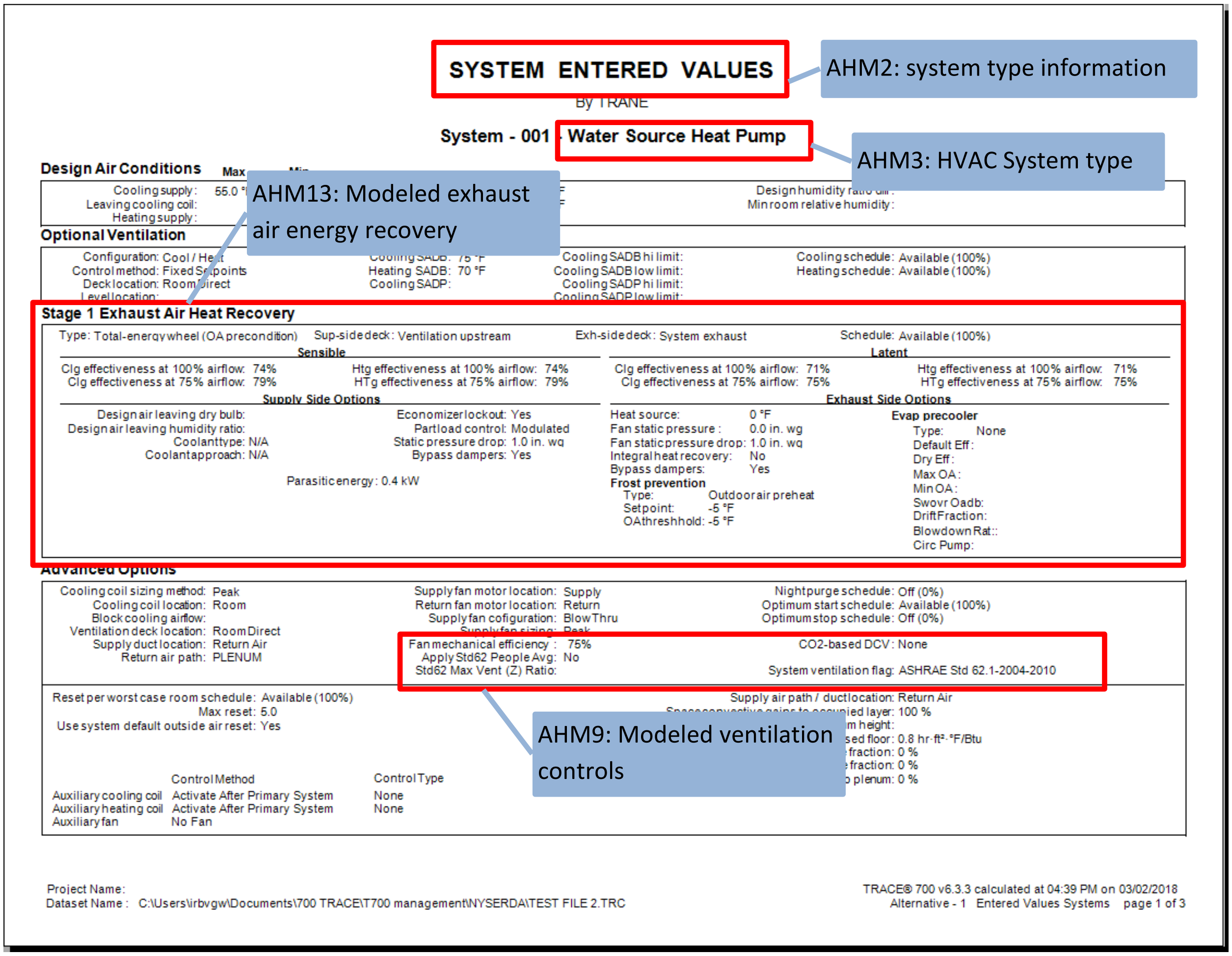
Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Hpl 1: Heating plant - 005 [Sum of dsn coil capacities=3,530 mbh]													
Heating water circ pump [F.L.Rate=1.62 kW] (Misc Accessory Equipment)													
Electric (kWh)	1,180.6	1,057.2	1,128.7	805.5	540.8	168.9	112.1	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]	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

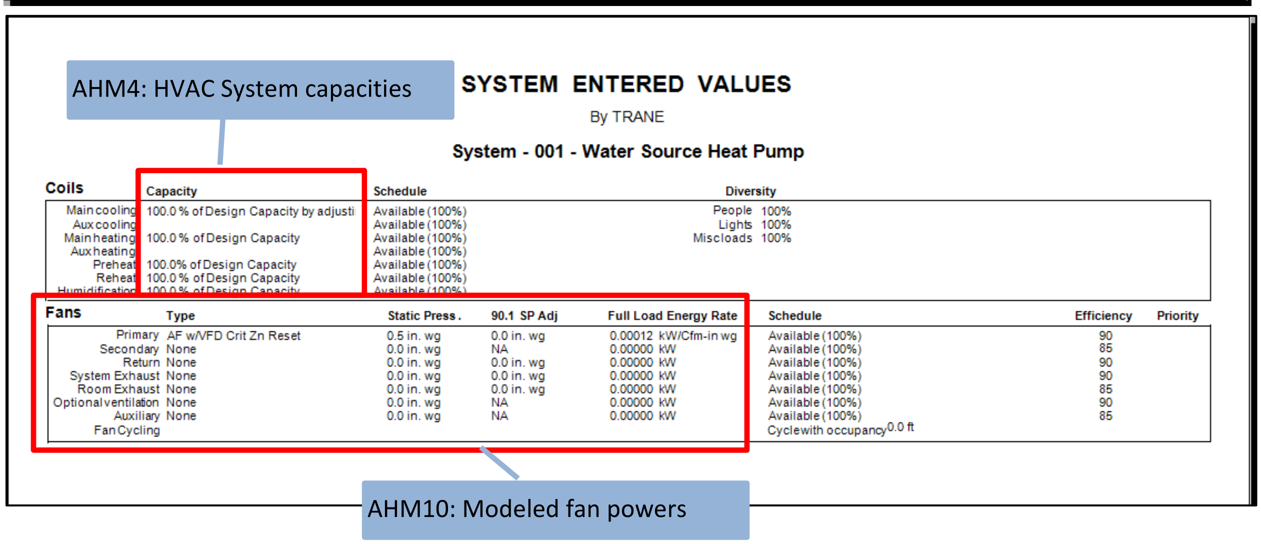
WHM12: Annual hot water pump energy

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





System Checksums Report

System Checksums
By TRANE

System - 001

System 3 - 2007/2010 - Packaged Rooftop Air Conditioner

COOLING COIL PEAK / CLG SPACE PEAK

Cooling Coil 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

AHM13: Modeled exhaust air energy recovery airflows

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave 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

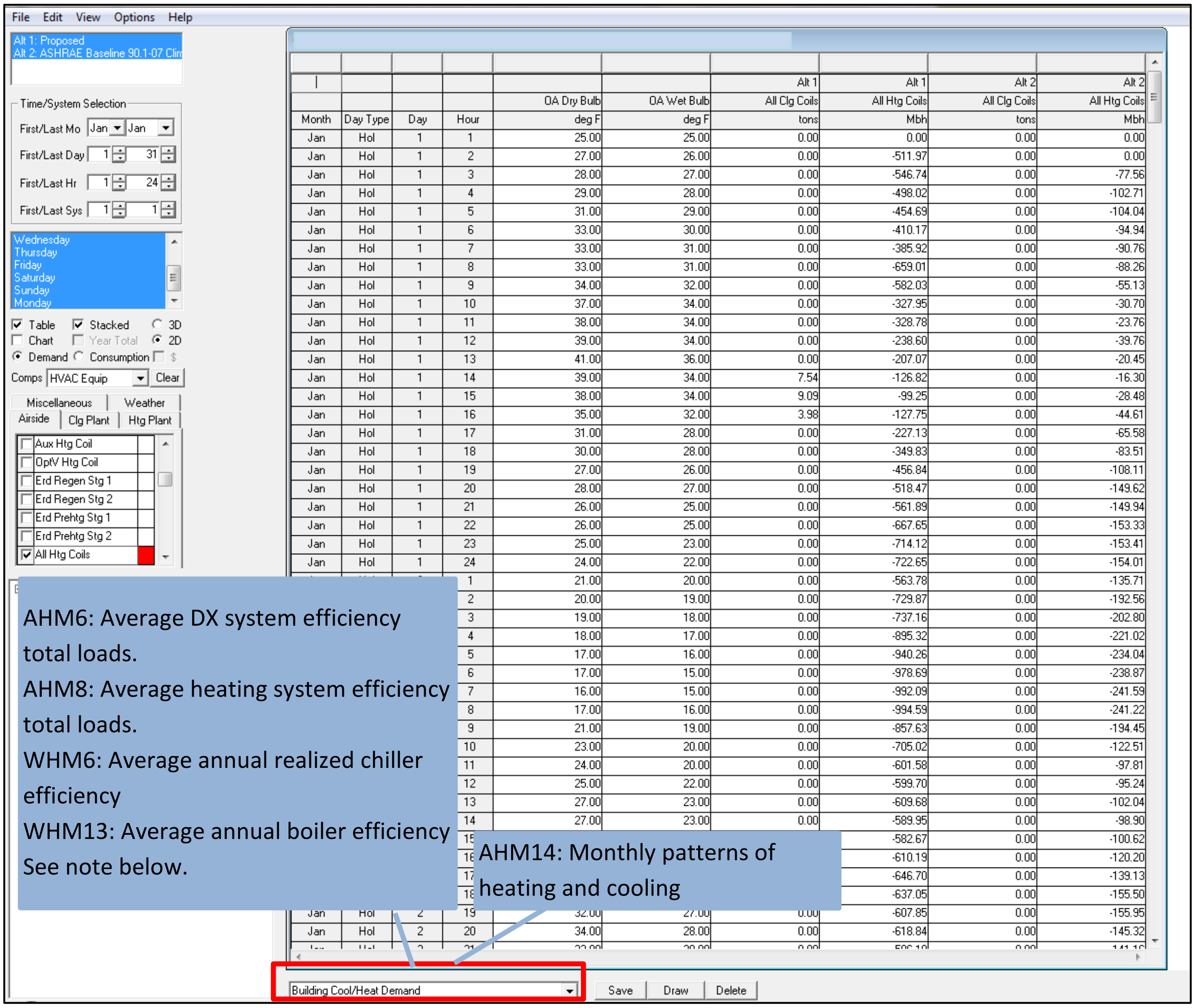
HEATING COIL SELECTION

	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



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 AHM6, AHM8, WHM6 and WHM13, 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

		Occupancy	Lights		Receptacle	Infiltration	HVAC Avail	Service Hot Water
Assembly	Max Sch Fraction	0.80	0.65		0.75	1.00	n/a	0.65
	Min Sch Fraction	0.00	0.05		0.05	0.25	n/a	0.00
	EFLH	2606	3340		3839	3918	6456	312
Health	Max Sch Fraction	0.80	0.90		0.90	0.25	n/a	0.82
	Min Sch Fraction	0.40	0.50		0.40	0.25	n/a	0.15
	EFLH	4691	5438		5169	2190	8760	2751
Hotel	Max Sch Fraction	0.90	0.90		0.90	0.25	n/a	0.80
	Min Sch Fraction	0.20	0.10		0.10	0.25	n/a	0.00
	EFLH	5074	3285		3285	2190	8760	2628
Office	Max Sch Fraction	0.95	0.90		0.90	1.00	n/a	0.57
	Min Sch Fraction	0.00	0.05		0.40	0.25	n/a	0.05
	EFLH	2450	2856		4425	5280	4640	1551
Parking	Max Sch Fraction	0.00	1.00		1.00	1.00	n/a	n/a
	Min Sch Fraction	0.00	0.50		1.00	1.00	n/a	n/a
	EFLH	0	6674		8760	8760	n/a	n/a
Retail	Max Sch Fraction	0.80	0.90		0.90	1.00	n/a	0.62
	Min Sch Fraction	0.00	0.05		0.20	0.25	n/a	0.04
	EFLH	2371	3558		4528	4801	5279	2305
School	Max Sch Fraction	0.95	0.90		0.95	1.00	n/a	0.83
	Min Sch Fraction	0.00	0.18		0.35	0.25	n/a	0.05
		Occupancy	Lights		Receptacle	Infiltration	HVAC Avail	Service Hot Water
	EFLH	2096	4107		4421	6125	3514	1828
Residential	Max Sch Fraction	1.00	1.00		1.00	1.00	n/a	0.80
	Min Sch Fraction	0.25	0.10		0.40	1.00	n/a	0.00
	EFLH	6041	2884		5840	8760	8760	2628

The table summarize information included in the COMNET Appendix C.[28]

28 https://comnet.org/appendix-c-schedules

Appendix B: Third-Party Reviews

Review of performance-based submittals requires involvement of the qualified professionals and an additional 20-30 hours of staff time compared to prescriptive-based submittals. The City of Seattle charges a fee of $190 per hour for the model reviews, making it in the applicant's best interest to have everything in order before they submit the project. Pre-submittal meetings with the applicants are often held to discuss the modeling approaches and any unusual conditions. The reviews are done in-house, but if the volume of performance-based submittals increases significantly over time, the city may start relying on the external consultants. In Oregon, permit applicants pursuing performance path were required to hire a reviewer who meets the qualification requirements, is approved by the local building official, and must be independent of the applicant, energy analyst, and design team.

References

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4. U.S. Green Building Council, ADVANCED ENERGY MODELING FOR LEED Technical Manual v2.0 September 2011 Edition, Washington, DC.
5. eQUEST Detailed Simulation Reports Summary
6. International Code Council, 2015 International Building Code (3rd Printing as adopted by New York State), Washington, DC
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8. Whole Building Approach Instructions October 1, 2014 (v1.1), State of Oregon Building Codes Division
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10. Pacific Northwest National Lab

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