TIP 287: Reducing Technology Evaluation Costs Through a Technology Performance Exchange

Deliverable 2.5: Draft Data Entry Forms

E. Lee, D. Studer

Produced under direction of the Bonneville Power Administration by the National Renewable Energy Laboratory (NREL) under Interagency Agreement 13-0881 and Task No. WFS7.1000.

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Technical Report
NREL/TP-5500-60219
August 2013
Contract No. DE-AC36-08GO28308

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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National Renewable Energy Laboratory
Golden, Colorado

August 16, 2013

Internal Report Prepared for
Bonneville Power Administration

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Executive Summary

Novel energy efficiency technologies often are not readily adopted in the public and private sectors because data beyond those currently available in the market are necessary in order to make an effective business case. This data gap is seen as a key barrier to increasing market adoption of promising energy efficiency and renewable energy technologies.

To address the need for accessible, high-quality data, DOE's Federal Energy Management Program and Building Technologies Office, and the Bonneville Power Administration are collaborating to develop the Technology Performance Exchange (TPE). The TPE is a centralized, Web-based portal which allows users to share their own energy performance data for building-related products. Individuals and organizations that manufacture, supply, test, or evaluate technologies are able to upload and share product-specific energy performance data that can be quickly and easily used by other TPE members.

Data entry forms (DEFs), standardized documents that identify the minimum energy performance characteristics and supplemental criteria necessary for an end user to evaluate a product's energy performance, define on a technology-by-technology basis, the data that is accepted by the TPE. This standardization allows for a detailed and comprehensive dataset to be collected in a manner that enables meaningful collaboration and accurate analysis.

The National Renewable Energy Laboratory (NREL) was tasked with the creation of draft DEFs for the technologies approved as part of Stage Gate 2.4. These draft DEFs will subsequently be evaluated by the Bonneville Power Administration (BPA) in Stage Gate 2.6 to ensure that they are properly aligned with BPA's technology evaluation requirements.

As part of Stage Gate 2.4, BPA provided approval via email on June 21, 2013, to proceed with development of variable refrigerant flow (VRF) system and heat pump water heater (HPWH) DEFs. This report provides the draft VRF and HPWH DEFs developed as part of that approved effort. Additionally, due to BPA's interest and request, the DEFs that encompass variable-capacity packaged rooftop units and interior and exterior solid-state lighting (SSL) products have also been included. These DEFs were developed as part of DOE-funded activities and have already been integrated with the Technology Performance Exchange.

Nomenclature

AHRI	Air-Conditioning, Heating, & Refrigeration Institute
ANSI	American National Standards Institute
BPA	Bonneville Power Administration
BTO	Building Technologies Office
Btu	British thermal units per hour
C	Celsius
CC	total cooling capacity
cfm	cubic feet per minute
DEF	data entry form
DOE	U.S. Department of Energy
F	Fahrenheit
HC	total heating capacity
HPWH	heat pump water heater
HR	heat recovery
HVAC	heating, ventilating, and air-conditioning
IESNA	Illuminating Engineering Society of North America
in	inch
LED	light-emitting diode
NREL	National Renewable Energy Laboratory
OLED	organic light-emitting diode
PLED	polymer light-emitting diode
SSL	solid-state lighting
TIP	Technology Innovation Project
TPE	Technology Performance Exchange
VRF	variable refrigerant flow
W	watt

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1.0 Overview

Novel energy efficiency technologies often are not readily adopted in the public and private sectors because data beyond those readily available in the market are necessary in order to make an effective business case. This data gap is seen as a key barrier to increasing market adoption of promising energy efficiency and renewable energy technologies.

To address the need for accessible, high-quality data, DOE's Federal Energy Management Program and Building Technologies Office, and the Bonneville Power Administration are collaborating to develop the Technology Performance Exchange (TPE). The TPE is a centralized, Web-based portal which allows users to share their own energy performance data for building-related products. Individuals and organizations who manufacture, supply, test, or evaluate technologies are able to upload and share product-specific energy performance data that can be quickly and easily used by other TPE members.

Data entry forms (DEFs), standardized documents that identify the minimum energy performance characteristics and supplemental criteria necessary for an end user to evaluate a product's energy performance, define on a technology-by-technology basis, the data that is accepted by the TPE. This standardization allows for a detailed and comprehensive dataset to be collected in a manner that enables meaningful collaboration and accurate analysis.

The National Renewable Energy Laboratory (NREL) was tasked with the creation of draft DEFs for the technologies approved as part of Stage Gate 2.4. These draft DEFs will subsequently be evaluated by the Bonneville Power Administration (BPA) in Stage Gate 2.6 to ensure that they are properly aligned with BPA's technology evaluation requirements.

BPA indicated via a teleconference held on April 10, 2013, that the following technologies were of interest. Meeting attendees included Tyler Dillavou (BPA), Jack Callahan (BPA), Jason Koman (U.S. Department of Energy [DOE] Building Technologies Office [BTO]), David Catarious (DOE Federal Energy Management Program [FEMP]), and Daniel Studer (NREL):

1. Variable-capacity packaged rooftop units (RTUs) (residential and commercial applications, including packaged variable-capacity heat pumps)
2. Interior solid-state lighting (SSL) products
3. Exterior SSL products
4. Ductless mini-split heat pumps
5. Ductless multi-split heat pumps
6. Variable refrigerant flow (VRF) systems
7. VRF systems with heat recovery (HR) capability
8. Residential heat pump water heaters (HPWHs).

Variable-capacity packaged RTUs (including variable-capacity heat pumps), as well as interior and exterior SSL products, are already within the scope of the Technology Performance Exchange (TPE), as DEFs that cover these types of products have already been developed. Therefore, NREL and BPA agreed that the following five technology categories would be further investigated as part of TIP 287 Task 2.2. These items are listed in order of priority to BPA, starting with the technology of greatest interest:

1. Ductless mini-split heat pumps
2. Ductless multi-split heat pumps
3. VRF systems
4. VRF systems with HR capability
5. Residential HPWHs.

NREL was then tasked with generating a feasibility analysis to identify the likelihood that detailed DEFs were likely to be developed successfully for those five technologies.

To execute this task, NREL performed the following tasks:

- A background literature review to determine the parameter definitions needed to characterize each technology
- Evaluated the extent to which the necessary parameters were fundamental versus product specific
- Assessed the ability to measure the identified parameters in a laboratory setting
- Determined whether the required effort was likely to be completed within budget.

Based on this approach, NREL recommended moving forward with development of a DEF for HPWH products and two DEFs to encompass ductless heat pump technologies (ductless mini-split heat pumps, ductless multi-split heat pumps, VRF systems, and VRF systems with HR capability). Specifically, NREL recommended developing a single DEF to characterize indoor unit performance across all four system types, and a separate DEF to characterize outdoor unit performance.

Approval to proceed with development of these three DEFs was provided by BPA via email on June 21, 2013. This report provides the draft VRF and HPWH DEFs developed as part of that approved effort. Additionally, due to BPA's interest and request, the existent DEFs that encompass variable capacity packaged RTUs and interior and exterior solid-state lighting (SSL) products have also been included. These DEFs were developed as part of DOE-funded activities and have already been integrated with the TPE.

2.0 Background

To ensure that end users can effectively use the data contained in the TPE, the types of data—and the actual data fields that will be prioritized in the TPE domain—need to be defined. Data submitters will be encouraged to submit energy performance data through the use of predefined DEFs.

2.1 Guiding Principles

NREL staff attempted to ensure that DEFs:

- Contain the minimum *product-specific* energy performance characteristics and supplemental criteria necessary for an end user to evaluate a product's energy performance.
- Request energy performance characteristics in a way such that certain products in a technology category are not inherently or unfairly favored over others.
- Do not include energy performance characteristics that have only a minimal impact on energy use.
- Request energy performance characteristics that are in the "goldilocks" region: neither too detailed nor too vague. For example, it could be necessary to request the outlet water temperature of boiler products at various part-load ratios (e.g., 25%, 50%, 75%, full load). DEFs that request too few inputs (e.g., outlet water temperature at one or two part-load ratio values) will fail to characterize the product's energy performance correctly, leading to improper product evaluation and selection. Requesting too much data (e.g., outlet water temperature at 50 part-load ratio values) will increase the burden on data submitters and raise the entry barrier for products to be included in the TPE.
- Specify the submission of energy performance characteristics such that end user analysis options are reasonably unconstrained. Depending on the analysis method an end user pursues (spreadsheet analysis, whole-building energy simulation, etc.), different energy performance characteristics may be required.
- Request supplemental criteria—product properties that enable appropriate product comparisons. For a "display devices" technology category, such criteria might include the display size. This information would enable an end user to fairly compare two products by evaluating the energy consumption of each, and to determine how many of each product would be required to meet a specific need.
- Do not reference simplified metrics in lieu of energy performance characteristics. The built-in assumptions inherent to simplified metrics may not apply to the application being investigated. Such divergence between the use cases assumed as part of metric development and those used by end users during product evaluation could skew the evaluation results, hindering adoption of the most efficient products and limiting realized energy savings.

3.0 Draft Data Entry Forms

The tables in the following sections provide an overview of the draft VRF and HPWH DEFs created as part of TIP 287, as well as the DEFs for RTUs, SSL replacement lamps, and SSL luminaires. (Note that while BPA expressed interest in interior and exterior SSL products, the existing TPE SSL technology categories, SSL replacement lamps and SSL luminaires, make no distinction regarding the application environment and so cover both interior and exterior SSL products.) Each table contains:

1. The minimum energy performance characteristics and supplemental criteria necessary for an end user to evaluate a product's energy performance.
2. Descriptions that provide parameter-related context.
3. An enumerated list for applicable parameters.
4. Testing standards (if any) that provide a standardized methodology for deriving the identified parameter.

Cells that are highlighted in green are not product specific. These parameters have been identified as "basic information" and are requested for all products, regardless of technology category.

NREL researchers also determined that to characterize energy performance, performance maps were necessary for products within the scope of the VRF, HPWH, and RTU technology categories. When applicable, performance map templates for each technology category are provided after the DEF table.

3.1 Variable Refrigerant Flow Systems

Table 3–1 defines the draft DEF for VRF system indoor units. This draft DEF, along with the draft DEF for VRF system outdoor units (Table 3–4), is meant to encompass heating, ventilating, and air-conditioning (HVAC) systems that use refrigerant as the transport medium between indoor terminal units and outdoor units, as opposed to more traditional ducted systems that use air as the transport medium.

3.1.1 Indoor Units

Table 3–1 Draft DEF for Variable Refrigerant Flow Systems—Indoor Units

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Manufacturer/Brand Owner	The name of the company that manufactures the product and/or that owns the product brand.		
Brand	The brand name under which the submitted product is marketed and/or sold in the U.S. In some cases, this may be identical to the name of the manufacturer/brand owner.		
Product Line/Family Name	If the product being submitted is part of a family of products or models, supply the product line or family name here. As an example, if the submission were an automobile, this field would contain the model name.		

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Model Number	The unique model number used by the manufacturer/brand owner to identify the specific product being submitted to the Technology Performance Exchange. Sometimes referred to as “catalog number.” Model numbers should be entered in the same style as that used by the manufacturer/brand owner, including all applicable slashes (/) and dashes (-). If certain alphanumeric characters in the model number identify product variations that do not impact energy performance, please replace each of those alphanumeric characters with an asterisk (*) when entering the model number on this website. This convention reduces the need to submit separate forms for product variations that have identical performance data. However, if a subset, but not all options for a specific character in the model number do not affect energy performance, include all such options inside parentheses within the larger model/product number. Example: Product family X uses product numbers that contain eight alphanumeric characters. The first three characters denote product variations that affect energy performance; a subset of options denoted by the fourth character do not affect performance; and the last four characters do not affect energy performance at all. The manufacturer/brand owner would submit a separate “Add Product” form for each unique combination of the first four characters that affect energy performance; on each form, the submitted model numbers would have the form: ABC(1,2,3)****, ABC4****, ABC5****, etc.		
UPC	If provided, the user must submit all 12 digits without spaces or dashes.		
ENERGY STAR® Label	Indicate whether the product has earned the ENERGY STAR® label.	• Yes • No • NA	

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
ENERGY STAR® Version Number	List the version number of the most current ENERGY STAR® specification under which the product earned the ENERGY STAR® label.		
FEMP Designated Product	Indicate whether the product currently meets the energy performance requirements necessary to be identified as a Federal Energy Management Program-designated product.	• Yes • No • NA	
Rated Cooling Capacity	The rated amount of sensible and latent heat the equipment can remove from the conditioned space in a defined interval of time (AHRI 1230 § 3.3.5).		• ANSI/AHRI Standard 1230-2010
Rated Cooling Sensible Heat Ratio	The sensible cooling capacity divided by the total cooling capacity at rated conditions (AHRI 1230 § 7.2a).		• ANSI/AHRI Standard 1230-2010
Rated Heating Capacity	The amount of heat the equipment can add to the conditioned space in a defined interval of time (AHRI 1230 § 3.3.2).		• ANSI/AHRI Standard 1230-2010
Working Refrigerant	The refrigerant to be utilized by the split system in which this indoor unit is installed.	• 12 • 134a • 22 • 404A • 407A • 407C • 410A • 502 • 507 • 744 • Other	
Mounting Technique	The mounting option used for this indoor unit.	• Ceiling Cassette • Ceiling Suspended • Ducted • Floor Standing • Wall Mounted	

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Rated Cooling Air Flow Rate	Airflow rate at AHRI rated conditions. Typically this is the maximum flow condition for units with multiple airflow rate settings (AHRI 1230 § 6.1.5.1).		• ANSI/AHRI Standard 1230-2010
Rated Heating Air Flow Rate	Airflow rate at AHRI rated conditions. Typically this is the maximum flow condition for units with multiple air flow rate settings. (AHRI 1230 § 6.1.5.4)		• ANSI/AHRI Standard 1230-2010
Total Fan Efficiency	Overall fan efficiency, calculated as the ratio of the power delivered to the fluid by the fan blades to the electrical input power provided to the motor. It implicitly includes the motor and fan blade efficiencies. This should be reported at rated conditions.		
Fan Power Input	Fan input power at rated conditions.		
Cooling Performance Map	A document that provides a tabular representation of the terminal unit in cooling operation under various conditions. The information must be formatted in alignment with the provided template, and uploaded as an .xls file.		
Heating Performance Map	A document that provides a tabular representation of the terminal unit in heating operation under various conditions. The information must be formatted in alignment with the provided template, and uploaded as an .xls file.		

Cooling Performance Map

Table 3–2 defines the draft performance map for VRF indoor units in cooling mode. For each unique set of independent variables, the following dependent variables are requested:

- Total cooling capacity (CC) in Watts
- Sensible cooling capacity (SC) in Watts

The data requested by this performance map are aligned well with the data provided by manufacturers of such systems. These values are requested at rated airflow conditions, while the refrigerant in the system is allowed to run at the value necessary to meet the part-load condition specified.

Table 3–2 Draft Cooling Operation Performance Map for VRF Indoor Units

Outdoor Air Dry–Bulb Temperature	Indoor Air Wet–Bulb Temperature													
	57°F (13.89°C)		61°F (16.11°C)		64°F (17.78°C)		67°F (19.44°C)		70°F (21.11°C)		73°F (22.78°C)		76°F (24.44°C)	
	CC	SC	CC	SC	CC	SC	CC	SC	CC	SC	CC	SC	CC	SC
23°F (–5.00°C)														
25°F (–3.89°C)														
30°F (–1.11°C)														
35°F (1.67°C)														
40°F (4.44°C)														
45°F (7.22°C)														
50°F (10.00°C)														
55°F (12.78°C)														
60°F (15.56°C)														
65°F (18.33°C)														
70°F (21.11°C)														
75°F (23.89°C)														
80°F (26.67°C)														
85°F (29.44°C)														
90°F (32.22°C)														
95°F (35.00°C)														
100°F (37.78°C)														
105°F (40.56°C)														
110°F (43.33°C)														

3.1.1.1 Heating Performance Map

Table 3–3 defines the draft performance map for VRF indoor units in heating mode. For each unique set of independent variables, the following dependent variables are requested:

- Total heating capacity (HC) in Watts

The data requested by this performance map are aligned well with the data provided by manufacturers of such systems. These values are requested at rated airflow conditions, while the refrigerant in the system is allowed to run at the value necessary to meet the part-load condition specified.

Table 3–3 Draft Heating Operation Performance Map for VRF Indoor Units

Outdoor Air Temperature		Indoor Air Dry-Bulb Temperature							
		59°F (15.0°C)	61°F (16.11°C)	64°F (17.78°C)	67°F (19.44°C)	70°F (21.11°C)	73°F (22.78°C)	76°F (24.44°C)	80°F (26.67°C)
Dry-Bulb	Wet-Bulb	HC	HC	HC	HC	HC	HC	HC	HC
–4.0°F (–20.00°C)	–4.4°F (–20.22°C)								
0.0°F (–17.78°C)	–0.4°F (–18.00°C)								
5.0°F (–15.00°C)	4.5°F (–15.28°C)								
10.0°F (–12.22°C)	9.0°F (–12.78°C)								
15.0°F (–9.44°C)	14.0°F (–10.00°C)								
20.0°F (–6.67°C)	19.0°F (–7.22°C)								
25.0°F (–3.89°C)	23.0°F (–5.00°C)								
30.0°F (–1.11°C)	28.0°F (–2.22°C)								
35.0°F (1.67°C)	32.0°F (0.00°C)								
40.0°F (4.44°C)	36.0°F (2.22°C)								
45.0°F (7.22°C)	41.0°F (5.00°C)								
47.0°F (8.33°C)	43.0°F (6.11°C)								
50.0°F (10.0°C)	46.0°F (7.78°C)								
55.0°F (12.78°C)	51.0°F (10.56°C)								
60.0°F (15.56°C)	56.0°F (13.33°C)								

3.1.2 Outdoor Units

Table 3–4 Draft DEF for Variable Refrigerant Flow Systems—Outdoor Units

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Manufacturer/Brand Owner	The name of the company that manufactures the product and/or that owns the product brand.		
Brand	The brand name under which the submitted product is marketed and/or sold in the U.S. In some cases, this may be identical to the name of the manufacturer/brand owner.		
Product Line/Family Name	If the product being submitted is part of a family of products or models, supply the product line or family name here. As an example, if the submission were an automobile, this field would contain the model name.		

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Model Number	The unique model number used by the manufacturer/brand owner to identify the specific product being submitted to the Technology Performance Exchange. Sometimes referred to as “catalog number.” Model numbers should be entered in the same style as that used by the manufacturer/brand owner, including all applicable slashes (/) and dashes (-). If certain alphanumeric characters in the model number identify product variations that do not impact energy performance, please replace each of those alphanumeric characters with an asterisk (*) when entering the model number on this website. This convention reduces the need to submit separate forms for product variations that have identical performance data. However, if a subset, but not all options for a specific character in the model number do not affect energy performance, include all such options inside parentheses within the larger model/product number. Example: Product family X uses product numbers that contain eight alphanumeric characters. The first three characters denote product variations that affect energy performance; a subset of options denoted by the fourth character do not affect performance; and the last four characters do not affect energy performance at all. The manufacturer/brand owner would submit a separate “Add Product” form for each unique combination of the first four characters that affect energy performance; on each form, the submitted model numbers would have the form: ABC(1,2,3)****, ABC4****, ABC5****, etc.		
UPC	If provided, the user must submit all 12 digits without spaces or dashes.		
ENERGY STAR® Label	Indicate whether the product has earned the ENERGY STAR® label.	• Yes • No • NA	

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
ENERGY STAR® Version Number	List the version number of the most current ENERGY STAR® specification under which the product earned the ENERGY STAR® label.		
FEMP Designated Product	Indicate whether the product currently meets the energy performance requirements necessary to be identified as a Federal Energy Management Program-designated product.	• Yes • No • NA	
Rated Total Cooling Capacity	At rated conditions, the total cooling energy that can be provided to the refrigerant loop by this outdoor unit in a defined interval of time (AHRI 1230).		• ANSI/AHRI Standard 1230-2010
Rated Cooling Coefficient of Performance	At rated conditions, the ratio of cooling capacity to the power input (AHRI 1230).		• ANSI/AHRI Standard 1230-2010
Rated Heating Capacity	At rated conditions, the total heating energy that can be provided to the refrigerant loop by this outdoor unit in a defined interval of time (AHRI 1230).		• ANSI/AHRI Standard 1230-2010
Rated Heating Coefficient of Performance	At rated conditions, the ratio of heating capacity to the power input (AHRI 1230).		• ANSI/AHRI Standard 1230-2010
Working Refrigerant	The refrigerant to be utilized by the split system in which this outdoor unit is installed.	• 12 • 134a • 22 • 404A • 407A • 407C • 410A • 502 • 507 • 744 • Other	

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Cooling Performance Map	A document that provides a tabular representation of the outdoor unit in cooling operation under various conditions. The information must be formatted in alignment with the provided template, and uploaded as an .xls file.		
Heating Performance Map	A document that provides a graphical tabular representation of the outdoor unit in heating operation under various conditions. The information must be formatted in alignment with the provided template, and uploaded as an .xls file.		

3.1.2.1 Cooling Performance Map

Table 3–5 defines the draft performance map for VRF outdoor units in cooling mode. For each unique set of independent variables, the following dependent variables are requested:

- CC in watts
- CP (Compressor Power) in watts
- FP (Condenser Fan Power) in watts

Note that the independent variable "combination ratio," the ratio of outdoor unit rated capacity to the sum of the indoor unit rated capacities, will be varied from 50% to 130%, in 10% increments. However, in the interest of conserving space and avoiding repetition, only one representative performance map table is shown below. In reality, nine such tables would be requested, each with a different combination ratio (50, 60, 70, 80, 90, 100, 110, 120, and 130 percent).

The data requested by this series of performance maps, although numerous, are aligned well with the data provided by manufacturers of such systems. These values are requested at rated airflow conditions, while the refrigerant in the system is allowed to run at the value necessary to meet the part-load condition specified.

Table 3–5 Draft Cooling Operation Performance Map for VRF Outdoor Units

Combi-nation Ratio	Outdoor Air Dry-Bulb Temperature °F (°C)	Indoor Air Temperature Dry-Bulb/Wet-Bulb																				
		68°F (20°C) / 57°F (13.9°C)			73°F (22.8°C) / 61°F (16.1°C)			79°F (26.1°C) / 64°F (17.8°C)			80°F (26.7°C) / 67°F (19.4°C)			85°F (29.4°C) / 70°F (21.1°C)			88°F (31.1°C) / 73°F (22.8°C)			91°F (32.8°C) / 76°F (24.4°C)		
		CC	CP	FP	CC	CP	FP	CC	CP	FP	CC	CP	FP	CC	CP	FP	CC	CP	FP	CC	CP	FP
50% – 130%	23°F (–5°C)																					
	25°F (–3.9°C)																					
	30°F (–1.1°C)																					
	35°F (1.7°C)																					
	40°F (4.4°C)																					
	45°F (7.2°C)																					
	50°F (10°C)																					
	55°F (12.8°C)																					
	60°F (15.6°C)																					
	65°F (18.3°C)																					
	70°F (21.1°C)																					
	75°F (23.9°C)																					
	80°F (26.7°C)																					
	85°F (29.4°C)																					
	90°F (32.2°C)																					
	95°F (35°C)																					
	100°F (37.8°C)																					
	105°F (40.6°C)																					
	110°F (43.3°C)																					
	115°F (46.1°C)																					
	118°F (47.8°C)																					
	122°F (50°C)																					

3.1.2.2 Heating Performance Map

Table 3–6 defines the draft performance map for VRF outdoor units in heating mode. For each unique set of independent variables, the following dependent variables are requested:

- HC (watts)
- CP (watts)
- FP (watts)

Note that the independent variable "combination ratio," the ratio of outdoor unit rated capacity to the sum of the indoor unit rated capacities, will be varied from 50% to 130%, in 10% increments. However, in the interest of conserving space and avoiding repetition, only one representative performance map table is shown below. In reality, nine such tables would be requested, each with a different combination ratio (50, 60, 70, 80, 90, 100, 110, 120, and 130 percent).

The data requested by this series of performance maps, although numerous, are aligned well with the data provided by manufacturers of such systems. These values are requested at rated airflow conditions, while the refrigerant in the system is allowed to run at the value necessary to meet the part-load condition specified.

Table 3–6 Draft Heating Operation Performance Map for VRF Outdoor Units

Combi-nation Ratio	Outdoor Air Dry-Bulb / Wet-Bulb Temperature °F (°C)	Indoor Air Dry-Bulb Temperature																							
		59°F (15.0°C)			61°F (16.1°C)			64°F (17.8°C)			67°F (19.4°C)			70°F (21.1°C)			73°F (22.8°C)			76°F (24.4°C)			80°F (26.7°C)		
		HC	CP	FP	HC	CP	FP	HC	CP	FP	HC	CP	FP	HC	CP	FP	HC	CP	FP	HC	PI	FP	HC	PI	FP
50% - 130%	–4°F (–20.0°C) / –4.4°F (–20.2°C)																								
	0°F (–17.8°C) / –0.4°F (–18.0°C)																								
	5°F (–15.0°C) / 4.5°F (–15.3°C)																								
	10°F (–12.2°C) / 9°F (–12.8°C)																								
	15°F (–9.4°C) / 14°F (–10.0°C)																								
	20°F (–6.7°C) / 19°F (–7.2°C)																								
	25°F (–3.9°C) / 23°F (–5.0°C)																								
	30°F (–1.1°C) / 28°F (–2.2°C)																								
	35°F (1.7°C) / 32°F (0.0°C)																								
	40°F (4.4°C) / 36°F (2.2°C)																								
	45°F (7.2°C) / 41°F (5.0°C)																								
	47°F (8.3°C) / 43°F (6.1°C)																								
	50°F (10.0°C) / 46°F (7.8°C)																								
	55°F (12.8°C) / 51°F (10.6°C)																								
	60°F (15.6°C) / 56°F (13.3°C)																								

3.2 Heat Pump Water Heaters

Table 3–7 below defines the draft DEF for HPWH units. This draft DEF is meant to encompass water storage tanks that use a vapor compression cycle as the primary means of heating the water in the tank. Auxiliary heat is included in the scope by means of electrical resistance heating (up to two supplemental heating elements). This scope excludes (1) remote water loop heat pump systems, in which the vapor compression cycle is used to produce hot water and provides heating and cooling to other components/zones in a building; and (2) HPWHs that use gas as the supplemental heating fuel.

Table 3–7 Draft DEF for HPWHs

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Manufacturer/Brand Owner	The name of the company that manufactures the product and/or that owns the product brand.		
Brand	The brand name under which the submitted product is marketed and/or sold in the U.S. In some cases, this may be identical to the name of the manufacturer/brand owner.		
Product Line/Family Name	If the product being submitted is part of a family of products or models, supply the product line or family name here. As an example, if the submission were an automobile, this field would contain the model name.		

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Model Number	The unique model number used by the manufacturer/brand owner to identify the specific product being submitted to the Technology Performance Exchange. Sometimes referred to as “catalog number.” Model numbers should be entered in the same style as that used by the manufacturer/brand owner, including all applicable slashes (/) and dashes (-). If certain alphanumeric characters in the model number identify product variations that do not impact energy performance, please replace each of those alphanumeric characters with an asterisk (*) when entering the model number on this website. This convention reduces the need to submit separate forms for product variations that have identical performance data. However, if a subset, but not all options for a specific character in the model number do not affect energy performance, include all such options inside parentheses within the larger model/product number. Example: Product family X uses product numbers that contain eight alphanumeric characters. The first three characters denote product variations that affect energy performance; a subset of options denoted by the fourth character do not affect performance; and the last four characters do not affect energy performance at all. The manufacturer/brand owner would submit a separate “Add Product” form for each unique combination of the first four characters that affect energy performance; on each form, the submitted model numbers would have the form: ABC(1,2,3)****, ABC4****, ABC5****, etc.		
UPC	If provided, the user must submit all 12 digits without spaces or dashes.		
ENERGY STAR® Label	Indicate whether the product has earned the ENERGY STAR® label.	• Yes • No • NA	

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
ENERGY STAR® Version Number	List the version number of the most current ENERGY STAR® specification under which the product earned the ENERGY STAR® label.		
FEMP Designated Product	Indicate whether the product currently meets the energy performance requirements necessary to be identified as a Federal Energy Management Program-designated product.	• Yes • No • NA	
Rated Capacity	The heating capacity associated with the change in water temperature of the heat pump condenser coil at specified rated conditions (AHRI Standard 1301). This rating should be performed with the supplemental heater disabled (heat-pump-only mode).		AHRI 1301-2013
Rated Tank Volume	The manufacturer-rated (labeled) tank water storage capacity.		
Actual Tank Volume	The actual tank water storage capacity. This often differs from the rated tank volume, as manufacturers are provided an allowance of up to 10% when reporting tank volume (Burch and Erikson 2012).		
Storage Tank Height	The height of the storage tank itself, without any heat pump equipment included in the dimension.		
Required Height Necessary for Installation	The nominal height of the tank, including any heat pump equipment and housing, but not including pipe connections.		
Refrigerant Designation	The refrigerant used in this heat pump water heater unit.	• 12 • 134a • 22 • 404A • 407A • 407C • 410A • 502 • 507 • 744 • Other	
Upper Supplemental Heater Capacity	The rated heating capacity of the uppermost supplemental heater.		

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Lower Supplemental Heater Capacity	If applicable, the rated heating capacity of the lower supplemental heater.		
Parasitic Fuel Consumption Rate	The rate of parasitic fuel consumption by non-water heating equipment. Primarily, this will be composed of the electrical energy used for control and display purposes.		
Rated Inlet Air Dry-Bulb Temperature	The air dry-bulb temperature entering the evaporator during the rating test. AHRI Standard 1301 specifies standard rating conditions with dry-bulb values of 35.0°C (95°F), 27.0°C (80.6°F), 10.0°C (50°F), or −8.5°C (16.7°F), although the standard allows for application ratings at non-standard conditions, provided they are labeled. The single value supplied here should correspond to the conditions used to calculate the rated capacity.		AHRI 1301-2013
Rated Inlet Air Wet Bulb Temperature	The air wet-bulb temperature entering the evaporator during the rating test. AHRI Standard 1301 specifies standard rating conditions with dry-bulb values of 24.0°C (75.2°F), 21.8°C (71.2°F), 7.0°C (44.6°F), or −9.5°C (14.9°F), although the standard allows for application ratings at non-standard conditions, provided they are labeled. The single value supplied here should correspond to the conditions used to calculate the rated capacity.		AHRI 1301-2013
Rated Air Volumetric Flow Rate	The airflow rate passing through the evaporator during rating testing. AHRI Standard 1301 does not specify a rating condition, so the manufacturer's specified or nominal conditions should be used.		AHRI 1301-2013
Rated Coefficient of Performance	A ratio of the rated heat pump water heating capacity to the total input power, expressed as a dimensionless value (AHRI Standard 1301). This rating should be performed with the supplemental heater disabled (heat pump-only mode), and at the rated conditions prescribed for this heat pump water heater system.		AHRI 1301-2013
Rated Heat Pump Sensible Heat Ratio	The fraction of total energy transfer between the evaporator coil and air that is associated with sensible capacity (change in air temperature) expressed as a dimensionless value, and at the rated conditions prescribed for this heat pump water heater system.		

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Off-Cycle Heat Loss Coefficient	The heat loss coefficient to ambient conditions. This is typically equivalent to the overall skin heat loss coefficient, which can be determined from knowledge of the heat transfer properties from the water in the tank to the ambient surroundings, an average tank water temperature, and an ambient temperature according to the equation Q = UA (T_tank – T_ambient). This can also be inferred if the tank skin thermal (conduction) resistance is known by supplementing the conduction resistance with values for film (convection) thermal resistance.		
Minimum Ambient Air Temperature for Compressor Operation	The minimum ambient operating temperature for the compressor. This can be inferred from the operating range of the heat pump. Below this value, the heat pump will not operate and the supplemental heating system is required to produce hot water, thus reducing the efficiency of the heat pump water heater.		
Heat Pump Fan Total Efficiency	Overall evaporator fan efficiency, calculated as the ratio of the power delivered to the fluid by the fan blades to the electrical input power provided to the motor. It implicitly includes the motor and fan blade efficiencies. This should be reported at rated conditions.		
Heat Pump Fan Rated Power Input	Evaporator fan input power at rated conditions.		
Performance Map	A document detailing the HPWH's performance under various conditions. The information must be formatted in alignment with the provided template, and uploaded as an .xls.		
HPWH Control Details	A document that provides additional product performance-related information pertaining to the unit control strategy. This information should include a description of the various operational modes available to the unit, along with detailed information related to cut-in and cut-out temperatures/times for heat pump and supplemental heater operation. This information must be formatted as a PDF file.		

3.2.1 Heat Pump Water Heater Performance Map

Table 3–8 defines the required draft performance map inputs for characterizing HPWH performance. Independent variables include the evaporator coil entering air temperature (typically the ambient air temperature surrounding the tank) and the ratio of actual versus rated airflow rate across the evaporator coil. Three dependent variables are requested for each independent variable permutation:

- Heat pump water heating capacity – the rate of heat gain to the water via the heat pump condenser coil (watts)
- Water heater power input – the total power input to the water heater (watts)
- Heat pump COP – the coefficient of performance of the heat pump (unitless)

The data requested by this performance map are more exhaustive than what are typically provided by manufacturers; however, these data represent a key measure of the performance of these units under varying boundary conditions. Without these data, the performance must be inferred based solely on fixed rated values, which give little indication of the performance spectrum.

Table 3–8 Draft Performance Map for HPWH Units

Evaporator Air Entering Temperature [°F (°C)]	Airflow Rate/Rated Airflow Rate	Heat Pump Water Heating Capacity (W)	Water Heater Power Input (W)	Heat Pump COP
40°F [4.44°C]	1.0			
50°F [10.0°C]	1.0			
60°F [15.56°C]	1.0			
70°F [21.11°C]	1.0			
80°F [26.67°C]	1.0			
90°F [32.22°C]	1.0			
100°F [37.78°C]	1.0			
40°F [4.44°C]	0.75			
50°F [10.0°C]	0.75			
60°F [15.56°C]	0.75			
70°F [21.11°C]	0.75			
80°F [26.67°C]	0.75			
90°F [32.22°C]	0.75			
100°F [37.78°C]	0.75			
40°F [4.44°C]	0.5			
50°F [10.0°C]	0.5			
60°F [15.56°C]	0.5			
70°F [21.11°C]	0.5			
80°F [26.67°C]	0.5			
90°F [32.22°C]	0.5			
100°F [37.78°C]	0.5			
40°F [4.44°C]	0.25			
50°F [10.0°C]	0.25			
60°F [15.56°C]	0.25			
70°F [21.11°C]	0.25			
80°F [26.67°C]	0.25			
90°F [32.22°C]	0.25			
100°F [37.78°C]	0.25			

3.3 Rooftop Units

Table 3–9 below defines the draft DEF for RTUs. Drafts of the required performance maps for RTUs can be found in subsequent sections. Products covered within this technology category include vapor compression-driven unitary cooling equipment (both with and without heating capabilities) and vapor compression-driven unitary air-source heat pumps. Units containing stepped- or variable-speed compressors or fans are included in this technology category. However, units employing the use of desiccant wheels, direct or indirect evaporative technologies (other than evaporatively-cooled condensers), split systems, and heating-only systems are not covered by this technology category.

Table 3–9 Draft DEF for RTUs

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Manufacturer/Brand Owner	The name of the company that manufactures the product and/or that owns the product brand.		
Brand	The brand name under which the submitted product is marketed and/or sold in the U.S. In some cases, this may be identical to the name of the manufacturer/brand owner.		
Product Line/Family Name	If the product being submitted is part of a family of products or models, supply the product line or family name here. As an example, if the submission were an automobile, this field would contain the model name.		

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Model Number	The unique model number used by the manufacturer/brand owner to identify the specific product being submitted to the Technology Performance Exchange. Sometimes referred to as “catalog number.” Model numbers should be entered in the same style as that used by the manufacturer/brand owner, including all applicable slashes (/) and dashes (-). If certain alphanumeric characters in the model number identify product variations that do not impact energy performance, please replace each of those alphanumeric characters with an asterisk (*) when entering the model number on this website. This convention reduces the need to submit separate forms for product variations that have identical performance data. However, if a subset, but not all options for a specific character in the model number do not affect energy performance, include all such options inside parentheses within the larger model/product number. Example: Product family X uses product numbers that contain eight alphanumeric characters. The first three characters denote product variations that affect energy performance; a subset of options denoted by the fourth character do not affect performance; and the last four characters do not affect energy performance at all. The manufacturer/brand owner would submit a separate “Add Product” form for each unique combination of the first four characters that affect energy performance; on each form, the submitted model numbers would have the form: ABC(1,2,3)****, ABC4****, ABC5****, etc.		
UPC	If provided, the user must submit all 12 digits without spaces or dashes.		
ENERGY STAR® Label	Indicate whether the product has earned the ENERGY STAR® label.		
ENERGY STAR® Version Number	List the version number of the most current ENERGY STAR® specification under which the product earned the ENERGY STAR® label.	• Yes • No • NA	

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
FEMP Designated Product	Indicate whether the product currently meets the energy performance requirements necessary to be identified as a Federal Energy Management Program-designated product.		
AHRI Certified Reference Number	Provide this number if your product is certified under the AHRI Unitary Large Equipment, Unitary Air Conditioner Equipment, or Unitary Heat Pump Equipment certification program.		
Nominal Cooling Capacity	The nominal (net) cooling capacity of the unit at rated conditions.		• AHRI 340/360
Energy Efficiency Ratio	"A ratio of the Cooling Capacity in Btu/h to the power input values in watts at any given set of rating conditions expressed in Btu/W·h." (AHRI 340/360 2007)		• AHRI 340/360
Integrated Energy Efficiency Ratio	"A single number cooling part-load efficiency figure of merit." (AHRI 340/360 2007)		• AHRI 340/360
Seasonal Energy Efficiency Ratio	"The total heat removed from the conditioned space during the annual cooling season, expressed in Btu's, divided by the total electrical energy consumed by the air conditioner or heat pump during the same season, expressed in watt-hours." (AHRI 210/240 2008)		• AHRI 210/240
Cooling Mode: Indoor Fan Speed Control	Select the type of indoor fan speed control for the unit, when it is in cooling mode. Select "constant speed" for units that operate at a single, constant speed. Select "stepped speed" for units that operate at multiple discrete steps. Select "variable speed" for variable speed control.	• Constant Speed • Stepped Speed • Variable Speed	
Cooling Mode: Number of Discrete Fan Speeds	Enter the number of discrete operating speeds for the indoor fan motor when the unit is in cooling mode, excluding "off."		
Cooling Mode: Minimum Fan Speed as a Fraction of Maximum	Divide the minimum fan RPM (when in cooling mode) by the maximum fan RPM (when in cooling mode).		
Heating Mode: Indoor Fan Speed Control	Select the type of indoor fan speed control for the unit, when it is in heating mode. Select "constant speed" for units that operate at a single, constant speed. Select "stepped speed" for units that operate at multiple discrete steps. Select "variable speed" for variable speed control.	• Constant Speed • Stepped Speed • Variable Speed	

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Heating Mode: Number of Discrete Fan Speeds	Enter the number of discrete operating speeds for the indoor fan motor when the unit is in heating mode, excluding “off.”		
Heating Mode: Minimum Fan Speed as a Fraction of Maximum	Divide the minimum fan RPM (when in heating mode) by the maximum fan RPM (when in heating mode).		
Internal Static Pressure at Full Speed	Internal static pressure of the unit at full indoor fan speed including all filters, coils and accessories used in this model.		
Compressor Staging	Select the type of compressor staging for the unit. Select "single stage" for units with single stage (on/off) control. Select "multiple, discrete stages" for units with multiple compressors, discrete unloading stages, or compressors with stepped speed motors that are controlled to operate at discrete stages. Select "variable" for compressors that operate at variable speeds or with modulating unloading.	• Single Stage • Multiple, Discrete Stages • Variable	
Number of Discrete Cooling Stages	Enter the number of discrete operating stages for the compressors, excluding “off.”		
Degradation Coefficient	"Degradation Coefficient (CD). The measure of the efficiency loss due to the cycling of the units as determined in Appendices C and D [of the standard]" (AHRI 210/240 2008).		
Refrigerant	Select the type of refrigerant.	• R-22 • R-410A • R-407c • R134-A	
Active Dehumidification	Select "Yes" if the unit contains an active dehumidification system (in addition to the dehumidification that takes place during normal DX cooling operation).	• Yes • No	
Evaporatively Cooled Condenser	Select “Yes” if the unit uses evaporative cooling to enhance heat rejection from the condenser coils.	• Yes • No	
Minimum Outdoor Dry-Bulb for Cooling Operation	This is the minimum outdoor dry-bulb temperature at which the DX cooling coils will be able to operate.		

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Maximum Outdoor Dry-Bulb for Cooling Operation	This is the maximum outdoor dry-bulb temperature at which the DX cooling coils will be able to operate.		
Condenser Fan Speed Operation	Select the condenser fan control option for the unit. If the unit has several constant-speed condenser fans that stage on in conjunction with multiple compressors, select “stepped speed.”	• Constant Speed • Stepped Speed • Variable Speed	
Air-Source Heat Pump	Select "yes" if this unit is a "Commercial and Industrial Unitary Heat Pump. One or more factory-made assemblies, which normally include an indoor conditioning coil, an air moving device, compressor(s), and an outdoor coil(s), including means to provide a heating Function and may or may not include a cooling Function" (AHRI 340/360 2007).	• Yes • No	
Minimum Outdoor Dry-Bulb for Heat Pump Operation	This is the minimum outdoor dry-bulb temperature at which the DX coils will be able to operate in heating mode during heat pump operation.		
Maximum Outdoor Dry-Bulb for Heat Pump Operation	This is the maximum outdoor dry-bulb temperature at which the DX coils will be able to operate in heating mode during heat pump operation.		
Type of Heating	Select the type of heating that the unit uses. This is independent of heat pump operation. If your unit is an air-source heat pump without supplemental heating, or has no heating coil/furnace section, select “none.”	• Gas • Electric • None	
Heating Staging	Select the type of heat staging for the unit. Select “single stage” for units with single stage (on/off) control. Select “multiple, discrete stages” for units with multiple discrete stages (low-fire / high-fire). Select “modulating” for modulating burners.	• Single stage • Multiple, discrete stages • Modulating	
Number of Heating Stages	Enter the number of heating stages, excluding “off.”		
Turndown Ratio	Enter the turndown ratio for the burner (full input/minimum input).		

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Economizer Control Types Available	Select all economizer options available for this model.	• None • Fixed Dry-Bulb • Differential Dry-Bulb • Fixed Enthalpy • Differential Enthalpy • Electronic Enthalpy • Fixed Dew Point and Dry-Bulb • Differential Dry-Bulb and Enthalpy	
Performance Map	A document detailing the RTU's performance under various conditions. The information must be formatted in alignment with the provided template, and uploaded as an .xls.		
RTU Control Documentation	A document describing the unit's typical sequence of operation (SOO) and/or other control-related information. The document must be formatted as a PDF.		
Product Data Sheet	A document that provides additional product performance-related information. Such documents may contain energy performance data, mounting diagrams, dimensions, a description of factory options/accessories, or other technical details about the product. This information must be formatted as a PDF file.		

3.3.1 Cooling Mode Performance Map

Table 3–10 defines the draft performance map for RTUs in cooling mode. For each unique set of independent variables, the following dependent variables are requested:

- Supply fan flow rate (cfm)
- Total static pressure (in.)
- Fan efficiency
- Supply fan power draw (W)
- Gross total cooling capacity (MBH)
- Gross sensible heat ratio
- Gross power draw (W)
- Leaving dry-bulb temperature (°F)

Note that the independent variables "fan speed stage" and "compressor staging" depend on product properties supplied by the user. The performance map points requested will be expanded for products that have more than one fan or compressor stage, with the number of "stages" capped at four. Thus, for an RTU that had a variable-speed fan and a variable-speed compressor, the performance map would request 768 sets of dependent variables (48 points per fan speed/compressor stage combination × 4 fan speed stages × 4 compressor stages).

Table 3–10 Draft Cooling Operation Performance Map for RTUs

# of Points	Source	Independent Variables				
		Evaporator Coil Entering Air Conditions		Condenser Coil Entering Air Condition	Fan Speed Stage	Compressor Staging
		Dry-Bulb Temperature (°F)	Wet-Bulb Temperature (°F)	Dry-Bulb Temperature (°F)		
1	AHRI 340/360 IEER - 100%	80	67	95	*i*	*j*
2	AHRI 340/360 IEER - 75%	80	67	81.5	*i*	*j*
3	AHRI 340/360 IEER - 50%	80	67	68	*i*	*j*
4	AHRI 340/360 IEER - 25%	80	67	65	*i*	*j*

# of Points	Source	Independent Variables				
		Evaporator Coil Entering Air Conditions		Condenser Coil Entering Air Condition	Fan Speed Stage	Compressor Staging
		Dry-Bulb Temperature (°F)	Wet-Bulb Temperature (°F)	Dry-Bulb Temperature (°F)		
5	low ambient cooling	80	67	Minimum	*i*	*j*
6	low ambient cooling	80	67	Intermediate	*i*	*j*
7	low ambient cooling	80	67	40	*i*	*j*
8		50	48	50	*i*	*j*
9		60	58	50	*i*	*j*
10		65	50	50	*i*	*j*
11	AHRI Low Temp	67	57	50	*i*	*j*
12		72	70	50	*i*	*j*
13		80	50	50	*i*	*j*
14		80	77	50	*i*	*j*
15		82	60	50	*i*	*j*
16		84	82	50	*i*	*j*
17		65	50	Intermediate 1	*i*	*j*
18	AHRI 340/360 Low Temp Cooling	67	57	Intermediate 1	*i*	*j*
19		72	70	Intermediate 1	*i*	*j*
20		80	50	Intermediate 1	*i*	*j*
21		80	77	Intermediate 1	*i*	*j*
22		82	60	Intermediate 1	*i*	*j*
23		84	82	Intermediate 1	*i*	*j*
24		90	88	Intermediate 1	*i*	*j*
25		90	64	Intermediate 1	*i*	*j*
26		95	70	Intermediate 1	*i*	*j*
27		72	70	Intermediate 2	*i*	*j*
28		80	50	Intermediate 2	*i*	*j*

# of Points	Source	Independent Variables				
		Evaporator Coil Entering Air Conditions		Condenser Coil Entering Air Condition	Fan Speed Stage	Compressor Staging
		Dry-Bulb Temperature (°F)	Wet-Bulb Temperature (°F)	Dry-Bulb Temperature (°F)		
29		80	77	Intermediate 2	*i*	*j*
30		82	60	Intermediate 2	*i*	*j*
31		84	82	Intermediate 2	*i*	*j*
32		90	88	Intermediate 2	*i*	*j*
33		90	64	Intermediate 2	*i*	*j*
34		95	70	Intermediate 2	*i*	*j*
35		102	82	Intermediate 2	*i*	*j*
36		105	60	Intermediate 2	*i*	*j*
37		80	77	Maximum	*i*	*j*
38		82	60	Maximum	*i*	*j*
39		84	82	Maximum	*i*	*j*
40		90	88	Maximum	*i*	*j*
41		90	64	Maximum	*i*	*j*
42		95	70	Maximum	*i*	*j*
43		102	82	Maximum	*i*	*j*
44		105	60	Maximum	*i*	*j*
45		112	88	Maximum	*i*	*j*
46		120	70	Maximum	*i*	*j*
47		120	80	Maximum	*i*	*j*
48		125	88	Maximum	*i*	*j*

3.3.2 Heating Mode, Heat Pump Performance Map

Table 3–11 defines the draft heating mode performance map for RTUs that provide heating via heat pump operation. For each unique set of independent variables, the following dependent variables are requested:

- Supply fan flow rate (cfm)
- Total static pressure (in.)
- Supply fan power draw (W)
- Gross heating total capacity (MBH)
- Gross power draw (W)
- Leaving dry-bulb temperature (°F)

Note that the independent variables "fan speed" and "compressor stage" depend on product properties supplied by the user. The performance map points requested will be expanded for products that have more than one fan or compressor stage, with the number of "stages" capped at four. Thus, for an RTU that had a variable-speed fan and a variable-speed compressor, the performance map would request 304 sets of dependent variables (19 points per fan speed/compressor stage combination × 4 fan speeds × 4 compressor stages).

Table 3–11 Draft Heating (Heat Pump) Operation Performance Map for RTUs

# of Points	Source	Independent Variables				
		Indoor Coil Entering Air Conditions		Outdoor Coil Entering Air Condition	Fan Speed Stage	Compressor Stage
		Dry-Bulb Temperature (°F)	Wet-Bulb Temperature (°F)	Dry-Bulb Temperature (°F) at 70% RH		
1	Standard Rating Conditions (High Temp Steady State Heating)	70	60	47	*i*	*j*
2	Standard Rating Conditions (Low Temp Steady State Heating)	70	60	17	*i*	*j*
3	Maximum Operating Conditions	80	-	75	*i*	*j*

# of Points	Source	Independent Variables				
		Indoor Coil Entering Air Conditions		Outdoor Coil Entering Air Condition	Fan Speed Stage	Compressor Stage
		Dry-Bulb Temperature (°F)	Wet-Bulb Temperature (°F)	Dry-Bulb Temperature (°F) at 70% RH		
4		40	-	Minimum	*i*	*j*
5		50	-	Minimum	*i*	*j*
6		60	-	Minimum	*i*	*j*
7		70	-	Minimum	*i*	*j*
8		40	-	Intermediate 1	*i*	*j*
9		50	-	Intermediate 1	*i*	*j*
10		60	-	Intermediate 1	*i*	*j*
11		70	-	Intermediate 1	*i*	*j*
12		40	-	Intermediate 2	*i*	*j*
13		50	-	Intermediate 2	*i*	*j*
14		60	-	Intermediate 2	*i*	*j*
15		70	-	Intermediate 2	*i*	*j*
16		40	-	Maximum	*i*	*j*
17		50	-	Maximum	*i*	*j*
18		60	-	Maximum	*i*	*j*
19		70	-	Maximum	*i*	*j*

3.3.3 Heating Mode, Electric Resistance/Furnace Performance Map

Table 3–12 defines the draft heating mode performance map for RTUs that provide heating via an electric resistance heater or a gas furnace. For each unique set of independent variables, the following dependent variables are requested:

- Supply fan flow rate (cfm)
- Heat input (MBH)
- Heat input (W)
- Steady-state efficiency (%)
- Heat output (MBH)
- Leaving air temperature (°F)
- Supply fan power draw (W)
- Supply fan efficiency (%)

Note that the independent variables "fan speed stage" and "heating stage" depend on product properties supplied by the user. The performance map point requested will be expanded for products that have more than one fan or heating stage, with the number of "stages" capped at four. Thus, for an RTU that had a variable-speed fan and a modulating gas furnace, the performance map would request 96 sets of dependent variables (6 points per fan speed/heating stage combination × 4 fan speeds × 4 heating stages).

Table 3–12 Draft Heating (Electric Resistance/Furnace) Operation Performance Map for RTUs

Independent Variables		
Entering Air Conditions Dry-Bulb Temperature (°F)	Fan Speed Stage	Heating Stage
−20	*i*	*j*
0	*i*	*j*
20	*i*	*j*
40	*i*	*j*
60	*i*	*j*
80	*i*	*j*

3.4 Solid-State Lighting Replacement Lamps

Table 3–13 below defines the draft DEF for SSL replacement lamps. The scope of this technology category is limited to solid-state lighting lamps that are intended to replace traditional light sources in existing luminaires. Solid-state lighting replacement lamp products listed here may include decorative, directional, linear, and omnidirectional sources.

Table 3–13 Draft DEF for SSL Replacement Lamps

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Manufacturer/Brand Owner	The name of the company that manufactures the product and/or that owns the product brand.		
Brand	The brand name under which the submitted product is marketed and/or sold in the U.S. In some cases, this may be identical to the name of the manufacturer/brand owner.		
Product Line/Family Name	If the product being submitted is part of a family of products or models, supply the product line or family name here. As an example, if the submission were an automobile, this field would contain the model name.		

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Model Number	The unique model number used by the manufacturer/brand owner to identify the specific product being submitted to the Technology Performance Exchange. Sometimes referred to as “catalog number.” Model numbers should be entered in the same style as that used by the manufacturer/brand owner, including all applicable slashes (/) and dashes (-). If certain alphanumeric characters in the model number identify product variations that do not impact energy performance, please replace each of those alphanumeric characters with an asterisk (*) when entering the model number on this website. This convention reduces the need to submit separate forms for product variations that have identical performance data. However, if a subset, but not all options for a specific character in the model number do not affect energy performance, include all such options inside parentheses within the larger model/product number. Example: Product family X uses product numbers that contain eight alphanumeric characters. The first three characters denote product variations that affect energy performance; a subset of options denoted by the fourth character do not affect performance; and the last four characters do not affect energy performance at all. The manufacturer/brand owner would submit a separate “Add Product” form for each unique combination of the first four characters that affect energy performance; on each form, the submitted model numbers would have the form: ABC(1,2,3)****, ABC4****, ABC5****, etc.		
UPC	If provided, the user must submit all 12 digits without spaces or dashes.		
ENERGY STAR® Label	Indicate whether the product has earned the ENERGY STAR® label.	• Yes • No • NA	

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
ENERGY STAR® Version Number	List the version number of the most current ENERGY STAR® specification under which the product earned the ENERGY STAR® label.		
FEMP Designated Product	Indicate whether the product currently meets the energy performance requirements necessary to be identified as a Federal Energy Management Program-designated product.	• Yes • No • NA	
Initial Luminous Flux	Luminous flux at the beginning of product life, where luminous flux is "the time rate of flow of radiant energy, evaluated in terms of standardized visual response." (Adapted from IESNA Lighting Ready Reference, 4th ed., 2003.)		• IESNA LM-79-08
Standard Photometric Data	For directional lamps, provide standard photometric electronic data in accordance with IES LM-63; the format is commonly called an *.ies file. For non-directional lamps, this field should be left blank.		• IESNA LM-63-02
Input Power	Power consumed by the lamp during steady-state operation in the "on" mode.		• IESNA LM-79-08
Lamp Distribution Type	A general description of distribution type, such as "omnidirectional." "Directional" lamp examples include R-lamps and PAR-lamps. "Linear" lamp examples include T8 and T5 lamps.	• Omnidirectional • Directional • Linear • Other	
ANSI Lamp Designation	The first letter symbol (shape classification) and the first number symbol (reference dimension) from the lamp designation format in ANSI standard C79.1-2002. Exclude hyphens (e.g., enter "T8" rather than "T-8"). For lamps with a reference diameter in IP units, no additional characters should be entered. For lamps with a reference diameter in SI units, add a space and "(SI)" after the reference number (e.g., "PAR121 (SI)"). For rectangular lamps, SI units are customary; separate the two millimeter dimensions with an "x", and do not add "(SI)" (e.g., "REC142x200").		
Correlated Color Temperature	"The absolute temperature of a blackbody whose chromacity most nearly matches that of the light source." (IESNA Lighting Ready Reference, 4th ed., 2003.)		• IESNA LM-79-08

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Specification Sheet	A document that provides additional product performance-related information. Such documents may contain energy performance data, wiring diagrams, dimensions, photometric data, or other technical details about the product. This information must be formatted as a PDF file.		
Color Rendering Index	"A measure of the degree of color shift objects undergo when illuminated by the light source as compared with those same objects when illuminated by a reference source of comparable color temperature." (IESNA Lighting Ready Reference, 4th ed., 2003.)		• IESNA LM-79-08
Lumen Maintenance	The elapsed operating time over which the LED light source will maintain 70% of its initial light output. (Adapted from IES LM-80-08, definition 3.6.)		• IESNA LM-80-08

3.5 Solid-State Lighting Luminaires

Table 3–14 below defines the draft DEF for SSL luminaires. Products encompassed by this technology category include solid-state lighting luminaires that contain a solid-state lighting source (LED, OLED, or PLED) and driver in the same product package. This category excludes solid-state lighting replacement lamps, which are intended to replace non solid-state lighting lamps in existing non solid-state lighting fixtures.

Table 3–14 Draft DEF for SSL Luminaires

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Manufacturer/Brand Owner	The name of the company that manufactures the product and/or that owns the product brand.		
Brand	The brand name under which the submitted product is marketed and/or sold in the U.S. In some cases, this may be identical to the name of the manufacturer/brand owner.		
Product Line/Family Name	If the product being submitted is part of a family of products or models, supply the product line or family name here. As an example, if the submission were an automobile, this field would contain the model name.		

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Model Number	The unique model number used by the manufacturer/brand owner to identify the specific product being submitted to the Technology Performance Exchange. Sometimes referred to as “catalog number.” Model numbers should be entered in the same style as that used by the manufacturer/brand owner, including all applicable slashes (/) and dashes (-). If certain alphanumeric characters in the model number identify product variations that do not impact energy performance, please replace each of those alphanumeric characters with an asterisk (*) when entering the model number on this website. This convention reduces the need to submit separate forms for product variations that have identical performance data. However, if a subset, but not all options for a specific character in the model number do not affect energy performance, include all such options inside parentheses within the larger model/product number. Example: Product family X uses product numbers that contain eight alphanumeric characters. The first three characters denote product variations that affect energy performance; a subset of options denoted by the fourth character do not affect performance; and the last four characters do not affect energy performance at all. The manufacturer/brand owner would submit a separate “Add Product” form for each unique combination of the first four characters that affect energy performance; on each form, the submitted model numbers would have the form: ABC(1,2,3)****, ABC4****, ABC5****, etc.		
UPC	If provided, the user must submit all 12 digits without spaces or dashes.		
ENERGY STAR® Label	Indicate whether the product has earned the ENERGY STAR® label.	• Yes • No • NA	

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
ENERGY STAR® Version Number	List the version number of the most current ENERGY STAR® specification under which the product earned the ENERGY STAR® label.		
FEMP Designated Product	Indicate whether the product currently meets the energy performance requirements necessary to be identified as a Federal Energy Management Program-designated product.	• Yes • No • NA	
Mounting Type	The type of mounting application, such as "fully recessed."	• Fully Recessed • Surface-Mounted • Suspended • In-grade • Pole • Bollard	
Lamp Distribution Type	A general description of distribution type, such as "omnidirectional." "Directional" lamp examples include R-lamps and PAR-lamps. "Linear" lamp examples include T8 and T5 lamps.	• Omnidirectional • Directional • Linear • Other	
Standard Photometric Data	For directional lamps, provide standard photometric electronic data in accordance with IES LM-63; the format is commonly called an *.ies file. For non-directional lamps, this field should be left blank.		• IESNA LM-63-02
Specification Sheet	A document that provides additional product performance-related information. Such documents may contain energy performance data, mounting diagrams, dimensions, photometric data, or other technical details about the product. This information must be formatted as a PDF file.		
Input Power	The luminaire input power.		
Lumen Maintenance	The elapsed operating time over which the LED light source will maintain 70% of its initial light output. (Adapted from IES LM-80-08, definition 3.6.)		• IESNA LM-80-08
Total Luminous Flux	The total luminous flux emitted by the luminaire expressed in lumens.		

Parameter	Parameter Description (this will be available to the site user)	Enumerations (if required)	Related Testing Standards
Input Voltage	The luminaire input voltage or voltages at which the SSL luminaire is designed to operate. List multiple voltages only if a single model number is associated with a product that can operate at multiple voltages.		• ANSI C82.2 (fluorescent) • ANSI C82.6 (HID)
Luminous Efficacy	The quotient of the luminaire's total emitted luminous flux by the total luminaire input power, expressed in lumens per watt. (Adapted from IESNA Lighting Ready Reference, 4th ed., 2003.)		
Correlated Color Temperature	"The absolute temperature of a blackbody whose chromacity most nearly matches that of the light source." (IESNA Lighting Ready Reference, 4th ed., 2003.)		
Color Rendering Index	"A measure of the degree of color shift objects undergo when illuminated by the light source as compared with those same objects when illuminated by a reference source of comparable color temperature." (IESNA Lighting Ready Reference, 4th ed., 2003.)		
Input Power Factor	The ratio of active power (watts) to apparent power (volt-amperes). "The active power is to be measured with a wattmeter capable of indicating the average power in watts. The apparent power is to be the products of the true rms values of the input voltage and current" (ANSI C82.13).		• ANSI C82.2 (fluorescent) • ANSI C82.6 (HID)
Total Harmonic Distortion	The ratio of the root mean squared "values of the harmonic content to that of the fundamental current, expressed as a percentage" (ANSI C82.13).		• ANSI C82.6 (HID) • ANSI C82.2 is the comparable standard for fluorescent, but C82.2-2002 doesn't discuss THD.

4.0 References

2007 Standard for Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment. ANSI/AHRI Standard 340/360-2007 with Addenda 1 & 2. Arlington, VA: Air-Conditioning, Heating, and Refrigeration Institute.

2008 Standard for Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment. ANSI/AHRI Standard 210/240 with Addendum 1. Arlington, VA: Air-Conditioning, Heating, and Refrigeration Institute.

2010 Standard for Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment. ANSI/AHRI Standard 1230 with Addendum 1. Arlington, VA: Air-Conditioning, Heating, and Refrigeration Institute.

2013 Standard for Performance Rating of Commercial Heat Pump Water Heaters. AHRI Standard 1301. Arlington, VA: Air-Conditioning, Heating, and Refrigeration Institute.

American National Standard for Electric Lamps—Nomenclature for Glass Bulbs Intended for Use with Electric Lamps. ANSI C79.1-2002. Rosslyn, VA: National Electrical Manufacturers Association.

American National Standard for Lamp Ballasts—Ballasts for High Intensity Discharge (HID) Lamps – Methods of Measurement. ANSI C82.6-2005. Rosslyn, VA: National Electrical Manufacturers Association.

American National Standard For Lamp Ballasts—Definitions—for Fluorescent Lamps and Ballasts. ANSI C82.13-2002. Rosslyn, VA: National Electrical Manufacturers Association.

American National Standard for Lamp Ballasts—Method of Measurement of Fluorescent Lamp Ballasts. ANSI C82.2-2002. Rosslyn, VA: National Electrical Manufacturers Association.

Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products. IESNA LM-79-08. New York, NY: Illuminating Engineering Society of North America.

Approved Method: Measuring Lumen Maintenance of LED Light Sources. IESNA LM-80-08. New York, NY: Illuminating Engineering Society of North America.

Burch, Jay and Erikson, Paul. Using Ratings Data to Derive Simulation-Model Inputs for Storage-Tank Water Heaters. Portland, Oregon : s.n., 2004. Proceedings of the 29th Passive Solar Conference. pp. 393-398.

Mennie, H. D., ed. *IESNA Lighting Ready Reference, Fourth Edition.* A Compendium of Materials From The IESNA Lighting Handbook, 9th Edition. New York, NY: Illuminating Engineering Society of North America, 2003.

Standard File Format for Electronic Transfer of Photometric Data and Related Information (Reaffirmed 2008). IESNA LM-63-02. New York, NY: Illuminating Engineering Society of North America.