RESNET® HERS® Addendum 77,

Integrated Heat Pump Water Heater (iHPWH)

Date Approved:	June 23, 2026
Voluntary Compliance Date:	TBD
Mandatory Compliance Date:	TBD
Transition Period:	TBD
Proponent:	SDC 300
Organization:	RESNET

Purpose:

Addendum 77 amends ANSI/RESNET/ICC 301 for the RESNET® HERS® to address inappropriate installations of heat pump water heaters. The energy performance calculations of Addendum 77 derate labeled performance when units are installed without sufficient space to provide an adequate source of heat to operate as tested for their rating.

Amendment:

NOTE: The administrative amendments to sections 301.1 and 303.1 have been moved from this addendum to an addendum dedicated to administrative updates to the RESNET HERS® Standards. The technical amendments are as follows:

Modify ANSI/RESNET/ICC 301-2022 Chapter 3 as follows:

1. ***Add definitions to Chapter 3 Definitions***

   Heat Pump Water Heater (HPWH) - A water heater that transfers thermal energy from one temperature level to another temperature level for the purpose of heating water, including all ancillary equipment such as fans, storage tanks, or controls necessary for the device to perform its function.

   Integrated Heat Pump Water Heater (iHPWH) – An air-source Heat Pump Water Heater where the heat pump is integrated with a storage tank contained in a single factory-made assembly.

   Split-System Heat Pump Water Heater – An air-source Heat Pump Water Heater where the heat pump is separate from the storage tank.

2. ***Add acronyms to Chapter 3***

   HPWH – Heat pump water heater

   iHPWH – Integrated heat pump water heater

3. ***Add new table note 'v.2' and 'v.3' to 'Service water heating systems' section from Table 4.2.2(1) [See item 5. below for the table note edits]:***

Building Component	Energy Rating Reference Home	Rated Home
Service water heating systems [p, t, u, v.1, v.2, v.3]	Fuel type: same as Rated Home Efficiency: Electric: EF = 0.97 - (0.00132 * store gal) Fossil fuel: EF = 0.67 - (0.0019 * store gal) Use (gal/day): Determined in accordance with Section 4.2.2.~~6~~7.1.4 Tank temperature: 125°F Location: IECC Climate Zones 1-3: Attached garage if present, otherwise Conditioned Space Volume IECC Climate Zones: 4-8: Unconditioned basement if present, otherwise Conditioned Space Volume	Same as Rated Home[t] Same as Rated Home Same as Rated Home Determined in accordance with Section 4.2.2.~~6~~7.2.11 Same as Energy Rating Reference Home Same as Rated Home

4. Modify the footnote 'u' in 'Table 4.2.2(1)' as follows:

u. The Uniform Energy Factor (UEF) or Energy Factor (EF) shall be obtained for residential hot water equipment.~~, or~~ For commercial hot water equipment, UEF, COP or the Thermal Efficiency (TE) and Standby Loss (SL) shall be obtained ~~for commercial hot water equipment~~ from manufacturer's literature or from AHRI directory for equipment being used where available. When UEF is obtained, the First Hour Rating (FHR) shall also be obtained. For commercial water heaters where EF or UEF is not available, an Approved commercial hot water system calculator shall be used to determine the EF or UEF.

Where a manufacturer provided or AHRI published EF or UEF is not available for the residential hot water equipment, the guidance provided in Item 1 below shall be used to determine the effective EF of the water heater. Where a manufacturer provided or AHRI published TE or SL is not available for commercial hot water equipment, the guidance provided in Item 2 below shall be used to determine the effective TE and SL of the water heater.

1. For residential oil, gas and electric water heaters or Heat Pumps, default EF values provided in Table 4.5.2(3) for age-based efficiency or Table 4.5.2(4) for non-age-based efficiency shall be used.

2. For commercial water heaters, values provided in Table C404.2 "Minimum Performance of Water-Heating Equipment" in the IECC shall be used.

5. Modify the footnote 'v' in 'Table 4.2.2(1)' as follows and create new table note v.2 and v.3:

v.1. ~~The heat sources and sinks associated with the Service Hot Water System shall be included in the energy balance for the space in which the Service Hot Water System is located.~~ Where the heat sources and sinks associated with a Service Hot Water System are entirely within the Rated Home, they shall be included in the energy balance for the corresponding spaces. Where any heat source or sink is beyond the boundaries of the Rated Home, the source or sink shall contribute to the simulated performance of the Service Hot Water equipment. For a Service Hot Water System with a storage tank, the simulation shall include storage tank heat losses to the appropriate space. [1]

v.2. For air-source HPWH, the simulation shall account for where supply air intake is extracted and exhaust air is discharged. Where necessary, all air-source HPWH simulations shall include supplementary electric resistance elements to meet the hot water demand of the Dwelling Unit.

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[1] (Informative Note) Storage tank UA values may be determined using procedures outlined in J. Maguire and D. Roberts, "Deriving Simulation Parameters for Storage-Type Water Heaters Using Ratings Data Produced from the Uniform Energy Factor Test Procedure." NREL/CP-55000-71633, National Renewable Energy Laboratory, Golden, CO February 2021. This method applies to noncondensing gas-fired and electric resistance storage water heaters. This method does not apply to instantaneous water heaters, condensing gas-fired water heaters, or HPWHs.

The COP_{eff} from Eqn 4.x-y of an air-source HPWH shall be adjusted for the temperature of its supply air and the tank heat transfer shall be adjusted for the temperature of the space.

v.3 For all HPWH, the UEF shall be separated into the heat pump COP[2] ,which excludes electric resistance power, and the tank UA according to Tables X and Y.

Table X: Heat pump COP Values

First Hour Rating[3] (gal/hr)	**COP_{hp}**
>= 18, < 51	1.0005 * UEF - 0.0789
>= 51, < 75	1.0909 * UEF - 0.0868
>= 75	1.1022 * UEF - 0.0877

Table Y: HPWH Tank UA Values

Tank Volume (gal)	**Tank UA (Btu/hr-F)**
<= 58	3.6
> 58, <= 73	4.0
> 73	4.7

In addition, all iHPWH installations shall account for the containment volume of the iHPWH by using the effective COP (COP_{eff}[4] as determined by Equation 4.x-y.

$$COP_{eff} = (COP_{hp} - 0.92) * (1 - (1.009 * \exp(-5.492*(RV)))) + 0.92 \qquad \text{Eq 4.x-y}$$

Where:

[2] (Informative Note) Heat pump COP does not include any power from electric resistance heating elements.

[3] (Informative Note) At the time of publication of this Standard, there were no HPWH products on the market with a First Hour Rating < 18 gal/hr.

[4] (Informative Note) In contrast to COP_{hp}, COP_{eff} accounts for decreased heat pump COP and increased electric resistance heating. In accordance with Table note v.2, additional electric resistance heating may be required to meet the load.

COP_{hp} = Value determined from Table X

RV = Relative Volume = MIN [(iHPWH Containment Volume, ft^3)/1,500 ft^3), 1.0]

Containment Volume = The volume of the smallest enclosed space that contains the iHPWH. The containment volume shall be permitted to be expanded as follows:

Where the enclosed space containing the iHPWH includes a louvered door or upper and lower vents with a total net free area of 300 in^2 or larger, the volume of the adjacent air thermal resource shall be permitted to be included in the containment volume.

Where a ducted intake and ducted exhaust directly connect the iHPWH to a nearby air thermal resource, that air thermal resource volume shall be the containment volume.

Where either intake or exhaust ductwork combined with at least 150 in^2 of vents connects the iHPWH with a nearby air thermal resource, the air thermal resource volume supplying air to the iHPWH shall be permitted to be included in the containment volume.

Air thermal resource = The air available to the supply air intake of an iHPWH. Where the air thermal resource is outdoors, assume a containment volume of 1,500 ft^3.

6. Modify 'Service Hot Water Equipment' section from 'Table 4.5.2(1)' as follows:

Table 4.5.2(1) Minimum Rated Features	
Building Element	**Minimum Rated Feature**
15. Service Hot Water Equipment	For Residential Equipment - Equipment type, location, efficiency (Uniform Energy Factor and First Hour Rating; or Energy Factor), extra tank insulation R-Value, flow rates of showers and Bathroom sink faucets. For Integrated Heat Pump Water Heaters – containment volume (ft^3) and containment volume location(s). If the enclosed space containing the iHPWH has intentional openings to an adjacent space, the net free opening area (in^2) shared with the adjacent space. If ducted, the space to which the exhaust air is discharged and the space from which the intake air is supplied. For Split System Heat Pump Water Heaters - the location of both the heat pump and the storage tank. For Commercial Equipment - Equipment type, location, Uniform Energy Factor, COP, or Thermal Efficiency and Standby Loss, extra tank insulation value, flow rates of showers and Bathroom sink faucets. Distribution Related: Distribution System Type (standard, recirculation), Recirculation System controls [none, timer, temperature, demand (manual) or demand (sensor)], pipe insulation R-Value, pipe length for standard distribution, branch length for recirculation, supply + return loop length, pump power (Watts, HP).

7. Modify 'Building Element: Service Hot Water (SHW) Equipment' table within Normative Appendix B as follows:

Location	Determine and record location of service hot water equipment	Determine and record whether the water heater is in Conditioned or Unconditioned Space Volume, Unrated Heated Space or Unrated Conditioned Space.
Efficiency	Determine and record the Energy Factor, Uniform Energy Factor, COP, or thermal efficiency of the service hot water equipment	Look for the water heater's nameplate and product literature. Record the manufacturer, model number and if listed directly on the nameplate, the efficiency rating. Search for the model number in the manufacturer's data sheets or appropriate efficiency rating directory to determine and record the EF, UEF, COP, or thermal efficiency rating. When UEF is recorded, also record the First Hour Rating. When thermal efficiency is recorded, also record the standby loss if available. When the efficiency rating cannot be determined, approximate the age of the unit and use a default efficiency.
Extra tank insulation value	Determine and record the insulation value of any exterior wrap	Visually determine and record whether the water heater is or is not wrapped with exterior insulation. When insulation is present, look for the labeled/stamped R-value or measure the thickness of the wrap and determine and record the R-Value.
Individual service hot water equipment type	Determine and record type, capacity, and fuel source of standalone water heater serving single Dwelling Unit	Identify whether the equipment is storage or instantaneous, identify its fuel source and record storage tank capacity in gallons. Also record whether the SHW equipment is an iHPWH, Split System Heat Pump Water Heater, or supplemented by a desuperheater and/or if it is integrated with the space heating system.

		Integrated Heat Pump Water Heater – For Integrated Heat Pump Water Heaters, determine the containment volume, per Eqn. 4.x-y, and record the containment volume location. Measure dimensions of the smallest enclosed space that contains the iHPWH. If the volume of that smallest enclosed space is less than 1,500 ft^3 but is connected to another space by a louvered door or vents or the iHPWH is directly ducted to or from another space, measure the dimensions of that space to calculate its volume. Record whether the system has a ducted intake and exhaust and record the spaces to and from which the air is ducted. If the space that contains the iHPWH has intentional openings to an adjacent space, record the total net free opening area (in^2) of any grilles/louvers/door undercuts. Where the net free area of a grille or louvered opening is not specified by the manufacturer, the net free area shall be calculated as 35% of the area of the grille or louvered opening. *Split System Heat Pump Water Heater* – For Split System Heat Pump Water Heaters, record the location of both the heat pump and the storage tank.