Interim Addendum 90i
Service Hot Water

Date Approved: May 29, 2025

Voluntary Compliance Date: May 29, 2025

Mandatory Compliance Date[1]: May 29, 2026

Transition Period:

Proponent: SDC 300

Organization: RESNET

Purpose:

The Addendum corrects errors in service hot water criteria established by the RESNET HERS Standards Addendum 81.

Amendment:

Note: This addendum amends criteria within Addendum81. All strike through and underline text in black print was deleted or added respectively by Addendum 81. All text in red print indicate changes made by Addendum 90i.

Modify MINHERS Chapter 3 as follows:

303.1 Technical Requirements

Exception 4: RESNET Home Energy Ratings shall be calculated using the modifications of Standards ANSI/RESNET/ICC 301~~-2019~~ established by MINHERS addenda:

- Addendum 66, CO_2e Index
- ~~Addendum 79, Table 5.1.2(1) Informative Note Correction~~

[1] The Mandatory Compliance Date- The date on which compliance with an amendment approved for publication shall be required for any Dwelling Unit or Sleeping Unit with a Building Permit Date on or after that date. Alternatively, the date of the HERS Rater or RFI's first site visit, the date of the application of the permit, or the date of the contract on the home is permitted to be used as the Building Permit Date.

- Addendum 81, Supplemental Criteria for Adoption of ANSI/RESNET/ICC 301-2022
- Addendum 90i, Addendum 81 Modifications

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

4.2.1.1. Modeling Assumptions. The assumptions specified in Normative Appendix C shall apply to all simulation models. The Energy Rating Reference Home and the Rated Home Shall be configured with at least one Bedroom.

(Note: The cycles per year are updated to include multi-family Dwelling Units. Also, the coefficients in the 'Service Hot Water Use' equations for refFgph and refWgph amend those in Addendum 81)

4.2.2.7.1.4. Service Hot Water Use. Service hot water system use in gallons per hour for the Energy Rating Reference Home shall be determined in accordance with Equation 4.2-29:

$$HWgph = (refDWgph + refCWgph + F_{mix}*(refFgph + refWgph)) \quad \textbf{(Equation 4.2-29)}$$

where:

HWgph = gallons per hour of hot water use

refDWgph[2] = reference dishwasher gallons per hour

~~= (0.7801*Nbr+1.976)*h_{DW}~~

SCY[3] = 123.7+16.2*Nbr for one- and two-family Dwellings and Townhouses

SCY = 135.7+13.5*Nbr for all other Dwelling Units

= (SCY*8.16 / 365)*h_{DW}

refCWgph[4] = reference clothes washer gallons per hour

~~= (0.6762*Nbr + 2.3847)*h_{CW}~~

SCY = 189.5+32.9*Nbr for one- and two-family Dwellings and Townhouses

SCY = 213.9+27.5*Nbr for all other Dwelling Units

= (4.52*SCY*((3*2.08+1.59) / (2.874*2.08+1.59)) / 365) *h_{CW}

F_{mix} = $1 - ((T_{set} - T_{use})/ (T_{set} - T_{mains}))$

where:

T_{set} = Water heater set point temperature = 125 °F

T_{use} = Temperature of mixed water at fixtures = 105 °F

T_{mains} = $(T_{amb,avg} + \textit{offset}) + \textit{ratio} * (\Delta T_{amb,max} / 2)$

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[2] (Informative Reference) Dishwasher hot water use is based on 2006 minimum federal standards (10 CFR 430) for dishwasher hot water use of 8.16 gallons per cycle.

[3] (Informative Reference) The Standard Cycles per Year (SCY) are derived from occupancy data reported in "Estimating Daily Domestic Hot-Water Use in North American Homes" as published in ASHRAE Transactions Volume 121, Part 2.

[4] (Informative Reference) Clothes washer hot water use is based on 2006 minimum federal standards (10 CFR 430) for clothes washers of 4.52 gallons per cycle as modified for clothes washer capacity of 3 cubic feet rather than 2.874 cubic feet used in testing.

* sin (0.986 * (day# - 15 - *lag*) – *hemisphere**90)
(with a minimum value of 32 ºF)

where:

T_{mains} = temperature of potable water supply entering residence (ºF)

$T_{amb,avg}$ = annual average ambient air temperature (ºF)

$\Delta T_{amb,max}$ = maximum difference between monthly average ambient temperatures[5] (ºF)

0.986 = degrees/day (360/365)

day# = Julian day of the year (1-365)

offset = 6°F

ratio = 0.4 + 0.01 ($T_{amb,avg}$ – 44)

lag = 35 – 1.0 ($T_{amb,avg}$ – 44)

hemisphere = 1 for northern hemisphere, -1 for southern hemisphere

refFgph = (14.36 + 10.~~0~~17*Nbr)*h_F for one- and two-family Dwellings and Townhouses

= (21.~~9~~ 75 + 8.~~3~~46*Nbr)*h_F for all other Dwelling Units

= reference climate-normalized hourly fixture water use in Energy Rating Reference Home (in gallons per hour)

refWgph = (9.~~8~~95*Nbr $^{0.43399}$)*h_F for one- and two-family Dwellings and Townhouses

= (11.27*Nbr$^{0.34323}$) *h_F for all other Dwelling Units

= reference climate-normalized hourly hot water waste due to distribution system losses in Energy Rating Reference Home (in gallons per hour)

where:

Nbr = number of Bedrooms in the Rated Home, not to be less than 1.

4.2.2.7.2.8. Clothes Dryers. Clothes Dryer annual energy use for the Rated Home shall be determined in accordance with Equation 4.2-34 and shall be based on the clothes dryer located within the Rated Home. If no clothes dryer is located within the Rated Home, a clothes dryer in the nearest shared laundry room on the project site shall be used if available for daily use by the occupants of the Rated Home. If the shared laundry room has multiple clothes dryers, the clothes dryer with the lowest EF or CEF shall be used.

CDkWh/y = (((RMC-0.04)*100)/55.5)*(8.45/CEF)*ACY **(Equation 4.2-34)**

where:

RMC = Remaining Moisture Content = (0.97 * (CAPw / IMEF) – LER/312) / ((2.0104 * CAPw + 1.4242) * 0.455) + 0.04

[5] (Informative Reference) For example: $T_{amb,avg,july} – T_{amb,avg,january}$

ACY = Annual Cycles per Year = ~~(164+46.5*Nbr)~~SCY *[~~(~~(3*2.08+1.59) / (CAPw*2.08+1.59)]~~)~~

SCY = 189.5 + 32.9*Nbr for one- and two-family Dwellings and Townhouses

= 213.9 + 27.5*Nbr for all other Dwelling Units

Nbr	= Number of Bedrooms in home.
CEF	= Combined Energy Factor is the clothes dryer efficiency[6] (lbs dry clothes/kWh) based on current U.S. DOE clothes dryer testing procedures. (default = 3.73 for electric dryers or 3.30 for gas dryers)
CAPw	= Capacity of clothes washer (ft^3) from the manufacturer's data
IMEF	= Integrated Modified Energy Factor, which has replaced MEF as the U.S. DOE Energy Factor test metric for clothes washers. (default = 1.57 for top load clothes washers or 1.84 for front load clothes washers)
LER	= Labeled Energy Rating of clothes washer (kWh/y) from the Energy Guide label.

For natural gas clothes dryers, annual energy use shall be determined in accordance with Equations 4.2-35a and 4.2-35b.

Therms/y = (result of Equation 4.2-31)*3412*(1-0.07)*(3.73/3.30)/100000 **(Equation 4.2-35a)**

kWh/y = (result of Equation 4.2-31)*0.07*(3.73/3.30) **(Equation 4.2-35b)**

When a Dwelling Unit has no in-unit clothes dryer, and no shared clothes dryers are available in the building or on the project site for daily use by the Rated Home occupants or they exist, but the ratio of Dwelling Units to shared clothes dryers is greater than 14, the clothes dryer values from Table 4.2.2.7(1) shall be assumed for both the Energy Rating Reference Home and Rated Home.

Internal Gains for ventless clothes dryers shall use $f_{internal}$ = 1.0 and $f_{sensible}$ = 0.9.

4.2.2.7.2.9. Dishwashers. Dishwasher annual energy use for the Rated Home shall be determined in accordance with Equation 4.2-36a and shall be based on the dishwasher located within the Rated Home, with the highest kWh/y. If no dishwasher is located within the Rated Home, a dishwasher in the nearest shared kitchen in the building shall be used only if available for daily use by the occupants of the Rated Home.

dWkWh/y = dWkWh/cyc * dWcpy **(Equation 4.2-36a)**

where:

dWkWh/y = dishwasher annual electric use excluding water heater energy use

dWkWh/cyc = [(GHWC * 0.5497/ Gas$ - LER * Elec$ * 0.02504 / Elec$) / (Elec$ * 0.5497 / Gas$ - 0.02504)] / 208

GHWC = Labeled annual cost when used with a gas water heater

Gas$ = Labeled price of gas in $/therm

[6] (Informative Reference) See the CEC Appliance Efficiency Database http://www.energy.ca.gov/appliances/ or the ENERGY STAR Appliance database https://www.energystar.gov/products/appliances/clothes_dryers.

LER = Labeled dishwasher Energy Rating using electric water heater in kWh/y
Elec$ = Labeled price of electricity in $/kWh
dWcpy = dishwasher cycles per year = ~~(88.4 + 34.9*Nbr)~~SCY*12/dWcap
SCY = 123.7 + 16.2*Nbr for one- and two-family Dwellings and Townhouses
= 135.7 + 13.5*Nbr for all other Dwelling Units
Nbr = Number of bedrooms in Rated Home
dWcap = Dishwasher capacity where Standard = 12 and Compact = 8

For dishwashers where an Energy Guide label is not available, dishwasher inputs from Table 4.2.2.7.2.9 shall be used.

Table 4.2.2.7.2.9 Default Dishwasher Inputs

Default Dishwasher Energy Guide Label Data				
Energy Guide Label Information	ENERGY STAR Defaults		NAECA minimum	ERI Reference
Dishwasher Size	compact	standard	standard	standard
Annual Energy kWh/y (LER)	203	270	307	467
Annual Gas Hot Water Cost ($/y)	$14.20	$22.23	$22.32	$33.12
Electricity Price ($/kWh)	$0.12	$0.12	$0.12	$0.12
Gas Price ($/therm)	$1.09	$1.09	$1.09	$1.09
Label Cycles per Year (LCY)	208	208	208	208

When a Dwelling Unit has no in-unit dishwasher and no shared dishwashers are available in the building for daily use of the Rated Home occupants, the energy and hot water use of the Rated Home dishwasher shall be the same as the Energy Rating Reference Home in accordance with Section 4.2.2.7.1.

4.2.2.7.2.10. Clothes Washers. Clothes Washer annual energy use and daily hot water use for the Rated Home shall be determined as follows and shall be based on the clothes washer located within the Rated Home. If no clothes washer is located within the Rated Home, a clothes washer in the nearest shared laundry room on the project site shall be used if available for daily use by the occupants of the Rated Home. If the shared laundry room has multiple clothes washers, the clothes washer with the highest LER shall be used.

Annual energy use shall be calculated in accordance with Equation 4.2-37a.

CWkWh/y = Cwappl / LCY * ACY **(Equation 4.2-37a)**

where:

Cwappl = (GHWC * gasH2O / gas$ - (LER*elec$) * elecH2O / elec$)
/
(elec$ * gasH2O / gas$ - elecH2O)

GHWC = Gas Hot Water Costs from Energy Guide Label
gasH2O = 0.3914 (gal/cyc) per (therm/y)
elecH2O = 0.0178 (gal/cyc) per (kWh/y)
LER = Label Energy Rating (kWh/y) from the Energy Guide Label.
elec$ = Electric Rate from Energy Guide Label. (default = $0.12 per kWh)

gas$ = Gas Rate from Energy Guide Label. (default = $1.09 per therm)

LCY = Label Cycles per Year from Energy Guide Label (default = 6 loads per week = 312)

ACY = Annual Cycles per Year.

and where:

ACY = SCY * [(3.0*2.08+1.59)/(CAPw*2.08+1.59)]

where:

SCY = 189.5 + 32.9*Nbr for one- and two-family Dwellings and Townhouses

= 213.9 + 27.5*Nbr for all other Dwelling Units

~~SCY = (164 + Nbr*46.5).~~

CAPw = washer capacity in cubic feet from the Energy Guide Label

Daily hot water use shall be calculated in accordance with Equation 4.2-37b.

CWgpd = (LER – Cwappl) * elecH2O * ACY / 365 **(Equation 4.2-37b)**

For clothes washers where an Energy Guide label is not available, clothes washer inputs from Table 4.2.2.7.2.10 shall be used.

Table 4.2.2.7.2.10 Default Inputs for Clothes Washer Based on Year

Standard Clothes Washer Models					
	ERI Ref 2006[a]	Std 2008-2017[b]	ENERGY STAR 2006-2017[c]	Std 2018-present	ENERG STAR 2018-presen
Clothes Washer Inputs:					
LER [Label Energy Rating in kWh/y]=	400	380	260	284	152
GHWC [Cost with gas hot water in $/y]=	$27	$27	$18	$18	$12
elec_price [$/kWh]=	$0.12	$0.12	$0.12	$0.12	$0.12
gas_price [$/therm]=	$1.09	$1.09	$1.09	$1.09	$1.09
IMEF [ft3/(kWh/cyc)]=	1	1.21	1.63	1.57	2.06
CAPw [ft3]=	3	3.2	3.5	4.2	4.2
IWF [(gal/cyc)/ft3]=	11.4	9.5	5.2	6.5	4.3
LCY [Label Cycles per Year] =	312	312	312	312	312

Notes

a: Used for standard clothes washers between 2006 – 2007

b: Used for standard clothes washers between 2008 – 2017

c: Used for ENERGY STAR clothes washers between 2006 and 2017

d: Consortium for Energy Efficiency Tier II efficiency minimum requirements

When a Dwelling Unit has no in-unit clothes washer, and no shared clothes washers are available in the building or on the project site for daily use by the Rated Home occupants or they exist, but the ratio of Dwelling Units to shared clothes washers is greater than 14, the energy and hot water use of the Rated Home clothes washer shall be the same as the Energy Rating Reference Home, in accordance with Section 4.2.2.7.1.

Normative Appendix C: Modeling Assumptions

C1. Material Thermal Properties

The following thermal properties shall be applied where the respective materials are used in a model:

Table C.1(1) Material Thermal Properties

Material	Conductivity (Btu/hr-F-ft)
Soil (adjacent to the home's foundation)	1.000
Wood	0.067
Drywall	0.092

C2. Conversions between Infiltration Metrics

There are a large number of descriptors and variables used in the determination and representation of envelope leakage and infiltration in residential buildings. Conversions between infiltration metrics within the software shall use the following conventions and procedures.

C2.1 General Nomenclature

ELA = effective leakage area (in^2) *[US: ASTM e 779-92]* [7]
CFA = conditioned floor area (ft^2)
SLA = specific leakage area (in^2/in^2) = ELA / (CFA*144)
C = leakage coeffieient (result of least squares regression of test data) [8]
n = flow exponent (result of least squares regression of test data) [9]
ΔP = pressure differential (Pa)
EqLA = equivalent leakage area (in^2) *[Canadian: CAN/SGSB-149.10-M86]* [10]
EqLA = equivalent leakage area (in^2) *[Canadian: CAN/SGSB-149.10-M86]*
ach_4 = annual average air change rate (conditioned space volume changes per hour)
ach_{50} = air changes per hour at 50 Pa pressure differential
cfm_{50} = airflow through leakage area at 50 Pa pressure differential
cfm_{25} = airflow through leakage area at 25 Pa pressure differential
wsf = weather and shielding factor *[from ASHRAE Standard 62.2]*
H = vertical distance between the lowest and highest above grade points within the pressure envelope (ft) [11]
Hr = reference height = 8.202 feet (2.5 m)
Hf = average floor to ceiling height (ft) [12]
NL = normalized leakage *[ASHRAE Standard 62.2]*

C2.2 Conversion Equations

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[7] The standard reference pressure differential for the calculation of ELA is 4 Pa (U.S. Standard).
[8] The units of measured data used in the least squares regression determine the units and value of 'C'. For SI units, 'C' will be derived from airflows measured in m^3/s and for IP units; 'C' will be derived from airflows measured in ft^3/min (cfm). As a result, the value and units of 'C' will differ substantially based on whether the regression is performed using IP units or SI units. The units of pressure in both systems are Pa
[9] Where 'n' is not determined by multi-point test data regression, 0.65 is used.
[10] The standard reference pressure differential for the calculation of EqLA is 10 Pa (Canadian Standard).
[11] 'H' shall be based on the Infiltration Volume as determined in accordance with ANSI/RESNET/ICC 380 and shall include the above-grade height of attics, crawlspaces and basements when they are included in the Infiltration Volume.
[12] 'Hf' shall be calculated as the Infiltration Volume divided by the Conditioned Floor Area (CFA).

$NL = 1000 * SLA * (H/Hr)^{0.4}$ [*ASHRAE Standard 62.2*] (Eq. 1)

$SLA = NL / (1000 * (H/Hr)^{0.4})$ (Eq. 2)

$SLA = ELA / (CFA*144)$ (Eq. 3)

$ELA = (CFA*144) * SLA$ (Eq. 4)

$SLA = ach_4 * (Hf/Hr) / (1000 * wsf * (H/Hr)^{0.4})$ (Eq. 5)

$ach_4 = SLA * 1000 * wsf * (H/Hr)^{0.4} * Hr/Hf$ (Eq. 6)

$ELA = 0.283316 * C * 4^n$ *['C' input in IP units]* (Eq. 7)

$EqLA = 0.2937 * C * 10^n$ *['C' input in IP units]* (Eq. 8)

$C = ELA / (0.283316 * 4^n)$ *['C' returned in IP units]* (Eq. 9)

$C = EqLA / (0.~~2037~~2937 * 10^n)$ *['C' returned in IP units]* (Eq. 10)

$cfm_{50} = C * 50^n$ *['C' input in IP units]* (Eq. 11)

$cfm_{25} = C * 25^n$ *['C' input in IP units]* (Eq. 12)

$ach_{50} = (cfm_{50} * 60) / (CFA * Hf)$ (Eq. 13)

$cfm_{50} = CFA * Hf * ach_{50} / 60$ (Eq. 14)

$ach_{50} = SLA / (0.283316 * 4^n) * (50^n * 60 * 144 / Hf)$ (Eq. 15)

$SLA = ach_{50} * (0.283316 * 4^n) / (50^n * 60 * 144 / Hf)$ (Eq. 16)

$ach_{50} = SLA * 19200$ *[for Hf =Hr and n = 0.65]* (Eq. 17)

$SLA = ach_{50} / 19200$ *[for Hf =Hr and n = 0.65]* (Eq. 18)

$ELA = 0.054863 * cfm_{50}$ *[for n = 0.65]* (Eq. 19)

$ach_{50} = 19.2 * ach_4 / (wsf * (H/Hr)^{0.4})$ *[for n = 0.65]* (Eq. 20)

$NL = ach_4 * (Hf/Hr) / wsf$ *[for n = 0.65]* (Eq. 21)