RESNET HERS$_{H2O}$

Technical Guidelines

February 19, 2018

1.0 Calculating HERS$_{H2O}$ Index. A **HERS$_{H2O}$** Index shall be calculated as:

$$= \frac{indoor\ and\ outdoor\ gpd\ for\ the\ rated\ home}{indoor\ and\ outdoor\ gpd\ for\ the\ reference\ home} * 100$$

Indoor and outdoor gallons per day (GPD) values for the reference and rated home shall be determined in accordance with sections 3 and 4.

2.0 Determining the Indoor Reference Home GPD. The indoor reference home shall be calculated as:

$$ref_{in}gpd = refFgpd + refWgpd + refDWgpd + refCWgpd + refTgpd + refSofgpd + totOther$$

Where:
refFgpd= daily fixture water use for the reference home
refWgpd= daily water use wasted for the reference home
refDWgpd= daily dishwasher water use for the reference home
refCWgpd= daily clothes washer water use for the reference home
refTgpd= daily toilet water use for the reference home
refSofgpd= daily water softener water use for the reference home
totOther= total other/unidentified water use for the reference home

2.1 Determining Reference Fixture Water Use. Reference fixture water use shall be calculated as:

$$refFgpd = 14.6 + 10 * Nbr$$

Where:
Nbr= number of bedrooms in the rated home

This value is determined in accordance with ANSI/RESNET/ICC 301-2014 Addendum A- 2015 Domestic Hot Water Systems.

2.2 Determining Reference Water Use Wasted. Reference fixture water waste shall be calculated as:

$$refWgpd = 9.8 * Nbr^{0.43}$$

Where:
Nbr= number of bedrooms in the rated home

This value is determined in accordance with ANSI/RESNET/ICC 301-2014 Addendum A- 2015 Domestic Hot Water Systems.

2.3 Determining Reference Dish Washer Water Use. Reference dish washer water use shall be calculated as:

$$refDWgpd = \frac{(88.4 + 34.9 * Nbr) * 8.16}{365}$$

Which simplifies to:

$$refDWgpd = 1.97 + 0.7802 * Nbr$$

Where:

Nbr= number of bedrooms in the rated home

This value is determined in accordance with ANSI/RESNET/ICC 301-2014 Addendum A- 2015 Domestic Hot Water Systems.

2.4 Determining Reference Clothes Washer Water Use. Reference clothes washer water use shall be calculated as:

$$refCWgpd = \frac{4.52 * (164 + 46.5 * Nbr) * \left[(3 * 2.08 + 1.59)\middle/(2.874 * 2.08 + 1.59)\right]}{365}$$

Which simplifies to:

$$refCWgpd = 2.1012 + 0.5958 * Nbr$$

Where:
Nbr= number of bedrooms in the rated home

This value is determined in accordance with ANSI/RESNET/ICC 301-2014 Addendum A-2015 Domestic Hot Water Systems.

2.5 Determining Reference Toilet Water Use. Reference toilet water use shall be calculated as:

$$refTgpd = refFPO * refGPF * Occ$$

Where:
refFPO= the reference flushes per person per day = 5.05
refGPF= the reference gallons per flush for toilets = 1.6
Occ= the number of occupants = 1.09 + 0.54 * Nbr
Nbr= number of bedrooms in the rated home

2.6 Determining Reference Water Softener Use. Reference water softener water use shall be calculated as:

IF
the rated home has a water softener
AND
$$water\ hardness\ at\ the\ rated\ home\ location\ is\ \geq 180\ \frac{miligrams}{liter}$$

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THEN

$$refSofgpd = \frac{grains\ of\ hardness}{gallon\ of\ water} * sum\ of\ indoor\ water\ uses\ in\ the\ reference\ home$$
$$* \frac{5\ gallons\ used}{1,000\ grains\ removed}$$

IF NOT: $refSofgpd = 0$

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2.7 Determining total other usage. Total other shall be determined as:

$$totOther = 5.93 * Nbr$$

Where:

Nbr= the number of bedrooms in the rated home

3.0 Determining the Outdoor Reference Home Annual Water Use (in thousands of gallons per year)**.** The reference home outdoor annual water use shall be calculated using the following two equations

*If the rated home has a netET of less than 12 inches/year **OR** the rated home has an automatic irrigation system, use Equation 1.*

Equation 1:$\left[\frac{exp(A)}{1 + exp(A)}\right] * 1.18086 * [2.0341 * netET^{0.7154} * Ref\_Irr\_Area^{0.6227} + 0.5756 * ind\_Pool * netET]$

*If the rated home has a netET of greater than 12 inches/year **AND** the rated home does NOT have an automatic irrigation system, use Equation 2.*

Equation 2:$\left[\frac{exp(B)}{1 + exp(B)}\right] * 1.22257 * [1.4233\ +\ 0.6311\ *\ netET\ +\ 0.9376 * Ref\_Irr\_Area]$

Either equation shall be constrained as follows:

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IF
Rate_Irr_Area < Ref_Irr_Area

THEN

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Ref_Out= equation 1 or 2 (as identified above) equation 1 (Using Rate_Irr_Area and pool indicator=0) equation 1 (with Ref_Irr_Area and pool indicator=0)

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AND

Outdoor Reference Home GPD shall never be lower than equation 2

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Where:

Exp(A)= exponent of [1.4416 + 0.5069 * (Rate_Irr_Area/1,000)]
Exp(B)= exponent of [0.6911 + 0.00301 * netET * (Rate_Irr_Area/1,000)]

Ref_Irr_Area= The size of the irrigated area in the reference home, calculated in accordance with section 3.1
Rate_Irr_Area= The size of the irrigated area in the rated home
netET= The annual historic sum of mean reference evapotranspiration minus the mean precipitation for all months that evapotranspiration exceeds precipitation
ind_Pool= Indicator representing the presence or absence of a swimming pool in the rated home

3.1 Reference Irrigated Area. Reference irrigated area shall be calculated as:

IF

the lot size of the rated home is < 7,000 ft^2

THEN

$$Ref\_Irr\_Area = \text{Lot\_Area} * (0.002479 * \text{Lot\_Area}\wedge 0.6157)$$

IF
The lot size of the rated home is ≥7,000 ft^2 Then
*Ref_Irr_Area = lot_area * 0.577*

Where:
Ref_Irr_Area= The size of the landscape that receives supplemental water in the reference home
Lot_Area= The size of the lot on which the rated home is being constructed

4.0 Determining Indoor Rated Home GPD. The rated home's indoor GPD shall be calculated as:

$$Indoor_{gpd} = Shower_{gpd} + KitchF_{gpd} + LavF_{gpd} + Waste_{gpd} + CW_{gpd} + DW_{gpd} + Toilets_{gpd} + Soft_{gpd} + Other + EP_{gpd}$$

Where:
Shower$_{gpd}$ = daily shower water use for the rated home
KitchF$_{gpd}$ = daily kitchen faucet water use for the rated home
LavF$_{gpd}$ = daily lavatory water use for the rated home
Waste$_{gpd}$ = daily water use wasted for the rated home
CW$_{gpd}$ = daily clothes washer water use for the rated home
DW$_{gpd}$ = daily dishwasher water use for the rated home
Toilets$_{gpd}$ = daily toilet water use for the rated home
Soft$_{gpd}$ = daily water softener water use for the rated home
Other$_{gpd}$ = daily other/unidentified water use for the rated home
EP$_{gpd}$ = daily excess pressure adjustment

4.1 Determining Rated Shower Water Use. Rated home shower water use shall be determined as:
$$Shower_{gpd} = FixtureTot * shower_{pc} * SHeff$$

Where:

FixtureTot= Determined in accordance with ANSI/RESNET/ICC 301-2014 Addendum A-2015 Domestic Hot Water Systems $=\frac{adjFmix}{Fmix} * refFgpd * VintFact$

Shower_pc= Percent of fixture water use consumed by showers = 54%

SHeff= the ratio of the average rated flow rate of showerheads to the reference home flow rate $=\frac{average\ flow\ rate\ of\ showerheads\ in\ the\ rated\ home}{2.5}$

> This value is derived from ANSI/RESNET/ICC 301-2014 Addendum A-2015 Domestic Hot Water Systems.

4.2 Determining Kitchen Faucet gpd for the rated home. Kitchen faucet gpd shall be determined as:

$$KitchF_{gpd} = FixtureTot * faucet_{pc} * KitchFeff * kitch$$

Where:

FixtureTot= Determined in accordance with ANSI/RESNET/ICC 301-2014 Addendum A-2015 Domestic Hot Water Systems $=\frac{adjFmix}{Fmix} * refFgpd * VintFact$

faucet$_{pc}$= Percent of fixture water use consumed by faucets = 46%

KitchFeff= the ratio of the average rated flow rate of kitchen faucets to the reference home flow rate $=\frac{average\ flow\ rate\ of\ kitchen\ faucets\ in\ the\ rated\ home}{2.2}$

Kitch= the percentage of faucet use that is attributed to kitchen faucets= 69%

> This value is derived from ANSI/RESNET/ICC 301-2014 Addendum A-2015 Domestic Hot Water Systems.

4.3 Determining Lavatory Faucet gpd for the rated home. Lavatory faucet use shall be determined as:

$$LavF_{gpd} = FixtureTot * faucet_{pc} * LavFeff * Lav$$

Where:

Lav= the percentage of faucet use that is attributed to lavatory faucets= 31%

FixtureTot= Determined in accordance with ANSI/RESNET/ICC 301-2014 Addendum A-2015 Domestic Hot Water Systems $=\frac{adjFmix}{Fmix} * refFgpd$

faucet_pc= Percent of fixture water use consumed by faucets = 46%

LavFeff= the ratio of the average rated flow rate of lavatory faucets to the reference home flow rate = 1 for standard faucets and 0.95 for high efficiency faucets

> This value is derived from ANSI/RESNET/ICC 301-2014 Addendum A-2015 Domestic Hot Water Systems.

4.4 Determining Daily Water Use Wasted gpd in the rated home. Water use wasted gpd in the rated home shall be determined as:

$$Waste_{gpd} = F_{eff} * (oWgdp + sWgdp * WDeff)$$

Where:

F$_{eff}$ = Fixture efficiency of showerheads, kitchen faucets, and lavatory faucets weighted by contribution to total fixture use (by volume)

oWgpd= daily standard operating condition hot water wasted quantity as determined by ANSI/RESNET/ICC 301-2014 Addendum A-2015 Domestic Hot Water Systems

sWgpd = daily structural hot water wasted quantity as determined by ANSI/RESNET/ICC 301-2014 Addendum A-2015 Domestic Hot Water Systems

WDeff= distribution system water use effectiveness from Table 4.2.2.5.2.11(3) of ANSI/RESNET/ICC 301-2014 Addendum A-2015 Domestic Hot Water Systems

> This value is determined in accordance with ANSI/RESNET/ICC 301-2014 Addendum A- 2015 Domestic Hot Water Systems.

4.5 Determining clothes washer gpd in the rated home. Clothes washer gpd in the rated home shall be determined as:

$$\text{CW}_{\text{gpd}} = CAPw * CWwf * ACY/365$$

Where:

CAPw= washer capacity in cubic feet = the manufacturer's data or the CEC database or the EPA Energy Star website or the default value of 2.874 ft^3

CWwf= clothes washer water factor= manufacturer's data

ACY= Adjusted cycles per year determined in accordance with ANSI/RESNET/ICC 301-2014 Addendum A-2015 Domestic Hot Water Systems

> This value is determined in accordance with ANSI/RESNET/ICC 301-2014 Addendum A- 2015 Domestic Hot Water Systems.

4.6 Determining dish washer gpd in the rated home. Dish washer gpd in the rated home shall be determined as:

DWgpd = [(88.4+34.9*Nbr) * (12/dWcap) * (4.6415*(1/DW_EF)-1.9295)] / 365

Where:

Nbr= number of bedrooms in the rated home

dWcap= capacity of the dishwasher in the rated home (in table settings) as included in the manufacturer's data

DW_EF= The energy factor of the dishwasher installed in the rated home

> This value is determined in accordance with ANSI/RESNET/ICC 301-2014 Addendum A- 2015 Domestic Hot Water Systems.

4.7 Determining Toilet gpd in the rated home. Toilet gpd in the rated home shall be determined as:

$$Toilet_{gpd} = refFPO * gpf * Occ$$

Where:
refFPO= the reference flushes per person per day = 5.05
gpf= the average gallons per flush of all toilets installed in the rated home
Occ= the number of predicted occupants in the rated home= 1.09 + 0.54*Nbr
Nbr= the number of bedrooms in the rated home

4.8 Determining Water Softener gpd in the rated home. Water softener gpd in the rated home shall be determined as:

$$Soft_{gpd} = \frac{grains\ of\ hardness}{gallon\ of\ water} * sum\ of\ indoor\ water\ uses\ in\ the\ rated\ home$$
$$* \ gallons\ used\ per\ 1{,}000\ grains\ of\ hardness\ removed$$

4.9 Determining Other gpd in the rated home. Other gpd in the rated home shall be determined as:

$$Other = TotOther_{br} * Nbr$$

Where:
TotOther_br= the average value (in gpd) of other/unidentified usage per bedroom= 5.93 gpd
Nbr= the number of bedrooms in the rated home

4.10 Determining Excess Pressure Adjustment in the rated home. Excess pressure adjustment gpd in a rated home without a pressure-reducing valve or a pressure tank shall be determined as:

$$EP_{gpd} = MAX\ \{[(Showergpd + (0.5 * (LavFgpd + KitchFgpd\ +\ Othergpd))) * .006 * (PR - 90)], 0\}$$

Where:
PR = Static water pressure (in psi) measured at the indoor fixture outlet on the lowest floor and (if more than one) closest to the water service entry to the house

Note: Shower and lavatory faucets controlled by integral or accessory pressure-compensating devices may be excluded from this equation.

5.0 Determining Outdoor Rated Home GPD. The rated home outdoor GPD shall be calculated as:

If the rated home has an automatic irrigation system

$$\left[\frac{exp(A)}{1 + exp(A)}\right] * 1.18086$$
$$* \left[2.0341 * netET^{0.7154} * Rate_{Irr_{Area}}^{0.6227} + 0.5756 * ind_{Pool} * netET\right]$$

If the rated home does not have an automatic irrigation system

$$\left[\frac{\exp(B)}{1 + \exp(B)}\right] * 1.22257 * [1.4233 + 0.6311 * netET + 0.9376 * Rate\_Irr\_Area]$$

Outdoor Rated Home GPD shall never be lower than

$$\left[\frac{\exp(B)}{1 + \exp(B)}\right] * 1.22257 * [1.4233 + 0.6311 * netET + 0.9376 * Rate\_Irr\_Area]$$

Where:
Exp(A)= exponent of [1.4416 + 0.5069 * (Rate_Irr_Area/1,000)]
Exp(B)= exponent of [0.6911 + 0.00301 * netET * (Rate_Irr_Area/1,000)]
Irr_Area= The size of the landscape that might receive supplemental water in the rated home
netET= The annual historic sum of mean reference evapotranspiration minus the mean precipitation for all months that evapotranspiration exceeds precipitation
ind_Pool= Indicator representing the presence or absence of a swimming pool

5.1 Smart Controllers. Sensor and weather based irrigation controllers that are certified by the U.S. EPA WaterSense program shall decrease the portion of predicted rated home outdoor water use associated with irrigation (less the water use associated with pools) by 15% in homes that have automatic irrigation

5.2 Residential Irrigation Capacity Index (RICI). In rated homes where documentation is provided, a RICI may be calculated as

$$RICI_{rat} = \frac{sum\ of\ flow\ (gpm)\ of\ all\ irrigation\ valves}{ft^2\ irrigated\ area} * 1,000$$

5.2.1 Applying RICI. A rated home where documentation for a RICI is provided may adjust the portion of water use associated with irrigation (less the water use associated with pools) in the rated home's outdoor gpd by 10% for every point from a baseline RICI (RICI_ref) of 5.

5.3 Commissioning of an Automatic Irrigation System. In rated homes where documentation has been provided, the water use associated with irrigation shall be decreased by 5% were a certified professional (as identified by a certification labeled by the U.S. EPA WaterSense program or other certification program identified by RESNET) in accordance with ASABE 626 verifies:

- DU is at least 65% on turf areas
- Sprinklers are operating at the correct pressure +/- 10%
- The system operates without leaks
- The system prevents runoff and overspray from leaving the property (checked during the audit)
- Two seasonal water schedules (initial grow-in period and established landscape) are posted at the controller

Appendix A: Applying adjustments to the outdoor water use of rated homes. Because the HERS_{H2O} Index model includes a number of percent adjustments for the outdoor water use of the rated home, the order of application becomes important. The correct order in which to apply these adjustments is as follows:

1	Use of a smart controller	Reduces the outdoor water use in the rated home by 15% for using a smart controller as defined in section 5.1
2	Use of the RICI adjustment	Adjusts the outdoor water use in the rated home by 10% for every point of RICI reduction below a baseline of 5 as defined by section 5.2
3	Commissioning adjustment	Adjusts the outdoor water use in the rated home by 5% when a certified irrigation professional commissions the system as defined in section 5.3.