National Association of State Energy Officials (NASEO)

NATIONAL HOME ENERGY RATING TECHNICAL GUIDELINES

September 19, 1999

A. GENERAL PROVISIONS

1. Purpose. The provisions of this document are intended to establish national residential energy efficiency rating Guidelines, consistent with the provisions of the Energy Policy Act of 1992, which any provider of home energy ratings may follow to produce uniform energy efficiency ratings for residential buildings.

a. Relationship to other Guidelines. These Guidelines are a companion document to the "National Accreditation Procedures for Home Energy Rating Systems" as promulgated and maintained by the National Association of State Energy Officers (NASEO) and the Residential Energy Services Network (RESNET), and recognized by the mortgage industry.

b. Relationship to State Law. These Guidelines specifically recognize the authority of each state that has a state law or regulation which requires certification or licensing of home energy rating systems. To the extent that such state laws or regulations differ from these Guidelines, state law or regulation shall govern.

2. Scope. These Guidelines apply to existing or proposed, site-constructed or manufactured, one and two family residential buildings, or other residential buildings three stories or less in height excepting hotels and motels.

3. Definitions and acronyms.

Accreditation Procedures – The set of standards and procedures entitled "Mortgage Industry National Accreditation Procedures for Home Energy Rating Systems" as published and maintained by NASEO and RESNET.

Adiabatic – A condition wherein heat neither enters nor leaves a system.

Annual Fuel Utilization Efficiency or *AFUE* – The ratio of annual output energy to annual input energy that includes any non-heating season pilot input loss.

Climate zone – A geographical area defined as having similar long-term climate conditions.

COP – Coefficient of Performance, which is the ratio of the rate of heat delivered to the rate of energy input, in consistent units, for a complete heat pump system under designated operating conditions.

Conditioned space boundary – The continuous planes of the building envelope that comprise the primary thermal and air flow barrier between the directly or indirectly conditioned space and either the outdoors or an adjacent unconditioned space.

Confirmed Rating – An energy rating accomplished using data gathered from an on-site

audit inspection and, if required, performance testing of the physical building and its installed systems and equipment.

Data analyst – A person trained to enter the information compiled by a data collector into the rating tool and to produce the energy efficiency rating of a home.

Data collector – A person trained to evaluate the minimum rated features of a home on site and collect all the information required to create a rating.

Detached one- and two-family dwelling – A building with one or two independent dwelling units with an individual or central HVAC system.

Directly Conditioned space – An enclosed space having heating equipment with a capacity exceeding 10 BTU/hr-ft^2, or cooling equipment with a capacity exceeding to 10 BTU/hr-ft^2. An exception is if the heating and cooling equipment is designed and thermostatically controlled to maintain a process environment temperature less than 65E Fahrenheit or greater than 85E Fahrenheit for the whole space the equipment serves.

Distribution System Efficiency – A system efficiency factor, not included in manufacturer's performance ratings for heating and cooling equipment, that adjusts for the energy losses associated with the delivery of energy from the equipment to the source of the load, such energy losses associated with heat transfer across duct or piping walls and air leakage to or from forced air distribution systems.

Energy analysis tool – A calculation procedure for determining a home's energy efficiency rating and estimating annual purchased energy consumption and cost.

EER – Energy Efficiency Ratio, which is the ratio of net equipment cooling capacity in Btu/h to total rate of electric input in watts under designated operating conditions.

Energy efficiency rating or rating – An unbiased indication of a home's relative energy efficiency based on consistent inspection procedures, operating assumptions, climate data and calculation methods.

Energy factor – A measure of water heater energy efficiency as determined under Department of Energy Regulations, 10 CFR 430.23(e)(2)(ii).

Energy saving measure or feature – Any material, component, device, system, construction method, process or combination thereof that will result in a reduction of energy use.

EPAct – The U.S. Energy Policy Act of 1992.

Estimated annual energy cost savings – Positive dollar difference between estimated annual energy costs for a home with energy saving measures and estimated annual energy costs of the same home in its current condition.

Exposed wall – Walls subjected to heat loss or gain.

Fenestration – A glazed opening and its associated sash and framing that is installed into a building.

Guidelines (HERS Guidelines) Minimum criteria that a HERS Provider must meet in order to receive accreditation.

HERS – Home energy rating system.

HERS-BESTEST – The Home Energy Ratings System Building Energy Simulation Test published in NREL Report No. NREL/TP-472-7332.

HERS provider – A person or organization that develops, manages, and operates a home

energy rating system.

Home – A one or two family dwelling or multi-family dwelling of three stories or less.

Home energy rater or rater – The person trained to perform the functions of both a data collector and a data analyst, and to inspect a home to evaluate the minimum rated features and prepare an energy efficiency rating (see also Data collector and Data analyst).

Home Energy Rating System or HERS – The materials and procedures needed to operate a home energy rating program including but not limited to: marketing materials, training materials, publications, rating tool, quality control, data bases collection and maintenance, agreements, data collection sheets, home owner reports, and other related materials and services.

HSPF – Heating Seasonal Performance Factor which is the total heating output of a heat pump during its normal annual usage period for heating, in Btu, divided by the total electric energy input during the same period, in watt-hours.

HVAC – Heating, Ventilating and Air Conditioning.

Indirectly Conditioned space – Enclosed space that is not directly conditioned:

(1) With area weighted heat transfer coefficient (U-value) to directly conditioned space exceeding that to the outdoors or to unconditioned spaces; or

(2) through which air to or from directly conditioned spaces is transferred at a rate exceeding three air changes per hour.

Internal gains – The heat gains within a home attributable to lights, people, and miscellaneous equipment including domestic hot water equipment losses.

MEC '93 – the Model Energy Code as promulgated by the Council of American Building Officials (CABO) in 1993 as amended in 1994.

NASEO – National Association of State Energy Officers.

NREL – National Renewable Energy Laboratory.

Projected Rating – A rating performed prior to the construction of a new building or prior to implementation of energy-efficiency improvements to an existing building.

Purchased energy – The portion of the total energy requirement of a home purchased from a utility or other energy supplier.

Rated Home – The specific home being evaluated using the rating procedures and Guidelines contained in this document.

Rating tool – A procedure for calculating a home's energy efficiency rating, annual energy consumption, and annual energy costs.

Reference Home – A hypothetical home configured in accordance with the specifications set forth in Section B.4 of these Guidelines.

RESNET – Residential Energy Services Network.

R-value – thermal resistance value measured in h-ft^2-F/Btu.

SEER – Seasonal Energy Efficiency Ratio, which is the total cooling output of an air conditioner during its normal annual usage period for cooling, in Btu/h, divided by the total electric energy input during the same period, in watt-hours.

Thermal boundary wall – Any wall that separates directly or indirectly conditioned space from unconditioned space or ambient conditions.

Above grade thermal boundary wall is any thermal boundary wall not in contact with soil.

Thermal storage mass – Materials or equipment incorporated into a home that will store heat, produced by renewable or non renewable energy, for release at a later time.

Typical Meteorological Year or TMY Data – Hourly climate data published by the National Climatic Center, Asheville, NC, based on historical climate data in 216 locations.

U-value – Thermal transmittance value measured in Btu/h-ft^2-F.

B. TECHNICAL REQUIREMENTS FOR CONDUCTING RATINGS

1. Rating procedure

a. To determine the energy efficiency rating of a home, all HERS provider shall–
   (1) If rating an existing home, visit the home to collect the data needed to calculate the rating;
   (2) If rating a new, to-be-built home, follow the procedures set forth in Section B.8 of these Guidelines to collect the data needed to calculate the rating;
   (3) Use the collected data to estimate the annual purchased energy consumption for heating, cooling and water heating for both the Rated Home and the Reference Home as defined in Section B.4 of these Guidelines.
   (4) If the energy efficiency rating is conducted to evaluate proposed energy conserving improvements to the home, calculate additional estimates of annual purchased energy consumption with the home reconfigured to include those improvements sufficient to consider interactions among improvement options.

b. Estimates completed by all HERS providers under paragraphs a.(3) and a.(4) of this section must be–
   (1) Based on the minimum rated features set forth in Section B.5 of these Guidelines.
   (2) Conducted using the standard operating assumptions established in Section B.6 of these Guidelines.
   (3) Conducted using an energy analysis (rating) tool that has been certified for accuracy under Section C.1 of these Guidelines.

c. All HERS providers shall compare the estimates provided under paragraph B.1.a. of this section to determine the energy efficiency rating of the home and, if applicable, the energy efficiency rating of the home with proposed conservation measures installed.

d. To encourage the use of energy efficient lights and appliances, HERS providers may provide additional information on estimated lights and appliance energy consumption in the Rated Home. This information shall not change the rating score set forth in Section B.2.a. of these Guidelines.

2. Rating point score and star rating.

a. Point score. The Reference Home shall have a point score of 80 points on a 0 to 100 point scale. Each 5% increase or decrease in the relative energy efficiency

potential of the Rated Home with respect to the Reference Home shall constitute a 1-point increase or decrease, respectively (from 80), in the Rated Home's score. The method used to calculate the score shall be approved by the accrediting body and be consistent for each HERS provider operating within a state. Except in states or territories whose laws or regulations require a specific alternative method, which shall control, equations 1 and 2 shall be used in a 2-step process to calculate the point score for the Rated Home, as follows:

Step (1) Calculate the individual normalized Modified End Use Loads (nMEUL) for heating, cooling, and hot water using equation 1:

nMEUL = REUL * (nEC_x / EC_r) **(Eq. 1)**

where:

nMEUL = normalized Modified End Use Loads (for heating, cooling or hot water).

REUL = Reference Home End Use Loads (for heating, cooling or hot water) as computed using accredited simulation tools.

nEC_x = normalized Energy Consumption for Rated Home's end uses (for heating, cooling or hot water).

EC_r = estimated Energy Consumption for Reference Home's end uses (for heating, cooling or hot water) as computed using accredited simulation tools.

and where:

nEC_x = (a* EEC_x – b)*(EC_x * EC_r) / (EEC_x * REUL)

where:

EC_x = estimated Energy Consumption for the Rated Home's end uses (for heating, cooling or hot water) as computed using accredited simulation tools.

EEC_x = Equipment Efficiency Coefficient for the Rated Home's equipment, such that EEC_x equals the energy consumption per unit load in like units as the load, and as derived from the Manufacturer's Equipment Performance Rating (MEPR) such that EEC_x equals 1.0 / MEPR for AFUE, COP or EF ratings, or such that EEC_x equals 3.413 / MEPR for HSPF, EER or SEER ratings.

and where the coefficients 'a' and 'b' are as defined by Table 1 below:

Table 1. Coefficients 'a' and 'b'

Fuel type and End Use	a	b
Electric space heating	1.9924	0
Natural gas space heating	1.2544	0.6082
Fuel oil space heating	2.4321	2.1180
Electric air conditioning	2.9301	0
Electric water heating	0.8800	0
Natural gas water heating	0.9404	0.7415
Fuel Oil water heating	1.5569	1.9376

Step (2) Determine the point score using equation 2:

Point score = 100 - ((TnML / TRL) * 20) **(Eq. 2)**

where:

TnML = $nMEUL_{HEAT}$ + $nMEUL_{COOL}$ + $nMEUL_{HW}$ (Total of all normalized Modified End Use Loads as calculated using equation 1).

TRL = $REUL_{HEAT}$ + $REUL_{COOL}$ + $REUL_{H\ W}$ (Total of all Reference Home End Use Loads).

b. Star rating. The Rated Home will be given a star rating between one and five-plus stars, determined by the numerical score and the corresponding number of stars depicted in Table 2:

TABLE 2. Score, Star and Efficiency Scales for Rated Homes

Score Range	Stars	Relative Efficiency Change (with respect to Reference Home)
=>0 and <20	**i**	=>-400% and < -300%
=>20 and <40	**i** +	=>-300% and < -200%
=>40 and <50	**i i**	=>-200% and <-150%
=>50 and <60	**i i** +	=>-150% and < -100%
=>60 and <70	**i i i**	=>-100% and <-50%
=>70 and <80	**i i i** +	=>-50% and <0%
=>80 and <83	**i i i i**	=>0% and <15%
=>83 and <86	**i i i i** +	=>15% and <30%
=>86 and <90	**i i i i i**	=>30% and <=50%
=>90 and <=100	**i i i i i** +	=>50%

3. Rating report.

a. For each rating conducted under this part, a report shall be prepared containing, at a minimum, the following information:
   (1) The numerical rating score determined in Section B.2.a of these Guidelines;
   (2) The star rating determined in Section B.2.b of these Guidelines, except that all plus (+) ratings other than 5+ are optional;
   (3) The estimated annual purchased energy consumption for space heating, space cooling, domestic hot water, and all other energy use, and the total of these four estimates;
   (4) The estimated annual energy cost for space heating, space cooling, domestic hot water, and all other energy use, and the total of these four estimates;
   (5) The unique physical location (full street address or recorded real property identifier) of the Rated home;
   (6) The name of the individual accomplishing the rating;
   (7) The date the rating was accomplished; and
   (8) The rating tool (including version number) used to calculate the rating;

b. If ratings are conducted to evaluate energy saving improvements to the home, in addition to the information set forth under paragraph B.3.a of this section, each rating report must include–
   (1) The estimated annual energy cost savings for the home reconfigured to include those improvements;
   (2) The discount rate applied to, and present worth value of the energy cost savings; and
   (3) The financing interest rate and the life of the measures used by the HERS provider to determine the present worth value.

c. The rating report must also provide either:
   (1) The estimated lights and appliance energy consumption of the Rated Home: or
   (2) Information that additional energy savings related to lights and appliance use may be attainable and that the information available on Energy Guide labels and from other recognized sources may be used to consider the energy efficiency of appliances.

d. If a Projected Rating conducted under Section B.8.a of these Guidelines, the Rating shall be identified as a Projected Rating.

e. For each rating conducted under these Guidelines, the following items are to be prominently displayed on all reports and labels:
   (1) Date of the rating;
   (2) Annual estimated energy costs for heating, cooling, water heating and all other use;
   (3) Rating point score; and
   (4) Star rating;
   (5) As an alternative to reporting the rating point score and star rating, any

home achieving a rating score of 86 or greater may, at the request of the person for whom the rating is being conducted, be labeled an ENERGY STAR® Home.

4. Reference Home configuration.

a. All HERS providers shall establish a Reference Home used in an annual purchased energy consumption comparison with the Rated Home. The Reference Home is a hypothetical home having the following characteristics –

(1) The same shape and size as the Rated Home;

(2) The same area of surfaces bounding Conditioned Space as the Rated Home,

(3) All enclosure elements that meet, but not exceed, the requirements, expressed as U and U_o values, of Paragraph 502.2 of MEC '93 with the components that meet the U_O requirement for walls determined by:

(a) For detached one and two family homes, the U-values for wall assemblies from Table 3a; or

(b) For attached homes, the U-values for wall assemblies from Table 3b; and for all homes-

Table 3a. Opaque wall U-values (U_W) for detached homes

Heating degree days base 65 (HDD65) From nearest location listed in Chapter 9 of ASHRAE Standard 90.2	U_W air to air Includes framing
> 13000	0.038
9000-12999	0.046
6500-8999	0.052
4500-6499	0.058
3500-4499	0.064
2600-3499	0.076
<2600	0.085

Table 3b. Opaque wall U-values (U_W) for attached homes

Heating degree days base 65 (HDD65) From nearest location listed in Chapter 9 of ASHRAE Standard 90.2	U_W air to air Includes framing
>9000	0.064
7100-8999	0.076
3000-7099	0.085
2800-2999	0.100
2600-2799	0.120
<2600	0.140

(c) The U-values for fenestration calculated using Equation 3 or U=1.3, whichever is less;

Equation 3: $\mathbf{U_F = [(U_O \times A_O)-(U_W \times A_W)-8]/A_F}$

Where:

U_F = Required average U-value of the fenestration systems.

U_O = Average U-value requirement for walls from paragraph 502.2 of MEC '93.

A_O = Gross exposed wall area, not including basement walls, of the Rated Home.

U_W = Value from Table 2a or 2b based on HDD65 criteria of Rated Home location.

A_W = Net opaque wall area, calculated as: $A_O - A_F - 40$.

A_F = Area of fenestration calculated using the gross area calculated under Section B.4.a.7. of these Guidelines.

Note: For walls of attached homes, the U-value calculation in paragraph (3) above is completed using the fenestration area calculated as A_F in Section B.4.a.7 of these Guidelines and the actual area of walls that experience heat loss or gain. Areas of common walls that separate homes are not included in $\mathbf{A_O}$, Equation 3.

(4) The same foundation type as the Rated Home, where:

(a) For Rated Homes on ventilated crawl spaces, assume for the Reference Home, insulation of the floor above the crawl space meeting the requirements of MEC '93;

(b) For Rated Homes on non-ventilated crawl spaces, assume for the Reference Home, insulation of the crawl space walls meeting the requirements of MEC '93;

(c) For Rated Homes on basements that are directly or indirectly conditioned spaces, assume for the Reference Home, insulation of the basement walls meeting the requirements of MEC '93;

(d) For Rated Homes with slab on grade construction, assume insulation of the slab edge meeting the requirements of MEC '93;

(5) Solar absorptivity of opaque areas of exterior walls of 0.50 and of opaque areas of roofs of 0.75;

(6) An area of exterior doors of 40 square feet, facing north, and with the door U-value at 0.20.

(7) Vertical fenestration area (A_F)is determined-

(a) for one and two family detached homes, by equation 4;

(b) for attached homes, by equation 5.

Equation 4: $\mathbf{A_F = 0.18 \times A_{FL} \times F_A}$

Equation 5: $\mathbf{A_F = 0.18 \times A_{FL} \times F_A \times F}$

Where:

A_F = Total fenestration area.

A_{FL} = Total floor area of directly conditioned space.

F_A = (Above grade thermal boundary wall area)/(total thermal boundary wall area).

F = (Above grade thermal boundary wall area)/(above grade thermal boundary wall area + common wall area)>=.56

And where:

Thermal boundary wall is any wall that separates directly or indirectly conditioned space from unconditioned space or ambient conditions.

Above grade thermal boundary wall is any thermal boundary wall not in contact with soil.

(8) Vertical fenestration distributed-

(a) For detached homes, equally in each of the four cardinal directions, north, south, east and west; and

(b) For attached homes, equally in each of the four cardinal directions, north, south, east and west, which if necessary may require fenestration facing the same direction as common walls;

(9) A frame factor equal to 27% of the gross fenestration area calculated under Section B.4.a.7. of these Guidelines;

(10) The glazed area of the fenestration with a shading coefficient (SC) of 0.70 assumed during the cooling season, which represents the combined SC of the glazing and the use of nonwhite draperies; and with a SC of 0.88, representing the SC of the glazing only, assumed at all other times;

(11) No external shading assumed at any time;

Note: For the calculation of solar gains from all fenestration areas determined under Section B.4.a.7. of these Guidelines, the values in Table 4 are used to represent the combined effect of the framing factor in Section B.4.a.9. of these Guidelines and the glazed area shading coefficients in Section B.4.a.10. of these Guidelines.

Table 4. Shading and Solar Heat Gain Coefficients

Season	SC[1]	SHGC[2]
Heating	0.675	0.581
Cooling	0.541	0.466

[1] For calculation tools using shading coefficients

[2] For calculation tools using solar heat gain coefficients as defined by NFRC 200.

(12) The same fuel type for heating, cooling and water heating as used in the Rated Home.

(13) One each heating, cooling and hot water system of the same type as in the Rated Home except as required by the exceptions in Section B.4.a.14. of these Guidelines;

(14) If the Rated home contains multiple heating, cooling or water heating systems using different fuel types, then the applicable Reference Home system capacities and fuel types shall be weighted in accordance with the loads distribution (as calculated by accepted engineering practice for that equipment and fuel type) of the subject multiple systems.

(15) The minimum NAECA efficiency in effect on January 1, 1992 for the same type of HVAC equipment found in the Rated Home except that the efficiencies given in Table 5 will be assumed when;

(a) A type of device not covered by NAECA is found in the Rated Home;

(b) The Rated Home is heated by electricity using a device other than an air source heat pump; or

(c) The Rated Home does not contain one or more of the required HVAC equipment systems.

Table 5. Reference Home Equipment Efficiencies

Rated Home Fuel	Function	Reference Home Device
Electric	Heating	6.8 HSPF Air Source Heat Pump
Non Electric Warm Air Furnace	Heating	78% AFUE Gas Furnace
Non Electric Boiler	Heating	80% AFUE Gas Boiler

Rated Home Fuel	Function	Reference Home Device
Any Type	Cooling	10 SEER Electric Air Conditioner

(16) The sizing of HVAC equipment determined in accordance with accepted engineering practice for that equipment and fuel type.

(17) A distribution system efficiency of 0.80, which is to be multiplied by the equipment efficiencies determined under Section B.4.a.15. of these Guidelines.

(18) The efficiency of the water heater;

(a) For Rated Homes with a storage type water heater, the minimum NAECA Energy Factor in effect on January 1, 1992 for the fuel type and size found in the Rated Home;

(b) For Rated Homes with a non-storage type water heater, the minimum NAECA Energy Factor in effect on January 1, 1992 is used to provide domestic hot water in the Rated Home.

(c) For Rated Homes without water heaters, the minimum NAECA Energy Factor in effect on January 1, 1992 for a 40 gallon storage type water heater using the same fuel as the predominant heating fuel type in the Rated Home shall be used for the purpose of calculating the HERS Score. (Note: This energy use may be excluded from the purchased energy cost estimate for the Rated Home.)

(19) An annual average air change rate as determined from normalized building leakage (nL) using Equation 6.

Equation 6: ach = nL x W

where:

ach = average annual air changes per hour

nL (normalized leakage) = 0.57 for the Reference Home.

W = Weather factor from W Tables in ASHRAE Standard 136 for the site most climatologically representative of the Rated Home's location.

(20) An internal mass for furniture and contents of 8 pounds per square foot of floor area;

(21) Only the structural mass and associated heat capacitance calculated as follows:

(a) For masonry floor slabs, as found in the Rated Home;

(b) For masonry basement walls, as found in the Rated Home, but with any basement wall insulation as required under paragraph (3) assumed to be located on the interior side of the basement walls;

(c) For walls other than basement walls, for ceilings, floors, and interior partition walls, using equivalent areas to the Rated Home assuming light frame construction.

5. Minimum rated features.

a. All HERS providers shall calculate the estimated annual purchased energy consumption for heating, cooling and water heating set forth in Section B.1 of these Guidelines using the energy loss and gain associated with the minimum rated features set forth in Table 7.

b. For existing homes, the envelope thermal characteristics of building elements 1 through 7 set forth in Table 7 are determined by site observation.

c. If data for the minimum rated features set forth in paragraph (b) of this Section can not be obtained by observation or without destructive disassembly of the home, all HERS providers shall use default values. The default values are determined from the following sources listed in the preferential order of use:
   (1) for manufactured homes, available manufacturer's data:
   (2) current and historical local building practices; or
   (3) current and historical local building codes.

d. Default values set forth in paragraph (c) of this section shall be established or approved by the accrediting body and be consistent for all HERS providers operating within a state.

e. For existing homes, the determination of air leakage and duct leakage values set forth as building elements 10 and 11 in Table 7 are determined by data collected on site using the following procedures listed in preferential order of use:
   (1) current on-site diagnostic tests conduced in accordance with nationally accepted pressurization test standards; or
   (2) observations of the condition of the building and duct system made by the HERS provider. Based on these observations values used will be;
      (a) for envelope air leakage, a minimum normalized leakage rate of nL = 0.67, where nL may be converted to an air change rate using Equation 6 of Section B.4.a(19) to compute average annual air changes per hour(ach); and
      (b) for distribution system efficiency, default values in accordance with Table 6, below.
   (3) The energy efficiency of the mechanical equipment set forth as building elements 12 through 14 in Table 7 is determined by data collected on site using the following sources listed in preferential order of use:
      (a) current on-site diagnostic test data as corrected using the following equation:

$$Eff,rated = Eff,listed * Es,measured / Es,listed$$

where:

Eff,rated = annual efficiency to use as input to the rating
Eff,listed = listed annual efficiency by manuf. or directory
Es,measured = measured steady state efficiency of system
Es,listed = manufacturer's listed steady state efficiency, under the same operating conditions found during measurement

(b) name plate data;
(c) manufacturer's data sheet; or
(d) equipment directories.

Table 6. Default Values [1] for Distribution System Efficiencies

Distribution System Configuration and Condition:	Forced Air Systems		Hydronic Systems[2]	
	Heating	Cooling	Heating	Cooling
Observable leakage pathways [3] with distribution system components located in *unconditioned* space	0.70	0.70		
Observable leakage pathways with entire distribution system located in *conditioned* space [4]	0.75	0.75		
Distribution system components located in *unconditioned* space	0.80	0.80	0.95	0.95
Entire distribution system located in *conditioned* space	0.85	0.85	1.00	1.00
Proposed [5] "leak free" with entire air distribution system located in the *conditioned* space	1.00	1.00		
Proposed "leak free"air distribution system with components located in the *unconditioned* space	0.95	0.95		

Table 6. Default Values [1] for Distribution System Efficiencies

Distribution System Configuration and Condition:	Forced Air Systems		Hydronic Systems[2]	
	Heating	Cooling	Heating	Cooling
"Ductless"[6] systems	1.00	1.00		

Table 6 Notes:

1. *Default values* given by this table are for distribution systems that have been visually inspected only, and which meet MEC '93 minimum requirements for duct system insulation. Visual inspection is **not** the recommended method of determining forced air distribution system leakage. The recommended and preferred method of determining forced air distribution system leakage is through pressurization testing accomplished in accordance with Section B.5.e.(1) of this Guideline.
2. *Hydronic systems* shall mean those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed loop piping and that do not depend on ducted, forced air flows to maintain space temperatures.
3. *Observable leakage pathways* shall mean that elements of the air distribution system (including joints, seams, connection flanges, collars, boots, panned ducts, construction cavities used as airflow pathways, and other like system components) can be visually determined to contain one or more flaws through which unconditioned air may be forced into or out of the designated air duct system.
4. *Entire system in conditioned space* shall mean that no component of the distribution system, including the air handler unit, is located outside of the plane of the conditioned space boundary. Conditioned space shall mean any building space directly or indirectly heated or cooled in accordance with the definitions provided in section A.3. of this Guideline. Any other air distribution system condition results in *system components located in unconditioned space*.
5. *Proposed "leak free"* shall mean *substantially leak free* as defined by the 1998 IECC (International Energy Conservation Code) to be a leakage rate of not more than 5% of the rated fan flow rate at a pressure differential of 25 Pascal across the entire system, including the manufacturer's air handler enclosure. This ***proposed condition is reserved for Projected Ratings*** and must be specified as the required performance in the construction documents. This proposed condition ***requires confirmation through field testing*** of installed systems.
6. Ductless systems may have forced air flow across a coil but shall not have any ducted air flows external to the manufacturer's air handler enclosure.

f. If the Rated Home does not utilize at least one each heating, cooling and hot water system, the Reference Home equipment efficiencies as specified in section B.4.a.(15) shall be assumed for the relevant missing system(s) in the Rated Home for the purposes of calculating the rating.

g. If the Rated Home utilizes multiple heating, cooling or hot water systems, the

operating conditions specified in Section B.6 of these Guidelines shall be used for each system and the relevant purchased energy consumption calculations shall be appropriately weighted by system capacity in accordance with the loads distribution as calculated by accepted engineering practice for that equipment and fuel type.

h. If information on the energy efficiency of mechanical equipment cannot be determined from the sources listed in paragraph (3) of this section, the values set forth in Tables 8 and 9 shall be used.

i. Any HERS provider may base annual purchased energy consumption estimates for the Rated Home on additional features if the HERS provider's energy analysis tool is capable of doing so.

TABLE 7.-- Minimum Rated Features

Building element	Minimum rated features
1. Floor/Foundation Assembly.	Construction type (slab-on-grade, crawl space; basement), insulation (edge, under slab, cavity, sheathing), vented or unvented (crawl space), capacitance (if slab or basement receives appreciable solar gain).
2. Walls	Construction type, insulation value (cavity, sheathing); capacitance, color (light, medium, or dark).
3. Roof/Ceiling Assembly	Construction type, insulation value (cavity, sheathing), roof color (light, medium, or dark).
4. Rim Joist	Insulation value (cavity, sheathing).
5. Doors	Construction type, insulation value.
6. Windows	Construction type, orientation, U-value (of complete assembly), solar heat gain coefficient, shading.
7. Skylights	Construction type, orientation, tilt, U-value (of complete assembly), heat gain coefficient, shading.
8. Passive Solar System (Direct Gain system)	Solar type, collector type and area, orientation, tilt efficiency, storage tank size, pipe insulation value.
9. Solar Domestic Hot Water Equipment	System type, collector type and area, orientation, tilt, efficiency, storage tank size, pipe insulation value.
10. Air Leakage	Air leakage measurement type (default estimate, blower door test, tracer gas test), volume of conditioned space.
11. Distribution System	System type, location, insulation value (duct and pipe), air leakage measurement type (default estimate, duct blaster, pressure pan threshold, blower door subtraction).

TABLE 7.-- Minimum Rated Features

Building element	Minimum rated features
12. Heating Equipment	Equipment type, location, efficiency (AFUE, HSPF).
13. Cooling Equipment	Equipment type, location, efficiency (SEER, COP).
14. Domestic Hot Water Equipment	Equipment type, location, energy factor or seasonal efficiency, extra tank insulation value, pipe insulation value.
15. Control Systems	Thermostat type.

TABLE 8.– Default Values for Mechanical System Efficiency (Age-based)

Mechanical Systems	Units	Pre-1960	1960-69	1970-74	1975-83	1984-87	1988-91	1992 to present
Heating:								
Gas Furnace	AFUE	0.60	0.60	0.65	0.68	0.68	0.76	0.78
Gas Boiler	AFUE	0.60	0.60	0.65	0.65	0.70	0.77	0.80
Oil Furnace or Boiler	AFUE	0.60	0.65	0.72	0.75	0.80	0.80	0.80
Air-Source Heat Pump	HSPF	4.50	4.50	4.70	5.50	6.30	6.80	6.80
Ground-Water Geothermal Heat Pump	COP	2.70	2.70	2.70	3.00	3.10	3.20	3.50
Ground-Coupled Geothermal Heat Pump	COP	2.30	2.30	2.30	2.50	2.60	2.70	3.00
Cooling:								
Air-Source Heat Pump	SEER	5.00	6.10	6.50	7.40	8.70	9.40	10.00
Ground-Water Geothermal Heat Pump	EER	10.00	10.00	10.00	13.00	13.00	14.00	16.00
Ground-Coupled Geothermal Heat Pump	EER	8.00	8.00	8.00	11.00	11.00	12.00	14.00
Central Air Conditioner . . .	SEER	5.00	6.10	6.50	7.40	8.70	9.40	10.00
Room Air Conditioner	EER	5.00	6.10	6.10	6.70	7.70	8.10	8.50
Water Heating:								
Storage Gas	EF	0.47	0.47	0.47	0.49	0.55	0.56	0.56
Storage Oil	EF	0.47	0.47	0.47	0.48	0.49	0.54	0.56
Storage Electric	EF	0.79	0.80	0.80	0.81	0.83	0.87	0.88

TABLE 9.– Default Values for Mechanical System Efficiency (not Age-based)

	Units	Rating

TABLE 9.– Default Values for Mechanical System Efficiency (not Age-based)

Heating:		
Gas Wall Heater (Gravity)	SE	0.65
Gas Floor Furnace	SE	0.60
Gas Water Heater (Space Heating).	AFUE	0.75
Electric Furnace	HSPF	3.413
Electric Radiant	HSPF	3.413
Heat Pump Water Heater (Space)	HSPF	5.11
Electric Water Heater (Space)	HSPF	2.73
Cooling:		
Electric Evaporative Cooling	EER	30
Gas Absorption Cooler	COP	0.40
Water Heating:		
Heat Pump	COP	2.00
Instantaneous Electric	EF	0.87
Instantaneous Gas	EF	0.75
Solar (Use SRCC Adjustment Procedures)	EF	2.00

6. Operating condition assumptions.

a. Alternate operating conditions assumptions shall only be used where authorized by state law or regulation. Alternate operating condition assumptions shall be applied equally to both the Reference Home and the Rated Home and shall be consistent for all HERS providers operating within the state.

b. All HERS providers shall estimate the annual purchased energy consumption for heating, cooling and hot water for both the Rated Home and the Reference Home using the following assumptions–

(1) Temperature control set points for heating and cooling of 68EF and 78EF, respectively;

(2) Where programmable offsets are available in the Rated Home, 5EF temperature control point offsets with an 11 p.m. to 7 a.m. schedule for heating and a 9 a.m. to 3 p.m. schedule for cooling, and with no offsets assumed for the Reference Home;

(3) Internal heat gains from lights, people and equipment of 72,000 Btu/day

for detached homes and 36,000 Btu/day for attached homes;

(4) When calculating annual purchased energy for cooling, internal latent gains assumed as 0.20 times sensible internal heat gains;

(5) Estimated hot water usage based on Equation 7.

Equation 7: Gallons/day = 30 gallons+(10 gallons* number of bedrooms).

(6) The climatologically most representative TMY or equivalent climate data, which may be interpolated between climate sites if interpolation is established or approved by the accrediting body and consistent for all HERS providers operating within a state.

(7) Corrections for climate conditions and mis-sizing of equipment, using correction factors to HSPF, SEER and AFUE that are established or approved by the accrediting body and consistent for all HERS providers operating within a state.

(8) Local residential energy or utility rates that–

(a) Are revenue-based and include customer service and fuel charges;

(b) Are updated at least annually; and

(c) Are confirmed by the accrediting body.

7. Non-rated energy consuming devices. Consistent with Section B.3.a.(3) and (4) of these Guidelines all HERS providers shall calculate and report the annual purchased energy consumption and energy cost for the operation of all non-rated energy consuming devices in the Rated and Reference Homes. Actual efficiency of these devices is not considered and usage estimates are based on Table 10. The data in Table 10 may be modified if they are established or approved by the accrediting body consistent for all HERS providers operating within the state.

TABLE 10.–Annual Energy Use for Non-Rated Features

End use	Units/year	Energy estimate	Applicability
Ceiling Fan	kWh	220/ea	If present.
Dishwasher	kWh	299/per cooking area	If present, or if space is dedicated for DW.
Dryer, electric	kWh	875/ea	If present, or if 220V wiring is present @ dryer location
Dryer, gas	Therms kWh	60/ea 100/ea	If present, or if gas piping is present @ dryer location. a

TABLE 10.–Annual Energy Use for Non-Rated Features

End use	Units/year	Energy estimate	Applicability
Lights	kWh	940	All homes.
Microwave Oven-built-in	kWh	191/per cooking area	If permanently installed.
Miscellaneous Plug Loads	kWh	500	All homes.
Pool Pump	kWh	1700/ea	If present
Range/Oven Combo-electric	kWh	450/per cooking area	If present, or if 220V wiring is present @ range location.
Range/Oven Combo-gas w/pilot	Therms	44/per cooking area	If present, or if gas piping is present @ range location
Range/Oven Combo-gas w/o pilot	Therms	22/per cooking area	If present.
Refrigerator	kWh	1150	Each one present.
Television	kWh	720	All homes.
Washer, clothes	kWh	99/ea	If present, or facilities present for washer.
Well pump	kWh	288/ea	If present.

8. Projected Ratings for to-be-built or to-be-improved homes.

a. A HERS provider may calculate the Projected Rating of a to-be-built or to-be-improved home based on architectural drawings with material, mechanical and electrical specifications for a to-be-built home, or based on a site audit for a to-be-improved home; and by:

(1) Using either the envelope leakage rate specified as the required performance by the construction documents, the site-measured envelope leakage rate, or a default value for normalized leakage of nL = 0.67, where nL may be converted to an air change rate using Equation 6 of Section B.4.a(19) to compute average annual air changes per hour(ach);

(2) Using either the distribution system efficiency specified as the required performance by the construction documents, the site-measured distribution system efficiency, or a default distribution system efficiency value from Table 6; and

(3) Using the planned location and orientation of the proposed home, or if

the proposed orientation is unknown, calculating ratings for the home facing each of the four cardinal directions, north, south, east and west, and using the lowest rating score as the Projected Rating.

b. Upon completion of construction and verification of the proposed specifications, all rated features of the home shall be confirmed using site inspections and envelope air leakage rates and distribution system efficiencies derived from on-site diagnostic tests conducted in accordance with Section B.5.e.(1) of this Guideline, and the actual orientation of the home.

C. ADMINISTRATION OF A HOME ENERGY RATING SYSTEM

1. Energy analysis tool requirements.

a. In order to be certified for the purpose of providing home energy ratings under these Guidelines, an energy analysis (rating) tool must:

(1) Demonstrate the ability to calculate annual purchased energy consumption for each building type which ratings are provided;

(2) Estimate the total annual purchased energy consumption associated with minimum rated features set forth in Section B.5 of these Guidelines;

(3) Calculate energy use of non-rated energy consuming devices set forth in Section B.7 of these Guidelines;

(4) Reflect the operating condition assumptions described in Section B.6 of these Guidelines; and

(5) Pass all tests in Tier 1 and Tier 2 of the Home Energy Ratings System Building Energy Simulation Test (HERS BESTEST)–NREL Report no. NREL/TP-472-7332 which is administered by, and has pass-fail criteria set by the accrediting body.

b. Future guideline requirements. On or before September 30, 2003, all HERS providers accredited under these Guidelines, shall have updated their energy analysis tool to be capable of rating the following additional features–

(1) Thermostat set-back and set-up;

(2) Effects of part load and weather conditions on HVAC systems;

(3) Demand and time of use utility rates;

(4) Solar water heating;

(5) Sunspaces; and

(6) Whole house fans.

c. Energy analysis tools certified under paragraph (a)(5) of this section must be retested and recertified if a new version of the tool is released that includes changes to the engineering algorithms.

2. Site data collection manual.

All HERS providers shall provide data collectors with a manual containing procedures for the on-site collection of data that are:

a. Consistent with those provided in Appendix A as extracted from Guideline No. 10 of the Home Energy Rating Systems Council Guidelines;

b. Established or approved by the Accrediting Body and updated as supplemental or revised information becomes available.

3. Training home energy raters. Each person seeking a position as a full rater, data collector, or data analyst for any HERS provider shall receive training by an accredited rater training organization prior to performing rating tasks without supervision. The training shall be conducted in accordance with a syllabus developed by all HERS providers. The syllabus must specify subjects applicable to each position (i.e., rater, data collector or data analyst) and must include–

a. Classroom training. Each rater shall receive classroom training on–
   (1) Basic principles of building science (i.e., viewing the home as a system);
   (2) Thermal resistance of insulation materials
   (3) The minimum rated features for buildings;
   (4) Blower door testing procedures
   (5) Duct leakage testing procedures
   (6) Variations in construction types and their ramifications;
   (7) Types and efficiencies of windows;
   (8) Types and efficiencies of heating, cooling, water heating, and lighting systems;
   (9) Types and characteristics of space conditioning and domestic hot water distribution systems;
   (10) Types of thermostatic controls;
   (11) Determination of azimuth;
   (12) Determination of air leakage;
   (13) Determination of fuels used by major appliances;
   (14) Utility rate structures;
   (15) On-site inspection procedures;
   (16) Producing a scaled and dimensioned drawing of a home;
   (17) Calculating the area of rectangles, triangles, circles, ovals and combinations of these shapes;
   (18) Calculating the volume of boxes, pyramids, spheres, and other geometric shapes;
   (19) Completing a home energy rating checklist or entering data into a home energy rating software program;
   (20) Completing a home energy improvement analysis or entering data into a home energy rating software program that performs improvement analysis;
   (21) Basic knowledge of financial incentive programs and energy efficient mortgages;
   (22) Communicating the benefits of energy saving measures and practices to the consumer; and
   (23) Quality assurance.

b. Written examination. Each rater shall be given a written examination that

evaluates the rater's understanding of the subjects in paragraph (a) of this section.

c. Field training. Each rater shall perform two ratings (or portions of ratings for those seeking to be data collectors or data analysts), including software operations, in the presence of trainers.

d. Probationary period. Each rater shall complete a probationary period where close supervision is provided. This period covers a minimum of five ratings, after which the supervisor shall determine if additional training is needed.

e. Challenge test. A challenge test may be taken, which, if passed in all competencies, will waive the classroom training requirement. The requirements of paragraphs (c) and (d) of this section may not be waived.

f. Continuing education. Each rater shall complete a minimum of 12 hours of approved continuing education during each 3-year period of certification.

4. Quality control.

a. All HERS providers shall establish a quality assurance plan that includes–
   (1) Periodic peer review and reevaluation of raters;
   (2) Random auditing of each rater's work;
   (3) Evaluation of the training program by raters after field experience;
   (4) Customer evaluation of rating services;
   (5) Random review of the inputs into the rating tool to ensure that they are consistent with the data collected in the field; and
   (6) Verification of the accuracy and completion of the input forms and output of the first five ratings performed by each rater.

b. All HERS providers shall maintain a permanent quality assurance file that is updated at least every two years or when changes to the system are made, and contains:
   (1) A description of local rate structure for electricity, gas and other locally used fuels;
   (2) A description of climatological data (including interpolation methods) used;
   (3) A description of the data storage and maintenance systems including:
      (a) Software for data base,
      (b) Training for data entry personnel, and
      (c) Data quality assurance procedures that will be exercised;
   (4) A description of each rating tool that the HERS provider uses including a list of which home types the tool supports;
   (5) The results and date of the certified accuracy test conducted for the rating tool;
   (6) An example of the rating outputs produced;
   (7) The materials and tests used to provide training for home energy raters;
   (8) The materials used to document the site data collection procedures; and
   (9) A description of the individual elements of the quality assurance plan set forth in paragraph (a) of this section.

c. All HERS providers shall maintain an electronic database of information for

each home rated. The minimum content of the database is –

(1) A unique file reference of ID number;
(2) Date of on-site inspection;
(3) Raters name;
(4) Tool name and version:
(5) Identification of climate data used for the rating;
(6) Type of rating, either projected or confirmed:
(7) Use of rating, either –
    (a) Time of sale rating;
    (b) Pre-home improvement rating;
    (c) Post home improvement rating; or
    (d) Information only rating;
(8) Address of Rated Home;
(9) Home type;
(10) Floor area of conditioned space;
(11) Fuel types used by building heating, cooling and water heating systems;

(12) Minimum rated feature energy efficiency data used to determine the rating;
(13) In the four categories of heating, cooling, water heating and all other uses, the –
    (a) Estimated annual purchased energy consumption in total;
    (b) Estimated annual purchased energy consumption by fuel;
    (c) Estimated annual energy costs in total; and
    (d) Estimated annual energy cost by fuel.
(14) Estimated total annual energy cost for all uses; and
(15) Rating score of the Rated Home on 0-100 points scale and 1-5+ stars category
(16) To extent allowed by state statute, all HERS providers shall for 10% or for 500 of the homes rated annually, whichever is less, maintain a database of the following –
    (a) Homeowners authorization for the release of consumption information by utility companies;
    (b) Climate data site used for energy estimation;
    (c) Any energy efficiency improvements made to the home and date of completion.

5. Guideline compliance.

a. Full accreditation. Any HERS provider may be accredited as being in full compliance with these Guidelines if it demonstrates that it can –
    (1) Conducts ratings in accordance with the provisions of Section B.1 of these Guidelines;
    (2) Reports the results of ratings in accordance with the provisions of Section B.3 of these Guidelines;
    (3) Produces documentation of a correctly configured Reference Home in

accordance with the provisions of Section B.4 of these Guidelines;

(4) Provides documentation that their energy analysis tool is certified in accordance with the Accreditation Procedures as having passed HERS-BESTEST.

(5) Provides training in accordance with the provisions of Section C.3 of these Guidelines;

(6) Provides documentation of a quality control plan and a permanent quality assurance file in accordance with the provisions of Section C.4 of these Guidelines;

(7) Provides documentation of a monitoring and evaluation program in accordance with the provisions of Section C.5 of these Guidelines;

b. Basic compliance. Any exiting HERS provider may be accredited for a period of up to two years, as being in basic compliance with these Guidelines, by demonstrating that it meets all the provisions of paragraph (a) of this section except that it may –

(1) Use a simplification of utility rate structures;

(2) Rate only the features set forth by Section B.5 of these Guidelines, that may be rated with its existing system capabilities;

(3) Use only those standard operating conditions set forth in Section B.6 of these Guidelines that can be handled by their existing energy analysis tool;

(4) Pass only the Tier 1 set of HERS-BESTEST tests;

(5) Meet the training requirements of Section C.3 of these Guidelines by –

(a) Verification that each person with responsibilities in the conduction of ratings has completed classroom training on all items set forth in Section C.3.a of these Guidelines;

(b) Verification that each person with responsibilities for the conduction of ratings has received field training;

(c) Verification that all personnel have successfully passed a written objective examination in all areas applicable to their designated job descriptions; and

(d) Verification of a probationary period set forth in Section C.3.d of these Guidelines; and

(6) Use an existing program to monitor and evaluate the accuracy of ratings.

6. Accreditation.

a. All HERS providers operating in voluntary compliance with these Guidelines shall be accredited only by a State or by an other independent Accrediting Body authorized by the state to:

(1) establish and coordinate consistent adjustments to these Guidelines within a State for –

(a) default values for minimum rated features set forth in Section B.5 of these Guidelines;

(b) operating condition assumptions and local climatic data interpolation set forth in Section B.6 of these Guidelines;

(c) alternate standard operating condition assumptions set forth in Section B.5 of these Guidelines.

(2) administer the procedures for certification of energy analysis tools established by HERS-BESTEST set forth in the NREL Report No. NREL/TP-472-7332 referenced in Section C.1 of these Guidelines;

(3) evaluate the training of home energy raters set forth in Section C.3 of these Guidelines;

(4) review and evaluate the quality control procedures set forth in Section C.4 of these Guidelines; and

(5) evaluate the site data collection manual and monitoring and evaluation program set forth in Sections C.2 and C.5 of these Guidelines.

b. The accreditation process shall be conducted fully consistent with the "Mortgage Industry National Accreditation Procedures for Home Energy Rating Systems" and with applicable state law, included but not limited to statutes and regulation related to home energy rating systems and to the state's required administrative procedures. In cases where the national Accreditation Procedures and state law or regulation differ, the state law or regulation shall govern.

c. Any Lender or agency in a mortgage business who offers mortgage or loan incentives for energy efficiency on the basis of a home energy rating should require that such ratings be conducted in accordance with these Guidelines and that the rating provider is accredited in accordance with the "Mortgage Industry National Accreditation Procedures for Home Energy Rating Systems."

D. REVISION OF TECHNICAL GUIDELINES

1. Periodic review of technical Guidelines

At least triennially, the provisions set forth in these Technical Guidelines shall be reviewed by the Buildings Committee of NASEO in collaboration with other stakeholders. At a minimum, this review shall include consideration and evaluation of changes in the law, technological innovations, and comments received from interested parties.

2. Submission of proposals to change Technical Guidelines:

a. Proposals to change these Technical Guidelines may be submitted in writing, at any time, to NASEO.

b. All proposals to change that meet the criteria set forth in this section of these procedures shall be accepted for consideration and evaluation.

c. Proposals to change these Technical Guidelines shall include the following:

(1) Identification of the proposal to change, including the following minimum information:

(a) Proponent(s) full name(s),

(b) Organizational affiliation(s) or representation(s),
(c) Full mailing address(es),
(d) Daytime phone number(s),
(e) Signature of primary proponent, and
(f) Date

(2) Specific revisions to the Technical Guidelines in a format that clearly identifies the manner in which the Technical Guidelines are to be altered (ie. underline/strikeout format or equivalent). Any proposal to change that does not include proposed alteration(s) shall be rejected and returned to the proponent.

(3) Substantive reason(s) or justification for each proposed change. The lack of substantive justification for a proposed change may result in the return of the proposals to change to the proponent(s).

(4) Supporting documentation that may be needed for the reasoned evaluation of the proposal.

d. Proposals to change these Technical Guidelines shall be considered and evaluated at least annually.

(1) The effective date of any annual revisions to these Technical Guidelines shall be January 1.

(2) Only those proposals to change that are received on or prior to the last working day of April shall be considered for the revisions to these technical Guidelines that may become effective on January 1 of the following year.

3. Public Review Process

a. Revisions to these Technical Guidelines shall occur only after the relevant proposals to change have been subjected to public scrutiny and comment using the following review process:

(1) The National Association of State Energy Officials shall appoint a Technical Guidelines Revision Advisory Committee. This Committee shall be responsible for conducting the periodic evaluation and the annual evaluation of proposals to change through a consensus process, whereby both consenting and the non-consenting opinions are documented and incorporated as comments into each report or proposal to change.

(2) Following initial evaluation by the Technical Guidelines Revision Advisory Committee, proposals to change shall be posted on the appropriate Internet web pages for a period of not less than 30 days during which public comment shall be accepted.

(3) Following the public comment period, the Technical Guidelines Revision Advisory Committee shall meet to reconcile public comments with the initial comments of the Committee and, if changes are determined necessary, a final set of recommended changes with consensus comments that considers public comments shall be prepared

on each proposal for change.

(4) Proposals for change receiving two-thirds majority support from the Technical Guidelines Revision Advisory Committee after public comment shall be incorporated into a set of revised Technical Guidelines.

b. The revised Technical Guidelines shall be published on the appropriate Internet web pages and submitted to the NASEO Building Committee not later than the end of July each year in which changes are recommended.

NATIONAL HOME ENERGY RATING
TECHNICAL GUIDELINES

September 19, 1999

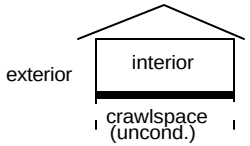
Appendix A

ON-SITE INSPECTION PROCEDURES FOR MINIMUM RATED FEATURES

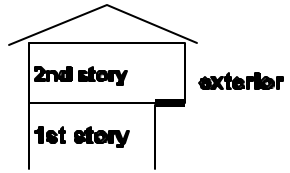
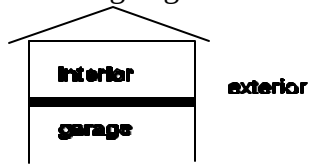
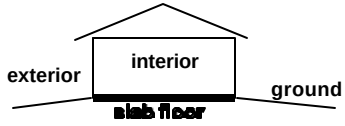
Excerpted from: ***Guidelines for Uniformity: Voluntary Procedures for Home Energy Ratings, Version 2.0***, Home Energy Rating Systems Council (HERSC), August, 1996. Reprinted with the permission of the HERS Council.

ON-SITE INSPECTION PROCEDURES FOR MINIMUM RATED FEATURES

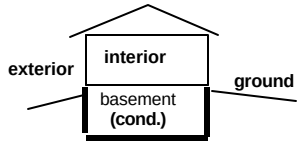
Building Element: Foundation

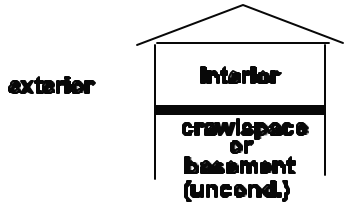
Rated Feature	Task	On-Site Inspection Protocol
Conditioning of space	Determine whether a crawl space or basement is unconditioned, indirectly conditioned or directly conditioned	To determine whether a crawl space or basement is conditioned, assess the insulation placement in the walls or floor/ceiling assembly. A vented crawl space is considered unconditioned regardless of the location or existence of insulation. This is because the ambient temperature of the crawl space is close to the outdoor ambient temperature.  An unvented crawl space or basement may be considered either unconditioned, indirectly conditioned, or fully conditioned, based on the following criteria: *Unconditioned* - Foundation walls are not insulated, floor/ceiling assembly is insulated, and any heating or plumbing distribution systems in the space is insulated. The intention in an unconditioned crawl space or basement is to minimize the heating system losses into the space by means of the distribution and plumbing insulation, and to minimize heat flow through the insulated floor/ceiling assembly. *Conditioned, indirectly* - Foundation walls are not insulated with floor/ceiling assembly insulated and distribution system in the space uninsulated, or foundation walls insulated with floor ceiling assembly insulated or non-insulated and distribution system uninsulated. In an indirectly conditioned crawl space or basement, heating or cooling is unintentionally delivered to the space either through the floor/ceiling assembly or by unintentional losses from the heating/cooling system. Indirectly conditioned spaces are typically between the

Building Element: Foundation (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Conditioning of space (continued)	Determine whether a crawl space or basement is unconditioned, indirectly conditioned or directly conditioned (continued)	temperature of the outdoor ambient temperature and the indoor conditioned space temperature. *Conditioned, directly* - Foundation walls insulated or uninsulated and basement or crawl space is intentionally or unintentionally conditioned, by means of a forced air heating or cooling system, hydronic heat, electric resistance, etc. Fully conditioned spaces are typically maintained at the same temperature as the above grade spaces. The distinction between indirectly and directly conditioned basement spaces may be difficult, but is important from a heat transfer perspective. Rater judgment will have to be utilized in many cases. Interview the owner about the temperature in the basement during the heating season, and assess the potential for standby loss from the heating equipment and distribution system, e.g., jacket insulation, leakiness of ducts, insulation on distribution systems, etc.
Construction type	Identify floor over crawl space	A crawl space is typically defined as a foundation condition with a clear vertical dimension 4 feet high or less. Crawl spaces may be vented or unvented. Vented crawl spaces have some form of vent or louver in the crawl space walls, or are constructed in such a manner so that air moves freely from outside the walls to inside the crawl space. Unvented crawl spaces are constructed without any form of vents or louvers in the wall, and are constructed to exclude, to the greatest extent possible, air leakage from outside the walls to inside the crawl space. Crawl spaces may be accessed by a hatchway in the floor of the house or in the wall of the crawl space. To identify a crawl space, look for foundation vents and/or stairs leading up to floor levels from the outside of the building.
	Identify floor over full basement	A full basement has characteristics similar to an unvented crawl space, except that the clear vertical dimension is typically greater than 4 feet. Stairs that lead from the main floor to a below grade space are an indication of a basement in a house, although a house may have a basement with access similar to a crawl space access.

Building Element: Foundation (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Construction type (continued)	Identify floor over exterior space	Floor area that borders exterior unenclosed space above grade is considered floor to exterior. For example, in a two story house, the second story may extend horizontally further than the first story, creating some floor area that is exposed to the exterior. 
	Identify floor over unconditioned garage	Identify floors over an unconditioned garage. 
	Identify slab on grade foundation	A slab on grade can be recognized by the absence of either a crawl space or basement. A slab on grade is constructed by pouring a concrete slab directly on the ground as the floor for the house. 
	Identify walkout basement	A walkout basement, if fully conditioned, is typically considered partially slab on grade construction (where the floor level is above grade) and partially a basement (where the floor level is below grade).

Building Element: Foundation (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Interior surface condition	Determine the inside surface condition of floor (exposed or covered)	*Covered* - If floor is covered with wall-to-wall carpet, consider it covered. Floors with only area rugs are not considered covered. *Exposed* - If the floor has tile, linoleum or wood, consider it exposed.
Surface area	Measure floor dimensions	Measure the exterior linear perimeter to the nearest ½ foot of all floors over unconditioned space. Use these dimensions to calculate floor area. For conditioned basements and crawl spaces, find dimensions of basement walls and floor. Divide walls into above and below grade sections.
Thermal mass	Determine presence of thermal mass	Concrete slabs and basement walls when uninsulated or insulated on the exterior can be considered as thermal storage mass when combined with solar gain from south fenestration. Note type of thermal mass: concrete, brick, tile, water. South fenestration is defined as fenestration oriented between 45E SE to 45E SW. Slab-on-grade construction in climates with more than 3600 HDD (65) may not be considered solar storage mass unless properly insulated (edge, perimeter, or under slab).

Building Element: Floor of conditioned basement or crawl space		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Insulation	Determine insulation in walls and floor of conditioned basement or crawl space	If basement or crawl space is determined to be fully conditioned, its walls and floor are considered part of the building envelope. (The floor between the house's ground floor and the basement or crawl space is considered an interior boundary with no associated heat transfer calculated.)  Determine insulation type, thickness and R-value in walls. Wall insulation may be located inside foundation wall (studs and batts, foam under drywall, etc.), integral with foundation wall (insulated cores of block wall, insulating concrete block such as insulating formwork) or outside the foundation wall (rigid foam insulation).

Building Element: Floor of unconditioned basement or crawl space		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Insulation	Determine amount of floor insulation	 Visually verify the presence of floor insulation between the floor joists. Measure the thickness of the insulation to quantify its R-value. Typically, the floor insulation used is fiberglass batts and is found between the floor joist cavities. Multiply the thickness of the insulation (in inches) by the appropriate R-value per inch based on the insulation type in order to calculate the total existing floor insulation R-value.

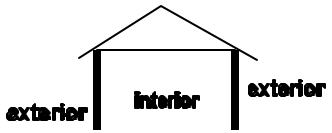
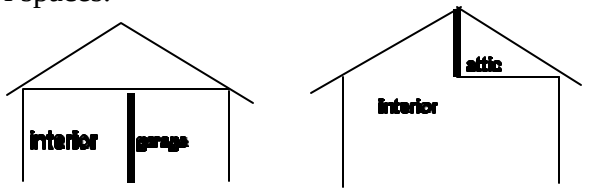
Building Element: Slab-on-grade		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Perimeter	Determine perimeter of slab foundation	Determine the perimeter of the slab foundation by measuring each dimension to the nearest ½ foot and adding them together.

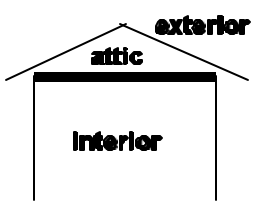
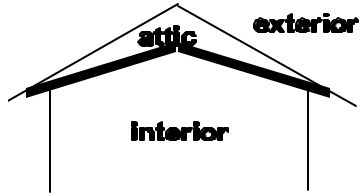
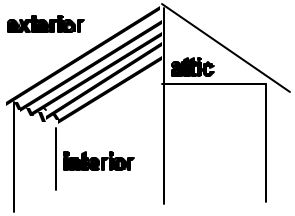
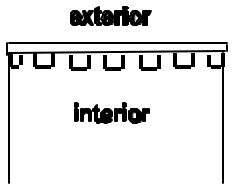
Building Element: Slab-on-grade		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Insulation	Determine if slab perimeter insulation exists	If present, slab perimeter insulation is usually installed on the outside of the slab and extends both above and below grade. To identify slab perimeter insulation, look for a protective coating above grade as opposed to the usual exposed slab edge at any conditioned space(s). Move a little bit of dirt away from an edge of the slab where conditioned space is located. If present, the rigid insulation around the perimeter of the slab may be seen. However, it may be difficult to visually verify the existence of slab
Insulation (continued)	Determine if slab perimeter insulation exists (continued)	perimeter insulation because of the protective covering which may be installed over the rigid insulation. Slab insulation may also occur between the foundation wall and the slab itself, although this is harder to assess and verify. If the floor has carpeting, a sharp needle may be poked through the carpet near the baseboard on an outside wall. If the needle penetrates beyond the depth of the carpet, there is probably foam insulation between the slab and foundation wall. Under slab insulation cannot be assumed to exist unless visually verified by a photograph of construction, at chase way, at sump opening or at plumbing penetrations.

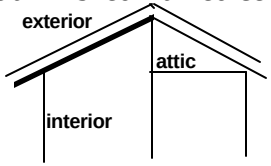
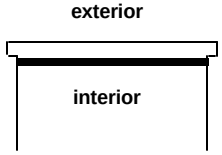
Building Element: Walls		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Color	Determine the color of the wall	Identify the color of the wall as light, medium, or dark.
Construction type	Determine the structural system of walls	*Wood framing* - is very common in residential construction. Wood studs are located 16" or 24" on center all along the wall. Knocking on the wall will give a "hollow" sound in the cavities between the studs and a "solid" sound at the stud locations. *Metal framing* - can be found in some newer residential construction. A strong magnet slid against the wall will hold to metal framing. Also check inside the attic at the edges for evidence of metal wall framing. *Masonry walls* - include walls constructed of concrete or brick. A wood framed wall with brick veneer would <u>not</u> be considered a masonry wall. Also note the siding or finish material on the wall.
Construction type (continued)	Determine the structural system of walls (continued)	*Foam core walls* - are a sandwich panel consisting of a foam center with outer layers of structural sheathing, gypsum board or outer finish materials. Foam core panels may be structural (load bearing) or non-structural. Non-structural panels are frequently used in post and beam construction. *Log walls* - are typically solid wood walls, using either milled or rough logs or solid timbers. Some homes may have the appearance of solid log walls, yet may actually be wood frame walls with siding that looks like solid logs inside and out. Some log walls are manufactured with insulated cores. Unless manufacturer's documentation is available or visual inspection of insulation type and thickness can be made, assume no added insulation exists in a log wall.

Building Element: Walls		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Framing members	Determine framing member size for all framed walls exposed to unconditioned space	To determine whether 2x4 or 2x6 framing exists: Measure the width of the window jambs; Subtract the widths of the wall coverings and sheathing materials (approximately .25" to 1.0" for stucco, .5" to .6" for interior sheetrock, and .5" to .75" for other exterior siding materials); Compare the remaining width to 3.5" for a 2x4 wall or 5.5" for a 2x6 wall; If exposed garage walls exist, examine them for reference (although they will not *always* be the same as other walls); If a wall does not come close to the framing width of a 2x4 or 2x6, inspect for foam sheathing on the inside or outside of the walls. In superinsulated construction, "double stud" or "strapped" walls may account for thickness greater than 5.5". For brick veneer walls, assume 4.5" - 5" for brick, airspace and sheathing material.

Building Element: Walls (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Framing members (continued)	Determine framing member size for all framed walls exposed to unconditioned space (continued)	Check the framing member size on all sides of the house. If an addition has been added, be sure to check the walls of the addition separately. If the house has more than one story, check the framing member size for each floor.
Insulation value	Determine type and thickness of existing insulation and resultant R-value	<u>Framed Walls</u> Check at plumbing outlet under sink or, in order of preference, remove cable outlet plate, telephone plate, electrical switch plates and/or electrical outlet plates on exterior walls. Probe the cavity around the exposed plate with a non-metal device (such as a plastic crochet hook or wooden skewer). Determine type of insulation (fiberglass, cellulose insulation, foam, etc.). Inspect outlets/switch plates on each side of the house to verify that all walls are insulated. Multiply the wall framing member size (in inches) by the R-value per inch. Be sure to use the actual thickness of the insulation when calculating the total insulation R-values. Use 3.5" for 2 x 4 walls and 5.5" for 2 x 6 walls constructed after 1945. Parts of the house that were added later must be checked separately from the original walls. <u>Sheathing</u> Insulated sheathing may exist on walls, but can be difficult to verify. Walls with insulated sheathing may be thicker than walls without insulated sheathing. Visual verification of insulated sheathing may be found in the attic at the top of the wall, exterior wall penetrations, and at the connection between the foundation and the wall.

Building Element: Walls (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Location	Determine whether walls border exterior space, attic, garage or crawl space	*Wall to exterior* - Walls border exterior space.  *Wall to enclosed unconditioned space* - Walls that border unconditioned attics, garages and crawl spaces. 
Surface area	Determine surface area of all walls exposed to unconditioned space	Measure linear perimeter of the walls to the nearest ½ foot. Measure the interior wall height of the walls to the nearest 1/4 foot. Use these measurements to calculate surface area.
Thermal mass	Determine type and thickness of all mass walls	If the dwelling's walls are constructed of concrete, masonry or brick, determine their type and thickness. <u>Solid concrete walls (poured)</u> Measure the thickness of the poured concrete wall in inches. <u>Concrete Masonry Unit</u> Cinder block or uninsulated concrete wall - hollow in the middle. May contain vermiculite or perlite insulation. Check for additional insulation (interior furring, foam board, foam fill). Measure the thickness of the wall in inches.

Building Element: Roof/Ceiling		
Rated Feature	**Task**	**On-Site Inspection Protocol**
All ceiling areas between conditioned and unconditioned space	Obtain measurements of all ceiling areas	Measure the linear perimeter of the ceiling area to the nearest ½ foot and use these measurements to calculate surface area of the ceiling. If a ceiling area is vaulted, it may be necessary to calculate dimensions geometrically. Identify the ceiling as one of the following types. <u>Ceiling to attic</u> If the ceiling has attic space above (even if the ceiling is vaulted, as in a scissor truss) it is considered ceiling to attic. If there is a vaulted ceiling check it's angle against the angle of the roof -- if the ceiling angle is gentler there is attic space above the ceiling. Also check for an attic access, either separate or from an attic over another part of the house.   Framed ceilings fall into two categories: *Roof on exposed beams or rafters* - when you look up from inside the room, you will see exposed beams or rafters.  

Building Element: Roof/Ceiling (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
All ceiling areas between conditioned and unconditioned space (continued)	Determine ceiling construction type (continued)	*Finished framed ceiling* - if the ceiling is framed (has no attic space above it, but you cannot see the rafters because the ceiling is finished with drywall, plaster, paneling, etc.) consider it a finished framed ceiling.  
	Determine the size of the framing members for framed ceilings	Determine the framing member size for framed ceilings exposed to unconditioned spaces. Check the framing by looking for an access through an attic over another part of the house or by looking at the rafters from the outside.
Color	Determine the color of the roof	Identify the color of the roof as light, medium or dark. Also check for a special reflective roof coating.
Construction type	Determine the roof's construction type	Identify the type of roofing surface. Some common types include: Asphalt shingle; Pebble/gravel built-up roof; Tile roof; Wood shingle roof; Rubber roof/roof coating; Metal.

Building Element: Roof/Ceiling (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Insulation value	Determine R-value of insulation in attic	<u>Ceiling to Attic</u> Determine the type of insulation present (cellulose, fiberglass, rockwool, etc.). Measure the average depth in four places. Take all measurements at least 6' from the access door (for horizontal or vertical access).
Insulation value (continued)	Determine R-value of insulation in attic (continued)	Average the four measurements. Be sure to get four readings which accurately reflect the insulation level (do not just measure the low or high spots; the depth should be representative of the entire attic area being examined). Multiply the average depth of insulation by its R-value per inch to obtain the total R-value.
	Determine the R-value of insulation in framed ceiling	Determine the insulation R-value which exists in the ceiling area (cavity). Use the following method for calculating the overall ceiling R-value: Determine the type of ceiling insulation present (may be a combination of more than one type); Multiply the R-value of the material by the depth of the insulation; If there is no access to the framed ceiling, ask the customer for documentation of insulation or use a default value based on age.

Building Element: Rim Joist		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Insulation value	Determine insulation value	The rim joist is the band joist around the perimeter of the floor joists over a basement or crawl space, or between 2 stories of a house. <u>Crawl space or Basement</u> From the basement or crawl space, visually identify and measure the depth of insulation at the rim joist. The insulation used is generally fiberglass batts, often folded in an L-shape and attached to the rim joist. Rigid board insulation may also be found.
Insulation value (continued)	Determine insulation value (continued)	<u>Between Stories</u> Look for access to the area from a garage or a utility access trap door. Visually identify and measure insulation if it exists. If no access can be found, assume insulation exists at the rim joist between stories if: Insulation was found at the rim joist at the top of the crawl space or basement in the same house; or Insulation is found in the walls of the same house. Otherwise, assume no rim joist insulation exists.

Building Element: Doors		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Construction type	Determine construction type of doors	Determine if the exterior door(s) is fiberglass, metal, or wood by making a close inspection of its texture, distinguishing the sound produced when knocking on it, and checking its side view.
Insulation	Determine whether doors are insulated	Judge whether the exterior door(s) is insulated (or not) by its sound, temperature transfer, labeling, or thermal break. *Sound* - Insulated/solid door will sound dull when knocked on. An uninsulated/hollow door will sound hollow. *Heat transfer* - Feel the inside and outside of the door with flat palms. Insulated/solid door will less readily transfer heat. The inside will feel warmer in cold outside weather and cooler in hot outside weather than an uninsulated/hollow door.
Insulation (continued)	Determine whether doors are insulated (continued)	*Labeling* - Check the side view of the door at the hinges for a descriptive label. *Thermal break* - Check the side view of metal doors for thermal breaks.
Surface area	Determine surface area of doors	Measure the surface area of the door(s) to the nearest ½ square foot.

Building Element: Windows		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Area	Determine area of windows	Measure the area of the window openings using width times height to the nearest inch. Window openings are measured from the outside edge of the framing and include the frame width.
Construction type	Determine window framing and glazing characteristics	<u>Framing Type</u> Examine each window frame in order to determine the type of material used. Open the window and examine it to see whether the frame is made of metal, wood, or vinyl. Tap the frame with fingernail or knuckle to test if it's vinyl or metal. Wood frames are usually thicker than metal. If the window is dual-pane or multiple-pane and is metal framed, determine if a thermal break is present by looking for two separated metal extrusions connected by a rubber spacer. Ask the customer for documentation if you can't tell. Some wood windows may have vinyl or aluminum cladding. Check both the inside and outside, since some windows will have vinyl cladding on one side only.

Building Element: Windows		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Construction type (continued)	Determine window framing and glazing characteristics (continued)	<u>Glazing Type</u> Check all windows in the house for number of panes and existence of tint and/or low-e coating. To determine whether the windows are single-paned or multiple-paned: Look at frame width and spacers; Look at reflections; Look at edge thickness. To determine if glazing has a tint or low-e coating: Check the customer's product literature if available; Perform a "match test" - there should be one reflection per pane or coating, including low-e and tinting (e.g., a double-paned window with low-e and tint should show 4 reflections); Compare to glazing samples with and without tinting; Compare the windows within the space, since tinting is often applied only to certain windows in a house; Look for a low-e label or etching on the glass.
Orientation	Determine orientation of all windows	Use a compass (adjusting for magnetic deviation) to determine orientation of all windows.

Building Element: Windows		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Shading	Determine shading of windows	Identify shading by external shade screens, house overhangs/awnings, and shade from trees and other buildings.

Building Element: Windows		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Shading (continued)	Determine shading of windows (continued)	<u>External Shade Screens</u> The most common screen is an insect screen that covers some or all of the window. If it is a full-coverage type screen, assume it is a shade screen. Compare samples of the screen's mesh pattern to those of a window screen sample to determine the type and shading coefficient of the screen. Ask customer for documentation for the shading coefficient (SC) of the screen. If you cannot determine the shading coefficient of the screen, use 36% SC as a default. <u>Projection (Overhang)</u> The shading impact of an overhang can be found by measuring the distance of the projection from the exterior wall surface and the distance (height) between the top of the window and the bottom edge of the overhang. Measure the length of the overhangs over each exterior wall. Measure the height above the window to the bottom edge of the overhang. <u>Exterior Shading</u> *Full (40% SC)* - Consider a 40% SC for an entire side of a house as being roughly equivalent to having a shade screen over a window. For trees and/or bushes to equal this effect, there should be a very dense amount of trees and/or bushes along the entire side of the house that shade both its vertical and horizontal surfaces almost totally. *Partial (70% SC)* - Based on the above definition for full shading, partial shading is considered to be anything in between full and none (no shading). *None (100% SC)* - No shading indicates there may be small plants or shrubs only, two feet tall or less, or no trees or tall bushes at all.

Building Element: Windows		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Shading (continued)	Determine shading of windows (continued)	<u>External Shade Screens</u> The most common screen is an insect screen that covers some or all of the window. If it is a full-coverage type screen, assume it is a shade screen. Compare samples of the screen's mesh pattern to those of a window screen sample to determine the type and shading coefficient of the screen. Ask customer for documentation for the shading coefficient (SC) of the screen. If you cannot determine the shading coefficient of the screen, use 36% SC as a default. <u>Projection (Overhang)</u> The shading impact of an overhang can be found by measuring the distance of the projection from the exterior wall surface and the distance (height) between the top of the window and the bottom edge of the overhang. Measure the length of the overhangs over each exterior wall. Measure the height above the window to the bottom edge of the overhang. <u>Exterior Shading</u> *Full (40% SC)* - Consider a 40% SC for an entire side of a house as being roughly equivalent to having a shade screen over a window. For trees and/or bushes to equal this effect, there should be a very dense amount of trees and/or bushes along the entire side of the house that shade both its vertical and horizontal surfaces almost totally. *Partial (70% SC)* - Based on the above definition for full shading, partial shading is considered to be anything in between full and none (no shading). *None (100% SC)* - No shading indicates there may be small plants or shrubs only, two feet tall or less, or no trees or tall bushes at all.

Building Element: Windows (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Solar heat gain factor	Determine solar heat gain factor of glazing	Check product information and consult NFRC guide.
U-value	Determine window U-value	Look for an NFRC label on new windows (it will display full window U-value). If no label can be found but customer has documentation, look up product information in NFRC Certified Products Directory to determine U-value, or consult manufacturer's literature.

Building Element: Skylights		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Area	Determine area of skylights	See windows.
Construction type	Determine framing and glazing characteristics of skylights	See windows.
Orientation	Determine orientation of skylights.	Determine the orientation of the lower edge of the skylight. Use this direction as the orientation of the skylight.
Shading	Determine shading of skylights	See windows.
Solar heat gain coefficient	Determine solar heat gain coefficient of skylights	See windows.

Building Element: Skylights		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Tilt	Determine tilt of skylights	Measure the tilt of the skylight relative to horizontal. This can be done with a level and angle finder instrument, or geometrically with a protractor (from the ceiling length and heights).
U-value	Determine skylight U-value	See windows.

Building Element: Air leakage		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Blower door test	Determine effective leakage area from a blower door test	Use current protocol, such as ANSI/ASTM E-779-87.
Conditioned volume of space	Determine conditioned volume of space	Determine conditioned and indirectly conditioned volume of space by multiplying conditioned floor area by ceiling height. The house may need to be split into different spaces with different ceiling heights and added to each other for both conditioned and indirectly conditioned spaces. For areas with vaulted ceilings, volume must be calculated geometrically.
Estimate	If diagnostic equipment is not used, determine window type and distribution system to estimate leakage	To be determined.

Building Element: Air leakage		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Tracer gas test		To be determined.

Building Element: Heating & Cooling/Distribution System		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Air leakage (ducts)	Determine air leakage from ducts	If diagnostic equipment is not used, consider location and characteristics of the distribution system to select standard default value.
Insulation	Determine the value of distribution system insulation	Air ducts may be insulated with insulation blankets or rigid insulation board. Inspect the duct or pipe insulation for R-value labeling (printed on the insulation by the manufacturer). If the insulation is not marked with the R-value, identify type and measure the thickness of the insulation to determine R-value. Check for internal insulation by tapping on the exterior and listening to the sound.
Location of air ducts	Determine the location of ducts	Air ducts may be located in the attic, crawl space, basement or in a conditioned area. You must locate and differentiate between supply and return ducts. Ducts may be located in more than one area (e.g., some return ducts in attic and some in conditioned space, etc.).

Building Element: Heating & Cooling/Distribution System		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Type	Identify type of distribution system used to provide space heating and cooling	*Forced air* - a central fan unit connected to ducts which supply heated or cooled air to each room in the home. Forced air systems have supply and return duct work. Supply ducts typically run to each room; return duct work may come from each room or from one or more central locations in the home. *Forced hot water* - heated water is pumped through a series of radiator elements to supply heat. The radiator elements may be conventional radiators, baseboard "fin tube" radiators, cast iron baseboards or radiant hot water panels located at the baseboards or on walls or ceilings. *Hot water radiant system* - heated water is circulated through plastic or metal tubing which is installed in a concrete slab or finished floor or, occasionally, in walls or ceilings. *Unit heater/air conditioner* - heating or cooling is supplied directly from a heating or cooling device located within the space it serves. Window air conditioners and through-the-wall heaters are common examples. Unitary equipment typically has no distribution system.

Building Element: Heating & Cooling/Distribution System		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Type (continued)	Identify type of distribution system used to provide space heating and cooling (continued)	*Steam heating* - steam systems utilize a distribution system with cast iron radiators connected to a boiler that creates steam. The steam rises into the radiators through one set of pipes, condenses into water, and drains back to the boiler through another set of pipes. *Electric radiant system* - electric cables are installed in concrete floor slabs or in the ceiling. Electric current is passed through the cables, causing them to heat up, heating the floor or ceiling assembly which radiates the heat to the space. Electric radiant systems may also be comprised of individual radiant panels mounted on the walls or ceilings. *Baseboard electric resistance* - electric elements are installed in baseboard enclosures. Electric current is passed through the electric element to provide heat to the space.

Building Element: Heating and Cooling/Energy Source		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Fuel type	Determine fuels used for heating and cooling	Heating systems may use natural gas, propane, oil, electricity, or some other fuel. Typically the homeowner will know what type of heating fuel is used. Cooling is typically driven by electricity, however some cooling equipment may use natural gas or propane. Look for electric cables and dedicated fuses or circuit breakers for the cooling equipment or gas lines running to the equipment. Note that gas equipment will also have electric cables to power some of the components. Be sure to distinguish between refrigerant lines and possible gas supply lines. *Oil* - look for a large storage tank (typically oblong-shaped) or fill pipes which would indicate a buried tank. Oil is typically supplied to the heating equipment via a 1/4" - 3/8" copper line. A fuel filter may be evident in the line.
Building Element: Heating and Cooling/Energy Source (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**

Fuel type (continued)	Determine fuels used for heating and cooling (continued)	*Natural gas* - look for a meter connected to piping on the exterior of the home. Piping to the heating equipment is typically done with ½" - 1" iron piping. *Propane* - look for storage tank(s) (typically cylindrical-shaped). Large tanks may be buried with a 12" - 18" cap exposed above grade. Fuel is typically supplied to equipment through 1/4" - 3/8" diameter copper piping. *Electric* - look for large gauge cables running to a central piece of equipment or look at circuit breaker panel for circuits marked for resistance heat circuits (electric resistance or electric radiant systems). *Other fuels* - include coal, wood, processed wood pellets, or other combustible products.

Building Element: Heating and Cooling/Equipment		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Control system	Identify the control system for the heating and cooling system(s)	Determine the type of control systems. There may be separate controls for the heating and cooling systems. Thermostat controls may be programmable. Note types of features available and/or utilized.
Efficiency	Determine the heating and cooling equipment efficiency	Check nameplate for efficiency rating. If the nameplate is missing, use appropriate directories to determine an appropriate default value. SEER is used to measure the efficiency of central air conditioning and air source heat pump systems. AFUE is used to measure the efficiency of furnaces and boilers. EER is used to determine the efficiency of room air conditioners and ground source heat pumps. Check nameplate for SEER or AFUE rating. EER can be calculated from nameplate information by dividing btu output by watt input.

Building Element: Heating and Cooling/Equipment (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Equipment type	Identify type(s) of equipment for heating and/or cooling	*Furnace* - comprised of a combustion chamber and heat exchanger (natural gas, propane or oil) or an electric resistance element (electric) and a fan which forces air across the heat exchanger or resistance element to provide heat in a forced air system. *Fan coil unit* - hot water from a boiler, domestic water heater, or heat pump is circulated through a coil. A fan blows air over the coil to provide heating. This device is used in a forced air system. *Boiler* - this device creates hot water or steam, and can be powered by any fuel type. Can be used with forced air (in conjunction with a fan coil unit), forced hot water, steam, or hot water radiant slab systems. *Split system central air source heat pump* - these systems move energy from one location to another using the vapor compression cycle. They are electrically driven, and can provide heating in winter and cooling in summer by reversing the direction of heat flow. Split system heat pumps consist of an outdoor unit and an indoor air handling unit, resembling a furnace. These systems require ductwork for air distribution. Most air source heat pumps incorporate electric resistance supplemental heat in the indoor section. However, some heat pump systems use fossil fuel furnace for supplemental heating. These are known as "dual fuel" or add-on systems. *Single package central air source heat pump* - a single package central heat pump is similar to a split system, except it combines the functions of the indoor and outdoor units into one cabinet, usually mounted on the roof or on the ground. It also requires a separate distribution system. These are uncommon in single-family residences, however they are sometimes found in multi-family dwellings. *Ground source heat pumps* - are coupled to the ground through the use of a water well sometimes the same well as used for domestic water (known as "open loop" or

Building Element: Heating and Cooling/Equipment (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Equipment type (continued)	Identify type(s) of equipment for heating and/or cooling (continued)	which water or a water/antifreeze mixture is circulated (known as "closed loop"). Look for 3/4" or larger diameter piping going to and from the heat pump. Circulating pumps may be installed in this piping (closed loop systems) or the pump for the water well may be used for circulating water through the heat pump (open loop). The same piece of equipment can be used in either open or closed loop applications, however given the same piece of equipment, closed loop applications typically have lower efficiency ratings than open loop applications. Ground source heat pumps can also utilize a direct expansion of the refrigerant with copper piping buried in the ground. Look for 0.25" - 0.50" copper piping leading from the unit to the outdoors with no outdoor unit. *Split system central air conditioner* - similar to a split system air source heat pump. Consists of an outdoor unit and a coil in the forced air distribution system, usually in a fossil fuel furnace. These systems are electrically powered and provide cooling. *Single packaged central air conditioner* - similar to single packaged air source heat pumps, providing cooling only. *Through-the-wall ductless air source heat pump* - a single packaged air source heat pump designed to be installed without a distribution system. Provides both heating and cooling and is usually installed through an exterior wall. *Window/through-the-wall air conditioner* - a single packaged ductless air conditioner designed to be installed without a distribution system. *Direct evaporative cooler* - is used primarily in very dry climates. Evaporative coolers work by blowing air over a damp pad or by spraying a fine mist of water into the air. Direct evaporative coolers add moisture to the home. *Indirect evaporative cooler* - evaporation takes place on only one side of a heat exchanger. Hot air is forced across the other side of a heat exchanger where it cools

Building Element: Heating and Cooling/Equipment (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Equipment type (continued)	Identify type(s) of equipment for heating and/or cooling (continued)	*Absorption cooler* - this is a gas air conditioner. Look for a cooling tower, an exhaust pipe, a gas burner to evaporate refrigerant and a heat exchanger similar to an electric air conditioner. *Unitary space heater* - these are fossil fuel burning heaters which have individual controls and no distribution system. They may be equipped with a fan for forcing air circulation over a heat exchanger, or they may use simple convective forces. These heaters are typically mounted on outside walls in order to facilitate venting and can use natural gas, kerosene, propane, or other types of fossil fuel.
Location	Determine the location of heating and cooling equipment	Note whether systems are located in conditioned or unconditioned space.

Building Element: Domestic Hot Water System		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Efficiency	Determine the Energy Factor or Seasonal Efficiency of the water heater	<u>Storage Water Heater</u> Look for the water heater's rating plate and product literature. Some water heaters will list their EF right on the rating plate. If the water heater is wrapped and there is no accessible information, approximate the age of the unit and use a default efficiency. If accessible, record the Make and Model #. Look up the EF rating of that model in an appropriate efficiency rating directory.

Building Element: Domestic Hot Water System (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Efficiency (continued)	Determine the Energy Factor or Seasonal Efficiency of the water heater (continued)	If the EF rating is not listed in the directory use a default based on the estimated age of the water heater. <u>Instantaneous Water Heaters</u> Check the unit's nameplate for the RE (Recovery Efficiency). If a gas model, note whether there is a standing pilot light.
Extra tank insulation value	Determine the insulation value of any exterior wrap	Visually determine if the water heater is wrapped with exterior insulation. If so, measure thickness of the wrap and determine R-value.
Location	Determine location of storage tank	Determine whether water heater is located in conditioned or unconditioned space.
Pipe insulation value	Determine the insulation value of the pipes	Determine whether pipe insulation is installed on all 3/4" or larger, non-recirculating hot water mains. Measure depth of insulation and identify material to determine R-value.

Building Element: Domestic Hot Water System (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
System type	Determine type and heat source of water heater	<u>Storage</u> These water heaters are the most common type. Water is heated in an insulated tank that typically ranges in capacity from 30 to 75 gallons. Storage water heaters may use electric resistance, gas, propane, oil or electric heat pump. *Storage electric* - look for rigid or flexible 240 A/C conduit, UL seal, no vent, no burner or pilot tubing. Thermostats are usually hidden behind metal access doors. Often there is both an upper and a lower thermostat. *Storage gas* - look for a vent connection (top of tank), gas connector and line valve, thermostat, burner and pilot tubing, burner compartment doors, and "AGA" seal rating plate. Most gas water heaters have legs to lift the unit above the floor level to provide combustion air to the burner.

Building Element: Domestic Hot Water System (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
System type (continued)	Determine type and heat source of water heater (continued)	*Storage propane* - look for the same features as those listed for gas water heaters. Also, look for a rating plate or tag that states "For Use with LP Gas Only." *Storage oil* - look for features that are similar to a gas water heating storage system. In addition, oil systems are usually furnished with draft regulators which are attached to the vent pipe between the tank and chimney (hinged metal flap with counterweight to allow for variations in flue gas pressure). Vent dampers may also be apparent on the vent pipe. *Storage heat pump* - water heaters remove heat from the air in the room where they are located and then release the heat to the water in the storage tank. Look for the same features as those found on electric water heating systems. In addition, there will be a fan, condenser and evaporator. Also, the system may be one single unit, or may be a split system. *Combination DHW/furnace system* - natural gas combo systems use heat drawn from a hot water tank circulating through an air handling module to heat the space. *Geothermal heat pump de-superheaters* - devices which utilize heat pump cycle superheater to heat domestic hot water. Look for insulated lines between air handler unit and storage water heater tank. <u>Instantaneous</u> These water heaters heat water on demand, instead of storing pre-heated water in a large tank. They are usually small units, with storage of no more than 2 gallons, and are often attached to a wall close to the point of use. Instantaneous water heaters may be used in addition to a primary storage water heater to serve fixtures in a distant location of the house, so check for a main storage unit as well. Determine if the instantaneous heater uses gas or electricity.

Building Element: Domestic Hot Water System (continued)

Rated Feature	Task	On-Site Inspection Protocol
System type (continued)	Determine type and heat source of water heater (continued)	*Instantaneous gas* - look for a connector and line valve, vent connection, thermostat, burner and pilot tubing, and AGA seal. Check whether unit has a pilot light or intermittent ignition device. *Instantaneous electric* - look for the absence of a gas line, vent or pilot light. Look for a UL seal. *Super-heater* - check for this supplementary heat source.

Building element: Solar Domestic Hot Water System

Rated Feature	Task	On-Site Inspection Protocol
Collector	Determine area, orientation, and tilt of collector	Determine the area of the collector. Determine the orientation of the solar collector by taking a compass reading (adjusting for magnetic deviation) in the direction toward which the collector faces. Determine the tilt of the collector. A site selection and angle finder instrument can be used to determine the tilt of the collector. Geometric calculations based on horizontal length and vertical height measurements can also be used.
Efficiency	Determine efficiency of solar system	Look for SRCC label. Check for SRCC system and component name plates. Refer to the Directory of SRCC Certified Solar Collector and Water Heating System Ratings, or other SRCC literature for energy factor (EF) and other performance data.
Extra tank insulation value	Determine the insulation value of any exterior wrap	See Domestic Hot Water, above.

Building element: Solar Domestic Hot Water System (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Pipe insulation value	Determine the insulation value of the pipes	Determine the R-vlaue of insulation installed on pipes.
Solar collector type	Identify type of solar collector	Identify the type of solar collector by checking for the SRCC label or manufacturer's information.
Storage tank size and location	Determine the capacity of the storage tank and location	To determine the size of the storage tank refer to documentation or a label indicating the tank capacity. Note if storage is inside or outside of conditioned space.

Building element: Solar Domestic Hot Water System (continued)

Rated Feature	Task	On-Site Inspection Protocol
System type	Determine type of solar systems	Identify whether a solar domestic hot water system exists. These systems collect and store solar thermal energy for domestic water heating applications. If a solar water heating system exists, determine system type. For systems manufactured after Jan. 1, 1995, system type, energy factor (EF), and other performance characteristics shall be determined from the SRCC label (usually affixed to the solar storage tank) and by referring to SRCC literature. For systems lacking an SRCC label, energy factor and other performance characteristics can be determined using a certified HERS modeling tool, or appropriate default values. Identify as passive or active. Base your evaluation on these criteria: *Passive* - No purchased electrical energy is required for recirculating water through a passive solar collector. Three types of passive systems are integrated collector storage (ICS), thermosiphon systems and self-pumped systems. *Integrated Collector Storage (ICS)* - consists of a single unit which incorporates both collector and water storage. An example is the common "bread box" design. Storage is usually outside the conditioned space.

Building Element: Solar Domestic Hot Water System (continued)		
Rated Feature	**Task**	**On-Site Inspection Protocol**
System type (continued)	Determine type of solar systems (continued)	*Thermosiphon* - consists of a flat-plate solar collector and hot water storage tank. Instead of using a pump, circulation of the fluid is achieved by natural convection action. The storage tank must be located above the collector, and is usually outside the conditioned space. *Self-pumped* - circulates fluid from storage to collectors without purchased electrical energy. Photovoltaic and percolating systems are examples of self-pumped systems. The storage tank is usually inside the conditioned space. *Active* - Also known as pumped systems. *Pumped* - purchased electrical energy input is required for operation of pumps or other components. The storage tank is usually inside the conditioned space.

Building Element: Passive Solar Heating System		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Direct gain	Identify system type and determine solar aperture orientation, aperture area	A solar direct gain system can reduce heating, cooling, and lighting energy requirements through proper sizing, placement, orientation, and/or control of windows, skylights, shading devices, and solar storage mass within the building. To determine aperture area, measure width and height of south-facing glazing and indicate tilt angle. Note glass type(s) (e.g., double glazing) and presence of night insulation (if any). Determine orientation with a compass reading (adjusted for magnetic deviation). Determine the type of thermal mass, its thickness and dimensions. Determine if the mass will be lit by direct solar rays between the hours of 9:00 a.m. and 3:00 p.m. during the winter. Note any trees or other obstructions to solar gain.
Greenhouse or solarium	Identify system type and determine solar aperture orientation, aperture area and information about thermal mass	A greenhouse or solarium creates a South-glazed buffer zone between the house and the exterior and can help heat the living area. They may be used in conjunction with thermal mass (such as bricks or drums filled with water) to store heat and reradiate it at night. See Direct gain, above, for specific inspection items.

Building Element: Passive Solar Heating System		
Rated Feature	**Task**	**On-Site Inspection Protocol**
Thermal storage mass	Identify system type and determine solar aperture orientation, aperture area and information about thermal mass	Thermal mass systems consist of solar-exposed heavyweight materials with high heat capacitance and relatively high conductance (high thermal diffusivity) such as masonry, brick, concrete, tile, stone, or water placed in the same zones(s) as the solar collection area(s). These elements may be integral with the building or distinct elements within the building. Distinct components: *Trombe wall* - uses a heat storage mass placed between the glass and the space to be heated. Measure area of storage mass, determine material, thickness, and capacitance. *Water wall* - replaces the existing wall, or parts of it, with containers that hold water.
Thermosiphon Air Panel (TAP)	Identify system type	*Thermosiphon air panel (TAP)* - has one or more glazing layers of glass or plastic, an air space, an absorber, another air space, and (often) an insulated backing. These are similar in appearance to active flat-plate collectors, often mounted vertically on walls, or ground-mounted, so that the living space is higher than the collector to facilitate convection from the TAP to the house. See Greenhouse, above, for specific inspection items.