National Standard for Home Energy Audits

Tuesday 8:30am – 10:00am / St. Charles Room A

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Purpose: "to define a framework for a home energy audit process."

- To increase the energy efficiency, comfort, and durability of homes.
- To insure suggested improvements provide "reasonable and consistent projections of energy savings."
- Reduce detrimental energy improvement recommendations.
- Reduce waste and pollution, protecting the environment.

Home Energy Assessment Levels

1. Energy Survey (On-Line or In-Home)
2. Diagnostic Home Energy Survey
3. Comprehensive Home Energy Audit

Alternative Paths to the Comprehensive Audit

1. Home Performance Assessment
2. Home Energy Rating (HERS)
3. An equivalent home performance program recognized by RESNET.

Accreditation Criteria: The Home Energy Assessment Provider shall be granted authority by RESNET to

- Evaluate the performance of Energy Auditors.
- Probationary period for maximum three homes.
- Provide a written agreement for each Energy Auditor.
- Provide for complaint processes and disciplinary procedures.

Accreditation Criteria: The Provider's Quality Assurance Designee

- Internal review of submitted energy assessments during the probationary period.
- Ongoing review of 10% of submitted energy audit reports.

Accreditation Criteria: The Energy Auditor

- Certified only for specific surveys / audits.
- Have 12 hours continuing education every 3 years.
- Shall pass the RESNET national Energy Auditor test.
- Will enter into a written agreement with an Home Energy Assessment Provider.
- Must comply with the RESNET Code of Ethics.
- Provide clients the RESNET Standard Disclosure form.

1. On-Line Energy Survey

2. In-Home Energy Survey

In-Home Survey: *Homeowner Interview (required)*

- Energy Use
- Comfort problems
- Interest in energy upgrades
- Discuss current energy bills

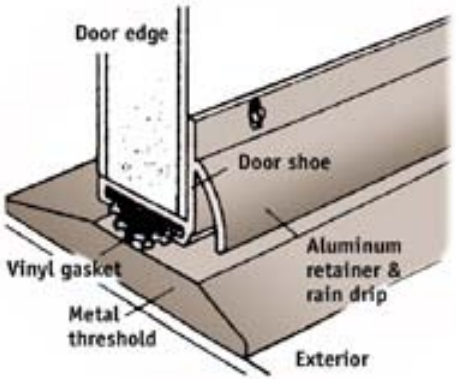
In-Home Survey: *Homeowner Interview*

Limitations of the In-Home Energy Survey

- Visual inspection only
- No diagnostics
- Generalized information on the report

In-Home Survey: Homeowner Interview

Information on no-cost / low-cost do-it-yourself home improvements.



In-Home Survey: Homeowner Interview

Recommend other inspections: 2. **Diagnostic Home Energy Survey**

- Possible use of diagnostic equipment
- In-depth report on how to prioritized energy upgrade recommendations (ie. cost vs. savings)

OR

In-Home Survey: Homeowner Interview

Recommend other inspections:

3. **Comprehensive Home Energy Audit** (by HERS Rater or BPI Building Analyst)

- Combustion appliance testing included
- Use of diagnostic equipment included
- Calculated energy and environmental savings report
- In-depth report with prioritized energy upgrade recommendations (ie. calculated savings)

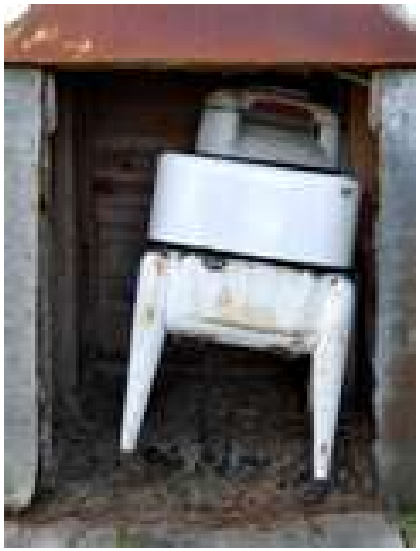
Standardized In-Home Survey

- R-Values per climate zone
- Square feet and age of house
- Window descriptions
- HVAC (type, model, location, age, etc.)

Standardized In-Home Survey

- Ductwork (location, type, R-value, leakage observations, etc.)
- Type of foundation
- List of possible air leakage sites in the home

Standardized In-Home Survey



- Appliance age and efficiency
- Number of incandescents capable of being changed to CFLs

Standardized In-Home Survey

Visual indications of condensation

- Around windows
- On ceilings
- At supply registers (is there a ventless fireplace)

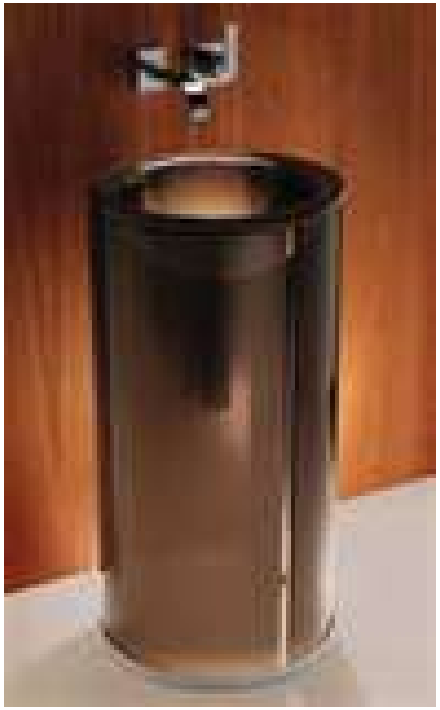
Standardized In-Home Survey

Exhaust fans

- Do they work?
- Locations
- Vented to outside?

Standardized In-Home Survey

Number and type of water fixtures



Standardized In-Home Survey

Other Plumbing Areas to Note

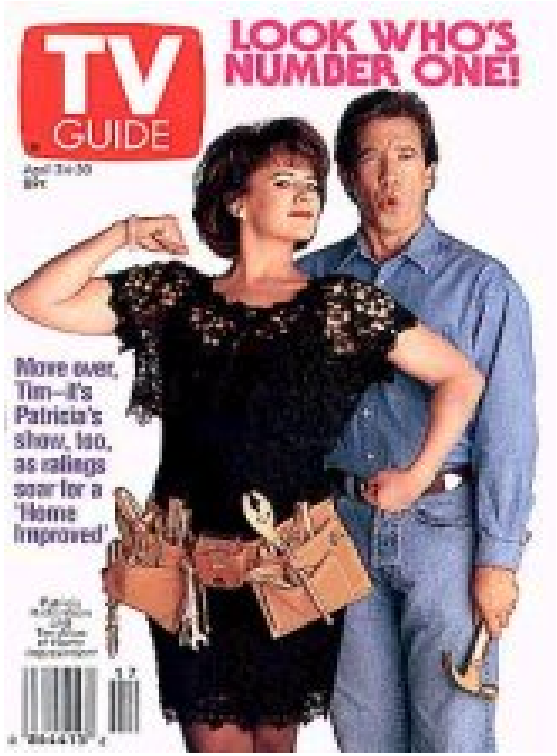
Bidet and low flow toilet or water closet (has an integral trap).

Sink or lavatory with low flow faucet.

Standardized In-Home Survey

- All collected data
- Whole house solutions
- Overview of how the house works as a system
- ENERGY STAR appliances

Standardized In-Home Survey *Report*



Standardized report of prioritized upgrades:

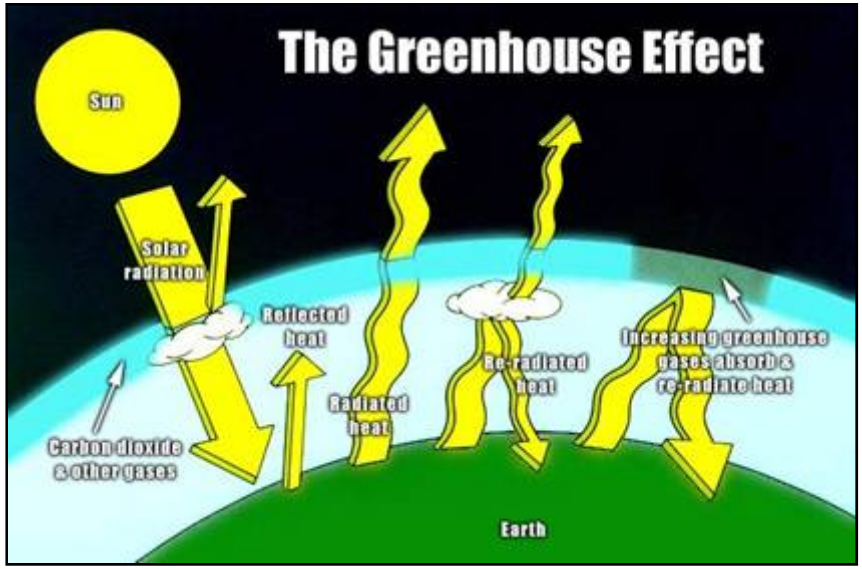
- Mechanical equipment
- Thermal envelope (air and insulation)
- Lighting
- Appliances

Standardized In-Home Survey *Report*

When recommending upgrades to the HVAC system, advise on:

- A licensed contractor
- Right sizing
- Correct duct sealing
- Proper refrigerant charge
- Balanced air flow

Standardized In-Home Survey *Report*



Greenhouse gas production in the U.S. rose 16% between 1990 and 2000.

- Information on ENERGY STAR or better appliances
- Benefits of reduction of carbon emissions
- Concerns about combustion safety (include Safety Notification Form when obvious problems exist)

Approved by RESNET:

Provider:

RESNET Residential Energy Service Network
GWS Engineers - Consultants - Inspectors

www.resnet.us

Home Energy Audit Survey

Date of Inspection: _____

Homeowner concerns: _____

Name: _____ **Home Phone:** _____
Address: _____ **Cell:** _____
City, State, Zip: _____ **Fax:** _____
Reported Sq.Ft: _____ **Home Age:** _____

House Components:

Brick / Rock:	Y / N	Basement:	Conditioned Unconditioned	# of Faucets: Type:	_____
Siding:	Wood Masonite Vinyl	Moisture Exhaust Fans?	Bath: Y / N Kitchen: Y / N Vent to Outside? Y / N	# of Shower Heads: Type:	_____
Slab:	Y / N	Wall Construction	Wood / Metal ICF / SIP	# of Stories:	
Crawl Space:	Vented Unvented	Cantilever Floor?	Y / N	Evidence of Condensation	Y / N Where?

Attic Inspection:

Insulation R-value:	Attic:	Walls: Framed Floor:	Vent. Type:	Passive / Turbine / Power	
Insulation Type			Hot walls backed?	Yes	No
Furrdowns sealed?	Yes	No	Knee walls backed?	Yes	No
Floor joists blocked?	Yes	No	Skylights, insul/backed?	Yes	No
Fireplace sealed?	Yes	No	Chases sealed?	Yes No	#:
Plate penetrations sealed?	Yes	No	Attic Doors to Seal?	Yes No	#:
Ventilation 1:300	Yes	No	Chimney Blockage?	Yes	No

Lights, Windows, Doors

# of Unsealed Can Lights:	# of Other Hard Wired Light Fixtures:
# Incandescent bulbs:	# of Light Fixtures Eligible for CFLs:
Windows: Low E: Yes No	Windows: Metal / Metal with break / Vinyl / Wood

Ext. Doors to Seal:	Windows: Single / Double / Triple

Duct System

Duct System: Sealed / Unsealed	Location of Ducts: Conditioned / Unconditioned
Filters: Clean / Dirty	R-value of Duct Insulation: #1: #2: #3:
Mechanical Ventilation: Yes / No	Type of Ducts: Flex / Metal / Other:

HVAC Equipment Data

Heating Fuel Type Manufacturer	Model #	Location	Evidence Of Flame Rollout?	Condenser Manufacturer Tonnage	Model #	Efficiency
#1			Yes No	Tons:		Furnace: Condenser:
#2			Yes No	Tons:		Furnace: Condenser:
#3			Yes No	Tons:		Furnace: Condenser:
Combustion Air Provided?			Yes / No	If No, describe:		
Unit orientation?			Vertical (V) Horizontal (H)	#1.	#2.	#3.
Unit type?			Upflow (U) Downflow (D) Horizontal (H)	#1.	#2.	#3.
Condition of exhaust air vent system			Good Poor	Comments:		

Appliances

Appliances	Age	Efficiency	Appliance	Age	Efficiency
Refrigerator			Clothes dryer		
Freezer			Trash compactor		
Dishwasher			Microwave		
Clothes washer			Other		

Comments: _____

Signature: _____ **Date:** _____

Rater Referred? Yes No **Name of rater referred:** _____

DRAFT

Diagnostic Home Energy Survey

1. This Survey must be conducted by Rater (HERS Certified).
2. Carry out the provisions of the Energy Survey.
3. Additional diagnostics ***may*** be considered:
   - Blower door
   - Duct leakage testing
   - Infrared scanning

Diagnostic Home Energy Survey Report

1. The report shall include all items as required in the In-Home Energy Survey
2. The report must be detailed, including results of any diagnostic tests performed:
   - Envelope tightness and location of air leakage areas.
   - Duct leakage assessment.
   - Specific areas of insulation problems from IR scan.

Diagnostic Home Energy Survey Report

3. Generalized energy savings from considered energy upgrades (only the Comprehensive Audit will present specific energy savings).

Comprehensive Home Energy Audit

Purpose: "to cause improvement to be made to the audited home."

This audit includes:

- An evaluation
- Performance testing
- Proposed treatments for improvements

Comprehensive Home Energy Audit

The complete evaluation:

1. Review of previous collected data.
2. Further measurement and performance testing.
3. Combustion appliance testing.
4. Computerized simulation analysis of the home's energy performance.

Comprehensive Home Energy Audit

5. The Auditor will provide a “scope of work”: a prioritized schedule of improvements.
6. The homeowner will also be guided to Certified Contractors in their area.

Comprehensive Home Energy Audit

Based on HERS Rating:

1. Provide results of combustion appliance testing.
2. Provide a work scope based on BPI Building Analyst standards.
3. Provide the relative energy efficiency of the home.
4. Provide calculated energy and environmental savings.

Comprehensive Home Energy Audit

Based on Home Performance Assessment:

1. The procedures adopted by the Building Performance Institute for the certified Building Analyst classification, or

2. The specifications required by the U.S. EPA and DOE for the Home Performance with ENERGY STAR Program.

Comprehensive Home Energy Audit

Requirements for Raters:

1. RESNET HERS Certification
2. Prepare a work scope according to the BPI Building Analyst Standards
3. Perform combustion testing according to the BPI Building Analyst Standards

Comprehensive Home Energy Audit

Requirements based on Home Performance Assessment:

1. The Auditor shall be a Building Analyst certified by BPI.
2. The Auditor shall be trained in building simulation and performance modeling according RESNET Mortgage Industry HERS Standards.

Comprehensive Home Energy Audit

Requirements based on Home Performance Assessment:

3. The Auditor must be able to perform HERS Index computations and reference home configuration,

Comprehensive Home Energy Audit

OR

A person certified by another home performance program recognized by RESNET.

END of PART 1

RESNET Required Skills

705 REQUIRED SKILLS AND CERTIFICATION

705.1 Minimum skills and knowledge base required for an individual to conduct an In-Home Home Energy Survey

705.1.1 Basics of heat transfer concepts

705.1.2 Basics of building performance testing

705.1.3 Basics of air distribution leakage

705.1.4 Calculating gross and net areas

705.1.5 Definitions/energy terminology

705.1.6 Basic combustion appliance concerns

705.1.7 Basics of envelope leakage, thermal bypass, thermal bridging

705.1.8 Determining envelope insulation

RESNET Required Skills

705.1.8.1 Presence/absence of insulation and when observable, the quality of its installation

705.1.8.2 Recommended levels of insulation by climate zone

705.1.9 HVAC – determining equipment efficiencies from model numbers or default tables

705.1.10 Household appliances – determine efficiency from model numbers or vintage

705.1.11 Energy units

705.1.12 Measuring building dimensions

705.1.13 Identification and documentation of energy survey inspected features of the home

705.1.14 Basics of specifications

705.1.15 Determining window and door efficiency

RESNET Required Skills

705.1.16 Determining building orientation and shading characteristics

705.1.17 Defining the thermal boundaries

705.1.18 Basics of measure interaction, expected life, and bundling for optimal performance considering the house as a system and the emerging need for deep savings."

705.1.1 Basics of Heat Transfer Concepts

First Law of Thermodynamics:

Energy is neither created nor destroyed.

705.1.1 Basics of Heat Transfer Concepts

Second Law of Thermodynamics:
Heat moves from hot to cold.

705.1.1 Basics of Heat Transfer Concepts

Types of heat flow:

Conduction: Heat flow from molecule to molecule either through a substance or between two materials of different temperatures touching each other.

705.1.1 Basics of Heat Transfer Concepts

Types of heat flow:

Convection: Heat transferred by a moving fluid because of density differences between warmer and cooler parts of the fluid.

705.1.1 Basics of Heat Transfer Concepts

Types of heat flow:

Radiation: Transfer of heat through matter or space by means of electromagnetic waves. Radiation travels by line of sight.

705.1.1 Basics of Heat Transfer Concepts

Types of radiation:

- Emitted
- Absorbed
- Reflected
- Transmitted

705.1.1 Basics of Heat Transfer Concepts

Types of heat gain:

- Solar gains
- Internal gains
- Air leakage
- Transmission

705.1.2 Basics of Building Performance Testing

Air movement requires:

- A pressure difference across the building envelope
- A hole in the envelope

705.1.2 Basics of Building Performance Testing

Stack-effect pressure: Stratification of the air in a home due to pressure differences.

1 cfm in, 1 cfm out---always!

705.1.2 Basics of Building Performance Testing

Wind pressure:

Pressures created within the house due to wind.

705.1.2 Basics of Building Performance Testing

The most preferred means of measuring air leakage across the building shell is the blower door.

- CFM50
- ACH50
- NACH

705.1.2 Basics of Building Performance Testing

Normal areas of air leakage:

- Furrdowns
- Leaky ducts
- Open floor joists
- Knee walls
- Weather stripping
- Can lights
- Plate penetrations
- Open chases
- Fireplace
- Windows

705.1.3 Basics of Air Distribution Leakage

25% duct leakage equals one ton of air conditioning.

This is very often the #1 place to start energy improvements.

705.1.3 Basics of Air Distribution Leakage

Duct leakage outside the conditioned space affects the operating pressures within the building shell:

- Return leaks suck (make the house negatively pressurized)
- Supply leaks blow (make the house positively pressurized)

705.1.3 Basics of Air Distribution Leakage

Duct leakage testing:

- Performed with a duct leakage testing device and a blower door.
- Measures total duct leakage and duct leakage to outside the conditioned space.

705.1.3 Basics of Air Distribution Leakage

Duct sealing:

- Use of code approved tape or mastic (mastic is the better choice.
- All joints and seams.
- Between all supply boots and return boxes and the drywall

705.1.4 Calculating gross and net areas

- Be able to do plan take-offs.
- Square footage
- Volume
- May need numerous formulas from Geometry

705.1.5 Definitions and Energy Terminology

Sensible Heat: The heat either absorbed or released when a component changes temperature.

705.1.5 Definitions and Energy Terminology

Latent Heat: The amount of heat either absorbed or released when a material changes phases (solid to liquid or liquid to gas).

705.1.5 Definitions and Energy Terminology

Pascal and Inches of Water Column (IWC): Units of measurement of air pressure.

1 IWC = 249.1 Pascal

705.1.5 Definitions and Energy Terminology

Temperature: A measurement of how fact the molecules of a substance are moving or vibrating.

705.1.5 Definitions and Energy Terminology

Energy: A quantity of heat or work

- Kinetic energy is energy in transition or motion.
- Potential energy is stored energy.

705.1.5 Definitions and Energy Terminology

Heating Degree Day: The number of degrees per day the daily average temperature is below 65°F.

705.1.5 Definitions and Energy Terminology

Comfort has four determining factors:

- Air temperature
- Relative humidity
- Moving air
- Mean radiant temperature

705.1.5 Definitions and Energy Terminology

Relative Humidity: The amount of moisture in the air at a specific temperature compared to the total amount of water the air at that temperature can hold.

705.1.5 Definitions and Energy Terminology

Dew point: The temperature of the air at which condensation or saturation occurs.

705.1.6 Basic Combustion Appliance Concerns

Combustion Basics:

Oxygen + Natural Gas →

Carbon Dioxide + Water + Carbon Monoxide + Oxygen

705.1.6 Basic Combustion Appliance Concerns

Open-combustion: these units draw air from the surrounding room.

Sealed-combustion: combustion air is brought directly into the unit from the outside. Safer and usually more efficient.

705.1.6 Basic Combustion Appliance Concerns

Backdrafting: The reverse flow of exhaust gases from the flue of a combustion appliance into the living space due to negative pressures within the building shell.

Can occur between 3 and 5 Pascals of negative pressure.

705.1.6 Basic Combustion Appliance Concerns

Flame roll-out or Spillage: The situation where the flame "spills" outside the combustion chamber because of negative pressure in the building.

Can occur at negative pressures equal to or greater than 6 Pascal.

705.1.7 Basics of Envelope Leakage

Thermal Boundary: the combination of the air barrier and the insulation which encloses the conditioned space.

Ideally, the insulation should be in contact with the air barrier.

705.1.7 Basics of Envelope Leakage

Thermal Bridging: Heat flow around the insulation within the building shell due to conductive materials in the wall either alone or in contact with each other.

705.1.7 Basics of Envelope Leakage

Thermal Bypass: Airflow carrying heat across the thermal boundary and around the insulation.

705.1.8 Determining Envelope Insulation

Determine the thermal boundary by mapping where the conditioned space meets exterior walls (ambient, garage, or attic).

705.1.8 Determining Envelope Insulation

R-value: a measurement of thermal resistance.

U-factor: The amount of heat flowing across a 1 square foot of material or building cross-section having a 1°F ΔT.

$R = 1 / U$

$U = 1 / R$

705.1.8 Determining Envelope Insulation

For framed walls:

- Determine the width of the wall at a window or door.
- Check at plumbing or cable/telephone/ electrical box for presence of insulation.
- Estimate R-value at 3.5/inch.
- Infrared may be used to determine the quality of the installation.

705.1.8 Determining Envelope Insulation

For attics:

- Take depth measurements in four locations.
- Average the depth measurements.
- Estimate the R-value at 3.5/inch.
- Infrared may be used to determine the quality of the installation.

705.1.8 Determining Envelope Insulation

Be able to advise customers as to the optimum amount of insulation needed in your geographic area.

Zone	Gas	Heat pump	Fuel oil	Electric furnace	Ceiling: Attic	Ceiling: Cathederal	Wall [A]	Floor	Crawl space [B]	Slab edge	Basement: Interior	Basement: Exterior
1	✔	✔	✔		R-49	R-38	R-18	R-25	R-19	R-8	R-11	R-10
1				✔	R-49	R-60	R-28	R-25	R-19	R-8	R-19	R-15
2	✔	✔	✔		R-49	R-38	R-18	R-25	R-19	R-8	R-11	R-10
2				✔	R-49	R-38	R-22	R-25	R-19	R-8	R-19	R-15
3	✔	✔	✔	✔	R-49	R-38	R-18	R-25	R-19	R-8	R-11	R-10
4	✔	✔	✔		R-38	R-38	R-13	R-13	R-19	R-4	R-11	R-4
4				✔	R-49	R-38	R-18	R-25	R-19	R-8	R-11	R-10
5	✔				R-38	R-30	R-13	R-11	R-13	R-4	R-11	R-4
5		✔	✔		R-38	R-38	R-13	R-13	R-19	R-4	R-11	R-4
5				✔	R-49	R-38	R-18	R-25	R-19	R-8	R-11	R-10
6	✔				R-22	R-22	R-11	R-11	R-11	(C)	R-11	R-4
6		✔	✔		R-38	R-30	R-13	R-11	R-13	R-4	R-11	R-4
6				✔	R-49	R-38	R-18	R-25	R-19	R-8	R-11	R-10

(**A**) R-18, R-22, and R-28 exterior wall systems can be achieved by either cavity insulation or cavity insulation with insulating sheathing.
For 2 in x 4 in walls, use either 3-1/2-in thick R-15 or 3-1/2-in thick R-13 fiber glass insulation with insulating sheathing.
For 2 in x 6 in walls, use either 5-1/2-in thick R-21 or 6-3/4-in thick R-19 fiber glass insulation.
(**B**) Insulate crawl space walls only if the crawl space is dry all year, the floor above is not insulated, and all ventilation to the crawl space is blocked. A vapor retarder (e.g., 4- or 6-mil polyethylene film) should be installed on the ground to reduce moisture migration into the crawl space.
(**C**) No slab edge insulation is recommended.
NOTE: For more information, see: Department of Energy Insulation Fact Sheet (D.O.E./CE-0180). Energy Efficiency and Renewable Energy Clearinghouse, P.O. Box 3048, Merrifield, VA 22116; phone: (800) 363-3732; www.ornl.gov/roofs+walls/insulation/ins_11.html

705.1.9 Determining Equipment Efficiencies

Formula: Efficiency = Output / Input

What is the efficiency of a furnace with an input of 120,000 BTUH and an output of 100,000 BTUH?

100,000 / 120,000 = 0.833 or 83.3%

705.1.9 Determining Equipment Efficiencies

Other helps:

- The model number of the furnace.
- Default equipment efficiency tables (see RESNET 2006 Mortgage Industry HERS Standards, p. 3-34)
- Preston's Guide

705.1.9 Determining Equipment Efficiencies

Efficiency ratings to understand:

- Annual Fuel Utilization Efficiency (AFUE)
- Heating Seasonal Performance Factor (HSPF)
- Coefficient of Performance (COP)
- Steady State Efficiency (SSE)
- Seasonal Energy Efficiency Ratio (SEER)

705.1.10 Household Appliance Efficiency

Ratings can be found:

- Default charts as in *Residential Energy*, Table A-19, p. 294
- Some designations from the model numbers or unit plates.

705.1.10 Household Appliance Efficiency

Ratings can also be found from:

- The EPA website.
- The American Home Appliance Manufacturers Association (AHAM)
- The American Council for an Energy Efficient Economy (ACEEE)
- Gas Appliance Manufacturer's Association (GAMA)

705.1.11 Energy Units

- BTU: The amount of heat required to raise the temperature of 1 pound of water 1°F.
- Kilowatt (kW): A unit of electric power.
- 1 kWh = 3412 BTU

705.1.11 Energy Units

Natural gas measurements:

- Hundred cubic feet = 1 ccf = 100 cf
- Thousand cubic feet = 1 mcf = 1000 cf
- 1 ccf = 1 therm = 100,000 BTU
- 1 mcf = 1,000,000 BTUs (MMBTU)

705.1.11 Energy Units

Air conditioning:

- 1 ton of refrigeration = 12,000 BTUs
- 1 ton of air conditioning = 400 cfm

705.1.12 Measuring Building Dimensions

Exterior measurements:

- Measure to the brick ledge or to the exterior siding.
- Measure to the nearest inch.
- The gross surface area is the area of the floor, the walls, and the ceiling.
- The net surface area does not include the windows or the doors.

705.1.12 Measuring Building Dimensions

Interior measurements:

- Measure the conditioned space to the nearest square foot.
- Windows should be measured to the nearest inch (the total of the rough opening or the combination of the glass, the sash, and the frame)

705.1.12 Measuring Building Dimensions

Interior measurements:

- Stairways and landings are counted as square footage on both the starting and ending levels.
- Do not include the “footprint” of protruding chimneys or bay windows.
- Include all conditioned space.

705.1.13 Identification and Documentation of Energy Audit Inspected Features of the Home

As previously discussed in this slide presentation. This includes:

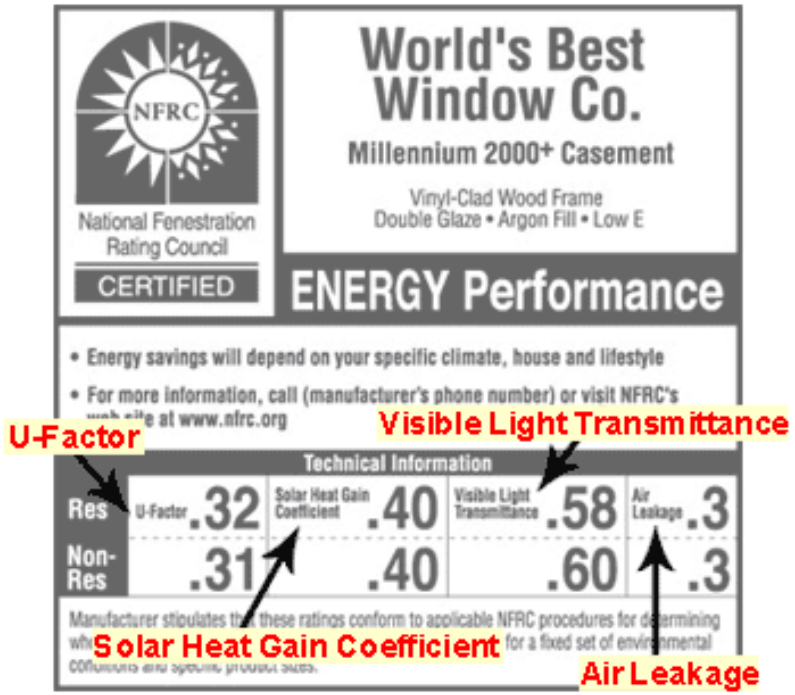
- The interview.
- The survey.
- The report.

705.1.14 Basics of Specifications

Not a clue what they want here! There are no plans for an existing house.

705.1.15 Determining Window & Door Efficiency

- Efficiency ratings performed by the National Fenestration Rating Council (NFRC)
- Every window has an NFRC Window label.



705.1.15 Determining Window & Door Efficiency

Window components:

- Glass assembly
- Sash: the part holding the glass.
- Frame: the part attached to the house and holding the glass assembly and sash.

705.1.15 Determining Window & Door Efficiency

Window efficiency components:

- U-factor: thermal transmittance, includes heat transfer by conduction, convection, and radiation through the window.

705.1.15 Determining Window & Door Efficiency

Window efficiency components:

- Solar Heat Gain Coefficient (SHGC): the ratio of solar heat passing through the glass compared to the solar heat hitting the glass at a 90° angle.
- A single pane of glass has an SHGC of 87.

705.1.15 Determining Window & Door Efficiency

Window efficiency components:

- Visible transmittance: A measurement of the amount of visible light admitted by the window.

705.1.16 Determining Building Orientation

Ways to determine orientation:

- Wait to see what side of the house the rising sun hits first.
- Back your car up to the front door and read the compass.
- Hold a compass and face the window from the inside or face away from the window on the outside (adjust for magnetic deviation if needed).

705.1.16 Determining Shading Characteristics

- Draw a site plan for the house including all things providing shading on the house.
- Note blinds and curtains.
- Measure the following items:
  - Width of the overhang (soffit or porch)
  - Height from the top of the window to the soffit.
  - Height from the bottom of the window to the soffit.

705.1.18 Life Cycle Costing

Use of software to estimate:

- The expected life of improvements
- Measured interaction of components
- Estimated energy savings of installed energy upgrades.
- Priority of upgrades for best payback period.

Reference List:

- RESNET 2006 Mortgage Industry HERS Standards
- *Residential Energy* by John Krigger and Chris Dorsi
- Observational Diagnostics (www.sivadhome.com/library.htm)
- Saturn Energy Auditor Field Guide
- ACEEE
- ARI
- EPA
- *Residential Construction Academy*, Michael Joyce