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DECODING UNVENTED ATTICS: FROM CONCEPT TO SIMULATION TO INSPECTION

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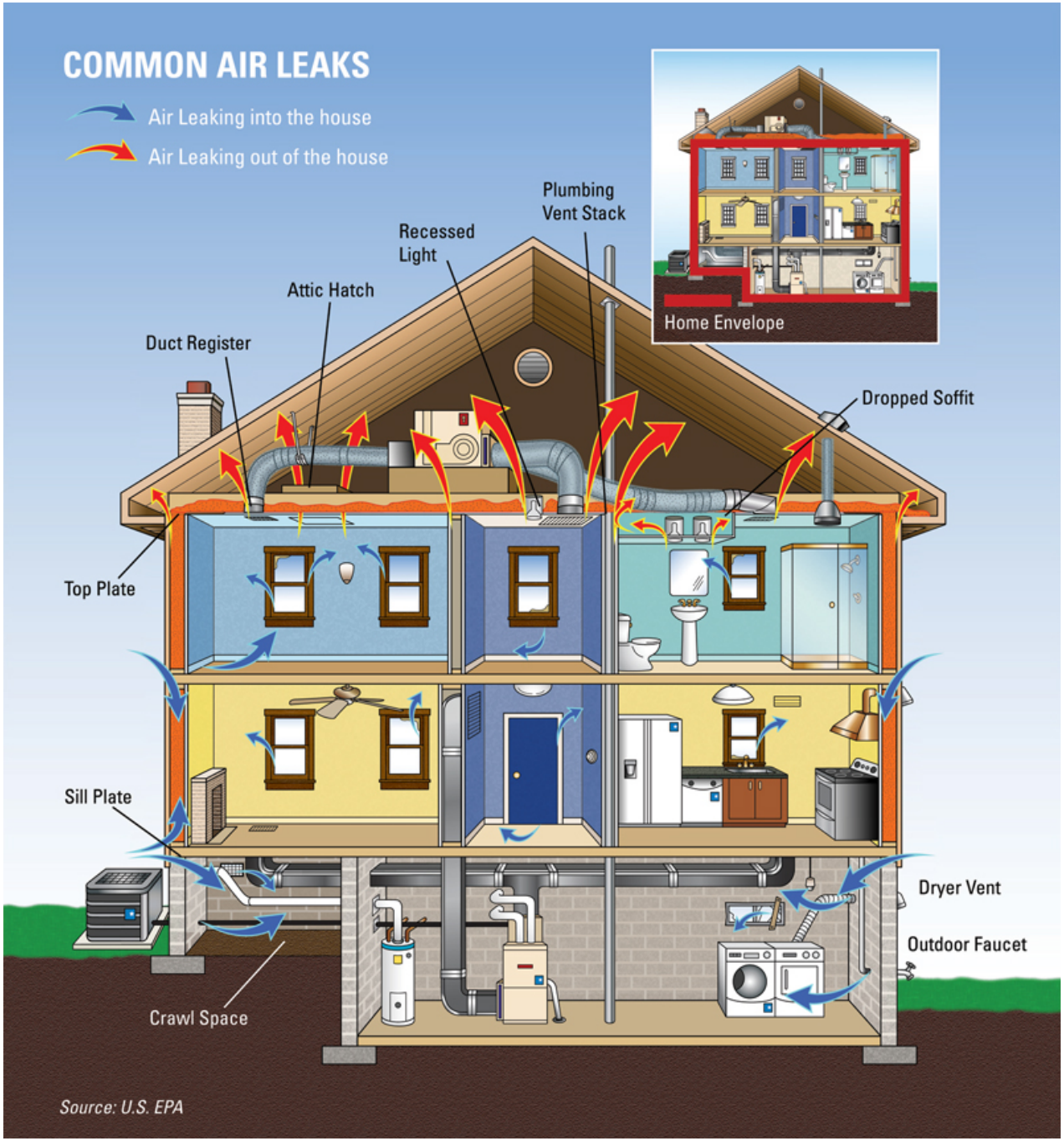
Overview

1. **Basic Principles:** UVA vs. Traditional Vented Attics
2. **Design Considerations:** Code compliance, SPF Type, Other…
3. **Energy Modeling** Guidance for UVA
4. **Quality:** Jobsite Prep, Safety, Evaluation and Inspection

Basic Principles

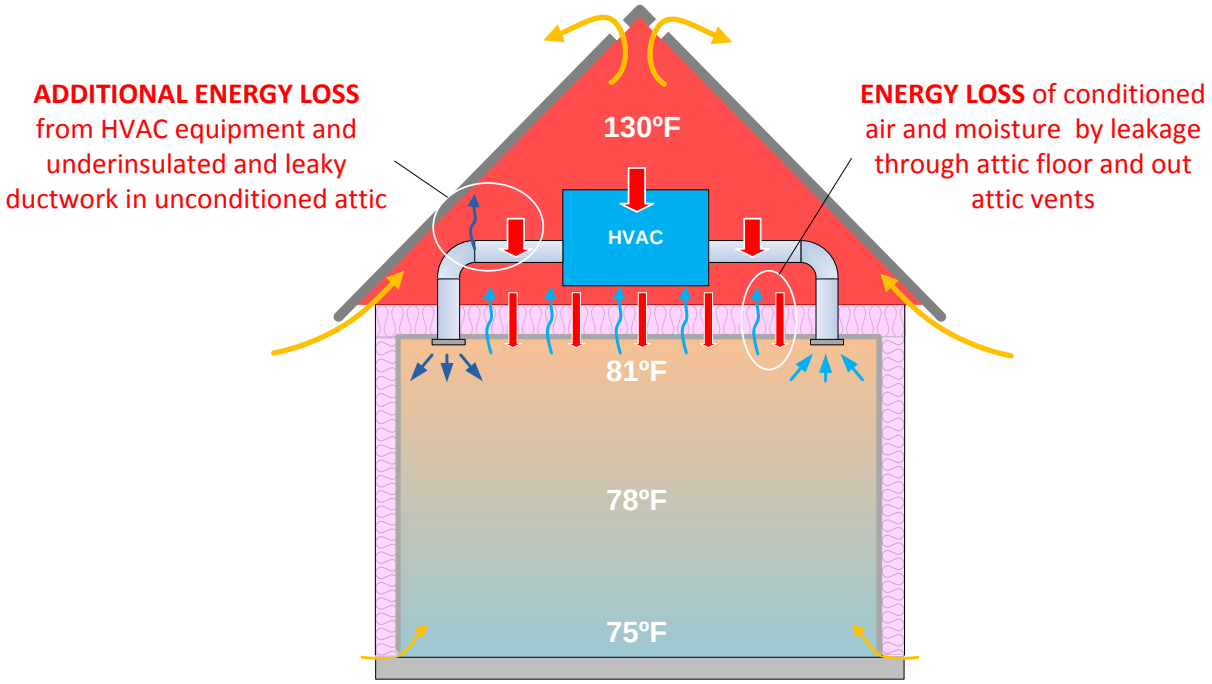
Traditional Vented Attic

- Uses vented soffit to introduce air into the attic
- Uses (one or more) gable/ridge/turbine/roof vents to release air from the attic
- Removes accumulated heat in summer, providing some cooling of roof deck and attic space
- Removes moisture in winter
- Moderately high air leakage in existing homes


COMMON AIR LEAKS
Air Leaking into the house
Air Leaking out of the house
Home Envelope
Plumbing Vent Stack
Recessed Light
Attic Hatch
Duct Register
Dropped Soffit
Top Plate
Sill Plate
Dryer Vent
Outdoor Faucet
Crawl Space
Source: U.S. EPA

Basic Principles

Vented attic performance in summer…



Basic Principles

Traditional Vented Attic

- High summer temperatures in attic increases cooling loads from under-insulated HVAC systems in hot attic
- Low winter temperatures in attic increases heating loads from under-insulated HVAC systems in hot attic
- Measurable gains in energy efficiency are possible with attic-mounted HVAC systems using conditioned attic

Basic Principles

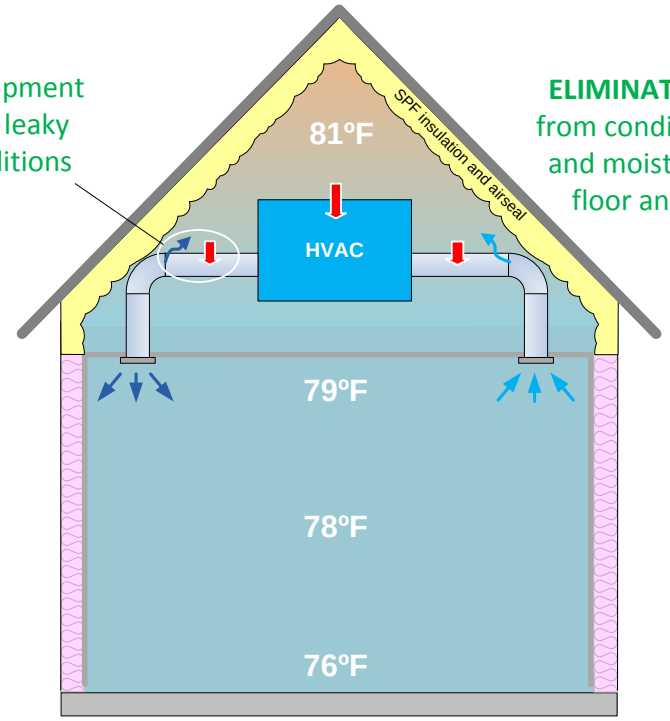
Unvented (Conditioned) Attic

- No outside air introduced into attic
- Insulation and air barrier plane at roof deck, bringing entire volume of attic into conditioned space
- Minimizes air leakage through ceiling
- HVAC systems operate more efficiently in conditioned space
- Passively conditioned by HVAC equipment
- Energy savings from HVAC systems in conditioned space are greater than energy losses from increased envelope area (roof v. attic floor)

Basic Principles

Unvented attic performance in summer…

ENERGY from HVAC equipment and underinsulated and leaky ductwork passively conditions attic



ELIMINATES ENERGY LOSS from conditioned air leakage and moisture through attic floor and out attic vent

Design Considerations

UVA and Model Building Codes

Since 2006, UVAs (aka *Conditioned Attics*) are permitted in the International Residential Code (IRC)

- Requirements per 2006 and 2009 IRC Section R806.4; 2012 IRC Section 806.5
- Added to IBC in 2015
- Includes air-impermeability requirements and certain limitations for insulations
- IRC and IBC are model codes that require adoption by state or local jurisdictions

Confirm that UVAs are included in State/Local Code

- Work with builder/homeowner to confirm state/local codes through local code office

Design Considerations

UVA Code Requirements

- Included in IRC model building code since 2007 (IBC in 2012)
- Air-impermeable insulation only (foam plastics)…until 2018
- Single insulation plane
- Use vapor retarders where needed
- Most common UVA assemblies
    - SPF below roof deck, from top plate to ridge
    - Foam plastic sheathing below or above roof deck

Design Considerations

Insulation Levels

Minimum ceiling insulation levels are provided by International Residential Code (IRC), International Energy Conservation Code (IECC) and ASHRAE 90.1

- R-value minimum / U-value maximums prescribed in code
- Levels can depend on climate zone and version of code adopted by local jurisdictions
- Discuss current local code requirements with customer
- Lower ceiling/attic R-values can be permitted under performance path designs

Climate Zone	1	2	3	4AB	5+4C	6	7+8
R-value min	R30	R38	R38	R38	R49	R49	R49
U-factor max	0.035	0.030	0.030	0.030	0.026	0.026	0.026

From Tables R402.1.1 and R402.1.3 of 2012 IECC for standard truss attics. Wrapping top chord / rafters will provide some continuous insulation and can reduce these prescriptive levels. Refer to code.

Design Considerations

Vapor Retarders

Vapor retarders can prevent condensation on underside of roof deck, particularly in colder climates

- Class I or II vapor retarders required in IECC Climate Zones 5-8 and Marine 4
- 2” or more MD-SPF inherently provides vapor retarder per ASTM Standard
- LD-SPF may need supplemental vapor retarder on warm-in-winter side
- Supplemental vapor retarders include:
  - Plastic films
  - Certain paints
  - The use of vapor retarding paints under fire protective coatings merits caution unless the configuration has been fire tested. Check with coating manufacturer.

Design Considerations

UVA Using Spray Polyurethane Foam Insulation

1. Air-Impermeable

- Meets code requirements for insulation in contact with roof deck

2. Remains in-place

- Adhesively bonds to all surfaces
- Does not sag or settle

3. Structural benefits

- Wind uplift resistance from reduced depressurization (MD and LD SPF)
- Racking resistance and mechanical adhesion of roof deck (MD SPF)

4. Water resistance

- MD-SPF may provide a secondary water barrier
- LD-SPF promotes interior drying

Design Considerations

Low-Density and Medium-Density SPF Attributes

Both product classes are used across climate zones when vapor retarder requirements are met

Attribute	Importance	LD-SPF	MD-SPF
Tight Clearance (e.g., ice damming, shallow rafters)	Cold Climates		✓
Wind Uplift / Water Barrier	Hurricanes	✓	✓✓
Integral Vapor Retarder	Cold Climates		✓
Water Resistance	Secondary Water Barrier		✓
Vapor Permeable	Promotes Drying in Hot Climates	✓	

Design Considerations

Asphalt Shingles

Any insulation under roof deck increases shingle temperature*

- Other factors: shingle color, latitude, slope, orientation,
- 7-10°F increase (FL)
- Minimal impact on service life (1-2 years on 30-year shingle)

Review manufacturer's shingle warranty regarding roof deck insulation

Photos courtesy of InterNACHI

* Parker, D.S., "*Literature Review of the Impact and Need for Attic Ventilation in Florida Homes*", FSEC-CR-1496-05 May 2005

Design Considerations

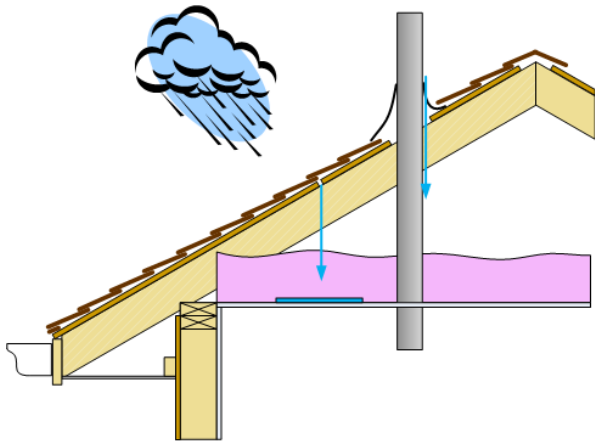
Water Leakage and Detection

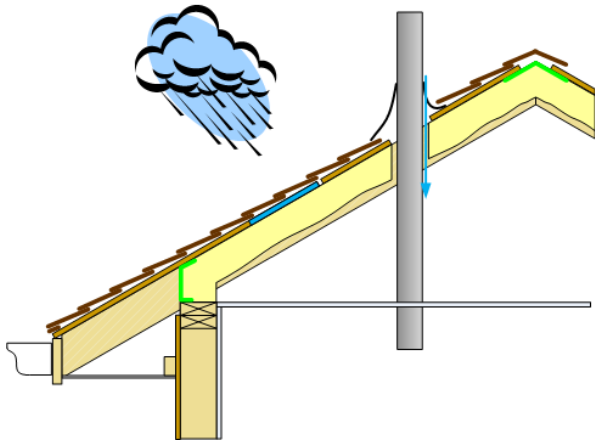
Many roof water leaks occur at flashings and penetrations

- Generally not concealed by SPF
- Easy to locate

Field Leaks (away from flashings) are not as common

- Leak location possible for LD-SPF
- Water will not pass through MD-SPF under normal conditions
- No severe damage expected to plywood decking *





* Research project in progress at University of Florida (Dr. D. Prevatt)

Design Considerations

Fire Protection

SPF is combustible like other organic materials commonly used in building

Building codes require protective coverings over all foam plastic insulations in attic spaces

- 15-minute thermal barrier over foam when attic is used other than for ‘service of utilities’… e.g., storage
- Ignition barrier over foam in limited-access attics
- Product-specific assembly testing to allow unprotected foam is possible
- Reference the building code in your area and product data sheet or evaluation report

Design Considerations

Fire Protection

For easy access attics or those used for storage, foam surface must be covered with a:

- Prescriptive **15-minute thermal** barrier (1/2" gypsum), or
- Equivalent 15-minute thermal barrier coating or covering
- Approved assemblies and interior finishes meeting certain fire test requirements
- No uncovered SPF

For attics with limited access for service of utilities (NO storage), foam surface must be covered with a:

- Prescriptive **ignition barrier**, or
- Alternate ignition barrier assembly tested per AC-377 Appendix X, or A1.0
- Uncovered foam OK if it passes AC-377 Appendix X
- 15-minute thermal barrier between attic and interior spaces (e.g. finished ceiling of top floor) is still required
- No covering needed for small inaccessible areas such as above collar ties and behind kneewalls

Design Considerations

HVAC Systems

Creating an unvented attic (UVA) with SPF can:

- Reduce uncontrolled air leakage
- Lower HVAC energy needs
- Improved insulation performance
- HVAC system inside the building envelope operates under more moderate temperatures

Most HVAC systems are oversized to account for excess air leakage:

- Affects the energy efficiency as well as effectiveness dehumidification
- SPF permits downsize (or “rightsize”) the HVAC system for better performance

Adjustments or downsizing of HVAC system may be needed:

- Good IAQ
- Mechanical ventilation or ERV/HRV
- Avoid short-cycling of AC system for proper dehumidification
- Supplemental humidification/dehumidification to control relative humidity

Energy Use & HERS Modeling Guidance for Unvented Attics

Modeling inputs can have a significant impact on Energy Use and HERS Index values.

Inconsistent inputs between users – try to correct

Anecdotal reports and independent feedback indicate improperly modelled unvented attics can impact HERS scores by as much as 10%.

Concern that unvented attics using SPF in modeling not reflective enough of energy efficiency benefits offered

Software Tools Examined:

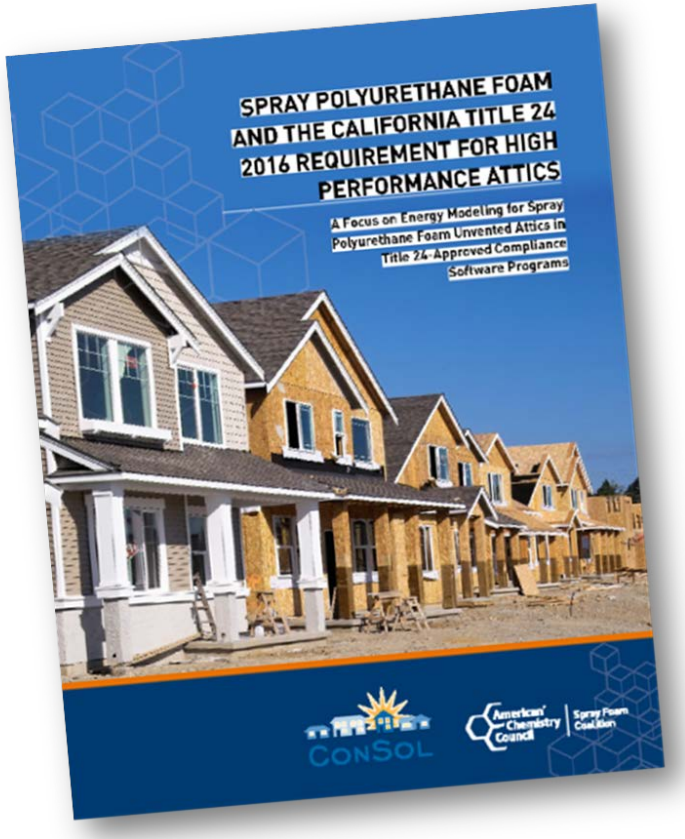
- **CBECC and Energy Pro**
- **REM/Rate**
- **EnergyGauge USA**

California Title 24 Compliance

- **Unvented Attics are allowed in the Title 24 (2016) Performance Path but you have to be aware of some subtleties of how to implement one in the approved software - Energy Pro and CBECC**

- **SFC study indicates that an R-28 Unvented Attic will out-perform a Title 24 (2016) conventional (prescriptive) attic with total R-value of R-51 in all California Climate zones**

Title 24 Modeling Guidance



- American Chemistry Council – Spray Foam Coalition publication
- Provides useful tips and research on incorporating SPF Unvented Attic into 2016 Title 24 Requirements
- Modeling guidance for both CBECC and Energy Pro Software
- Includes section on Common Errors in Modeling SPF UVAs

Title 24 Modeling Guidance - EnergyPro

- **EnergyPro (v6.7.0.3) treats the entire attic, including the ceiling plane and roof deck, as an "assembly". User needs to build the roof deck assembly within the JA-4 dialogue window. See SFC document for details.**

Name	Type	R-Value	U-Factor	Const. Type	JA4
R-19 Metal Deck Roof	Roof	21.4	0.047	Span Deck ...	4.2....
R-0 Roof Cathedral	Roof	3.4	0.297	Wood Fram...	4.2....
R-11 Roof Cathedral	Roof	11.9	0.084	Wood Fram...	4.2....
R-13 Roof Cathedral	Roof	14.5	0.069	Wood Fram...	4.2....
R-19 Roof Cathedral	Roof	19.6	0.051	Wood Fram...	4.2....
R-30 Roof Cathedral	Roof	28.6	0.035	Wood Fram...	4.2....
R-38 Roof Cathedral	Roof	35.7	0.028	Wood Fram...	4.2....
R-0 Grg. Roof Attic	Roof	3.3	0.305	Wood Fram...	4.2....
R-0 Roof Attic	Roof	3.3	0.305	Wood Fram...	4.2....
R-11 Roof Attic	Roof	13.2	0.076	Wood Fram...	4.2....
R-13 Roof Attic	Roof	14.7	0.068	Wood Fram...	4.2....
R-19 Roof Attic	Roof	20.8	0.048	Wood Fram...	4.2....
R-21 Roof Attic	Roof	23.3	0.043	Wood Fram...	4.2....
R-30 Roof Attic	Roof	32.3	0.031	Wood Fram...	4.2....
R-38 Roof Attic	Roof	40.0	0.025	Wood Fram...	4.2....
R-38 Ceiling w/ R-13 BD	Roof	50.4	0.020	Wood Fram...	4.2....
R-0 Ceiling Plane w/ R-38 BD	Roof	19.6	0.051	Wood Fram...	4.2....
R-0 Ceiling Plane w/ R-30 BD	Roof	19.6	0.051	Wood Fram...	4.2....
R-0 Ceiling Plane w/ R-22 BD	Roof	19.6	0.051	Wood Fram...	4.2....

General | JA-4 | Layers

Description

Construction: Wood Framed Attic

Description: 2x4 @ 24 in. O.C.

Insulation: - no insulation - JA-4 4.2.1-A13

Added Interior Insulation

Framing: Wood

Insulation: 30 R-value

Thickness: 10.25 inches

Added Exterior Insulation

Framing: None

Insulation: 0 R-value

Thickness: 0 inches

Properties

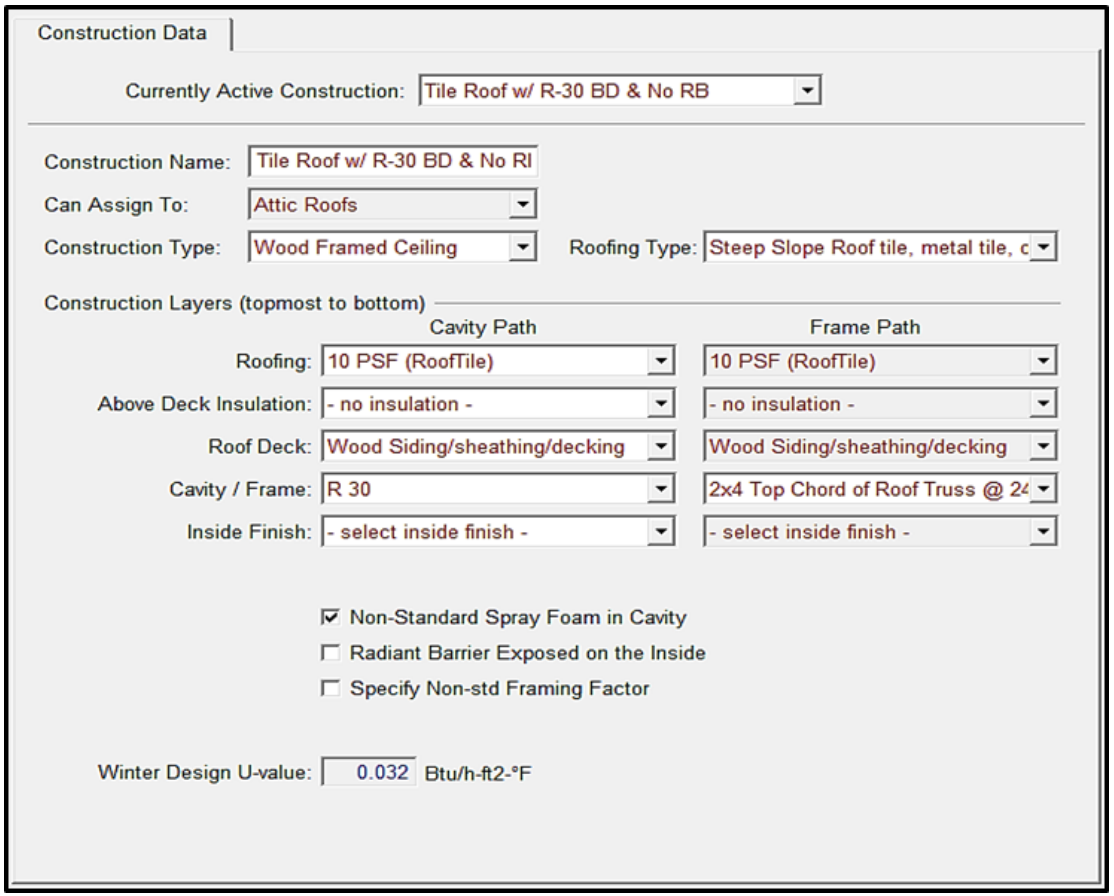
Heat Capacity: 0.0 Btu/ft²-°F

U-Factor: 0.051 Btu/hr-ft²-°F

R-Value: 19.6 R-value

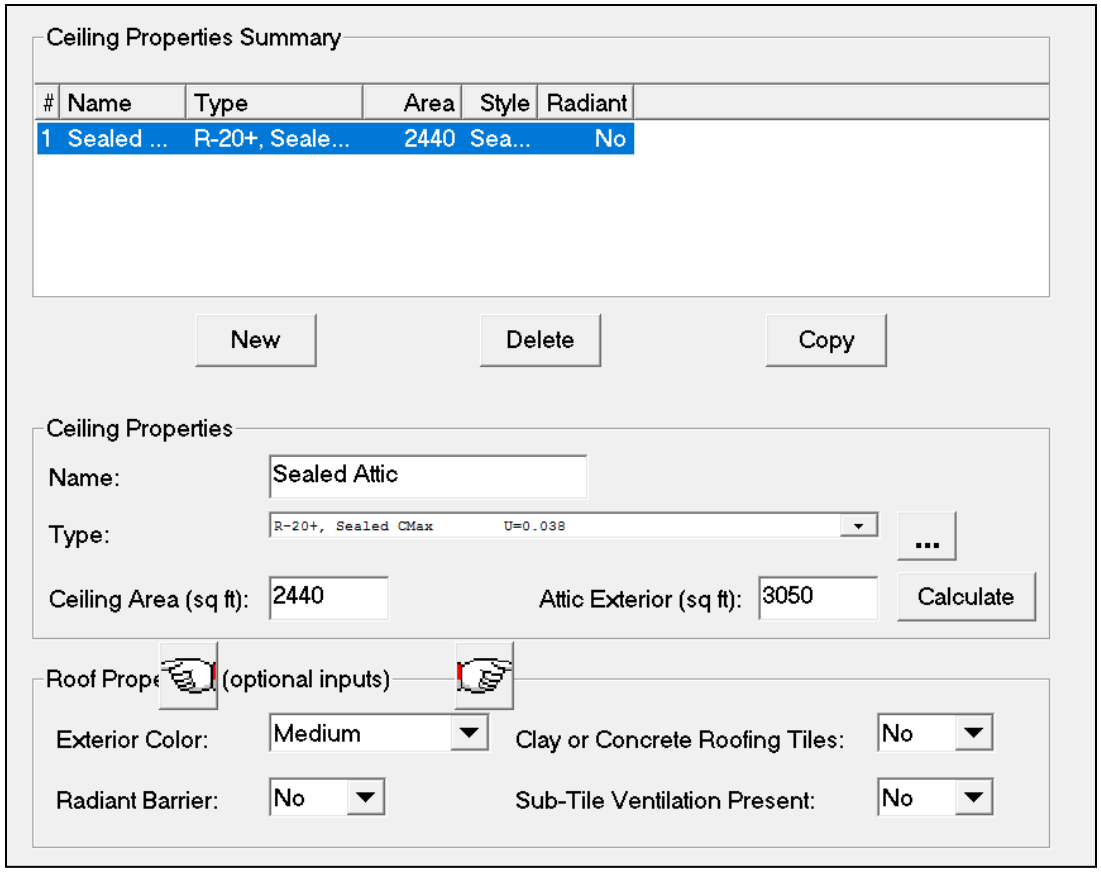
Title 24 Modeling Guidance - CBECC-Res

- **CBECC-Res requires the user to define the roof deck and ceiling assemblies within two different dialogue boxes. See SFC document for details.**



Energy Use & HERS Index Modeling Guidance – REM/Rate

REM/Rate™



- REM/Rate is the most used software
- Sealed attic choice as ceiling type
- Cavity Insulation Grade 1 is the expectation
- Building airtightness values between 1.5 & 3.0 ACH50 common

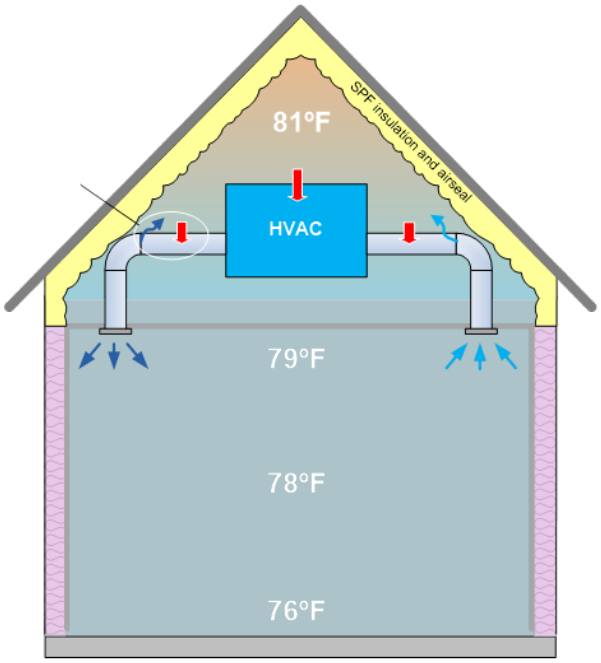
Energy Use & HERS Index Modeling Guidance – REM/Rate

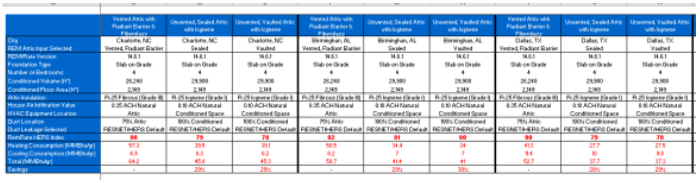
- Feedback from many REM/Rate users modeling SPF unvented attics indicated that the HERS value scores did not appear appropriate (or fair) for the amount of heating and cooling energy usage determined particularly when compared to other attic construction approaches

- HERS index values did not line up with energy savings values

- Concern this situation misleads consumers and puts spray foam products at a competitive disadvantage

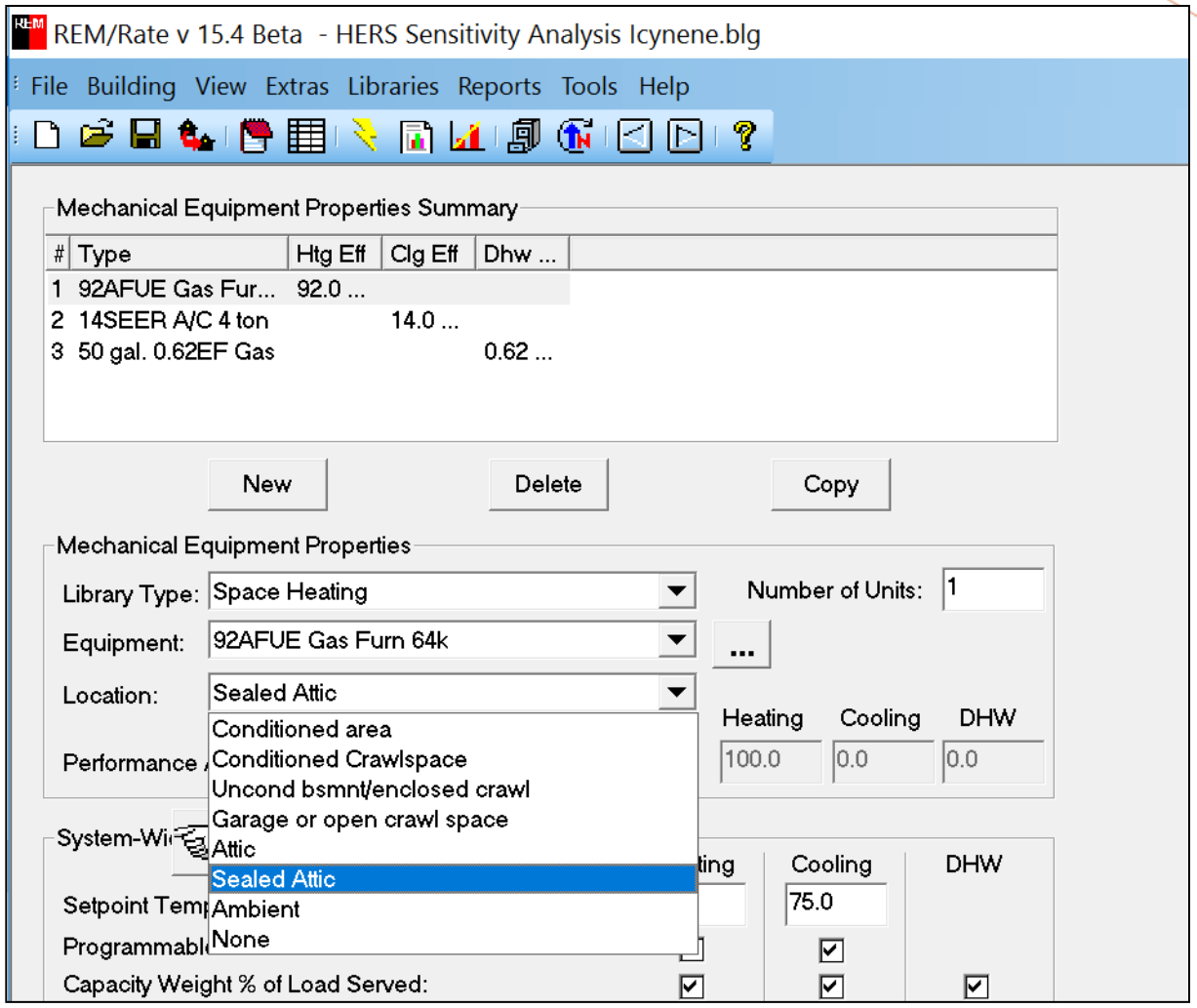
Energy Use & HERS Index Modeling Guidance – REM/Rate





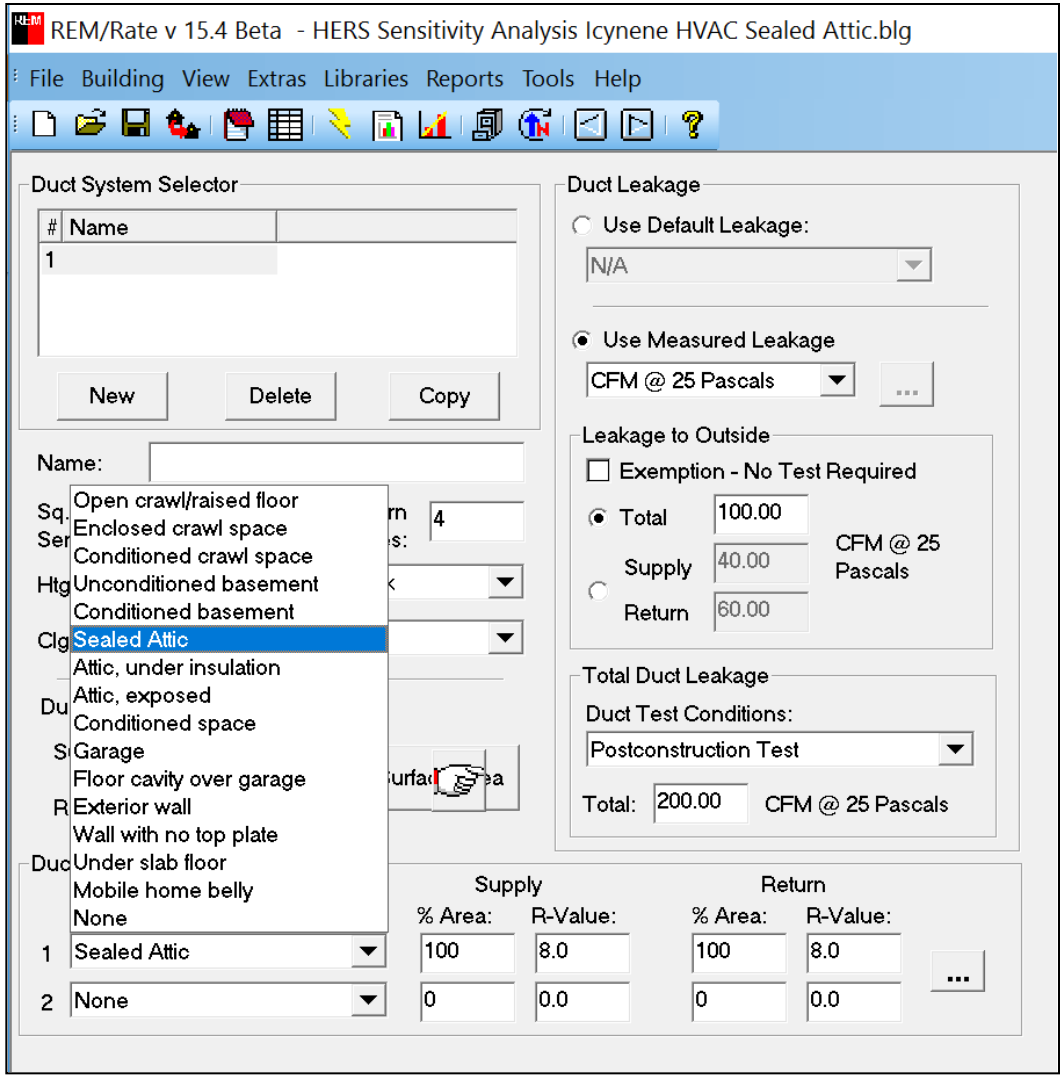
- In response to concerns, HERS sensitivity analysis conducted for two different SOG house models in five different southern locations
- Example, in two-story Phoenix house, 1 HERS value higher observed for the unvented attic case (with superior building airtightness) even though it was determined to use 12.3 MMBtu/yr less energy (or 20% less) than a vented attic with radiant barrier
- Example, sealed attic case scored at least 1 HERS value greater vs vaulted ceiling although energy use was same
- Analysis forwarded to NORESCO for review and feedback
- Provided field data related to the energy modeling of unvented attics

REM/Rate Beta Modifications – Mechanical Equipment



- **NORESCO responded by making modifications to more accurately reflect temperature conditions experienced by ducts & HVAC system in unvented attics**

REM/Rate Beta Modifications – Duct Systems



- **Work continuing**
- **Using measure duct leakage has significant impact – design stage**

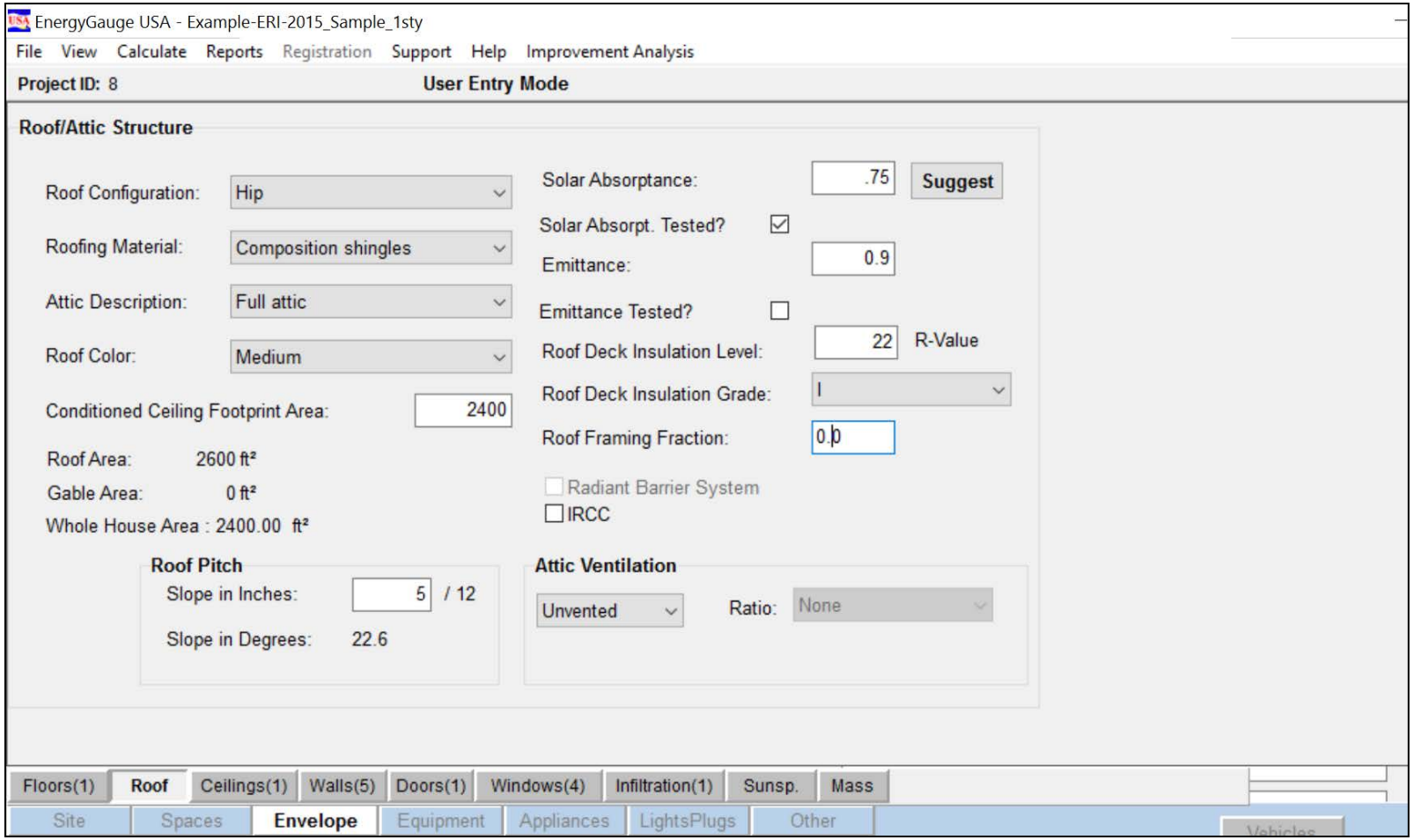
Energy Use & HERS Index Modeling Guidance – EnergyGauge USA

- **EnergyGauge USA facilitates performance path analysis**

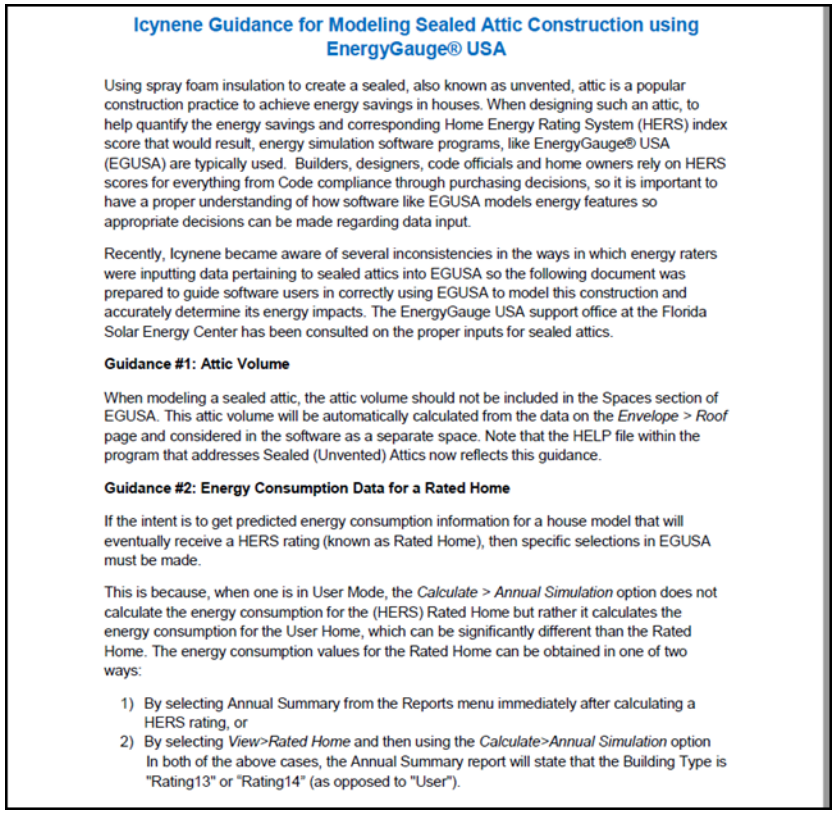
- **Code compliance tool for Florida, weather files included for other locations**

Energy Use & HERS Index Modeling Guidance – EnergyGauge USA

- **Most sealed/unvented attic inputs at Roof tab**



Energy Use & HERS Index Modeling Guidance – EnergyGauge USA



Icynene Guidance for Modeling Sealed Attic Construction using EnergyGauge® USA

Using spray foam insulation to create a sealed, also known as unvented, attic is a popular construction practice to achieve energy savings in houses. When designing such an attic, to help quantify the energy savings and corresponding Home Energy Rating System (HERS) index score that would result, energy simulation software programs, like EnergyGauge® USA (EGUSA) are typically used. Builders, designers, code officials and home owners rely on HERS scores for everything from Code compliance through purchasing decisions, so it is important to have a proper understanding of how software like EGUSA models energy features so appropriate decisions can be made regarding data input.

Recently, Icynene became aware of several inconsistencies in the ways in which energy raters were inputting data pertaining to sealed attics into EGUSA so the following document was prepared to guide software users in correctly using EGUSA to model this construction and accurately determine its energy impacts. The EnergyGauge USA support office at the Florida Solar Energy Center has been consulted on the proper inputs for sealed attics.

Guidance #1: Attic Volume

When modeling a sealed attic, the attic volume should not be included in the Spaces section of EGUSA. This attic volume will be automatically calculated from the data on the *Envelope > Roof* page and considered in the software as a separate space. Note that the HELP file within the program that addresses Sealed (Unvented) Attics now reflects this guidance.

Guidance #2: Energy Consumption Data for a Rated Home

If the intent is to get predicted energy consumption information for a house model that will eventually receive a HERS rating (known as Rated Home), then specific selections in EGUSA must be made.

This is because, when one is in User Mode, the *Calculate > Annual Simulation* option does not calculate the energy consumption for the (HERS) Rated Home but rather it calculates the energy consumption for the User Home, which can be significantly different than the Rated Home. The energy consumption values for the Rated Home can be obtained in one of two ways:

1) By selecting Annual Summary from the Reports menu immediately after calculating a HERS rating, or
2) By selecting *View>Rated Home* and then using the *Calculate>Annual Simulation* option

In both of the above cases, the Annual Summary report will state that the Building Type is "Rating13" or "Rating14" (as opposed to "User").

- Seeking clarification on sealed/unvented attic modeling
- Eliminate inconsistencies in the ways in which energy raters use it
- Guidance document produced with EnergyGauge USA support office at the Florida Solar Energy Center
- Facilitate accurate determination of its energy impacts – Energy use and HERS Index values

Energy Use & HERS Index Modeling Guidance – EnergyGauge USA

- **Attic Volume**
  - When modeling a sealed attic, the attic volume should not be included in the Spaces section of EGUSA.

- **Energy Consumption Data for a Rated Home**
  - If the intent is to get predicted energy consumption information for a house model that will eventually receive a HERS rating (known as Rated Home) select:
    - Annual Summary from the Reports menu immediately after calculating a HERS rating
    - View>Rated Home and then using the Calculate>Annual Simulation option

- **Specifying Duct Leakage**
  - Duct air leakage can have a significant impact on the calculations for a house model with a sealed attic. When considering the input for duct leakage type, a proposed duct leakage should be chosen.

Quality: Initial Evaluation (Test-In)

Complete Evaluation of Existing Home before Installation

Items to address and check can include:

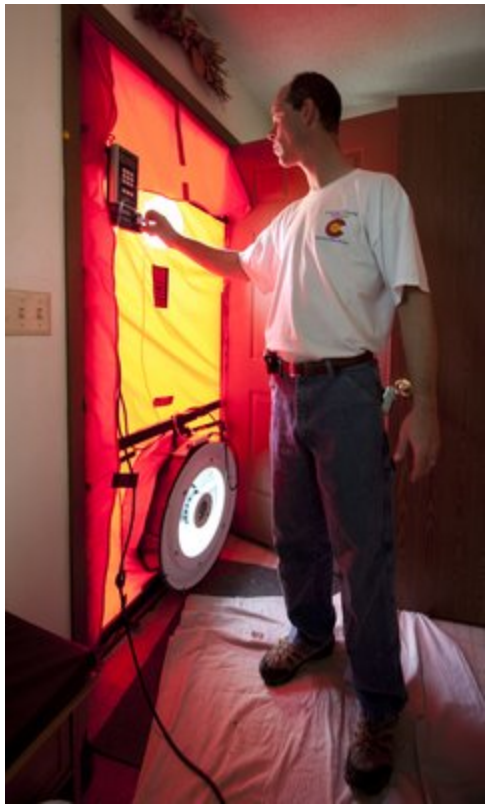
- Air Leakage Testing
- Existing Attic Insulation
- Inspection of Related Systems
- Combustion Appliances
- Safe Access
- Energy Savings Estimate
- Trained Professionals (BPI and RESNET)

Quality: Initial Evaluation (Test-In)

Air Leakage Testing

Perform a blower door test on existing homes before and after SPF installation

- Evaluate air leakage and natural ventilation before SPF application
- Use as baseline for quality check and energy savings estimate



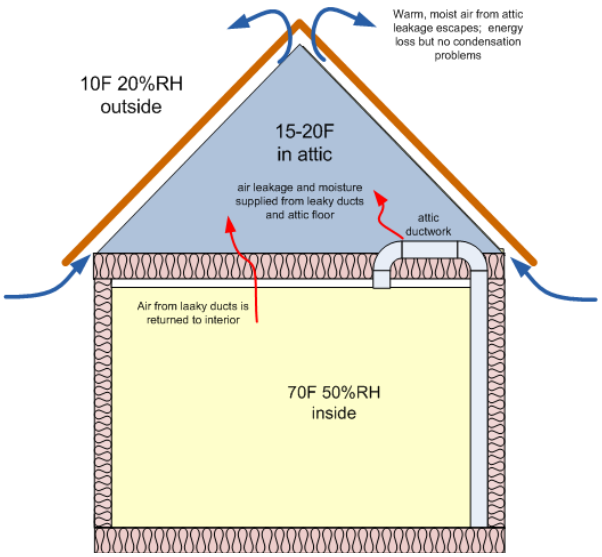
Courtesy NREL PIX

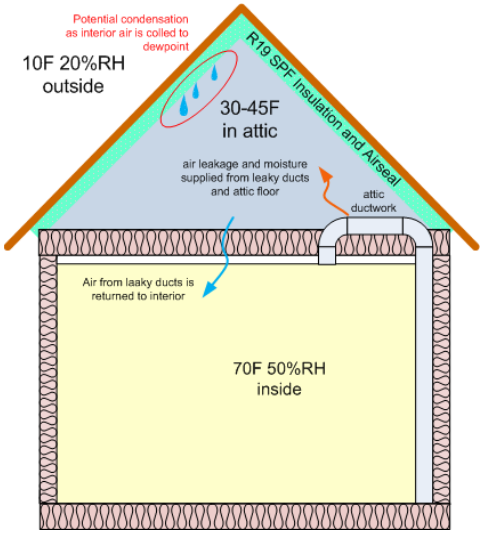
Quality: Initial Evaluation (Test-In)

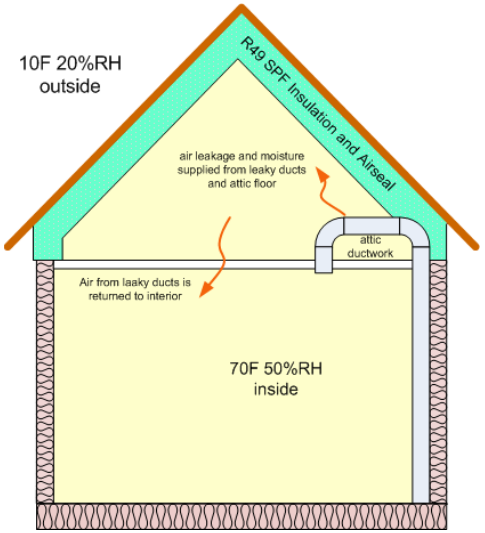
Existing Attic Insulation

Consider removing existing attic floor insulation wherever practical per 2012 IRC

- Potential source of odor in older homes
- Contributes to potential condensation in attic if left in place, esp. in colder climates







Quality: Initial Evaluation (Pre-Insp)

Inspection of Related Systems

Perform a thorough inspection of existing systems in the attic space

- Plumbing (no open vent stacks)
- Ductwork (check connections, leaks)
- Wiring (mark junction boxes)
- Ventilation (bathroom vents properly routed)
- Combustion Appliance Ventilation
- Condition of Roof Deck (leaks, mold)
- Non-compliant insulations
- Environmental Hazards

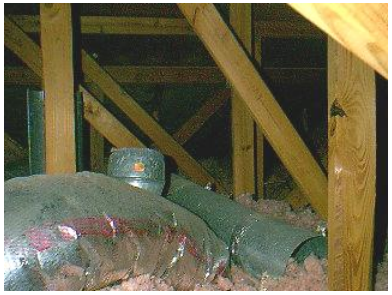
Reducing air leakage in a home can exacerbate other existing problems

Advise building owner of repairs prior to SPF application

“Do No Harm”








Photos courtesy of InterNACHI

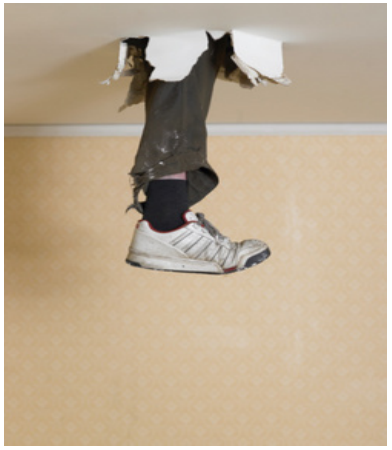
Quality: Initial Evaluation (Pre-Insp)

Safe Access Considerations

Identify safe access to and from attic; factors include:

- Trip hazards
- Fall-through hazards
- Overhead hazards
- Confined spaces
- Emergency egress

Include evaluation in safety plan and correct conditions where possible



Quality: Initial Evaluation (Pre-Insp)

Combustion Appliances

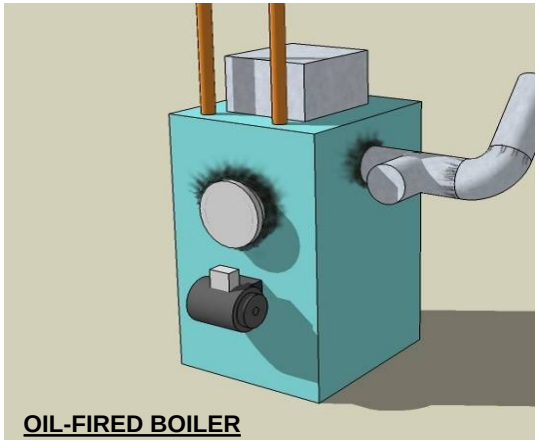
Combustion appliances are any devices in the home that burn fuel, including

- Gas, propane or oil fired heaters and fireplace inserts
- Gas or propane dryers and hot water heaters
- Fireplaces and wood burners
- Kerosene space heaters
- Gas or wood fired ranges and ovens

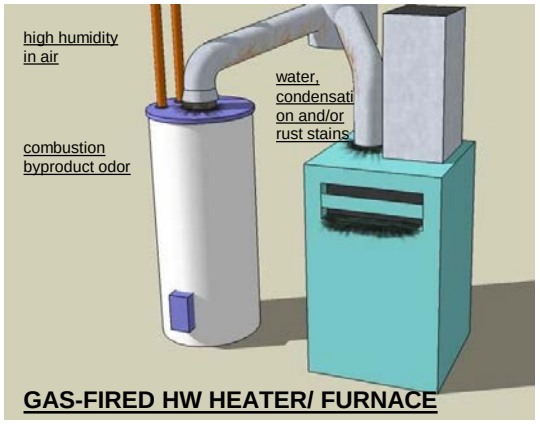
Improving air tightness can eliminate supplier air and adversely affect ventilation of combustion appliances

- Many buildings may have existing problems
- Air sealing increases conditions for backdrafting
- Excessive backdrafting can result in dangerously-high CO levels

Do not improve air sealing of home if any UNVENTED combustion appliances are being used



OIL-FIRED BOILER



GAS-FIRED HW HEATER/ FURNACE

Quality: Initial Evaluation (Pre-Insp)

Trained Professionals

Initial evaluation requires experience, training and specialized equipment; consider

- Becoming trained, or
- Hiring a professional weatherization expert to perform this evaluation

Examples of weatherization training and professionals

- Building Performance Institute (BPI) Building Analyst
- RESNET HERS Rater – EnergySmart Contractor

Check tax incentive and rebate programs

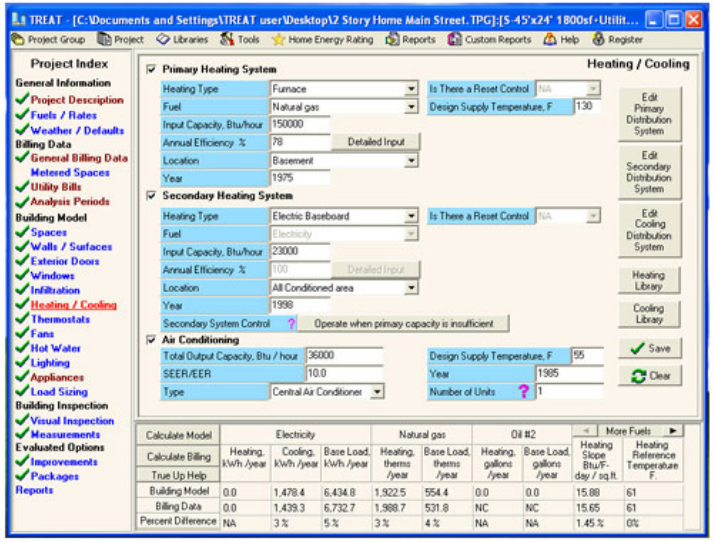
- Some programs require participation by a certified weatherization professional

Quality: Initial Evaluation (Simulation)

Energy Savings Estimate

Help set savings expectations for your customers.

- Evaluate current windows, doors, insulation, HVAC, appliances, lighting
- Use residential energy modeling software to evaluate energy savings from UVA



TREAT

Quality: Jobsite Prep and Safety

Safe Workplace

- Ingress/Egress
- Confined Spaces
- Walking Surfaces
- Lighting
- Isolation, Ventilation and Containment
- Personal Protective Equipment
- Fire Extinguishers and Spill Kits
- Re-Entry Time
- Adjacent Areas

Jobsite Prep

- Vehicle Parking
- Hose Path
- Attic Clear
- Clean Substrates
- Surface Protection
- Cover Soffits and Attic Vents

Quality: Jobsite Prep and Safety

Ingress/Egress Considerations

- Use proper ladders to access attic hatch
- Have a plan for emergency evacuation
- Properly address confined spaces under new OSHA Construction Confined Space March 2016

Photo courtesy of InterNACHI

Quality: Jobsite Prep and Safety

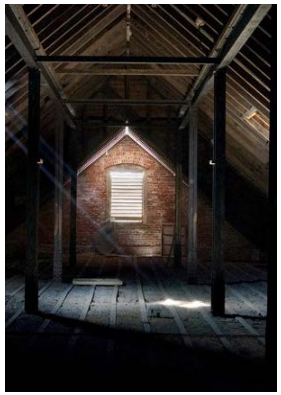
Walking Surfaces

- Avoid walking on attic floor joists
- Set up temporary walkways over open joists
- Remove or clearly mark trip hazards
- Clearly mark overhead hazards

Quality: Jobsite Prep and Safety

Lighting

- Provide adequate lighting in all parts of attic
- Minimizes trips and falls
- Improves quality of work



Quality: Jobsite Prep and Safety

Ventilation and Containment

- Attics generally have poor natural ventilation
- As job progresses, natural ventilation decreases
- Use proper workspace ventilation techniques
- Includes supply and exhaust ventilation, with exhaust rate > supply rate (negative pressure)

Photos courtesy of Allegro Safety

Quality: Jobsite Prep and Safety

Ventilation and Containment

- Shutting down all HVAC systems and sealing all attic openings to living space during application helps containment
- Vacate occupants during and for a period of time after application. Manufacturers typically have recommended re-occupancy times.

Quality: Jobsite Prep and Safety

Personal Protective Equipment

- SPF application in attics is an interior application
- With little or no ventilation, attics will naturally contain and concentrate airborne SPF chemicals
- Complete skin, eye and respiratory protection (SAR) is required at all times by OSHA
- Use head, foot and ear protection as needed
- CPI publishes guidelines for what to consider when selecting proper PPE at www.spraypolyurethane.org
- Refer to CPI's Model Respiratory Protection Program

Quality: Jobsite Prep and Safety

Fire Extinguishers

- SPF is a combustible material
- Unprotected SPF can be ignited by flame, sparks or heat from incandescent lighting
- SPF sprayed too thick or too fast without cooldown between passes can self-ignite
- Availability of type ABC dry chemical fire extinguishers present and readily accessible when spraying foam in an attic helps reduce risks

Photo courtesy of InterNACHI

Quality: Jobsite Prep and Safety

Vehicle Parking

- Safe for applicators
- Properly cordoned off

Hose Paths

- Chemical and SAR hoses through home
- Vent exhaust safely outside

Quality: Jobsite Prep and Safety

Attic Clear

- Helpful to have homeowner make prior arrangements to clear attic
- Verify issues identified during Initial Evaluation have been addressed

Courtesy Building Performance Institute

Quality: Jobsite Prep and Safety

Clean Substrates

- Check that surfaces to be sprayed are free of excessive dust and moisture
- Check whether old insulation has been removed BEFORE spraying

Photo courtesy of InterNACHI

Protect Surfaces

- Cover finished surfaces to protect from overspray
- Seal penetrations to occupied spaces below the attic

Quality: Jobsite Prep and Safety

Block Soffits

- The installation of blocking can be used to prevent foam from filling soffit area
- Install on exterior plane of wall for better performance by insulating over top plate

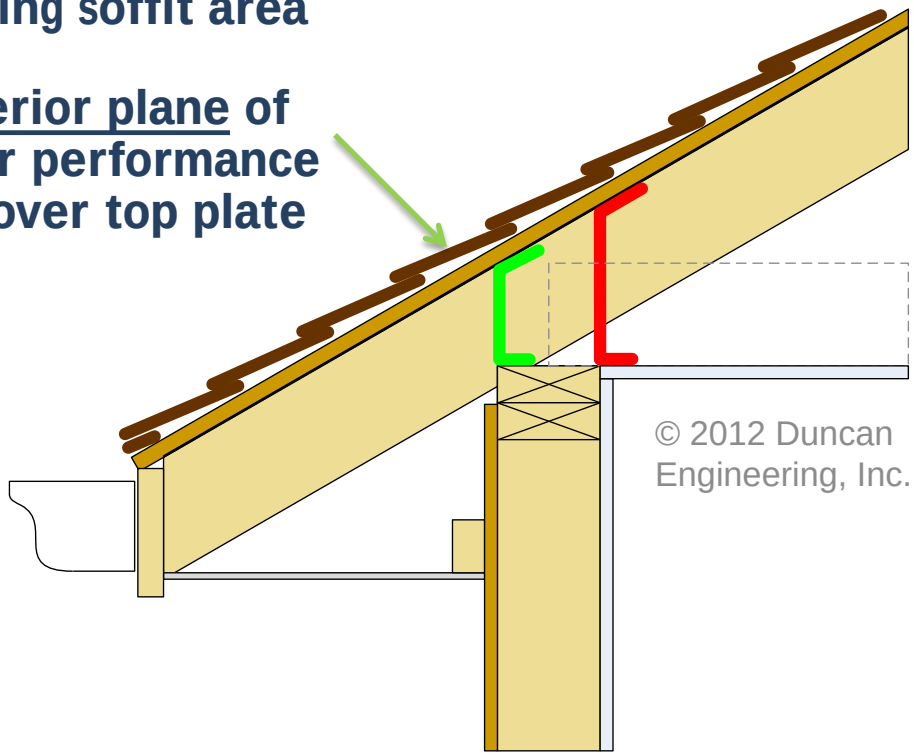


Photo courtesy of InterNACHI

Quality: Jobsite Prep and Safety

Vented Roof Deck

- **The installation of vent chutes from soffit to ridge vent can be used if vented roof deck is needed**

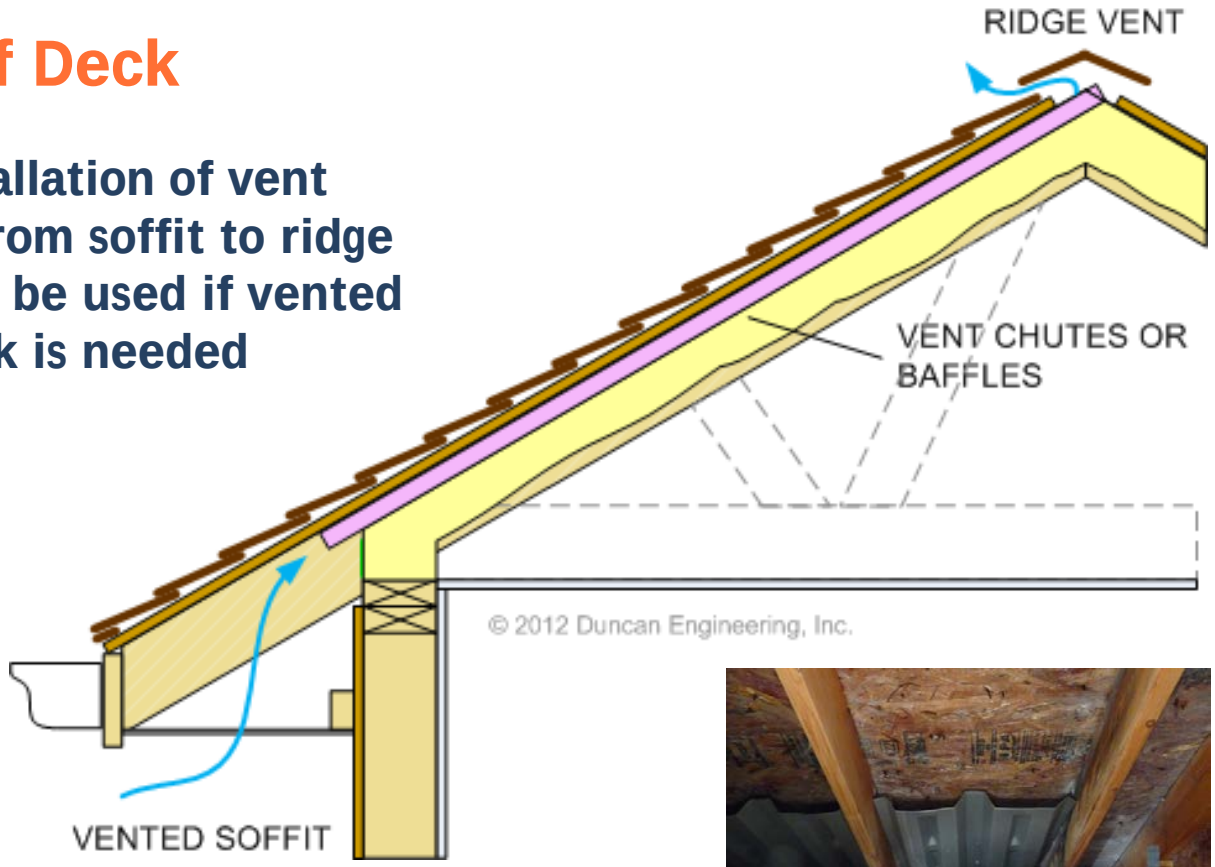


Photo courtesy of InterNACHI

Quality: Jobsite Prep and Safety

Cover Attic Vents

- Check whether all gable and ridge vents have been covered prior to foam application
- Consider using fabric or foam board

Photos courtesy of InterNACHI

Quality: Application Techniques

Topics to Consider

- Exothermic Temperatures
- Adhesion
- Installed Thickness
- Picture Framing
- Bury Rafters
- Protective Coatings and Coverings

Quality: Application Techniques

Exothermic Temperatures

High pass thickness and quick successive passes can be a problem with MD-SPF.

Thick passes can generate excessive exothermic temperatures within MD-SPF.

Excessive exothermic temperatures can:

- Reduce performance → reduce energy savings
- Shrink, crack or delaminate → air leakage, moisture
- Cause incomplete reaction → persistent odors
- Char or self-ignite the foam → persistent odor, building fire

Always follow manufacturer's installation instructions regarding maximum pass thickness and cooling time between passes.

Quality: Application Techniques

Adhesion

- Proper adhesion is a key to durability and long-term performance
- Check that substrate is clean and dry before application
- Check substrate moisture levels before and during application
- Check adhesion to avoid air pockets and hidden voids

Quality: Application Techniques

Picture Framing Spray Technique

- **Minimize shrinkage issues (cracking and delamination) as well as air pockets or voids, especially with closed-cell SPF**

- **Some applicators have found the following steps useful:**
  - Surround perimeter of the stud or rafter cavity. Spray diagonally at the juncture of the stud and the substrate
  - Applying to perimeter at ~100 sq.ft. at a time
  - Return back to the start point to fill in the center of the cavity, using the maximum pass recommended by the manufacturer
  - Spray additional lifts or passes after the initial lift or pass has had adequate time to cool

Quality: Application Techniques

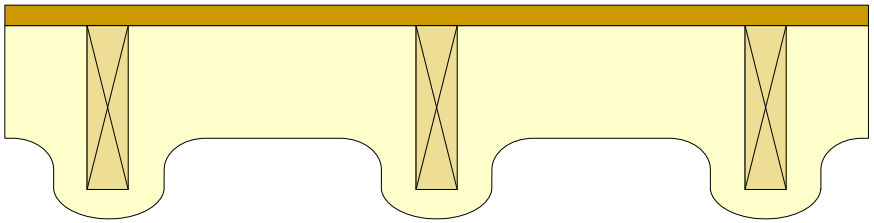
Installed Thickness Considerations

- Install foam to the thickness specified in contract and per manufacturer's instructions
- Check local building codes for R-values required under prescriptive path designs
- Guidance on thickness measurement techniques and frequency can be found in SFC's SPF Installation Guidance available on spraypolyurethane.org

Quality: Application Techniques

Cover Rafters (optional)

- Confirm with homeowner that attic space will not be finished (e.g. gypsum wall board or other paneling installed)
- Covering underside of rafters provides a continuous layer of insulation, reducing thermal bridging and increasing thermal performance (U-factor) of roof assembly…and may allow reduced R-values for the rafter cavities



Quality: Application Techniques

Protective Coatings and Coverings

- Read Evaluation Report (ER) and/or Manufacturers Installation Instructions (MII) to determine if fire protective coatings are needed
- Install protective coverings or coatings over foam using product and thickness as specified by ER/MII, or, if applicable, verify ESR/MII allows uncovered foam in the attic - based on specific product/assembly fire testing
- Do not mix or combine fire protective coatings with vapor retarder coatings or other coatings, unless fire testing has been performed on this combination or permitted under MII
- Consider installing signs in attic regarding storage if only ignition barriers are used

Quality: Final Evaluation

Complete Evaluation After Installation can include:

- Clean-Up
- Temporary Ventilation
- Air Leakage Testing
- Combustion Safety (CO Monitoring)
- HVAC Modifications

Quality: Final Evaluation

Clean-Up and Shut Down

Photos courtesy of InterNACHI

Have you:

Removed all temporary protective coverings?

Removed all items from premises before leaving?

- Foam scraps and dust
- Consumables (jump suits, gloves, masking materials)
- ALL chemicals and chemical containers

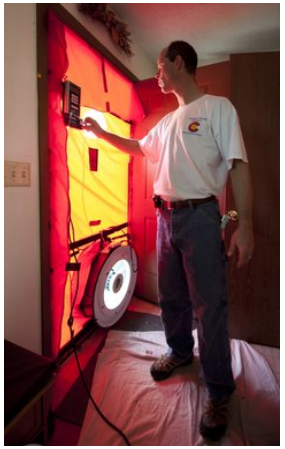
Temporary Ventilation

With attic closed-off, ventilate attic space for a period of time as specified by the manufacturer after installation to remove residual odors from foam and coatings

Quality: Final Evaluation

Air Leakage Testing

- Repeat blower door test after installation
- Inspect for air leaks in foam and repair
- Confirm energy savings projections



Combustion Safety

- Concurrent with blower door testing, conduct CO measurements of all combustion appliances

HVAC Modifications

- If application of SPF renders the home to be insufficiently ventilated, work with HVAC contractor to add mechanical ventilation or HRV/ERV.

Questions?