

We will be starting soon!



Thanks for joining us



Energy Code Compliance: Using HERS Measures (Part 1)



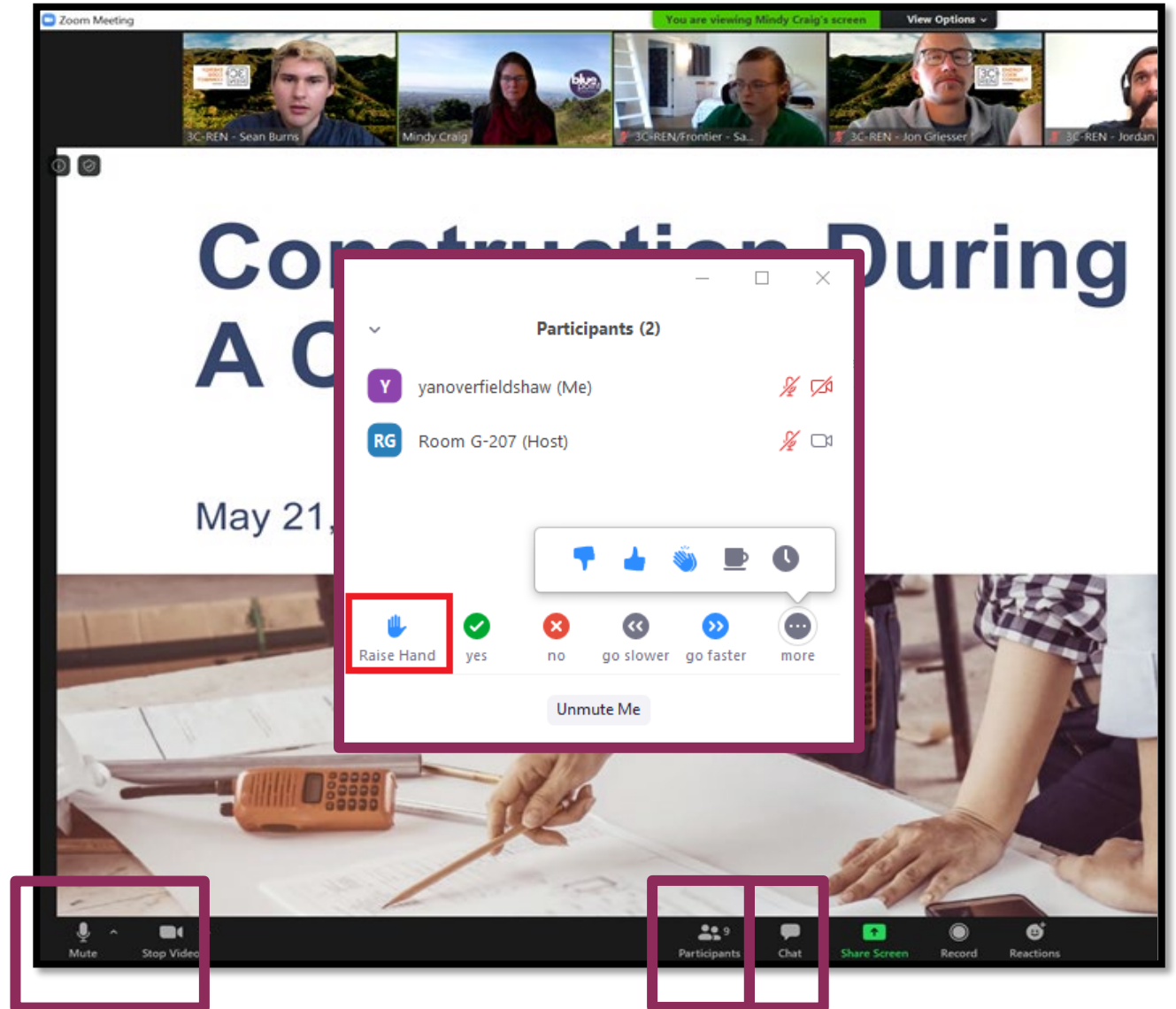
Jennifer Rennick, AIA, CEA – In Balance Green Consulting
Paul Dunn, HERS I & II – Central Coast Energy Compliance

January 31, 2024



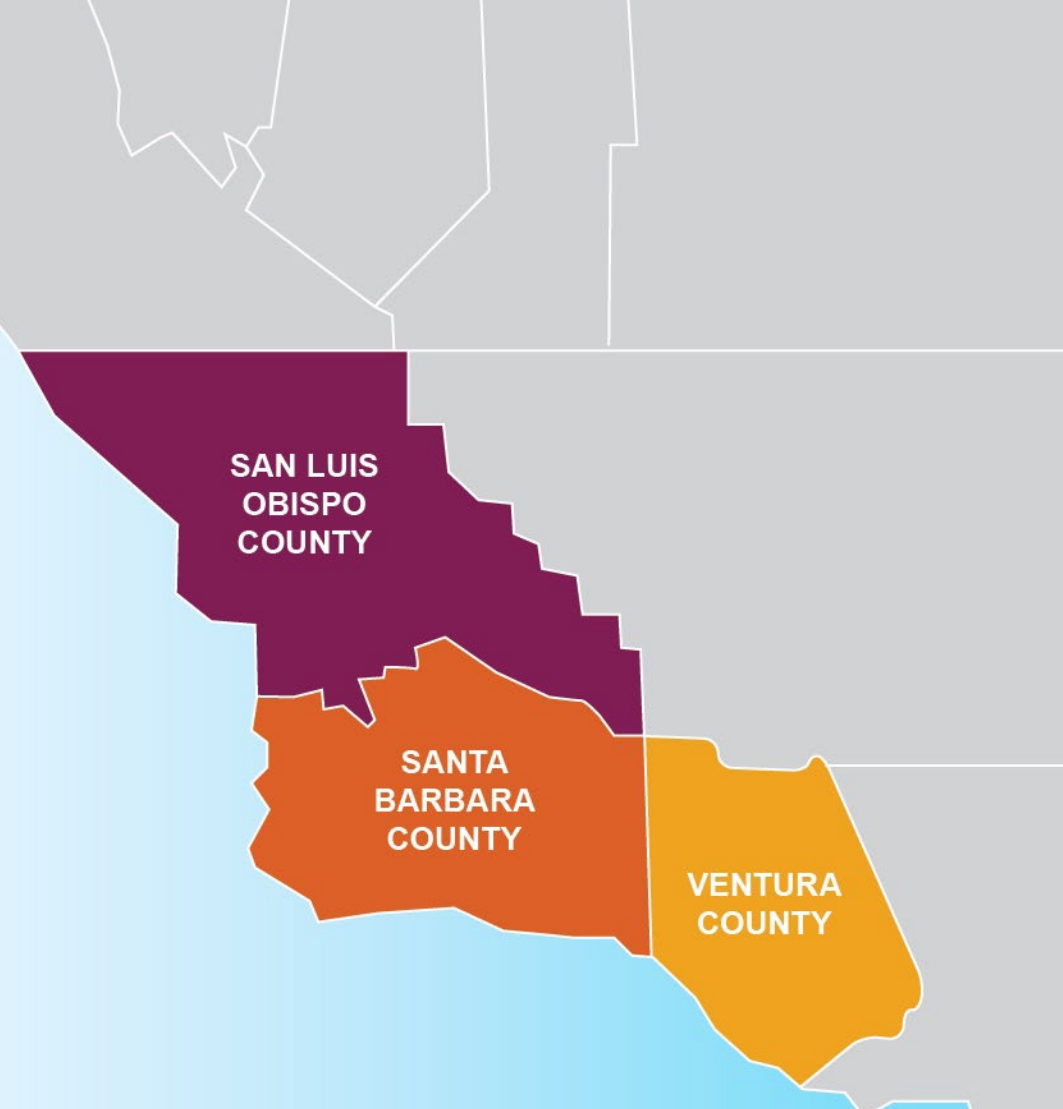
Zoom Orientation

- Please be sure your full name is displayed
- Please **mute** upon joining
- Use "Chat" box to share questions or comments
- Under "Participant" select "Raise Hand" to share a question or comment verbally
- The session may be **recorded** and posted to 3C-REN's on-demand page. Feel free to ask questions via the chat and keep video off if you want to remain anonymous in the recording.



3C-REN: Tri-County Regional Energy Network

- Three counties working together to improve energy efficiency in the region
- Services for –
 - **Building Professionals:** industry events, training, and energy code compliance support
 - **Households:** free and discounted home upgrades
- Funded by ratepayer dollars that 3C-REN returns to the region





ENERGY
CODE
CONNECT

- Serves all building professionals
- Three services –
 - **Energy Code Coach**
 - **Training and Support**
 - **Regional Forums**
- Makes the Energy Code easy to follow

Energy Code Coach:
3c-ren.org/codes
805.781.1201

Event Registration:
3c-ren.org/events





BUILDING PERFORMANCE TRAINING

- Serves current and prospective building professionals
- Expert instruction:
 - **Technical skills**
 - **Soft skills**
- Helps workers to thrive in an evolving industry

Event Registration:
3c-ren.org/events





HOME
ENERGY
SAVINGS

Multifamily (5+ units)

- No cost technical assistance
- Rebates up to \$750/apartment plus additional rebates for specialty measures like heat pumps

Single Family (up to 4 units)

- Sign up to participate!
- Get paid for the metered energy savings of your customers

Enrollment:
3C-REN.org/contractor-participation



Today's Learning Objectives

- Learn the roles and communication points for integrating HERS measures into permit plans, Title 24 documents and construction schedules.
- Identify the library of HERS measures and which are Mandatory/Prescriptive and which are optional for use in Performance compliance.
- Understand the requirements for Quality Insulation Installation (QII) and tips for passing the first time.
- Learn the process for checking Air Leakage and how to use the tools at key construction milestones.

Learning Units:

- 0.10 ICC CEU pending for this course
- 1.0 AIA HSW pending for this course



Overview of Forms for Residential Single Family and Low-Rise Multifamily Construction

Single Family (Duplexes and Townhouses)

- **CF1R** – Forms used to show **Compliance** with the energy code at initial plan submittal
- **CF2R** – Forms used during construction to demonstrate that the energy code features met **Installation** requirements
- **CF3R** – Forms used after installation to confirm that the energy code features met the **Verification** requirements

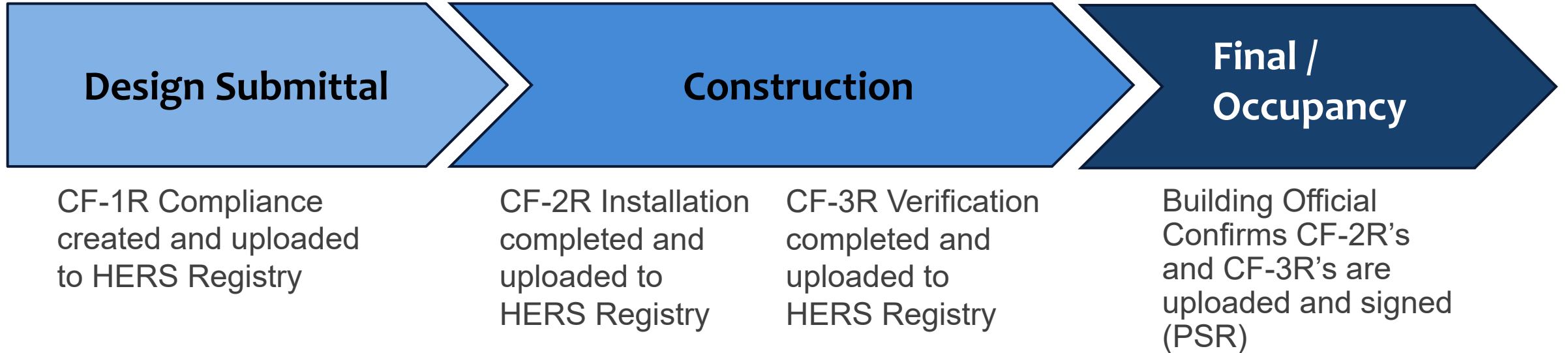
New Under the 2022 Energy Code

Low-Rise Multifamily (3 Stories or Less)

- **LMCC** – Forms used to show **Compliance** with the energy code at initial plan submittal
- **LMCI** – Forms used during construction to demonstrate that the energy code features met **Installation** requirements
- **LMCV** – Forms used after installation to confirm that the energy code features met the **Verification** requirements



Process for Residential Permitting



HERS – Home Energy Rating System

We have two HERS Providers, CalCERTS and CHEERS, in California. These organization are responsible for training and certifying HERS Raters, and supporting the California Energy Code HERS Registry.

Note: Low-Rise Multifamily 2022 Energy Code projects are *not* on a HERS Registry yet.



CEC – 2022 Supporting Documents - Forms



CALIFORNIA
ENERGY COMMISSION

Enter keywords, e.g. Tracking Progress



HOME

PROCEEDINGS ▾

RULES AND REGULATIONS ▾

PROGRAMS AND TOPICS ▾

FUNDING ▾

DATA AND REPORTS ▾

SHOWCASE ▾

California Energy Commission > Programs and Topics > [All Programs](#) > Building Energy Efficiency Standards > 2022 Building Energy Efficiency Standards > **2022 Supporting Documents - Forms - Residential**

Electric – Including Solar and Battery



Envelope



Existing Conditions



Lighting



Mechanical



Plumbing



Pool and Spa

California Energy Commission
www.energy.ca.gov

Note: Most forms are for reference only – Single Family forms must be registered with a HERS provider.

Multifamily forms – Prescriptive compliance can be form filled at Energy Code Ace. Performance method forms “ are coming soon.”



2022 Supporting Docs CF2R & CF3R

Envelope



Reminder:

E – Enforcement Agency
H – HERS

CF2R

- CF2R-ENV-01-E Fenestration Installation
- CF2R-ENV-03-E Insulation Installation
- CF2R-ENV-04-E Roofing Ventilation and Radiant Barrier
- CF2R-ENV-20a-H Building Air Leakage Diagnostic Test - Building Enclosures and Dwelling Unit Enclosures
- CF2R-ENV-20b-H-EnclosureAirLeakage-SinglePointTest-Automatic Meter
- CF2R-ENV-21-H QII - Air Infiltration Sealing - Framing Stage
- CF2R-ENV-22-H QII - Insulation Installation

CF3R

- CF3R-ENV-20a Building Enclosure Air Leakage Diagnostic Test - Building Enclosures and Dwelling Unit Enclosures - Single Point Test - Manual Meter
- CF3R-ENV-20b Building Enclosure Air Leakage Diagnostic Test - Building Enclosures and Dwelling Unit Enclosures - Single Point Test - Automatic Meter
- CF3R-ENV-21-HERS QII - Air Infiltration Sealing - Framing Stage
- CF3R-ENV-22-HERS QII - Insulation Installation



CALIFORNIA ENERGY COMMISSION

QII - AIR INFILTRATION SEALING – FRAMING STAGE

CEC-CF2R-ENV-21-H

SAMPLE FORM – NOT VALID FOR SUBMISSION TO BUILDING DEPARTMENTS

D. Ceiling Air Barrier Adjacent to Unconditioned Space

The responsible person's signature on this compliance document affirms that all applicable requirements in



CALIFORNIA ENERGY COMMISSION

QII - AIR INFILTRATION SEALING – FRAMING STAGE

CEC-CF2R-ENV-21-H

SAMPLE FORM – NOT VALID FOR SUBMISSION TO BUILDING DEPARTMENTS

CERTIFICATE OF INSTALLATION

Note: This table completed by HERS Registry.

Project Name:	Enforcement Agency:
Dwelling Address:	Permit Number:
City and Zip Code:	Permit Application Date:

A. Air Barrier Materials

Note: SPF insulation is an acceptable air barrier and sealant when installed to a minimum thickness of 2 inches for closed cell and 5.5 inches for open cell, except where not allowed by manufacturer (e.g., flues, vents, can lights, etc.).

The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.

01	A continuous sealed exterior air barrier is required in all thermal envelope assemblies to limit air movement between unconditioned/outside spaces and conditioned/inside spaces, and must comply using one of the following methods: 1. Using individual materials that have an air permeance not exceeding 0.004 cfm/ft ² under a pressure differential of 0.3 in. w.g. (1.57 pcf) (0.02 L/s.m ² at 75 pa) when tested in accordance with ASTM E2178; or 2. Using assemblies of materials and components that have an average air leakage not to exceed 0.04 cfm/ft ² under a pressure differential of 0.3 in. w.g. (1.57 pcf) (0.2 L/s.m ² at 75 pa) when tested in accordance with ASTM E2357, ASTM E1677, ASTM E1680, or ASTM E283; or 3. Testing the complete building and demonstrating that the air leakage rate of the building envelope does not exceed 0.40 cfm/ft ² at a pressure differential of 0.3 in. w.g. (1.57 pcf) (2.0 L/s.m ² at 75 pa) in accordance with ASTM E779 or an equivalent approved method.
02	Method of Compliance:

B. Raised Floor Adjacent to Unconditioned Space or Separate Dwelling Units

The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.

01	All gaps in the raised floor are sealed.
02	All chases are sealed at floor level using a sealed hard cover.
03	All holes (e.g., for plumbing and electrical wires) that penetrate the floor or bottom plates of walls are sealed.
04	Subfloor sheathing is glued or sealed at all panel edges to create a continuous airtight subfloor air barrier.

C. Walls Adjacent to Unconditioned Space

The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.

01	All penetrations through the exterior wall air barrier are sealed to provide an airtight envelope to unconditioned spaces such as the
----	---

2022 Supporting Docs LMCI & LMCV

Envelope



LMCC (Certificates of Compliance)

- LMCC-ENV-01-E Envelope Component Approach

LMCI (Certificates of Installation)

- LMCI-ENV-21-H QII – Air Infiltration Sealing – Framing Stage
- LMCI-ENV-22-H QII – Insulation Installation
- LMCI-ENV-E Envelope Component Approach

LMCV (Certificates of Verification)

- LMCV-ENV-21-H QII – Air Infiltration Sealing – Framing Stage
- LMCV-ENV-22-H QII – Insulation Stage

Note: Air Leakage Testing is part of the Mechanical section under the LMCI-MCH-27 and 24-H forms.

Reminder:

E – Enforcement Agency
H – HERS

CEC-LMCI-ENV-22-H

 CALIFORNIA ENERGY COMMISSION
SAMPLE FORM – NOT VALID FOR SUBMISSION TO BUILDING DEPARTMENTS

QII - INSULATION INSTALLATION

CERTIFICATE OF INSTALLATION
Note: This table completed by HERS Registry.

Project Name:	Enforcement Agency:
Dwelling Address:	Permit Number:
City and Zip Code:	Date Permit Issued:

A. Insulation Materials Installed

01	Roof Deck Insulation Material Installed	
02	Ceiling Insulation Material Installed	
03	Exterior Wall Insulation Material Installed	
04	Raised Floor Insulation Material Installed	
05	Slab Edge Insulation Material Installed	

B. All Surfaces

01	Air barrier installation and preparation for insulation was done and verified prior to insulation being installed.
02	All surfaces between conditioned and unconditioned space are sealed and insulated to meet or exceed the levels specified on the Certificate of Compliance.
03	All structural framing areas shall be insulated in a manner that resists thermal bridging through the assembly separating conditioned from unconditioned space. Structural bracing, tie-downs, and framing of steel, or specialized framing used to meet structural requirements of the California Building Code (CBC) are allowed and must be insulated. These areas shall be called out on the building plans with diagrams and/or specified design drawings

List of CF2R and CF3R Forms

–Example Project on CalCERTS

Installation and Verification Certificates that MAY be Required from the CF1R		Installation Certificate (CF2R)	Certificate of Verification (CF3R)
You may add tested measures if the Yes/No option is available.			
CF2R-ELC-01	Electric Ready Requirements:	YES	N/A
CF2R-ENV-01	Fenestration Installation:	YES	N/A
CF2R-ENV-03	Insulation Installation:	YES	N/A
CF2R-ENV-04	Roofing-Radiant Barrier:	No	N/A
CF2R-ENV-20	Building Leakage Diagnostic Test:	No	No
CF2R-ENV-21	QII-Framing Stage:	No	No
CF2R-ENV-22	QII-Insulation Installation:	No	No
CF2R-LTG-01	Lighting:	YES	N/A
CF2R-MCH-01	Space Conditioning Systems, Ducts and Fans:	YES	N/A
CF2R-MCH-02	Whole House Fan:	No	N/A
CF2R-MCH-25	Refrigerant Charge:	YES	YES
CF2R-MCH-27	IAQ and MV:	YES	YES
CF2R-MCH-31	HERS Whole House Fan:	No	No
CF2R-MCH-32	Local Mechanical Exhaust:	YES	YES
CF2R-PLB-02	SD HWS Distribution:	No	N/A
CF2R-PLB-03	Pool and Spa:	<input type="radio"/> No	N/A
CF2R-PLB-22	HERS SD HWS Distribution:	YES	YES
CF2R-PVB-01	Photovoltaic Systems:	YES	N/A
CF2R-PVB-02	Battery Storage Systems:	No	N/A
CF2R-SRA-02	Minimum Solar Zone Area Worksheet:	No	N/A

* Fan Efficacy Airflow is required and can be satisfied by EITHER the MCH-23 and MCH-22 OR the MCH-28. The exact measure is determined by the CF2R-MCH-01.

** The MCH-26 is determined on the CF2R-MCH-01.



After CF2R/CF3R's are complete, the project can obtain final Occupancy approval.

CERTIFICATE OF VERIFICATION		CF3R-ENV-21-H
QII - Air Infiltration Sealing - Framing Stage		(Page 1 of 6)
Project Name: <input type="text"/>	Enforcement Agency: <input type="text"/>	Permit Number: <input type="text"/>
Dwelling Address: <input type="text"/>	City: <input type="text"/>	Zip Code: <input type="text"/>

A. Air Barrier Materials	
01	<p>A continuous sealed exterior air barrier is required in all thermal envelope assemblies to limit air movement between unconditioned/ outside spaces and conditioned/ inside spaces, and must comply using one of the following methods:</p> <ol style="list-style-type: none"> Using individual materials that have an air permeance not exceeding 0.004 cfm/ft² under a pressure differential of 0.3 in. w.g. (1.57 pcf) (0.02 L/s.m² at 75 pa) when tested in accordance with ASTM E2178; or Using assemblies of materials and components that have an average air leakage not to exceed 0.04 cfm/ft² under a pressure differential of 0.3 in. w.g. (1.57 pcf) (0.2 L/s.m² at 75 pa) when tested in accordance with ASTM E2357, ASTM E1677, ASTM E1680, or ASTM E283; or Testing the complete building and demonstrating that the air leakage rate of the building envelope does not exceed 0.40 cfm/ft² under a pressure differential of 0.3 in. w.g. (1.57 pcf) (2.0 L/s.m² at 75 pa) when tested in accordance with ASTM E779 or an equivalent approved method.
02	Method of Compliance: Method 2 (Assemblies of Materials)
03	Verification Status: Pass - all applicable requirements are met.
04	Correction Notes:
<p>Note: SPF insulation is an acceptable air barrier and sealant when installed to a minimum thickness of 2 inches for closed cell and 5.5 inches for open cell, except where not allowed by manufacturer (e.g. flues, vents, can lights, etc).</p>	
<p>The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.</p>	

Approval Process

- CF1R on HERS Registry
- CF2R on HERS Registry
- CF3R on HERS Registry
- Enforcement Agency (AHJ) can access the **Watermarked Forms**
- AHJ will see "PASS" on List of Required Forms

PSR – Project Status Report - Compliance

CF2R's

2019 Code HOME CF1R CF2R CF3R \$ Pin Project Actions Activity Paul Dunn

Project Home (ID: 2070403) / Dwelling / STATUS REPORT - Compliance

CF2R INFORMATION - Certificate of Installation (Documents the proper installation of required energy features)

System	Form	Registered Date	Registration Number		
	CF2R-ENV-01-E Fenestration Installation	2023-11-24 08:38:03	222-P010006992B-000-001-E01001A-0000 Installer/Builder Info	✓	✓

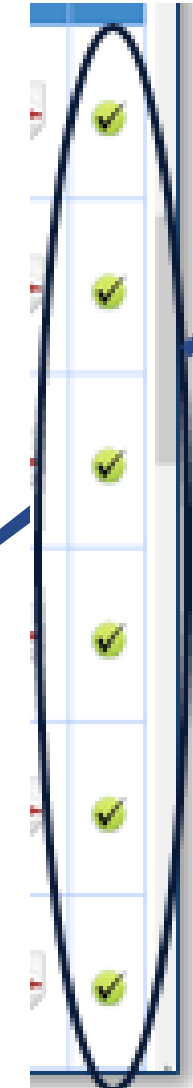
CF3R's

2019 Code HOME CF1R CF2R CF3R \$ Pin Project Actions Activity Paul Dunn

Project Home (ID: 2070403) / Dwelling / STATUS REPORT - Compliance

CF3R INFORMATION - Certificate of Verification (Documents the verification of HERS Measures)

System	Form	Registered Date	Registration Number		
System 1	CF3R-MCH-25-H (Refrigerant Charge)	2023-11-22 17:59:48	222-P010006992B-000-001-M25001A-M25A Paul Dunn (CC2005798) (Central Coast Energy Compliance)	✓	✓
System 1	CF3R-MCH-26-H (Rated Equipment)	2023-11-22 17:59:48	222-P010006992B-000-001-M26001A-M26A Paul Dunn (CC2005798) (Central Coast Energy Compliance)	✓	✓
	CF3R-MCH-27-H (IAQ and MV)	2023-11-22 17:59:48	222-P010006992B-000-001-M27001A-M27A Paul Dunn (CC2005798) (Central Coast Energy Compliance)	✓	✓
Exhaust Fan 1	CF3R-MCH-32-H (Local Mechanical Exhaust)	2023-11-22 17:59:48	222-P010006992B-000-001-M32001A-M32A Paul Dunn (CC2005798) (Central Coast Energy Compliance)	✓	✓
System 1	CF3R-MCH-33-H (VCHP Credit)	2023-11-22 17:59:48	222-P010006992B-000-001-M33001A-M33A Paul Dunn (CC2005798) (Central Coast Energy Compliance)	✓	✓



Quality Insulation Installation (QII) ENV-21, 22 and MCH-21

CF1R-PRF-01-E

Calculation Description: Title 24 Analysis

Input File Name: Sample Res Project.ribd22

HERS FEATURE SUMMARY

The following is a summary of the features that must be field-verified by a certified HERS Rater as a condition for meeting the modeled energy performance for this computer analysis. Additional detail is provided in the building tables below. Registered CF2Rs and CF3Rs are required to be completed in the HERS Registry

- Quality insulation installation (QII)
- Indoor air quality ventilation
- Kitchen range hood

HERS QII Work Flow:

- Triggered on CF1R
- Job Site Meeting “Review Requirements”
- HERS Inspection: Framing
 - Envelope Measures
 - HVAC/Duct Measures
- HERS Inspection: Insulation Install
 - Envelope Measures

CF2R and CF3R Forms

- CF2R-ENV-03-E Insulation Installation
- CF2R-ENV-21-H QII - Air Infiltration Sealing - Framing Stage
- CF2R-ENV-22-H QII - Insulation Installation
- CF2R-MCH-21-H QII - Air Infiltration Sealing - Framing Stage
- CF3R-ENV-21-HERS QII - Air Infiltration Sealing - Framing Stage
- CF3R-ENV-22-HERS QII - Insulation Installation



QII – Air Sealing - Framing Stage for Low-rise Multifamily LMCI-ENV-21-H



CALIFORNIA ENERGY COMMISSION

QII - AIR INFILTRATION SEALING - FRAMING STAGE

CEC-LMCI-ENV-21-H

SAMPLE FORM – NOT VALID FOR SUBMISSION TO BUILDING DEPARTMENTS

CERTIFICATE OF INSTALLATION

Note: This table completed by HERS Registry.

Project Name: _____ Enforcement Agency: _____

I. Air Barriers in Multifamily Dwellings

01	Each dwelling unit must be sealed to stop air movement between dwelling units. Treat adjacent dwelling units as unconditioned space for air sealing.
02	All penetrations through the floor and ceiling of each dwelling unit are sealed, including electric and gas utilities, water pipes, drain pipes, fire protection service pipes, and communication wiring.
03	Elevator penthouse, mechanical penthouse, stairwell doors, roof access hatches, and plumbing stacks that separate conditioned and unconditioned space are all sealed.
04	Vertical chases for garbage chutes, elevator shafts, HVAC ducting and plumbing shall be treated as unconditioned space for sealing.
05	Common hallways shall be treated as unconditioned space for sealing.

The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.

	not exceed 0.40 cm ³ /m ² at a pressure differential of 0.5 in. w.g. (1.57 pa) (2.0 L/s.m ² at 75 pa) in accordance with ASTM E779 or an equivalent approved method.
02	Method of Compliance

Note:
SPF insulation is an acceptable air barrier and sealant when installed to a minimum thickness of 2 inches for closed cell and 5.5 inches for open cell, except where not allowed by manufacturer (e.g., flues, vents, can lights, etc.).

Multifamily Project



Hardworking HERS Rater

Forms are similar to Single Family, except items describing where assemblies must be sealed to stop air movement between dwellings.

Insulation Installation CF2R-ENV-03-E (Non-HERS / Installer or GC)

The first half of this form is to document what insulation was installed, how much, and where...

INSULATION INSTALLATION
CALIFORNIA ENERGY COMMISSION CEC-CF2R-ENV-03-E

CERTIFICATE OF INSTALLATION

Note: This table completed by HERS Registry.

Field Name	Data Entry	Field Name	Data Entry
Project Name		Enforcement Agency	
Dwelling Address		Permit Number	
City and Zip Code		Permit Application Date	

A. Roof/Ceiling Insulation

Field	Field Name	Entry 1	Entry 2	Entry 3
01	I.D.			
02	Manufacturer & Brand			
03	Assembly/ Framing Material			
04	Assembly Thickness (inches)			

...the second half of this form list reminders for the **Mandatory Measures and other insulation requirements.**

INSULATION INSTALLATION
CALIFORNIA ENERGY COMMISSION CEC-CF2R-ENV-03-E

H. Installed Insulation

Field	Field Description
01	Installed insulation R-values are the same or greater than listed on the CF1R.
02	No gaps or voids between the insulation and framing.
03	No gaps between the sides or ends of batt insulation.
04	Loose-fill insulation must be installed to the minimum installed weight per square foot (density) of the manufacturer's cut sheet for the proposed R-value.
05	Batt insulation is not compressed (no stuffing of the insulation into the cavity) and is installed to its full thickness.
06	Insulation is cut around obstructions such as electrical boxes.
07	Batt insulation is delaminated around all plumbing and electrical lines in ceilings, walls, and floors.
08	Band joists are insulated to the same R-value as the wall.
09	In all narrow cavities the insulation shall be cut to fit or filled with expanding foam.
10	Insulation was installed per manufacturer instructions.

The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.

I. Wall Insulation



Meeting the Code Mandatory Measures will make QII –HERS much easier!

QII – Insulation and Electrical Wiring

CF2R-ENV-03-E Mandatory and part of QII



CALIFORNIA ENERGY COMMISSION

INSULATION INSTALLATION

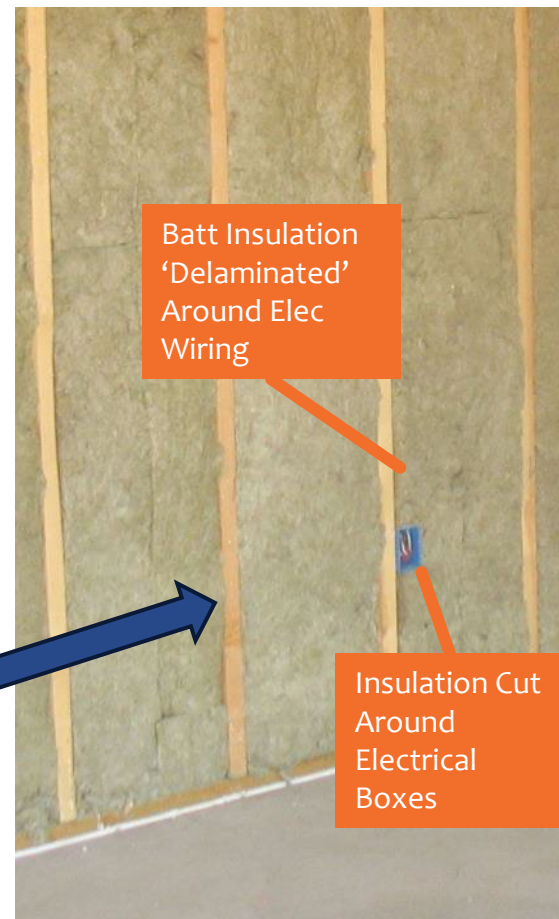
CEC-CF2R-ENV-03-E

H. Installed Insulation

Field	Field Description
01	Installed insulation R-values are the same or greater than listed on the CF1R.
02	No gaps or voids between the insulation and framing.
03	No gaps between the sides or ends of batt insulation.
04	Loose-fill insulation must be installed to the minimum installed weight per square foot (density) of the manufacturer's cut sheet for the proposed R-value.
05	Batt insulation is not compressed (no stuffing of the insulation into the cavity) and is installed to its full thickness.
06	Insulation is cut around obstructions such as electrical boxes.
07	Batt insulation is delaminated around all plumbing and electrical lines in ceilings, walls, and floors.
08	Band joists are insulated to the same R-value as the wall.
09	In all narrow cavities the insulation shall be cut to fit or filled with expanding foam.
10	Insulation was installed per manufacturer instructions.

The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.

I. Wall Insulation



Batt Insulation
'Delaminated'
Around Elec
Wiring

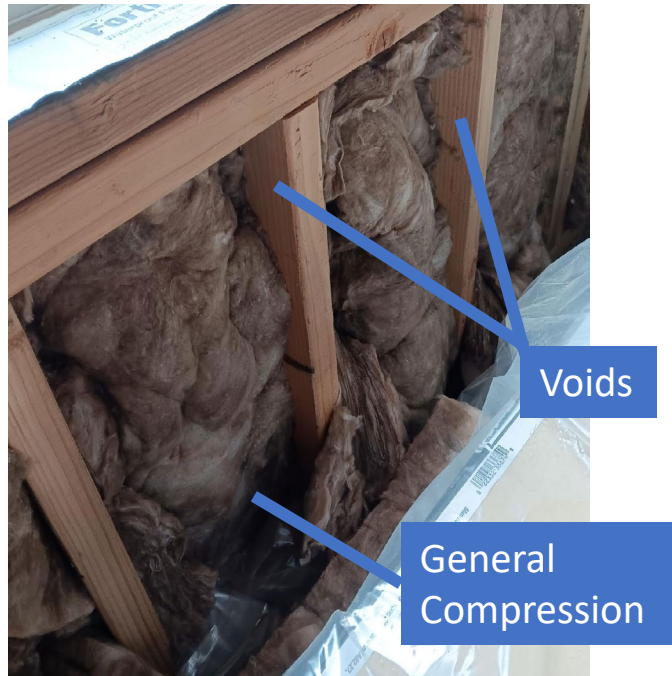
Insulation Cut
Around
Electrical
Boxes



Unfinished Job:
Electrical Wiring is on
the surface of the batt
insulation.

-- PASS on the Left, FAIL on the Right.

QII – Eliminate the Voids, Gaps, Compression and “No Stuffing”



Insulation was compressed and “stuffed,” and not cut to size.



Insulation was compressed at the framing members.



Insulation needs to be in tight contact with the studs.



-- All of these would FAIL QII

QII – Made Easy with Blown-in Products



CALIFORNIA ENERGY COMMISSION

INSULATION INSTALLATION

CEC-CF2R-ENV-03-E

H. Installed Insulation

Field	Field Description
01	Installed insulation R-values are the same or greater than listed on the CF1R.
02	No gaps or voids between the insulation and framing.
03	No gaps between the sides or ends of batt insulation.
04	Loose-fill insulation must be installed to the minimum installed weight per square foot (density) of the manufacturer's cut sheet for the proposed R-value.
05	Batt insulation is not compressed (no stuffing of the insulation into the cavity) and is installed to its full thickness.
06	Insulation is cut around obstructions such as electrical boxes.
07	Batt insulation is delaminated around all plumbing and electrical lines in ceilings, walls, and floors.
08	Band joists are insulated to the same R-value as the wall.
09	In all narrow cavities the insulation shall be cut to fit or filled with expanding foam.
10	Insulation was installed per manufacturer instructions.

The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.

I. Wall Insulation



QII – Expanding Foam for Narrow Cavities and Windows



QII - AIR INFILTRATION SEALING – FRAMING STAGE
CALIFORNIA ENERGY COMMISSION CEC-CF2R-ENV-21-H
SAMPLE FORM – NOT VALID FOR SUBMISSION TO BUILDING DEPARTMENTS

C. Walls Adjacent to Unconditioned Space

The responsible person’s signature on this compliance document affirms that all applicable requirements in this table have been met.

01	All penetrations through the exterior wall air barrier are sealed to provide an airtight envelope to unconditioned spaces such as the outdoors, attic, garage, and crawlspace.
02	Exterior wall air barrier is sealed to the top plate and bottom plate in each stud bay.
03	All electrical boxes, including knockouts, that penetrate the air barrier to unconditioned space are sealed.
04	All openings in the top and bottom plate, including all interior and exterior walls, to unconditioned space are sealed; such as holes drilled for electrical and plumbing.
05	Exterior bottom plates (all stories) are sealed to the floor.
06	All gaps around windows and doors are sealed. The sealant used follows manufacturer specifications.
07	Rim joist gaps and openings are fully sealed.
08	Fan exhaust duct outlet/damper at the exterior wall are sealed.
09	Knee walls have solid and sealed blocking at the bottom, top, left, and right sides to prevent air movement into insulation.



Performance Method Credit: Spray Foam and HERS

Screen-Shot of EnergyPro Input:

Attic

Unventilated

Truss Heel Height: inches

Insulation covers framing at underside of roof deck

This tab is used to edit the attributes of the assembly used for Residential Title 24 Performance calculations in the software.

Insulation

Location	Insulation	Framing	Thickness
Cavity:	<input type="text" value="R 42"/>	<input type="text" value="2x8 @ 24 in. O.C."/>	
Above Roof Deck:	<input type="text" value="0"/> R-value	<input type="text" value="None"/>	<input type="text" value="0"/> inches
Below Roof Deck:	<input type="text" value="0"/> R-value	<input type="text" value="None"/>	<input type="text" value="0"/> inches

Other

Exterior Wall Finish:

Non standard spray foam insulation requiring QII Inspection



Spray foam will expand unevenly as it cures. Closed Cell Medium Density: Measure to 1/2" variance in depth for an average installed R-Value

Table 4.1.7: Required Thickness of SPF Insulation (inches) to Achieve Specified R-values

Equivalent R-Values for SPF insulation	11	13	15	19	21	22	25	30	38
Required thickness of ccSPF Insulation @ R5.8/inch	2.00	2.25	2.75	3.50	3.75	4.00	4.50	5.25	6.75
Required thickness of ocSPF insulation @ R3.6/inch	3.0	3.5	4.2	5.3	5.8	6.1	6.9	8.3	10.6

NOTE:

A HERS rater shall verify the installation of SPF insulation using the procedures specified in RA3.5.56 whenever R-values other than the default R-value per inch listed in Table 4.1.7 are used for compliance (see "Thermal Specifications" in sections RA3.5.6.1).

If spray foam has a higher R-value than Table 4.1.7 default values, a HERS rater can verify the higher R-value...

-- But the rater will need documentation of the material's R-value from the installer

Attic Ceiling Insulation: HERS Existing Conditions and New Construction

Screen-Shot of EnergyPro Inputs:

HERS Measures

- Quality Insulation Installation
- Envelope Leakage Testing

Status:

Existing Leakage: ACH50

New Leakage: ACH50

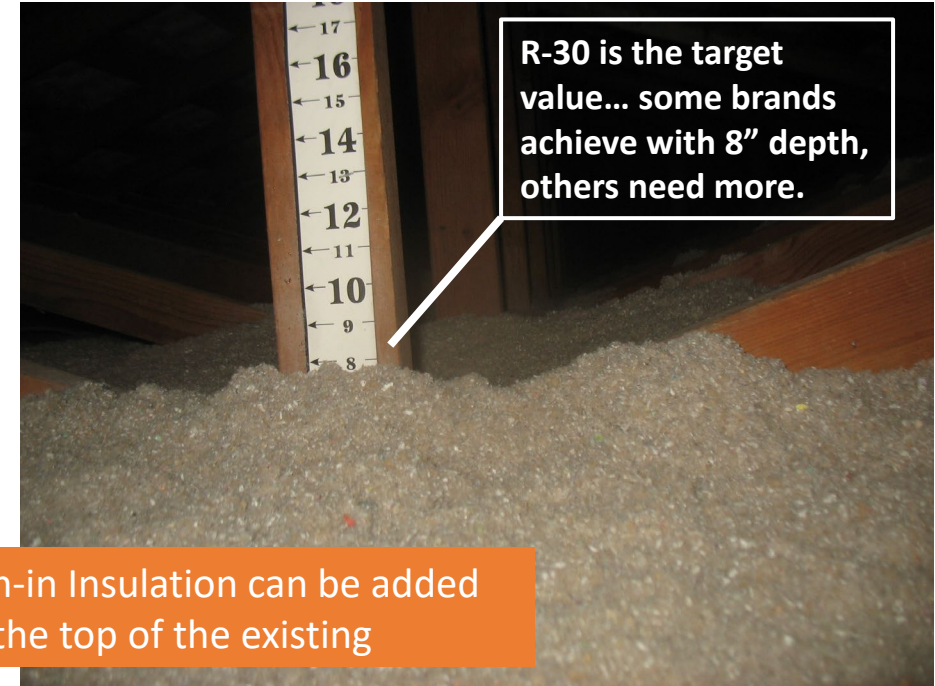
- Project includes New or Replaced Kitchen Hoods

HERS Verified Existing Conditions being Altered

- Wall/Door Construction
- Fenestration
- Roof Construction
- HVAC
- Attic Construction
- Domestic Hot Water
- Floor Construction
- Building Leakage



HERS – Verified Existing Condition
R-19 in theory, lots of room for improvement



Blown-in Insulation can be added
over the top of the existing

Add New Insulation – Credit
under the Performance Method



-- It's ugly up there. If home owners knew what their attics looked like...

QII – Batt Insulation over Spray Foam Air-Barrier

Excerpt from form CEC-CF2R-ENV-21-QII-H:

A. Air Barrier Materials

Note: SPF insulation is an acceptable air barrier and sealant when installed to a minimum thickness of 2 inches for closed cell and 5.5 inches for open cell, except where not allowed by manufacturer (e.g., flues, vents, can lights, etc.).



2" Closed Cell Spray Foam is adhered to underside of roof deck.



Remaining cavity is filled with Batt Insulation.
(Blown-in insulation would also be acceptable.)



QII – Batt Insulation over Spray Foam –Works for Walls too

Excerpt from Form CEC-CF2R-ENV-21-QII-H:

A. Air Barrier Materials

Note: SPF insulation is an acceptable air barrier and sealant when installed to a minimum thickness of 2 inches for closed cell and 5.5 inches for open cell, except where not allowed by manufacturer (e.g., flues, vents, can lights, etc.).



2" Closed Cell Spray Foam is adhered to underside of roof deck and walls.



Remaining cavity will be filled with Batt or Blown-in insulation.

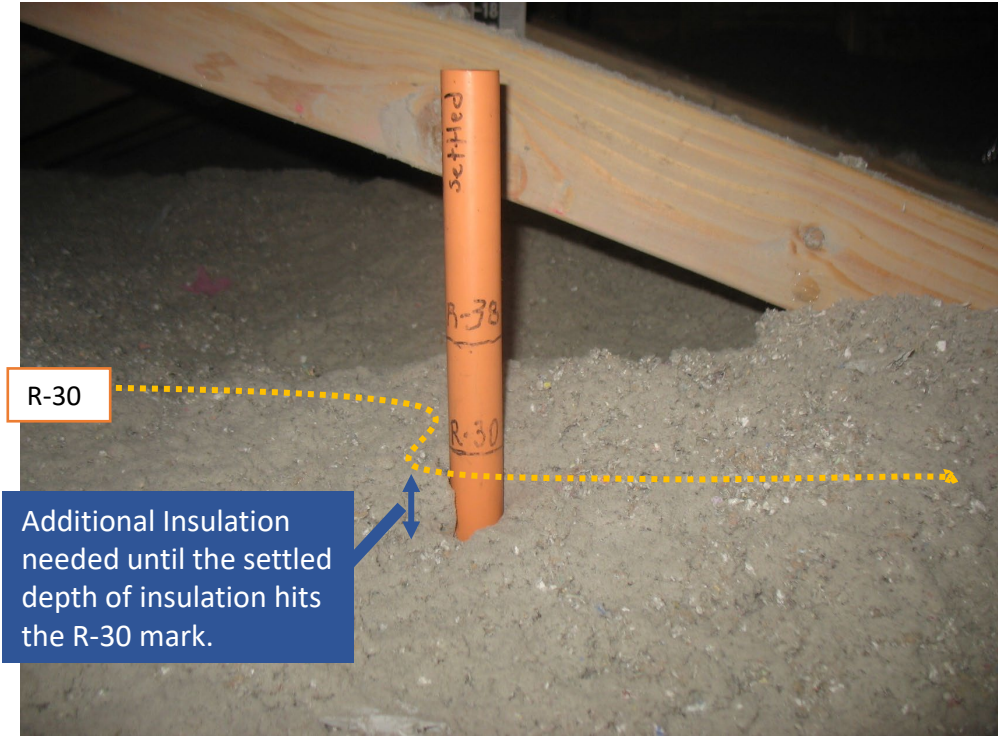


QII – Insulation Installation - CF3R-ENV-22-H

CERTIFICATE OF VERIFICATION	CF3R-ENV-22-H
QII - Insulation Installation	(Page 1 of 7)

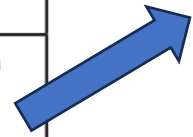
A. Insulation Materials Installed		
01	Roof Deck Insulation Material Installed	n/a
02	Ceiling Insulation Material Installed	Loose-fill
03	Exterior Wall Insulation Material Installed	Loose-fill
04	Raised Floor Insulation Material Installed	n/a
05	Slab Edge Insulation Material Installed	n/a
06	Verification Status	Pass - all applicable requirements are met.

B. All Surfaces	
01	Air barrier installation and preparation for insulation was done and verified prior to insulation being installed.
02	All surfaces between conditioned and unconditioned space are sealed and insulated to meet or exceed the levels specified on the Certificate of Compliance
03	All structural framing areas shall be insulated in a manner that resists thermal bridging through the assembly separating conditioned from unconditioned space. Structural bracing, tie-downs, and framing of steel, or specialized framing used to meet structural requirements of the CBC are allowed and must be insulated. These areas shall be called out on the building plans with diagrams and/ or specified design drawings indicating the R-value of insulation and fastening method to be used.
04	All insulation was installed according to the manufacturer's installation instructions.
05	Labels or specification/ data sheets for each insulation material shall be provided to the HERS rater. Loose-fill material includes insulation material bag labels or coverage charts.
06	Loose-fill insulation - the installed depth and density of insulation is verified in at least 6 random locations to ensure that the minimum thickness and installed density meet R-value specified on the Certificate of Compliance, and are consistent with the manufacturer's coverage chart.



R-30

Additional Insulation needed until the settled depth of insulation hits the R-30 mark.



Loose-fill insulation depth and density is verified in at least 6 random locations to show the CF1R value has been met.



QII – Tub and Shower Enclosures



CALIFORNIA ENERGY COMMISSION

QII – INSULATION INSTALLATION

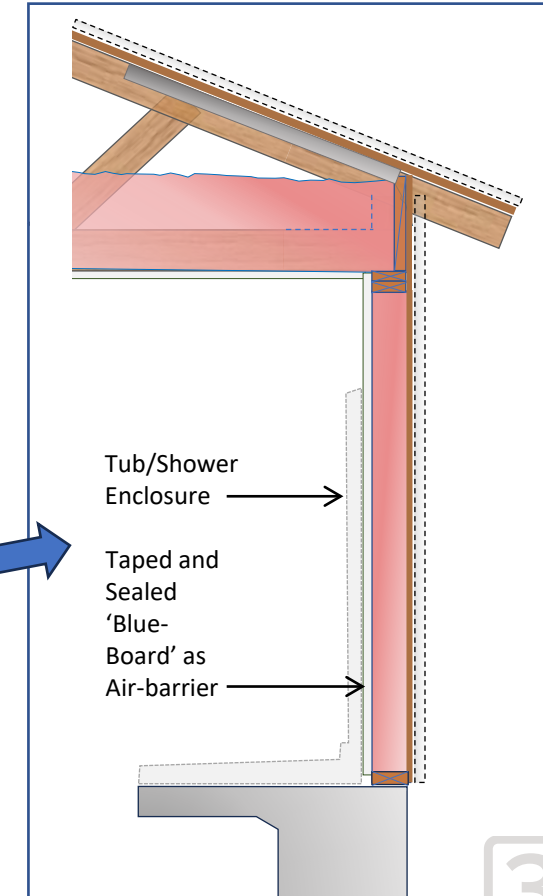
CEC-CF3R-ENV-22-H

SAMPLE FORM – NOT VALID FOR SUBMISSION TO BUILDING DEPARTMENTS

D. Wall Adjacent to Unconditioned Space

01	Insulation quality was verified prior to the installation of the interior air barrier (typically gypsum board).	
02	Loose-fill and batt insulation is in contact with all six sides of wall cavities (top, bottom, back, left, right, front [to be installed later]) with no gaps, voids, or compression. Special Situation: Where framing depth is greater than required insulation thickness (e.g., double walls or framed bump-outs) a secondary air barrier shall be installed and in contact with the insulation, so that the insulation fills the cavity formed by the additional air barrier.	
03	Insulation fits snugly around obstructions (e.g., electrical boxes, plumbing and wiring) with no gaps, voids or compression.	
04	Structural metal tie-downs and shear panels are insulated between exterior air barrier and metal.	
05	Hard to access wall stud cavities, such as corner channels or wall intersections, are insulated to the proper R-value prior to the installation of exterior sheathing or exterior stucco lathe.	
06	Insulation and interior air barrier are installed behind tub, shower, fireplace enclosures and stairwells to the R-value listed on the Certificate of Compliance when located against exterior walls.	
07	All single-member window and door headers shall be insulated to a minimum of R-3 for a 2x4 framing, or equivalent width, and a minimum of R-5 for all other assemblies. No header insulation is required for single-member headers that are the same width as the wall, provided that the entire wall has at least R-2 insulation.	
08	After insulation is installed: All insulated walls have interior and exterior air barriers, including kneewalls and walls of skylight wells. Exception: Rim joists. Interior air barrier (typically gypsum board) is sealed to top plate.	
09	Verification Status	<input type="checkbox"/> Pass - all applicable requirements are met; or <input type="checkbox"/> Fail - one or more applicable requirements are not met. Enter reason for failure in corrections notes field below; or <input type="checkbox"/> All N/A - This entire table is not applicable.
10	Correction Notes	

The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met unless otherwise noted in the Verification Status and the Corrections Notes in this table.



Exterior Wall with a Continuous Air and Thermal Boundary – Install before the Tub/Shower is Installed



QII – Insulate hard to access wall cavities before exterior sheathing; insulate fireplace and tub enclosures



Insulation was blow-in behind the OSB panels.
Note: The proper air-barrier is at the exterior walls, not the fireplace surface.



Proper insulation and air-barrier missing behind tub at the exterior walls.



QII – Insulation and Air Sealing can be a Team Sport



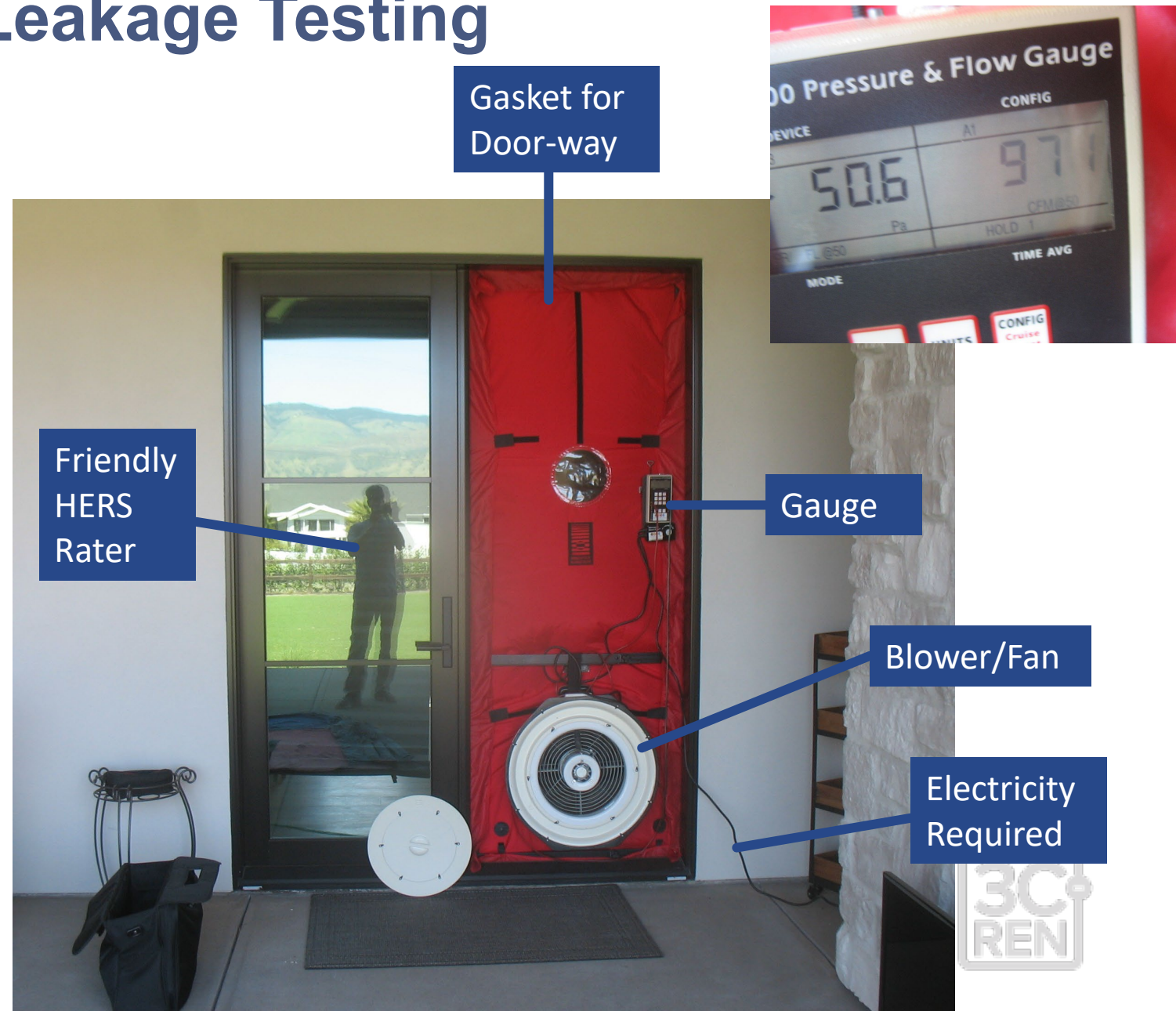
- Well executed job site work flow makes HERS QII and Envelope Air Leakage Sealing go smoothly and easily.
- Follow up with each trade to ensure one trades person is not undermining the other trades person's work.

“I've found that certain trades can affect thermal performance...
In a bad way....!” --P.D., HERS Rater



Building/Envelope Air Leakage Testing

- Measure Pressure (Pa) and Airflow Leakage (cfm)
- Equipment:
 - Blower Door Kit
 - Pressure & Flow Gauge
 - Shows a “Positive Pressurization” Test
- Envelope Leakage to/from:
 - Outdoors
 - Attic
 - Crawlspace



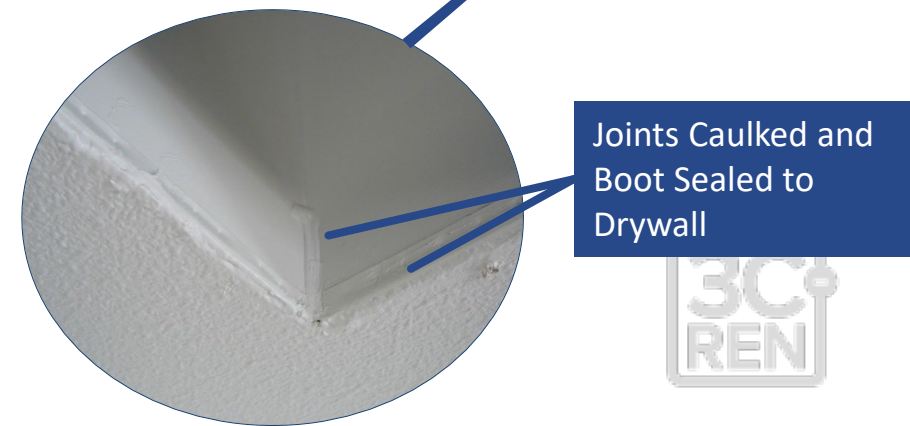
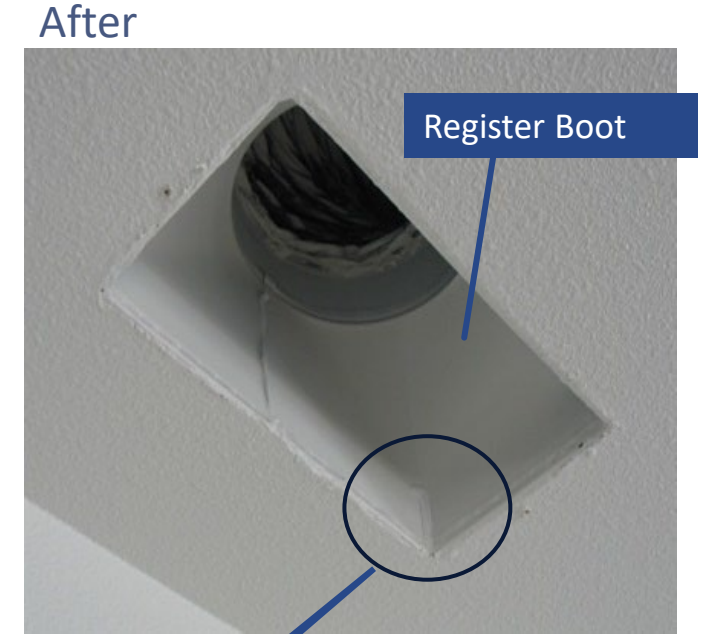
Envelope Air Leakage Testing and Common 'Un-seen' Problem Areas



HVAC Registers are "sealed" for the duration of the Envelope Leakage Test



Common Problem Area – Connection to Drywall



Envelope Air Leakage Testing –Best Practices or Needed Performance Method Credit?

Screen-Shot of EnergyPro Inputs:

HERS Measures

- Quality Insulation Installation
- Envelope Leakage Testing

Status:

Existing Leakage: ACH50

New Leakage: ACH50

- Project includes New or Replaced Kitchen Hoods

HERS Verified Existing Conditions being Altered

<input type="checkbox"/> Wall/Door Construction	<input type="checkbox"/> Fenestration
<input type="checkbox"/> Roof Construction	<input type="checkbox"/> HVAC
<input type="checkbox"/> Attic Construction	<input type="checkbox"/> Domestic Hot Water
<input type="checkbox"/> Floor Construction	<input type="checkbox"/> Building Leakage

Excerpt from the ACM:

ACH50 defaults to 5 for newly constructed buildings in single-family houses and townhomes have heating and cooling system **ducts**, or both, **outside** the conditioned space

In single-family homes and townhomes with **no ducts** in **unconditioned space**, the **default ACH50 is 4.4**

User input of an ACH50 that is less than the default value becomes a special feature requiring HERS verification.

New Homes with Ductless Systems are compared to ACH50 of 4.4. We usually target less than 2 ACH to 'see' much of a credit.



Building/Enclosure Air Leakage ENV-20-H and MCH-24-H

CF1R-PRF-01-E

HERS FEATURE SUMMARY

The following is a summary of the features that must be field-verified by a certified HERS Rater as a condition for meeting the modeled energy performance for this computer analysis. Additional detail is provided in the building tables below. Registered CF2Rs and CF3Rs are required to be completed in the HERS Registry

- Quality insulation installation (QII)
- Building air leakage/reduced infiltration
- Kitchen range hood
- Verified Existing Conditions
- Duct Sealing required if a duct system component, plenum, or air handling unit is altered

BUILDING ENVELOPE - HERS VERIFICATION

01	02	03	04	05
Quality Insulation Installation (QII)	High R-value Spray Foam Insulation	Building Envelope Air Leakage	CFM50	ACH @ CFM50
Required	Not Required	Required	400.0	2

ACH – Air Changes per Hour

HERS Work Flow:

- Triggered on CF1R
- “Kick-off” Job Site “Review” Meeting
- “Pre-Test(s)” can be performed after:
 - Envelope Sealing
 - HVAC/Duct Sealing
- Final Blower Door Test

CF2R and CF3R Forms

- CF2R-ENV-20a-H Building Air Leakage Diagnostic Test - Building Enclosures and Dwelling Unit
- CF2R-ENV-20b-H-EnclosureAirLeakage-SinglePointTest-Automatic Meter
- CF2R-MCH-24a-H-Enclosure Air Leakage Worksheet-Single Point Test-Manual Meter
- CF2R-MCH-24a-H-Enclosure Air Leakage Worksheet-Single Point Test-Automatic Meter
- CF3R-ENV-20a Building Enclosure Air Leakage Diagnostic Test - Building Enclosures and Dwelling Unit Enclosures - Single Point Test - Manual Meter
- CF3R-ENV-20b Building Enclosure Air Leakage Diagnostic Test - Building Enclosures and Dwelling Unit Enclosures - Single Point Test - Automatic Meter
- CF3R-MCH-24a Building Air Leakage Diagnostic Test Worksheet - Building Enclosures and Dwelling Unit Enclosures - Single Point Test - Manual Meter
- CF3R-MCH-24b Building Air Leakage Diagnostic Test Worksheet - Building Enclosures and Dwelling Unit Enclosures - Single Point Test - Automatic Meter



QII - Air Infiltration Sealing CF2R-ENV-21-H



QII - AIR INFILTRATION SEALING – FRAMING STAGE
CALIFORNIA ENERGY COMMISSION
CEC-CF2R-ENV-21-H
SAMPLE FORM – NOT VALID FOR SUBMISSION TO BUILDING DEPARTMENTS

C. Walls Adjacent to Unconditioned Space

The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.

01	All penetrations through the exterior wall air barrier are sealed to provide an airtight envelope to unconditioned spaces such as the outdoors, attic, garage, and crawlspace.
02	Exterior wall air barrier is sealed to the top plate and bottom plate in each stud bay.
03	All electrical boxes, including knockouts, that penetrate the air barrier to unconditioned space are sealed.
04	All openings in the top and bottom plate, including all interior and exterior walls, to unconditioned space are sealed; such as holes drilled for electrical and plumbing.
05	Exterior bottom plates (all stories) are sealed to the floor.
06	All gaps around windows and doors are sealed. The sealant used follows manufacturer specifications.
07	Rim joist gaps and openings are fully sealed.
08	Fan exhaust duct outlet/damper at the exterior wall are sealed.
09	Knee walls have solid and sealed blocking at the bottom, top, left, and right sides to prevent air movement into insulation.

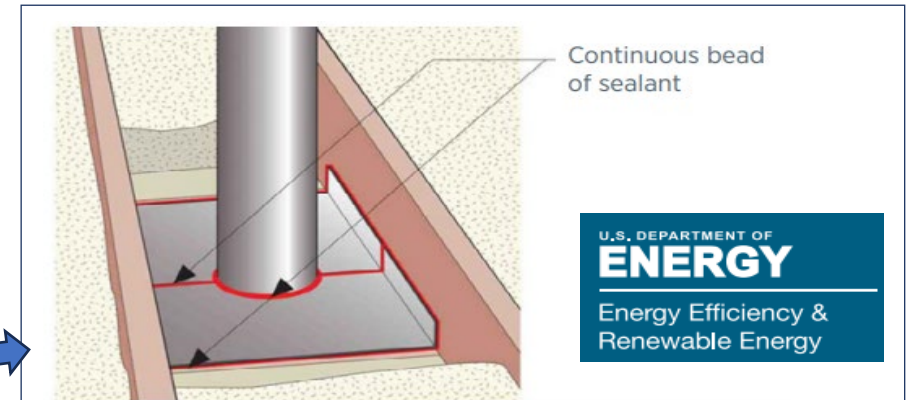
E. Roof Air Barrier – Unvented Attics Adjacent to Unconditioned Space

The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.

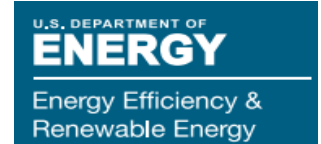
01	There is a continuous air barrier at the roof deck and gable ends.
02	Chimneys and flues require sheet metal flashing at the roof deck. The flashing is sealed to the chimney/flue with fire rated caulk. The flashing is sealed to the surrounding framing.
03	All penetrations in the roof deck and gable ends for plumbing, electrical, etc. are sealed.



Conditioned 'Daylit' Basement to Crawl Space – Penetrations are air sealed and walls will be insulated.



Drawings and instructions in the guide show contractors the proper way to air seal around typical breaks in the ceiling. Here, sheet metal and fire-rated caulk provide air sealing around a flue pipe.



Meeting QII – Air Infiltration Sealing at the Framing Stage will make –HERS Building /Enclosure Air Leakage Testing much easier!

QII - Air Infiltration Sealing CF2R-ENV-21-H



QII - AIR INFILTRATION SEALING – FRAMING STAGE
 CALIFORNIA ENERGY COMMISSION CEC-CF2R-ENV-21-H
SAMPLE FORM – NOT VALID FOR SUBMISSION TO BUILDING DEPARTMENTS

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01	All penetrations through the exterior wall air barrier are sealed to provide an airtight envelope to unconditioned spaces such as the outdoors, attic, garage, and crawlspace.
02	Exterior wall air barrier is sealed to the top plate and bottom plate in each stud bay.
03	All electrical boxes, including knockouts, that penetrate the air barrier to unconditioned space are sealed.
04	All openings in the top and bottom plate, including all interior and exterior walls, to unconditioned space are sealed; such as holes drilled for electrical and plumbing.
05	Exterior bottom plates (all stories) are sealed to the floor.
06	All gaps around windows and doors are sealed. The sealant used follows manufacturer specifications.
07	Rim joist gaps and openings are fully sealed.
08	Fan exhaust duct outlet/damper at the exterior wall are sealed.
09	Knee walls have solid and sealed blocking at the bottom, top, left, and right sides to prevent air movement into insulation.

E. Roof Air Barrier – Unvented Attics Adjacent to Unconditioned Space

The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.

01	There is a continuous air barrier at the roof deck and gable ends.
02	Chimneys and flues require sheet metal flashing at the roof deck. The flashing is sealed to the chimney/flue with fire rated caulk. The flashing is sealed to the surrounding framing.
03	All penetrations in the roof deck and gable ends for plumbing, electrical, etc. are sealed.

Meeting QII – Air Infiltration Sealing at the Framing Stage will make –HERS Building /Enclosure Air Leakage Testing much easier!



Continuous Sealant

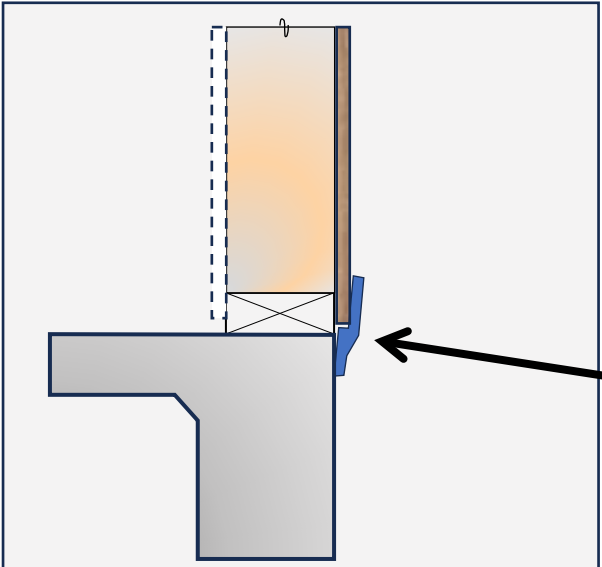
Exterior Bottom (Sill) Plates Sealed to Floor



Continuous Gasket between Plate and Concrete

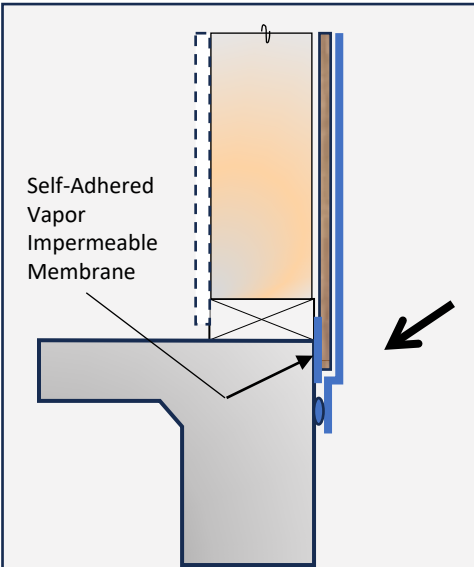
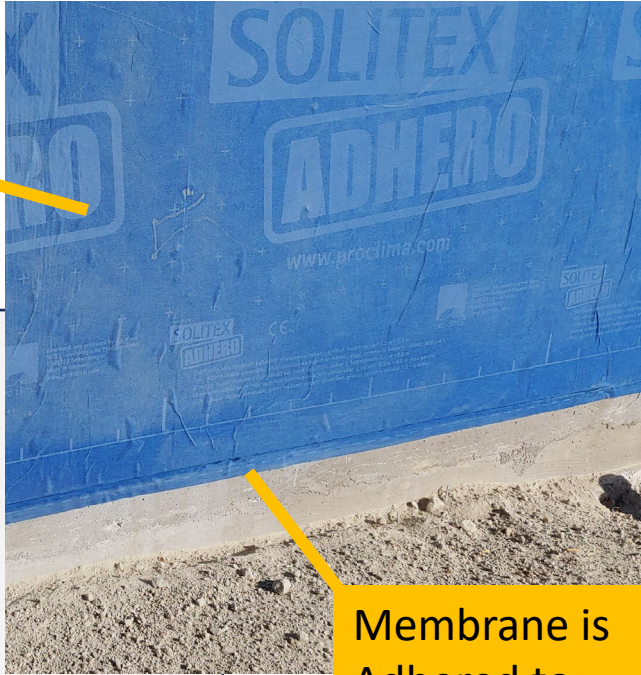
QII –Air Infiltration Sealing at the Sill Plates (and other Joints)

Liquid Applied Membrane



Typical sheathing location relative to sill plate

Self-Adhered Membrane



Sheathing extends below the sill plate

Membrane is Adhered to Foundation



QII - Air Infiltration Sealing CF2R-ENV-21-H



CALIFORNIA ENERGY COMMISSION

CEC-CF2R-ENV-21-H

QII - AIR INFILTRATION SEALING – FRAMING STAGE

SAMPLE FORM – NOT VALID FOR SUBMISSION TO BUILDING DEPARTMENTS

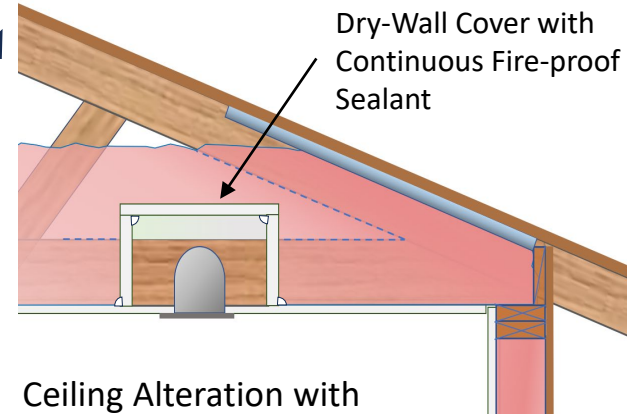
D. Ceiling Air Barrier Adjacent to Unconditioned Space

The responsible person’s signature on this compliance document affirms that all applicable requirements in this table have been met.

01	There is a continuous air barrier at the ceiling level. All openings into walls, drops, chases or double walls are sealed.
02	All penetrations through the top plate of interior and exterior walls are sealed.
03	Fire sprinklers penetrating a ceiling air barrier shall be sealed to prevent air movement according to the manufacturer’s instructions.
04	All fixtures cut into ceiling air barrier (e.g., HVAC registers, electrical boxes, fire alarm boxes, exhaust fan housing, and recessed lighting fixtures) are sealed to the surrounding dry wall. If it is not possible to seal the fixture directly, a secondary air barrier shall be created around the fixture.
05	All installed recessed lighting fixtures that penetrate the ceiling to unconditioned space are rated to be Insulation Contact and Airtight (IC and AT) which allows direct contact with insulation.
06	All dropped ceiling areas are covered with hard covers that are sealed to the framing, or else the bottom and sides of dropped ceiling areas are all insulated and sealed as ceilings and walls as required on the Certificate of Compliance.
07	All vertical chases (e.g., HVAC ducts and plumbing) and soffits are sealed at the ceiling level.
08	Chimneys and flues require sheet metal flashing at the ceiling level. The flashing shall be sealed to the chimney/flue with fire rated caulk. The flashing shall be sealed to the surrounding framing.
09	Framing locations where air may move down into the walls from the attic (e.g., double walls, pocket doors, architectural bump-outs, etc.) have a sealed hard cover to prevent air movement.
10	Attic access forms an airtight seal between the conditioned space and unconditioned space. Vertical attic access requires mechanical compression using screws or latches.



Continuous Bead of Sealant



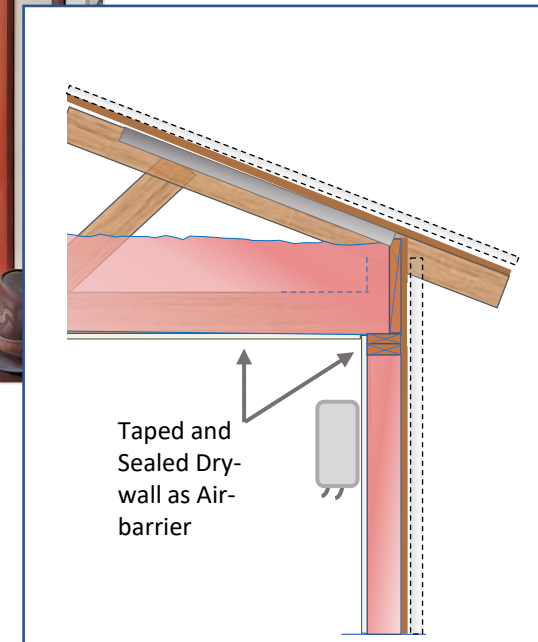
Ceiling Alteration with Existing Recessed Fixture

Meeting QII – Air Infiltration Sealing at the Framing Stage will make –HERS Building /Enclosure Air Leakage Testing much easier!

VCHP Compliance Option –Shown on MCH-33-H –But Impacts Envelope Enclosure

Wall and Ceiling Penetrations for the Mechanical System Refrigerant, Condensate, and Communication Lines need to be Air Sealed.

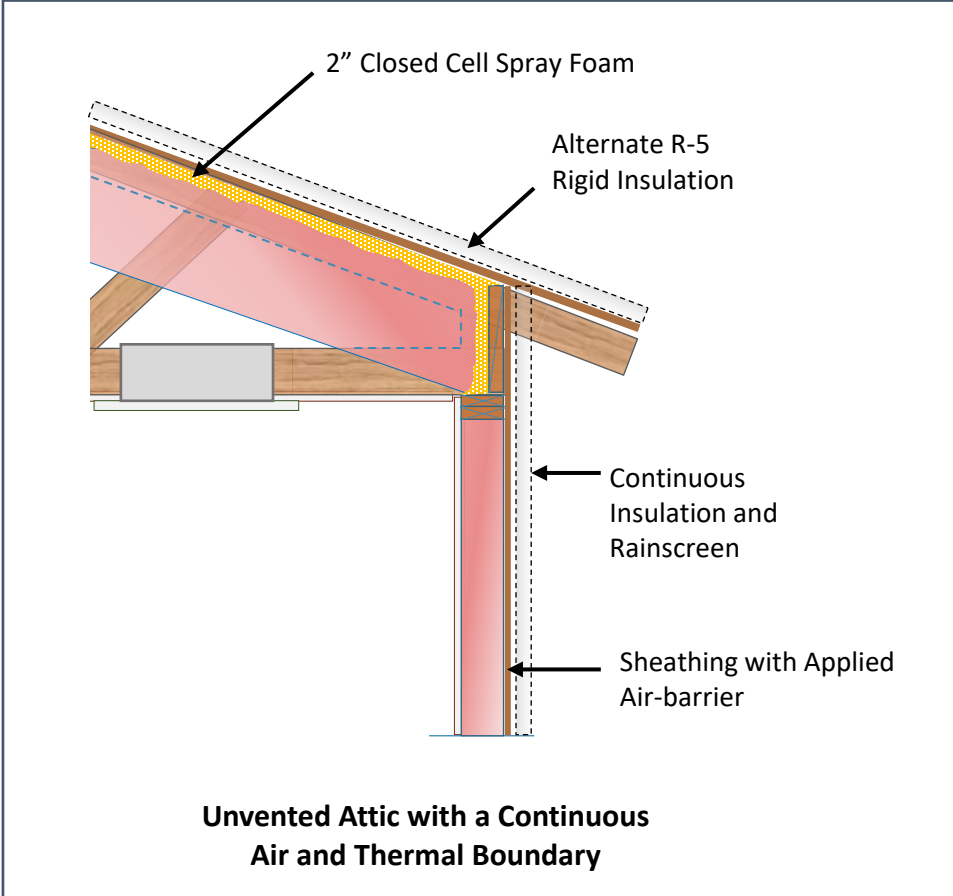
CERTIFICATE OF VERIFICATION		CF3R-MCH-33-H		
Variable Capacity Heat Pump Compliance Credit		(Page 2 of 4)		
C. Verification: Ducted Indoor Units Located Entirely in Directly Conditioned Space - RA3.1.4.3.8				
This section does not apply to this project.				
D. Verification: Ductless Indoor Units Located Entirely in Directly Conditioned Space - RA3.1.4.1.8				
A visual inspection shall confirm that ductless indoor units are located entirely in conditioned space in accordance with the procedures of SC3.1.4.1.8.				
01	02	03		
Indoor Unit Name or Description of Area Served	Indoor Unit Installation Location Verification	Compliance Statement		
Living Unit	Indoor unit mounted entirely on the surface of walls, ceilings, or floors	Complies		
Right Bed Unit	Indoor unit mounted entirely on the surface of walls, ceilings, or floors	Complies		
Left Bed Unit	Indoor unit mounted entirely on the surface of walls, ceilings, or floors	Complies		
Notes:				
E. Verification: Wall Mounted Thermostats - SC3.4.5				
Field verification according to the procedure in SC3.4.5 shall confirm that VCHP space conditioning zones that are greater than 150 ft ² , are controlled by a permanently installed wall-mounted thermostat.				
01	02	03	04	05
Indoor Unit Name or Description of Area Served	Is a Wall-mounted Thermostat Installed in the Zone Served by the Indoor Unit?	Does the Thermostat Control the Zone's Indoor Unit?	Is the Thermostat Mounted Permanently to the Wall?	Compliance Statement
Living Unit	Yes	Yes	Yes	Complies
Right Bed Unit	Yes	Yes	Yes	Complies
Left Bed Unit	Yes	Yes	Yes	Complies
Notes:				



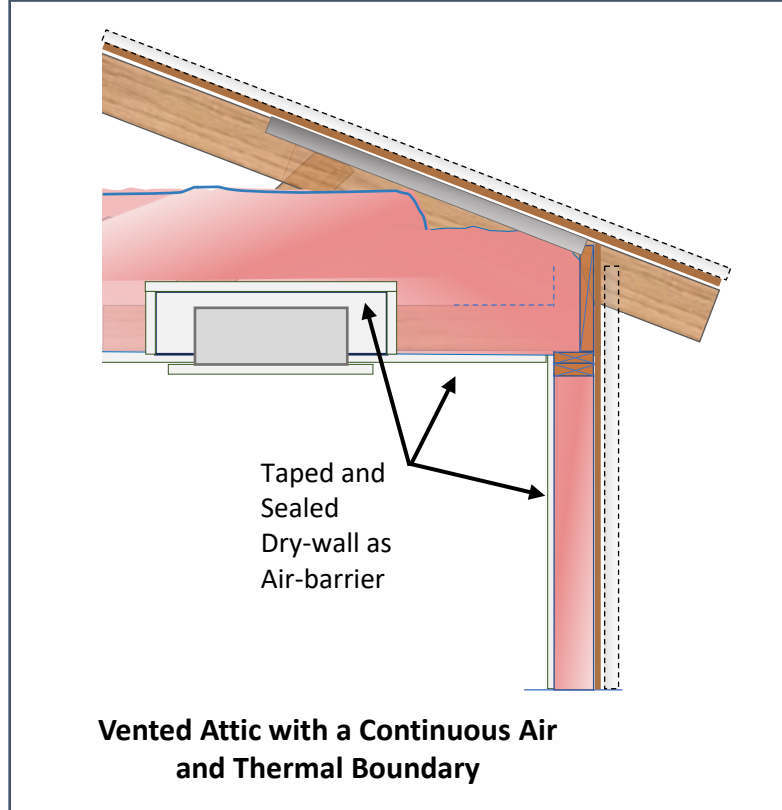
Vented Attic with a Continuous Air and Thermal Boundary

VCHP Compliance Option – Shown on MCH-33-H – But Impacts Envelope Enclosure

Indoor units shall be installed within the air and thermal boundaries



Ductless Recessed-Ceiling



Questions about Title 24?

3C-REN offers a *free* Code Coach Service



Online:
3c-ren.org/codes

Call:
805.781.1201

Energy Code Coaches are local experts who can help answer your Title 24 questions. Coaches have decades of experience in green building and energy efficiency improvements. They can provide citations and offer advice for your project to help your plans and forms earn approval the first time.

Closing

- Continuing Education Units Available
 - Contact shuskey@co.slo.ca.us for AIA and ICC LUs
- Coming to Your Inbox Soon!
 - Slides, Recording, & Survey – Please Take It and Help Us Out!
- Upcoming Courses:
 - February 8 - [Retaining Profit – Minimize Call Backs on Heat Pump Installs](#)
 - February 13 - [Elements of a Whole House Assessment: The Home Energy Audit Explained](#)
 - February 14 - [Energy Code Implementation: Single Family New Construction](#)
 - February 20 - [Practical Ways to Address Embodied Carbon](#)
 - February 27 - [Residential Load Calculation and Duct Design for Building Departments](#)
- Visit www.3c-ren.org/events for our full catalog of trainings.





Thank you!

For more info:
3c-ren.org

For questions:
info@3c-ren.org



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